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Comments on the distribution, taxonomy and advertisement call of the Guyanan glass frog *Hyalinobatrachium ignioculus* (Anura: Centrolenidae)

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Abstract. We report the presence of *Hyalinobatrachium ignioculus* in Venezuela. This discovery extends the species' known distribution from a single locality in western Guyana into southeastern Venezuela. We also describe its previously unknown advertisement call. We compare bioacoustics and key morphological characters of new material with previous descriptions of the similar *H. crurifasciatum* and *H. eccentricum*. Advertisement calls of the three species are similar, but being slightly longer in duration and higher in frequency in *H. ignioculus*. We also found that morphologically *H. ignioculus* can only be distinguished from *H. crurifasciatum* by the presence of a reddish or brown ring around the pupil and generally smaller size of adult males in the former; and from *H. eccentricum* by the presence of a light yellow pupillary ring in the latter. We therefore tentatively doubt that the three represent different species. However, we acknowledge the need of comparing type material and genetic sequences before suggesting any taxonomic changes.

Key words. *Hyalinobatrachium crurifasciatum*, *H. eccentricum*, *H. ignioculus*, Venezuela, Guyana, Guiana Shield.

Introduction

Currently, 25 glass frog species, subfamily Centroleninae, are known to inhabit Venezuela (Barrio-Amorós 2004, 2006, Señaris & Ayarzagüena 2005, Castroviejo-Fisher et al. 2007). Twelve of them belong to the genus *Hyalinobatrachium*, which is widely distributed through the rain forests of the country. Four species have been reported from the Venezuelan portion of the Guiana Shield: *H. iaspidiense* (Ayarzagüena, 1992), *H. crurifasciatum* Myers & Donnelly, 1997, *H. eccentricum* Myers & Donnelly, 2001 and *H. taylori* (Goin, 1968). The description of a fifth species is awaiting publication (Barrio-Amorós & Brewer-Carías in press).

Recently, Noonan & Bonett (2003) described *Hyalinobatrachium ignioculus* from Peters Mountain, 3.6 km north of Imbaimadai in the Pacaraima Mountains (05°44'N, 60°18'W; 600 m elevation), Administrative Region 7, Guyana. They provided a morphological description of male and female adults as well as larvae and compared them to published descriptions of *H. orientale* (Rivero, 1968), *H. taylori, H. iaspidiense* and *H. crurifasciatum*. However, they did not compare it to *H. eccentricum* from Cerro Yutajé (Estado Amazonas, Venezuela), which together with *H. crurifasciatum* is the most similar species to *H. ignioculus*. Here we provide new distribution records of *H. ignioculus* from Venezuela (first country record) and for the first time describe its advertisement call. In this context, we also discuss its taxonomic status.

Material and methods

Specimens were collected at seven different localities in Venezuela by the authors and collaborators during field trips between 2004 and 2006 (see Appendix for localities and museum number collections). They were fixed in 70 % ethanol or 4-10 % formalin and all preserved in 70 % ethanol. All specimens are deposited in the Museo de Historia Natu-

ral La Salle (MHNLS), Caracas. The acronym of the Museo de Biología de la Universidad Central de Venezuela, Caracas, MBUCV, is referred to in the Appendix. For identification of specimens and assessment of morphological and color characteristics, we followed Myers & Donnelly (1997, 2001), Noonan & Bonett (2003), Señaris & Ayarzagüena (2005), and Cisneros-Heredia & McDiarmid (2007). For the description of nuptial excrescences, we followed Flores (1985) with the additions of Cisneros-Heredia & McDiarmid (2007). Six call parameters (number of notes, call duration, time between calls, lower, upper and dominant frequencies) were measured and compared to the ones described for *H. crurifasciatum* (Myers & Donnelly 1997; Señaris & Ayarzagüena 2005) and *H. eccentricum* (Myers & Donnelly 2001). Vocalizations were recorded in the wild by the junior author in 2004 and 2005 from two specimens (MHNLS 17280, 17143). Sound recording equipment included a Sony WM D6C tape recorder and a Sennheiser Me 80 directional microphone. Recordings were digitized and edited at a sampling frequency of 44.1 KHz and 16 bit resolution with a Delta 66 digitizing board and Peak 3.2 software. All calls were edited with Audacity 1.2.2. Praat 4.2.22 software was used to obtain numerical information and to generate audiospectrograms and oscillograms. Frequency information was obtained through Fast Fourier Transformations (FFT), width 1024 points. Air temperature and humidity were measured immediately after sound recording. Digitized calls were deposited in the Fonoteca Zoológica of the Museo Nacional de Ciencias Naturales (Madrid, Spain).

Results and discussion

We report the first records of *Hyalinobatrachium ignioculus* (Figs. 1, 2) in Venezuela (Fig. 3, Appendix). Previously, the known distribution of *H. ignioculus* had been limited to its type locality in Guyana. The presence of this glass frog species in Venezuela, however, is no surprise, as the type locality lies approximately but 70 km from the Venezuelan border.

Hyalinobatrachium ignioculus belongs to the *H. fleischmanni* (Boettger, 1893) species group due to the presence of white bones, lack of vomerine teeth and white pigment in peritoneum covering liver and viscera but not covering the urinary bladder (Ruiz-Carranza & Lynch 1991, 1998). Within this group, the species most similar to *H. ignioculus* are *H. crurifasciatum* and *H. eccentricum*. According to the original descriptions (Myers & Donnelly 1997, Noonan & Bonett 2003) the main morphological differences between *H. crurifasciatum* and *H. ignioculus* are as follows (character states of *H. ignioculus* in parentheses): *H. crurifasciatum* has green limb bands in life (absent); pericardium partially transparent (white); absence of a reddish ring around the pupil (present, see Figs. 1, 2 and 4); smooth skin on the dorsum in preservative (pustulated); nuptial excrescences Type-I (Type-II) and adult size in males 22.0-24.0 mm (20.8-23.0 mm). Following Myers & Donnelly (2001), *H. eccentricum* has green limb bands in life (absent in *H. ignioculus*); a brown circumpupillary zone concealing the pupil and pupillary ring absent (red circumpupillary zone concealing the pupil and pupillary ring present); in preservative, smooth skin on the dorsum (pustulated); nuptial excrescences similar to Type-I, but lees extensive (Type-II) and pericardium partially transparent (white). Nevertheless, some of the characters used before to differentiate these three species are not consistent with the new data provided here. Green limb bands, pericardium partially transparent, skin smooth in preservative (pustulate in life), brown to reddish circumpupillary zone concealing the pupil, nuptial excrescences similar to Type-I but less extensive (see Ayarzagüena 1992: Fig. 5b, and Type-V of Cisneros-Heredia & McDiarmid 2007) appear in several of the new specimens of *H. ignioculus* we have collected in Venezuela. This implies that *H. ignioculus* can only be differentiated from *H. crurifasciatum* by

the presence, in the former, of a reddish or brown ring around the pupil (Figs. 1, 2 and 4) and adult size of males not larger than 23.0 mm; and from *H. eccentricum* by the presence of a light yellow pupillary ring.

Our bioacoustic analysis shows that the three species considered have a largely similar advertisement call. When comparing Fig. 5 with Myers & Donnelly (1997: Figs. 9-10), Myers & Donnelly (2001: Fig. 14) and Señaris & Ayarzagüena (2005: Fig. 115), their call structures are identical. All calls analyzed consist of a single high-pitched note, modulated in frequency and energy. The notes are pulsated in wave-forms, with ascending and descending frequency, so the spectrograms have a saw-shape. They start with a fast increase in their frequency (from = 3500 to = 5000 Hz) and continue with the ascending-descending pattern described above. The call parameters studied show some slight differences between species (Table 1). Call duration overlaps to some extent for all species but it seems to be shorter in *H. ignioculus*. Our sample size was insufficient to characterize differences in time between calls, a character that also seems to be highly variable within individuals. Frequencies measured are higher for *H. ignioculus* than the other species (*H. ignioculus* > *H. crurifasciatum* > *H. eccentricum*). However, differences are minor, and due to the low sample size and incomplete data could reflect an artifact rather than real differences.

Señaris & Ayarzagüena (2005), after a detailed study of the Guiana Shield's glass frogs, decided to place all the specimens matching the morphological and bioacoustical description of *H. crurifasciatum* under that name, even those placed in *H. orientale* by Cannatella & Lamar (1986) and Duellman (1997) from La Escalera, Sierra de Lema (Estado Bolivar, Venezuela). Señaris & Ayarzagüena (2005) specified that the iris of all the specimens placed under *H. crurifasciatum* is golden. Furthermore, they only mention two individuals (MHNLS 11225-6) having a dark brownish iris in preservative, both from Cerro Guanay (Estado Amazonas, Venezuela), (i.e., close to the type locality of *H. eccentricum*). Following Señaris & Ayarzagüena (2005), *H. crurifasciatum* is a widely distributed species throughout the Venezuelan Guyana, ranging from its type locality at the Brazilian-Venezuelan border in southern Estado Amazonas, through Estado Bolivar uplands. Nonetheless, observations of specimens from eastern Guyana without the

Tab. 1. Call characteristics of *Hyalinobatrachium ignioculus*, *H. crurifasciatum* and *H. eccentricum*. Time is given in seconds (s) and frequency in Hertz (Hz). When available, average is followed by ± Standard Deviation, range and number of observations (N). All our recordings were made between 18 and 22°C and correspond to specimens MHNLS 17280 and 17143.

	H. ignioculus	*H. crurifasciatum*	*H. crurifasciatum*	*H. eccentricum*
source	this work	Myers & Donnelly (1997)	Señaris & Ayarzagüena (2005)	Myers & Donnelly (2001)
number of notes	1	1	1	1
call duration [s]	0.17 ± 0.033 0.13–0.21, N = 6	0.237 ± 1.974 0.20–0.29, N = 32	0.17–0.22	0.22
time between calls [s]	31.9 ± 3.17 28.88–36.30, N = 4	3.33 ± 1.20 1.8–6.3, N = 31	?	?
lower frequency [Hz]	4160.7 ± 127.52 3967.7–4283.6, N = 6	3500	3730	3480
upper frequency [Hz]	5557.1 ± 249.72 5283.8–5870.3, N = 6	4600	5040	4700
dominant frequency [Hz]	4919.7 ± 52.07 4838.9–4991.9, N = 6	4000–4500	4440–4750	4160

Fig. 1. *Hyalinobatrachium ignioculus* (MHNLS 18056, adult male) from Santa Elena de Uairén (Estado Bolivar, Venezuela). Photography: César l. Barrio-Amorós.

Fig. 2. *Hyalinobatrachium ignioculus* (MHNLS 18059, adult female) from La Laja, Sierra de Lema (Estado Bolivar, Venezuela). Photography: Charles Brewer-Carías.

colored circumpupillary ring have to be confirmed.

An alternative hypothesis would be that Myers & Donnelly (1997) and/or Señaris & Ayarzagüena (2005) overlooked the presence of a reddish ring around the pupil in the individuals that they studied (which is sometimes not easily appreciable in preserved specimens). The original description of *H. crurifasciatum* does not include a picture of living specimens and, unfortunately, there is no such picture (M.A. Donnelly, pers. comm.). Furthermore, the photograph of *H. crurifasciatum* included in Señaris & Ayarzagüena (2005: Fig. 184) does not allow the examination of this character. The type localities of *H. eccentricum* and *H. crurifasciatum* lie on the western side of the Parima-Maigualida mountain chain, while the one of *H. ignioculus* is far on the eastern side. This chain is recognized as an important geographic barrier for many amphibians and reptiles (Barrio-Amorós & Brewer-Carías in press). However, some species of glass frog

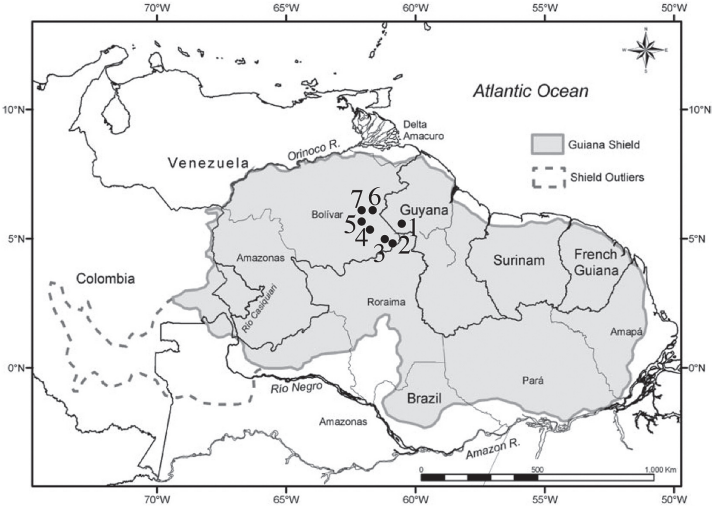

Fig. 3. Distribution of *Hyalinobatrachium ignioculus*. For detailed localities see Appendix. 1 = Peters Mountain; 2 = Santa Elena de Uairén; 3 = Quebrada Jaspe; 4 = Salto Karuay; 5 = Auyan-Tepui; 6 = La Escalera; 7 = La Laja.

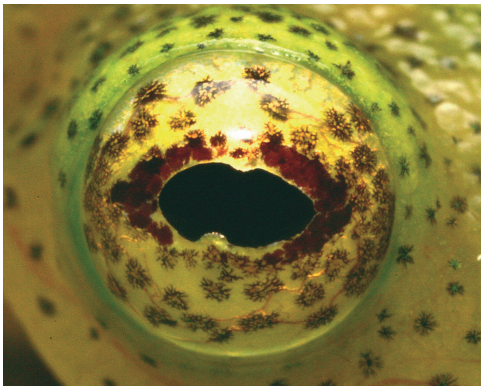

Fig. 4. Detail of the eye of *Hyalinobatrachium ignioculus* (MHNLS 18058, adult male). Photography: Charles Brewer-Carías.

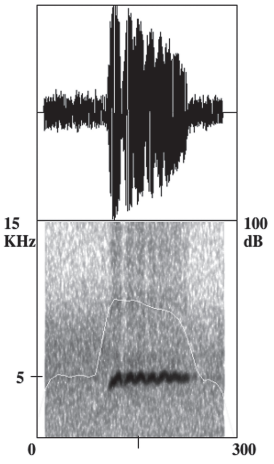

Fig. 5. Oscillogram (top) and spectrogram (bottom) of 300 ms section of the call of *Hyalinobatrachium ignioculus* (MHNLS 17280). Curve indicates intensity. Air temperature and humidity at the time of recording were 22°C and 87%, respectively.

like *H. taylori* occur at both sides of this massif (Señaris & Ayarzagüena 2005).

In conclusion, the data we present here indicate that the morphological and bioacoustic differences between *H. crurifasciatum*, *H. eccentricum* and *H. ignioculus* are scarce and place *H. eccentricum* and *H. ignioculus* as candidates to be junior synonyms of *H. crurifasciatum* in concordance with Cisneros-Heredia & McDiarmid (2007) and Kok & Castroviejo-Fisher (2008). Nonetheless, prior to any taxonomic decision, type material must be compared and DNA sequences (preferably from types or topotypic material) should be examined.

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References

Ayarzagüena, J. (1992): Los centrolénidos de la Guyana venezolana. – Publicaciones Asociacion Amigos de Doñana, **1**: 1-48.

Barrio-Amorós, C.L. (2004): Amphibians of Venezuela, systematic list, distribution and references; an update. – Revista Ecología Latino Americana, **9(3):** 1-48.

Barrio-Amorós, C.L. (2006): Geographic distribution: *Hyalinobatrachium ibama*. – Herpetological Review, **37**: 238.

Barrio-Amorós, C.L. & C. Brewer-Carías (in press): Herpetological results of the 2002 expedition to Sarisariñama, a tepui in Venezuelan Guayana, with the description of five new species. – Zootaxa.

Boettger, O. (1893): Ein neuer Laubfrosch aus Costa Rica. – Berichte über die Senckenbergische naturforschende Gesellschaft in Frankfurt am Main, **1893**: 251-252.

Cannatella, D.C. & W.W. Lamar (1986): Synonymy and distribution of *Centrolenella orientalis* with notes on its life history (Anura: Centrolenidae). – Journal of Herpetology, **20**: 307-317.

Castroviejo-Fisher, S., J. Ayarzagüena & C. Vilà (2007): A new species of *Hyalinobatrachium* (Centrolenidae: Anura) from Serranía de Perijá, Venezuela. – Zootaxa, **1441**: 51-62.

Cisneros-Heredia, D.F. & R.W. McDiarmid (2007): Revision of the characters of Centrolenidae (Amphibia: Anura: Athesphatanura), with comments on its taxonomy and the description of new taxa of glassfrogs. – Zootaxa, **1572:** 1-82.

Duellman, W.E. (1997): Amphibians of La Escalera region, southeastern Venezuela: taxonomy, ecology, and biogeography. – Natural History Museum, Univ. of Kansas, scientific papers, **2**: 1-52.

Flores, G. (1985): A new *Centrolenella* (Anura) from Ecuador, with comments on nuptial pads and prepollical spines in *Centrolenella*. – Journal of Herpetology, **13**: 313-320.

Goin, C. (1968): A new centrolenid frog from Guyana. – Quarterly Journal of the Florida Academy of Sciences, **30**: 115-118.

Kok, P.J.R. & S. Castroviejo-Fisher (2008): Glassfrogs (Anura: Centrolenidae) of Kaiteur National Park, Guyana, with notes on the distribution and taxonomy of some species of the family in the Guiana Shield. – Zootaxa, **1680:** 25-53.

Myers, C.W & M.A. Donnelly (1997): A tepui Herpetofauna on a Granitic Mountain (Tamacuari) in the borderland between Venezuela and Brazil. Report of the Phipps-Tapirapecó Expedition. – American Museum Novitates, **3213**: 1-71.

Myers, C.W & M.A. Donnelly (2001): Herpetofauna of the Yutajé-Corocoro Massif, Venezuela: Second report from the Robert G. Goelet American Museum Terramar Expedition to the northwestern tepuis. – Bulletin of the American Museum of Natural History, **261:** 1-85.

Noonan, B.P. & R.M. Bonett (2003): A new species of *Hyalinobatrachium* (Anura: Centrolenidae) from the highlands of Guyana. – Journal of Herpetology, **37**: 92-97.

Rivero, J. A. (1968): Los Centrolenidos de Venezuela (Amphibia, Salientia). – Memoria de la Sociedad de Ciencias Naturales La Salle, **28:** 301-334.

Ruiz-Carranza, P.M. & J.D. Lynch (1991): Ranas Centrolenidae de Colombia I: propuesta de una nueva clasificación genérica. – Lozania, **57:** 1-30.

Ruiz-Carranza, P.M. & J.D. Lynch (1998): Ranas Centrolenidae de Colombia XI. Nuevas especies de ranas de cristal del genero Hyalinobatrachium. – Revista de la Academia Colombiana de Ciencias Exactas, Físicas y Naturales, **22:** 571-586.

Señaris, J. C. & J. Ayarzagüena (2005): Revisión taxonómica de la familia Centrolenidae (Amphibia: Anura) de Venezuela. – BIOSFERA, Publicaciones del Comité Español del programa Hombre y Biosfera-Red IberoMaB de la UNESCO, **7**: 1-337.

Appendix
Specimens examined

Hyalinobatrachium crurifasciatum: VENEZUELA: Pico Tamacuari, Sierra Tapirapecó, Amazonas, MBUCV 6428 (paratopotype). *Hyalinobatrachium ignioculus:* VENEZUELA: Estado Bolívar: Salto Karuay (05°41'27" N, 61°51'40"W; 900 m), MHNLS 17131–4. Campamento Guayaraca, Auyan-Tepui (05°41'06"N, 62°31'32" W; 1005 m), MHNLS 17327. Quebrada Jaspe (04° 55' N, 61° 05' W; 900 m), MHNLS 17280. La Escalera, Km 127 on the road from El Dorado to Santa Elena de Uairén (05°57'34" N, 61°23'30" W; 1250 m), MHNLS 17123 and 17143. Campamento Ya Koo, Santa Elena de Uairén (04° 39'N, 61° 07'W), MHNLS 18056. La Laja, río Uei, Sierra de Lema (06°02'N, 61° 28'W; 485 m), MHNLS 18057-9. Quebrada in La Escalera, Sierra de Lema (06°00'N, 61°28'W; 470 m, MHNLS 18060-1.

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