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DISTRIBUTION, VOCALIZATION AND TAXONOMIC STATUS OF *HYPYSIBOAS RORAIMA* AND *H. ANGELICUS* (AMPHIBIA: ANURA: HYLIDAE)

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ABSTRACT

The distribution of the poorly known hylid frog Hypsiboas roraima Duellman & Hoogmoed, on the Guiana Shield is redefined, including new records from Venezuela. The advertisement call of this species is analyzed and Hypsiboas angelicus Myers & Donnelly is associated as a junior synonym of H. roraima.

KEYWORDS: *Hypsiboas roraima*; *H. angelicus*; Hylidae; Guiana Shield; Guyana; Venezuela.

INTRODUCTION

Hypsiboas roraima (Fig. 1) was described from three females collected at elevations of 1430-1480 m on the northern slopes of Mount Roraima in Guyana. Originally, the species was described as *Hyla roraima* and assigned to the *Hyla geographica* group (Duellman & Hoogmoed, 1992). *Hypsiboas roraima* superficially resembles *H. fasciatus* but the latter exhibits bold markings on the posterior surfaces of the thighs (absent in *H. roraima*). A comprehensive comparison of *H. roraima* with other sympatric hylids can be found in Duellman & Hoogmoed (1992). Faivovich *et al.* (2005) presented a phylogenetic analysis of the family

Hylidae, placed this species in the genus *Hypsiboas*, and more particularly within the *Hypsiboas benitezii* Group (with no close relationship with *H. fasciatus* which is currently in the *Hypsiboas albopunctatus* Group after Faivovich *et al.*, 2005), supported mainly by molecular data and by the presence of flat mental gland.

MacCulloch & Lathrop (2005) extended the distribution of *Hypsiboas roraima* to Mount Ayanganna, Guyana, at 870-1550 m and offered a more complete description of the species based on 18 females and 11 males. Up to this point, the species was reported only in Guyana, but its presence in Venezuela was expected (Barrio-Amorós, 1998, 2004) inasmuch

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as the type locality is on the northern slopes of Mount Roraima, a tepui that includes the triple border point of Venezuela, Guyana, and Brazil. Simultaneously, Barrio-Amorós & Duellman (2009) and Señaris *et al.* (2009) reported *Hypsiboas roraima* from Venezuela, although without mentioning any voucher specimen.

Recently, Myers & Donnelly (2008) described *Hypsiboas angelicus* from a single specimen collected on the summit of Auyán-tepui in Bolívar state, Venezuela. They mentioned its remarkably similarity to *Hypsiboas roraima*, distinguished only by the pattern of pigmentation on the palpebral membrane.

Herein, we redefine the distribution of *Hypsiboas roraima*, describe its advertisement call, and associated *Hypsiboas angelicus* Myers & Donnelly as a junior synonym of *H. roraima* Duellman & Hoogmoed.

MATERIAL AND METHODS

We examined all available specimens of *Hypsiboas roraima* and the single specimen of *H. angelicus*. Thirteen measurements on each specimen were made using digital callipers to 0.1 mm: SVL: snout-vent length; 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; HeL: head length from tip of snout to the posterior border of skull; HW: head width between angle of jaws; ED: horizontal eye diameter; IOD: inter-orbital distance between proximal edges of eyelids; UEW: upper eyelid width; TD: horizontal tympanum diameter; F3D: width of Finger III; T4D: width of Toe IV; 1FiL: length of Finger I from inner edge of thenar tubercle to tip of finger; 2FiL: length of Finger II from inner edge of thenar tubercle to the tip of finger. Life and/or preserved color patterns were analysed. Vocalizations were recorded by JCS using a Sony WM D6C with a Sennheiser directional microphone model Me-80. The recording was digitized at a sampling rate of 22050 Hz and size of 16 bits and analyzed using Canary 1.2 software (Charif *et al.*, 1995) on a Macintosh computer. Institutional acronyms follow Frost (2009) with the exception of UGDB – University of Guyana Department of Biology (now UG-CSBD).

RESULTS AND DISCUSSION

Venezuelan specimens of *Hypsiboas roraima*

After the report of *Hypsiboas roraima* from Sierra de Lema, Venezuela (Barrio-Amorós & Duellman,

2009), there are further observations, which expand its distribution and provide data on its natural history. During a survey of the herpetofauna of the Río Cucurital Basin in the western part of Canaima National Park in Venezuela, JCS collected two specimens of *Hypsiboas roraima* on the slopes of Auyán-tepui at 950-1000 m (Señaris *et al.*, 2009). These specimens (MHNLS 16085, 16086) were calling inside arboreal bromeliads in a shrubby area adjacent to Quebrada Rutapá, a tributary of the Cucurital river (05°43'17.7"N, 62°34'21.1"W, 950 m) on 9 November 2002.

A specimen (MHNLS 11380) collected by S. Gorzula on 28 February 1988 at Sur Sima Aonda (06°00'N, 62°35'W, 1600 m) on the summit of Auyán-tepui was reported as "Hylid species b" by Gorzula & Señaris (1999). Another specimen (MHNLS 11101) was collected by S. Gorzula on 26 November 1982 at "Caminata Uno" Guayaraca (05°42'N, 62°31'W, 950 m) on the southern slope of Auyán-tepui. This specimen was misidentified as "*Scinax* species a" by Gorzula & Señaris (1999), who mentioned its close similarity to other specimens collected by J. Ayarzagüena from La Escalera region in Sierra de Lema. Two specimens (MHNLS 10103 and KU 181072, Fig. 1C) are from higher elevations in the Sierra de Lema, Salto El Danto (1150 m), and km 112 on the El Dorado-Santa Elena de Uairén road (860 m), respectively. CLBA found an adult female (MHNLS 19656) at La Laja, Sierra de Lema (05°57'N, 61°30'W, 490 m) (Fig. 1B, D), and a sub-adult female (MHNLS 19657) at El Peñón, on the southern slope of Auyán-tepui, 1700 m (Fig. 1A).

Distribution and Habitat

In addition to the Venezuelan localities mentioned above, *Hypsiboas roraima* is known from Mounts Roraima, Ayanganna, and Wokomung in Guyana (Fig. 2). Although it has not been reported from Brazil, its presence in northern Roraima State is expected. The elevation range of the species is from 490 m at La Laja (Sierra de Lema) to 1700 m at Auyán-tepui summit. Only a few hylids have been reported from above 1500 m (Señaris & Ayarzagüena, 2002; MacCulloch *et al.*, 2007) in the eastern Pantepui highlands (with the exception of *H. roraima* at Auyán-tepui and *H. jimenezi* at Auyán-tepui and Chimantá Gorzula, 1992; Señaris *et al.*, 2009, and several species of *Tepuihyla* and *Myersobhyla* McDiarmid & Donnelly 2005). *Hypsiboas roraima* is nocturnal. Some specimens were collected on branches or leaves

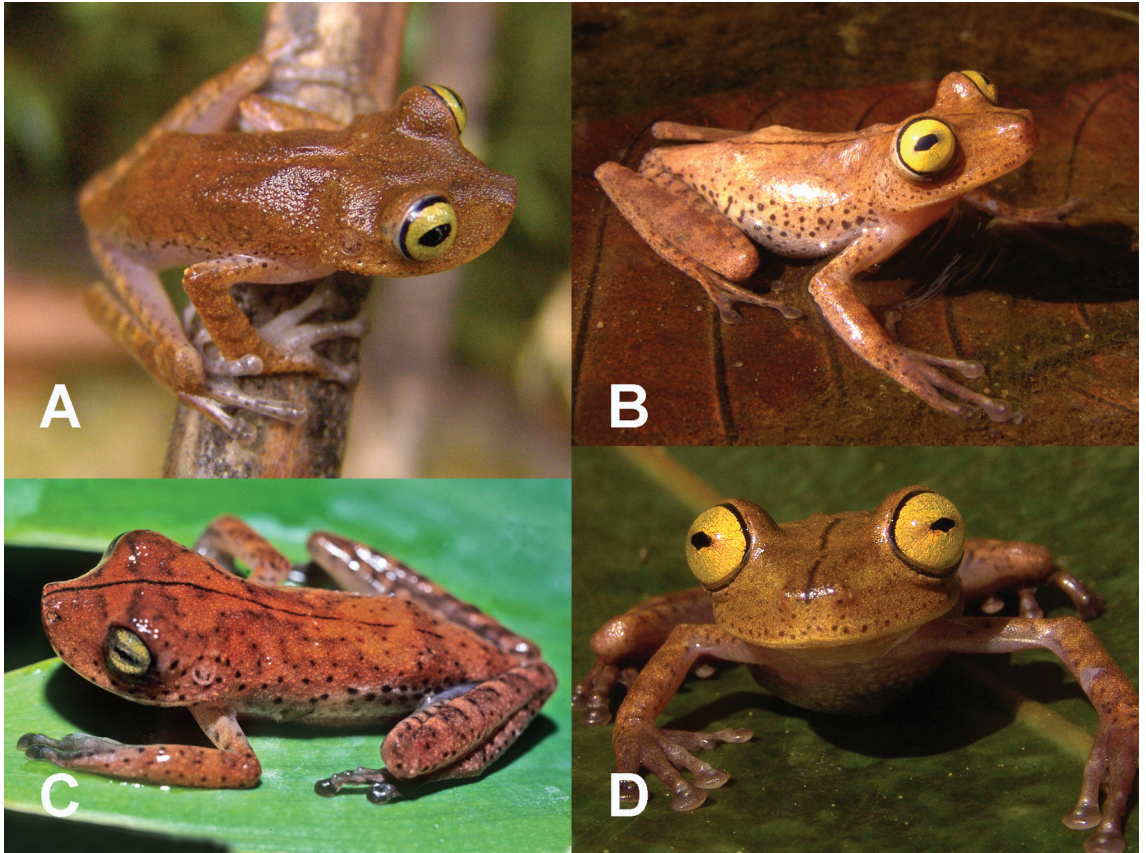


FIGURE 1: *Hysiboas roraima* in life. **A:** adult female, MHNLS 19657 from El Peñón, southern slope of Auyán-tepui. **B and D:** adult female, MHNLS 19656 from La Laja, Sierra de Lema; photos by CLBA. **C:** subadult female, KU 181072 from La Escalera, km 112 El Dorado-Santa Elena de Uairén. Photo by W.E.D.



FIGURE 2: Map of the western Guiana Shield, NE South America, with the distribution of *Hysiboas roraima* in Guyana and Venezuela. The white square is the type locality, Roraima (NE slope section) in Guyana. White circles are **1:** Mount Ayanganna; **2:** Mount Wokomung; **3:** La Escalera, Sierra de Lema (including different localities). The black square is the type locality of *H. angelicus*, Auyán-tepui, and contains all localities in and around Auyán-tepui.

in forest. Two males (MHNLS 16085-16086) were detected at night by their calls and both were calling in arboreal bromeliads between 2.5 and 4 m above the ground. The only water available in the area was inside leaves of bromeliads. A male (MHNLS 11101) was found on an epiphytic bromeliad on a tree, similar to the observations for MHNLS 10103 in the Sierra de Lema (J. Ayarzagüena, field notes May 1986). Based on a comment by D.B. Means, Faivovich *et al.* (2006) mentioned that males of *Hysiboas roraima* call from bromeliads close to small streams.

Vocalization

Advertisement calls of *Hysiboas roraima* from Quebrada Rutapá, headwater of Río Cucurital, Canaima National Park, Bolívar State, Venezuela (MHNLS 16085), were recorded on 8 November 2002, between 07:45 and 08:30 PM, at 22°C. The call consists of one modulated note (Fig. 3) repeated continuously, with a rate of 3-5 calls per second (180-300

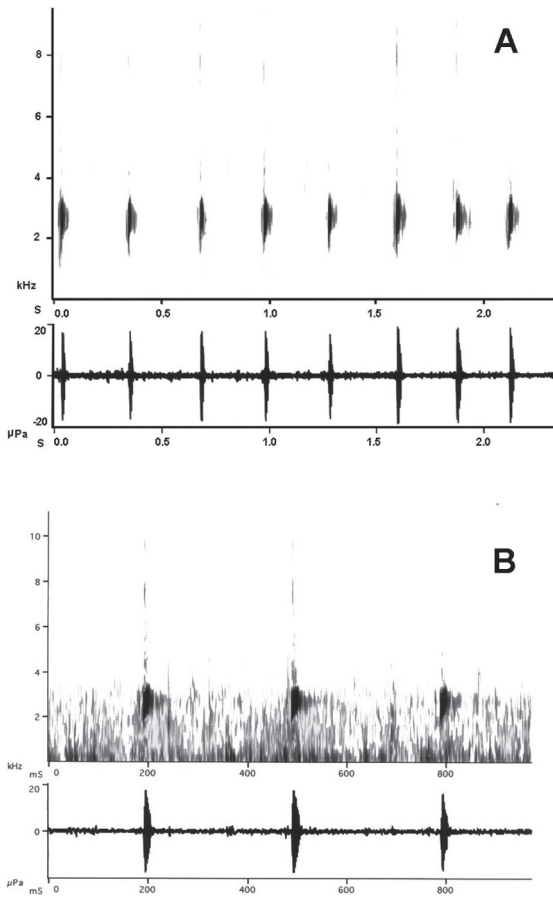


FIGURE 3: Vocalization of *Hypsiboas roraima* from Quebrada Rutapá, western piedmont of Auyán-tepui, 950 m. **A:** Spectrogram and waveform of a 2.2 seconds sequence of the call, showing eighth notes. **B:** Spectrogram and waveform of one second sequence of the call, showing three notes. Temperature of the air was 22°C.

calls/minute). The notes duration vary from 14.1 to 23.7 msec ($\bar{x} = 19.05 \pm 2.9$, $n = 52$) and the notes intervals from 200.7 to 417.4 msec ($\bar{x} = 285.5 \pm 52.01$, $n = 51$). The fundamental frequency ranges from 1600 to 1700 Hz and the dominant frequency from 2540 Hz to 2661 Hz ($\bar{x} = 2616 \pm 33$, $n = 22$). Other harmonics appear at 5050-5170 Hz, 7278-7903 Hz, 10150-10160 Hz and 12092-12854 Hz (Fig. 3A, B).

Compared with the recorded vocalization of *Hypsiboas roraima*, the advertisement call of *H. angelicus* (Myers & Donnelly, 2008) also is a long train of short “beeps” for one minute at 16.4°C (taken at 1600 m). The rate was 2.6 notes per minute and the dominant frequency rises from 1800 to 2400 Hz. The variation between the call of both species could be attributed to the differences in air temperature, as in the case of *Hyloscirtus labialis* (Lüddecke & Sánchez, 2002).

Morphology and Color Pattern

Measurements of all examined specimens are in Table 1. All measurements fall within the ranges reported by Duellman & Hoogmoed (1992) and MacCulloch & Lathrop (2005).

Although MacCulloch & Lathrop (2005) reported no webbing on the hand in *H. roraima*, basal webbing is present in all specimens, as illustrated in Duellman & Hoogmoed (1992).

Myers & Donnelly (2008:29-30) discuss the presence of elongate tubercles on either side of a vertical channel below the vent in the holotype of *H. angelicus*. They expressed uncertainty if these tubercles

TABLE 1: Measurements (in mm) of the adult male holotype of *Hypsiboas angelicus* and adult males and females of *H. roraima* from Guyana and Venezuela. Abbreviations are defined in the materials and methods section. Values are means \pm standard deviation; maximum and minimum values are in parentheses.

Character	<i>H. angelicus</i> (male)	<i>H. roraima</i> Males (n = 28)	<i>H. roraima</i> Females (n = 25)
SVL	38.4	39.9 \pm 2.2 (36.0 – 44.9)	43.2 \pm 2.5 (37.5 – 47.2)
SL	20.5	21.2 \pm 1.4 (17.6 – 24.5)	23.2 \pm 1.3 (20.0 – 24.9)
FeL	—	19.9 \pm 1.1 (17.9 – 22.3)	21.5 \pm 1.3 (18.1 – 22.5)
HeL	13.6	14.1 \pm 0.9 (12.8 – 15.9)	15.0 \pm 0.8 (13.0 – 15.9)
HW	13.8	13.7 \pm 0.9 (12.2 – 15.0)	14.7 \pm 0.9 (12.5 – 16.2)
ED	4.7	4.6 \pm 0.5 (3.5 – 5.5)	4.8 \pm 0.5 (3.7 – 5.6)
IOD	—	5.4 \pm 1.2 (4.0 – 7.5)	6.3 \pm 1.3 (4.2 – 7.5)
UEW	4.0	4.1 \pm 0.44 (3.4 – 4.9)	4.2 \pm 0.3 (3.5 – 4.7)
TD	2.2	2.0 \pm 0.2 (1.7 – 2.4)	2.2 \pm 0.3 (1.6 – 2.8)
F3D	2.1	1.9 \pm 0.2 (1.6 – 2.3)	2.2 \pm 0.2 (1.8 – 2.6)
T4D	1.9	1.7 \pm 0.2 (1.2 – 1.9)	6.8 \pm 0.5 (1.6 – 2.3)
1FiL	5.7	6.3 \pm 0.4 (5.5 – 7.2)	6.8 \pm 0.5 (5.8 – 8.1)
2FiL	6.6	6.7 \pm 0.4 (6.0 – 7.7)	7.3 \pm 0.6 (6.6 – 8.8)

might be diagnostic of *H. angelicus* or they are resulting from the fusion of round cloacal tubercles. Similar elongate tubercles were found in two specimens of *H. roraima* from Mount Wokomung, ROM 43423 and 43432, and one male from the base of Auyán-tepui, MHNLS 16085 (Fig. 4A), and less developed in a female from the high slopes of Auyán-tepui, MHNLS 19657 (Fig. 4B). We conclude that the pattern of cloacal tubercles is variable in *H. roraima*.

Color pattern of nearly all specimens is similar to that reported in Duellman & Hoogmoed (1992) and MacCulloch & Lathrop (2005). Interestingly, none of the Venezuelan specimens exhibits the dorsal pattern of large dark brown patches on a reddish-brown background. Five of seven Venezuelan specimens have a middorsal line (broken in MHNLS 10103). One specimen (MHNLS 10103) has a striking dorsal pattern resembling that of *Myersiophyla kanaïma* (Goin & Woodley). However, other characters, notably iris color (gray with contrasting pupil in preservative in *H. roraima* vs uniformly black in *M. kanaïma*), conclusively demonstrate that this specimen is *H. roraima*. Color patterns of Venezuelan specimens are shown in Fig. 1; photos of specimens from Guyana are in MacCulloch & Lathrop (2005).

Pigmentation pattern on the palpebral membrane in *Hypsiboas roraima* shows considerable individual variation. The holotype of *H. angelicus*, as referred by Myers & Donnelly (2008), lacks pale (or white) reticulation on the palpebral membrane (Fig. 5A). Most specimens have extensive reticulation

(Fig. 5C) and in some it is reduced (Fig. 5B). A few specimens have small unconnected dark brown spots with or without reticulation (Fig. 5D). Color of the pigment also is variable. In most individuals it is white (Fig. 5C), whereas in some specimens it is pale brown (Fig. 5B) or white and brown together (Fig. 5D).

Taxonomic status of *Hypsiboas angelicus* Myers & Donnelly

Altogether the authors have had the opportunity of examining all known voucher specimens of *Hypsiboas roraima* (see Appendix) and the holotype of *H. angelicus*. Myers & Donnelly (2008) described *H. angelicus* from the summit of Auyán-tepui (1600 m). Although recognizing its close similarity to *H. roraima*, they defended the particularity of *H. angelicus* by its lack of pale reticulation on the palpebral membrane (vs. pale reticulation in *H. roraima*). Myers & Donnelly (2008) stated that because variability in the amount of palpebral membrane reticulation in *H. roraima* had never been demonstrated, it would serve as a valid character to distinguish *H. angelicus* from *H. roraima*.

In a larger series of *H. roraima* from Guyana (Roraima, Ayanganna, and Wokomung) and Venezuela (Sierra de Lema and Auyán-tepui, including specimens from the summit [type locality of *H. angelicus*]) we found that the pale (usually bright white, occasionally pale brown) reticulation on the palpebral membrane can be well defined (28 of 46



FIGURE 4: Cloacal region of two specimens of *Hypsiboas roraima*, showing variation in cloacal tubercles. **A:** male MHNLS 16085 from the Río Cucurital, similar in shape and disposition to EBRG 2733, the holotype of *H. angelicus* (compare with Fig. 24 in Myers & Donnelly, 2008). **B:** female MHNLS 19657, with less developed elongated tubercles.

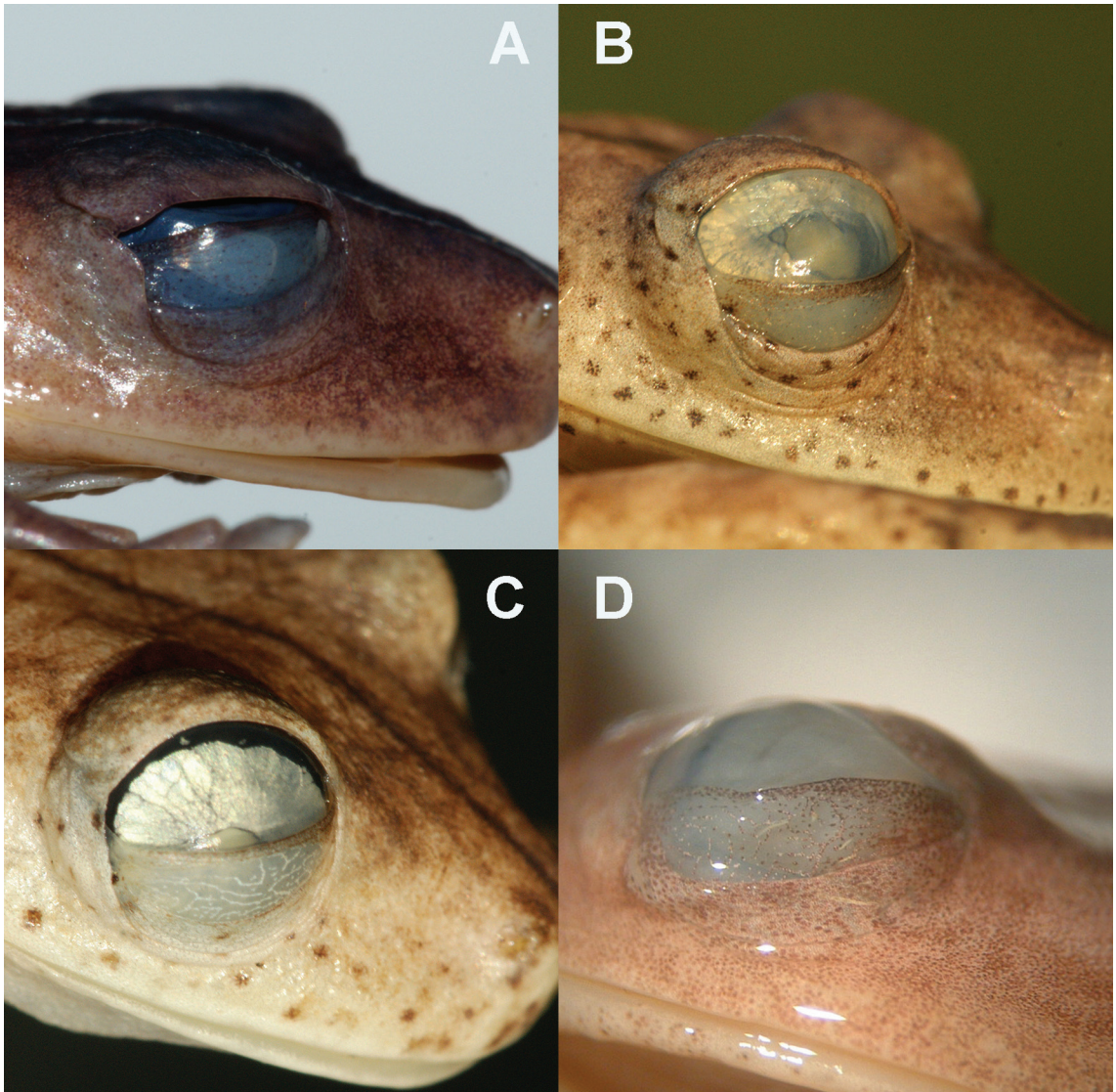


FIGURE 5: Variation in palpebral membrane pigmentation in *Hypsiboas roraima*. **A:** The holotype of *Hypsiboas angelicus*, EBRG 2733, showing dark spots. **B:** MHNLS 19656, showing a poorly defined reticulation, better described as small dark spots, white spots and short lines. **C:** MHNLS 16085, showing a well defined white reticulation. **D:** ROM 43426, showing pale brown and white spots and poorly defined reticulation.

specimens examined for this character, e.g. MHNLS 16085), poorly defined, represented by small white or brown spots instead of lines (15 of 46, e.g. MHNLS 10103, 16086), or represented by small brown spots (MHNLS 19656 and EBRG 2733, holotype of *H. angelicus*). Three specimens of 43 (EBRG 2733 – holotype of *H. angelicus*; MHNLS 11380 and 11101) have no reticulation. The condition of the palpebral membrane in the holotype of *H. angelicus*, although rare, is within the range of variability exhibited by *H. roraima*. There are no other characters supporting the validity of the taxon *H. angelicus* (Table 1; Myers & Donnelly, 2008). Therefore, we consider *Hypsiboas*

angelicus Myers & Donnelly, 2008 as a junior synonym of *H. roraima* Duellman & Hoogmoed, 1992.

RESUMEN

Redefinimos la distribución del bilido guayanés Hypsiboas roraima Duellman & Hoogmoed. Analizamos su canto y consideramos Hypsiboas angelicus Myers & Donnelly como un sinónimo menor de H. roraima.

PALABRAS-CLAVE: *Hypsiboas roraima*; *H. angelicus*; Hylidae; Escudo Guayanés; Guyana; Venezuela.

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APPENDIX

Specimens examined

Hypsiboas roraima: Venezuela, *Estado Bolívar*: EBRG 2733 (holotype of *H. angelicus*), male from summit of Auyán-tepui, 05°58'N, 62°33'W, 1600 m. MHNLS 16085-16086, from Rutapa creek, Cucurital river, SE slopes of Auyán-tepui, 05°43'17.7"N, 62°34'21.1"W, 950 m. MHNLS 11101, from Guayaraca, southern slope of Auyán-tepui, 05°42'N, 62°31'W, 950 m. MHNLS 11380, from the Auyán-tepui summit, south of Sima Aonda, 06°00'N, 62°35'W, 1600 m. MHNLS 19657, female from El Peñón, southern slopes of Auyán-tepui, 05°03'N, 62°28'W, 1700 m. MHNLS 10103, from Salto El Danto, La Escalera, 05°57'44"N, 61°23'45"W, 1160 m. MHNLS 19656, an adult female from la Laja, Sierra de Lema, 05°57'N, 61°30'W, 490 m. KU 181072, immature female, from La Escalera, km 112 El Dorado-Santa Elena de Uairén road, 06°00'02"N, 61°23'30"W, 860 m. Guyana; *Rupununi District*: BMNH 1979.560 (holotype), an adult male, KU 182470, UGDB 14 (paratypes), from north slope of Mount Roraima, 05°38'N, 60°44'W, 1480 m. ROM 39596-39627, from Mount Ayanganna, 05°24'N, 59°57'W, 870-1550 m. ROM 43423-43436, from Mount Wokomung, 05°06'N, 59°50'W.