

THE TADPOLE AND ADVERTISEMENT CALL OF *SPHAENORHYNCHUS PALUSTRIS* BOKERMANN, 1966 (AMPHIBIA, ANURA, HYLIDAE)

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ABSTRACT: The tadpole of *Sphaenorhynchus palustris* is described and illustrated from Municipality of Porto Seguro, State of Bahia, Brazil. *Sphaenorhynchus* tadpoles are very similar, however the tadpole of *S. palustris* is promptly distinguished from the other already described species by its very long spiracular tube. We also describe the advertisement call of *S. palustris*, from the same locality. It is a short trill, consisting of 1 to 3 pulsed notes; note duration varies from 0.01 to 0.05 s and note interval varies from 0.15 to 0.19 s; dominant frequency was about 2.62 ± 0.2 kHz. The Atlantic Rain Forest of the southern State of Bahia is one of the well-preserved areas remaining of this fragmented ecosystem; consequently it has unique value for amphibian conservation.

KEYWORDS: Anura, Hylidae, *Sphaenorhynchus palustris*, tadpole, advertisement call.

INTRODUCTION

The Neotropical frog genus *Sphaenorhynchus* has a disjunct distribution in the Amazon basin east of Andes and eastern Brazil, associated to the Atlantic Rain Forest (see Frost, 2007). The genus currently consists of 11 species (Faivovich *et al.*, 2005): *S. bromelicola* Bokermann, 1966, *S. carneus* (Cope, 1868), *S. dorisae* (Goin, 1967), *S. lacteus* (Daudin, 1801), *S. orophilus* (A. Lutz and B. Lutz, 1938), *S. palustris* Bokermann, 1966, *S. pauloalvini* Bokermann, 1973, *S. planicola* (A. Lutz and B. Lutz, 1938), *S. platycephalus* (Werner, 1894), *S. prasinus* Bokermann, 1973, and *S. surdus* (Cochran, 1953). The tadpoles of all *Sphaenorhynchus* species occurring in eastern Brazil (*S. bromelicola*, *S. orophilus*, *S. palustris*, *S. pauloalvini*, *S. planicola*, *S. prasinus*, and *S. surdus*) have been described, except those of *S. palustris* and *S. surdus*. Furthermore, the advertisement call has been described only for *S. prasinus* and *S. pauloalvini*.

The type locality of *Sphaenorhynchus palustris* is Reserva Nacional de Sooretama, Municipality of Linhares (actually Municipality of Sooretama), State of Espírito Santo (Frost, 2007). Pimenta and Silvano (2001) extended this range 302Km airline northward to Municipality of Porto Seguro, State of Bahia. The purpose of this paper is to describe the tadpole morphology and advertisement call of *Sphaenorhynchus palustris*.

MATERIAL AND METHODS

Tadpoles were collected from a temporary pond at edge of the forest at Reserva Particular do Patrimônio Natural Estação Veracruz (16°20'S, 39°10'W; altitude 30-60 m), Municipality of Porto Seguro, southern region of the State of Bahia, Brazil, on 17-18 August 2006, by I. Nunes, B.V.S. Pimenta and C.A.G. Cruz. We observed in the pond several stages of tadpole development and juvenile specimens, which were used for identification of the tadpole.

Forty tadpoles were preserved in 5% formalin and housed at Museu Nacional, Rio de Janeiro, Brazil (MNRJ 42616). Oral disc papillae were colored with methylen blue for better visualization. Descriptions and measurements are based on tadpoles ranging from stages 35 to 36 (n = 9) (according to Limbaugh and Volpe, 1957, as modified by Gosner, 1960) and at 37 to 38 (n = 4) were used to corroborate variations in morphology and morphometry (see Table 1). Sixteen morphometric characters were used in the tadpole. Six measurements follow Altig and McDiarmid (1999): TL (total length), BL (body length), TAL (tail length), MTH (maximum tail height), TMH (tail muscle height), and TMW (tail muscle width). We also used ten other measurements: IND (internarial distance: straight line distance between inner corners of the nostrils), IOD (interorbital distance: straight line distance between the inner corners of the eyes), BH (body height: greatest body height), BW (greatest

TABLE 1: Measurements (in millimeters) of the tadpoles of *Sphaenorhynchus palustris* (SD = standard deviation).

Measurements	Stages 35-36 (N = 9)			Stages 37-38 (N = 4)		
	Mean	SD	Range	Mean	SD	Range
TL	47.96	2.74	44.60-51.00	52.70	1.47	51.40-54.00
BL	14.51	0.62	13.80-15.50	15.75	0.47	15.50-16.45
BH	8.32	0.41	7.80-9.10	8.58	0.35	8.32-9.10
BW	9.78	0.54	9.10-11.05	10.89	0.57	10.40-11.44
TAL	33.44	2.32	30.55-36.00	36.95	1.77	35.00-38.50
TMH	5.23	0.35	4.72-5.84	5.82	0.16	5.60-6.00
TMW	4.61	0.35	4.00-5.28	5.28	0.22	5.12-5.60
DFH	2.51	0.24	2.08-2.86	3.06	0.17	2.86-3.25
VFH	2.66	0.25	0.34-2.99	3.19	0.13	2.99-3.25
ED	1.95	0.13	1.74-2.19	2.21	0.08	2.10-2.25
IOD	4.79	0.09	4.56-4.88	4.82	0.16	4.64-5.04
IND	3.90	0.18	3.70-4.25	4.16	0.06	4.10-4.25
ODW	2.72	0.18	2.50-3.05	2.94	0.10	2.85-3.05

body width), ED (eye diameter: the horizontal diameter of eye in lateral view), ODW (oral disc width: the maximum horizontal width of the oral apparatus, in a frontal view), DFH (dorsal fin height: greatest height of fin, above the tail musculature), VFH (ventral fin height: greatest height of fin, below the tail musculature), END (eye-nostril distance: straight line distance from anterior corner of the eye to posterior margins of nostril), and NSD (nostril to tip of snout distance: straight line distance from anterior corner of nostril to tip of snout). Nomenclature of morphological traits follows Altig and McDiarmid (1999), except the position of the intestinal mass that follows Faivovich (2002). Measurements (in millimeters) were taken using an ocular grid in a Zeiss stereomicroscope, except for total length, body length, and tail length, which were measured with calipers to the nearest 0.05 mm. Morphological characters of tadpoles of the genus *Sphaenorhynchus* have been previously reported in Bokermann (1966; 1973), Cruz (1973), Cruz and Peixoto (1980), Suárez-Mayorga and Lynch (2001).

Advertisement calls were recorded in the field (at the same time we collected tadpoles) with a Marantz Portable Cassette Recorder PMD222 with a Sennheiser ME66 directional microphone. Tapes were analyzed with Avisoft-SASLab Light for Windows, version 3.74. Calls were digitized at a sample rate of 11.025 Hz, sample size of 16 bits. Call classification and call components terminology follows Duellman and Trueb (1994) and Littlejohn (2001). We measured the temporal parameters from the waveform, whereas we determined the dominant frequency from the audiospectrogram. The parameters were frame 100%, grid resolution time 0.73 ms, overlap 93.75%, grid

resolution frequency 90 Hz, FFT size 256 points, and window function hamming. Acoustical characters of advertisement call for the genus *Sphaenorhynchus* follows Bokermann (1973).

RESULTS

Description of the tadpole

External morphology – Measurements of the tadpoles of *Sphaenorhynchus palustris* are presented in Table 1. Tadpole body wider than deep, oval in dorsal and in lateral views (Fig. 1A and 1B); body length approximately 30% of the total length; snout not prominent, subelliptical in lateral view and semi-circular in dorsal view; eyes latero-dorsal; nostrils small, elliptical, directed and located antero-laterally, nearer to the tip of snout than the eyes; presence of a valve on the nostril opening. Spiracle single, sinistral, with long spiracular tube, directed backwards (Fig. 1B); vent tube deep, medial with both walls attached directly to ventral fin; intestinal mass longitudinally positioned to the body axis; robust tail musculature, tapering gradually to the tip; myomeres developed after the first third of the tail musculature; dorsal fin continuous, extended onto the posterior third of the body; ventral fin origin at the most postero-ventral tip of the body; tail fins heights equivalent. Oral disc anteroventral, width approximately 27-30% of the body width (Fig. 1A); tooth row formula 2(2)/3(1); A-2 row interrupted medially by a wide gap, P-1 row interrupted medially by a narrow gap, P-3 three times shorter than P-2, A-2 and P-1 slightly shorter than A-1 and P-2, A-1 and P-2 of equal width; marginal papillae uniformly arranged as a single row of few large

papillae around the oral disc, anterior labium with a wide gap on the median region, and posterior labium with a narrow, medial; sub-marginal papillae absent;

beak finely serrated; upper jaw sheath semicircular in shape, without a medial projection, and lower jaw sheath U-shaped (Fig. 1C).

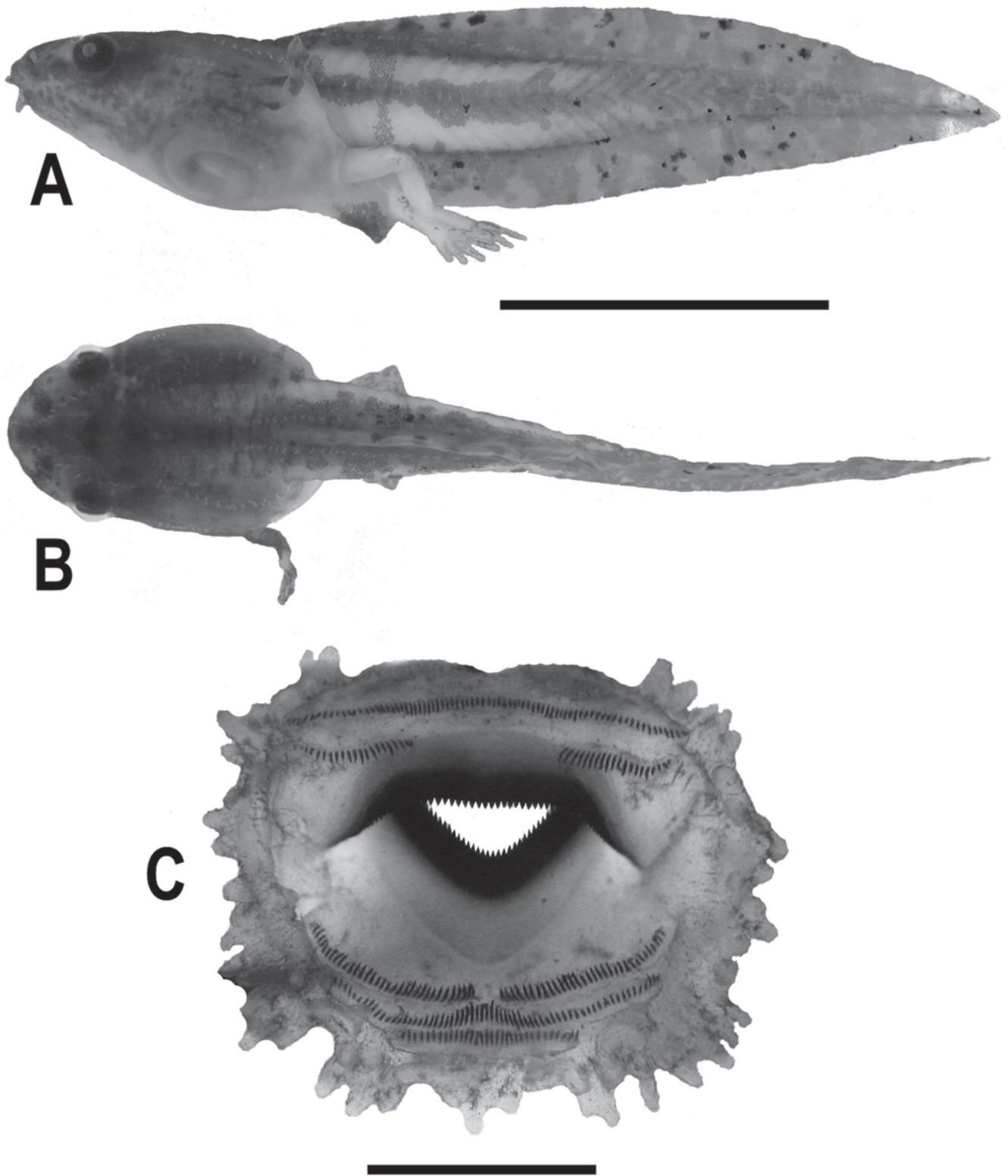


FIGURE 1: The tadpole of *Sphaenorhynchus palustris*, stage 36 (MNRJ 42616): (A) lateral view, (B) dorsal view (scale bar = 15 mm); (C) oral disc (scale bar = 1 mm).

Color in life – Body dark brown and tail musculature cream. Overall body is reddish, with a white strip extending from the snout, through the eye, to the junction of the body with the tail musculature. The ventral surface of the body is uniformly lighter without any markings. The intestines appear gray and they are visible through the body wall. The developing legs are cream. The tail musculature and fins with brown pigmentation. A few of the oral disc papillae are pigmented. In preservative (5% formalin), the coloration shades away, overall appearing light cream.

Intraspecific variation – The narrow gap found on the row marginal papillae, immediately below the P-3 tooth row, is present on 47% of tadpoles. For the specific values of measurements of the all stages examined see Table 1.

Description of advertisement call

The advertisement call was recorded at about 10:00 pm; three males were calling at the base of aquatic vegetation on the water surface inside of a pond in a forest edge.

General description – The call is a short trill of notes consisting of 1 to 3 pulsed notes ($1,4 \pm 0,6$; $N = 16$) (Fig. 2A and 2B). The numbers of pulses by note ranges from 3 to 6 ($4,7 \pm 0,8$; $N = 16$) and two notes have aggregated pulses (Fig. 2A). Two of the recorded males were calling away from others individuals and their calls consisted of 1-2 notes. The other male recorded was calling in chorus and the call has increased the number of notes, 1-3 notes.

Temporal structure – For non-chorus callers, the call duration ranges from 0.02 to 0.05 s ($0,03 \pm 0,01$ s; $N = 10$) when the call consisted of a single note and from 0.19 to 0.22 s ($0,21 \pm 0,02$ s; $N = 3$) when the calls presented two notes. For the male calling in a chorus, the duration of call was 0.03 s for one note, 0.223 s for two notes, and 0.427 for three notes calls. Call interval ranges from 55.48 to 14.67 s ($29,1 \pm 14,43$ s; $N = 13$). The duration of the notes varies from 0.01 to 0.05 s ($0,03 \pm 0,01$ s; $N = 22$) and note intervals vary from 0.15 to 0.19 s ($0,16 \pm 0,02$ s; $N = 6$).

Spectral structure – The dominant frequency in both notes was about $2,62 \pm 0,18$ kHz (2.24-2.84 kHz, $N = 22$) (Fig. 2C). The calls present one visible harmonic; however, one male had calls with one lower harmonic, being the frequency mean $1,71 \pm 0,03$ kHz

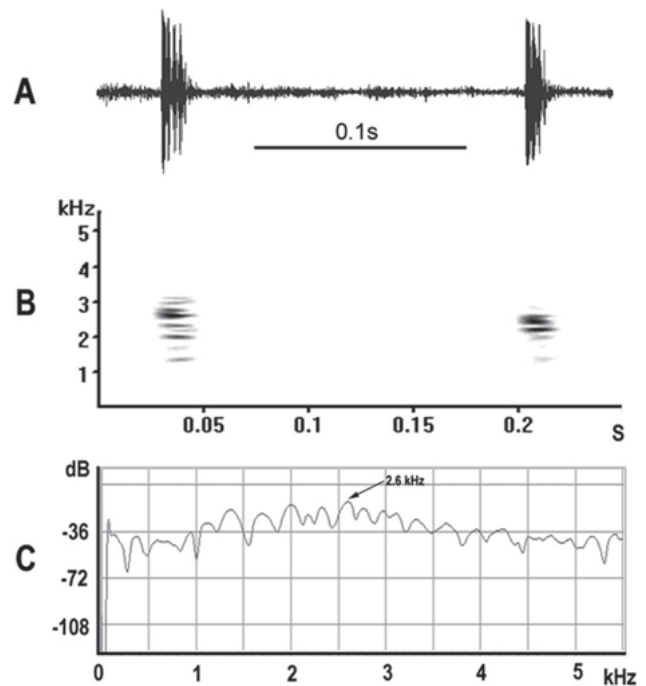


FIGURE 2: Advertisement call of *Sphaenorhynchus palustris*, recorded on 18/VIII/2006. Air temperature 18.7°C: (A) Waveform; (B) Audiospectrogram; (C) Power spectrum of the first note.

(1.64-1.72 kHz, $N = 9$) (Fig. 2B). Because of the narrow band filter analyses, figure 2B shows artifacts that could be misleading interpreted as additional harmonics (see Vielliard, 1993).

DISCUSSION

The comparison of the tadpole of *Sphaenorhynchus palustris* with those of other species of the genus *Sphaenorhynchus*, distributed in the Brazilian Atlantic Rain Forest, showed a great similarity among them (Table 2). The tadpole of *Sphaenorhynchus palustris* is promptly distinguished from the other already described tadpoles of the genus by the very long spiracular tube (short spiracular tube in *S. bromelicola*, *S. orophylus*, *S. pauloalvini*, *S. planicola*, and *S. prasinus*). The presence of a valve in the nostril differentiates *S. palustris* from *S. bromelicola*, *S. pauloalvini*, and *S. prasinus*. The few large marginal papillae differentiate *S. palustris* from *S. planicola* and *S. prasinus* (both with large and isolated marginal papillae between smaller marginal papillae). The absence of submarginal papillae distinguishes *S. palustris* from *S. orophylus* and *S. pauloalvini* (submarginal papillae on the lateral areas and in the entire oral disc, respectively). The dorsal view of the snout is rounded in *S. palustris* and triangular in *S. bromelicola*.

TABLE 2: Larval morphological characteristics with at least two states for 9 described tadpoles of the genus *Sphaenorhynchus*. Characteristics in bold type indicate a diagnostic character.

Species	Marginal papillae arrangement	Nostril valve	Spiracle length	Tooth row formula	Source
<i>S. bromelicola</i>	Uniserial	Absent	Median	2/3(1)	Bokermann, 1966
<i>S. carneus</i>	Presence of submarginal papillae	Absent	Short	1/2-3(1)	Suárez-Mayorga and Lynch, 2001
<i>S. dorisae</i>	Uniserial	Absent	Short	2/3(1)	Suárez-Mayorga and Lynch, 2001
<i>S. lacteus</i>	Presence of submarginal papillae	Absent	Short	2/3(1)	Suárez-Mayorga and Lynch, 2001
<i>S. orophylus</i>	Presence of submarginal papillae	Present	Short	2/3(1)	Cruz and Peixoto, 1980
<i>S. palustris</i>	Uniserial	Present	Long	2/3(1)	Present study
<i>S. pauloalvini</i>	Presence of submarginal papillae	Absent	Short	2/3(1)	Bokermann, 1973
<i>S. planicola</i>	Presence of isolated large papillae	Present	Short	2/3(1)	Cruz, 1973
<i>S. prasinus</i>	Presence of isolated large papillae	Absent	Short	2/3(1)	Bokermann, 1973

The tadpoles of the *Sphaenorhynchus* species present in Colombia (see Suárez-Mayorga and Lynch, 2001) are very similar to the species from Brazilian Atlantic rain forest (Table 2). However, the tadpole of *S. carneus* has a tooth row formula 1/2-3(1), which distinguishes this tadpole from the all other tadpoles in the genus.

Bokermann (1973) described the advertisement call of two species of *Sphaenorhynchus* from Bahia: *S. prasinus* and *S. pauloalvini*. The advertisement call of *S. palustris* is promptly differentiated from *S. prasinus* by its higher dominant frequency (2.24-2.84 kHz in *S. palustris* and 1.30-1.50 kHz in *S. prasinus*) and from *S. pauloalvini* by the lower number of notes by call (1-3 notes in *S. palustris* and 6-8 notes in *S. pauloalvini*). Bokermann (1973) reported 2 to 3 harmonics in *S. pauloalvini* calls with a fundamental harmonic around 1.0 kHz.

The Municipality of Porto Seguro is located in the Atlantic coast of the southern State of Bahia, near patches of secondary and undisturbed forests. In spite of the endangered status of the Atlantic Rain Forest (see Dean, 1999; Morellato and Haddad, 2000), this “hotspot” still possesses the greatest richness and endemism of amphibians anurans in the world (see Duellman, 1999), and the Atlantic Forest from the southern area of the State of Bahia has some of the remaining well preserved areas of this fragmented ecosystem (Silvano and Pimenta, 2003). Deforestation seems to influence declines and population fluctuations in many cases (Haddad and Abe, 1999). Thus, the example of the anurofauna shows the importance of studies of the dynamics of the fauna as a principle for preservation of this Brazilian biome.

RESUMO

O girino e o canto de anúncio de *Sphaenorhynchus palustris*, obtidos no Município de Porto Segu-

ro, Estado da Bahia, Brasil, são descritos e ilustrados. Embora os girinos do gênero *Sphaenorhynchus* sejam bastante similares entre si, o girino de *S. palustris* se distingue prontamente dos demais girinos conhecidos deste gênero pelo espiráculo muito comprido. O canto de anúncio de *S. palustris* é também descrito da mesma localidade. O canto é curto e trinado, constituído de 1 a 3 notas pulsionadas; duração das notas varia de 0.01 a 0.05 s e o intervalo entre elas varia de 0.15 a 0.19 s; frequência dominante é em média 2.62 ± 0.2 kHz. A Mata Atlântica do sul do Estado da Bahia é um das regiões mais bem preservadas deste ecossistema fragmentado, sendo de grande importância para a preservação dos anuros.

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