PROCEEDINGS OF THE
BIOLOGICAL SOCIETY
OF WASHINGTON

The advertisement calls of two sympatric frogs, *Leptodactylus lithonaetes* (Amphibia: Anura: Leptodactylidae) and *Pristimantis vilarsi* (Amphibia: Anura: Strabomantidae)

W. Ronald Heyer* and César Luis Barrio-Amorós

(WRH) Division of Amphibians and Reptiles, National Museum of Natural History, PO Box 37012, Smithsonian Institution, Washington, D.C. 20013-7012, U.S.A., e-mail: heyerr@si.edu; (CLBA) Fundación AndígenA, Apartado Postal 210, 5101-A Mérida, Venezuela, e-mail: cesarlba@yahoo.com

PROCEEDINGS OF THE BIOLOGICAL SOCIETY OF WASHINGTON
122(3):282–291. 2009.

The advertisement calls of two sympatric frogs, *Leptodactylus lithonaetes* (Amphibia: Anura: Leptodactylidae) and *Pristimantis vilarsi* (Amphibia: Anura: Strabomantidae)

W. Ronald Heyer* and César Luis Barrio-Amorós

(WRH) Division of Amphibians and Reptiles, National Museum of Natural History, PO Box 37012, Smithsonian Institution, Washington, D.C. 20013-7012, U.S.A., e-mail: heyerr@si.edu; (CLBA) Fundación AndígenA, Apartado Postal 210, 5101-A Mérida, Venezuela, e-mail: cesarlba@yahoo.com

Abstract.—The advertisement calls of the frog species *Leptodactylus lithonaetes* and *Pristimantis vilarsi* are described for the first time based on calls recorded in the Venezuelan State of Amazonas. The call of *L. lithonaetes* bears an overall resemblance to that of *L. rugosus*, suggesting a sister-group relationship between the two species. The call of *Pristimantis vilarsi* is similar to those of other species in the *P. conspicillatus* species group.

The advertisement calls of *Leptodactylus lithonaetes* Heyer, 1994 and *Pristimantis vilarsi* (Melin, 1941) have not been described. CLBA obtained recordings of one individual of *L. lithonaetes* from a lowland base camp at Autana (4°48′19″N, 67°29′04″W, 89 masl), Amazonas, Venezuela and one individual from Tobogán de La Selva, (5°35′N, 67°32′W), Amazonas, Venezuela. *Leptodactylus lithonaetes* also occurs on the top of Autana (~1400 masl), but no recordings were made from there. *Pristimantis vilarsi* was also recorded from Tobogán de La Selva, Amazonas, Venezuela. The purpose of this paper is to describe these calls and comment on the natural history of these two species.

The Tobogán de la Selva calls were recorded on 15 April 2005, with a Sony MZ-N10 Mini Disc recorder and Sony ECM-MS907 microphone at a temperature of 26°C. The Autana calls were recorded with the same equipment on 25 August 2006, at a temperature of 27.8°C. The Sony recorder is an early model that uses a compression algorithm that introduces some frequency and intensity level distortion. CLBA was unaware of this problem and did no testing of the potential effects prior to making the recordings. The sampling rate was 44.1 kHz and the frequency response 20–20,000 Hz ± 3 dB. The calls were analyzed using Raven 1.2 software (Charif et al. 2004). The recordings are deposited in the Fundación AndigenA Phonographic Collection and are available by contacting CLBA. No voucher specimens were collected due to the lack of permits at the time of the field trips. Terminology follows Heyer et al. (1990). Temporal data were evaluated from expanded wave forms; dominant frequencies from spectrum analyses; and beginning and ending frequency data in the initial part of the call from appropriately expanded portions of audiospectrogram analyses. The initial rise component of *Leptodactylus lithonaetes* ends with a well-defined pulse (just past 5.46 s as illustrated in Fig. 4); the initial rise component for *L. rugosus* lacks a well-defined pulse (ending of initial rise component for *L.

* Corresponding author.

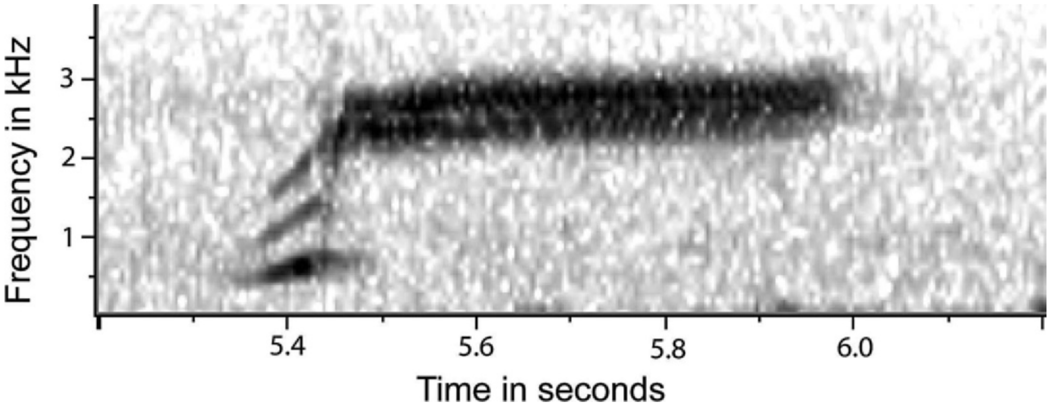

Fig. 1. Audiospectrogam of advertisement call of *Leptodactylus lithonaetes*, Tobogán call 1.

rugosus illustrated in Fig. 4, just past 1.15 s).

Leptodactylus lithonaetes

Two calls were recorded from the Tobogán de La Selva individual. The calls are separated by 126 s. Three calls were recorded from the Autana individual. The first and second Autana calls are separated by 20.2 s, while the second and third calls are separated by 1.9 s. The calls consist of two distinct components, beginning with a short rising frequency portion of 3–8 pulses, immediately followed by a long, pulsed, high frequency portion (Figs. 1, 2). The first component of the call begins at low intensity and ends with a high intensity pulse. The second component of the call is moderately intensity modulated, being slightly quieter at the beginning and end (Fig. 2). Most of the pulses in the call are distinct, but some are unclear and may consist of single or multiple pulses. Quantitative data are presented in Table 1. The variation in call parameters from single individuals is comparable to that between individuals. The dominant frequency is the fundamental frequency. Harmonic structure is present and strongest in the initial portion of the call.

The advertisement calls of *Leptodactylus lithonaetes* are remarkably similar to two analyzed calls of *L. rugosus* (Figs. 1, 3; Table 1). The intensity modulations of the long second call components of *L. rugosus* from La Escalera and km 104 on the El Dorado-Santa Elena road, Bolívar, Venezuela are slightly more pronounced than in *L. lithonaetes*. The second component of the call has the greatest intensity in the first quarter in the km 104 recording, whereas the La Escalera recording has the greatest intensity in the last half of the second component of the call. All of the calls of *L. lithonaetes* lack dominant frequency modulation in the second component of the call. In the recordings of *L. rugosus*, there is slight (La Escalera call) to pronounced (km 104 call) rising dominant frequency modulation at the beginning of the second component of the call (compare Figs. 1, 3, 4). The most consistent difference observed in the available calls is that there is a distinct, intense pulse at the end of the initial rising component of the call in *L. lithonaetes* that is not observed in the calls of *L. rugosus* (Fig. 4). The distinct, intense pulse defined as the last pulse in the initial rising component of the call could arguably be described as the first pulse of the long component call. Irrespective of whether this pulse is the last pulse of the first call component or the first pulse of the second call component, the pulse involved only occurs in the calls of *L. lithonaetes*.

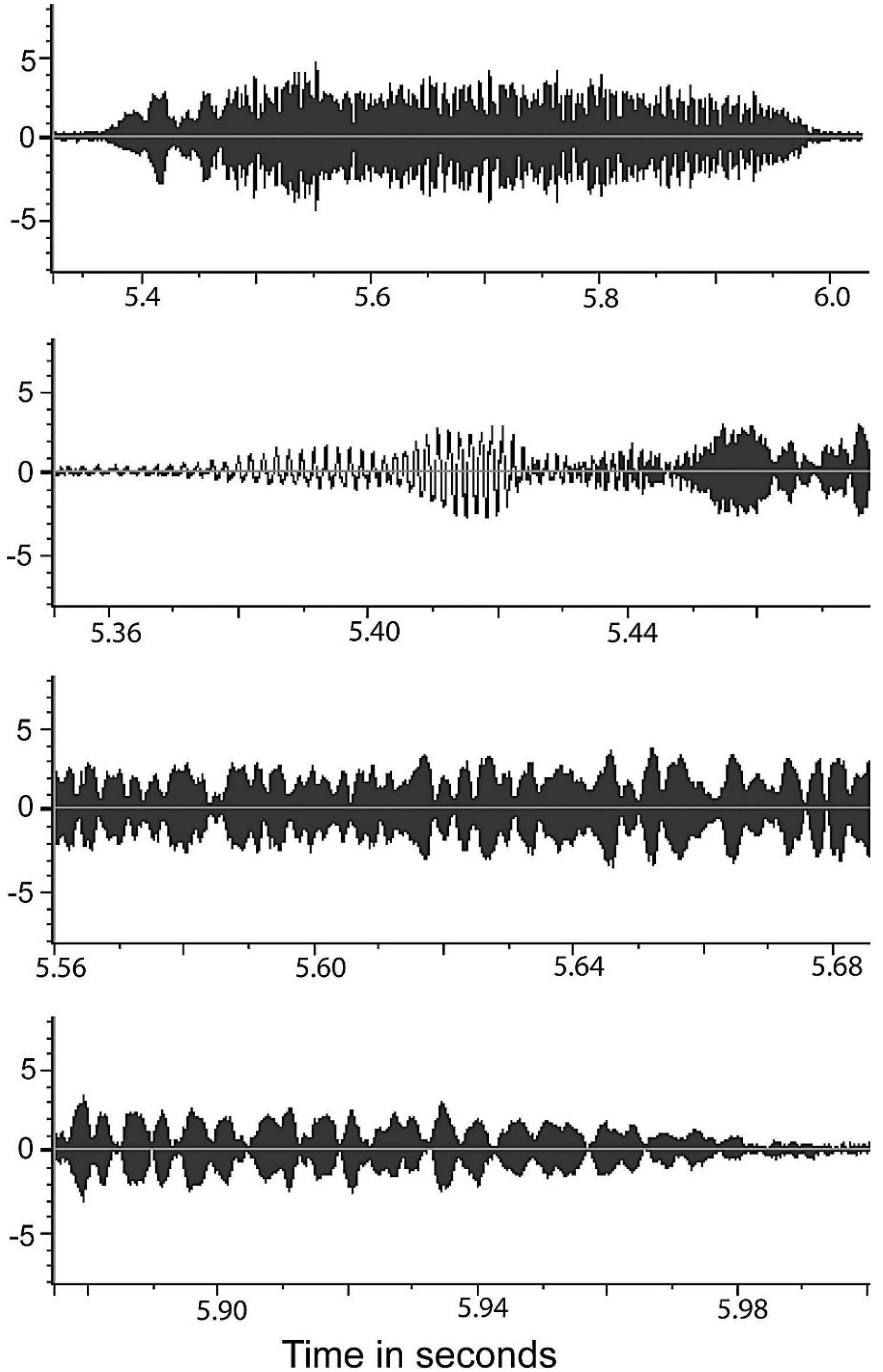

Fig. 2. Wave form of the advertisement call of *Leptodactylus lithonaetes* (top), followed by beginning, middle, and end portions of call, Tobogán call 1. The vertical axes units are the actual sample values in the signal, which are proportional to the sound pressure at the microphone when the sound was recorded.

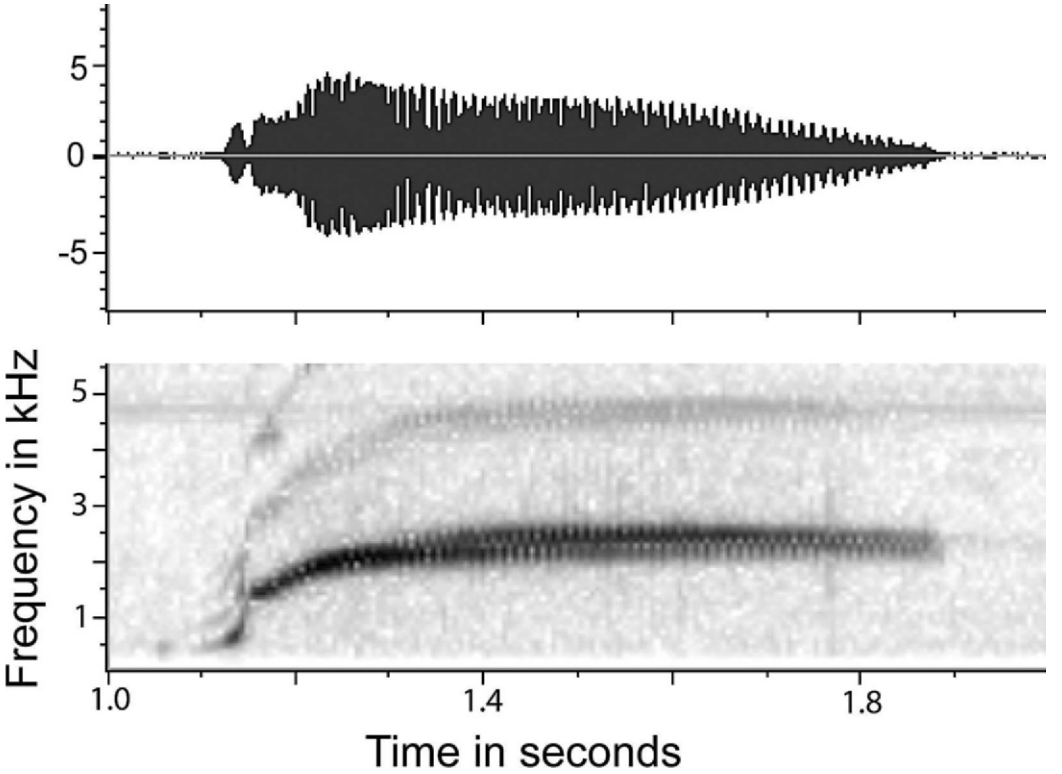

Fig. 3. Wave form (above) and audiospectrogram (below) of the advertisement call of *Leptodactylus rugosus* (USNM recording 113, cut 3, km 104 on the El Dorado-Santa Elena road, Bolívar, Venezuela). For the wave form, the vertical axis units are the actual sample values in the signal, which are proportional to the sound pressure at the microphone when the sound was recorded.

A distinct feature occurs in the long components of the calls in both *Leptodactylus lithonaetes* and *L. rugosus*. The dominant frequency is visually different between consecutive pulses in the audiospectrograms (Figs. 1, 3). Short portions of consecutive pulses from the middle of the Autana 2 call of *L. lithonaetes* and the km 104 call of *L. rugosus* were evaluated. The dominant frequencies of consecutive pulses in the call of *L. lithonaetes* are 3180-3180-3036-2800-3142-3180-2762-3087-3094-3180-3013-2684 Hz. The individual cycle values for the last pulse (average 2684 Hz) are 2202-2489-2602-2602-2385-2602-2602-2602-3180 Hz. The comparable data for the recording of *L. rugosus* are 2177-2390-2177-2337-2200-2337-2397 Hz, with individual cycle values for the last pulse (average 2397 Hz) of 2512-2512-2344-2344-2344-2344-2512-2512-2344-2198-2344-2344-2198-2344-2198 Hz. Frequency (Hz) varies both within and between consecutive pulses.

The advertisement calls of *L. lithonaetes* and *L. rugosus* together are distinctive among species of *Leptodactylus*. To the human ear, the calls sound more bird-like than frog-like. A bird-like call likely occurred in the common ancestor of these two species rather than being independently derived in each.

The only consistent feature we find that distinguishes the calls of *L. lithonaetes* from those of *L. rugosus* is the intense pulse of energy at the end of the first component of the call of *L. lithonaetes* that is not present in the two calls analyzed for *L. rugosus* (Fig. 4). If this difference between the calls of *L. litho-*

Table 1.—Parameter data for advertisement calls of *Leptodactylus lithonaetes* and *L. rugosus*. Tobogán = Tobogán de La Selva. Km 104 = El Dorado-Santa Elena road, km 104. The number of pulses in the initial rise component of the Autana 2 and La Escalera calls are not clearly differentiated as to whether 3 or 4 and 1 or 2 pulses are involved, respectively, for the two calls.

	Leptodactylus lithonaetes					*Leptodactylus rugosus*	
	Tobogán 1	Tobogán 2	Tobogán 3	Autana 1	Autana 2	La Escalera	Km 104
Call duration in s	0.720	0.620	0.801	0.787	0.826	0.911	0.776
Initial rise duration in s	0.071	0.096	0.075	0.081	0.080	0.068	0.039
Initial rise number of pulses	8	5	3	3	3–4	1–2	1
Initial rise pulse rate/s	113	52	40	37	38–50	15–29	26
Initial rise dominant frequency	596	600	776	771	766	690	609
Initial rise fundamental beginning frequency	462	484	547	612	547	484	526
Initial rise fundamental ending frequency	694	694	897	875	831	913	804
Long portion duration in s	0.566	0.524	0.726	0.706	0.746	0.843	0.737
Long portion beginning pulse rate/s	232	260	325	288	118		
Long portion middle pulse rate/s	278	275	481	345	117	213	209
Long portion end pulse rate/s	240	195	316	279	210		
Long portion beginning pulse duration in s	0.002–0.005	0.003–0.005	0.002–0.007	0.002–0.006	0.002–0.010		
	0.0036	0.0038	0.0032	0.0035	0.0076		
Long portion middle pulse duration in s	0.003–0.005	0.003–0.004	0.001–0.003	0.001–0.006	0.002–0.011	0.003–0.006	0.004–0.006
	0.0040	0.0034	0.002	0.0031	0.0063	0.0047	0.0055
Long portion end duration in s	0.003–0.004	0.003–0.006	0.001–0.006	0.001–0.005	0.002–0.009		
	0.0034	0.0046	0.0031	0.0035	0.0048		
Long portion dominant frequency	2575	2343	2749	2670	2844	2842	2842
	2838	2747	3184	3187			

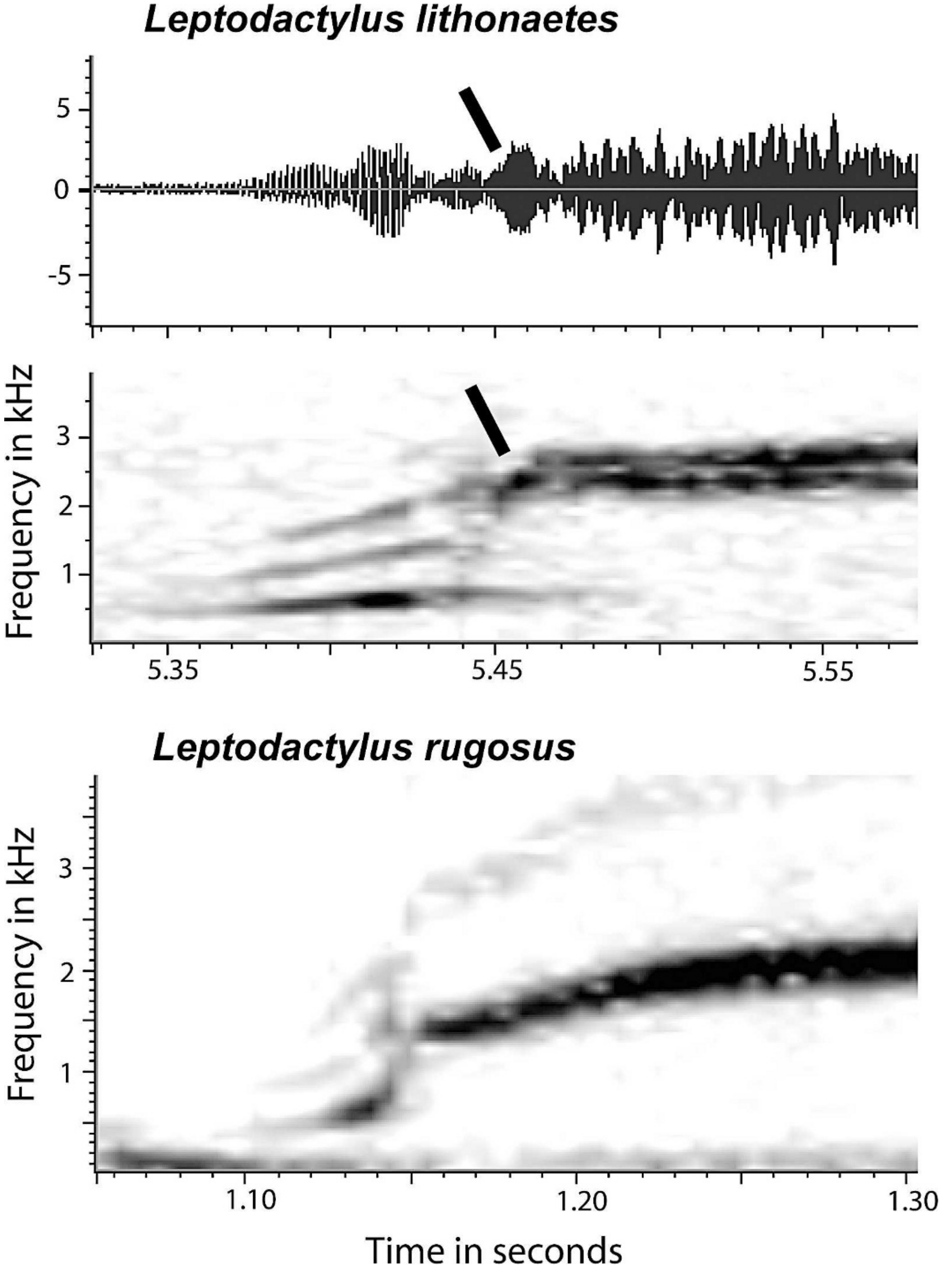

Fig. 4. Beginning of advertisement calls of *Leptodactylus lithonaetes* (Tobogán de La Selva) and *L. rugosus* (km 104). Dark bars in *L. lithonaetes* figures indicate high intensity pulse not found in *L. rugosus* recordings. Also note the flat aspect of the beginning of the long portion of the call in *L. lithonaetes* in contrast to the rising dominant frequency in the *L. rugosus* call. The vertical axis units of the wave form are the actual sample values in the signal, which are proportional to the sound pressure at the microphone when the sound was recorded.

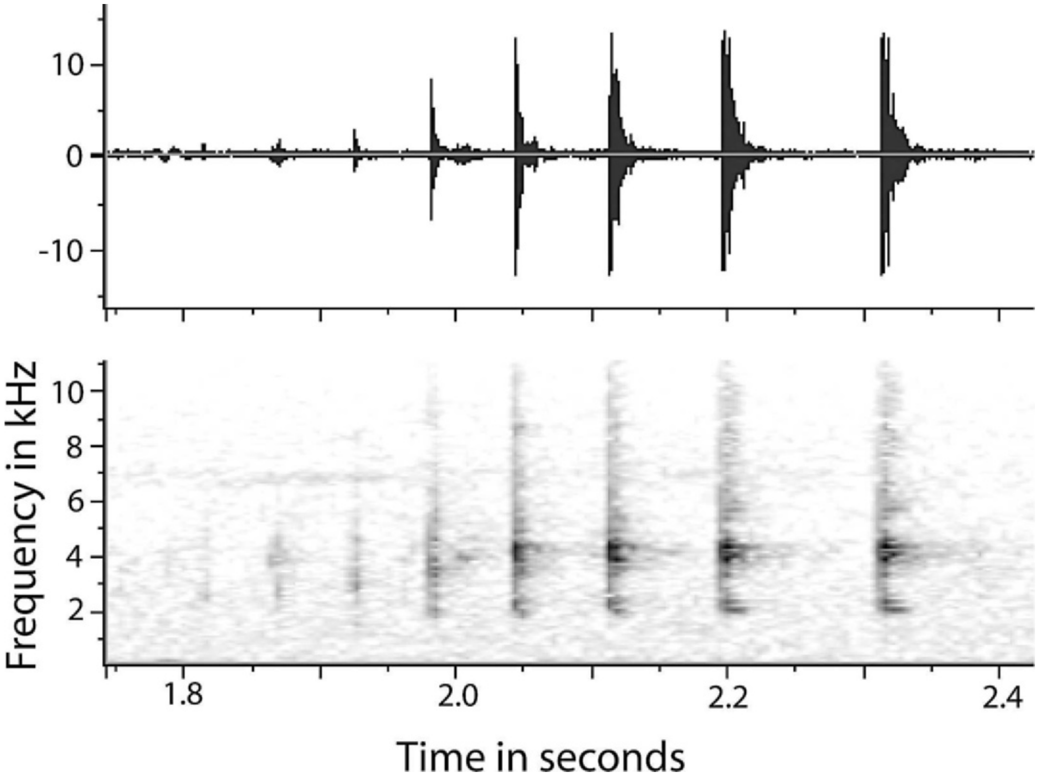

Fig. 5. Wave form (above) and audiospectrogram (below) of the advertisement call of *Pristimantis vilarsi*. The vertical axis units of the wave form are the actual sample values in the signal, which are proportional to the sound pressure at the microphone when the sound was recorded.

naetes and *L. rugosus* is consistent, would females be able to distinguish between the calls of the two species? More recordings and call experiments are needed to answer this question. To date, *L. lithonaetes* and *L. rugosus* are not known to co-occur. One possibility is that there has been little or no selection to differentiate between the calls of these two presumably closely related allopatric species.

Pristimantis vilarsi

The single recorded call consists of eight notes, with a duration of 0.521 s (Fig. 5). The notes are given at a rate of 14/s. The call is strongly intensity modulated, beginning very quietly and gaining pronounced, incremental amplitude through the first four notes, with a noticeable increase in intensity over the last four notes that have nearly equivalent amplitude peaks. Duration increases from the first through the eighth note — 0.003, 0.003, 0.004, 0.006, 0.007, 0.012, 0.013, 0.021 s. Each note is pulsed, with individual pulse duration of the eighth note ranging between 0.0012–0.0025 s (Fig. 6). Frequencies vary among pulses, with the dominant frequencies of four consecutive pulses measured in the eighth note being 4444, 4210, 4375, and 4000 Hz. The dominant frequency of the final four notes of the call (signals not strong enough to measure in the first four notes) range from 3799–4284 Hz (comprising the second harmonic frequency of the call); the fundamental frequency ranges from 1959–2256 Hz. At least one additional harmonic to that of the dominant frequency is apparent in the call.

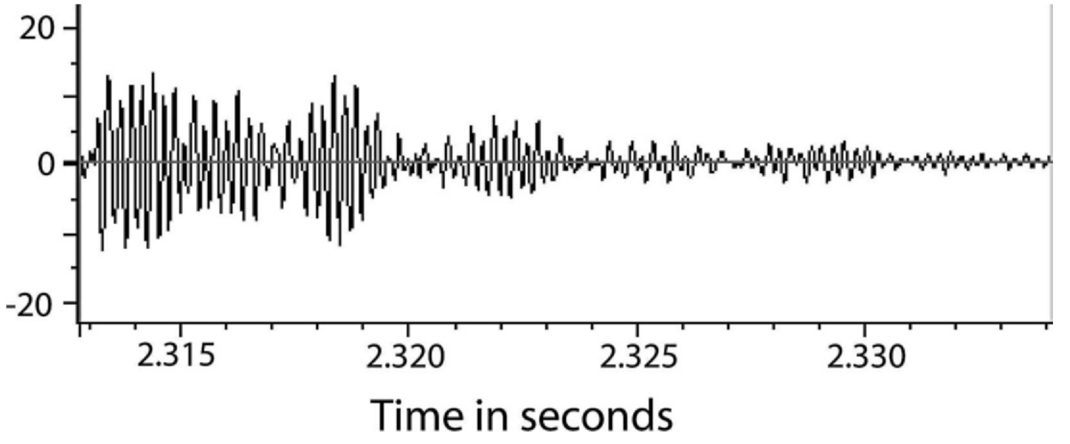

Fig. 6. Expanded wave form of final note of the advertisement call of *Pristimantis vilarsi*. The vertical axis units are the actual sample values in the signal, which are proportional to the sound pressure at the microphone when the sound was recorded.

Fig. 7. *Leptodactylus lithonaetes* from Raudal Ceguera, Autana, Estado Amazonas, Venezuela, 25 August 2006.

Fig. 8. *Leptodactylus rugosus* calling from exposed rock at La Laja, Sierra de Lema, Estado Bolívar, Venezuela, 26 October 2006. Note the unexpanded double vocal sacs and the pectoral spines.

Discussion

Many collections have been made at Tobogán de la Selva, a well-known locality near Puerto Ayacucho. Specimens from the area are represented in many museum collections such as AMNH, EBRG, FMNH, KU, MCNC, SCN (better known in Latin America as MHNLS), and USNM (see Leviton et al. 1985). Tobogán de la Selva is currently managed by local indigenous people who charge a fee to enter. Nocturnal activities are not allowed by the community, but by taking a local guide, one can hike upstream along the paths at night into the rainforest. At night, the two most commonly heard calls are those of *Leptodactylus lithonaetes* and *Pristimantis vilarsi*. During the day the calls of *Dendrobates leucomelas*, *Anomaloglossus* sp., and *Synapturanus salseri* are heard.

Calling sites for males of *Leptodactylus lithonaetes* and *L. rugosus* are usually located along rocky creeks on granitic outcrops of the Guiana Shield. Males of both species call completely exposed (Figs. 7, 8), but some males of *L. lithonaetes* also call while hidden beneath boulders. The black granitic outcrops can reach temperatures over 50°C during the day, and *L. lithonaetes* individuals often hide beneath large rocks or inside rocky caves that provide diurnal refuge for many different animals (*Bothrops atrox*, *Gonatodes* sp., *Tropidurus hispidus*, *Plica pansticta*, *Plica* sp., bats and rodents; Barrio-Amorós, pers. obs.). Both *Leptodactylus* species are biogeographically separated by the SSE-NNW axis of the Sierra de Maigualida-Parima-Tapirapecó, with *L. lithonaetes* occurring to the west and *L. rugosus* to the east, characteristic of many other reptiles and amphibians (Barrio-Amorós & Brewer-Carias 2008).

Of all the species included in the *Pristimantis conspicillatus* group (sensu Hedges et al. 2008), the calls of only a few are known. Lescure & Marty (2000) illustrated the wave forms and audiospectrograms of *P. chiastonotus* and *P. zeuctotylus*. Rodríguez (1994) described and illustrated the calls of *P. buccinator* and *P. fenestratus* from the Peruvian Amazon. Kaiser et al. (1995) described and illustrated the call of *P. charlottevillensis* from Tobago and reported that the call of *P. terraebolivaris*, a coastal Venezuelan species, is similar in terms of note rate. The call of *P. zeuctotylus* (Lescure & Marty 2000) bears some similarity (although the dominant frequency is about 3 kHz) to the call of *P. vilarsi*, raising again the possible synonymy of *P. zeuctotylus* with *P. vilarsi* mentioned by Barrio-Amorós & Molina (2006). We know of no other calls of species of the *P. conspicillatus* group. For the known calls of the *P. conspicillatus* group, the number of notes per call ranges from 1–8, all notes are relatively short, and the dominant frequency ranges between about 3–4 kHz.

Males of *Pristimantis vilarsi* call in choruses. Males of *P. vilarsi* were widespread through the forest where the recording was made. A leader initiated the calling bout and nearby males called for a few seconds and then were silent. The silence lasted for one or two minutes before a new chorus started. Males call from bushes about 0.3–1 m above the substrate. Males of *P. vilarsi* are quite rare in collections; of 66 specimens studied by Barrio-Amorós & Molina (2006), only five were males. This sexual disparity probably indicates the difficulty of catching calling males, even though the males can be locally abundant based on the observed commonness of their advertisement calls (Barrio-Amorós & Molina 2006).

Acknowledgments

Research for this study was supported by NSF award DEB-0342912 to Rafael O. de Sá and W. Ronald Heyer. CLBA thanks Charles Brewer-Carías and Goran Safarek for financial support for fieldwork undertaken at the two localities where the recordings were made.

Literature Cited

Barrio-Amorós, C. L., & C. Brewer-Carías. 2008. Herpetological results of the 2002 expedition to Sarisariñama, a tepui in Venezuelan Guayana, with the description of five new species.—Zootaxa 1942:1–68.

———, & C. R. Molina. 2006. A new *Eleutherodactylus* (Anura, Brachycephalidae) from the Venezuelan Guayana, and redescription of *Eleutherodactylus vilarsi* (Melin).—Zootaxa 1302:1–20.

Charif, R. A., C. W. Clark, & K. M. Fristrup. 2004. Raven 1.2 User's Manual. Cornell Laboratory of Ornithology, Ithaca, New York, 191 pp.

Hedges, S. B., W. E. Duellman, & M. P. Heinicke. 2008. New World direct-developing frogs (Anura: Terrarana): Molecular phylogeny, classification, biogeography, and conservation.—Zootaxa 1737:1–182.

Heyer, W. R., A. S. Rand, C. A. G. Cruz, O. L. Peixoto, & C. E. Nelson. 1990. Frogs of Boracéia.—Arquivos de Zoologia Museu de Zoologia da Universidade de São Paulo 31(4):231–410.

Kaiser, H., C. M. Dwyer, W. Feichtinger, & M. Schmid. 1995. A new species of *Eleutherodactylus* (Anura: Leptodactylidae) from Tobago, West Indies, and its morphometric and cytogenetic characterization.—Herpetological Natural History 3:151–163.

Lescure, J., & C. Marty. 2000. Atlas des amphibiens de Guyane. Patrimoines Naturels, Vol. 45, Paris, 388 pp.

Leviton, A. E., R. H. Gibbs Jr., E. Heal, & C. E. Dawson. 1985. Standards in herpetology and ichthyology: Part I. Standard symbolic codes for Institutional Resource Collections in Herpetology and Ichthyology.—Copeia 1985(3):802–832.

Rodríguez, L. O. 1994. A new species of the *Eleutherodactylus conspicillatus* group (Leptodactylidae) from Peru, with comments on its call.—Alytes 12(2):49–63.

Associate Editor: Robert P. Reynolds.