

Tadpole and vocalisations of *Phyllodytes wuchereri* (Anura: Hylidae) from Bahia, Brazil

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Abstract. The genus *Phyllodytes* comprises eleven species strictly associated with bromeliads. Despite the fact that knowledge of the reproductive biology and natural history of a single species is important for any conservation and taxonomic issues, tadpoles and vocalisations of most species of *Phyllodytes* have not as yet been described. Herein we describe the tadpole (external and internal oral morphology) and the two different call types of *Phyllodytes wuchereri*. We conducted field surveys at the Serra da Jibóia, Elísio Medrado municipality, Bahia State. The tadpoles inhabit bromeliad phytotelms and have a depressed body, low fins, and a ventrally located oral disc that is bordered by a single row of marginal papillae with a wide anterior gap. The labial tooth row formula is 2(2)/4(1). We also provide field observations on the natural history of adults and tadpoles. The advertisement call has a mean duration of 4.3 ± 0.3 s and is emitted in series of 18 ± 2 multi-pulsed notes per call. A second call type was recorded and is herein referred to as courtship call. Finally, we compare our results with tadpole morphology and call data that is available for other *Phyllodytes* species.

Key words. Acoustic repertoire, larval external morphology, internal oral anatomy, reproductive biology, natural history, systematics.

Introduction

The genus *Phyllodytes* WAGLER, 1830 comprises eleven species that are distributed from Paraíba to northern Rio de Janeiro states, eastern Brazil, all of which strictly associated with bromeliads (PEIXOTO et al. 2003, FROST 2013). Some phenetic groups have tentatively been proposed, mainly based on colouration patterns (PEIXOTO et al. 2003, CARAMASCHI et al. 2004) and advertisement call structure (ROBERTO & ÁVILA 2013). Nevertheless, the phylogenetic relationships of *Phyllodytes* species are still not clear, as only few were included in recent molecular phylogenetic analyses (FAIVOVICH et al. 2005, JOWERS et al. 2008). Because larval and acoustic features provide relevant information for anuran taxonomy and phylogeny (GERHARDT & DAVIS 1988, HAAS 2003, GINGRAS et al. 2013), the lack of call and tadpole descriptions of most *Phyllodytes* species hampers the appropriate reconstruction of phylogenetic relationships and character evolution within the genus.

Phyllodytes wuchereri is endemic to the Atlantic Forest morphoclimatic domain and known only from a few

localities in the southern and central regions of Bahia State (CARAMASCHI et al. 2004, JUNCÁ 2006). This species was revalidated and morphologically distinguished from *P. luteolus* based on the presence of two white dorsolateral stripes that run from the posterior corner of the eye towards the groin and are framed by a dark brown to black line, which is a character state absent in *P. luteolus* and all other species of the genus (CARAMASCHI et al. 2004). JUNCÁ (2006) noted that the northernmost population of *P. wuchereri* (Serra da Jibóia, Bahia state) does not exhibit the marbled dorsal pattern found in populations from southern Bahia (CARAMASCHI et al. 2004). She suggested that this northernmost population might represent an undescribed taxon, but the lack of information on tadpoles and call characteristics precluded adequate comparisons. Recently, CRUZ et al. (2014) described the advertisement and courtship calls of *P. wuchereri* and provided some field observations for a population from Camacan municipality in the southeastern region of Bahia state.

Here we describe the advertisement call and a courtship call type and the tadpole's external and internal oral mor-

phology of *P. wuchereri* from the northernmost distribution of the species, in the Serra da Jibóia, Bahia state, and compare our results with information available on calls and tadpoles of other species of this genus.

Material and methods

We conducted field surveys at the Serra da Jibóia, Elísio Medrado municipality, Bahia state, Brazil (12°51' S, 39°28' W; 815 m a.s.l.). We collected seven tadpoles of *Phyllodytes wuchereri* together with one male (ASUFRN 275) and one female, all of which were found inhabiting the same bromeliad (one tadpole died and was not used for the present description). The presence of an adult couple in the same bromeliad assures us that the tadpoles collected are referable to this species. Moreover, the overall morphology matches the descriptions of other tadpoles of this genus and differs markedly from that of *P. melanomystax*, which is found in syntopy in the studied area. Additionally, no other species that occurs in the studied location reproduces in bromeliads. Tadpoles were euthanised in 5% lidocaine, fixed and preserved in 10% formalin. We adopted the terminology for external morphology and oral anatomy of ALTIG & McDIARMID (1999) and identified their developmental stages according to LIMBAUGH & VOLPE (1957), as modified by GOSNER (1960). The lot of four specimens (AAGARDA 9492) that was considered for description of the external morphology and analyses is deposited in the Coleção de Anfíbios e Répteis da UFRN (CLAR-UFRN, AAGARDA). The tadpole description and illustrations are based on one specimen at Gosner stage 36 (AAGARDA 9493) collected along with the lot.

We measured 20 morphometric variables with a Mitutoyo® digital calliper (precision tolerance ± 0.01 mm) and a micrometer ocular in a Leica-EZ4D stereomicroscope following ALTIG & McDIARMID (1999): total length (TL), body length (BL), tail length (TAL), maximum tail height (MTH), tail muscle height (TMH), tail muscle width (TMW), interorbital distance (IOD), and internarial distance (IND). The remaining variables were measured as follows: maximum body height (BH), maximum body width (BW), body width at eye level (BDE), maximum dorsal fin height (DFH), maximum ventral fin height (VFH), eye diameter (ED; longitudinal distance from the anterior to the posterior edges of eyes), eye–snout distance (ESD; from the pupil to the tip of the snout), eye–naris distance (END; distance from pupil to naris centre), naris–snout distance (NSD; distance from naris centre to the tip of the snout), naris diameter (ND; longitudinal distance along the antero–posterior axis), spiracle–snout distance (SSD; straight linear distance from spiracle opening to the tip of snout), and mouth width (MW; the widest portion of the oral disc). Measurements are provided in Table 1 and were rounded to the nearest 0.1 mm.

As for internal oral anatomy, one tadpole at Gosner stage 36 collected with the lot was dissected and its structures stained in an Alcian Blue solution (final repository:

Table 1. Morphometric measurements (in mm) of *Phyllodytes wuchereri* tadpoles (N = 6) from the Serra da Jibóia, Elísio Medrado municipality, Bahia state, Brazil. See Material and methods for abbreviations.

Variable	Tadpole stage						Mean \pm SD (range)
	27	29	30	36	36	38	
TL	17.3	26.0	29.6	29.9	31.5	33.1	27.9 \pm 6 (17.3–33.1)
BL	8.1	9.2	10.7	11.5	12.1	12.6	10.7 \pm 2 (8.1–12.6)
BH	3.0	3.1	4.0	4.1	4.0	4.6	3.8 \pm 0.6 (3.0–4.6)
BW	5.2	6.0	7.1	7.9	7.4	7.4	6.8 \pm 1 (5.2–7.9)
BWE	4.5	5.4	5.7	6.1	6.7	6.9	5.9 \pm 1 (4.5–6.9)
TAL	9.2	16.8	18.9	18.4	19.4	20.5	17.2 \pm 4 (9.2–20.5)
DFH	0.8	0.9	1.2	1.5	1.7	1.8	1.3 \pm 0.4 (0.8–1.8)
VFH	0.9	0.7	0.9	1.4	1.6	1.3	1.1 \pm 0.4 (0.7–1.6)
MTH	3.8	3.7	4.1	6.3	5.2	5.6	4.8 \pm 1 (3.7–6.3)
TMH	1.6	1.9	2.8	2.5	2.9	2.9	2.4 \pm 0.6 (1.6–2.9)
TMW	1.8	2.0	2.3	3.1	3.3	3.2	2.6 \pm 0.7 (1.8–3.3)
ED	0.9	1.0	1.1	1.5	1.4	1.5	1.2 \pm 0.3 (0.9–1.5)
IOD	3.2	3.7	3.4	4.7	4.3	4.8	4.0 \pm 0.7 (3.2–4.8)
ND	0.3	0.4	0.3	0.4	0.4	0.3	0.35 \pm 0.05 (0.3–0.4)
IND	1.9	1.8	1.8	2.4	2.3	2.2	2.1 \pm 0.3 (1.8–2.4)
ESD	2.8	2.9	3.0	3.7	3.7	3.4	3.3 \pm 0.4 (2.8–3.7)
END	1.6	1.6	2.0	2.4	2.5	2.3	2.1 \pm 0.4 (1.6–2.5)
NSD	1.2	1.3	1.0	1.3	1.2	1.1	1.2 \pm 0.1 (1.0–1.3)
SSD	4.8	5.0	7.1	7.3	7.3	7.1	6.4 \pm 1.2 (4.8–7.3)
MW	1.9	2.1	2.3	2.7	2.5	2.6	2.4 \pm 0.3 (1.9–2.7)

CLAR-UFRN, voucher number: AAGARDA 9494). We analysed its anatomy with a micrometer ocular in a Leica-EZ4D stereomicroscope. The drawings were prepared with the aid of digital photographs. Internal morphological features were recorded following the methodology and terminology suggested by WASSERSUG (1976) and WASSERSUG & HEYER (1988).

We recorded and collected the following four *Phyllodytes wuchereri* males during separate field surveys: two males (SUEFS 1815, SVL 20 mm; SUEFS 1816, SVL 22 mm) were recorded on 5 December 1999 (at approximately 20:00 h, 20°C air temperature); a third male (ASUFRN 275, SVL 23 mm) on 27 September 2013 (at 22:00 h, 19°C air temperature) calling from inside a plastic bag directly after having been collected; the fourth male (ASUFRN 541, SVL 22 mm) was recorded on 22 November 2013 (at 20:00 h, 20.2°C air temperature). Advertisement calls of the first two males were recorded using a Sony WM-D6 Digital Audio Track (DAT) and a Sony ECM-MS907 Electret Condenser Microphone, whereas the last two specimens were recorded with a Marantz PMD 661 and a Sennheiser ME66 directional microphone. We analysed the recorded calls with the software Raven Pro 1.4, constructing audio spectrograms with the following parameters: FFT window width = 512, Frame = 100, Overlap = 75, and flat top filter. Our terminology for call descriptions follows that of DUELLMAN & TRUEB (1986). Recording files are deposited

at the Arquivos Sonoros da Universidade Federal do Rio Grande do Norte (ASUFRN) and the Sound Library of the Universidade Estadual de Feira de Santana (SUEFS). Voucher specimens of *P. wuchereri* are deposited at the Museu de Zoologia da Universidade Estadual de Feira de Santana (MZFS) and in the Coleção de Anfíbios e Répteis da UFRN (CLAR-UFRN).

Results

Tadpole description

External morphology (based on one tadpole, stage 36): The body is elliptical in lateral view (Fig. 1A) and globular in dorsal and ventral views (Figs 1B, C), dorso-ventrally compressed ($BH/BW = 56\%$), and measures about 38% of the total length (Tab. 1). The maximum body width is reached in the posterior third of the body, across the intestinal coils portion. The snout is rounded in dorsal, ventral, and lateral views. The eyes are large ($ED/BL = 11\%$), positioned dorsally and directed dorsolaterally. Nares are small ($ND/IND = 16\%$), oval, without projections on the internal rim, directed anteriorly and located closer to the snout than to the eyes. The short and sinistral spiracle is located in the cen-

tre of the body ($SSD/BL = 60\%$), below the midline of the body height. The spiracle opening is rounded and dorso-posteriorly directed, with its internal wall being completely fused to the body wall. The cloacal tube opening is dextral, rounded and directed posteriorly with its inner wall being attached to the ventral fin. The dorsal fin is slightly arched and emerges at the body–tail junction, and the posterior region of the dorsal fin is damaged; the ventral fin originates at the posterior ventral terminus of the body and runs parallel to the longitudinal axis of the tail musculature; both fins are of about equal height and lower than both the body and tail musculature. The tail tip is rounded. The myotomes of the tail musculature are not strongly marked. The oral disc is positioned ventrally, not emarginated, accounting for 35% of the maximum body width (Fig. 1D); the oral disc is surrounded by one row of marginal papillae with a wide dorsal gap. Papillae are conical, longer than wide, with rounded tips. Submarginal papillae are present in small numbers and gathered on the disc commissure. Labial tooth row formula (LTRF): $2(2)/4$; keratodont row lengths are as follows: $A_2=P_1<A_1=P_2=P_4<P_3$. The P_4 keratodont row is fragmented. Jaw sheaths clearly serrated and pigmented; upper jaw sheath arc-shaped and lower jaw sheath U-shaped.

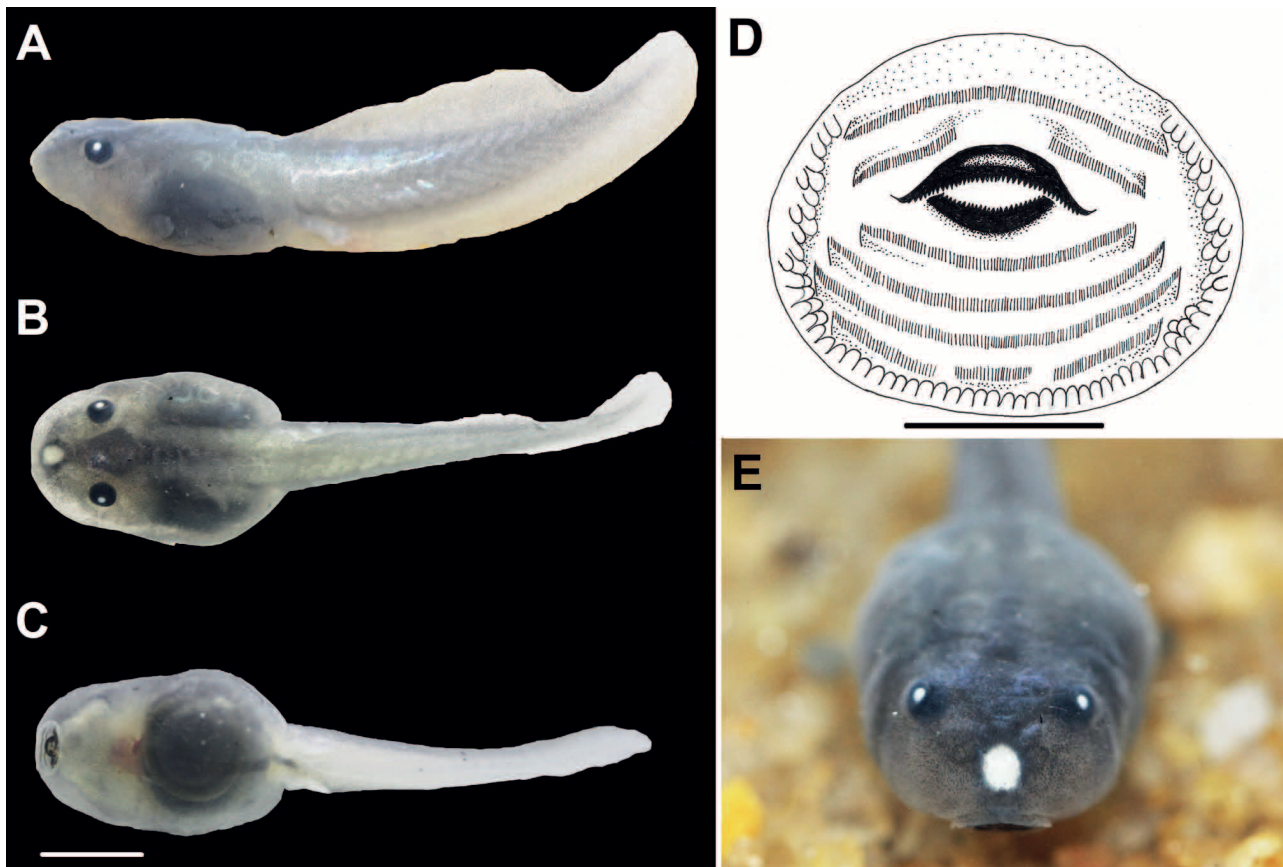


Figure 1. Tadpole of *Phyllodytes wuchereri* (AAGARDA 9493) at GOSNER stage 36 from the Serra da Jibóia, Elísio Medrado Municipality, Bahia state, Brazil. A) Lateral, B) dorsal, and C) ventral views of the tadpole, scale = 5 mm; D) oral disc, scale = 1 mm; E) frontal view.

Morphological variation: The LTRF of an additional tadpole at stage 29 is 2(1,2)/4 with similar gap lengths. In tadpoles at stage 27, 36 and 38, the P4 keratodont row is fragmented with two or three gaps. Most tadpoles ($N = 5$) exhibit some or other injury along their fins.

Colouration: In life, the body is yellowish grey with a translucent skin. A few golden blotches can be found on the posterior portion of the dorsal surface of the body. Ventrally, the body is also translucent, with the intestinal coils being visible. The tail musculature is homogeneously pigmented. Fins are not pigmented and slightly translucent with small brown dots being scattered along both fin extensions. A prominent white rounded marking is visible on the tip of the snout between the nostrils and eyes, covering about 11% of the body width (Fig. 1E). The colour pattern of preserved specimens is similar to that of live ones, but the background colouration is grey rather than yellowish, and the white rounded marking between the nares is less prominent.

Internal oral anatomy: The buccal floor is triangular, widening posteriorly (Fig. 2A). One pair of infralabial papillae is arranged transversally. Two short and conical lingual papillae are present. The buccal floor arena (BFA) is poorly defined and posteriorly bounded by one pair of long papillae with rounded tips. The anterior half of the BFA and the pre-pocket are free of any pustulations or papillae. The buccal pocket is transversally arranged on both sides of the medial region of the buccal floor. The velar surface is free, long, and bears a few projections on its posterior margin. The glottis is tall, with a narrow opening and moderately thick lips. The buccal roof (Fig. 2B) is triangular in shape, with a narrow prenarial arena. An inverted U-shaped ridge is present in the prenarial arena; its width is about 4 times its height. The nares are long, elliptical, perpendicular in orientation, and placed about one-third way back on the buccal roof. The narial walls are thick with smooth edges;

the outer margins extend into a flap that covers most of the narial opening; the posterior edges are also smooth and form a narial valve towards the inner corners of the nares. The postnarial arena is simple and without papillae, with a few scattered pustulations. The median ridge is overall broad, low, and has a smooth edge. The buccal roof arena (BRA) is rectangular in shape and devoid of papillae, with pustulations being sparsely distributed posteriorly. The glandular zone is poorly defined. The dorsal velum is softly curved, interrupted medially, and has free edges without pustulations.

Natural history: Tadpoles were spotted in small water bodies that had accumulated in bromeliad axils. We observed that tadpoles would usually be separated in different axils of the same bromeliad, and only once were two tadpoles observed in the same axil. Moreover, we did not observe any tadpoles attempting to move from one axil to another. We also observed defensive tadpole behaviour that was similar to that of conspecific adults: when disturbed, the tadpoles retreated deeper into their bromeliad axils. A few invertebrate larvae (probably Odonata) were also noticed to inhabit the same bromeliad. Although most of the tadpoles exhibited injuries along their fins, no predation attempt by the invertebrate larvae was observed. We only observed one adult male calling from each bromeliad, which suggests they might be territorial, although no physical interaction between males was observed.

Call description

Calling males were found on top of bromeliad leaves perched openly on rocky outcrops. We identified two distinct call types among vocalisations emitted by the recorded males: the advertisement call or call Type I was more frequently emitted and always in presence of other males

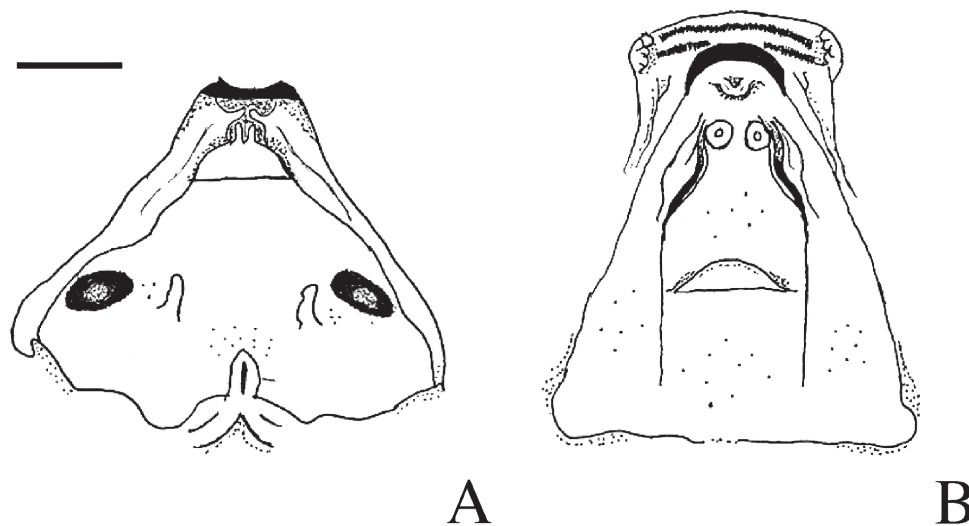


Figure 2. Internal oral anatomy of a *Phyllodytes wuchereri* (AAGARDA 9494) tadpole at Stage 36: A) Buccal floor; B) buccal roof; Scale = 1 mm.

that were calling from adjacent bromeliads; no female was observed near these calling males. The second call type is probably the “courtship call”, because these calls were emitted in the presence of a female that was inhabiting the bromeliad of the calling male, and no other males were heard or seen close to that particular bromeliad. In this situation, this male emitted no other call type during our observations.

Advertisement call/Type I: The call ($n = 10$ calls) of *Phyllodytes wuchereri* consists of a series of multi-pulsed notes (Figs. 3A, B) with a mean duration of 4.3 ± 0.3 s (3.9 – 4.7 s) and is emitted at intervals of 134 ± 10 s (120 – 143 s) between the calls. Each call is composed of 18 ± 2 (16 – 20) notes with mean duration of 121 ± 13 ms (49 – 140 ms; $n =$

182 notes) emitted at intervals of 123 ± 19 ms (87 – 195 ms) between each note. The average rate of emission is 4.2 ± 0.2 notes/s (3.9 – 4.4 notes/s). The mean dominant frequency is 3247 ± 81 Hz (3188 – 3445 Hz). The call exhibits an amplitude modulation, usually starting with low intensity and increasing during the call.

Courtship call/Type II: The courtship call of *Phyllodytes wuchereri* ($n = 5$) consists of a short and single multi-pulsed note, formed by sets of 8 – 10 non-concatenated groups of pulses (Figs 3C, D) with mean note durations of 655 ± 92 ms (531 – 752 ms). The initial groups of pulses are mostly similar in duration (range 4 – 31 ms), but then increase gradually, and the last group of pulses is almost five times longer than the preceding ones. The mean duration

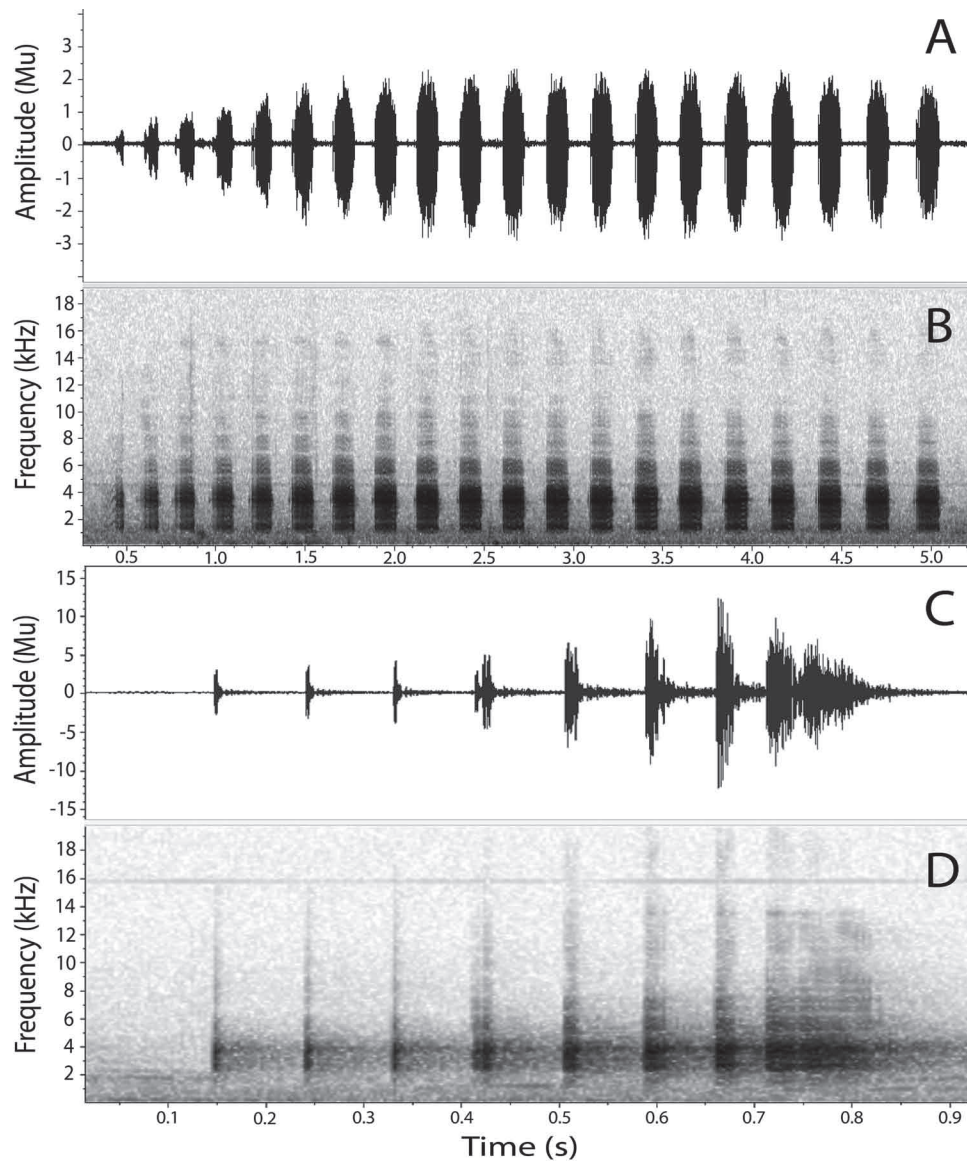


Figure 3. Call types of *Phyllodytes wuchereri* from the Serra da Jibóia, Elísio Medrado Municipality, Bahia state, Brazil. A) Amplitude of the waveform and B) spectrogram of the advertisement call composed of 20 notes (ASUFRN 541); air temperature 20.2°C ; C) amplitude of the waveform and D) spectrogram of the courtship call with 8 pulses (ASUFRN 275); air temperature 24.0°C .

Table 2. External morphological characteristics of *Phyllodytes* tadpoles described in the literature and the present paper. TL – total length (in mm); BRL – body length relative to TL (BL/TL); MP – rows of marginal papillae; BC – body constriction; EOD – emargination of oral disc; DFO – dorsal fin origin; VFO – ventral fin origin; SP – spiracle position; EP – eye position; BH – body height. * – Character states based on illustrations provided in the original tadpole description.

Species	Stage	TL	BRL (%)	LTRF	MP (rows)	BC	DFO	VFO	SP	EP	Ref
<i>P. wuchereri</i>	36	31.5	38	2(2)/4	one	absent	body–tail junction	on body	at midbody, in lower half	dorsally	Present study
<i>P. acuminatus</i>	38	26.0	41	2(2)/4	two	absent	body–tail junction	on body	at midbody, in lower half	dorsally	CAMPOS et al. 2014
<i>P. brevirostris</i>	35	17.3–32.7	38	2(2)/5	one anteriorly and two posteriorly	absent	on body	on body	at midbody, at midline	dorsally	VIEIRA et al. 2009
<i>P. edelmoi</i>	28	27.1	36	2(2)/5–6	two anteriorly and three posteriorly	absent	on body	on body	in body's last third, in lower half	dorso-laterally	PEIXOTO et al. 2003
<i>P. gyrinaethes</i>	34	30.0	35	1(1)/5	one	anteriorly and laterally	body–tail junction	on body	in body's last third, in lower half	laterally	PEIXOTO et al. 2003
<i>P. luteolus</i>	36	29.0	–	2(2)/4	one	laterally	at tail musculature*	on body*	at midbody, at midline	dorsally*	BOKERMANN 1966
<i>P. melanomystax</i>	36	34.6	32	2(2)/3	one	absent	on tail musculature*	on tail musculature*	at midbody, at midline	dorso-laterally	CARAMASCHI et al. 1992
<i>P. tuberculosus</i>	35	31.0	–	2(2)/4	one	laterally	on tail musculature*	on body*	at midbody, at midline	dorsally*	BOKERMANN 1966

of pulses is 13 ± 7 ms. The duration of the last pulse is 113 ± 4 ms (109–125 ms). Each group of pulses is followed by an interval of 63 ± 21 ms (14–86 ms). The mean dominant frequency is 3704 ± 99 Hz (3618–3790 Hz).

Discussion

The tadpole morphology of *P. wuchereri* reflects previous larval descriptions for the genus, except for the unusual tadpole of *P. gyrinaethes* (PEIXOTO et al. 2003), which presents a flattened snout and a superior labium of the oral disc that is divided into two flaps, a medially constricted body, and a dorsal fin that emerges on the body and sports small tubercles along its extension (none of these characteristics are present in *P. wuchereri*). Furthermore, the combination of a LTRF 2(2)/4, marginal papillae that are arranged in one row on the upper and lower labia, a spiracle located in the lower half at midbody, and a dorsal fin that emerges at the body–tail junction distinguishes the tadpole of *P. wuchereri* from those of other *Phyllodytes* species that have as yet been described (see Tab. 2 for a summary of external larval features of *Phyllodytes* species).

The presence of a conspicuous white rounded marking between the nares also distinguishes the tadpole of *P. wuchereri* from all other *Phyllodytes* tadpoles described so far, except *P. edelmoi*, for which a white rounded dot on the upper tip of the snout has likewise been reported from living tadpoles (PEIXOTO et al. 2003). Although tadpole colour patterns vary according to distinct selective envi-

ronmental pressures (CALDWELL 1982, THIBAudeau & ALTIG 2012), the white rounded marking was present in all specimens at different Gosner stages observed within this study. As other *Phyllodytes* tadpole descriptions did not state such a prominent characteristic, we consider it a valid morphological feature to distinguish *P. wuchereri* larvae from other tadpoles of this genus.

The internal oral anatomy of *Phyllodytes wuchereri* agrees with the only previous description available for that genus, *P. brevirostris* (VIEIRA et al. 2009). Both species exhibit a pair of transverse infralabial papillae, two lingual papillae, and both buccal and roof floors are triangular in shape. The main differences found are: *P. wuchereri* is mostly devoid of pustulations (14–26 pustulations are present on the buccal and roof surfaces in *P. brevirostris*), and only one pair of papillae is found bordering the posterior edge of the BFA (two pairs of papillae in the *P. brevirostris* tadpole; VIEIRA et al. 2009).

The advertisement call of *Phyllodytes wuchereri* is similar to the ones described for *P. tuberculosus* (JUNCA et al. 2012), *P. edelmoi* (LIMA et al. 2008), and *P. luteolus* (WEYGOLDT 1981). Advertisement calls of these four species are characterised by long sequences of multi-pulsed notes, emitted at regular intervals, and with an overlap in some acoustic parameters (e.g., call duration, dominant frequency, and number of notes per call). However, there are small differences that enable a distinction of their calls: the calls of *P. tuberculosus* and *P. edelmoi* differ from those of *P. wuchereri* by their longer mean call durations (6.7 ± 1.7 s, range 4.7–9.4 in *P. tuberculosus*; 5.2 ± 0.4 s, range 4.3–5.7

Table 3. Advertisement call parameters of *Phyllodytes wuchereri* described in this study and from literature. Mean \pm SD (range).

Acoustic parameters	<i>P. wuchereri</i> (this study)	<i>P. wuchereri</i> (CRUZ et al. 2014)
Call duration (s)	4.3 \pm 0.3 (3.9–4.7)	4.7 \pm 1.2 (2.8–6.8)
Note rate (notes/s)	4.2 \pm 0.2 (3.9–4.4)	3.6 \pm 0.4 (3.1–4.0)
Notes per call	18 \pm 2 (16–20)	16.2 \pm 3.3 (10–21)
Note duration (ms)	121 \pm 13 (49–140)	200 \pm 4 (110–320)
Internote intervals (ms)	134 \pm 10 (120–143)	120 \pm 2 (90–210)
Dominant frequency	3247 \pm 81 (3188–3445)	3300 \pm 140 (3010–3520)

in *P. edelmoi*) with lower mean dominant frequency (2.6 \pm 0.5 kHz, range 2.2–3.3 in *P. tuberculosus*; 2.8 \pm 0.2 kHz, range 1.5–3.3 in *P. edelmoi*). Additionally, the number of notes per call is higher in *P. edelmoi* (26.5 \pm 2.3; 22–29) and they do not overlap with those of *P. wuchereri*. The lower number of notes per call (8–15) and longer call duration (ca 5 s) differentiate the calls of *P. luteolus* from those of *P. wuchereri*. The call structure (long series of multi-pulsed notes emitted at regular intervals) distinguishes *P. wuchereri* calls from those of *P. acuminatus* (CAMPOS et al. 2014), *P. melanomystax* (NUNES et al. 2007), and *P. kautskyi* (SIMON & GASPARINI 2003), which emit harmonic calls. A longer call duration (4.3 \pm 0.3 s) and larger number of notes per call (18 \pm 2) clearly separates the calls of *P. wuchereri* from those of *P. gyrinaethes* (mean call duration of 1.7 \pm 0.3 s with 4.9 \pm 0.6 notes per call; ROBERTO & ÁVILA 2013).

Despite differences in colour patterns between *P. wuchereri* populations from southeastern Bahia and the population studied herein, we did not observe relevant differences in advertisement call parameters as most acoustic variables overlap between these populations (Tab. 3). Nevertheless, CRUZ et al. (2014) distinguished two main bandwidths in the advertisement call and mentioned that notes were formed in groups of pulses, features that were not observed by us. Moreover, the call described by CRUZ et al. (2014) as a courtship call (formed by two distinct multi-pulsed notes) does not match what we refer to as courtship calls here. In both situations, the male emitted this call in the presence of a female inhabiting the same bromeliad, but during our observations, no other male was heard calling or seen in the vicinity of the couple. In contrast, CRUZ et al. (2014) recorded their presumed courtship call with other males near the calling individual, and hence, differences could be related to a territorial function of the call they recorded. Territorial calls have already been described for other species belonging to this genus (JUNCÁ et al. 2012, NUNES et al. 2007), but in both cases no female was seen close to these calling males. The recognition of distinct calls emitted in similar situations may indicate that this species possesses a complex acoustic repertoire, and further observations and experiments are needed to confirm the function of these calls.

Many phytothelm-breeding anurans have evolved similar reproductive strategies to enhance their reproductive success in an environment with limited food resources such as water accumulations in bromeliad axils (LANNON

et al. 1987, LEHTINEN et al. 2004). For instance, the reduction of clutch sizes with eggs being laid in separate water reservoirs within the same bromeliad is a common strategy among anuran species that reproduce in bromeliad axils (e.g., BOKERMANN 1966, LANNON et al. 1987, ALVES-SILVA & SILVA 2009). Although we did not observe the entire reproductive behaviour of this species, it is likely that *P. wuchereri* also uses such strategy, mostly because only seven tadpoles were noticed to occur in separate phytothelms on the same bromeliad. Moreover, tadpoles were collected at different developmental stages (range 27–41), suggesting that their eggs had been laid over a certain period of time. Such reproductive strategy (tadpoles inhabiting different phytothelms of the bromeliad) was also reported for other species in the genus, such as *P. luteolus* (BOKERMANN 1966), *P. melanomystax* (CARAMASCHI et al. 1992), and *P. edelmoi* (PEIXOTO et al. 2003). Still, adequate natural history observations on the reproductive strategies of *P. wuchereri* are needed to confirm these hypotheses.

The phenetic grouping proposed by CARAMASCHI et al. (2004) places *P. wuchereri* in the *P. auratus* species group. However, *P. auratus* was later referred to a different genus in a molecular assessment of the species (JOWERS et al. 2008). Thus, the similarity in colour pattern is probably convergent. Therefore, *P. wuchereri* is not assigned to any previously proposed phenetic species group based on colour patterns (PEIXOTO et al. 2003, CARAMASCHI et al. 2004). On the other hand, ROBERTO & ÁVILA (2013) proposed a distinct species cluster based on advertisement call structures, with harmonic calls identifying the *P. kautskyi* species group and multi-pulsed calls the *P. luteolus* species group. Therefore, we (tentatively) assign *P. wuchereri* to the *P. luteolus* species group based on its advertisement call structure.

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