



Taxonomic status of *Pseudopaludicola riopiedadensis* Mercadal de Barrio and Barrio, 1994 (Anura, Leptodactylidae, Leiuperinae)

DARÍO CARDOZO^{1,3} & LUÍS FELIPE TOLEDO²

¹CONICET. Instituto de Biología Subtropical, Laboratorio de Genética Evolutiva, Universidad Nacional de Misiones; Félix de Azara 1552, CPA N3300LQF. Posadas, Misiones, Argentina

²Museu de Zoologia "Prof. Adão José Cardoso", Instituto de Biologia (IB), Universidade Estadual de Campinas (Unicamp), 13083-970, Caixa Postal 6109, Campinas, São Paulo, Brazil

³Corresponding author. E-mail: darcardz@gmail.com

Abstract

Pseudopaludicola riopiedadensis was described by Mercadal de Barrio and Barrio (1994) based on two adult females collected by Luiz Dino Vizotto in 1963 from Rio Piedade, São José do Rio Preto, São Paulo, Brazil. This taxon was differentiated from *P. ternetzi* based on a series of qualitative and morphometric characters. Nevertheless, the original description and the type material of *P. ternetzi* were not considered by Mercadal de Barrio and Barrio, and the morphological variation of *P. ternetzi* was not documented. This work reviews the sample collected by Vizotto in *P. riopiedadensis* type locality, evaluates the advertisement calls obtained from such population, the two vouchers assigned to *P. riopiedadensis*, and a large data set, including type specimens of *P. ternetzi* to document the morphological variation along its known distribution. Results indicate that *P. riopiedadensis* was described on the basis of highly variable characters applied to a small sample and share the unique *P. ternetzi* autapomorphy, a robust body structure with immaculate belly. The lack of differentiation in both advertisement call and morphology rejects the status of *P. riopiedadensis* as distinct species, and we therefore suggest to formally consider *P. riopiedadensis* as junior synonym of *P. ternetzi*.

Keywords: taxonomy, junior synonymies, advertisement call, external morphology

Introduction

The genus *Pseudopaludicola*, with 18 species currently recognized (Andrade & Carvalho, 2013; Frost, 2013, Pansonato et al., 2013; Roberto et al., 2013), represents a group of small bodied leptodactylid frogs in the subfamily Leiuperinae, widely distributed over northern and central South America (Frost, 2013).

The taxonomic history of this group is very dynamic, involving synonymies, re-descriptions, and species revalidations (Barrio, 1954; Milstead, 1963; Bokermann, 1966; Haddad & Cardoso, 1987; Lobo, 1994, 1996; Cardozo & Lobo, 2009; Caramaschi & Pombal, 2011; Cardozo & Baldo, 2012; Pansonato et al., 2013). The taxonomical changes proposed by Barrio (1954) to treat *P. ameghini* and *P. saltica* as synonymies of *P. falcipes*; the proposal of Milstead (1963) to include in the synonymy of *P. falcipes* the three species described by Cope (1887); and the arrangement proposed by Bokermann (1966) to consider *P. ameghini* as a synonymy of *P. ternetzi* were not fully accepted by several authors, because they did not published evidence to support their hypotheses. Several discrepancies were primarily studied by Haddad and Cardoso (1987) based in acoustic and morphometric characters, and Lobo (1996) studying the syntypes of *P. mystacalis* and *P. ameghini* housed at Academy of Natural Sciences of Philadelphia, USA (ANSP) and *P. ternetzi* type series, at the Museu Nacional, Rio de Janeiro (MNRJ). In this sense, a recent contribution performed by Pansonato et al (2013) studying the species distributed in Chapada dos Guimarães (type locality of *P. ameghini*, *P. mystacalis*, and *P. saltica*), based on morphometric and bioacoustic data, conclude that *P. ameghini* is a valid species.

Pseudopaludicola ternetzi was described by Miranda-Ribeiro (1937), primarily based on four adult specimens collected by Ternetz in 1928 at Passa Três, Goiás, Brazil. As was mentioned above, Lobo (1996) based on *P.*

ternetzi type specimens, re-described the taxon, assigned a lectotype (MNRJ 5462) and three paralectotypes (MNRJ 477, 5460–1). Later on, the type locality was updated, and several new paralectotypes were included in the type series (Caramaschi & Pombal, 2011; Cardozo & Baldo, 2012).

In the other hand, *P. riopiedadensis* was described by Mercadal de Barrio and Barrio (1994) based on two adult females collected by Luiz Lino Vizotto in 1963 in Rio Piedade, São José do Rio Preto, São Paulo, Brazil (Vizotto, 1964). In this field-trip, Luiz Dino Vizotto obtained several specimens assigned to *Pseudopaludicola ameghini*, recorded the advertisement calls of some of them, and provided to Avelino Barrio two of these vouchers for his collection at the Museum of Natural Sciences “Bernardino Rivadavia” in Buenos Aires, Argentina (L. D. Vizotto pers. comm.). The two females donated by Vizotto (MACN 2599, 2600) are the specimens used by Mercadal de Barrio and Barrio (1994) to describe *P. riopiedadensis*. However, in the diagnosis of *P. riopiedadensis*, by unknown reason, the other specimens collected along with the types at the same locality, were not considered as paratypes or referred specimens in the original description of *P. riopiedadensis* (Mercadal de Barrio & Barrio, 1994). Additionally, this taxon was discriminated from *P. ternetzi* based on a series of qualitative and morphometric characters, without consider the original description and the type material of *P. ternetzi*.

In this work we evaluate the taxonomic status of *P. riopiedadensis*, based on the morphological diagnostic character proposed for this taxon, we compare the data obtained from both *P. riopiedadensis* type specimens, and eight other vouchers collected by Vizotto in the same date and site (Vizotto, 1964), with similar data of *P. ternetzi*, including the lectotype, three paralectotypes, and a large data set of specimens, to document the morphological variation along its known distribution. In addition, we compare the advertisement calls of *P. riopiedadensis* and *P. ternetzi*, based on the original recordings by Vizotto from the type locality of *P. riopiedadensis*, and on recordings of *P. ternetzi* from a locality in Uberlândia which are assigned to that species based on Cytochrome b DNA sequences, which are identical to *P. ternetzi* individual from type locality (Veiga-Menoncello, pers. comm.).

Material and methods

We examined 45 preserved adults of *P. ternetzi* from Brazil and Paraguay, including almost all localities where *P. ternetzi* was identified by previous authors (Fig. 1). Such sample includes the lectotype, and three paralectotypes. In order to compare, we consider both type specimens, and eight other vouchers collected by Vizotto in 1963 in Rio Piedade, São Paulo, Brazil (Vizotto, 1964), as the total sample of *P. riopiedadensis* (see appendix I, for detailed reference). Museum acronyms are: Museu de Zoologia “prof. Adão José Cardoso”, Instituto de Biociências, Universidade Estadual de Campinas, Campinas, São Paulo, Brasil (ZUEC); Instituto de Investigación Biológica del Paraguay, Asunción, Paraguay (IIBP); Museu de Zoologia da Universidade de São Paulo, São Paulo, Brasil (MZUSP); Museu Nacional, Rio de Janeiro, Brasil (MNRJ), Museo Argentino de Ciencias Naturales “Bernardino Rivadavia”, Buenos Aires, Argentina (MACN, ex CENAI), Departamento de Zoologia, São Jose do Rio Preto, São Paulo, Brasil (DZSJRP). Eleven morphometric variables were measured: snout-vent length (SVL), HL (head length), HW (head width), ED (eye diameter), IOD (interorbital distance), IND (internarial distance) and TL (tibia length) following Duellman (1970), while eye-nostril distance (END), and NSD (nostril–snout distance) were recorded according Napoli (2005). Two other measurements, LII (length of finger II) and LIII (length of finger III), were taken from the base of the proximal subarticular tubercle to the tip of the respective finger. All measurements are given in millimeters (mm) and were recorded with an ocular micrometer in a Nikon SMZ 445 stereomicroscope, except for SVL, which was taken with calipers to the nearest 0.1 mm. Sex was determined by visual inspection of male secondary sexual characters as nuptial pads and/or extended vocal sacs in males, and the presence of ovarian follicles in females.

To assess the significance of any differences between both species, we measured 10 females of *P. ternetzi* from Brazil and Paraguay, the two *P. riopiedadensis* types, and five female vouchers collected by Vizotto in the *P. riopiedadensis* type locality. For comparison purposes, as the *P. riopiedadensis* type series is composed by females, we only compared females, and considered all *P. riopiedadensis* topotypical specimens collected by Vizotto as individuals of *P. riopiedadensis*. When variables presented normal distribution and homogeneous variances, groups were compared using the parametric Student t-test. In the case of variables without normal distribution, we performed the non-parametric Mann-Whitney U test. All analyses were performed using the software Statistica 7.0.

Pseudopaludicola ternetzi male vocalizations (one individual) were recorded in Uberlândia, state of Minas

Gerais, Brazil. The advertisement call was obtained with a cassette tape recorder equipped with an external cardioid microphone positioned ca. 50 cm from the calling male. In the other hand, *P. riopiedadensis* advertisement call from one male, was cordially given by Vizotto, being obtained in the same place and date with the two females used to describe *P. riopiedadensis* by Mercadal de Barrio and Barrio (1994). This call was recorder by a Sony tape recorder equipped with a cardioid microphone, with similar methodology used to *P. ternetzi* advertisement call (Vizotto, pers. comm.).

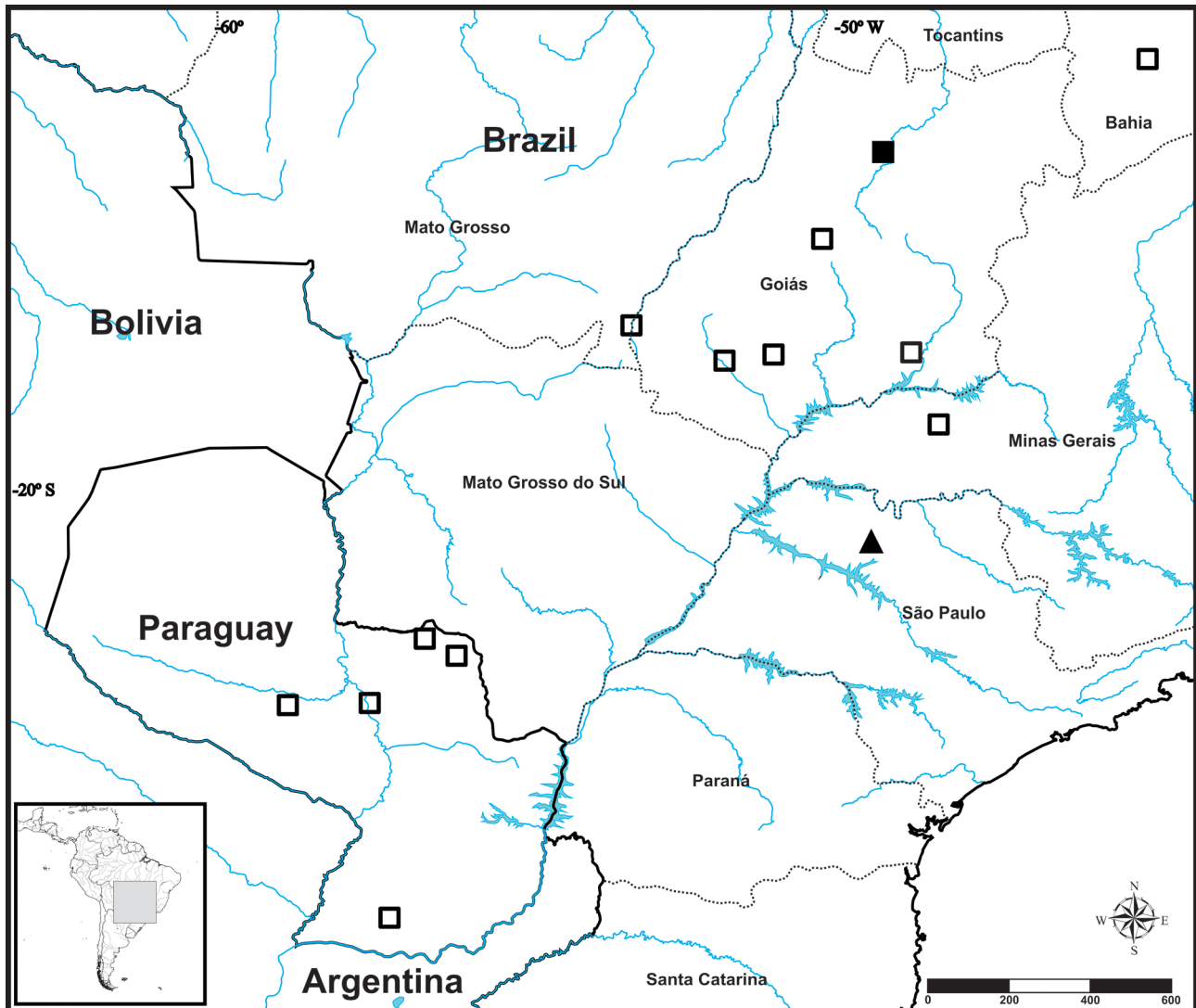


FIGURE 1. Distribution map of *P. ternetzi* (open square) showing the type locality, Uruaçu, Goiás, Brazil (solid square), and *P. riopiedadensis* type locality (solid triangle).

We analysed the calls using Raven 1.2 software (24 bits of resolution, 44 kHz of frequency sampling, and FFT and frame length of between 256 and 512 samples). The terminology for the bioacoustic analyses follows Toledo and Haddad (2005). For the recordings of *P. riopiedadensis* we applied the following configuration: filter all out of the 2500–5500 Hz range, brightness at 78 %, and contrast at 80 %. For the recordings of *P. ternetzi* we applied the following configuration: filter all out of the 1000–8000 Hz range, brightness at 63 %, and contrast at 80 %. Different recording parameters were used for both species because recordings were made with different equipment (Marantz PMD 666 with cardioid microphone for *P. ternetzi* and Sony tape recorder with cardioid microphone for *P. riopiedadensis*) and different environmental conditions (*P. ternetzi* recorded at 25°C and *P. riopiedadensis* recorded at 24°C). Therefore, these parameters were adjusted to make possible the analyses of call similarly. Recordings are housed at the Fonoteca Neotropical Jacques Vielliard (FNJV), Departamento de Biologia Animal, Unicamp, Campinas, Brazil (*P. riopiedadensis*: FNJV 11887; *P. ternetzi*: FNJV 11886).

Results

Voucher numbers in the original description of *P. riopiedadensis* used for comparing among species were not mentioned, so we were unable to review the specimens of *P. ternetzi* used for such comparison. Additionally, as the type locality of *P. riopiedadensis* was modified by a dam construction, we are not able to collect new specimens for molecular comparison. To perform a correct identification of *P. ternetzi* specimens, the vouchers from Uberlândia (Minas Gerais State, Brazil), were compared with *P. ternetzi* type locality individuals (Uruaçu, Goiás State, Brazil), by Cytochrome b DNA sequences, confirming the species identification (A. Veiga-Menoncello, com. pers.). Additionally, the specimens from Uberlândia, sited nearly 600 kilometers from Uruaçu (type locality of *P. ternetzi*), share the same diploid number and chromosome morphology (Fávero *et al.*, 2011).

In order to avoid confusion, we listed each morphological diagnostic characters proposed by Mercadal de Barrio and Barrio (1994) in the original description of *P. riopiedadensis* (in italics) and compare them with our observations, based on the specimens studied by us, as listed above.

Morphological characters (Fig. 2?3, Table 1). (1) *Evident tarsal tubercle (P. ternetzi); tarsal tubercle absent (P. riopiedadensis)*: The type material of *P. ternetzi*, as well as the rest of *Pseudopaludicola* specimens examined by us, lack of tarsal tubercle. Instead, there is a distal thickening of the tarsal fold, always present, with a variable degree of development among the specimens analyzed.

(2) *Tarsal fold parallel to the tibia (P. ternetzi), tarsal fold curved (P. riopiedadensis)*: Miranda-Ribeiro (1937) did not mention the tarsal fold in the original description of *P. ternetzi*. Nevertheless, the type specimens, as well as the total sample examined by us, has a curved tarsal fold. Although the degree of curvature of this fold is slightly variable, it is never parallel to the tibia.

(3) *Tympanum visible (P. ternetzi); not visible (P. riopiedadensis)*: In the original description of *P. ternetzi*, Miranda-Ribeiro described: “*Tympano indistincto*”. In all *P. ternetzi* vouchers examined by us, the tympanum is not visible (Fig. 3). Actually, none of the described species of *Pseudopaludicola* has visible tympanum.

(4) *Finger II > III (P. ternetzi); Finger II = III (P. riopiedadensis)*: In *P. ternetzi* description Miranda-Ribeiro (1937) considered the second hands fingers longer than third. However, in *P. riopiedadensis* type series the length of fingers is not consistent with Miranda-Ribeiro original description. Our results indicate that both the holotype MACN 2599 and the paratype, MACN 2600 have the finger II longer than III (Table 1). Such relation is variable among the other specimens collected by Vizotto.

(5) *Nostril midway between eye and end of the snout (P. riopiedadensis)*: our measurements indicate that *P. riopiedadensis* holotype has the END slightly shorter than NSD, while in the paratype such relation is inverted (Table 1). These same measurements were obtained for *P. ternetzi* type specimens, being in all cases the END longer than NSD (Table 1).

(6) *Internarial distance (IND) > Interocular distance (IOD) (P. riopiedadensis)*: Although this character has not been proposed by Mercadal de Barrio and Barrio to discriminate *P. riopiedadensis* from any other *Pseudopaludicola* species, is mentioned in the diagnosis. Nevertheless, this character state is coincident with *P. ternetzi* type series where $IND > IOD$ (Table 1).

(7) *In lateral view, the tip of the snout is at the same level than the jaw (P. ternetzi); the tip of the snout protruding from the jaw (P. riopiedadensis)*: In *P. ternetzi* lectotype, the three paralectotypes and the total sample examined by us, has the tip of the snout protruding from the jaw (in lateral view, Fig. 3). Therefore, this character state cannot be considered useful to diagnose *P. riopiedadensis* from *P. ternetzi*.

(8) Xiphisternon shape: the xiphisternon shape proposed in *P. riopiedadensis* original description (Mercadal de Barrio & Barrio, 1994), could not be corroborated by us, because in the unique voucher with the belly open (the holotype, MACN 2599), the xiphisternon was removed.

(9) Body aspect: the robustness of *P. riopiedadensis* was not considered as a diagnostic character by Mercadal de Barrio and Barrio (1994), probably because this character state was also present in *P. ternetzi* when *P. riopiedadensis* was described. In this sense, besides *P. riopiedadensis*, three others *Pseudopaludicola* species present a robust body aspect: *P. ameghini*, *P. giarettai*, and *P. ternetzi*. However, the diagnosis of this taxa allow a correct separation between all species, except *P. riopiedadensis* from *P. ternetzi* (see discussion below).

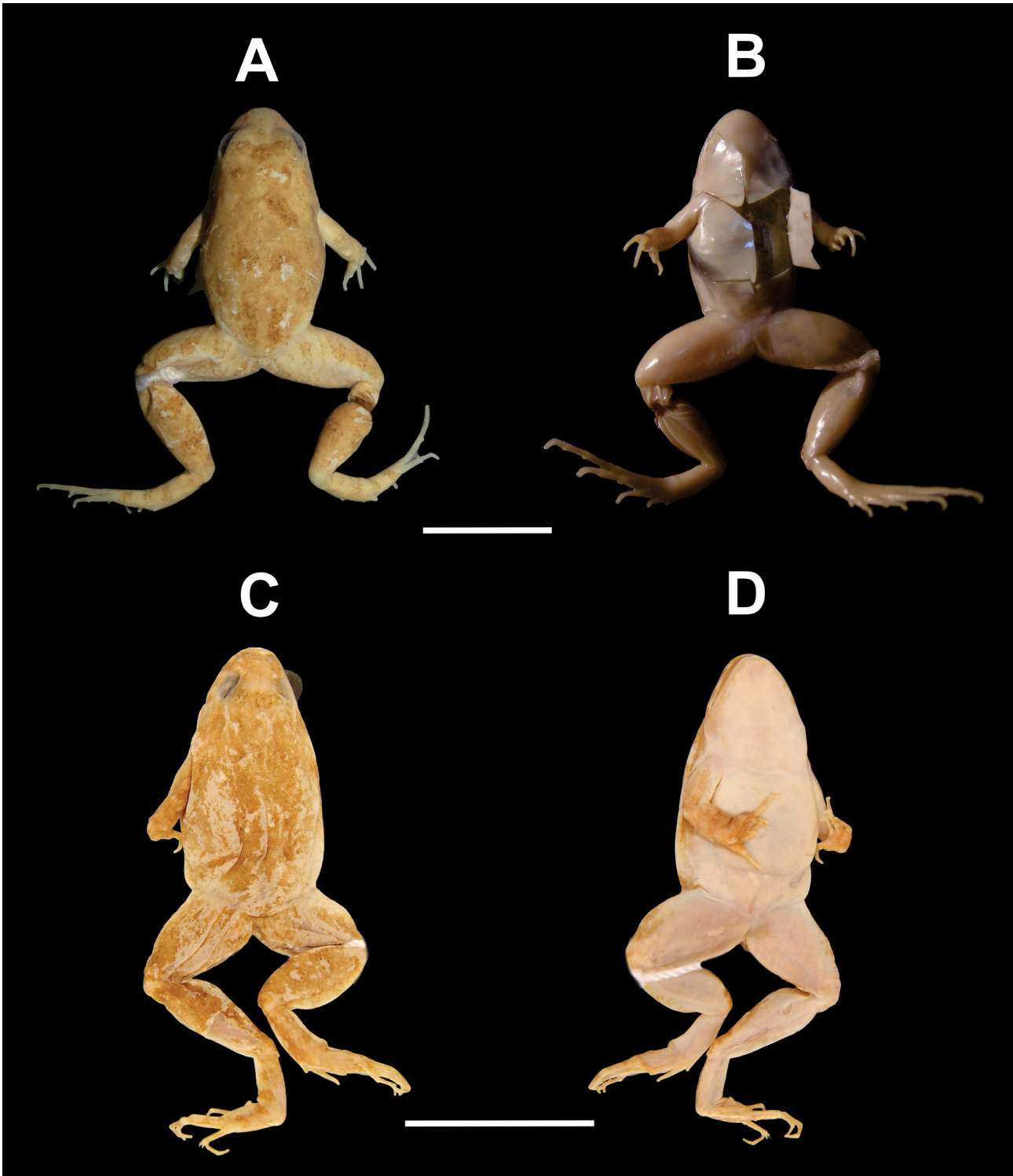


FIGURE 2. Dorsal and ventral view. Holotype of *P. riopiedadensis*, MACN 2599 (A–B); Lectotype of *P. ternetzi*, MNRJ 5462 (C–D). Scale bar 10 millimeters.

Statistical analysis (Table 2, online supplementary material). The variables SVL, IOD, IND, LIII, and TL present normal distribution and homogeneous variances, and could be evaluated by Student t-test. The variables HL, HW, ED, LII, END, and NSD were analyzed by the non-parametrical Mann-Whitney U test. In all cases the probability values greater than 0.05 (see Table 2 for mean, standard deviation, ranges, *p*-value and test used for each variable).

TABLE 1. Measurements of the type series of *Pseudopaludicola riopiedadensis* and *P. ternetzi*. Values in millimeters.

Museum Number	<i>P. riopiedadensis</i>	<i>P. riopiedadensis</i>	<i>P. ternetzi</i>
	MACN 2599	MACN 2600	MNRJ 5462
Type	Holotype	Paratype	Lectotype
Gender	Female	Female	Male
Snout-vent length (SVL)	20.6	20.7	15.2
Head length (HL)	6.2	6.3	4.6
Head width (HW)	6.8	7.2	6.1
Eye diameter (ED)	2.0	2.0	2.0
Interocular distance (IOD)	1.2	1.3	1.1
Internarial distance (IND)	1.5	1.5	1.2
Length finger II	1.6	1.6	1.5
Length finger III	1.5	1.3	1.2
Eye-nostril distance (END)	1.5	1.9	1.5
Nostril-snout distance (NSD)	1.5	1.3	0.8
Tibia length (TL)	10.9	10.7	8.7
Tympanum	Indistinct	Indistinct	Indistinct

TABLE 1. (Continued)

Museum Number	<i>P. ternetzi</i>	<i>P. ternetzi</i>	<i>P. ternetzi</i>
	MNRJ 0477	MNRJ 5460	MNRJ 5461
Type	Paralectotype	Paralectotype	Paralectotype
Gender	Female	Female	Female
Snout-vent length (SVL)	20.2	19.6	18.5
Head length (HL)	6.1	5.4	5.2
Head width (HW)	7.8	7.1	6.7
Eye diameter (ED)	2.2	2.3	2.2
Interocular distance (IOD)	1.1	1.2	1.2
Internarial distance (IND)	1.2	1.3	1.3
Length finger II	1.5	1.5	1.6
Length finger III	1.4	1.2	1.3
Eye-nostril distance (END)	1.8	1.8	1.8
Nostril-snout distance (NSD)	1.2	1.1	0.8
Tibia length (TL)	10.6	10.1	9.7
Tympanum	Indistinct	Indistinct	Indistinct

Advertisement call (Fig. 4; Table 3). The advertisement call of the male of *P. riopiedadensis* recorded at São José do Rio Preto, state of São Paulo, recorded by Vizotto (1964), generally consists of several notes (up to 40), but isolate notes can be emitted as well (Figure 3). These notes are pulsed (from 1 to 6 pulses per note) and the mean dominant frequency is around 3.5 kHz. The advertisement call of *P. ternetzi* recorded in Uberlândia, state of Minas Gerais, is similar to that of *P. riopiedadensis*. It also consists of several pulsed notes (from 1 to 5 pulses per note) and the mean dominant frequency is about 3.7 kHz (Table 3). Other acoustic parameters are presented in Table 3.

TABLE 2. Statistical analysis of *P. riopiedadensis* versus *P. ternetzi*. (SD= standard deviation; *p*-value= probability value). Values are in millimeters.

Variable	Group 1 <i>P. riopiedadensis</i> Females (N=7)	Group 2 <i>P. ternetzi</i> Females (N=10)	Test	<i>p</i> -value
SVL	20.1 ± 0.7 (19.3–21.0)	20.3 ± 1.2 (18.5–23.0)	Student t-test	0.4502
HL	6.2 ± 0.1 (6.0–6.4)	6.0 ± 0.4 (5.2–6.4)	Wilcoxon (Mann-Witney U)	0.0740
HW	7.1 ± 0.3 (6.8–7.7)	7.0 ± 0.3 (6.7–7.8)	Wilcoxon (Mann-Witney U)	0.7635
ED	2.2 ± 0.2 (2.0–2.3)	2.1 ± 0.2 (1.9–2.3)	Wilcoxon (Mann-Witney U)	0.6146
IOD	1.4 ± 0.1 (1.2–1.5)	1.3 ± 0.1 (1.1–1.5)	Student t-test	0.1211
IND	1.4 ± 0.2 (1.3–1.5)	1.3 ± 0.1 (1.2–1.6)	Student t-test	0.2033
LII	1.4 ± 0.2 (1.2–1.6)	1.5 ± 0.1 (1.5–1.6)	Wilcoxon (Mann-Witney U)	0.4558
LIII	1.4 ± 0.2 (1.3–1.5)	1.4 ± 0.1 (1.2–1.6)	Student t-test	0.8644
END	1.6 ± 0.1 (1.5–1.8)	1.7 ± 0.1 (1.5–1.8)	Wilcoxon (Mann-Witney U)	0.8136
NSD	1.2 ± 0.1 (1.1–1.3)	1.1 ± 0.1 (0.8–1.2)	Wilcoxon (Mann-Witney U)	0.6516
TL	10.4 ± 0.6 (9.6–11.0)	10.0 ± 0.4 (9.3–10.6)	Student t-test	0.1833

TABLE 3. Physical characteristics of the advertisement calls of *Pseudopaludicola riopiedadensis* obtained with the type series, and *P. ternetzi* recorded in Minas Gerais. Values presented as mean ± standard deviation (range; N). kHz= kilohertz, s= seconds, ms= milliseconds.

Parameter	<i>P. riopiedadensis</i>	<i>P. ternetzi</i>
Number of notes per call	12.80 ± 15.96 (1–40; 5)	273 (1)
Duration of the note (s)	0.07 ± 0.02 (0.01–0.09; 16)	0.03 ± 0.01 (0.01–0.04; 10)
Number of pulses per note	4.19 ± 1.22 (1–6; 16)	3.2 ± 1.0 (1–5; 15)
Duration of the pulses (ms)	15.75 ± 3.51 (9–24; 16)	5.00 ± 0.67 (4–6; 10)
Minimum frequency (kHz)	2.99 ± 0.11 (2.80–3.20; 16)	2.13 ± 0.07 (2.03–2.25; 10)
Dominant frequency (kHz)	3.48 ± 0.13 (3.27–3.79; 16)	3.74 ± 0.08 (3.62–3.79; 10)
Maximum frequency (kHz)	4.20 ± 0.12 (3.92–4.48; 16)	5.00 ± 0.32 (4.54–5.78; 10)
Interval between notes of the same call (ms)	17.0 ± 10.19 (0–33; 12)	29.0 ± 14.19 (18–61; 10)
Interval between pulses of the same note (ms)	0.33 ± 1.29 (0–5; 15)	4.90 ± 1.10 (3–7; 10)

Discussion

The scant morphological differences between members of *Pseudopaludicola* make the diagnosis of new species difficult, and in the vast majority of cases, omissions or misinterpretation of character states have resulted in erroneous diagnoses (see Lynch, 1989; Cardozo & Lobo, 2009). In *Pseudopaludicola*, the absence of tarsal tubercle has been previously mentioned by several authors (i.e. Berg, 1896; Parker, 1927; Lynch, 1971; 1989; Heyer, 1975; Lobo, 1995, 1996). Similarly, both the type series of *P. riopiedadensis* and other topotypes lack the tarsal tubercle. Additionally, we agree with Miranda-Ribeiro (1926) as well as with the other authors who

previously studied the external morphology of *Pseudopaludicola* that a visible tympanum is not present in any *Pseudopaludicola* known (Parker, 1927; Heyer, 1975; Lynch, 1989; Lobo, 1995; 1996).

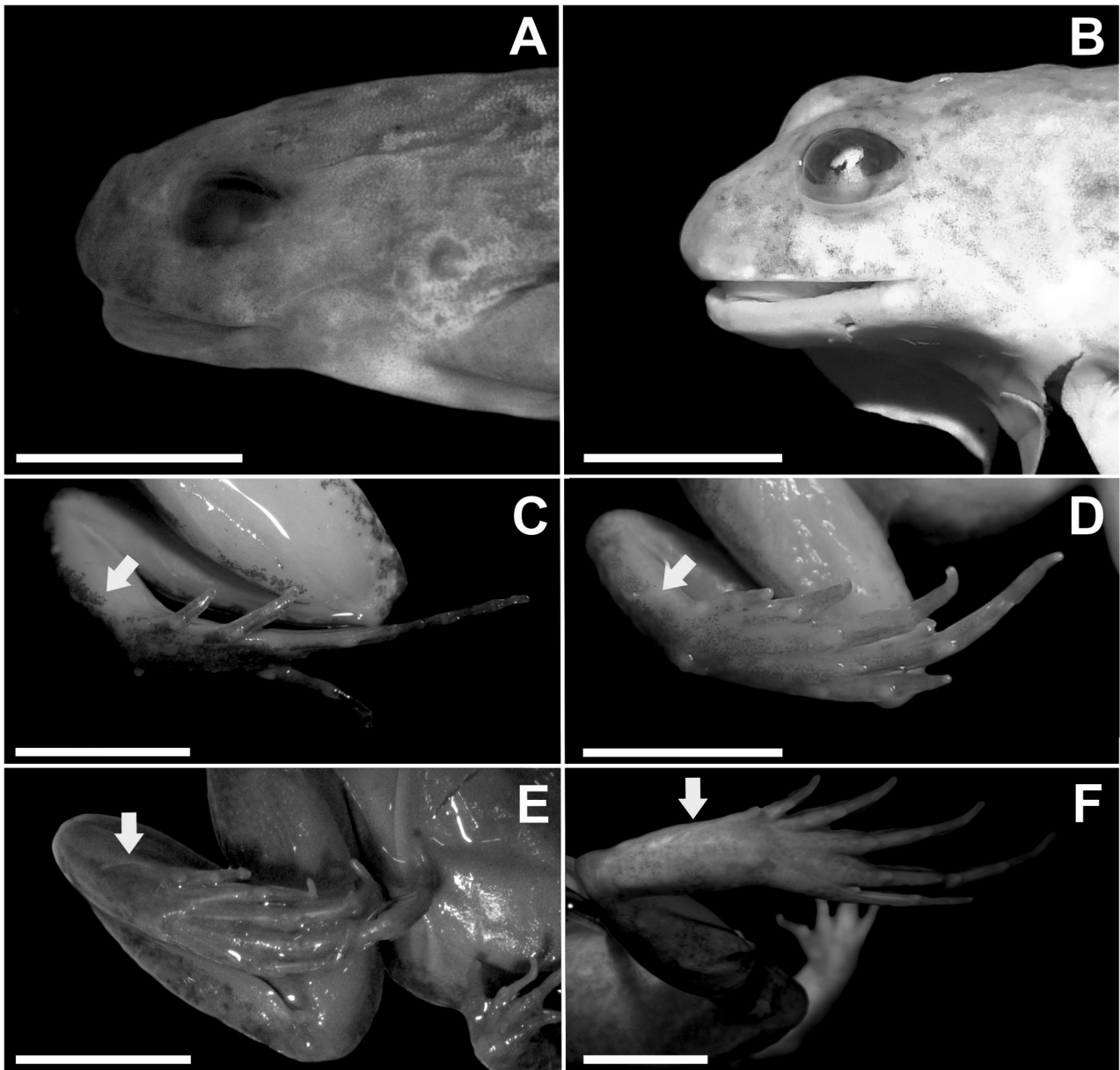


FIGURE 3. Lateral view of the head. (A) *Pseudopaludicola ternetzi* Lectotype (MNRJ 5462); (B) *Pseudopaludicola riopiedadensis* Holotype (MACN 2599). Tarsal fold (arrows) of *P. ternetzi* IIBP 896, (C), and Paralectotype, MNRJ 5460 (E); *P. riopiedadensis*, DZSJR 1014 (D), and Holotype, MACN 2599 (E). Scale bar 5 millimeters.

The length of the fingers in the species of *Pseudopaludicola* was previously reported in a controversial way by several authors (Miranda-Ribeiro, 1926; Cei, 1980), probably due to the different methodologies applied to take the measurements. We consider that the relationship between the first two fingers is the same, or the finger II is slightly longer than III, for all vouchers measurement, which makes this character not useful for diagnosing *P. riopiedadensis* from *P. ternetzi*.

The distance between nostrils and the end of the snout was previously used to discriminate *P. ameghini* from *P. falcipes* (Parker, 1927). Besides this, although Mercadal de Barrio and Barrio (1994) suggested that such relation were probably an autapomorphy of *P. riopiedadensis*, they did not provided the values in the species description. We consider that the distance of the nostril in relationship to the eye and the end of the snout is too subjective to be considered, especially when the sample size is rather small.

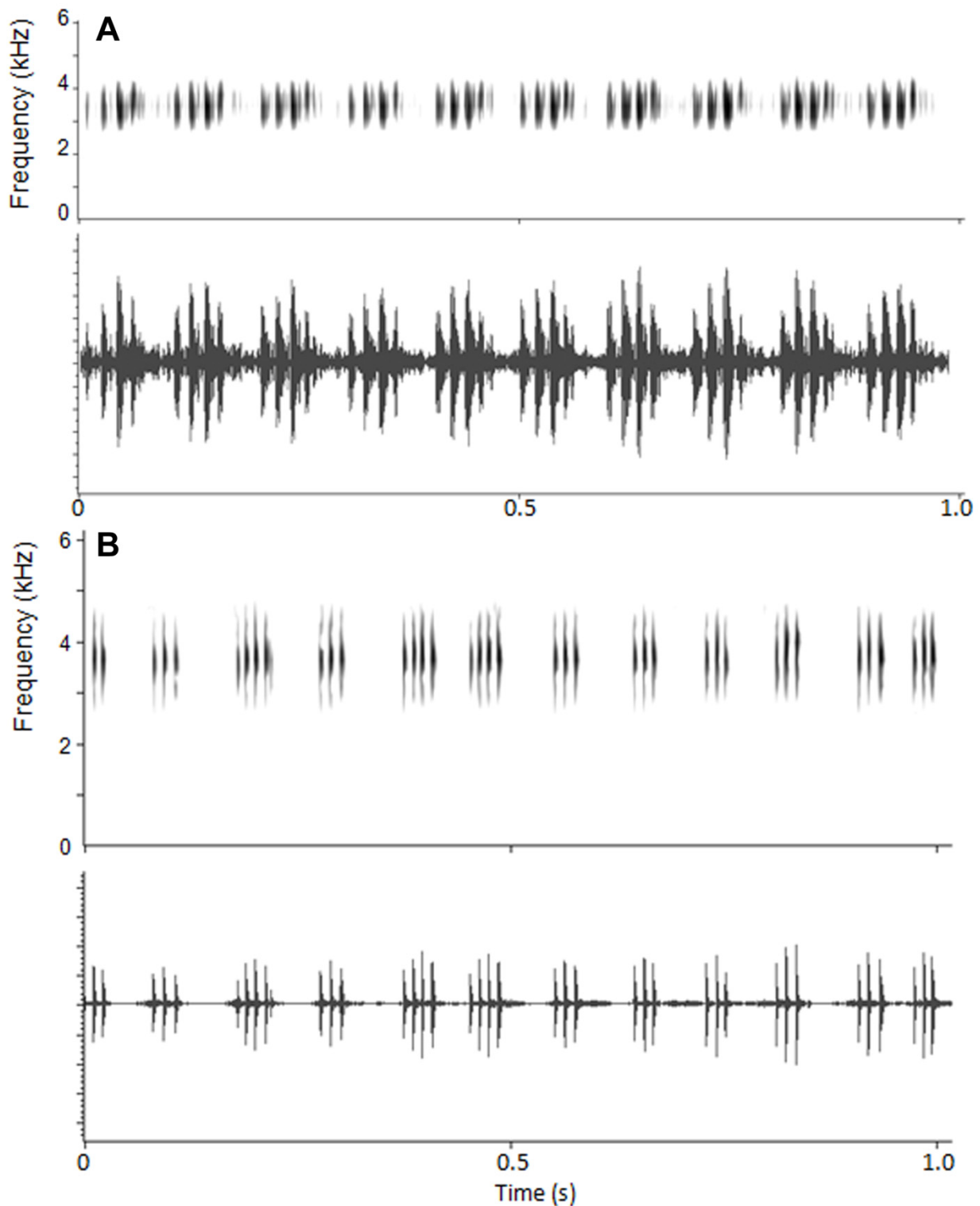


FIGURE 4. Spectrogram (above) and waveform (below) of the advertisement call of: (A) *Pseudopaludicola riopiedadensis* recorded by Vizotto (1964) at its type locality, São José do Rio Preto, Brazil (FNJV 11887); (B) *P. ternetzi* recorded in Uberlândia, Minas Gerais, Brazil (FNJV 11886).

In the original description of *P. riopiedadensis*, Mercadal de Barrio and Barrio (1994) presented drawings of the xiphisternon of several *Pseudopaludicola* species without voucher reference (figure 1, page 69). In this plate, the figure 1(5) corresponds to a specimen of *P. ternetzi* from Bagé, Rio Grande do Sul, Brazil. This specimen should be assigned to *P. falcipes*, the unique species of *Pseudopaludicola* known to occur in such region (South of Brazil), and is not consistent with the mentioned material examined by Mercadal de Barrio and Barrio (1994), which states that all specimens of *P. ternetzi* examined were from the North of Brazil. All *P. ternetzi* examined by

us presented the sternum ossified and the xiphisternon well developed (without the process previously reported for *P. riopiedadensis*), which is consistent with Lobo's description (1995; 1996).

In spite of the difference in the minimum frequency between calls (that of *P. riopiedadensis* is higher than that of *P. ternetzi*; Table 3), there are several important overlaps between them, such as the number of pulses per note, duration of the notes, interval between notes of the same call, and the dominant frequency range. Therefore, based on the observed slightly differences of the calls and the congruencies among them we do not have enough bioacoustic data to corroborate the existence of two species. A previous study (Toledo 2010) showed that even species with some degree of advertisement call overlap (such as between *P. serrana* Toledo 2010 and *P. murundu* Toledo, Siqueira, Duarte, Veiga-Menocello, Recco-Pimentel & Haddad, 2010) can be distinguished by at least three different parameters (see Toledo, 2010; Toledo *et al.* 2010). None of these parameters are the fundamental frequency, which can be more variable than central spectrum parameters (such as the dominant frequency) or temporal parameters (LFT, person. obs.).

Pseudopaludicola riopiedadensis was described on the basis of highly variable characters applied to a small sample size, only two specimens. These vouchers, as the other specimens collected at same locality and examined herein, share the same autoapomorphies proposed by Lobo (1995) to characterize *P. ternetzi* (robust body structure, and immaculate belly). Although the robust body structure also is present in *P. giarettai* (Carvalho, 2012), and *P. ameghini* (Cope, 1887), these species can be discriminated from *P. ternetzi* and *P. riopiedadensis* by their advertisement calls, and by a combination of morphological characters, as follows: from *P. giarettai* by the vocal sac yellowish (Carvalho, 2012), while in *P. ternetzi* and *P. riopiedadensis* the vocal sac is white or immaculate (Lobo, 1995, present study), and from *P. ameghini* by the dorsum intensively warty according to Pansonato *et al.* (2013), being slightly warty in *P. ternetzi* and *P. riopiedadensis*.

The statistical analysis does not allow discriminate two species, and all the characters listed above plus the similar advertisements calls are not useful to diagnose *P. riopiedadensis* from *P. ternetzi*. Therefore, no arguments remain to consider *P. riopiedadensis* as species separate from *P. ternetzi*, and we therefore suggest to formally consider *P. riopiedadensis* as junior synonym of *P. ternetzi*.

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APPENDIX I. Specimens examined.

Pseudopaludicola riopiedadensis (junior synonymy of *P. ternetzi*).—Brasil: São Paulo: São José do Rio Preto, Rio Piedade: DZSJRP 871 (♀), DZSJRP 874 (♂), DZSJRP 877 (♀), DZSJRP 879 (♂), DZSJRP 1006–9 (2 ♂, 2 ♀), DZSJRP 1013–4 (f#, ♂), MACN 2599 (♀, Holotype), MACN 2600 (♀, Paratype).

Pseudopaludicola ternetzi.—Brazil: Goiás: Cidade de Goiás: MNRJ 39818–20 (3 ♂), MNRJ 39821 (♀), MNRJ 39822 (♂), MNRJ 39823 (♀), MNRJ 39824–5 (2 ♂). Margem esquerda do Rio Tocantins, Minaçu: MNRJ 55630–1 (2 ♀). Passa Quatro, Goiás (vindo do Maranhão): MNRJ 447 (♀, Paralectotype), MNRJ 5460–1 (2 ♀, Paralectotypes), MNRJ 5462 (♂, Lectotype). Rio Verde: MZUSP 25503 (♂), MZUSP 25504 (♀), MZUSP 25505 (♂). Santa Rita do Araguaia, Fazenda Babilônia: MZUSP 66668 (♂), MZUSP 66670 (♀), MZUSP 66672 (♂), MZUSP 66673–4 (♀), MZUSP 66675 (♂), MZUSP 66676 (♀), MZUSP 66677 (♂), MZUSP 66728 (♂), MZUSP 66729 (♀), MZUSP 66730–1 (2 ♂). Serra de Caldas Novas: MZUSP 75120 (♂), MZUSP 75121–2 (2 ♂), MZUSP 75123 (♀), MZUSP 75124 (♂), MZUSP 75125 (♀), MZUSP 75126 (♂). Minas Gerais: Uberlândia: ZUEC 14036 (♀), ZUEC 14037–8 (2 ♂), ZUEC 14039 (♀). Paraguay: Concepción: Estancia Garay Cué S.A. Cerrados del Tagatiyá: IIBP 804–5 (2 ♂), IIBP 808 (♀), IIBP 866 (♀), IIBP 868 (♂); IIBP 896–7 (2 ♀), IIBP 900 (♀).