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THE CRITICALLY ENDANGERED VENEZUELAN DENDROBATID FROG *AROMOBATES MERIDENSIS* (AMPHIBIA: ANURA): REDESCRIPTION, NATURAL HISTORY AND CONSERVATION

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ABSTRACT

Aromobates meridensis is a poorly known Andean dendrobatid frog known only by females. We here redescribe the species, based on both males and females from the type locality. A preliminary assessment of the population status is presented, along with new data on natural history, including the description of its call. This critically endangered species is positive for the fungus *Batrachochytrium dendrobatidis* (*Bd*), and is only known to survive in two (perhaps three) creeks, with an estimated number of 56 to 129 adults in 2006.

Key Words: Dendrobatidae. Aromobatinae. *Aromobates meridensis*. Venezuela. Conservation.

EL CRITICAMENTE AMENAZADO SAPITO DE NIEBLA MERIDEÑO *AROMOBATES MERIDENSIS* (AMPHIBIA: ANURA): REDESCRIPCIÓN, HISTORIA NATURAL Y CONSERVACIÓN

RESUMEN

Aromobates meridensis es una rana dendrobátida andina poco conocida, representada en colecciones sólo por hembras. Redescribimos en este trabajo la especie basados en machos y hembras de la localidad típica. El estado de población actual es determinado de manera preliminar y presentamos información sobre su historia natural, incluida la descripción de su canto. Esta especie críticamente amenazada es portadora del hongo infeccioso *Batrachochytrium dendrobatidis* (*Bd*), y sólo sobrevive en dos (tal vez tres) quebradas, con un número estimado de 56 a 129 adultos en 2006.

Palabras Clave: Dendrobatidae. Aromobatinae. *Aromobates meridensis*. Venezuela. Conservación.

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INTRODUCTION

Dole and Durant (1972) described the dendrobatid frog *Colostethus meridensis* from El Chorotal, Estado Mérida, Andes of Venezuela, based only on females. Only a few other significant references mention this species. Edwards (1974) mistakenly presented a diagnosis of some collared dendrobatid (*Mannophryne*) under this name. Rivero (1988) neglected to include the species in his group VIII (*alboguttatus*). La Marca (1994 "1991") recognized it as a *Nephelobates,* presumably because of its fang-like teeth and the presence of an anal flap. The tadpole was described by Mijares-Urrútia and La Marca (1995) but no illustration was provided. Vial and Saylor (1993) included the species in their list of endangered amphibians without further comments. Since then, no more specific data have been gathered for the species, and it has been mentioned only in checklists (La Marca 1992; Barrio-Amorós 1998, 2004, 2009). Recently, Grant et al. (2006) transferred the species to the genus *Aromobates* Myers et al. 1991, in a new family Aromobatidae, although without a supporting molecular analysis. Santos et al. (2009) did not recognize the family Aromobatidae, but consider it a subfamily of Dendrobatidae. No data for male specimens have ever been presented.

During a survey for *Atelopus carbonerensis* an added objective was to report the amphibian fauna of the La Carbonera area and surroundings (including the type locality of *Aromobates meridensis*, El Chorotal). During 2005 and the early 2006 we conducted a preliminary census of the remaining population of *A. meridensis*, the results of which we present herein.

We here also redescribe the species based on both males and females, and illustrate the call. We propose to include the species in the CR/ A2ace; B1ab(iii,v) category (Critically Endangered), according to the IUCN criteria (Young et al. 2004; Stuart *et al*. 2008).

MATERIAL AND METHODS

Unfortunately we were unable to access the type series of *A. meridensis*, which is housed at the MBUCV (Museo de Biología de la Universidad Central de Venezuela), as it has been on loan to E. La Marca since May 2000, and not returned yet despite being requested. Our description is based on material deposited in the Colección de Vertebrados, Universidad de los Andes, Mérida, Venezuela (CVULA) from the type locality, Chorotal, along the road from Mérida to La Azulita, Estado Mérida, Venezuela.

The diagnosis follows the format used by Barrio-Amorós & Santos (2009) whereas the description follows Barrio-Amorós *et al.* (2006). Comparative data of Venezuelan congeners were taken from La Marca (1985), La Marca & Mijares (1988), Péfaur (1985, 1993), Myers et al. (1991), Rivero (1976a,b, 1978) and from selected specimens (see Appendix). Sex determination was accomplished by dissection (presence of testes or oviducts) plus expression of secondary sexual characters, such as presence or absence of vocal slits, and dimorphic size and coloration. Measurements (in mm) were taken with digital callipers to the nearest decimal. Measurements taken exclusively on adult frogs are slightly modified from Barrio-Amorós *et al.* (2006) as follows: SVL: straight length from tip of snout to vent; SL: shank length from outer edge of flexed knee to heel; FL: foot length from proximal edge of outer metatarsal tubercle to tip of toe IV; HAND: hand length from proximal edge of palmar tubercle to tip of finger III; HeL: head length from tip of snout to the posterior border of skull (posterior edge of prootic, noted through the skin) HW: head width between angle of jaws; InD: inter-narial distance between centers of nostrils; EN: distance of anterior edge of eye to nostril; ED: horizontal eye diameter; TD: horizontal tympanum diameter; ETS: distance between the anterior edge of the eye to the tip of snout; FD: disc width of Finger III; T4D: disc width of toe IV; 1FiL: length of Finger I from inner edge of thenar tubercle to tip of disc; 2FiL: length of Finger II from inner edge of thenar tubercle to the tip of finger disc. Calls were recorded using a Sony Hi-MD Walkman MZ-RH1 with a Sony ECM-MS907 microphone. The call was analyzed with Cool Edit Pro II software, and the graphics were made with Sound Ruler 0.9.6.0.

RESULTS

Aromobates meridensis (Dole et Durant)

Colostethus meridensis Dole & Durant, 1972. Carib. J. Sci. 12 (3-4): 191 (Original description).

Colostethus meridensis: La Marca, 1992. Cuad. Geogr. ULA 9: 57 (Checklist and distribution).

Nephelobates meridensis: La Marca, 1994 "1991". An. Invest. 1991, IGCRN: 40 (Listing in the description of *Nephelobates*).

Nephelobates meridensis: Barrio-Amorós, 1998. Acta Biol. Venez. 18(2): 23 (Checklist and distribution).

Nephelobates meridensis: Barrio & Fuentes, 1999. Acta Biol. Venez., 19 (3): 2 (Checklist).

Colostethus meridensis: Barrio-Amorós, 2004. Rev. Ecol. Lat. Am. 9(3): 8 (Checklist and distribution).

Aromobates meridensis: Grant et al., 2006. Bull Am. Mus. Nat. Hist. 299: 160 (Listing in the transfer of species to *Aromobates*).

Holotype: MBUCV 6168, collected by J. W. Dole and P. Durant at "Chorotal", 15 km south east of La Azulita, Mérida state, Venezuela, on 26 October of 1970 (not examined; see materials and methods).

Paratypes: MBUCV 6169-72, with same data as the holotype (not examined; see materials and methods).

Referred specimens: CVULA 1491, 4768, 5056, 4772, 4769, 5063, 2335, 5061, 2328, 4767, 4771, 1670, 4770, 5060, 2167, all from El Chorotal, edo. Mérida, Venezuela, between 1800 and 2200 m.

Definition: (1) Skin on dorsum smooth to shagreened. (2) Paired dorsal scutes present on discs. (3) Distal tubercle under finger IV present but indistinct. (4) Finger IV length surpassing distal subarticular tubercle of finger III. (5) Finger I slightly longer than finger II. (6) Digital discs present. (7) Finger discs weakly expanded. (8) Fringes absent on fingers, present on toes. (9) Metacarpal ridge absent. (10) Finger III swelling present on breeding adult males. (11) Carpal pad absent. (12) Male excrescences on thumb absent. (13) Thenar tubercle small, indistinct. (14) Black arm gland in adult males absent. (15) Tarsal keel (or fringe) long, straight, not distinct. (16) Toe discs weakly expanded. (17) Toe webbing basal between toes II, III and IV. (18) Metatarsal fold absent. (19) External coloration pattern: paracloacal marks absent, dorsally light to very dark brown, without consistent pattern; sometimes with irregular dark spots or blotches; no dorsolateral stripes nor a clear oblique lateral stripe (but see color pattern and variation); ventrolateral stripe absent. (20) Gular-chest markings present, white spotted on dark background. (21) Collar absent. (22) Throat coloration in males whitish with dark diffuse spotted to dark with whitish diffuse spotted. Throat coloration in females: whitish without reticulation to very diffuse greyish reticulation, and with or without dark solid spots. (23) Male abdomen color pattern: anteriorly diffuse dark reticulation that can fade posteriorly or not; bright yellow in breeding males. (24) Female abdomen color pattern: usually immaculate, bright lemon yellow in living females. (25) Iris coloration: dirty bronze with golden pupil ring. (26) Large intestine unpigmented, creamish white. (27) Adult testis whitish. (28) Medial Lingual Process absent. (29) Tympanum ½ hidden, indistinct. (30) Vocal sac structure absent or not distinct. (31) Teeth present on the maxillary arch. (32) Size moderate, up to 33 mm SVL in females, 32 mm SVL in males.

Diagnosis: *Aromobates meridensis* (characters in parentheses) differs by its larger size from small species of the genus, like *A. haydeeae* (Rivero), *A. duranti* (Péfaur), *A. mayorgai* (Rivero), *A. molinarii* (La marca), *A. orostoma* (Rivero), *A. serranus* (Péfaur), *A. saltuensis* (Rivero), none reaching 30 mm of SVL (up to 32.5 mm), and by its unique belly coloration and pattern (pattern in all cases different; see Rivero 1976a,b, 1978; La Marca 1985; Péfaur 1985, 1993). *Aromobates alboguttatus* (Boulenger), *A. duranti, A. molinarii, A. haydeeae, A. mayorgai*, *A. orostoma*, *A. saltuensis* and *A. serranus* have conspicuous dorsolateral stripes (absent to very ill defined). It is more appropriately compared to those species of *Aromobates* that exceed 30 mm in SVL. *Aromobates alboguttatus* has large white dots on the venter (belly immaculate on females, diffuse spotted with dark spots on males); *Aromobates capurinensis* (Péfaur) has the Finger I shorter than II (slightly longer), tarsal keel oblique (long, straight and indistinct), all toes basally webbed (only II to IV); *Aromobates leopardalis* (Rivero) has a spotted dorsum (without consistent pattern but not spotted), finger fringes (absent), finger I shorter than finger II (slightly longer), toes 1/3 webbed (basally between toes II to IV); *Aromobates nocturnus* Myers, Paolillo et Daly) is the most distinct species in the genus and the largest dendrobatoid with SVL reaching 62 mm (32.5 mm), having fully webbed toes (basal webbing), belly coloration mottled with grayish white in life (bright yellow with diffuse dark reticulation), and unique, being nocturnal (diurnal), aquatic (riparian), and releasing a mercaptanlike odor when molested (never noticed in *A. meridensis*). This last character is shared, however, by *A. nocturnus* and *A. leopardalis*. We realize that *A. meridensis*, by size and some other characters (see above), is most similar to *A. nocturnus* and *A. leopardalis* than to the rest of small to medium Aromobatids.

Description: SVL in males 22.8-31.8 mm (mean 27.8±3.3 mm), in females 21.0-32.5 mm (mean 28.8±3.6 mm). Dorsal skin smooth to shagreened; ventral skin smooth. Dorsal skin forming a usually well-defined, rounded, posteriorly projecting flap protecting the upper part of the vent, which opens at upper level of thighs; no anal tubercles.

Head as long as wide, greatest head width (between angles of jaws) 33.3-35.7 % of SVL. Snout rounded to truncate in profile; rounded, subacuminate to truncate in dorsal and ventral views. Nostrils situated near tip of snout and directed slightly anterolaterally; visible from anteriorly, barely visible from above and below. Canthus rostralis straight but indistinct; loreal region nearly flat. Interorbital region wider than upper eyelid. Snout longer than eye diameter. Tympanum indistinct and concealed in one third of the sample (barely distinct and with the upper half obscured by a very low supratympanic bulge formed by superficial slip of m. depressor mandibulae in CVULA 2328, 4769, 4771-2, 5060). In those cases, the tympanum is from one half to one third of the ED; tympanum positioned closely behind the eye, nearly touching angle of jaws.

Maxillary teeth present. Tongue longer than wide, rounded, one third free posteriorly; vocal slits moderately long, extending from near tongue insertion to nearly the end of tongue.

Hand moderate, its length 27.9-30-1 % of SVL. Relative lengths of adpressed fingers III>IV>I>II; tip of finger II equal in length when moved towards finger I, but usually shorter when measured separa-tely. Discs of all fingers moderately expanded; third finger disc 1.2 (in those males with preaxial swelling)-1.8 times width of distal end of adjacent phalanx. Base of palm with a large median metacarpal tubercle, rounded; elliptical much smaller inner metacarpal tubercle on base of first finger; one subarticular tubercle on fingers I, II, usually large, flat; and two subarticular tubercles on fingers III, IV, distal ones smaller, almost indistinct; all tubercles low, with rounded surfaces. No keel-like fringes on fingers. No ulnar tubercles or fold. The adult males CVULA 4770 (SVL 28.3 mm) and CVULA 7399 (SVL 32.0 mm) have the third finger swollen (Fig 1A).

Hind limbs of moderate length, with heel of adpressed limb extending from the point beyond the eye to the tip of snout; tibia 45-51.8 % of SVL. Relative lengths of adpressed toes IV>III>V>II>I; toe I reaching the subarticular tubercle of toe II. Toe discs moderately expanded, disc of toe IV usually 1.6 the width of distal end of adjacent phalanx.

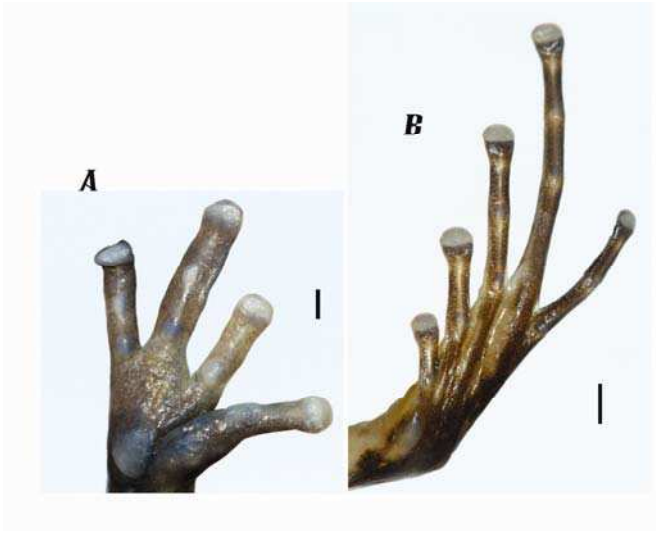

Fig 1A: Right hand of a male *Aromobates meridensis* CVULA 7399. Note the preaxial swelling of the third finger. Scale equals 1 mm. **1B**: Left foot of female *Aromobates meridensis* CVULA 4770. Scale equals 2 mm

Feet scantily webbed. Toes with indistinct fringes (fringes most notable in dehydrated material). Webbing formula I 2-2½ II 2-3 III 2 2/3-4 IV 4-3 V without noticeable variation. One to three non-protuberant subarticular tubercles on toes (one on toes I and II, two on toes III and V and three on toe IV, but distal and proximal tubercle of toe IV ill defined). Two metatarsal tubercles, including a small round outer metatarsal tubercle, and a larger elliptical inner metatarsal tubercle. A very weak (sometimes indistinct) inner tarsal fold or keel (Fig 1B). Table 1 shows the variation in measurements of *Aromobates meridensis*.

Color pattern and variation: In preservative, the dorsal coloration is light to very dark brown, without any consistent pattern (Fig. 2). Patterns may be formed by irregular dark spots or blotches; in some animals there are also some whitish spots, mainly paravertebral. A dark interorbital bar is present in almost all specimens, although this may not be easily distinguished in darker animals. There are no distinct dorsolateral stripes (sensu Grant et al. 2006). However, the brown dorsum is clearly offset from the darker flanks. Only in CVULA 2328, 2335, and 5060, and much less in 5061, there is a trace of an ill-defined dorsolateral stripe. An oblique lateral stripe is generally not apparent, except in a few specimens (CVULA 1491, 4772, 2328) in which it is more the result of a fusion of whitish spots. The upper lips are whitish and irregularly spotted or marbled with brown. In dark specimens (CVULA 1670, 4772, 4768) there is not clear differentiation between the canthal stripe and the color of the upper lips. Tympanic area usually with irregular white and brown reticulations.

Arms and forearms are pale to very dark brown, without well defined cross bars (except in CVULA 2328 and 4770), but usually with spots of different shapes. Forelimbs are cross-barred with well defined dark bars on paler brown background; with scattered whitish small spots in darker individuals (CVULA 4768 and 4772). Concealed surfaces of upper thighs light, but they can be heavily spotted or reticulated (CVULA 4768, 4770).

Ventrally all females have a white throat, chest and belly, with a more or less brown reticulated or spotted throat and chest (Fig. 3), from a maximum development in CVULA 5061, 2335 (both young), to a minimum in 2338 and 5056 (both adults). Only in the heavily marked animals (CVULA 5061 and 2335) do spots reach the belly. There is no ventrolateral stripe, and color of the flanks merges into that of the belly via a badly defined, flecky or reticulated, border.

Table 1. Measurements (in mm) of adult males and females of *Aromobates meridensis*. Abbreviations are defined in the materials and methods section. Values are means ± standart deviation; maximum and minimum values are in parentheses.

Character	Males (n= 5)	Females (n= 11)
SVL	27.8±3.3	28.8±3.6
	(22.8-31.8)	(21-32.5)
SL	13.0±1.8	14.1±1.8
	(10-14.6)	(10-15.8)
FeL	12.9±1.8	13.9±1.5
	(10.5-12.4)	(10.2-15)
FL	12.9±1.3	14.1±2
	(10.7-13.8)	(10.5-16)
HeL	10.1±1.3	10.1±1.1
	(8-11.5)	(8-11)
HW	9.8±1.2	10.1±1.3
	(8-11.4)	(7.5-11.5)
IND	3.4±0.5	3.7±0.4
	(2.6-4)	(3-4)
UEW	2.8±0.5	n=9; 3±2.4
	(2.1-3.3)	(2-3)
IOD	3.1±0.3	n=9; 3.4±0.5
	(2.8-3.5)	(2.8-3.8)
ED	3.4±0.6	3.3±0.4
	(2.5-3.9)	(2.7-3.7)
TD	1.4±0.3	n=4; 1.6±1.1
	(1.2-1.6)	(1.4-1.7)
EN	2.2±0.4	2.1±0.3
	(1.8-2.7)	(1.8-2.7)
ETS	4.1±0.7	4.3±0.5
	(3-4.8)	(3.2-4.9)
1FiL	4.7±0.7	4.7±0.7
	(3.8-5.4)	(3-5.5)
2FiL	4.2±0.7	4.2±0.7
	(3.2-4.9)	(2.9-4.9)

Fig 2: Dorsal view of a series of *Aromobates meridensis* reported in this work. Males on top row.

Males have a brown ventral coloration (Fig. 3), from pale brown (CVULA 1670 and 2167) to dark brown (CVULA 4770 and 5060). The throat and chest can be only brown (CVULA 5060), with whitish spots (CVULA 1670 and 2167) or with white and dark brown reticulation (CVULA 4770). There are no special chest markings. The belly is paler except in CVULA 5060, in which it is spotted with white irregular large marks. Inferior parts of the forelimbs are whitish, usually spotted with dark brown. In CVULA 5060, they are brown with small whitish spots.

Color in life, as described by Dole and Durant (1972), is bright reddish brown with few dark brown blotches; flanks dark brown; ventral surfaces bright lemon yellow, with dark brown spots on throat and thighs. Unfortunately, Dole and Durant (1972) do not define the sex of the live specimens they describe, but as they do not report any male, we can safely assume that their color description is of females.

We examined a living male from the newly discovered populations (see below). After some hours, the animal changed from the black color typical of a calling male to olive gray, in which a narrow black vertebral line was evident (not discernable when black; Fig. 4A); some ill-defined dark gray spots were on the back; and an interorbital bar was also ill-defined. The limbs showed transverse dark gray bars. The flanks were dark gray, bearing a line of white spots as a oblique lateral stripe. All fingers and toes had a white ring between the last phalanx and the discs. Ventrally, the throat was dirty yellow, with some scattered white small spots. The chest was gray (skin color) with some white spot. The belly anteriorly was dirty gray with yellow spots, and posteriorly lemon yellow with gray spots on the sides; immaculate in the center (Fig 4B).

The skin was smooth with definite tubercles in two dorsolateral rows in the scapular region and on dorsal surface of the thighs. This feature was described by Dole and Durant (1972), who noted that the skin of the (female) holotype was finely granulate, and distinctly tubercular on limbs and flanks. However, this is not evident in any of the preserved specimens examined by us. It is possible that the skin has become smoother with the time.

Three metamorphing juveniles (CVULA 7400-402) were very similar in coloration (Fig. 5), possessing a light brown dorsum with irregular dark brown marks and pale blue spots.

Fig 3: Ventral view of a series of *Aromobates meridensis* reported in this work. Males on top row.

Fig 4A: Dorsolateral view of *Aromobates meridensis* in life (CVULA 7399). Note the overall blackish coloration, the middorsal black stripe and the tuberculate posterior part of the dorsum and hind limbs. **4B**: ventral view of the same specimen.

Fig 5: A metamorphing *Aromobates meridensis*.

Vocalization: The call as defined by Dole and Durant (1972), consists of a series of "fluttery" trills, each series lasting about 2 s and separated usually by an interval of 30-60 s between calls. One call we recorded (not illustrated) is a fluttery trill consisting of 22 notes, during 2.4 s in total, each note lasting about 0.05 s; with a dominant frequency of 2950 Hz, and a fundamental frequency of 2400 Hz. Another call of a male in a different section of Caño Seco is very similar, has 20 notes during 2.43 sec, each note 0.05 sec, with a dominant frequency of 2798 Hz, and a fundamental frequency of 2500 Hz (Fig. 6).

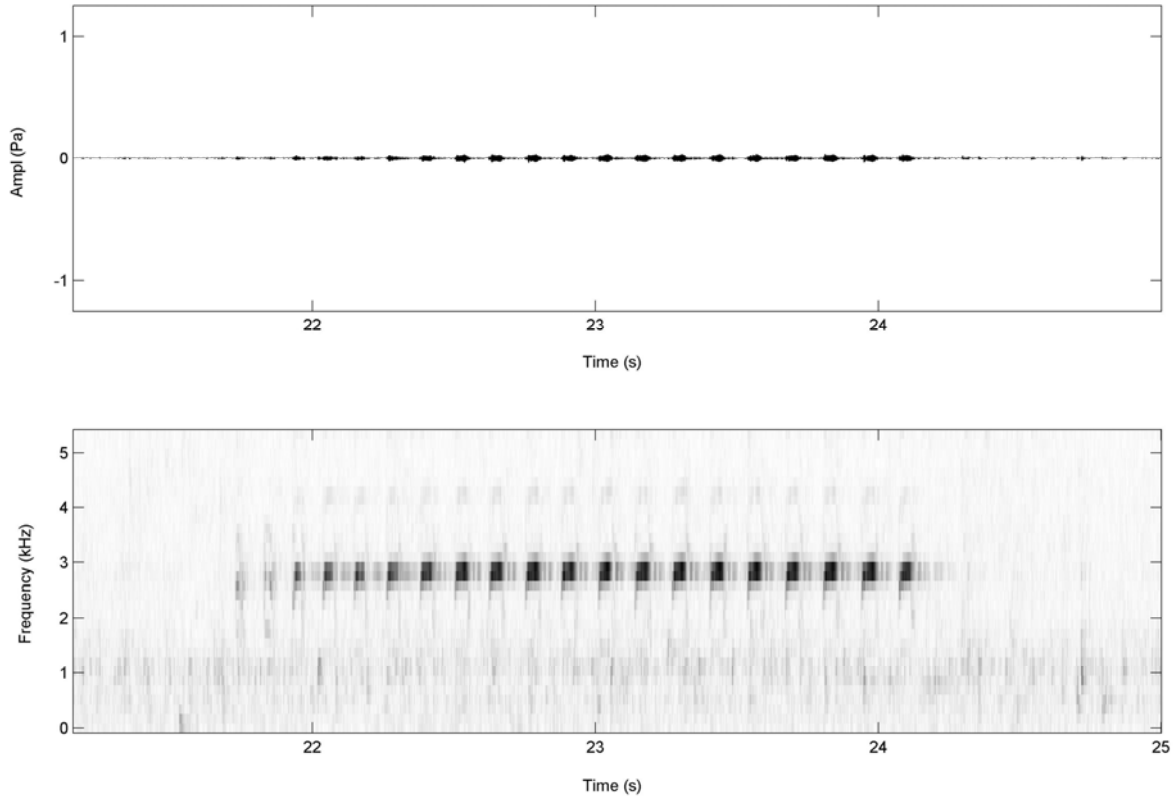

Fig 6: Waveform and spectrogram of a trill call of *Aromobates meridensis*, taken at 19ºC at Caño Seco.

Distribution: The species is only known from the surroundings of its type locality, El Chorotal, ranging from La Carbonera (elevation 2200 m) to the Altos de San Luis, near La Azulita (altitude 1880–2000 m), Estado Mérida, Venezuela (Fig 7). There is a report of a specimen from San Javier del Valle, on the way to La Culata, and a sighting at an elevation of 3300 m (both P. Durant, pers. comm.), which needs confirmation.

Fig 7: Distribution of *Aromobates meridensis* in nortwestern Venezuela.

Natural history: Dole and Durant (1972) until now were the principal source for information about the known behaviour of this taxon. They stated that the species is very secretive, living under boulders and moss along steep, heavily vegetated rocky mountain streams (Fig. 8). It was noted to live in sympatry with a *Mannophryne* species (apparently extinct at El Chorotal) and with *A. mayorgai* at the type locality and its surroundings (Dole and Durant 1972). Conversations with persons that know the species and were the main collectors of the CVULA series corroborated that the animal lived in narrow creeks and, although very secretive, was possible to find by turning over rocks. Curiously, males were never reported in the original description, and in the CVULA collection there are only four males, compared to 11 females. We believe that the difficulty of catching calling males exists because they establish their calling sites in crevices and holes, or under waterfalls. All calling males were positioned looking downstream, with the water flow. On the few occasions when we were able to approach calling males, they escaped by jumping deeper inside their resident crevice or climbed its walls. The wet rocks are actually of the exact same color as the living animals (Fig. 9A), especially the color of calling males, which are bright black; hidden males are virtually impossible to see (Fig. 9B). Females are brown in coloration. Some females, surprised while in the open, escaped quickly by jumping directly into the current, and disappearing immediately. One individual was seen at night in a small crevice not much wider than itself, apparently resting or sleeping. The only probable enemy we saw in the area is a snake, *Chironius monticola.* Snakes of this genus are well known frog eaters.

Fig 8: Natural habitat of *Aromobates meridensis* at Quebradón. The arrow indicates the calling site of a male.

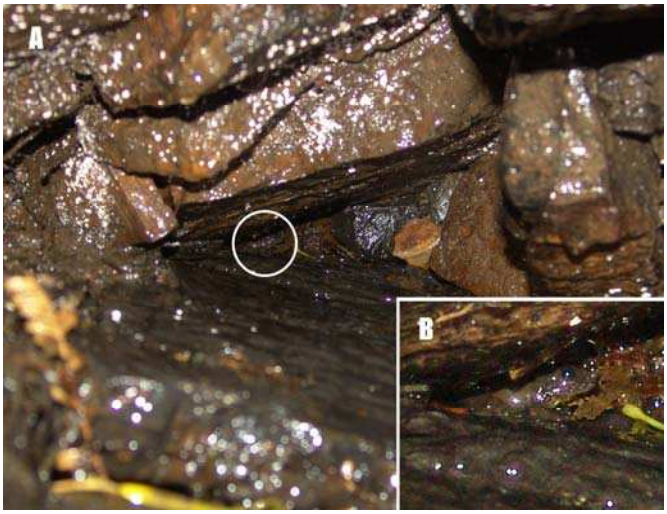

Fig 9A: A calling male hide at the deepest corner between two rocks behind a small waterfall. Its color makes him completely invisible. The white arrow indicates its position. **9B**: Augmented image of the hidden individual.

Larvae live in pools, where there can be a few to more than 15. We never saw more. They can be more or less widespread along the creek or more concentrated in some pools, and are apparently absent from others, which are at first glance identical in condition.

Taxonomic Remarks Of the available specimens, the males CVULA 4770 (28.3 mm SVL) and CVULA 7399 (32 mm SVL) have an apparently unique character within the genus, a preaxial swelling on the third finger. The testes in these specimens seem to be mature (whitish color), as in the other adult male CVULA 2167 (29 mm SVL). A smaller male (27.2 mm SVL) has small, not well-developed testes. Myers (1991) indicated that this character is more strongly developed in some species than in others and that, in some species at least, it may not be expressed in all males (present only in actively breeding males). Grant *et al*. (2006: Fig. 28) show four

conditions of swelling on third fingers among dendrobatoids. Among all Venezuelan dendrobatoids, only one was known to have a swollen third finger, *Anomaloglossus tamacuarensis* (Myers and Donnelly 1997). The case of *A. meridensis* would be the first for the genus *Aromobates*.

Conservation status: The last specimens of *A. meridensis* hosted at CVULA are from El Chorotal, north of San Eusebio (elevation 1800 m), and were collected in 1987. The senior author conducted exhaustive surveys of all suitable habitats for amphibians in the area at Chorotal in 2003, 2005, and 2007. It seems that El Chorotal, along the road from Mérida to La Azulita, the type locality of *A. meridensis* and *A. mayorgai*, appears to lack any kind of diurnal amphibian despite the presence of many suitable streams. At night, only *Hyalinobatrachium duranti* is common, and sporadically *Centrolene altitudinale* and *Hyloscirtus platidactylus* can be heard. Two males of *A.* cf. *mayorgai* were heard (and one photographed) at Cascada La Palmita (also known as Cascada de La Azulita), at a much lower altitude (elevation 800 m).

The apparent reason for the decline may be the existence of cattle pastures and agricultural plots where pesticides are used above the streams. A partial water analysis at Chorotal (type locality) shows a low value of dissolved oxygen (3.08 mg/l), less than the permitted minimum of 4 mg/l *sensu* the Venezuelan Norma Sanitaria de la Calidad de Agua Potable). The DBO5 (biochemical demand of oxygen during five days at 20ºC) shows a low concentration of bacterial contribution to dissolved oxygen, concluding that this parameter is influenced by the oxidative action of chemical products, like fertilizers and pesticides. The water analysis at Caño Seco, a creek with a surviving population of *A. meridensis*, reveals unpolluted water.

The presence of only one extant population of *A. meridensis* in a remote, pristine area within two creeks is alarming, and Lampo et al. (2008) already reported the presence of *Bd* in the species. A few tadpoles raised in captivity by the first author died after metamorphosis (Fig. 5) and tested positive for *Bd* with a high rate of contamination (M. Lampo, unpubl. data). Alerted by this information, Fundación AndígenA received funds from The Durrell Wildlife Conservation Programme and from the Iniciativa para las Especies Amenazadas (IEA) to assess the current population status of the species.

Animals were located in two nearby creeks at Finca El Cedral (elevation 1980 m; 8º39'N, 71º26'W), one a steeply cascading stream (Quebradón; Fig 8), and the other a rivulet (Caño Seco). Caño Seco is about 2-3 m wide, and with an average depth of about 50 cm. This is a very unassuming stream along the first 200 m of our transect, starting from our base camp, but it suddenly transforms into a steep stream, with slippery rocks and many small waterfalls, with a lot of crevices and holes among the rocks. Quebradón is a much wider waterway, from 15 to 20 m, in some places more than 30 m, with much bigger and deeper pools, yet it is also very steep, with high waterfalls (the highest more than 25 m). The species was absent above the highest waterfall.

The only feasable methodology to follow to locate the species was audio transects (Lips et al. 1999). Calling males were impossible to count directly, as they were highly shy and stopped calling as soon as they suspected our presence. We tried two different methods in the two localities. At Caño Seco (Fig 10) we scored calling males, females seen, and pools with larvae according to four categories (1-5=Infrequent; 6-10=Few; 11-15=Frequent; more than 15=Abundant). As regular transect was impossible to perform due to the steep terrain, we just followed the streams bed. We walked and stopped approximately every 25 m, reporting calling males, anecdotal sights, and the presence of larvae. Six replicates of our transect walks were made.

At Quebradón, a single transect was impractical due to the wideness of the stream and because males could see us from long distances, and would stop calling. To solve this dilemma, we counted calling males going downstream by stopping at elevated sites (e.g., large boulders dominating sectors of the creek) and by mapping quadrants of about 50 m². Then we counted all calling males first, and after, individuals seen and pools with tadpoles. Five replicate counts were made.

The census at Caño Seco revealed 15 calling males in a transect of 375 m length (which was the only sector where we heard males calling). The five counts at Quebradón revealed a maximum number of calling males of 13 in a 500 m long sector. All other searches revealed fewer calling males. In total, counting the most optimum numbers at both streams, there were only 28 calling males. Estimates for females or juveniles would be very difficult and invasive and are therefore impractical. The only study on sex ratios in aromobatine frogs is Sexton (1960), who observed 26 females and only eight males of *Mannophryne herminae* in a done habitat. However, in our experience, species of *Mannophryne* are much more abundant than other dendrobatids, such as *Aromobates*. In the case reported by Sexton (1960), the sex ratio was 3.25:1 in favor of females. If the sex ratio is similar in *A. meridensis*, the number of females would be 48.75 at Caño Seco, and 42.25 at Quebradón, with an adult population of 63 and 55 at each locality (rounded down to the nearest whole number). A hypothetical alternative would be to consider a jar with 14 *A. meridensis* at CVULA. Of these 14 specimens, collected between 1979 and 1987 at the type locality, only three are males (3:11). This means that there are 3.6 females per male. In such a scenario, there would be 54 females at Caño Seco and 46 at Quebradon, totalling 69 and 59 adults, respectively, for a maximum grand total of 128 adults. If the sex ratio were equal, the number of adult *A. meridensis* at Caño Seco would be 30, and in Quebradón 26. The total number of adults of this species would be 56. As a result of these calculations, we consider the total population to be between 56 and 128 adults in size. Larvae were much more evident at Caño Seco, which is a smaller stream with more shallow pools. Fig 10 shows the relative position of pools with larvae.

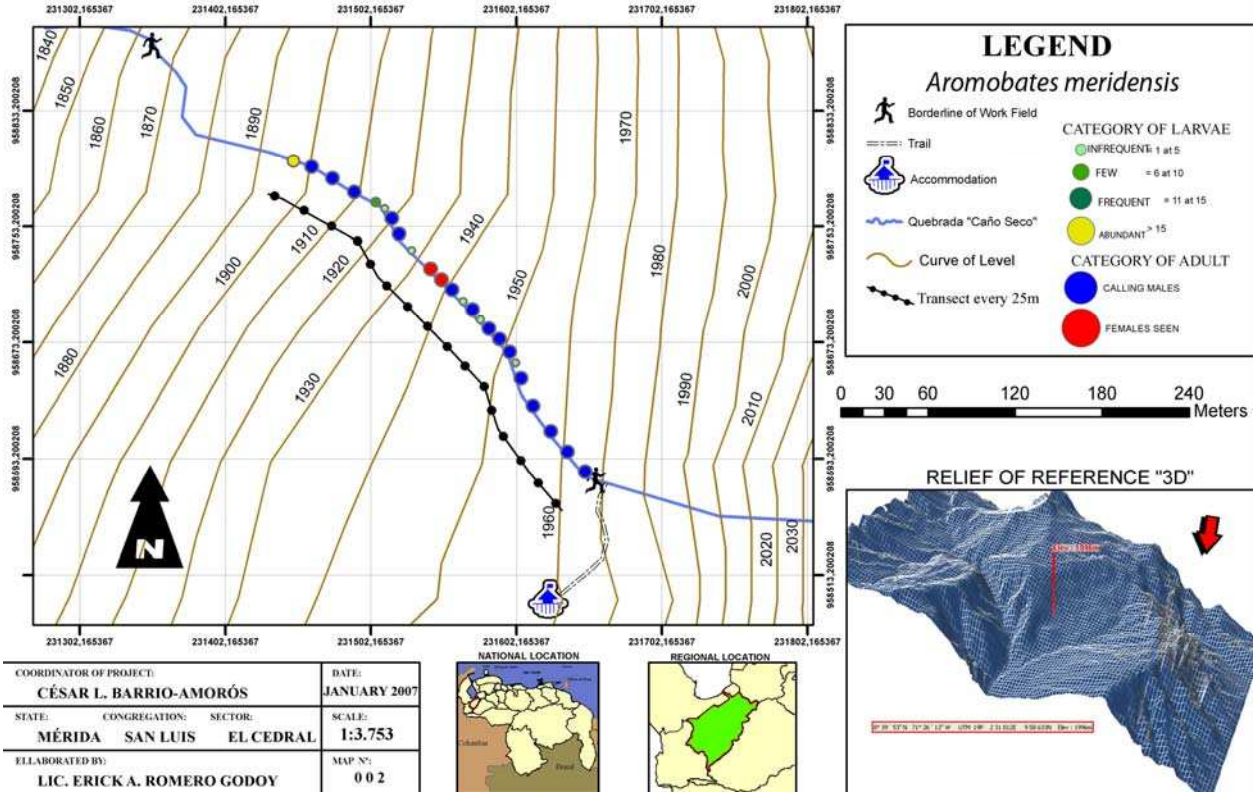

Fig 10: A representation of Caño Seco (blue line), with a parallel transect showing stops at each 25 m. Blue circles are indicative of calling males. Red circles correspond with females seen. Smaller circles correspond to larvae seen, as follows: small pale green circles: pools with 1-5 larvae; little bigger dark green circles : 6-10 larvae; yellow circle: more than 15 larvae.

CONCLUSION

Aromobates meridensis is a critically endangered frog from the Andes of Venezuela. It is infected by *Bd* (incidence unknown). It is absent from its type locality, and only surviving in two streams between elevations of 1700 and 2000 m. The remaining population is estimated to have between 56 to 128.8 adults. It was categorized as CR/B2ab(iii) by Young *et al.* (2004) and Stuart *et al.* (2008). We and herein categorizes the species as CR/ A2ace; B1ab(iii,v).

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Appendix

Examined species:

Aromobates alboguttatus: CVULA 1171, 1236-8: Monte Zerpa, 2200 m, Mérida.

Aromobates duranti: CVULA 0845. Sierra de la Culata, Mérida.

Aromobates haydeeae: CVULA 0910-1, 0917: 15 km SW Zumbador, Táchira. CVULA 1067-8: Páramo Zumbador, Mesa del Aura, Táchira.

Aromobates leopardalis: CVULA 5890, 5892, 3083-4, páramo de Mucubají, 3400 m, Mérida.

Aromobates mayorgai: CVULA 0281. La Carbonera, Mérida.

Aromobates meridensis: CVULA 1448, 1491, 1670: Vía Mérida-La Azulita, 2000 m; 31-8-79. CVULA 2167: La Empalizada, El Chorotal. CVULA 2328-9, 2335: El Chorotal; 27-1-80. CVULA4767-72: carretera 7 km N San Eusebio, El Chorotal, Distrito A. Bello; 13-4-87. CVULA 5056, 5060-3: La Empalizada; June 87.

Aromobates molinarii: CVULA 1873-4. Cascada de Bailadores, Mérida.

Aromobates orostoma: CVULA 3529. Km 590 Páramo Batallón y La Negra, Mérida. CVULA 3528, 3582: Páramo La Negra, vía Pregonero, 2500 m, Táchira.

Aromobates serranus: CVULA 3376-81. Vía El Morro, Mérida.

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