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A New Species of *Sphaenorhynchus* (Anura: Hylidae) from Northeastern Brazil

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ABSTRACT: We describe a new species of *Sphaenorhynchus* from highland forest habitats in the Reserva Biológica de Pedra Talhada, an Atlantic Forest remnant of northeastern Brazil. The new species is diagnosed by having a snout–vent length of 24.8–29.3 mm in males and 26.6 mm in the only available female; snout truncate in dorsal view, protruding in lateral view; vocal sac single, subgular, moderately developed, extending to the middle of the pectoral region, longitudinal folds present; dorsolateral black line from the tip of snout extending posteriorly beyond the eye to gradually disappear on the flanks; white glandular subcloacal dermal fold present; vomerine, premaxillary, and maxillary teeth present; and advertisement call with 2–3 pulsed notes (3–6 pulses each) with a duration of 0.19–0.24 s, a frequency range of 526.3–4438.8 Hz, and a dominant frequency of 2250–3000 Hz. It is the eighth species of the genus that occurs in northeastern Brazil.

Key words: Atlantic Forest; Hatchet-faced treefrogs; Reserva Biológica de Pedra Talhada; Species description; Taxonomy; Vocalization

THE GENUS *Sphaenorhynchus* Tschudi, 1838 is putatively a monophyletic group (Faivovich et al. 2005; Wiens et al. 2006; Pyron and Wiens 2011) that includes 15 species of small greenish treefrogs that are widespread in the Neotropics. Eleven species of the genus are associated with the Atlantic Forest domain in Brazil and have been recorded from the northern portion of the state of Rio Grande do Sul to the state of Pernambuco (Frost 2016), including *S. botocudo* Caramaschi, Almeida and Gasparini 2009, *S. bromelicola* Bokermann 1966, *S. canga* Araujo-Vieira, Lacerda, Pezzuti, Leite, Assis and Cruz 2015, *S. caramaschii* Toledo, Garcia, Lingnau and Haddad 2007, *S. mirim* Caramaschi, Almeida and Gasparini 2009, *S. palustris* Bokermann 1966, *S. pauloalvini* Bokermann 1973, *S. planicola* (Lutz and Lutz 1938), *S. prasinus* Bokermann 1973, *S. surdus* (Cochran 1953), and *S. orophilus* (Lutz and Lutz 1938). Three other species, *S. carneus* (Cope 1868), *S. dorisae* (Goin 1957), and *S. lacteus* (Daudin 1800), are associated with the Amazon basin and are distributed through western South America in Peru, Ecuador, Colombia, Guyana, and the Central Amazon in Brazil (Frost 2016), with *S. lacteus* also having been recorded in Trinidad (named as *Hyla orophila* by Kenny 1969) and northeastern Brazil (states of Maranhão and Piauí; Caramaschi et al. 2009; La Marca et al. 2010; Benicio et al. 2011). The 15th species, *S. platycephalus* (Werner 1894), is of uncertain status, being known only by the female holotype collected in “S. Amerika” (Harding 1991). In this paper, we describe a new species of *Sphaenorhynchus* collected during fieldwork at the Reserva Biológica de Pedra Talhada—Rebio de Pedra Talhada, a remnant of Atlantic Forest in the state of Alagoas, Brazil.

MATERIALS AND METHODS

Adult Morphology and Species Description

Type specimens are deposited in the Herpetological Collections of the Universidade Regional do Cariri, Ceará, Brazil (URCA-H) and Museo Argentino de Ciencias Naturales “Bernadino Rivadavia,” Buenos Aires, Argentina (MACN-He). Institutional abbreviations follow Sabaj (2016).

Specimens were fixed in 10% formaldehyde and stored in 70% ethanol. Muscle tissue was removed and preserved in 96% ethanol or frozen prior to fixing the voucher specimen in formalin. Sex was determined by examination of secondary sexual characters (nuptial pads and expansion of the vocal sac). Webbing formulae follow Savage and Heyer (1997) as modified by Myers and Duellman (1982). Terminology for snout profile follows Duellman (1970), with the exception of “mucronate snout in dorsal view” which follows Heyer et al. (1990). Characterization of the robustness of forearm, legs, and toes follow Araujo-Vieira et al. (2015). The definition of the tympanic membrane follows Wever (1985), who defined it as an area of modified skin (where the subcutaneous layers are missing) that is much thinner than the surrounding skin, has a softer texture and different pigmentation and, in many cases, is slightly or strongly translucent because of the underlying tympanic cavity.

Measurements were taken with digital calipers (± 0.1 mm). Ten measurements follow Duellman (1970): snout–vent length (SVL), head length (HL), head width (HW), internarial distance (IND), eye–nostril distance (END), eye diameter (ED), interorbital distance (IOD), upper eyelid width (UEW), tibia length (TL), and foot length (FL). Tarsal length (TAL) and eye–snout distance (ESD) follow Kok and Kalamandeen (2008); forearm length (FAL), thigh length (THL), and hand length (HAL) follow Heyer et al. (1990); third finger disc diameter (3FD) and fourth toe disc diameter (4TD) follow Napoli and Caramaschi (1998). Although it is possible to see premaxillary and maxillary teeth under high magnification in the new species, we confirmed their number in a specimen

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cleared and double-stained with alcian blue and alizarin red following Taylor and Van Dyke (1985).

Comments on other species of *Sphaenorhynchus* are based on preserved specimens (see Appendix in Supplemental Materials available on line) supplemented with descriptions by Lutz and Lutz (1938), Bokermann (1966), Kenny (1969), Bokermann (1973), Heyer et al. (1990), Harding (1991), Toledo et al. (2007), Caramaschi et al. (2009), and Araujo-Vieira et al. (2015). All values are reported as means \pm 1 SD (range).

Recording and Vocalization Analysis

Advertisement calls were recorded using a Marantz PMD 660 digital recorder set at a sampling rate of 44.1 kHz, with 16-bit resolution, and equipped with a Yoga EM-9600 external directional microphone. Air temperature was not recorded. All recordings were recorded on Raven Pro 64 v1.4 software (Cornell Lab of Ornithology, Ithaca, NY) with window size = 256 samples, window type = Hann, 3 dB bandwidth = 135 Hz, overlap = 50%, and DFT size = 512. Temporal traits were measured from oscillograms and spectral traits were measured from spectrograms. Dominant frequency was obtained through the Peak Frequency measurement function. Terminology for acoustic parameters follows Heyer et al. (1990).

DNA Sequencing and Analysis

Whole cellular DNA was extracted from frozen and ethanol-preserved tissues (liver or muscle) using either phenol-chloroform extraction methods or the Qiagen DNeasy isolation kit. We used the primers 16S-AR and 16S-BR (Palumbi et al. 1991) or 16S-Wilk2 (Wilkinson et al. 1996) to amplify and sequence \sim 570 nucleotide base pairs of the mitochondrial 16S rRNA gene. Polymerase chain reaction (PCR) amplification protocols employed are those of Faivovich et al. (2005). The PCR-amplified products were cleaned with 10U of exonuclease plus 1U of alkaline phosphatase per reaction. Sequencing was done on an ABI 3730XL automatic sequencer (Applied Biosystems) in both directions to check for potential errors and nuclear polymorphisms. The chromatograms obtained from the automated sequencer were read and assembled using the sequence editing software Sequencher v5.2.3 (Gene Codes, Ann Arbor, MI, USA). We aligned the complete sequences using the algorithm ClustalW (Thompson et al. 1994) implemented in the program BioEdit v7.2.5 (Hall 1999) and confirmed by visual inspection. Newly generated sequences were deposited in GenBank under accession numbers KY418013–KY418017.

We used uncorrected pairwise distances (p) as a tool to initially recognize the new species (Vences et al. 2005) with the threshold value for interspecific genetic divergence (uncorrected pairwise distances) for identifying candidate species of Fouquet et al. (2007). Uncorrected pairwise distances of the 16S rRNA gene fragment were calculated in PAUP* (Swofford 2002). Sequences were compared among the candidate new species (GenBank KY418013), and those species that are morphologically most similar to the new candidate species and for which tissue samples are available: *S. botocudo* (GenBank KY418014), *S. canga* (GenBank KY418015), *S. caramaschii* (GenBank KP096219), *S. orophilus* (GenBank KY418016), and *S. surdus* (GenBank KY418017). Tissue samples were unavailable for *S. bromelicola* and *S. palustris*.

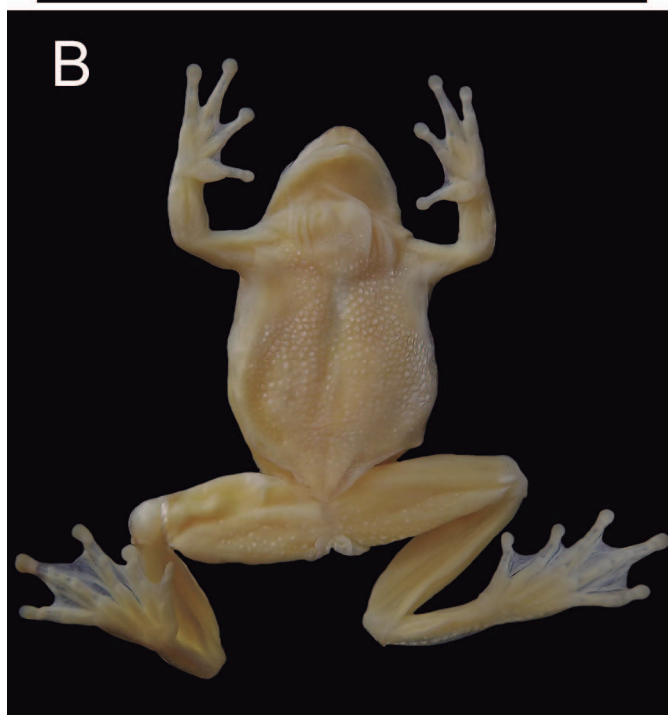
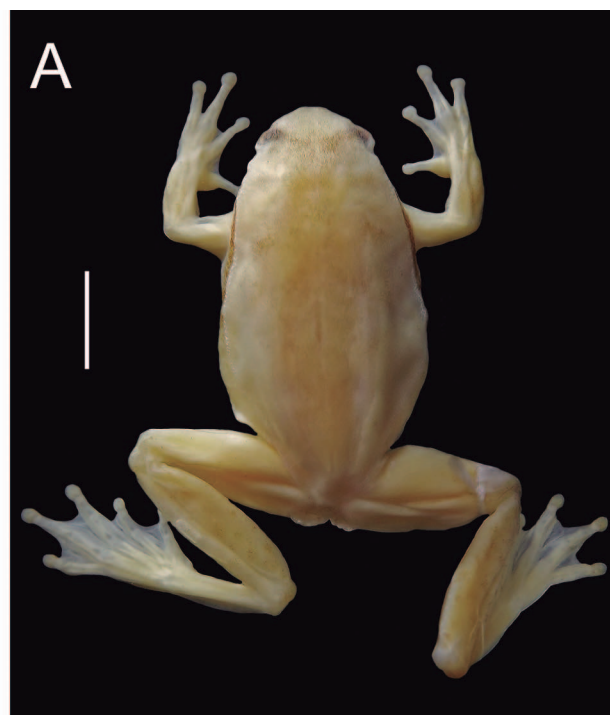


FIG. 1.—Holotype of *Sphaenorhynchus cammaeus* (URCA-H 9293; snout-vent length = 27.1 mm). (A) Dorsal view. (B) Ventral view. Scale bar = 5 mm. A color version of this figure is available online.

SPECIES ACCOUNT

Sphaenorhynchus cammaeus sp. nov.
(Figs. 1–7; Table 1)

Sphaenorhynchus prasinus: Da Silva et al. (2013: 1519–1520), Carvalho-e-Silva et al. (2015: 347).

Sphaenorhynchus aff. *palustris*: Araujo-Vieira et al. (2016).

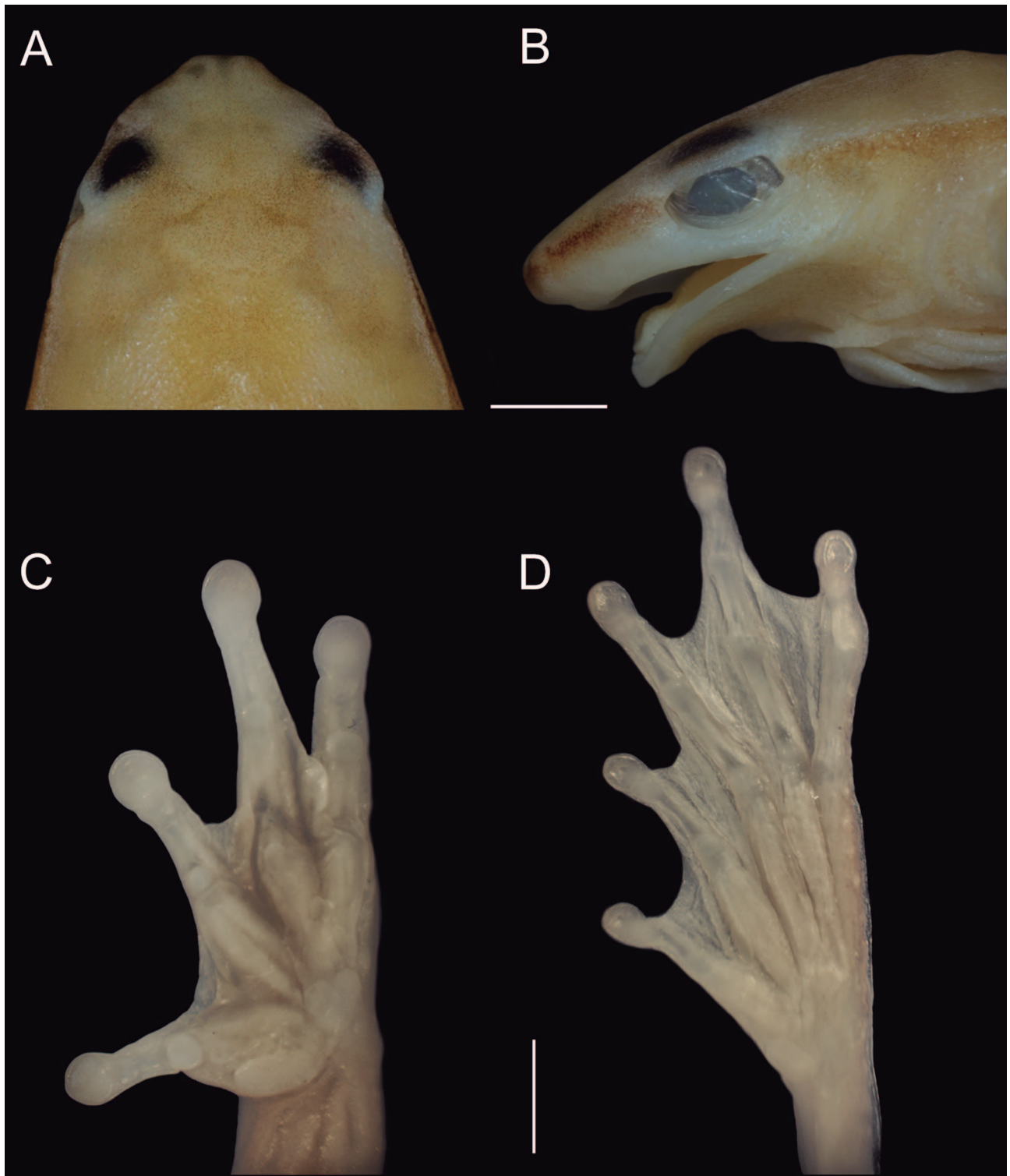


FIG. 2.—Holotype of *Sphaenorhynchus cammaeus* (URCA-H 9293). (A) Head in dorsal view. (B) Head in lateral view. (C) Left hand in ventral view. (D) Left foot in ventral view. Scale bars = 2 mm. A color version of this figure is available online.

Holotype.—URCA-H 9293, an adult male from Brazil: state of Alagoas: municipality of Quebrangulo: Reserva Biológica de Pedra Talhada: locality of Lagoa do Junco (09°14'22.38''S, 36°25'43.65''W, datum = SAD69 for all

coordinates; ~850 m above sea level), collected on 17 June 2014 by Igor Joventino Roberto, Cícero Ricardo de Oliveira, and Herivelto Faustino de Oliveira.

Paratypes.—URCA-H 6313–6321, adult males, collected at the type locality on 13 July 2013 by Igor J. Roberto, João



FIG. 3.—Dorsal (A) and ventral (B) views of the subcloacal dermal fold of *Sphaenorhynchus cammaeus* (MACN-He 48851, male). Dermal ornamentation on heel (C–F): dorsal (C) and ventral (D) views of the left heel of *S. cammaeus* (MACN-He 48851), with a crenulated dermal fold; dorsal (E) and ventral (F) views of the left heel of *S. canga* (MNRJ 56334, male) without dermal ornamentation on heel. Scale bars = 2 mm.

Antônio Araújo Filho, and Deivid Batista Oliveira. URCA-H 9285, 9286, 9288–9292, 9294, adult males, URCA-H 9287, mature female, collected at the type locality on 17–18 June 2014 by Igor Joventino Roberto, Cícero Ricardo de Oliveira, and Herivelto Faustino de Oliveira.

Referred specimens.—MACN-He 48851, adult male, MACN-He 48852, cleared and double-stained adult male,

both collected at the type locality on 13 July 2013 by Igor Joventino Roberto, João Antônio Araújo Filho, and Deivid Batista Oliveira.

Diagnosis.—The new species can be diagnosed by the following set of characters: (1) SVL 24.8–29.3 mm in males, 26.6 mm in the only available female; (2) tympanic membrane absent; (3) snout truncate in dorsal view,

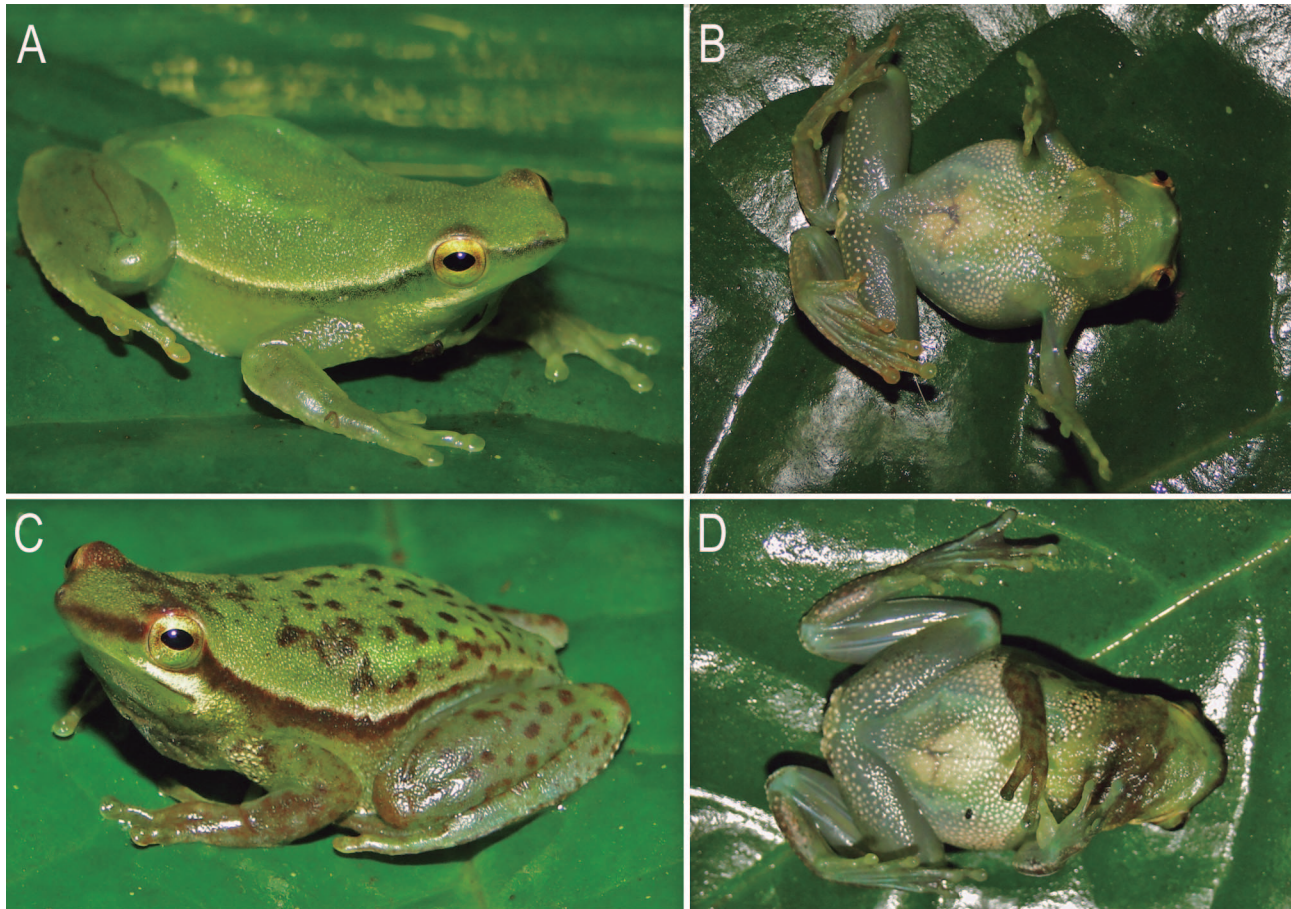


FIG. 4.—Dorsal and ventral views of *Sphaenorhynchus cammaeus* in life. (A–B) URCA-H 9285. (C–D) URCA-H 9286. A color version of this figure is available online.

protruding in lateral view; (4) canthus rostralis rounded, loreal region markedly convex; (5) vocal sac single, subgular, moderately developed, extending to the middle of pectoral region, longitudinal folds present; (6) canthal white line present; (7) dorsolateral white line from the posterior corner of eye to gradually disappearing on flanks; (8) dorsolateral black line from the tip of snout extending posteriorly beyond eye to gradually disappear on flanks; (9) nuptial pad smooth, whitish-cream colored; (10) webbing on feet moderately developed; (11) FL/SVL = 0.40–0.53; (12) white dermal folds slightly crenulated or with small tubercles on the ventrolateral margin of forearm and tarsus; (13) dermal appendages on elbow absent; (14) crenulated dermal fold on heel present; (15) subcloacal dermal fold present, white, glandular; (16) vomerine teeth present; (17) premaxilla and maxilla teeth present; (18) ventral surface of thighs with many white-colored tubercles; and (19) advertisement call with 2–3 pulsed notes (3–6 pulses) with duration of 0.19–0.24 s, frequency range of 526–4438 Hz, and dominant frequency of 2250–3000 Hz.

Comparisons.—The size (SVL 24.8–29.3 mm in males, 26.6 mm in the only known female) distinguishes *Sphaenorhynchus cammaeus* from *S. carneus* (15.1–19.8 mm in males, $n = 12$; 19.0–22.5 mm in females, $n = 3$; Duellman 1974), *S. mirim* (15.7–18.2 mm in males, $n = 11$; Caramaschi et al. 2009), *S. pauloalvini* (18–20 mm in males, $n = 22$; 22.0–24.0 mm in females, $n = 8$; Bokermann 1973), and *S.*

planicola (19.1–24.1 in males, $n = 22$). The snout truncate in dorsal view and protruding in lateral view separates the new species from *S. lacteus* (pointed in dorsal view), *S. dorisae* (rounded in dorsal view), *S. pauloalvini*, *S. planicola*, and *S. prasinus* (truncate in lateral view). The absence of a tympanic membrane differentiates *S. cammaeus* from *S. lacteus* and *S. pauloalvini* (tympanic membrane present; see also Araujo-Vieira et al. 2015: fig. 3B). A moderately developed vocal sac extending to the middle of the pectoral region differentiates males of *S. cammaeus* from those of *S. prasinus* (less developed, reaching the anterior of the pectoral region), *S. mirim*, and *S. planicola* (well developed, extending laterally and toward the posterior of the pectoral region). Additionally, the vocal sac of the new species is characterized by the presence of lateral longitudinal folds, which are absent in *S. pauloalvini*, *S. prasinus*, and *S. mirim*.

The presence of canthal and dorsolateral white lines delimited below by a dorsolateral black line separates *Sphaenorhynchus cammaeus* from *S. dorisae*, *S. mirim*, *S. pauloalvini*, and *S. planicola* (absent in these species). Also, the dorsolateral black line from the tip of the snout extending beyond the eye to gradually disappear on the flanks differentiates the new species from *S. dorisae*, *S. mirim* (absent in these species), *S. lacteus*, and *S. prasinus* (only canthal black line present).

The presence of a slightly crenulated dermal fold or small tubercles arranged inline on the ventrolateral margin of

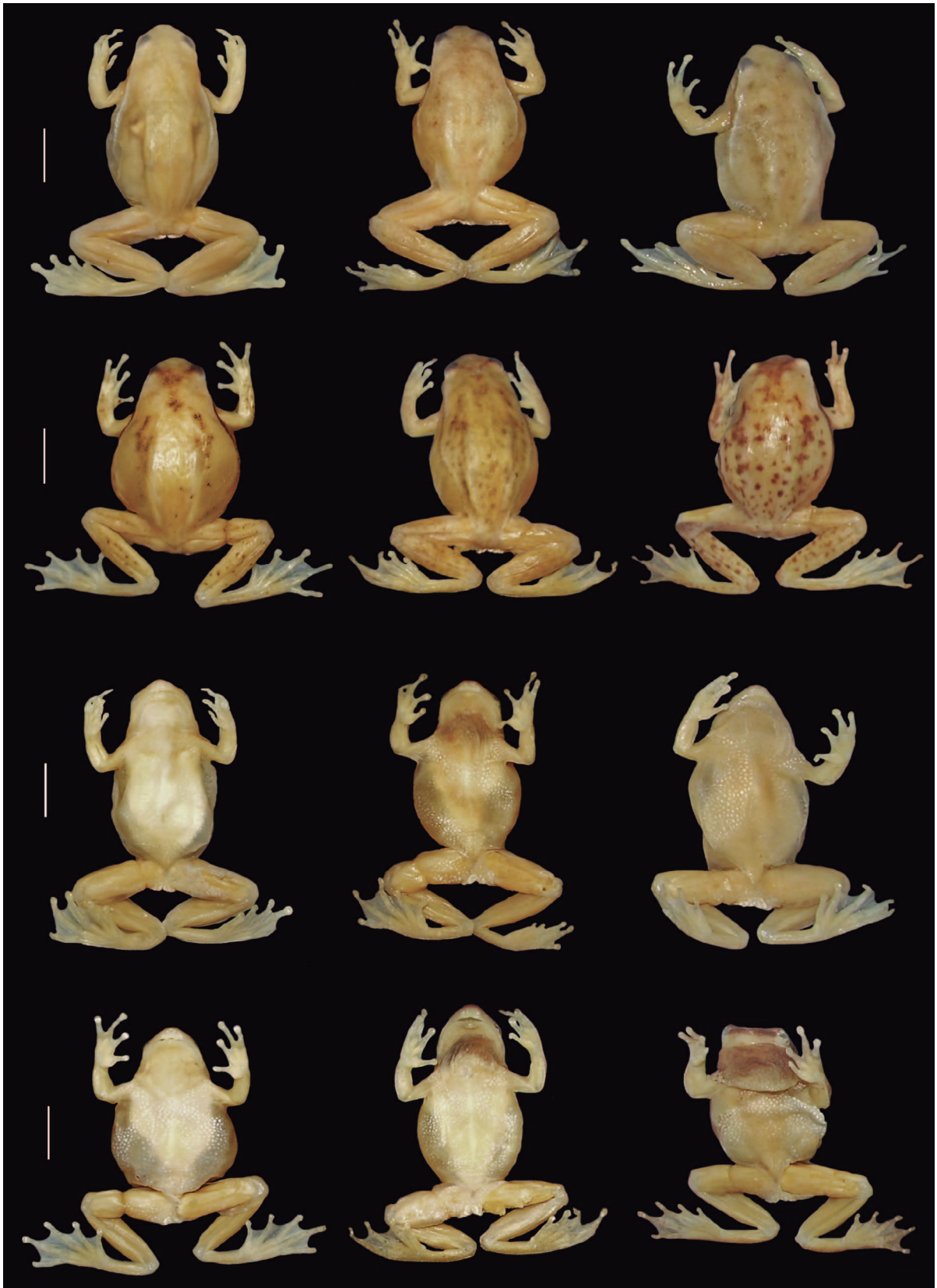


FIG. 5.—Variation in dorsal (upper two rows) and ventral (lower two rows) pattern within the type series of *Sphaenorhynchus cammaeus*. From left to right, in consecutive rows (order repeats in ventral view): URCA-H 9287–9292. Scale bars = 5 mm. A color version of this figure is available online.

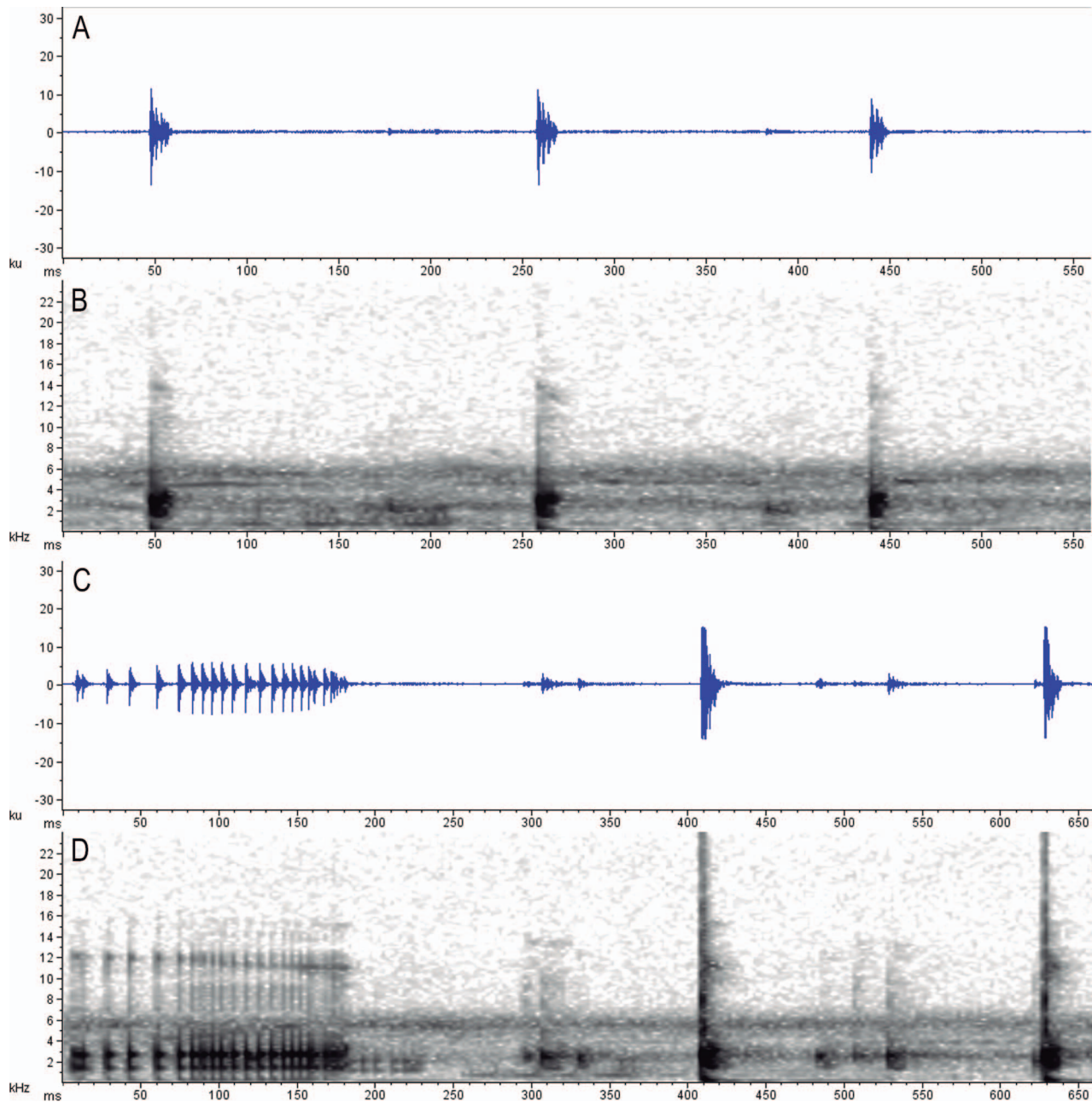


FIG. 6.—Advertisement call of *Sphaenorhynchus cammaeus* (individual 3 in Table 2). (A) Oscillogram and (B) spectrogram of the Type I call, composed of three pulsed notes; (C) Oscillogram and (D) spectrogram of the Type II call followed by the advertisement call composed of two notes. A color version of this figure is available online.

forearm and tarsus distinguishes the new species from *Sphaenorhynchus dorisae*, *S. lacteus*, *S. planicola*, and *S. prasinus* (well developed and smooth dermal fold on forearm and tarsus). The lack of dermal appendages on the elbow and the presence of a crenulated dermal fold on the heel also separate the new species from *S. dorisae* (dermal fold on elbow and triangular calcar appendage), *S. mirim*, *S. planicola*, and *S. prasinus* (dermal fold on elbow and round calcar appendage). Additionally, the presence of a white dermal fold in the subcloacal region of *S. cammaeus* differentiates it from *S. carneus* and *S. pauloalvini* (small and discrete tubercles), *S. dorisae* (white dermal flap with triangular lateral margins), and *S. lacteus*, *S. mirim*, *S.*

planicola, and *S. prasinus* (white dermal flap with round lateral margins).

Sphaenorhynchus cammaeus differs from *S. dorisae*, *S. mirim*, and *S. planicola* by the presence of maxillary and premaxillary teeth (absent in these species), and from *S. carneus* by the presence of vomerine, maxillary and premaxillary teeth (absent in *S. carneus*).

The dominant frequency of the advertisement call of *Sphaenorhynchus cammaeus* (2250–3000 Hz; Table 2) differentiates it from *S. carneus* (4479–5812 Hz, $n = 16$ calls from 5 males; Toledo et al. 2014), *S. mirim* (3085–3398 Hz, $n = 11$ calls from 3 males; Lacerda et al. 2011), *S. planicola* (3960–4073 Hz, $n = 2$ calls from 1 male; Toledo et

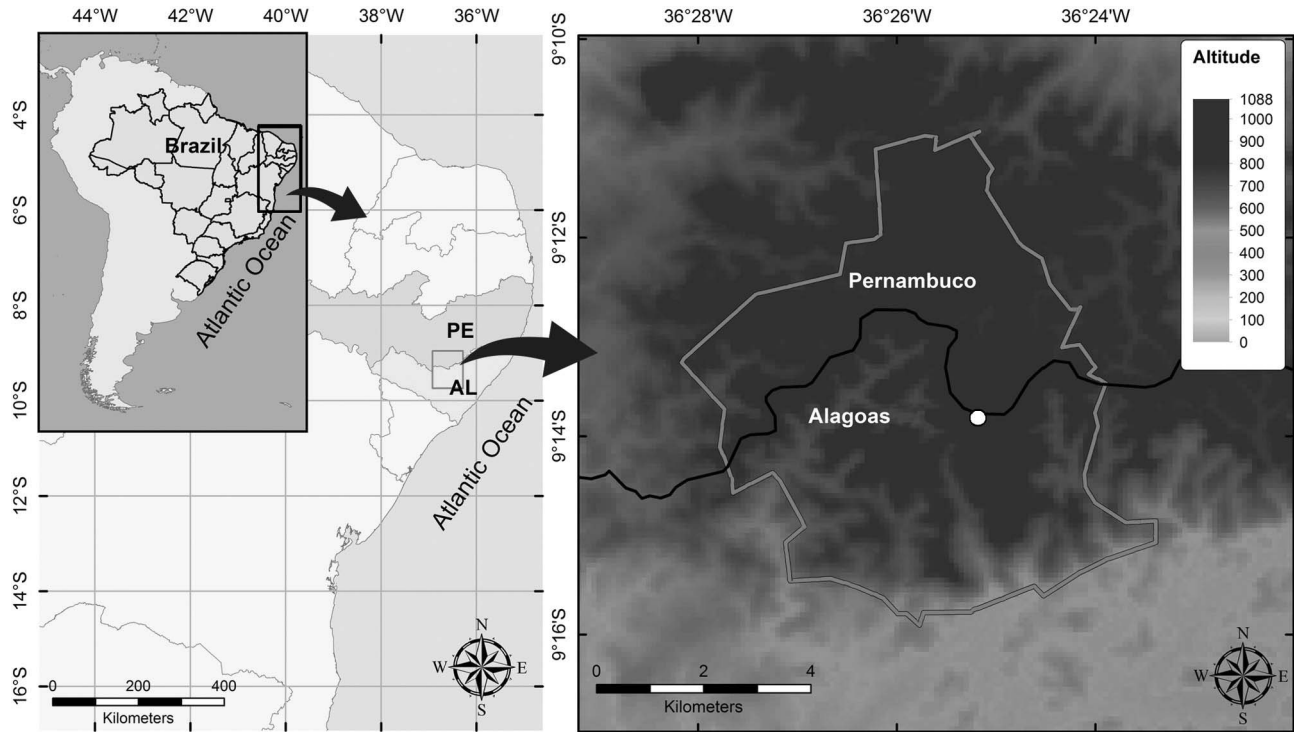


FIG. 7.—Maps indicating geographic boundary of the Reserva Biológica de Pedra Talhada (right panel) within the states of Pernambuco (PE) and Alagoas (AL; left panel), Brazil (inset). The white circle indicates the type locality for *Sphaenorhynchus cammaeus* (Lagoa do Junco, 09°14'22.38''S, 36°25'43.65''W). Altitude scale in meters.

al. 2014), and *S. lacteus* (1050–2240 Hz, $n = 27$ calls from 8 males; Duellman 1978; Duellman 2005; Toledo et al. 2014). The number of notes per call (2–3) separates the new species from *S. pauloalvini* (5–12, $n = 3$ males; Bokermann 1973; Toledo et al. 2014), *S. prasinus* (5–11, $n = 2$ males; Bokermann 1973; Toledo et al. 2014), and *S. mirim* (1, $n = 11$ calls from 3 males; Lacerda et al. 2011).

Compared to all species of *Sphaenorhynchus*, the new species is morphologically most similar to *S. botocudo*, *S. bromelicola*, *S. canga*, *S. caramaschii*, *S. palustris*, *S. orophilus*, and *S. surdus*. We found reliable morphological and acoustic characters, however, as well as molecular evidence, that distinguish the new species. The truncate snout in dorsal view separates *S. cammaeus* from *S. caramaschii*, *S. orophilus*, and *S. surdus* (round, mucronate or slightly mucronate). *Sphaenorhynchus cammaeus* has a fold in the subcloacal region (Fig. 3A,B) that differentiates it from *S. orophilus*, which has many enlarged tubercles in the subcloacal region that do not form a dermal fold (see Araujo-Vieira et al. 2015: fig. 5C,D). Also, the SVL range of 24.8–29.3 mm in males of *S. cammaeus* differentiates it from those of *S. orophilus* (30.0–35.0 mm, $n = 5$; Lutz and Lutz 1938). The dorsal color pattern, with black/dark-brown spots and a dorsolateral black/dark-brown line in life, differentiates the new species from *S. bromelicola* (spots on dorsum and dorsolateral line reddish in live specimens; Bokermann 1966).

Lateral longitudinal folds on the vocal sac, and a generally shorter foot in relation to SVL ($FL/SVL = 0.40$ – 0.53 , $n = 18$), separate the new species from *Sphaenorhynchus botocudo* (lateral longitudinal folds absent, and $FL/SVL = 0.64$ – 0.68 , $n = 16$, in *S. botocudo*; Caramaschi et al. 2009). A

rounded canthus rostralis and a markedly convex loreal region distinguish *S. cammaeus* from *S. bromelicola*, *S. palustris* (canthus rostralis straight and loreal region flat; Bokermann 1966), and *S. canga* (loreal region slightly convex; Araujo-Vieira et al. 2015). Also, the new species can be separated from *S. palustris* and *S. botocudo* by having less-developed toe webbing (webbing reaching the base of discs of all toes, except the postaxial webbing of Toe IV,

TABLE 1.—Measurements (mm) of the type series (including the holotype male) of *Sphaenorhynchus cammaeus* (Anura: Hylidae). Means are reported ± 1 SD (range).

Measurements	Males ($n = 18$)		Female ($n = 1$)
	Mean \pm SD (range)		
SVL	26.1 \pm 1.8	(22.5–29.3)	26.6
HL	8.3 \pm 0.7	(7.7–9.8)	8.4
HW	8.3 \pm 0.6	(7.3–9.5)	8.3
ED	2.1 \pm 0.3	(1.6–2.8)	1.9
END	2.9 \pm 0.2	(2.5–3.3)	3.0
ESD	3.9 \pm 0.3	(3.1–4.3)	3.8
IND	1.7 \pm 0.2	(1.4–2.0)	1.7
IOD	4.2 \pm 0.3	(3.5–4.8)	4.7
UEW	1.7 \pm 0.2	(1.3–2.1)	1.5
FAL	4.6 \pm 0.5	(4.1–5.6)	4.7
HAL	7.9 \pm 0.4	(7.1–8.5)	8.4
THL	12.4 \pm 0.6	(11.7–13.6)	13
TL	14.0 \pm 0.5	(13.0–15.1)	14.2
TAL	7.4 \pm 0.4	(6.7–8.1)	7.8
FL	12.0 \pm 0.4	(11.1–13.0)	11.8
3FD	1.0 \pm 0.0	(0.9–1.1)	1.1
4TD	0.9 \pm 0.1	(0.8–1.0)	0.9

SVL = snout–vent length; HL = head length; HW = head width; ED = eye diameter; END = eye–nostril distance; ESD = eye–snout distance; IND = internarial distance; IOD = interorbital distance; UEW = upper eyelid width; FAL = forearm length; HAL = hand length; THL = thigh length; TL = tibia length; TAL = tarsal length; FL = foot length; 3FD = third finger disc diameter; 4TD = fourth toe disc diameter.

TABLE 2.—Acoustic parameters of advertisement calls of four individuals of *Sphaenorhynchus cammaeus* recorded on 17–18 June 2014 at the Reserva Biológica de Pedra Talhada, municipality of Quebrangulo, locality of Lagoa do Junco, state of Alagoas, Brazil. Air temperature was not recorded; values are reported as mean \pm 1 SE (range, sample size).

Call parameters	URCA-H 9285	Individual 1	Individual 2	Individual 3	Pooled sample
Notes/call	2.7 \pm 0.4 (2–3, n = 19)	(2, n = 7)	2.5 \pm 0.5 (2–3, n = 9)	2.5 \pm 0.5 (2–3, n = 15)	2.5 \pm 0.5 (2–3, n = 50)
Call duration (s)	0.42 \pm 0.1 (0.25–0.51, n = 19)	0.20 \pm 0.006 (0.19–0.21, n = 7)	0.32 \pm 0.1 (0.21–0.42, n = 9)	0.34 \pm 0.1 (0.22–0.44, n = 15)	0.35 \pm 0.12 (0.19–0.44, n = 50)
Interval between calls (s)	12.1 \pm 5.3 (4.68–20.7, n = 18)	13.8 \pm 5.64 (8.85–24.9, n = 6)	13.3 \pm 2.4 (10.3–17.8, n = 8)	19.4 \pm 12.0 (7.7–42.1, n = 13)	14.7 \pm 8 (4.68–42.1, n = 45)
Note duration (s)	0.01 \pm 0.005 (0.008–0.03, n = 52)	0.01 \pm 0.002 (0.009–0.02, n = 14)	0.01 \pm 0.001 (0.01–0.015, n = 23)	0.01 \pm 0.002 (0.009–0.02, n = 38)	0.01 \pm 0.003 (0.008–0.03, n = 127)
Interval between notes (s)	0.22 \pm 0.01 (0.2–0.24, n = 33)	0.18 \pm 0.008 (0.17–0.19, n = 7)	0.19 \pm 0.01 (0.17–0.2, n = 14)	0.2 \pm 0.01 (0.18–0.22, n = 23)	0.20 \pm 0.02 (0.17–0.24, n = 77)
Pulses/note	4.1 \pm 1.0 (3–6, n = 52)	4.3 \pm 0.7 (3–5, n = 14)	3.8 \pm 0.5 (3–5, n = 23)	4 \pm 0.6 (3–5, n = 38)	4 \pm 0.8 (3–6, n = 127)
Minimum frequency (Hz)	951.7 \pm 152.8 (578.9–1473.7, n = 52)	864.7 \pm 133.3 (684.2–1105.3, n = 14)	1161.6 \pm 154.3 (859.7–1644.7, n = 23)	958.7 \pm 144.7 (526.3–1421.1, n = 38)	982.1 \pm 171.7 (526.3–1644.7, n = 127)
Maximum frequency (Hz)	3791.8 \pm 161.8 (3421.1–4157.9, n = 52)	4251.9 \pm 418.1 (3210.5–4789.5, n = 14)	3791.8 \pm 161.8 (3421.1–4157.9, n = 23)	3736.8 \pm 200.3 (3421.1–4210.5, n = 38)	3828.5 \pm 27 (3210.5–4838.1, n = 127)
Dominant frequency (Hz)	2906.2 \pm 114.4 (2437.5–3000, n = 52)	2504.5 \pm 227.9 (2250–2812.5, n = 14)	2836.9 \pm 85.8 (2625–3000, n = 23)	2615.4 \pm 73.9 (2437.5–2812.5, n = 38)	2761.2 \pm 192.2 (2250–3000, n = 127)

which almost reaches the base of the ultimate subarticular tubercle in these species; Bokermann 1966; Caramaschi et al. 2009). The crenulated dermal fold on the heel (Fig. 3C,D) and many white-colored tubercles on the ventral surface of thighs differentiate the new species from *S. canga* (dermal appendages on heel absent and uncolored tubercles on the ventral surface of thighs; Fig. 3E,F; see also Araujo-Vieira et al. 2015). A smooth, whitish-cream colored nuptial pad distinguishes *Sphaenorhynchus cammaeus* from *S. bromelicola*, *S. caramaschii*, *S. orophilus*, *S. palustris*, and *S. surdus* (light-brown colored nuptial pad in these species; Bokermann 1966; Toledo et al. 2007).

A short advertisement call and a lower number of notes per call (call duration of 0.19–0.44 s, 2–3 notes/call, $n = 50$, 4 males) separates *Sphaenorhynchus cammaeus* from *S. bromelicola* (call duration of \approx 1.1 s, 5 notes/call, $n = 1$ call from 1 male; Bokermann 1974), *S. caramaschii* (call duration of 5.23–11.0 s, 18–43 notes/call, $n = 5$ calls from 4 males; Toledo et al. 2007, 2014), and *S. orophilus* (call duration of 1.48–2.33 s, $n = 2$ calls from 2 males; Heyer et al. 1990; Toledo et al. 2014). Additionally, a short aggressive/territorial call with a higher number of notes (call duration of 0.18–0.20 s and 18–21 notes/call, $n = 2$ calls from 2 males) differentiates the new species from *S. canga* (13 notes/call, $n = 3$, 1 male; Araujo-Vieira et al. 2015), *S. orophilus* (call duration of 0.25 s, $n = 1$ call from 1 male; Heyer et al. 1990), and *S. palustris* (call duration of 0.47–0.83 s, 4–6 notes/call, $n = 4$ calls from 2 males; Lacerda and Moura 2013).

The percentage of nucleotide divergence expressed as uncorrected pairwise distances of the fragment of the mitochondrial ribosomal gene 16S rRNA showed that the new species differs by 3.5–6.8% from *S. botocudo*, *S. canga*, *S. caramaschii*, *S. orophilus*, and *S. surdus* (Table 3). These percentages are over the threshold level (\geq 3.0%) of genetic divergence for identifying candidate species of Neotropical anurans, as proposed by Fouquet et al. (2007).

Sphaenorhynchus cammaeus is distinguished from the holotype of *S. platycephalus* by having a smaller female with SVL 26.6 mm (SVL 33 mm, holotype IZUW 90, female; Harding 1991) and the snout truncate in dorsal view (rounded in *S. platycephalus*; Harding 1991). The presence of a slightly crenulated dermal fold or small tubercles arranged in line on the ventrolateral surface of forearm and tarsus, and a subcloacal dermal fold, differentiate the new species from *S. platycephalus* (absent in this species; Harding 1991).

Description of holotype.—Body robust, ovoid, head triangular, wider than long, representing 29.5% of the SVL (Fig. 1). Snout truncate in dorsal view, protruding in lateral view (Fig. 2A,B). Nostrils lateral, directed forward. Canthus rostralis rounded. Loreal region markedly convex (Fig. 2A). Eyes small, ED 50% of IOD, smaller than END. Tympanic membrane absent, unmodified skin in the area. Supratympanic fold weak, from the posterior corner of eye to shoulder. Vocal sac single, subgular, moderately developed, extending to the middle of pectoral region, longitudinal folds present (Fig. 1B). Vocal slits present, large, located on the lateral sides of tongue. Tongue large, ovoid, not notched posteriorly. Choanae anterior, rounded, and widely separated. Vomerine teeth small, irregularly distributed on dentigerous process posterior to choanae, each process bearing four teeth. Premaxillary and maxillary teeth present.

TABLE 3.—Uncorrected pairwise distances (p) among sequences of ~570 nucleotide base pairs of the mitochondrial 16S rRNA gene from six species of *Sphaenorhynchus* (Anura: Hylidae). Scam = *S. cammaeus*; Sbot = *S. botocudo*; Scan = *S. canga*; Scar = *S. caramaschii*; Soro = *S. orophilus*; and Ssur = *S. surdus*.

Species	GenBank accession number	Voucher	Locality	Scam	Sbot	Scan	Scar	Soro	Ssur
Scam	KY418013	MACN-He 48851	BRAZIL: Alagoas: Quebrangulo: Lagoa do Junco	—	—	—	—	—	—
Sbot	KY418014	MNRJt 483	BRAZIL: Espírito Santo: Mucurici: Lagoa Nova	5.5	—	—	—	—	—
Scan	KY418015	MNRJ 56336	BRAZIL: Minas Gerais: Mariana: Chapada de Canga	5.0	4.1	—	—	—	—
Scar	KP096219	CFBH 11285	BRAZIL: São Paulo: Ribeirão Branco: Fazenda São Luís	6.8	7.1	6.3	—	—	—
Soro	KY418016	CFBH 10573	BRAZIL: São Paulo: Bairro Alto	4.9	5.5	4.0	6.6	—	—
Ssur	KY418017	CFBH 8546	BRAZIL: Santa Catarina: Lages	3.5	3.0	3.0	6.0	3.2	—

Arms robust, with a poorly developed axillary membrane. Forearms robust, with small ulnar tubercles arranged inline. Hand large, HAL 38.4% of SVL. Fingers robust. Relative length of fingers I < II < IV < III. Discs round and expanded. Subarticular tubercles single, rounded; subarticular tubercles on Fingers III and IV smaller than other tubercles. Supernumerary tubercles present, small. Inner metacarpal tubercle single, elliptical; outer metacarpal tubercle flat, medially divided, smaller than inner metacarpal tubercle. Webbing formula: I 2–2⁺ II 1^{1/2}–2^{1/2} III 2[–]–2 IV (Fig. 2C); free parts of fingers fringed. Thick, smooth, whitish-cream colored nuptial pad covering the dorsal surface of Metacarpal II, and covering the external margin of the inner metacarpal tubercle extending to the penultimate subarticular tubercle.

Legs robust, THL about the same size as FL, slightly smaller than TL. A TL of about 27% of SVL. Dermal fold poorly developed and slightly crenulated on the ventrolateral margin of tarsus. Crenulated dermal fold on heel. Toes robust. Relative length of toes I < II < V < III < IV. Discs expanded. Subarticular tubercles single, rounded. Supernumerary tubercles very discrete, single, and rounded. Inner metatarsal tubercle elliptical; outer metatarsal tubercle small, rounded. Webbing formula: I 1–2⁺ II 1–2⁺ III 1–2⁺ IV 2⁺–1⁺V (Fig. 2D); free parts of toes fringed. Subcloacal dermal fold present. Dorsal surfaces, including arms and legs, slightly granular; vocal sac smooth; ventral skin granular.

Measurements of the holotype (mm).—SVL 27.1; HL 8.0; HW 7.7; IND 1.8; ESD 3.3; END 2.6; ED 2.0; IOD 4.0; UEW 1.7; FAL 4.1; HAL 8.1; THL 14.1; TL 12.1; TAL 7.6; FL 12.7; 3FD 0.9; 4TD 0.8.

Coloration in life.—Dorsum light green with scattered brown spots, especially on limbs. Dorsolateral black line extending from the tip of snout almost to the groin. Upper eyelids black. Canthal white line from tip of snout to anterior corner of eye; dorsolateral white line extending from posterior corner of eye to groin. Dermal ornamentation on the ventrolateral margin of forearms, tarsus, and subcloacal region white. Iris yellowish-green with few small black reticulations and a medial brown blotch. Venter and vocal sac whitish-green, the latter with some scattered black dots. Many white-colored tubercles on ventral surface of body, shoulders, and thighs. Skin translucent, especially on ventral surface of body and limbs, and on flanks, so that muscles, veins, green bones, and the white parietal peritoneum covering all organs are visible.

Coloration in preservative.—Green coloration becomes cream-colored and the color pattern fades and loses its golden, iridescent tones; the iris becomes black. Vocal sac

cream-colored with gray dots. Abdomen and thighs seat pads cream-colored with white granules. Canthal and dorsolateral white lines, dorsolateral black line, folds, tubercles, and pads maintain white.

Variation.—Measurements vary among male specimens in the type series (Table 1). The number of vomerine teeth is four (11 individuals), or five (URCA-H 6316, 6318, 6320, 9285, 9288, 9289) on both right and left processes. A slightly crenulated dermal fold on the ventrolateral margin of forearm and tarsus is present in two males (URCA-H 6314, 9290). The cleared and double-stained specimen (MACN-He 48852) has 10 premaxillary and 13 maxillary small teeth.

The dorsal coloration is mostly uniform green (Figs. 4, 5) but can vary from being conspicuously (URCA-H 9286) to finely spotted dark brown (URCA-H 9285, 9289, 9290). Four specimens (URCA-H 6313, 6314, 9286, 9292) have a blackish vocal sac. The dorsolateral white and black or dark-brown lines reach the groin in four individuals (URCA-H 6313, 9285, 9286, 9292) or end at the middle of flanks in six individuals (URCA-H 6314, 6319, 6321, 9288, 9289, 9291). In five individuals, the white dorsolateral line reaches the groin whereas the black dorsolateral line disappears just after the posterior corner of eye (URCA-H 6315, 6316, 6318, 6320, 9287). A distinct longitudinal white blotch below the eye is present in six individuals (URCA-H 9285–9287, 9290, 9292, 9294). The only available female (URCA-H 9287, SVL 26.6 mm) is very similar to males but lacks nuptial pads.

Etymology.—The specific epithet is a Medieval Latin name that means carved precious stone with two color layers. It is given in reference to the name of the type locality (Pedra Talhada = carved stone) and also to the beauty of the species.

Tadpoles.—The tadpole is unknown.

Advertisement call.—We analyzed 50 calls recorded from four males (three unvouchered and URCA-H 9285; Table 2). Two different call types of *Sphaenorhynchus cammaeus* were recorded: Type I and Type II (Fig. 6). The Type I call is referred to as an advertisement call, which is composed of a series of pulsed notes with 2–3 notes per call (2.5 ± 0.5 , $n = 50$). The calls have a duration of 0.19–0.44 s (0.35 ± 0.12 s, $n = 50$) and are separated by an interval of 4.68–42.1 s (14.7 ± 8.0 s, $n = 45$). Notes have 3–6 pulses (4.0 ± 0.8 , $n = 127$). Notes have a duration of 0.008–0.03 s (0.01 ± 0.003 s, $n = 127$), with an interval between notes of 0.17–0.24 s (0.2 ± 0.02 s, $n = 77$). The minimum frequency ranges from 526–1644 Hz (982.1 ± 171.7 Hz, $n = 127$) and the maximum frequency ranges from 3210–4838 Hz (3828 ± 273 Hz, $n = 127$). The dominant frequency ranges from 2250–3000 Hz (2761 ± 192 Hz, $n = 127$).

The Type II call was rarely emitted prior to the Type I call and might be an aggressive/territorial call (sensu Wells 2007). Two Type II calls from two individuals (unvouchered) were recorded and consist of a trill of 18–21 pulsed notes (one pulse per note), with a duration of 0.18–0.20 s. The interval between notes is 0.002–0.011 s (0.004 ± 0.003 s, $n = 18$) with the first six notes separated by a longer interval (0.08–0.11 s). The frequency ranges from 781.5–3833.3 Hz and the dominant frequency ranges from 2625–2812 Hz.

Natural history and geographic distribution.—Males of *Sphaenorhynchus cammaeus* were observed calling among aquatic vegetation (mostly *Eleocharis interstincta*, Cyperaceae), either above the water surface perched on the emerging vegetation or with only the hind limbs in the water in deeper places of a temporary pond—Lagoa do Junco. They were found calling from 1600 to 2300 h on July 2013 and June 2014. Males of *Dendropsophus branneri*, *D. elegans*, *D. aff. decipiens*, *D. haddadi*, *D. minutus*, *D. oliveirai*, *D. studerae*, and *Scinax eurydice* (Hylidae) and *Leptodactylus natalensis* (Leptodactylidae) were also observed calling in the same pond.

Sphaenorhynchus cammaeus is known only from the type locality in the Reserva Biológica de Pedra Talhada. This protected conservation unit was established in 1989 and encompasses 44.69 km² in the municipalities of Quebrangulo and Chã Preta in the state of Alagoas and in the municipality of Lagoa do Ouro in the state of Pernambuco (Fig. 7). The unit is located within the Atlantic Forest biome and is characterized by submontane ombrophilous forest, popularly known as Brejo de Altitude. Nusbaumer et al. (2015) provided a description of the flora and vegetation of the Reserva Biológica de Pedra Talhada, and Tscherner et al. (2015) described the abiotic parameters at the reserve.

Sphaenorhynchus cammaeus seems to be endemic to high-elevation areas in the Pedra Talhada mountain range (ca. 850 m above sea level), in highland humid forest. We propose to classify this species as data deficient, following the criteria of the International Union for Conservation of Nature (IUCN 2012), because the ecological and distributional data available are insufficient to determine its true conservation status. In addition to *S. cammaeus*, 665 species of invertebrates, 11 actinopterygians, 42 amphibians, 72 reptiles, 255 birds, and 48 mammals (Studer et al. 2015) have been recorded in the reserve. This includes two endemic and threatened snakes (*Atractus caete* and *Echinanthera cephalomaculata*; Di-Bernardo 1994; Passos et al. 2010; Ministério do Meio Ambiente [MMA] 2014), and 25 endangered species of birds (Studer 2015), which testifies to the importance of this area for conservation of the fauna of the Atlantic Forest.

Remarks.—The premaxillary and maxillary teeth are visible under high magnification in adults of *Sphaenorhynchus cammaeus* ($n = 19$ individuals) whereas our own observations showed that they are indiscernible in adults of *S. canga* ($n = 20$ individuals). Moreover, when comparing the teeth of the cleared and double-stained specimen of *S. cammaeus* (MACN-He 48852) with those of the other species of *Sphaenorhynchus* which have teeth, we observed an important difference in relation to the number and development of the teeth between the new species and *S. canga* (MNRJ 56335, UFMG-A 7209). *Sphaenorhynchus cammaeus* has a higher number (10 premaxillary and 13

maxillary teeth) and more-developed teeth on both the premaxilla and maxilla compared to those of *S. canga* (premaxilla and maxilla almost completely edentulous, each bearing 1–5 extremely small teeth; Araujo-Vieira et al. 2015).

Araujo-Vieira et al. (2016) provided a record of *Sphaenorhynchus* aff. *palustris* from the type locality of *S. cammaeus*. We examined the voucher (URCA-H 6319) and confirmed that this specimen is indeed an individual of *S. cammaeus* as described here. Therefore, *S. cammaeus* is currently not known to be sympatric with any other species of *Sphaenorhynchus*. On the other hand, *S. prasinus* was found in an open, disturbed area at midaltitude (09°16'10.7''S, 36°26'39.0''W, 500 m above sea level; URCA H-9295) only ~5.0 km SW from the type locality of the new species (Araujo-Vieira et al. 2016). *Sphaenorhynchus prasinus* seems to be mainly associated with areas of mid- and low altitudes, as previously reported by Bokermann (1973), Santos and Moura (2009), and Araujo-Vieira et al. (2016).

DISCUSSION

Sphaenorhynchus cammaeus is the eighth species of the genus that occurs in northeastern Brazil. *Sphaenorhynchus cammaeus* and *S. prasinus* occur north of the São Francisco River in the Pernambuco Endemism Center (sensu Prance 1982; Silva and Castelleti 2003). This biogeographical unit is composed of the fragments of Atlantic Forest between the states of Rio Grande do Norte and Alagoas in northeastern Brazil and is the most fragmented and threatened region of the Atlantic Forest. Only 360,455 ha of original forest cover remain, of which only 3371 ha are protected as conservation units (Ribeiro et al. 2009).

Five other species of *Sphaenorhynchus* occur to the south of the São Francisco River in the state of Bahia (*S. botocudo*, *S. bromelicola*, *S. mirim*, *S. palustris*, *S. pauloalvini*; Bokermann 1966; Haddad et al. 2013). The remaining species, *S. lacteus*, is associated with the Amazon basin, but there are two isolated populations in ecotonal areas in the states of Piauí and Maranhão (Caramaschi et al. 2009; La Marca et al. 2010; Benicio et al. 2011).

Some species of *Sphaenorhynchus* from the Atlantic Forest are known to inhabit degraded open areas associated with lowland forests or sandbanks (*S. botocudo*, *S. mirim*, *S. palustris*, *S. prasinus*; Lutz and Lutz 1938; Caramaschi et al. 2009; Lacerda et al. 2011; Lacerda and Moura 2013). *Sphaenorhynchus cammaeus* seems to be associated with ponds along the forest border in highlands above 800 m, however, as has also been recorded for *S. orophilus* and *S. caramaschii* (Lutz and Lutz 1938; Heyer et al. 1990; Toledo et al. 2007).

The aggressive/territorial call of *Sphaenorhynchus canga* and *S. orophilus* was described as an unusual call emitted prior to the advertisement calls for each species (Heyer et al. 1990; Araujo-Vieira et al. 2015), as was described here for the new species. This type of call was also reported for *S. palustris* by Lacerda and Moura (2013). The aggressive/territorial call of *S. canga* was erroneously reported by Araujo-Vieira et al. (2015) as a call composed of 3–6 notes/call, in which the longest first note had 13 pulses followed by shorter notes with small numbers of pulses. This call of *S. canga* is actually an aggressive/territorial call composed of 13 pulsed notes (the

longest first note in Araujo-Vieira et al. 2015), with a duration of 0.19–0.20 s (0.19 ± 0.004 , $n = 3$ calls from 1 male), followed by the shorter notes that are in fact the advertisement call of this species (KAV, personal observation; see also Araujo-Vieira et al. 2015: fig. 7C,D).

The values of uncorrected pairwise distances from comparisons of the fragments 16S rRNA showed that *Sphaenorhynchus cammaeus* possesses percentages of genetic divergence (uncorrected pairwise distances) greater than the threshold level proposed for identifying candidate species of Neotropical anurans (Table 3; see also Fouquet et al. 2007). It has been argued, however, that the magnitude of genetic divergence could vary from lineage to lineage (Padial et al. 2009; Blotto et al. 2013). Given variation in evolutionary rates and sampling density, one might expect intraspecific variation to be greater in some species than interspecific variation among others (Grant et al. 2006).

Considering that we identified many reliable morphological and acoustic characters with which to distinguish the new species from the remaining described species of *Sphaenorhynchus*, we acknowledge that uncorrected pairwise distances are a useful and appropriate starting point for identifying potential new species without conducting a complete phylogenetic analysis (Grant 2002; Vences et al. 2005). The uncorrected pairwise distance of 3% in the mitochondrial 16S rRNA gene is an acceptable value for finding candidate species of *Sphaenorhynchus*. Our continuation of this research includes phylogenetic studies involving all species of *Sphaenorhynchus* because we have identified other significant morphological and molecular differences among the species known to represent this genus.

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SUPPLEMENTAL MATERIAL

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APPENDIX

Specimens Examined

Sphaenorhynchus botocudo.—BRAZIL: Espírito Santo: Mucurici: Fazenda Matutina: MACN-He 46458, 46459 (cleared and double-stained adult female), MNRJ 50625, 50626 (paratypes), MNRJ 50629–50631 (paratypes), MNRJ 50635, 50636, 50639 (paratypes).

Sphaenorhynchus bromelicola.—BRAZIL: Bahia: Maracás: Fazenda Santo Onofre: 10 km E Maracás: MZUSP 73754 (holotype), MZUSP 73806–73813 (paratypes), MZUSP 73831–73840 (paratypes); Maracás: Fazenda Canabrava: MNRJ 4289, 4290, 4292; MZUSP 99475–99499, MZUSP 101507–101515, 101517, 101518 (cleared and double-stained adult male), MZUSP 101519, MZUSP 126109, ZUEC 2789.

Sphaenorhynchus canga.—BRAZIL: Minas Gerais: Mariana: Chapada de Canga: UFMG-A 5715 (holotype), MNRJ 56337–56346 (paratypes), MNRJ 5716, 5717 (paratypes), MNRJ 56335 (cleared and double-stained adult male); Mariana, 1.5 km W MG-129: UFMG-A 7192, 7194, 7205, 7207, 7208 (paratypes), MZUFV 11912–11915 (paratypes), UFMG-A 7209 (cleared and

double-stained adult male); Mariana, 5.2 km S MG-129: UFMG-A 11732, 11738, 11739 (paratypes).

Sphaenorhynchus caramaschii.—BRAZIL: São Paulo: Ribeirão Branco: Fazenda São Luiz: CFBH 2285–2294, 6934–6936 (paratypes), CFBH 6933 (cleared and double-stained adult female, paratype), CFBH 6937 (cleared and double-stained adult male, paratype), MNRJ 19373–19377; Iporanga, PETAR-Núcleo Ouro Grosso: CFBH 6320–6323; Ribeirão Grande: CFBH 15581, 15583; Pilar do Sul: CFBH 8289. Santa Catarina: Treviso: CFBH 9854, 10325, MZUSP 84589, 134045, 134047.

Sphaenorhynchus carneus.—BRAZIL: Acre: Cruzeiro do Sul: Fazenda São Geraldo: ZUEC 3527; Cruzeiro do Sul: Porto Walter: ZUEC 8429, 8431; Tarauacá, Flooded places near the church: ZUEC 5555 (cleared and double-stained adult male). Amazonas: Capim Flutuante-Rio Solimões: CFBH 4984, 4985; Seringal América-Rio Purus: MZUSP 50408, 504010; Lago Pacatuba: MZUSP 53710, 53712, 53714, 53715; Lago Amaná: MZUSP 58469, 58471, 58472, 58474; Tabatinga: MZUSP 111240. COLÔMBIA: Caquetá: Alingaros: MZUSP 99431, 99432, 99436, 99440, 99446, 99448, 99453, 99456, 99458, 99459, 99461, 99462, 99464–99466, 99468, 99469, 99471, 99472.

Sphaenorhynchus dorisae.—BRAZIL: Acre: Cruzeiro do Sul: Porto Walter: ZUEC 8426–8427; Rio Tejo: ZUEC 11091, 11095, 11096 (cleared and double-stained adult female), ZUEC 11097, 11098, 11100, 11103, 11106; Cruzeiro do Sul: MCP 10591–10595; Rodrigues Alves: Igarapé Croa-Alto do Juruá: CFBH 15721, 15723. Amazonas: Rio Solimões: Igarapé Belém: MZUSP 34669, 34672, 34674, 34676, 34677, 34680; Boca do Paraná do Catito: MZUSP 33190; Beruri: MZUSP 50552; Seringal América: Rio Purus: MZUSP 50413, 50415; Lago Januari: MZUSP 53720, 53723. PERU: Loreto: Estirón: Rio Ampiyacu: MZUSP 32808, 32810.

Sphaenorhynchus lacteus.—BRAZIL: Acre: Cruzeiro do Sul: Vila Militar: ZUEC 4689; Humaitá do Moa: ZUEC 5429 (cleared and double-stained adult male); Cruzeiro do Sul: MCP 10570–10590; Rio Branco: Sítio Engenheiro Ramon: ZUEC 5590; Rio Branco: Parque Zoológico UFAC: ZUEC 5570; Xapuri: route to Vila Boa Vista: ZUEC 5705; Mâncio Lima: Lagoa da Cobra: ZUEC 5853; Tarauacá: MZUSP 99335, 99337, 99339, 99340. Amazonas: Manaus: URCA-H 3495–3499; Manaus: Lago do Castanho-Rodovia Manaus: ZUEC 3929, 7041; Humaitá: MNRJ 4284–4287; Lago Amaná: MZUSP 58490, 58491, 58494, 58497, 58500; Igarapé Belém: Rio Solimões: MZUSP 32814, 32817, 32821, 32835, 32837, 32841, 32845, 32846; Puruzinho: Rio Madeira: MZUSP 51487, 51492, 51493; Boca do Acre: MZUSP 50310, 50311; São José (Jacaré): Rio Solimões: MZUSP 40365, 40367; Açaituba: Rio Purus: MZUSP 50465; Lago Januari: MZUSP 53726, 53730; Reserva Ducke: MZUSP 75715; Beruri: MZUSP 50581; Borba: MZUSP 51196; Tabatinga: MZUSP 11238. Pará: Surinam: MZUSP 84625; Tucuruí: MZUSP 76464; Belém: MZUSP 1505, 1507; Belém: Pasto de Búfalos: EMBRAPA: MNRJ 4288; Oriximiná: MZUSP 22526; Reserva Biológica Tapirapé: MZUSP 140061, 140064, 140065, 140068. Rondônia: Príncipe da Beira: MZUSP 99426; Porto Velho: MZUSP 99347, 99348, 99354, 99356, 99357, 99366, 99367, 99370, 99373–99376, ZUEC 2707. Maranhão: Anajatuba: MNRJ 18270–18275, 18277–18279; São Luiz Gonzaga do Maranhão: MNRJ 36635. COLÔMBIA: Caquetá: Los Alicangaros: MZUSP 99409, 99411, 99414, 99419, 99421, 99425; Isla Santa Sofia: Amazonas: MZUSP 39168–39170, 39172, 39174, 39175. PERU: Loreto: Estirón: Rio Ampiyacu: MZUSP 32801, 32802, 32804–32807.

Sphaenorhynchus mirim.—BRAZIL: Espírito Santo: Mucurici: Fazenda Matutina: MNRJ 50648–50650, 50652, 50653 (paratypes), MACN-He 46460, 46461, 46462 (cleared and double-stained adult female).

Sphaenorhynchus orophilus.—BRAZIL: Rio de Janeiro: Serra do Mar: 4 km outside Petropolis: canal leading to the dam at Quitandinha: MNRJ 3309. Between São Paulo and Rio de Janeiro: Bonito: Serra da Bocaina: MNRJ 1566, 2129–2131 (paratypes). Rio de Janeiro: Petrópolis: MZUSP 680, 681; Teresópolis: Alto do Soberbo: MZUSP 53464, 53465 (cleared and double-stained adult male); Teresópolis: Represa do Guinle: MNRJ 31731 (cleared and double-stained adult male), MNRJ 31732, 31734, 31735, 31737, ZUEC 4096; Rio de Janeiro: MNRJ 126. São Paulo: Bairro Alto: CFBH 10573; Borácea: MZUSP 60228–60230, 37668.

Sphaenorhynchus palustris.—BRAZIL: Bahia: Porto Seguro: RPPN

Estação Vera Céu: MZUSP 127831, 127834, 127835, MNRJ 42649–42657. Espírito Santo: Conceição da Barra: Vila de Itaúnas: MNRJ 54979, 54980; Conceição da Barra: Floresta Nacional Rio Preto: MNRJ 54981, 54982 (cleared and double-stained adult male), MNRJ 54983; Refúgio Sooretama: MZUSP 73758 (holotype), MZUSP 73770–73772 (paratypes).

Sphaenorhynchus pauloalvini.—BRAZIL: Bahia: Ilhéus: CEPEC: MZUSP 73751 (holotype), MZUSP 73773–73776 (paratypes), MZUSP 73791–73803 (paratypes), MZUSP 73841–73850 (paratypes); Una: MZUFBA 7621. Espírito Santo: Linhares: MZUSP 101500; Estação Experimental Linhares: MNRJ 4303–4306, 4308, 4310, 4312, 4314, 4316, 4318, 4320–4322, 4323 (cleared and double-stained adult female), MNRJ 4324–4329.

Sphaenorhynchus planicola.—BRAZIL: Espírito Santo: Fundação: CFBH 1586; Linhares: CFBH 1575, MNRJ 4331, 4332; Serra: CFBH 1439, 1440; São Mateus: MNRJ 18417, 18418; Marataízes: Distrito de Gomes: Fazenda Sr. Roberto Da Roseira: marsh near Guarnano lake: MNRJ 35025–35027; Anchieta: MNRJ 25335. Rio de Janeiro: Magé: Campos dos Escoteiros: Citrolândia: MNRJ 54803–54807, 54808 (cleared and double-stained adult male), MNRJ 54809–54811; Magé: Vila das Pedrinhas: MNRJ 36265, 4361, 4364; São João da Barra: MNRJ 6716, 6718–6725, 6728 (cleared and double-stained adult female); Maricá: MNRJ 39704; Barra da Tijuca: MNRJ 26880; Sernambetiba: Recreio dos Bandeirantes: MNRJ 3520; Recreio dos Bandeirantes: MNRJ 2084; Campos: Fazenda Barra Seca: MNRJ 41573–41583; Campos dos Goytacazes: Lagoas de Cima: marsh near the lake: MNRJ 54353–54359; Itaguaí: Old route Rio-São Paulo, Km 39, ZUEC 3808; Macaé: lake near the city access: ZUEC 8572. Minas Gerais: Iperó: Fazenda Ipanema: MNRJ 32824–32827. Bahia: Trancoso: MNRJ 47811, 47812; between Barras de Caravelas and Ponta de Areia: MNRJ 4366–4368, 4370, 4372–4374, 4377, 4378.

Sphaenorhynchus prasinus.—BRAZIL: Espírito Santo: Linhares: MZUSP 75641, 75643. Minas Gerais: Teófilo Otoni: MZUSP 99512, 99513; Almenara: Fazenda Limoeiro: MZUFV 4152, 5938, 5939; Marliéria: Parque Estadual Rio Doce: MZUFV 2631, 2633, MNRJ 20874; Aimorés: MNRJ 56347; Nanuque: MNRJ 4517. Pernambuco: Recife: Dois Irmãos: MZUSP 99503. Bahia: Ilhéus: CEPEC: MZUSP 73749 (holotype), MZUSP 73750, 73761–73762 (paratypes), MZUSP 73781–73787 (paratypes); Ponta da Tulha: MZUESC 6533, 6534, 6861 (cleared and double-stained adult male), MZUESC 6862–6863; Mata de São João: MZUFBA 2962, 2969–2973, 4344–4346, 7357; Itagibá: Fazenda Pedra Branca: MNRJ 4295–4297, 56348–56349; Teixeira de Freitas: Fazenda Alcopadro: MNRJ 29664–29668. Alagoas: Rio largo: MNRJ 38680–38683; Quebrangulo: Reserva Biológica Pedra Talhada: URCA-H 9295; Maceió: Área de Proteção Ambiental Catolé: MUFAL 12247.

Sphaenorhynchus surdus.—BRAZIL: Santa Catarina: Rio Vermelho: MZUSP 99510; São Bento do Sul: MZUSP 99508; near São Bento: Rio Vermelho: MNRJ 4402–4404, 4406, 4407, 4410, 4412 (cleared and double-stained adult male), MNRJ 4415; Campo Belo do Sul: UFRGS 2787, 2895–2897, 2899, 2901, 2911, 3089, 3137, MCP 8422; Ponte Serrada: CFBH 15752; Lages: CFBH 8546; Lontras: MCP 1300–1302 (cleared and double-stained adult male), MCP 1303–1305; Lébon Régis: MCP 8811; Campos Novos: MCP 9324. Rio Grande do Sul: Vacaria: UFRGS 2488–2491, 2507, 2788; Bom Jesus: UFRGS 2797, 2893, 2894, 2898, 2900, 2902–2910, 3075, 3076, 3082, 3100, 3102–3104, 3108, 3109, 3112, 3121, 3135, 3136, 3138, 3139, 3145; São José dos Ausentes: MCP 4618–4622. São Paulo: Conchas: MZUSP 99521, MNRJ 4333; Apiaí: MZUSP 101466; Guapiara: MNRJ 4335; Fazenda Iperó: MNRJ 18249. Paraná: Castro: Parque Florestal Caxambú: MHNCI 199, 221, 315–317, 319; São José dos Pinhais: Reserva Florestal Cambuí: MHNCI 852; Quatro Barras: Estrada Graciosa: Corvo: MHNCI 1738–1747; Quatro Barras: Pinheiros Gralha Azul: Chácara São Francisco de Assis: MHNCI 3657, 3658; Quatro Barras: Estrada Graciosa: Alto da Serra: Rio Taquari: MNRJ 4744–4747, 4751, 5750; Piraquara: Mananciais da Serra: MHNCI 1855, 2858, 2947, 2973, 2983, 5402, 5403; Piraquara: MCP 8324–8325; Campina Grande do Sul: Cedro: MHNCI 4603–4607; Telêmaco-Borba: Ribeirão Anta Brava: MHNCI 4896; Telêmaco-Borba: Taboal da Vila Preta: MHNCI 4965; Telêmaco-Borba: Lagoa do Gaícho: MHNCI 4979; Adrianópolis: Rocha Church's Dike: MHNCI 5401; Tijucas do Sul: DZSJRR 8656, 8788, 8789, 9049; Pirai do Sul, CFBH 8223.