Trabajo

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The advertisement call of *Dendropsophus soaresi* (Amphibia, Anura, Hylidae) from the type locality and other sites in the State of Piauí, Northeastern Brazil

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ABSTRACT

Many species identification issues can be minimized by providing descriptions of the advertisement calls from specimens in the type locality. In this paper, we detail the advertisement call of *Dendropsophus soaresi* from six localities in the State of Piauí, Northeastern Brazil, including the type locality (Picos, PI), and expand the known distribution of the species within the state. The previous mating call description attributed to *D. soaresi* was based on specimens from Mambaí, State of Goiás, approximately 960 km from its type locality. We present a comparative analysis of the advertisement calls of species within the *Dendropsophus marmoratus* Group.

Key words: Dendropsophini; *Dendropsophus marmoratus* Group; Picos Treefrog; Bioacoustics.

Introduction

The genus *Dendropsophus* Fitzinger, 1843 is currently composed of 105 species (Frost, 2025), distributed in nine groups (Faivovich *et al.*, 2005; Orrico *et al.*, 2021). The *D. marmoratus* species group was first proposed by Bokermann (1964) (as *Hyla marmorata* group) and included the larger species *H. marmorata*, *H. senicula*, *H. melanargyrea*, and *H. nahdereri*; and the smaller *H. microps*, *H. parviceps* (now in the *D. parviceps* Group; Orrico *et al.*, 2021), *H. schubarti* (now in the *D. leucophyllatus* Group; Orrico *et al.*, 2021), and "*H. moraviensis* Taylor from Costa Rica" (*nomen nudum*).

Currently, the *Dendropsophus marmoratus* Group is composed of eight species: *D. acreanus* (Bokermann, 1964), *D. dutrai* (Gomes & Peixoto, 1996), *D. marmoratus* (Laurenti, 1768), *D. melanargyreus* (Cope, 1887), *D. nahdereri* (B. Lutz & Bokermann, 1963), *D. novaisi* (Bokermann, 1968), *D. seniculus* (Cope, 1868), and *D. soaresi* (Caramaschi & Jim, 1983) (Faivovich *et al.*, 2005; Orrico *et al.*, 2021). The species of the *D. marmoratus* Group are small to medium-sized (combined SVL 27.4–44.2 mm in males, 30.0–52.0 mm in females) and have bark-like colored dorsum (Orrico *et al.*, 2021). The advertisement calls of seven out of the eight species of the *D. marmoratus* Group have been described (Table 1). These calls are considered simple, with dominant frequency varying between the first and the second harmonics in the same note, cyclic amplitude modulation (especially towards the end of the note), and many pulses (combined range 22–84 pulses per note) (Orrico *et al.*, 2021)

Sounds production by animals primarily serve to announce the presence of an individual to others of the same species (Duellman & Trueb, 1994). To achieve this, the bioacoustic parameters generated must be species-specific (Ryan, 1991; Wells, 1977) and have evolved to reduce acoustic

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Table 1. Descriptions of the advertisement calls of species of the *Dendropsophus marmoratus* group and respective authors.

Species	Advertisement call description(s)
Dendropsophus acreanus	Márquez *et al.* (1993)
Dendropsophus dutrai	Not described
Dendropsophus marmoratus	Duellman (1978); Duellman and Pyles (1983); Zimmerman (1983); Zimmerman and Bogart (1984); Rodriguez and Duellman (1994)
Dendropsophus melanargyreus	Duellman and Pyles (1983); Márquez *et al.* (1993); Teixeira and Giaretta (2009)
Dendropsophus nahdereri	Orrico *et al.* (2009); Conte *et al.* (2010)
Dendropsophus novaisi	Protázio *et al.* (2017)
Dendropsophus seniculus	Bokermann (1967); Hepp *et al.* (2012)
Dendropsophus soaresi	Guimarães *et al.* (2001); this paper

interference with sympatric species (Ryan 1991, Gerhardt & Huber 2002, Martins & Jim 2003, 2004, Silva *et al.* 2008). Due to this specificity, bioacoustic studies have become increasingly used in integrative taxonomic studies (Köhler *et al.* 2017). Bioacoustics is an important taxonomic tool in anuran amphibians, as each acoustic signal has relatively invariant characteristics that can be as useful as morphological characters in identifying the species that produce it (Gerhardt & Huber 2002). Furthermore, when bioacoustics are an essential feature in species delimitation, it is particularly important to obtain type locality recordings of that species when describing the calls of previously described species (Köhler *et al.*, 2017).

Dendropsophus soaresi is one of the seven species whose vocalizations have been described, although the recordings are from a population distant from the type locality. In this paper, we describe the advertisement call of *D. soaresi* from six localities in the State of Piauí, Northeastern Brazil, including the type locality (Picos, PI), and expand the known distribution of the species in the state.

Materials y methods

Eight specimens from six different municipalities in the State of Piauí, Northeastern Brazil, including the type locality (Municipality of Picos; Caramaschi and Jim, 1983) of *Dendropsophus soaresi* (Fig. 1), were recorded using a Tascam DR05 digital recorder with a Yoga Super-unidirectional Electric Condenser HT81 microphone. The recordings were made at 24 bits and a sampling rate of 48 kHz. The parameters were analyzed in Raven Pro 1.6.5, employing a Hann window type, with an FFT (Fast Fourier Transform) at 512 samples and 50% overlap. The Hann window type is the preferred choice for biological sound analysis according to Beeman (1998). The parameters, following Köhler *et al.* (2017), include call duration (CD) in seconds, interval between calls (IbC) in seconds, calls per minute (calls/min), pulses per note (pulses/note), pulses per second (pulses/s), pulse duration (PD) in seconds, dominant frequency (DF) in kHz, fundamental frequency (FF) in kHz, frequency modulation (FM) in a qualitative manner, and the presence or absence of harmonics. Voucher specimens are deposited in the Natural History Collection of the Federal University of Piauí (CHNUFPI – Coleção de História Natural da Universidade Federal do Piauí, Floriano, PI), with all specimens obtained in the State of Piauí, Brazil. This includes one specimen from the Municipality of Picos (CHNUFPI 2248 – 7°05'00.1"S, 41°29'59.9"W), the type locality of the species; one from Currais (CHNUFPI 1776 – 9°1'50"S, 44°23'34.6"W); three from Floriano (CHNUFPI 1459, 1460, 2616 – 6°48'45.7"S, 43°3'31.2"W); one from Ribeiro Gonçalves (CHNUFPI 2250 – 7°35'40"S, 45°20'33.31"W); one from São Francisco do Piauí (CHNUFPI 1513 – 6°59'35.1"S, 42°34'33.4"W); and one from Uruçuí (CHNUFPI 2252 – 7°13'58.4"S, 44°33'58"W). Recordings of the vocalizations are deposited in the Museu Nacional do Rio de Janeiro (MNVOC folder 76, tracks 01-08).

Results

In total, the advertisement calls of eight specimens (n = 317 calls) of *Dendropsophus soaresi* were analyzed. The individualized data per specimen and the overall average are presented in Table 2.

Figure 1. *Dendropsophus soaresi* (Caramaschi and Jim, 1983), in life (unvouchered specimen). Picos (PI), type locality. Photo: Marco Antonio de Freitas.

The advertisement call of *D. soaresi* (Fig. 2) consists of a single multipulsed note, with a duration of 0.34±0.03 s (0.25–0.49) and 32.9±1.9 (25–42) pulses per note. The amplitude gradually increases until about two-thirds of the note and then sharply decreases at the end, creating a fan-shaped note. The final pulse exhibits no modification in amplitude modulation and displays no cyclic modulation in emission intensity. The interval between calls is 0.99±0.19 s (0.49±2.10); the repetition rate is 45.9±4.3 (20.2–62.3) calls per minute; the pulse rate is 102.7±3.3 (79±114) pulses per second; the pulse duration is 0.007±0.001 s (0.002–0.020); the dominant frequency is at 3.43±0.18 (1.89–4.13) kHz; and the fundamental frequency is 2.00±0.11 (1.46–2.41) kHz. Frequency modulation shows an upward sweep with a terminal drop in frequency (U-D: up-down shape). All calls exhibited harmonics, with the dominant frequency most often located in the second harmonic; however, in specimens CHNUFPI 2248 and CHNUFPI 2616, it was also found in the first harmonic.

Discussion

The type specimens of *Dendropsophus soaresi* were collected in open vegetation, typically of "caatinga", in altitudes between 200 to 400 m (Caramaschi and Jim 1983). During this study we observed that the call is harsh, emitted by specimens perched on branches at 1 to 3 m high, usually about 1 m, on the borders of small lentic water bodies formed by recent rains. Formerly, in the State of Piauí, the species was known to occur, besides its type locality, in the municipalities of Brejo do Piauí, Caxingó, Ribeiro Gonçalves, São Raimundo Nonato, and Cajueiro da Praia (Roberto *et al.*, 2013; Araújo *et al.*, 2020). The present study expands the species distribution to the municipalities of Currais, Floriano, São Francisco do Piauí, and Uruçuí.

The advertisement call of *D. soaresi* was first described by Guimarães *et al.* (2001) based on ten calls of two specimens from the Municipality of Mambaí (State of Goiás), about 960 km from the type locality (Caramaschi and Jim 1983). Guimarães *et al.* (2001) reported calls with a repetition rate of 17–20 calls per minute, while we described a repetition rate of 45.9±4.3 (20–62) calls per minute. This sharp divergence in the call repetition rate is expected because this parameter has a wide variability according to the environment (such as temperature and humidity) and social factors (such as density of the chorus) (Wells, 2007). All other temporal

Table 2. . Bioacoustic analyses of *Dendropsophus soaresi*. CHNUFPI = voucher specimen deposited in the Natural History Collection of the Federal University of Piauí (Coleção de História Natural da Universidade Federal do Piauí), N = analyzed calls, CD = call duration in seconds, IbC = interval between calls, PD = Pulse duration, DF (kHz) = Dominant Frequency in kilohertz, FF (kHz) = Fundamental Frequency, H = presence of harmonics, FM = Frequency Modulation, U-D= Up in the beginning, Down at the end of the call, SVL = Snout-Vent Length in millimeters, Locality = municipality where the calls were recorded. * type locality of the species.

CHNUFPI	N	CD (s)	IbC (s)	Calls/min	Pulses /note	Pulses/s	PD (s)	DF (kHz)	FF (kHz)	H	FM	SVL	Locality/air temperature
1459	37	0.32±0.02 (0.25-0.36)	0.93±0.16 (0.74-1.37)	46.9±4.74 (37.3-56.6)	30.5±2.0 (25-33)	101.8±1.8 (97-105)	0.009±0.001 (0.008-0.01)	3.48±0.09 (3.36-3.62)	1.90±0.02 (1.89-1.98)	yes	U-D	32.7	Floriano (23.5°C)
1460	40	0.33±0.02 (0.26-0.37)	0.92±0.18 (0.68-1.50)	46.9±3.33 (40.4-53.7)	31.0±2.0 (26-35)	100.5±2.7 (94-103)	0.009±0.001 (0.009-0.012)	3.49±0.09 (3.36-3.62)	1.90±0.02 (1.89-1.98)	yes	U-D	31.2	Floriano (25.0°C)
2616	89	0.35±0.02 (0.25-0.39)	0.79±0.27 (0.49-2.00)	54.3±5.34 (40.3-61.2)	35.1±2.0 (30-39)	107.6±2.7 (97-114)	0.009±0.002 (0.008-0.020)	3.31±0.04 (1.89-3.53)	2.18±0.01 (1.89-2.41)	yes	U-D	29.5	Floriano (23.5°C)
1776	44	0.39±0.03 (0.30-0.49)	1.21±0.26 (0.80-2.10)	38.3±5.68 (20.2-56.3)	37.7±2.8 (32-42)	96.8±1.7 (95-103)	0.009±0.001 (0.008-0.011)	3.79±0.13 (3.38-4.13)	2.11±0.05 (2.06-2.16)	yes	U-D	30.7	Currais (28.3°C)
2248	30	0.35±0.02 (0.31-0.38)	0.96±0.19 (0.75-1.55)	47.0±4.1 (35.5-54.5)	30.8±1.6 (26-32)	102.1±2.1 (100-107)	0.009±0.001 (0.008-0.012)	3.03±0.72 (1.89-3.62)	1.90±0.02 (1.89-1.98)	yes	U-D	30.8	Picos* (26.0°C)
1513	20	0.32±0.01 (0.28-0.34)	0.97±0.13 (0.75-1.10)	45.3±3.1 (40.5-48.8)	30.6±2.7 (27-33)	103.4±2.7 (100-107)	0.003±0.009 (0.002-0.006)	3.58±0.13 (3.45-3.79)	1.87±0.09 (1.46-2.07)	yes	U-D	29.0	São Francisco do Piauí (26.8°C)
2250	11	0.32±0.02 (0.27-0.35)	1.40±0.2 (1.20-1.80)	32.9±3.1 (27.8-37.6)	33.1±0.7 (32-34)	101.4±8.5 (79-111)	0.005±0.001 (0.004-0.006)	3.05±0.15 (2.84-3.87	2.10±0.03 (2.00-2.15)	yes	U-D	30.3	Ribeiro Gonçalves (30.2°C)
2252	46	0.35±0.09 (0.33-0.38)	0.71±0.11 (0.53-1.00)	56.2±3.9 (46.0-62.3)	34.6±2.1 (30-37)	108.3±2.3 (104-113)	0.005±0.001 (0.004-0.014)	3.78±0.07 (3.66-3.94)	2.04±0.04 (2.01-2.11)	yes	U-D	29.4	Uruçuí (27.0°C)
Mean	317	0.34±0.03 (0.25-0.49)	0.99±0.19 (0.49-2.10)	45,9±4,3 (20.2-62.3)	32.9±1.9 (25-42)	102.7±3.3 (79-114)	0.007±0.001 (0.002-0.020)	3.43±0.18 (1.89-4.13)	2.00±0.11 (1.46-2.41)	-	-	-	-
Guimaraes *et al.* (2001)	10	0.39 ±0.06 (0,31-0,46)	--	10.91±5.57 (17 – 20)	33 ±4 (28 – 38)	--	0,011±0,001 (0.007-0.014)	3.29±0.15 (2.71–3.47)	--	yes	--	--	Mambaí/GO

parameters analyzed by Guimarães *et al.* (2001) [call duration: 0.39±0.06 s (0.31–0.46); pulses per note: 33±4 (28–38); and pulse duration 0.012±000.1 s (0.007–0.014)] are consistent with those presented here [call duration: 0.34±0.03 s (0.25–0.49); pulses per note: 32.9±2.9 (25–42); and pulse duration: 0.007±0.001 s (0.002–0.020)].

All calls of *D. soaresi* presented harmonics, with the dominant frequency usually located in the second frequency band. However, in the specimens CHNUFPI 2248 and CHNUFPI 2616 it was also located in the first harmonic. The dominant frequency was 3.43±0.18 kHz (1.89–4.13), while, according to Guimarães *et al.* (2001), the dominant frequency is 3.29±0.15 kHz (2.71–3.47). The slight difference observed in this parameter could be related to the different sizes of the observed anurans, as this characteristic influences the dominant frequency of the vocalization of an animal (Wells, 2007). Notwithstanding, the specimens' SVL was not provided by Guimarães *et al.* (2001).

The advertisement calls of *D. seniculus*, *D. marmoratus*, *D. acreanus*, *D. novaisi* (Bokermann 1967), *D. melanargyreus* (Márquez *et al.* 1993; Teixeira & Giaretta 2009), *D. nahdereri* (Orrico *et al.* 2009), and *D. soaresi* (present work) are similar in having a single multipulsed note with harmonics. Guimarães *et al.* (2001) did not classify the call of *D. soaresi* as harmonic, but it is possible to observe two frequency bands in the figure provided by them (Teixeira and Giaretta, 2009; pers. obs.). Márquez *et al.* (1993) refer that the call of *D. acreanus* and *D. melanargyreus* is a trill (pulse train), with no frequency modulation in *D. acreanus* and downward frequency modulation in *D. melanargyreus*, with both of them with harmonic structure. In the figure of *D. melanargyreus* of the calls reported by Márquez *et al.* (1993), it is possible to observe a dominant frequency with a slight ascendant modulation at the beginning of the call and descendant at the end. In the call of *D. soaresi*, we observed the same modulation structure.

The advertisement call parameters of species of the *Dendropsophus marmoratus* Group are summarized in Table 3. The calls are similar in structure, presenting a single multipulsed note with two harmonics (generally with dominant frequencies at the second harmonic), which could be a possible synapomorphy for the group according to Orrico *et al.* (2009) and Hepp *et al.* (2012), but not tested in the phylogeny of the Dendropsophini of Orrico *et al.* (2021). Nevertheless, it is possible to observe the greater similarity in the advertisement calls of the species *D. soaresi* and *D. melanargyreus*, which is congruent with the phylogeny proposed by Orrico *et al.* (2021) in which these are sister clades. Further acoustic comparisons could be provided only with a standardization of the bioacoustic analysis. The remarkably high number of harmonics (n = 32), without pulses, described by Bokermann (1967) for the advertisement call of *D. seniculus*, was correctly interpreted as side-bands (*sensu* Vielliard, 1993) by Orrico *et al.* (2009), and this was corroborated by Hepp *et al.* (2012). Subsequently, Orrico *et al.* (2009) considered the supposed fundamental harmonics

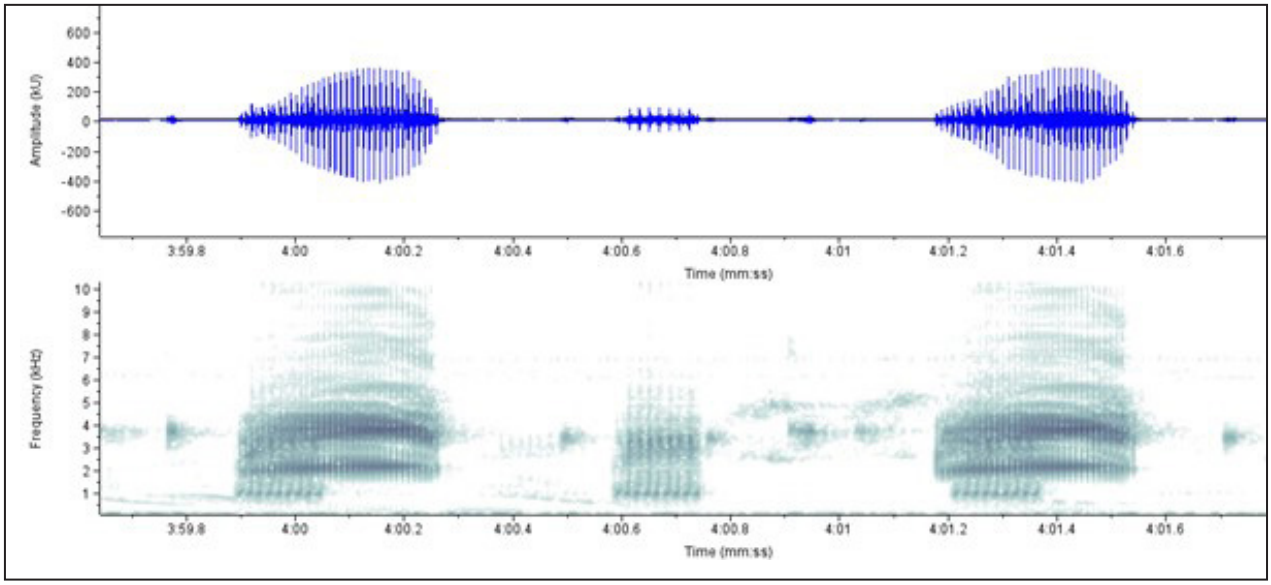

Figure 2. Oscillogram of two advertisement calls of *Dendropsophus soaresi*. Below, spectrogram of the same calls. Specimen CHNUFPI 2248, Municipality of Picos (PI), 30.8 mm SVL, air temperature 26.0°C.

Table 3. . Advertisement call parameters of the species of the *Dendropsophus marmoratus* Group presented as range (average ± standard deviation), when available. U – Up, D – Down Frequency modulation.

Species	No. of calls	Call duration (s)	Interval between calls (s)	Calls / minute	Notes / second	Pulses / note	Pulses / second	Pulse duration (s)	Dominant frequency (kHz)	Frequency modula-tion	Fundamental frequency (kHz)	Final pulse clusters	SVL (mm)	Author (s)
D. soaresi	317	0.25 - 0.49 (0.34 ± 0.03)	0.49 - 2.10 (0.99 ± 0.19)	20.2 - 62.3 (45.9 ± 4.3)	0.33 - 1.00 (0.76 ± 0.06)	25 - 42 (32.9 ± 1.9)	79 - 114 (102.7 ± 3.3)	0.02 - 0.20 (0.007 ± 0.001)	1.89 - 4.13 (3.43 ± 0.18)	U-D	1.46 - 2.16 (2.0 ± 0.11)	No	29.0 - 32.7 (30.45 ± 1.42)	Present work
D. soaresi	10	0.31 - 0.46		17 - 20		28 - 38		0.007 - 0.014	2.71 - 3.47	U-D		No		Guimarães *et al.* (2001)
D. acreanus	23	0.23 - 0.47 (0.33 ± 0.047)		17 - 53 (41.3 ± 10.5)		22 - 39 (30.4 ± 4.5)	67 - 125 (92.6 ± 14.9)		3.01 - 3.79 (3.46 ± 0.21)	No	1.61 - 1.85 (1.75 ± 0.74)	2	41.7	Márquez *et al.* (1993)
D. marmoratus	10	0.11 - 0.27 (0.21)		11.5 - 35.3 (20.2)			120 - 140 (130)		1.32 - 1.67 (1.51)	--	0.33 - 0.42 (0.37)	No	43	Duellman (1978)
D. marmoratus	27	0.17 - 0.26 (0.21)		11.5 - 35.3 (20.2)			120 - 140 (132)		1.32 - 1.69 (1.51)	--	0.33 - 0.42 (0.37)	No		Duellman & Pyles (1983)
D. marmoratus	3						156		2.10	No		No	43.0	Zimmerman (1983)
D. marmoratus	11	0.17 - 0.26 (0.22)	1.12 - 48.7 (6.25 ± 6.51)	9.61			138.9 - 194.3 (166.6)		3.36 - 3.49 (3.43)	--	1.29 - 1.78 (1.53)	No		Zimmerman & Bogart (1984)
D. marmoratus				20						--				Rodríguez & Duellman (1994)
D. melanargyreus	1	0.25 - 0.33 (0.28)		21.0 - 41.0 (30.5)			127 - 140 (136.3)		2.09 - 2.40 (2.24)	--	0.13 - 0.16 (0.14)	No	40 - 44	Duellman & Pyles (1983)
D. melanargyreus	16	0.37 - 0.46 (0.41 ± 0.19)		13 - 64 (35.1 ± 13.2)		34 - 39 (37.1 ± 1.5)	83 - 97 (91 ± 5.2)		3.04 - 3.66 (3.50 ± 0.18)	U-D	1.68 - 1.87 (1.82 ± 0.53)	No	36.2	Márquez *et al.* (1993)
D. melanargyreus	2	0.45 - 0.50		44		35-38(37)		0.012 - 0.014 (0.013)	2.88 - 3.51	D	1.46 - 1.92	No		Teixeira & Giaretta (2009)
D. nahdereri	60	0.44 - 0.98(0.70 ± 0.15)				31 - 66(48.1 ± 8.2)		0.01 - 0.02 (0.013 ± 0.002)	1.38 - 1.46 (1.39 ± 0.03)	No		1-3		Orrico *et al.* (2009)
D. nahdereri	11	0.60 - 0.91 (0.75 ± 0.10)			0.9 - 1.7 (1.29 ± 0.3)	47 - 76 (57 ± 10)			2.40 - 2.69 (2.59 ± 0.11)	No	1.69 - 1.83 (1.77 ± 0.06)	Yes	39.3 - 45.1 (42.9 ± 1.71)	Conte *et al.* (2010)

D. novaisi	12	0.75 - 0.97 (0.88 ± 0.06)	1.08 - 1.69 (1.38 ± 0.18)	20 - 25 (22.5 ± 3.33) 25 - 26 (25.5 ± 0.71)		60 - 84 (76.2 ± 5.7)		0.002 - 0.013 (0.004 ± 0.001)	2.22 - 4.093.19 - 3.56 (3.36 ± 0.17)	No	1.36 - 2.35 (1.87)	No	Protázio *et al.* (2017)
D. seniculus	1	0.30		16					2.0 – 3.0	U-D		Yes	Bokermann (1967)
D. seniculus	143	0.26 - 0.36 (0.31 ± 0.03)		56.6 - 66.3 (60.7 ± 2.88)	0.94 - 1.10 (1.01 ± 0.05)	35 - 55 (47.7 ± 3.7)	127.7 - 162.8 (151.8 ± 5.9)		1.87 - 4.50 (3.97 ± 0.69)	U-D	1.87 - 2.44 (2.08 ± 1.66)	Yes	Hepp *et al.* (2012)

of the advertisement calls of *D. marmoratus* and *D. melanargyreus* described by Duellman and Pyles (1983) — and consequently by Duellman (1978), since all were based on the same data — to be very low (0.12–0.14 kHz and 0.13–0.14 kHz, respectively) interpreting them as artifacts. Orrico *et al.* (2009) appear to have misinterpreted the data on pulse rate instead of the correct fundamental frequency column of the Table 2 in Duellman and Pyles (1983). Duellman (1978) and Duellman and Pyles (1983), using the same data, reported the fundamental frequency of 0.33–0.42 kHz for the advertisement call of *D. marmoratus* and 0.13–0.16 kHz for *D. melanargyreus*. Nevertheless, these values are considered unusually low, and we concur with Orrico *et al.* (2009) that they should be regarded as artifacts.

The call duration of *D. soaresi* [0.25–0.49 s (0.34±0.03)] is approximately the same as that of *D. acreanus* and *D. seniculus* (combined: 0.23–0.47 s), longer than that of *D. marmoratus* (0.11–0.27 s), and slightly shorter than the calls of *D. melanargyreus*, *D. nahdereri*, and *D. novaisi* (combined: 0.25–0.98 s). The call repetition rate of *D. soaresi* [20.2–62.3 (45.9±4.3) calls/minute; 17–20 in Guimarães *et al.* 2001; combined: 17–62.3] overlaps with that of *D. acreanus*, *D. marmoratus*, *D. melanargyreus*, and *D. novaisi* (combined: 11.5–64), and is slightly lower than that of *D. seniculus* (56.5–66.3); it is unknown in *D. nahdereri*. The number of pulses/note of *D. soaresi* [25–42 (32.9±1.9)] does not differ from that of *D. acreanus*, *D. melanargyreus*, *D. nahdereri*, and *D. seniculus* (combined: 22–76), and is smaller than in *D. novaisi* (60–84); it is unknown in *D. marmoratus*. The number of pulses/second in *D. soaresi* [79–114 (102.7±3.3)] does not differentiate from that of *D. acreanus* and *D. melanargyreus* (combined: 67–125) and is smaller than that in *D. marmoratus* and *D. seniculus* (120–192.3); it is unknown in *D. nahdereri* and *D. novaisi*. The dominant frequency in *D. soaresi* [1.89–4.13 (3.43±0.18) kHz] does not distinguish from that of *D. acreanus*, *D. marmoratus*, *D. melanargyreus*, *D. nahdereri*, *D. novaisi*, and *D. seniculus* (combined: 1.32–4.50). The fundamental frequency in *D. soaresi* [1.46–2.41 (2.0±0.11) kHz] does not differ from that of *D. acreanus*, *D. marmoratus*, *D. melanargyreus*, *D. nahdereri*, *D. novaisi*, and *D. seniculus* (combined: 1.29–2.44). All other species, except for *D. acreanus*, *D. marmoratus*, *D. novaisi*, and *D. nahdereri*, show frequency modulation in the calls. The modulation pattern is up-down (U-D) in the species *D. soaresi* and *D. seniculus*, while for the species *D. melanargyreus* the modulation was classified as descending (down) according to Márquez *et al.* (1993), confirmed by Teixeira and Giaretta (2009), but in the figure provided by Márquez *et al.* (1993) it is possible to observe an U-D modulation. The final pulses (*sensu* Hepp *et al.* 2012) are absent in *D. soaresi, D. marmoratus*, *D. melanargyreus*, and *D. novaisi*, while they are present in *D. acreanus*, *D. nahdereri*, and *D. seniculus*.

According to Gerhardt and Huber (2002), acoustic data are useful taxonomic characters in many anuran species groups. Although there is considerable overlap in the individual parameters of the advertisement calls within the *D. marmoratus* Group, the combination of these parameters usually form a unique profile for each species. For example, the vocalization of *D. soaresi* can be distinguished without parameter overlapping from those of *D. marmoratus* (pulse repetition rate), *D. novaisi* (call duration and number of pulses per note), and *D. seniculus* (pulse repetition rate) (see Table 2). This suggests that acoustic data could serve as a useful taxonomic tool for this group (Gerhardt and Huber, 2002) and the acoustic characters may also be informative in phylogenetic studies.

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