



Female Vocalization in the Oriente Streamside Frog, *Eleutherodactylus cuneatus* (Eleutherodactylidae), from Cuba

Ansel Fong G. and Irelis Bignotte-Giró

Centro Oriental de Ecosistemas y Biodiversidad (BIOECO), Museo de Historia Natural “Tomás Romay,” Enramadas # 601, Santiago de Cuba 90100, Cuba (ansel@bioeco.cu [corresponding author], irelis@bioeco.cu)

The Oriente Streamside Frog (*Eleutherodactylus cuneatus*; Fig. 1) is a Cuban endemic restricted to the eastern portion of the island (Díaz and Cádiz 2008). It is a riparian species, although frogs sometimes venture far from water, living in the leaf litter of forested areas and sometimes in disturbed habitats with streams (IUCN SSC Amphibian Specialist Group 2014; Díaz and Cádiz 2008).

Males call 24 hours a day (Bignotte-Giró et al. 2019), with the highest number of calling individuals in June–July and few or no vocalizations between October and February (Fong et al. 2010). Males usually vocalize from the ground or at low heights above the ground while perched on small objects such as rocks, earthen or stone walls, vines, stumps, and small shrubs (Henderson and Powell 2009; Bignotte-Giró et al. 2019; Fig. 2). The only known clutch was comprised of 43 eggs found under a rock on the edge of a mountain trail in July (Estrada and Hedges 1998).

Vocalizations of anuran males involve five recognized types of calls (Duellman and Trueb 1994) and female vocalizations have been reported for more than 20 species from around the world (Emerson and Boyd 1999; Zhang et al. 2017). The most common female vocalization consists of “reciprocal calls,” in which a female responds vocally to the advertisement call of a male (Duellman and Trueb 1994). However, a few confirmed reports document females initiat-

ing calls in the complete absence of males to solicit amplexus, emitting patterned mating calls during amplexus, or issuing territorial calls (Emerson and Boyd 1999).

At about 0915 h on 26 May 2005, we collected an adult female *E. cuneatus* (49.9 mm SVL with eggs clearly visible through the abdominal skin; Fig. 3) on a stream bank 2.1 km



Fig. 2. Male Oriente Streamside Frogs (*Eleutherodactylus cuneatus*) often call from the ground in forested areas near streams. Photograph by the senior author.



Fig. 1. The Oriente Streamside Frog (*Eleutherodactylus cuneatus*) is quite variable in color and pattern. Photographs by the senior author.



Fig. 3. Adult female Oriente Streamside Frog (*Eleutherodactylus cuneatus*, BSC.H-3280) collected 2.1 km WSW of La Caoba, San Luis Municipality, Santiago de Cuba Province, Cuba. Photograph by the senior author.



Fig. 4. Map of eastern Cuba depicting the locality (red dot) where we collected the female Oriente Streamside Frog (*Eleutherodactylus cuneatus*) in the foothills of the Sierra de Nipe.

WSW of La Caoba, San Luis Municipality, Santiago de Cuba Province, Cuba (Fig. 4). The vegetation in the area comprised a patchwork of coffee plantations, semideciduous forest, and mixed cultures. Another smaller individual (possibly a male) was close to the female but could not be captured.

The captive female was kept in a plastic bag from which she emitted short, one-note calls at long intervals from noon

to dawn. During this period, she laid five eggs. At about 1830 h, the female began a call sequence that was recorded using a Marantz PMD 222 tape recorder (with a Type II Maxell 60-minute cassette) and a Sennheiser ME 66 unidirectional microphone. Air temperature at the time of the recording was 28 °C. The specimen was deposited in the herpetological collection of BIOECO (BSC.H-3280, field number AFG 2884). For comparison, we analyzed a male call recorded at La Gran Piedra, Santiago de Cuba, at 0500 h on 27 August 2002 using the same equipment. Recordings were deposited at the Laboratorio de Sonidos Naturales Juan C. Gundlach at BIOECO, Santiago de Cuba.

Sounds were digitized at 44.1 kHz and 16 bits resolution and analyzed with Raven 1.1 software (Cornell Lab of Ornithology, Ithaca, New York, USA). Dominant frequency was the frequency of maximum energy in the power spectrum (FFT= 512 points, “Hanning” type window) measured with an error of 0.001 kHz. Temporal parameters were measured according to Díaz and Cádiz (2007, 2008) as follows: note duration (time from the beginning to the end of the note), note interval (time between the beginning of a note and the beginning of the next note), and call repetition rate (number of calls per minute). These variables were measured in oscillograms with an error of 0.01 mS.

Female calls comprised one note and a repetition rate of 15.2 calls per minute. Mean note duration was 72.65 ± 26.55 mS with longer silent intervals; the dominant frequency varied little (Table 1). All notes were descendant and had three harmonics (Fig. 5). Female call values were within the range of male calls, following the descriptions of Díaz and Cádiz (2007, 2008). When comparing the call with that of a male for one note only (Table 1), female values were similar although that of the female demonstrated slightly more variable temporal properties. The female’s dominant frequency was lower than that of the male, but that difference is undoubtedly attributable to the difference in body size.

In Cuba, female calls are known in four species of *Eleutherodactylus*, although only those of *E. guanahacabibes* have been described (Díaz and Estrada 2000). Díaz and Cádiz

Table 1. Acoustic properties of female and male calls of the Oriente Streamside Frog (*Eleutherodactylus cuneatus*). For each sex, one call was analyzed compounded by eight notes (male) and 17 notes (female). Means are listed ± one standard deviation (SD).

	Female		Male			
	Mean ± SD	Minimum	Maximum	Mean ± SD	Minimum	Maximum
Dominant frequency (kHz)	1.641 ± 0.095	1.533	1.809	1.907 ± 0.092	1.809	1.981
Note duration (mS)	72.65 ± 26.55	42.00	131.00	86.69 ± 11.78	64.00	102.40
Note interval (S)	4.03 ± 2.56	2.55	10.66	7.05 ± 1.89	5.06	9.53
Call repetition rate	—	—	15.2	—	—	9.4

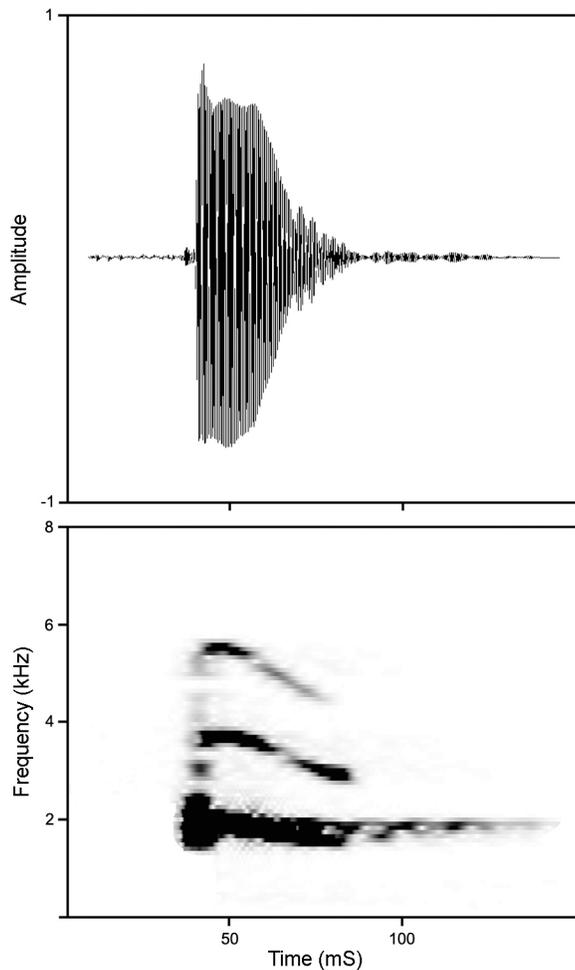


Fig. 5. Oscillogram (above) and sonogram (below) of one call of a female Oriente Streamside Frog (*Eleutherodactylus cuneatus*) from 2.1 km WSW of La Caoba, Santiago de Cuba Province, Cuba. Air temperature = 28 °C.

(2008) noted that female *E. intermedius* vocalized with characteristics similar to those of males and Alonso et al. (2007) included recordings of female *E. goini* and *E. zeus* in their sound guide of Cuban amphibians. So, *E. cuneatus* is the fifth Cuban species in which females are known to vocalize.

Although our data are preliminary, we interpret these calls in a breeding context. Considering that this was a large individual (maximum sizes reported for this species were 58.6 mm by Estrada and Hedges [1998] and 60.3 mm by Díaz and Cádiz [2008]), it could have been an old female with a large investment in current reproduction and a low probability of surviving to mate again (Judge et al. 2000). Supporting

this hypothesis is the fact that this female laid unfertilized eggs after calling, similar to the report of *E. guanahacabibes* females by Díaz and Estrada (2000). Among the six functions suggested for female vocalizations by Zhang et al. (2017), the hypotheses of advertising receptivity and attracting, finding, or localizing a mate seem the most plausible, as these would increase the likelihood of mating while minimizing costs (Judge et al. 2000).

Acknowledgements

We thank G. Budney, E. Inígo-Elías, and the Cornell Laboratory of Natural Sounds for their help and support in our work of recording and analyzing the natural sounds of Cuba. Fieldwork was part of the project “Caracterización y estrategia de conservación de la biodiversidad en la cuenca del río Cauto.” IdeaWild donated useful field equipment. We also thank W.E. Duellman and K.A. Judge for providing useful literature.

Literature cited

- Alonso, R., A. Rodríguez, and R. Márquez. 2007. *Guía Sonora de los Anfibios de Cuba. Sound Guide of the Amphibians of Cuba*. Alosa, Sons de la Natura, Barcelona, Cataluña, Spain.
- Bignotte-Giró, I., A. Fong, and G.M. López-Iborra. 2019. Acoustic niche partitioning in five Cuban frogs of the genus *Eleutherodactylus*. *Amphibia-Reptilia* 40: 1–11.
- Díaz, L.M. and A.R. Estrada. 2000. The male and female vocalizations of the Cuban frog *Eleutherodactylus guanahacabibes* (Anura: Leptodactylidae). *Caribbean Journal of Science* 36: 328–331.
- Díaz, L.M. and A. Cádiz. 2007. Guía descriptiva para la identificación de las llamadas de anuncio de las ranas cubanas del género *Eleutherodactylus* (Anura: Leptodactylidae). *Herpetotropicos* 3: 100–122.
- Díaz, L.M. and A. Cádiz. 2008. Guía taxonómica de los anfibios de Cuba. *Abc Taxa* 4: vi + 294 pp.
- Duellman, W. and L. Trueb. 1994. *Biology of Amphibians*. Johns Hopkins University Press, Baltimore, Maryland, USA.
- Emerson, S.B. and S.K. Boyd. 1999. Mating vocalizations of female frogs: control and evolutionary mechanism. *Brain, Behavior and Evolution* 53: 187–197.
- Estrada, A.R. and S.B. Hedges. 1998. Sistemática de las ranas ribereñas de Cuba (Leptodactylidae: *Eleutherodactylus*) con la descripción de una nueva especie. *Caribbean Journal of Science* 34: 218–230.
- Fong, A., J.M. Hero, R. Viña, and I. Bignotte-Giró. 2010. Population ecology of the riparian frog *Eleutherodactylus cuneatus* in Cuba. *Biotropica* 42: 348–354.
- Henderson, R.W. and R. Powell. 2009. *Natural History of West Indian Amphibians and Reptiles*. University Press of Florida, Gainesville, Florida, USA.
- IUCN SSC Amphibian Specialist Group. 2014. *Eleutherodactylus cuneatus*. The IUCN Red List of Threatened Species 2014: e.T56544A56053938. <<http://dx.doi.org/10.2305/IUCN.UK.2014-1.RLTS.T56544A56053938.en>>.
- Judge, K.A., S.J. Swanson, and R.J. Brooks. 2000. *Rana catesbeiana* (bullfrog). Female vocalization. *Herpetological Review* 31: 236–237.
- Zhang, F., J. Zhao, and A.S. Feng. 2017. Vocalizations of female frogs contain nonlinear characteristics and individual signatures. *PLoS One* 12: e0174815. DOI: 10.1371/journal.pone.0174815.