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Distribution extension, geographic distribution maps and comments on the advertisement call of *Pseudopaludicola pocoto* Magalhães, Loebmann, Kokubum, Haddad and Garda, 2014 (Anura: Leptodactylidae: Leiuperinae)

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The leptodactylid genus *Pseudopaludicola* comprises 21 species of small frogs occurring from northern Argentina to Venezuela, associated with open areas across Neotropical forests and open formations (e.g., Chaco, Pampas, Cerrado, and Caatinga) east of the Andes (Carvalho, 2012; Pansonato et al., 2012; Andrade et al., 2016; Frost, 2017). Several *Pseudopaludicola* species have been described recently, increasing considerably our knowledge about this genus (Toledo, 2010; Toledo et al., 2010; Carvalho, 2012; Pansonato et al., 2012; Roberto et al., 2013; Magalhães et al., 2014). Nevertheless, recognition of these species based on external morphology only has become harder (Roberto et al., 2013), as a result, most species of this genus are similar and diagnosed based mainly through differences on their advertisement calls (Carvalho, 2012; Roberto et al., 2013; Magalhães et al., 2014).

Pseudopaludicola pocoto Magalhães, Loebmann, Kokubum, Haddad and Garda, 2014 was described from the Municipality of Santa Quitéria, State of Ceará, Brazil. It was also recorded in the states of Rio Grande do Norte, Paraíba and Pernambuco, in northeastern Brazil, in areas associated with the Caatinga Biome (Magalhães et al., 2014; Santana et al., 2015; Lantyer-Silva et al., 2016). Recently, Andrade et al. (2015, 2017) extended the species' distribution to the states of Bahia and Minas Gerais. The record by Andrade et al. (2015) was the first for the species in the Atlantic Forest, in southeastern Brazil. However, this new record, caused a large distribution gap, because about 800 km separates the records between the municipalities of Xique-Xique in the state of Bahia (Andrade et al., 2017) and Carlos Chagas in the state of Minas Gerais (Andrade et al., 2015).

Herein, we present two new records for this species; a second record of *P. pocoto* in the state of Bahia, and the second record in the Atlantic Forest Biome, of the

Figure 1. Individual of *Pseudopaludicola pocoto* registered in the Municipality of Catuji, Minas Gerais state.

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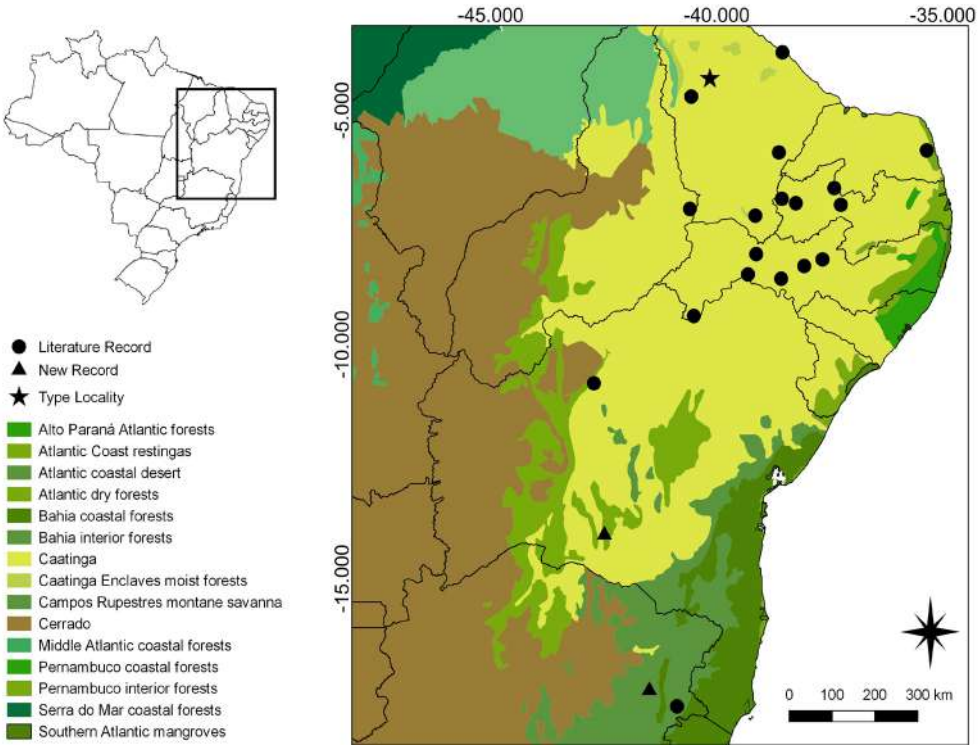

Figure 2. Map showing the known geographic distribution of *Pseudopaludicola pocoto*. Literature records (circles) and new records (triangles).

state of Minas Gerais (Fig. 1), and provide comments on its advertisement call. We collected one adult male of *P. pocoto* on 12 November 2014, in the Municipality of Caetité, State of Bahia, Brazil (-14.070363°S, -42.484881°W, WGS84, 907 m a.s.l.) and four adult males on 29 May 2016, in the Municipality of Catuji, State of Minas Gerais (-17.391400°S, -41.490371°W, WGS84, 395 m a.s.l.). We recorded the advertisement call of one individual from Municipality Caetité and one from Municipality Catuji and, compared it to the calls previously described for the species (Magalhães et al., 2014; Andrade et al., 2015, 2017). The advertisement calls was recorded using a Sony IC Recorder ICD-PX312F with an internal microphone, MP3 File, 48 kHz, 16 bits, while the individuals were calling in a small puddle of water on sand. We analysed the calls with Raven Pro 1.5, 64-bit version (Bioacoustics Research Program 2014) with the following settings: window type = Hann, window size = 256 samples, 3 dB filter bandwidth = 248 or 270 Hz, brightness = 50%, contrast = 50%, overlap = 75% (locked), hop size = 38 samples, DFT size = 1024 samples (locked), grid spacing = 43.1 or 46.9 Hz, frame = 100, flat top filter and generated audio spectrograms in R software using the package "Seewave" (Sueur et al., 2008; R Core Team, 2016). We followed the same characteristics and terminologies for calls descriptions adopted by Magalhães et al. (2014). All collected specimens are housed in the Coleção Zoológica de Referência da Universidade Federal de Mato Grosso do Sul (ZUFMS), under the following numbers: ZUFMS-AMP07451 (snout-vent length - SVL = 12.72 mm) and ZUFMS-AMP07452 (SVL = 13.99 mm).

The new record in Caetité extend the known distribution in approximately 360 km southward from Xique-Xique, State of Bahia (Andrade et al., 2017) and 450 km northward from Carlos Chagas, State of Minas Gerais (Andrade et al., 2015), contributing to extension of distribution within the Caatinga Biome. However, the record from Catuji, State of Minas Gerais, constitutes the second for the Atlantic Forest Biome. These records provided a significant increase in the distribution for

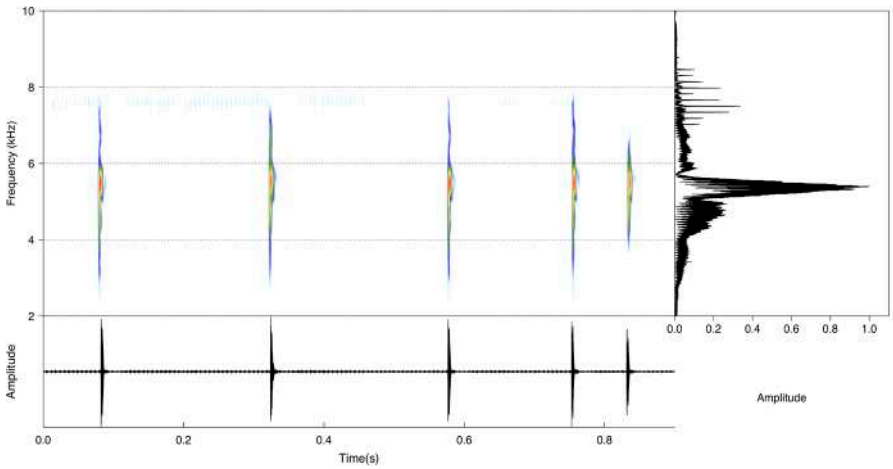

Figure 3. Spectrogram (top), and amplitude of the waveform (bottom) from a two call sequence of *Pseudopaludicola pocoto* advertisement call recorded at Municipality of Caetité, State of Bahia, Brazil (SVL = 13.99 mm).

this species and bridged the gap on our knowledge of its distribution (Fig. 2).

Many species of frogs are typical of the Caatinga Biome and the northern portion of the Atlantic Forest Biome, such as *Boana albomarginata* (Spix, 1824) (Magalhães et al., 2013), *Corythomantis greeningi* Boulenger, 1896 (Godinho et al., 2013; Silva et al., 2014); *Leptodactylus caatingae* Heyer and Juncá, 2003 (Heyer and Juncá, 2003; Vieira et al., 2006); *Physalaemus cicada* Bokermann, 1966 (Lisboa and Haddad, 2009); *Pipa carvalhoi* (Miranda-Ribeiro, 1937) (Santana et al., 2014), *Pleurodema diplolister* (Peters, 1870) (Andrade and Vaz-Silva, 2012); *Proceratophrys cristiceps* and *Rhinella granulosa* (Cassemiro et al., 2012). Thus, these two new records in the Atlantic Forest biome may indicate that *P. pocoto* also has a broad distribution along these biomes.

Pseudopaludicola pocoto was previously known to occur only in sites of the Caatinga Biome or ecotone sites (Magalhães et al., 2014), but here the two records

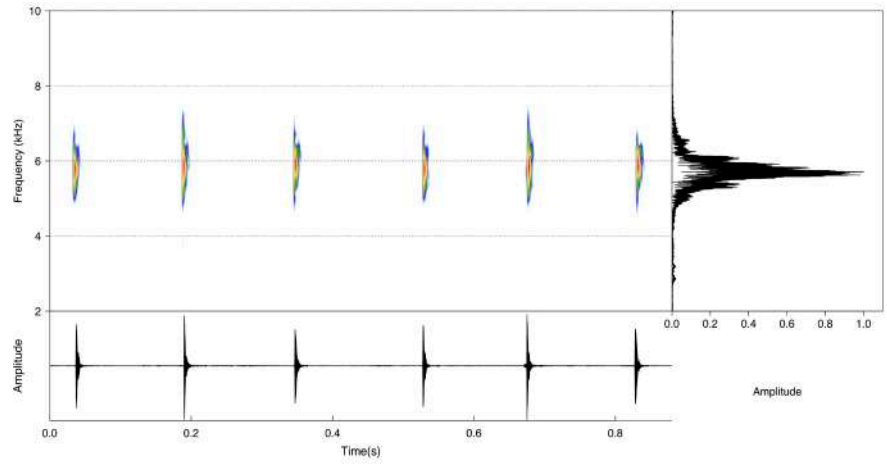

Figure 4. Spectrogram (top), and amplitude of the waveform (bottom) from a two call sequence of *Pseudopaludicola pocoto* advertisement call recorded at Municipality of Catuji, State of Minas Gerais, Brazil (SVL = 12.72 mm).

Table 1. Advertisement call traits of *Pseudopaludicola pocoto* from Municipality of Caetité, Bahia state (BA), Brazil (present study), and Catuji, Minas Gerais state (MG), Brazil (present study) and comparative data for populations from Northeastern Brazil (Magalhães et al., 2014), Municipality of Carlos Chagas, Minas Gerais state, Brazil (Andrade et al., 2015), Municipality of Cabrobó, Pernambuco state, Brazil (Lantyer-Silva et al., 2016) and Municipality of Xique-Xique, Bahia state, Brazil (Andrade et al., 2017). Mean ± SD (minimum–maximum); *n* = number of males recorded (number of analysed notes).

Acoustic variables	Caetité–BA (present study) *n* = 1 (40)	Catuji–MG (present study) *n* = 1 (14)	Magalhães et al. (2014) *n* = 9 (135)	Andrade et al. (2015) *n* = 2 (30)	Lantyer–Silva et al. (2016) *n* = 1 (30)	Andrade et al. (2017) *n* = 5 (50)
Note duration (ms)	263 ± 15 (233–291)	306 ± 19 (264–326)	238 ± 31 (126–290)	265 ± 32 (205–323)	274 ± 22 (223–309)	322 ± 36 (170–397)
Internote interval (ms)	230 ± 37 (186–411)	202 ± 19 (181–250)	220 ± 59 (136–507)	251 ± 61 (196–447)	203 ± 23 (181–263)	251 ± 15 (209–291)
Notes per minute	–	–	124 ± 16 (94–150)	–	–	108 ± 6.5 (100–118)
Pulses per note	3.0 ± 0.5 (2–3)	3	3	3	–	3.0 ± 0.05 (2–3)
Pulse duration (ms)	9 ± 1 (6–14)	8 ± 1 (6–10)	5 ± 1 (3–8)	6 ± 1 (3–8)	12 ± 2 (7–18)	8 ± 1 (6–10)
Interpulse interval (ms)	137 ± 65 (12–241)	137 ± 11 (105–154)	111 ± 21 (43–166)	122 ± 31 (54–205)	138 ± 40 (82–263)	151 ± 17 (112–187)
Pulse rate (pulses/second)	10.8 ± 1.5 (7.6–12.8)	9.7 ± 0.01 (9.2– 11.3)	13 ± 2 (10–18)	11 ± 2 (8–15)	–	9.4 ± 1 (7.6–12)
Dominant frequency (Hz)	5340.2 ± 0 (5340.2)	5684.8 ± 85.6 (5684.8–5657)	5636 ± 300 (5168–6374)	5001 ± 90 (4823–5168)	5804 ± 107 (5625–6000)	5133 ± 269.8 (4734–5437)
Air Temperature (°C)	–	–	24–25	20	–	27

in Minas Gerais are within the Atlantic Forest and not in ecotone areas with Cerrado or Caatinga. Despite these new distributional information, there are still gaps along the species distribution, and further studies are needed to elucidate how wide this species distribution actually is.

The call of *P. pocoto* (Figs. 3, 4) is characterized by a single note emitted as a series of well-defined sequences of two to three pulses and they overlap in almost all acoustic parameters analysed by other authors, except the dominant frequency, which was higher in the individual of Caetité, Bahia (=5340.2 Hz) than that described for Carlos Chagas, Minas Gerais (=5001 ± 90 Hz) (Andrade et al., 2015) and lower than that of Cabrobró, Pernambuco (=5804 ± 107 Hz) (Lantyer-Silva et al., 2016). The calls of the individuals from Catuji-Minas Gerais (=5684.8 ± 85.6 Hz) had the dominant frequency higher than those of Carlos Chagas (=5001 ± 90 Hz) and Xique-Xique-Bahia (=5133 ± 269.8 Hz) (Andrade et al., 2015, 2017) (Table 1). The calls analysed here, as in Andrade et al. (2017), have an amplitude increase between the first and second pulse, followed by a decrease in amplitude between the second and third pulse. However, the dominant frequency remained the same between the three pulses, different from those analysed by Magalhães et al. (2014) and Andrade et al. (2015) in which the calls exhibited upward frequency modulation, and in Andrade et al. (2017), the calls had a higher frequency in the second pulse.

Overall, the call of *P. pocoto* is similar along the entire species distribution. As data on their distributions are still deficient (Azevedo-Ramos and Galatti, 2002; Silvano and Segalla. 2005) it is possible that the distribution of *P. pocoto* could be larger and/or highly fragmented (Andrade et al., 2015). Further, more studies are needed in order to increase our knowledge of this species distribution.

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