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Correspondence

Advertisement call of *Hyloxalus elachyhistus* (Edwards, 1971) (Anura, Dendrobatidae)

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Hyloxalus elachyhistus (Edwards, 1971) is a poorly known dendrobatid frog distributed from southern Ecuador to northern Peru. It occurs on both the Pacific and Amazon Andean versants at altitudes between 710 and 2760 m a.s.l (Duellman 2004). The southernmost record of the species in Peru is located in Cajabamba, region of Cajamarca (Duellman 2004). It inhabits thorn forest, dry forest, montane dry forest, and humid montane forest (Duellman 2004). Climatically, its habitat is characterized by an annual mean temperature between 12 and 24°C and an annual mean precipitation between 500 and 2000 mm (Coloma 1995).

During a field trip, CK and PJV made recordings of the advertisement call of *H. elachyhistus*. We here describe it for the first time and compare it to those described for other species of *Hyloxalus* (Table 1).

Fieldwork was conducted within the Reserva Ecológica de Chaparri, situated in the region of Lambayeque, 40 km east to the coastal city of Chiclayo on the western slopes of the Andes (6°32'S, 79°28'W). The reserve extends from 350 to 1,350 m a.s.l. and is embedded as part of the Tumbesian region in the dry forest ecoregion of northwestern Peru. Several small, muddy to stony streams (0.5 m to 2 m wide; water depth between 5 and 60 cm), surrounded by comparatively dense vegetation can be found throughout the reserve (Fig. 1). Streams were surveyed between 450 and 550 m a.s.l. and searched opportunistically during day and night. A Garmin GPS Geko 201 was used for determining the GPS coordinates and the altitude above sea level. Humidity, air and water temperatures were taken with a digital thermo-hygrometer (Extech) with an external sensor.

During the survey, adults and larvae of *H. elachyhistus* of different stages were found throughout the day in the shaded parts of streams with comparatively low waterlevel and slow current. Our findings indicate that the known altitudinal distribution of the species can be extended downwards to a minimum of 466 m a.s.l.. Tadpoles were observed in wider and deeper parts of the bodies of water, but no clutches were found. At the Quebradas Chaparri and Pavas, we found *Pristimantis lymani* (Barbour & Noble, 1920) (Strabomantidae) and *Leptodactylus labrosus* (Jiménez de la Espada, 1875) (Leptodactylidae) living syntopically with *Hyloxalus elachyhistus*.

Several males were observed calling with apparent high motivation from amongst which the advertisement calls of two alternately calling individuals were recorded with a Sony WM-D6C recorder and a Sennheiser ME80 directional microphone on metal cassettes on 3 June at approximately 18:00 hrs while the respective specimens were observed. Recordings were digitalized with an external soundcard (Creative Sound Blaster, Model No. SB0270) for PC (Fujitsu Siemens Amilo M 7400, 1.4 GHz) and Soundblaster MediaSource software (48 kHz, 32 bit, mono), cut and analysed with Adobe Audition 1.5 (Adobe) and Syrinx (Burt 2007, available through http://zipprong.psych.washington.edu/index.html, v. 2.6h.). Frequency information was obtained through Fast Fourier Transformation (FFT, width 1024 points) with the Hanning window function. Nomenclature of call properties follows Köhler (2000). The two calling males were collected and euthanized with a paste of 20 % benzocaine, preserved in 10% formol and stored in 70% ethanol. These specimens have been deposited in the zoological collections of the Museo de Historia Natural de la Universidad Nacional Mayor de San Marcos, Lima, Peru (MUSM 19600) and of the Zoologisches Forschungsmuseum Alexander Koenig, Bonn, Germany (ZFMK 85034), respectively. Measurements of the snout–vent lengths (SVL) of the voucher specimens were taken with digital Venire callipers (rounded to the nearest 0.1 mm).

In total, 47 specimens were observed of which 19 called (Fig. 2). Calling sites were situated in little crevices under half-submerged stones or on the margins of the body of flowing water. Water temperatures, while animals were calling, ranged from 23.4 to 25.9°C and air temperatures from 26 to 29.5°C. Relative humidity ranged from 64 to 67%. An oscillogram and audiospectrogram depicturing the advertisement call are shown in Figure 3. The call can be characterized as a single, unpulsed, upward modulated note. The fundamental frequency ranges between 1.99 and

2.84 kHz (mean 2.37 kHz; n = 51) and the dominant frequency between 3.69 and 5.24 kHz (mean 4.46 kHz; n = 57). Three further harmonics are visible in the audiospectrogram (Fig. 3, Table 1). The note repetition rate is 1.21 notes/s and the note length is between 0.09 and 0.11 s (mean 0.10 s; SD 0.01 s; n = 57).

Comparisons of advertisement calls within the genus *Hyloxalus* are limited by the fact that calls have only been described for 14 of the currently 59 recognized species within this species group (Grant et al. 2006) (Coloma 1995, Lötters et al. 2003a, 2003b, Lötters et al. 2008, Páez-Vacas et al. 2010, Quiguango-Ubillús & Coloma 2008), i.e., *Hyloxalus awa* (Coloma, 1995), *H. azureiventris* (Kneller & Henle, 1985), *H. bocagei* (Jiménez de la Espada, 1871), *H. fallax* (Rivero, 1991), *H. italoi* (Páez-Vacas, Coloma & Santos, 2010), *H. maculosus* (Rivero, 1991), *H. mystax* (Duellman & Simmons, 1988), *H. nexipus* (Frost, 1986), *H. patitae* (Lötters, Morales & Proy, 2003), *H. pulchellus* (Jiménez de la Espada, 1875), *H. sauli* (Edwards, 1974), *H. toachi* (Coloma 1995), *H. vertebralis* (Boulenger, 1882), and *H. yasuni* (Páez-Vacas, Coloma & Santos, 2010). As a general pattern, the spatial structure of the known advertisement calls of *Hyloxalus* species are highly variable, ranging from single notes over grouped pairs of notes to trill calls consisting of series of rapidly repeated notes and buzz calls.

The advertisement call of *H. azureiventris* has a shorter note duration (32.57 vs. 100 ms) and shorter intervals between notes (46.95 vs. 75 ms) than that of *H. elachyhistus*. Those of *H. awa* have shorter note duration (50 vs. 100 ms) and a lower dominant frequency (3.0–3.4 vs. 3.69–5.24 kHz). The advertisement calls of *H. bocagei, H.italoi, H. maculosus* and *H. yasuni* are distinguished by being pulsed and having shorter note durations (38.04 ms in *H. bocagei*, 45.55 ms in *H. italoi*, 45.91 ms in *H. maculosus*, 33.89 ms in *H. yasuni* vs. 100 ms) (Páez-Vacas et al. 2010). Calls of *H. nexipus* are characterized by a shorter note duration (30–40 vs. 100 ms). Coloma (1995) thought it possible that the fundamental frequency of *H. nexipus* was below 2 kHz and further harmonics were at about 2.5 and 4.7 kHz. However, background noise in his recordings hampered analysis. Compared to the calls of *H. patitae,* the number of notes per note group is lower in *H. elachyhistus* (note groups containing three notes vs. one note) and the intervals between notes are higher (247.7±35.0 ms vs. 75±27 ms). The advertisement call of *H. pulchellus* has a shorter note duration (50 vs. 100 ms), a lower fundamental frequency (1.0–1.1 vs. 1.99–2.84 kHz) and a lower dominant frequency (2.7–3.0 vs. 3.69–5.24 kHz). Vocalizations of *H. sauli* have

Figure 2. *Hyloxalus elachyhistus* in life (call voucher ZFMK 85034, SVL 19 mm).

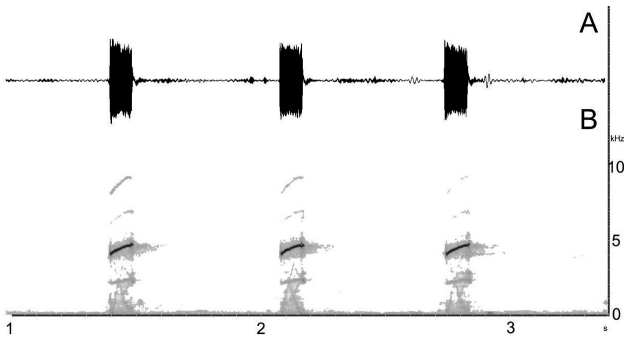

Figure 3. Oscillogram (A) and audiospectrogram (B) of the advertisement call of *Hyloxalus elachyhistus* ZFMK 85034, SVL 19 mm); air temperature during recording 28.6°C.

Figure 1. Stream along which *Hyloxalus elachyhistus* occurs at Chaparri.

Table 1. Properties of advertisement calls of *Hyloxalus elachyhistus* (MUSM 19600, SVL 21 mm; ZFMK 85034, SVL 19 mm) recorded at 28.6°C compared to advertisement calls of other *Hyloxalus* species.

	H. elachyhistus	*H. awa*	*H. azureiventris*	*H. bocagei*	*H. italoi*
Air temperature (°C)	28.6	24	24		
Number of calls studied	57	8	20	8	13
Note duration (ms)	90–110 100±10	50	29–37 32.57±2.54	34.66–44.8 38.04±3.42	38.22–64.22 45.55±7.34
Number of notes per second	1.21		12.6		
Call pulsed or unpulsed	unpulsed		unpulsed	pulsed	pulsed
Intervals between notes (ms)	39–135 75±27		41–52 46.95±2.97	44.39 –55.36 49.76±3.68	25.94–64.2 51.74±9.04
Fundamental frequency (kHz)	1.99–2.84		1.65–1.85	2.1–2.5	1.6–2.0
Maximum call energy of fundamental frequency (kHz)	2.37				
Dominant frequency (kHz)	3.69–5.24	3.0–3.4	3.4–3.6	4.1–4.9	3.4–3.8
Maximum call energy of dominant frequency (kHz)	4.46				
Harmonics (kHz)	5.99–7.33 7.96–9.70 12.06–14.43				
Source	This study	Coloma (1995)	Lötters & Kneller (2000)	Páez-Vacas et al. (2010)	Páez-Vacas et al. (2010)

a much shorter note duration (13.36 vs. 100 ms), shorter intervals between notes (35.85 vs. 75 ms), a lower fundamental frequency (1.3–1.9 vs. 1.99–2.84 kHz) and a lower dominant frequency (2.5–3.4 vs. 3.69–5.24 kHz). Calls of H. *toachi* have a shorter note duration (17–48 vs. 100 ms) and much longer intervals between notes (350–380 vs. 39–135 ms). The advertisement call of *H. vertebralis* is distinguished from that of *H. elachyhistus* by its higher fundamental frequency (1.10–1.20 kHz vs. 1.99–2.84 kHz), higher dominant frequency (2.7–3.1 kHz vs. 3.69–5.24 kHz), longer note duration (70 ms vs. 100 ms) and higher number of harmonics (2 vs. 3). Several call descriptions are rather 'anecdotal' and call properties are not quantitatively specified. This also applies to the descriptions of calls of *H. fallax* by Coloma (1995) and *H. mystax* by Duellman & Simmons (1988), which therefore do not allow quantitative comparisons of call properties.

Some attempts have been made to classify calls of dendrobatid frogs. According to these, the advertisement call of *H. elachyhistus* could be described as a 'single-note call' sensu Zimmermann (1990) or as a 'chirp call' sensu Lötters et al. (2003b), characterized by a series of relatively uniform, upward frequency-modulated notes.

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H. maculosus	*H. nexipus*	*H. patitae*	*H. pulchellus*	*H. sauli*	*H. toachi*	*H. yasuni*	*H. vertebralis*
	23	23.4	24.0–30.0				14
9	8	7	8	9	25	28	1
34.56–50.24 45.91±4.93	30–40	see text see text	50	11.18–16.77 13.36±1.94	17–48	25.74–54.8 33.89±6.99	70
pulsed				unpulsed		pulsed	
48.55–71.74 56.18±9.63				32.72–42.22 35.85±2.76	350–380	14.14–49.29 37.33±8.02	
2.0–2.2	see text		1.0–1.1	1.3–1.9	2.0–2.2	1.5–2.1	1.1–1.2
4.0–4.3	see text	4.09–4.17 4.13±0.04	2.7–3.0	2.5–3.4	4.0–4.3	3.1–3.9	2.7–3.1
Páez-Vacas et al. (2010)	Coloma (1995)	Lötters et al. (2003b)	Coloma (1995)	Páez-Vacas et al. (2010)	Guiguango-Ubillús & Coloma (2008)	Páez-Vacas et al. (2010)	Coloma (1995)

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