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Correspondence

Advertisement call and habitat of *Vitreorana uranoscopa* (Anura: Centrolenidae) in Brazil

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As presently defined, the glass frogs of the genus *Vitreorana* are comprised of nine disjunctively distributed species, five of which occur in the Cordillera de la Costa of Venezuela and the Guianas to French Guiana; Amazonia of Colombia and Ecuador, and four in the Atlantic Forest of Brazil and Argentina (Guayasamin et al. 2009, Frost 2014, Pontes et al. 2014). As presently recognized, *Vitreorana uranoscopa* (Müller, 1924) is distributed through the eastern and southern parts of Brazil, from Minas Gerais and Espírito Santo states to the north and east of Rio Grande do Sul, in the northeast of Argentina, and also in southeastern Paraguay (IUCN 2008, Machado et al. 2010, Maffei et al. 2011, Frost 2014, Zaracho 2014).

Heyer (1985) and Heyer et al. (1990) briefly described the call of *V. uranoscopa* from sites in eastern and southern Brazil and Zaracho (2014) from Argentina. Kwet & Márquez (2010) made available MP3-sound files of *V. uranoscopa* calls from the Island of Santa Catarina. Here we redescribe the advertisement call of *V. uranoscopa* based on (a) the original (uncompressed) files of Kwet & Márquez (2010), and (b) newly gathered records from a population from the Mantiqueira Range in the state of Minas Gerais and discuss congruencies in call variability amongst populations and the occurrence of the species in anthropogenically disturbed habitats. Although the call of this species has previously been described, some published data lack modern benefits of digital recording and analysis. Some of the previous works are furthermore incomplete by lacking information on sample size and certain important call characters. While this article was in press, Zaracho (2014) published a detailed call description of the species from the Argentinean Atlantic Forest, allowing for proper comparison with our data from Brazil.

Data were gathered at Córrego Grande, municipality of Florianópolis, Island of Santa Catarina, state of Santa Catarina, southern Brazil (27°36'21.98" S, 48°30'34.47" W, approximately 140 m a.s.l) on 9 October 2002 from 20:45–22:00 h. This site has a warm humid subtropical climate and is covered by disturbed coastal Atlantic Forest vegetation. Calls were recorded with a Sony WM-D6C tape recorder coupled to a Sennheiser ME66/K6 microphone; recordings were digitalised at 44.1 kHz and 16-bit resolution.

In Minas Gerais, field records were gathered on 9 January 2009 and 30–31 December 2011 in a rural area (22°42'15.82" S, 46°10'22.14" W, appr. 1,050 m a.s.l) in the municipality of Itapeva, Brazil. The regional climate is predominantly of the tropical highland type (PMI 2013), being wet/hot from September through March and mild/dry during the other months (IBGE 1978); the original vegetation used to be Mata Atlântica, portions of which can still be found as small, scattered, highly anthropogenically disturbed patches. Calls were recorded with a Marantz PMD 671 coupled to Sennheiser ME67/K6 microphones and a M-audio Microtrack II (Sennheiser ME66/K6) digital recorder, respectively (all set at 44.1 kHz and 16-bit resolution).

Sounds were analysed using Raven Pro 1.5, 64-bit version (Bioacoustics Research Program 2012). Temporal call variables were analysed in oscillograms and spectral variables in spectrograms, applying window type = Han-

Table 1. Acoustic variables of the advertisement call of *Vitreorana uranoscopa* from Florianópolis (SC) and Itapeva (MG), Brazil. Mean+SD (minimum–maximum), N – number of specimens recorded (number of analysed calls).

Variables	Florianópolis N = 2 (46)	Itapeva N = 5 (294)
Call duration (s)	0.037±0.0003 (0.020–0.084)	0.036±0.008 (0.013–0.057)
Inter-call interval (s)	3.7±0.6(0.213–7.958)	9.0±9.1 (0.194–37.2)
Pulse duration (s)	0.01±0.0001 (0.006–0.023)	0.01±0.002 (0.002–0.029)
Pulses/note	2.8±0.1 (2.0–4.0)	3.5±0.6 (1.0–5.0)
Pulses/second	77.8±4.4 (35.7–129.0)	97.6±9.1 (41.6–230.7)
Notes/minute	17.7±1.5 (16.7–18.8)	11.1±8.4 (3.2–51.4)
Peak of dominant freq. (Hz)	4892.6±57.2 (4651.2–4995.7)	4592.0±346.0 (3962.1–5062.5)
Max. dominant freq. (Hz)	7450.5±89.3 (6189.1–8038.3)	5536.8±1014.3 (5180.4–8333.8)
Min. dominant freq. (Hz)	2520.4±168.3 (2075.6–3321.0)	3475.2±937.8 (1219.7–3946.6)
Second harmonic band (Hz)	9554.2±153.2 (8785.5–9819.1)	8983.2±738.5 (7125.0–11250.0)

ning, FFT and DFT = 256 points, overlap = 85%, brightness and contrast = 50%. Call terminology largely follows Duellman & Trueb (1994). Figures were generated using the Seewave v.1.6 package (Sueur et al. 2008) on the R (v.2.13.0) platform (R Development Core Team 2011). Three hundred and forty calls from seven males were analysed; pooled means and standard deviations were determined by considering mean parameters of individual males. Analysed sound files are listed in Appendix 1. Samples of the analysed calls will be made available at Amphibiaweb (http:amphibiaweb.org) after publication.

Call record vouchers from Santa Catarina are housed in the herpetological collection of the Museu de Ciências e Tecnologia (MCT-PUCRS 6419–22), Pontifícia Universidade Católica do Rio Grande do Sul, Porto Alegre, state of Rio Grande do Sul, Brazil; those from Itapeva (AAG-UFU 0980 and 4605–06) are in the collection of frogs of the Museu de Biodiversidade do Cerrado, Universidade Federal de Uberlândia. Municipality of Uberlândia, state of Minas Gerais, Brazil.

At Córrego Grande (SC), about 20–30 males were heard and recorded when calling from 20:45–22:00 h along a small section of 40–50 m of the Córrego Grande streamlet. This watercourse has a rocky streambed, 5–10 m in width and 10–70 cm in depth and runs through the disturbed forest fragment between the Córrego Grande and Santa Mônica quarters (municipality of Florianópolis). Males called, usually several meters apart from each other, each perched on the upper sides of leaves about 80–500 cm from the ground. A freshly laid egg clutch containing 41 yellowish eggs was found 50 cm from a calling male. This egg clutch was attached to the upper side of an oval green leaf with about 4–5 times the area occupied by the egg mass; it was overhanging the water in a nearly vertical position about 150 cm from the ground and about 20–30 cm from the banks of the stream.

At Itapeva (MG), males were heard and recorded while calling at night along a streamlet (100 cm wide, 15–50 cm deep) with a sandy/rocky bed, running along a small forest fragment (1.4 × 0.6 km) surrounded by agricultural fields and cattle pastures (Fig. 1). Calling males (N = 8) were perched on the upper side of leaves between 100–400 cm from the ground.

The advertisement call of southern Brazilian *Vitreorana uranoscopa* consists of a single note type (Fig. 2, Tab. 1), which is released alone or in pairs (Fig. 2, N = 2 males). Notes last 0.020–0.084 s and are released at a rate of 16.7–18.8 notes per minute. Notes have 2–4 well-defined pulses that last 0.006–0.023 s each; pulses 1–2 are shorter (mean = 0.013 s) than 3–4 (mean = 0.022 s); and the pulse repetition rate was between 36 and 129 pulses per second. Typically, three harmonic bands can be discerned, the fundamental is the dominant and peaks between 4,651 and 4,996 Hz; the

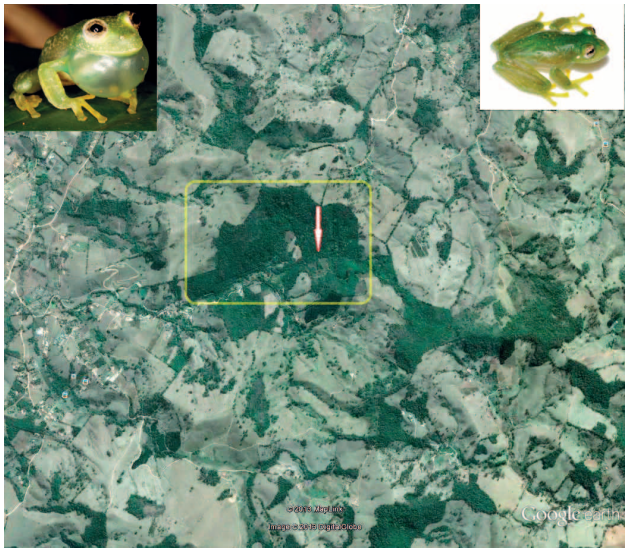

Figure 1. Satellite image of the area of occurrence of the studied population of *Vitreorana uranoscopa* in Minas Gerais. Note the minor size of the forest fragment (outlined in yellow) relative to the pasture/agricultural peripheral areas. The arrow points out the valley in which the streamlet runs where calls were recorded. The longer side of the yellow patch is about 1.3 km in length. Inserts: Adult males of the species: left: from Santa Catarina, right: from Minas Gerais.

second peaks between 8,785 and 9,819 Hz. Calls may have a discrete ascending frequency modulation followed by a discrete descending modulation toward its final portion (final pulses).

The advertisement calls from Minas Gerais consist of a single note (Figs 3A–B, Tab. 1), are more often released alone (Fig. 3A) or, rarely, in sequences (call groups) of 2–7 (sequence duration 0.44–1.80 s; N = 1 male) (Fig. 3B). Notes last 0.013–0.057 s, are released at a rate of 3–51 notes per minute, and have 1.0–5.0 well-defined pulses lasting 0.002–0.029 s; pulses 1–2 are shorter than 3–5; pulse repetition rates are between 42 and 231 pulses per second. Typically, three harmonic bands can be discerned, the fundamental is the dominant, peaking between 3,962 and 5,062 Hz; the second peaks between 7,125 and 11,250 Hz. Frequency modulation is unnoticeable throughout call duration.

Heyer (1985) provided notes on the advertisement call of *V. uranoscopa* from four Brazilian localities (Teresopolis RJ, Boracéia SP, Campo Alegre SC and Pirabeiraba SC), including sites close (≤ 40 km northeast) to type locality. Heyer et al. (1990) then referred to calls based on specimens from Boraceia as being: "given sporadically; call duration 0.04–0.1 s; 1–5 notes per call; note duration 0.03–0.05 s; note rate 0.9–3.2 per s; notes pulsed, each note of 2–3 pulses; pulse rate 80–100 per s; each pulse weakly partially pulsed; call uniform intensity; notes frequency modulated or not, if modulated, frequency rising throughout notes; dominant frequency range 4,100–5,400 Hz; only first harmonic apparent (sidebands due to note pulse rate)." Although their description is based on a few variables and an unspecified number of males, their values for variables such as dominant frequency, notes per call, note duration, and pulsed note structure are in agreement with our observations. Noteworthy here is that calls in our population had 1–5 pulses while those from Boracéia had only 2–3; in Boracéia, *V. uranoscopa* indeed called sporadically, but we found that males were calling at higher rates (Tab. 1, Figs 3A–B). We regard these differences as possibly resulting from a small size of the population investigated by these authors or even minor putative populational variations. Our results are in agreement with those of Argentinean populations described by Zaracho (2014), including the occurrence of grouped calls (2–7 calls per group) and the presence of harmonic structure. However, we did not record the initial note type sometimes preceding the regular notes (see Zaracho 2014: Fig. 3C). However, there is little doubt from the bioacoustic perspective, according to the overall similarity in calls, that the populations described by us are conspecific with that described by Zaracho (2014).

Wen et al. (2012) generalized that the calls of *Vitreorana* species have "short pulses, harmonics, and frequency modulation". In our data and that of Heyer et al. (1990), frequency modulation was very discrete or even unnoticeable. We also found at least three harmonic bands in the calls we analysed.

Some *Vitreorana* populations have been reported as declining in southeastern Brazil (Ribeiro et al. 2005), e.g., *V.* cf. *eurygnatha* at the Serra do Japi, a relatively large reservation in Jundiaí (SP) (Haddad & Sazima 1992). Even though *V. uranoscopa* presently is characterized as "Least Concern" by the International Union for Conservation of Nature (IUCN 2008), Eterovick et al. (2005) included it in a list of 20 Brazilian anuran species deserving attention regarding population declines. Considering that our studied sites represent anthropogenically disturbed areas (that

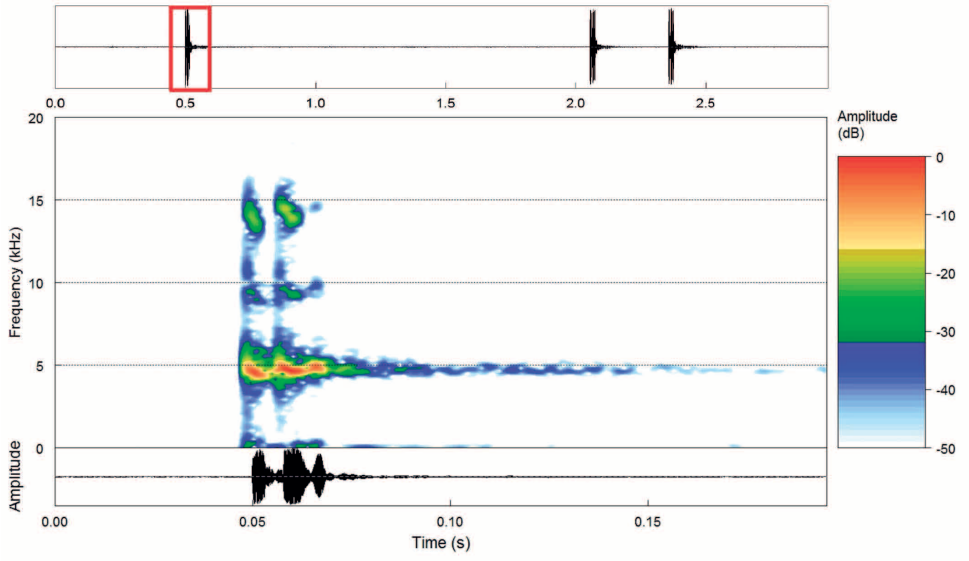

Figure 2. The advertisement call of *Vitreorana uranoscopa* from the municipality of Florianópolis (SC), Brazil. Top: Oscillogram with three calls. Bottom: Audiospectrogram (top) and corresponding oscillogram (bottom) detailing the note outlined in red. Sound file: AK 14B09, 9 October 2002; recording made between 20:45–22:00 h, air temperature 20.5°C.

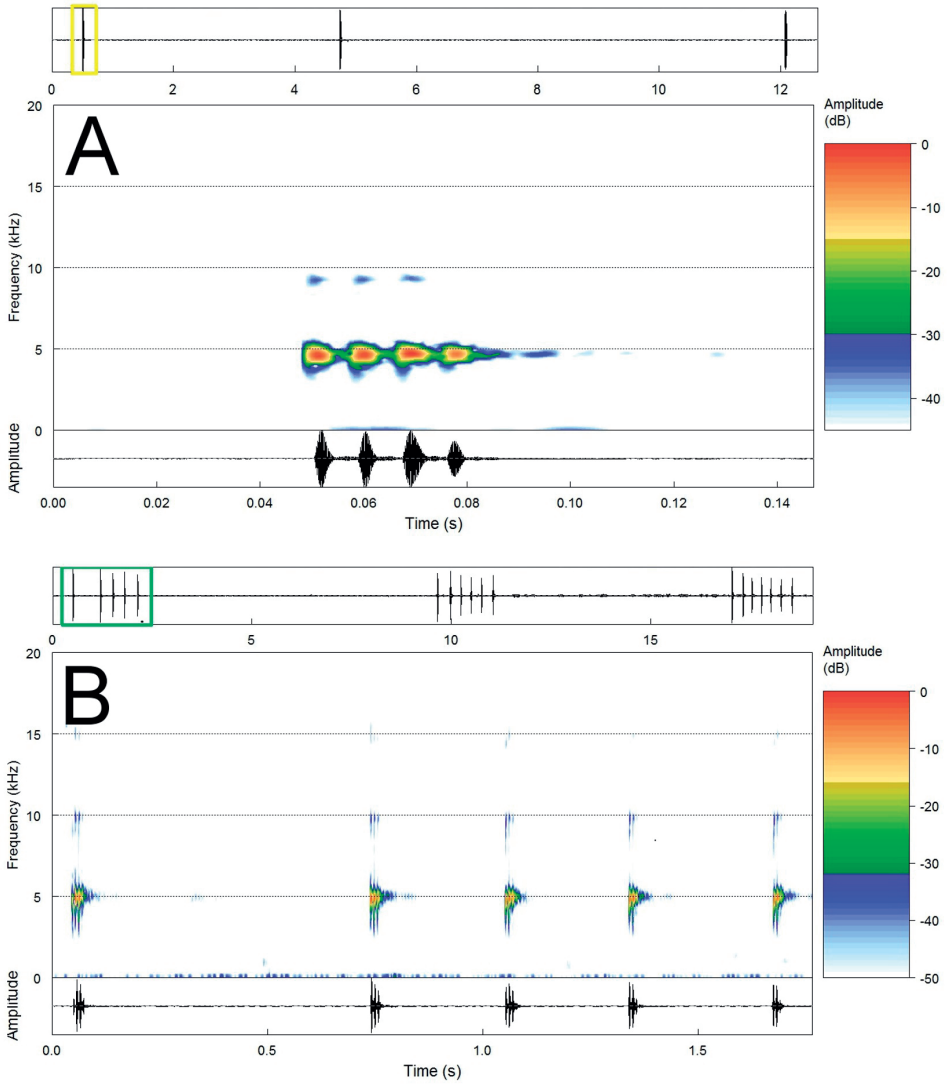

Figure 3. The advertisement calls of *Vitreorana uranoscopa* from Itapeva (MG), Brazil. (A) Audiospectrogram (top) and corresponding oscillogram (below) detailing the call outlined in yellow. Sound file: Vitreor_uranoscItapevaMG3aAAGm671_7.4s. 30 December 2011, air temperature 20°C, water temperature 18°C. (AAG-UFU 0980). (B) Top: Oscillogram of three calls groups in sequence. Bottom: Audiospectrogram (top) and corresponding oscillogram (bottom) detailing the first sequence (green square). Sound file: Vitreor_uranoscItapevaMG4gAAGm671_0.82s. 31 December 2011, 19:26 h, air temperature 20°C, water temperature 18°C.

in Minas Gerais being a tiny forest fragment), we suggest that research into the causes of possible *Vitreorana* population declines in the Atlantic Forest focus primarily on factors other than forest fragmentation, as, for example, air pollution can be expected in areas close to major urban centres as well and is the case in the Serra do Japí.

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Appendix 1
Sound files (.wav) of analysed calls

Vitreor_uranoscItapevaMG1aAAGmt
Vitreor_uranoscItapevaMG1bAAGmt
Vitreor_uranoscItapevaMG2aAAGmt
Vitreor_uranoscItapevaMG3aAAGm671
Vitreor_uranoscItapevaMG3bAAGm671
Vitreor_uranoscItapevaMG3cAAGm671
Vitreor_uranoscItapevaMG3dAAGm671
Vitreor_uranoscItapevaMG4aAAGm671
Vitreor_uranoscItapevaMG4bAAGm671
Vitreor_uranoscItapevaMG4cAAGm671
Vitreor_uranoscItapevaMG4dAAGm671
Vitreor_uranoscItapevaMG4eAAGm671
Vitreor_uranoscItapevaMG4fAAGm671
Vitreor_uranoscItapevaMG4gAAGm671
Vitreor_uranoscItapevaMG5aAAGm671
AK 14B09 and AK 14B14