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Article

Type of shelter and first description of the echolocation call of disk-winged bat (*Thyroptera devivoi*)

***Renato O. L. Rosa*[1,2], *Claysson H. A. Silva*[1], *Thiago F. Oliveira*[1,2], *Mauricio Silveira*[1,3,*] & *Ludmilla M. S. Aguiar*[1,2,3]**

[1]*Universidade de Brasília, Instituto de Ciências Biológicas, Departamento de Zoologia, Laboratório de Biologia e Conservação de Morcegos, 70910-900, Brasília, DF, Brasil*
[2]*Universidade de Brasília, Programa de Pós-Graduação em Ecologia, Campus Darcy Ribeiro, Asa Norte, 70910-900, Brasília, DF, Brasil*
[3]*Universidade de Brasília, Programa de Pós-Graduação em Zoologia, Campus Darcy Ribeiro, Asa Norte, 70910-900, Brasília, DF, Brasil*
**Corresponding author: Mauricio Silveira, e-mail: mausilv@gmail.com*

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Abstract: Thyropteridae is a family of bats endemic to the Neotropical region, and *Thyroptera devivoi* is the only species in the family that occurs exclusively in forest patches within savannas of northern South America and north of the Brazilian Cerrado. Primary data on the species are still scarce. Therefore, in this study our objective was to fill knowledge gaps on geographical distribution, roost-use, and echolocation for the species. We observed a *T. devivoi* colony of 15 individuals living under a dead palm leaf. The bats used the leaf as a roost for at least four days. After capturing one individual, we confirmed the species identification via skull size and the oblong shape of the adhesive disk. The new record reinforces the association of this species with non-forested formations, and its occurrence mainly in savannas. Echolocation calls of *T. devivoi* are consistent with those known for the genus, with multiharmonic, low intensity and high frequency pulses. Despite these new data, more studies are certainly needed to enhance distribution data for the species, as well as to clarify the biological and ecological requirements of the species.
Keywords: *echolocation, Brazil, Cerrado, Chiroptera, roost, Thyropteridae.*

Tipo de abrigo e primeira descrição da chamada de ecolocalização de morcegos com asas de disco (*Thyroptera devivoi*)

Resumo: Thyropteridae é uma família de morcegos endêmica da região Neotropical e *Thyroptera devivoi* é a única espécie da família que ocorre exclusivamente em manchas florestais das savanas do norte de América do Sul e do Cerrado Brasileiro. Dados primários da espécie são ainda escassos e o objetivo deste estudo foi preencher lacunas de conhecimento sobre distribuição geográfica, uso de abrigos e padrões de ecolocalização da espécie. Nós observamos uma colônia de *T. devivoi* com 15 indivíduos vivendo sob uma folha morta de palmeira. Os morcegos usaram a folha como abrigo ao menos por quatro dias. Depois de capturar um indivíduo, nós confirmamos a identificação da espécie por meio da morfologia do crânio e do disco adesivo. O novo registro reforça a associação da espécie com formações não florestais e a ocorrência principalmente em savanas. Os chamados de ecolocalização de *T. devivoi* são consistentes com o conhecido para o gênero, com pulsos multi-harmônicos de baixa intensidade e alta frequência. A despeito destes novos dados, mais estudos são certamente necessários para aprimorar os dados de distribuição assim como os requerimentos biológicos da espécie.
Palavras-chave: *abrigo, Brasil, Cerrado, Chiroptera, ecolocalização, Thyropteridae.*

Introduction

The Neotropical region has a rich and unique bat fauna, with six endemic families (Gardner 2008). Among those families exclusive of the Neotropics, the Thyropteridae, known as Disk-winged bats, are peculiar bats distinguished by the presence of adhesive suction pads near the thumbs and ankles, which allows bats to attach to smooth surfaces of leaves that are used as roosts (Riskin & Fenton 2001, Wilson 2007). These insectivorous leaf-roosting bats may spend at least half of their lives in the roost, but most *Thyroptera* roost data involves the young, still-furled leaves of *Heliconia* species (Findley & Wilson 1974, Riskin & Fenton 2001, Vonhof & Fenton 2004, Montero & Gillian 2015). Such roosts are well described and are the best-known roost type for this group of bats. However, such leaves usually form temporary roosts because developing leaves may remain furled for up to 60 h and occupation lasts for only a day (Vonhof & Fenton, 2004).

The family Thyropteridae has five recognized species, all belonging to the genus *Thyroptera* and occurring throughout the Neotropical region (Wilson 2007, Velazco et al. 2014). The most common and well known are *Thyroptera discifera* (Lichtenstein & Peters 1854) and *T. tricolor* Spix 1823. Both species are distributed from Central America to south-eastern South America (Findley & Wilson 1974, Tschapka et al. 2000, Vonhof & Fenton 2004, Dechmann et al. 2006, Gillam & Chaverri 2012, Buchalski et al. 2014, Montero & Gillam 2015). The other species are *Thyroptera lavali* Pine et al. 1993, an Amazonian species occurring in northern South America (Solari et al. 2004), and the recently described *Thyroptera wynneae* Velazco et al. (2014), known only by four specimens collected in the forests of Peru and southeastern Brazil (Hoppe et al. 2014, Velazco et al. 2014). The fifth species, *Thyroptera devivoi* Gregorin et al. (2006), is the only one known to occur in non-forested habitats, as it lives in savanna ecosystems found in the municipality of Bom Jesus, state of Piauí, (08°52′S, 44°57′W); Jalapão, in the state of Tocantins (10°33′S, 46°45′W); Barreirinhas, in the state of Maranhão (3º0´S, 43º6´W) (Santos et al. 2013); Tamton, Upper Takutu-Upper Essequibo Region, Guyana (2°21′N, 59°42′W) (Gregorin et al. 2006) and in the Department of Casanare, Colombia (06°02′15″N, 070°12′43″ W) (Rodriguez-Posada et al. 2017).

Although widely distributed, species of Thyropteridae are very elusive and not usually captured in mist nets, a fact that means they are generally poorly sampled in inventories, and few studies exist on the biology and ecology of most species (Solari et al. 2004, Velazco et al. 2014) reassuring the importance of any data on these rare animals. With the popularization in the recent years of bat recorders and acoustic study methods, bat vocalizations have begun to be used for sampling and species identification (Rydell et al. 2002, Barataud et al. 2013, Jung et al. 2014, Arias-Aguilar et al. 2018), especially for taxa rarely captured by traditional netting methods (O'Farrell & Gannon 1999).

However, to unequivocally identify vocalizations recorded in nature, especially in places with a large number of species with undescribed calls, it is necessary to have a call database that permits between-species comparisons (Arias-Aguilar et al. 2018). Moreover, some bats emit very low-intensity calls that are difficult to capture with most bat recorders, so that only fragmentary information is available for such Neotropical bat families, as the Thyropteridae, Furipteridae, Phyllostomidae, and Natalidae (Fenton 2013, Falcão et al. 2015). Within the Thyropteridae only two species have echolocation calls described in detail and they are *T. discifera* (Tschapka et al. 2000) and *T. tricolor* (Fenton et al. 1999, Barataud et al. 2013). Both species are characterized by low intensity broadband calls, with multiple harmonics.

Therefore, in this study, we aimed to fill knowledge gaps on the ecology, distribution, and echolocation of *Thyroptera devivoi*, one of the least-known but most ecologically distinct species in the family Thyropteridae. Accordingly, we present new information on roost use and provide the first detailed description of vocalizations for the species.

Materials and Methods

1. *Study Area*

Fieldwork was carried out in Chapada das Mesas National Park (CMNP), a Brazilian federal protected area located in Carolina municipality, Maranhão state (Figure 1). The National System of Nature Conservation Units - SNUC in its Article 8 defines that National Parks are Units of Integral Protection. According to Köppen-Geiger classification, Carolina has a Aw tropical climate (humid tropical savanna)-(Peel et al. 2007), with high temperatures ranging between 26-29°C and low temperatures between 20-23°C, with two well-defined seasons: dry winters (May to September) and rainy summers (October to April). Average annual rainfall is 1614 mm. August is the driest month and March that of greatest precipitation. The region is in a vegetational transition zone, with high biodiversity including species of three important Brazilian morphoclimatic domains: the Amazon, the Caatinga and the Cerrado (Ab'Sáber 2000). CMNP area is largely occupied by Cerrado and has a typical mosaic landscape, with enclaves of forest formations in a matrix predominantly composed by savannas and pastures (Olson et al. 2001, Moraes & Lima 2007). Bat captures of took place in a large forest enclave in the Cerrado located in the north of the park at coordinates 6°56'52.5"S, 47°21'37.7"W.

2. *Bat roost, collection, and identification*

We found a colony of *Thyroptera devivoi* in a roost and filmed it before the sunset on 11/October/2015 (Figure 2). Two days later (13/October/2015) we returned to the roost site to make a visual estimation of the number of individuals present in the colony. Later on that same day, we installed and opened three mist nets forming a triangle around the exit of the roost. On 14/October/2015 we returned to the bat roost to record the bat calls in the colony and to manually capture a specimen for correct species identification. Capture was achieved with the aid of a cloth bag installed at the roost exit. We collected a specimen and took tissue samples from the bat's patagium. The specimen was euthanized via anesthetic inhalation (Isoflurane) and later fixed and deposited in the Chiroptera Collection of the University of Brasília – CCUnB under accession number CCUnB1189.

For species identification, we used identification keys and articles related to the genus *Thyroptera* (Pine 1993; Solari et al. 2004; Gregorin et al. 2006; Velazco et al. 2014; Díaz et al. 2016). We made the following external and cranial measurements based on Velazco et al. (2014): Total Length (TL), Length of Tail (LT), Hind Foot Length (HF), Ear Length (Ear), Free Tail Length (FTL), Forearm Length (FA), Greatest Length of Skull (GLS), Condyloincisive Length (CIL), Braincase Breadth (BB), Rostral Length (ROL), Zygomatic Breadth (ZB), Postorbital Breadth (PB), Maxillary Toothrow Length (MTRL), Width at M3 (M3-M3), Length of Mandible (LMA) and Mandibular Toothrow Length (MANDL).

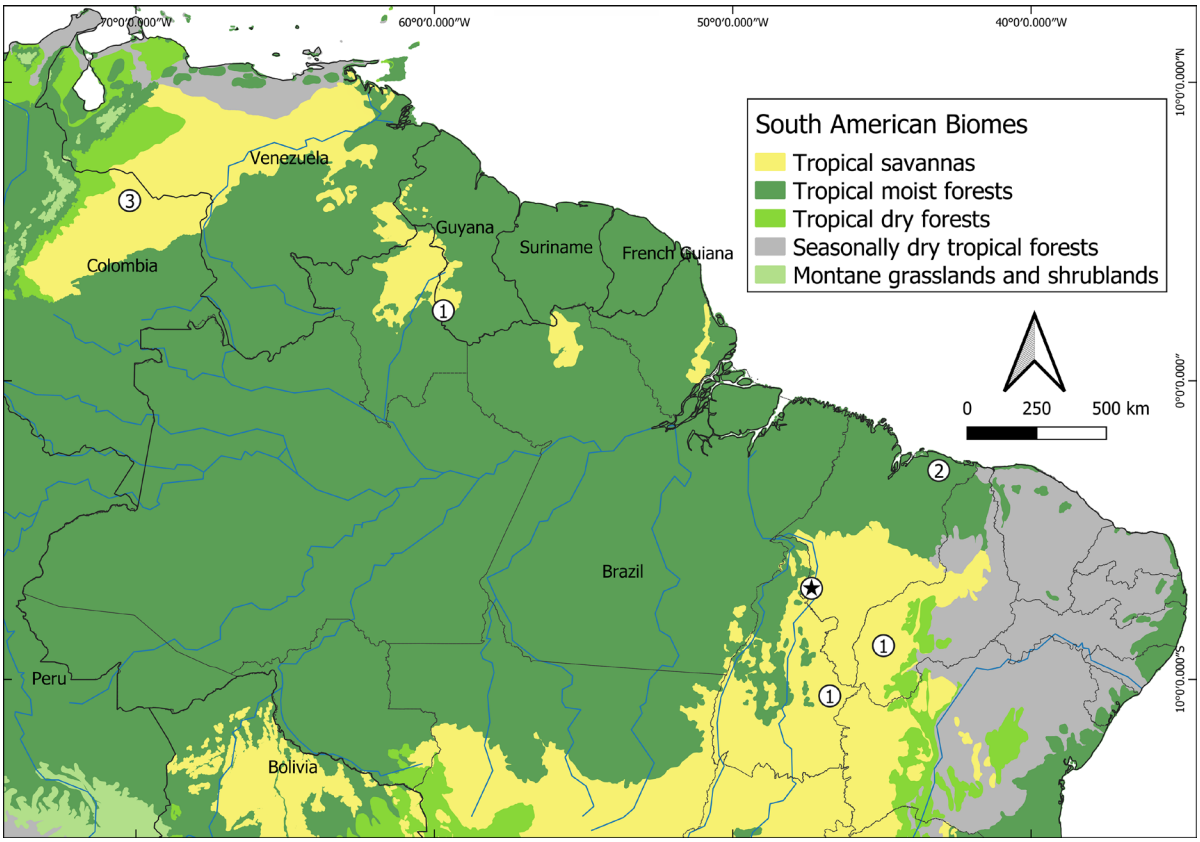

Figure 1. Map of the known localities of *Thyroptera devivoi* records, showing an occurrence restricted to neotropical savannas. Numbers refer to previous records: 1) Gregorin et al. (2006); 2) Santos et al. (2013); 3) Rodriguez-Posada et al. (2017). The limits for the South American biomes were obtained from Olson et al. (2001). Locality 2 is in a transition zone, but the capture of *T. devivoi* in this study occurred in a Cerrado area (see Santos et al. 2013). The star refers to the location of the present study.

Figure 2. The dead palm leaf used as roost by a colony of *Thyroptera devivoi* found in 2015 at Chapada das Mesas, Maranhão state, Brazil.

3. *Sound recordings and analyzed acoustic parameters*

We recorded bat echolocation calls using a Song Meter SM2BAT (Wildlife Acoustics, Maynard, Massachusetts, USA) ultrasonic bat detector in mono, with a single SMX-US (Wildlife Acoustics) omnidirectional microphone and a sampling frequency of 384 kHz. Files were saved as WAV files. To capture the echolocation calls ot the colony's individuals the recorder was placed about 1.5 meters below the entrance to the bat roost. The recorder was programmed to record one file of 30 seconds duration every two minutes during the entire night from 16:50 until 06:00. We selected for analyses those call sequences with at least three pulses and the best aspect-noise-ratio. We measured the following six acoustic parameters of each recorded pulse: pulse duration (ms) - measured from the start to the end of the pulse; pulse interval (ms) - measured from the start of one pulse to the start of the next pulse; maximum frequency (kHz) - measured at the start of the pulse; minimum frequency (kHz) - measured at the end of the pulse; peak frequency, which corresponded to the maximum intensity frequency; and bandwidth, which correspond to the difference between the maximum frequency and the minimum frequency.

We analyzed data using Avisoft-SAS Lab Pro version 5.1.05.30 (Avisoft Bioacoustics, Berlin, Germany), and processed calls with automatic element separation using -20 dB of maximum amplitude, using a 3-threshold algorithm. Pulses were plotted simultaneously on the spectrogram, showing the relationship between frequency, time, and intensity. On the oscillogram, temporal digitization of recordings represented pulse intensity and time. Spectrograms were constructed from 512 fast Fourier transforms using a Hamming window function with 93.75% overlap between consecutive fast Fourier transforms and a frame length of 100%.

The recordings and collections in this work were made as part of the Rede de Pesquisa project Biota do Cerrado under the license number 46596-1 ICMBio/MMA.

Results

No individuals were captured with mist nets. Though, manually we captured one adult male (Figure 3). We visually estimated that the colony consisted of 10 to 15 individuals that were dwelling inside of the sheath of a dead palm leaf that was hanging in the forest canopy (it was the only palm surrounded by neighboring trees) (Figure 2).

Figure 3. Specimen of *Thyroptera devivoi* collected in 2015 at Chapada das Mesas, Maranhão state, Brazil, showing the oval-shaped adhesive suction pads and skull morphology.

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There was an approximate 2.5 m height roost entrance facing downwards (Figure 2). The colony used the same roost for at least four days. The collected *T. devivoi* specimen was easily distinguished from the other species of the genus by the presence of oval-shaped adhesive suction pads, forearm greater than 35 mm, GLS greater than 14 mm and less than 15 mm, bicolored ventral hairs with darker bases and light brown tips, and calcaneus without obvious dermal projections (Pine 1993, Gregorin et al. 2006, Velazco et al. 2014, Díaz et al. 2016) (Table 1, Figure 3).

Analysis showed *Thyroptera devivoi* echolocation pulses are frequency modulated (FM), broadband, with low intensity and high frequency. The calls are multiharmonic, with three harmonics, but we were not always able to capture all of them. Most of the time the second harmonic was the one with most energy. We recorded 305 pulses of 65 calls, during one entire night. The pulses had broad bandwidth, ranging from 50 kHz to more than 150 kHz, with regular intervals of about 0.01ms and a short duration (0.002 ms) (Table 2; Figure 4).

Table 1. Measurements obtained from the male specimen of *Thyroptera devivoi* collected in 2015 at Chapada das Mesas, Maranhão state, Brazil (this study) and those obtained by Velazco et al. (2014) for males of the five species of the genus *Thyroptera*. Measurements from Velazco et al. (2014) are averages, with the intervals observed between parentheses and lastly the sample size.

Measurements (millimeters)	*T. devivoi* ♂ (this study)	Velazco et al. (2014)				
		T. devivoi ♂	*T. lavali* ♂	*T. wynneae* ♂	*T. discifera* ♂	*T. tricolor* ♂
Total Length (TL)	62.5	—	74.0	66.1 (64.4 – 68.0) 3	74.0, 76.0	71.9 (67 - 77) 12
Length of Tail (LT)	24.8	20.4, 21.7	23.0	26.3 (26.0 - 26.7) 3	33.0, 35.0	28.6 (25 - 30) 12
Hind Foot Length (HF)	2.8	—	6.0	4.1 (3.9 - 4.4) 3	5.5, 7.0	5.9 (4 - 7) 10
Ear Length (Ear)	12.6	—	8.0	12.0 (11.0 - 12.7) 3	13.5, 14.0	12.4 (11 - 13) 7
Free Tail Length (FTL)	3.3	4.8 (3.8 - 5.5) 3	—	3.4 (3.1 - 4.0) 3	—	6.0 (4.4 - 7.3) 7
Forearm Length (FA)	36.9	36.5 (35.7 - 37.7) 3	39.0, 39.0	33.7 (33.0 - 34.2) 3	32.8 (32.2 - 33.4) 4	36.7 (33.5 - 40.0) 18
Greatest Length of Skull (GLS)	14.5	14.9 (14.7 - 15.1) 3	15.5, 15.2	13.3 (12.9 - 13.8) 3	14.1 (13.5 - 14.5)	14.3 (13.8 - 15.7) 18
Condyloincisive Length (CIL)	10.8	13.8 (13.7 - 13.9) 3	14.6, 15.0	13.1 (12.5 - 13.6) 3	13.7, 13.7	13.5 (12.9 - 14.4) 18
Braincase Breadth (BB)	7.3	7.0 (6.7 - 7.2) 3	7.3, 7.2	6.7 (6.5 - 6.9) 3	6.9 (6.6 - 7.0) 3	7.3 (6.9 - 7.5) 17
Rostral Length (ROL)	5.5	5.8	—	4.9 (4.9 - 5.0) 3	—	—
Zygomatic Breadth (ZB)	7.8	7.5 (7.4 - 7.7) 3	8.1	7.0 (6.8 - 7.2) 3	7.1 (6.9 - 7.4) 3	7.4 (7.1 - 7.7) 10
Postorbital Breadth (PB)	2.9	2.7 (2.5 - 2.8) 3	2.8, 2.8	2.5 (2.5 - 2.6) 3	2.6 (2.6 - 2.7) 3	2.7 (2.6 - 2.8) 17
Maxillary Toothrow Length (MTRL)	5.6	6.0 (5.7 - 6.1) 3	6.2, 6.3	5.4 (5.3 - 5.6) 3	5.7 (5.5 - 5.8) 4	5.9 (5.6 - 6.3) 18
Width at M3 (M3-M3)	5.8	5.4 (5.3 - 5.5) 3	5.6, 5.5	4.8 (4.8 - 5.0) 3	5.0 (4.8 - 5.1) 3	5.2 (5.0 - 5.5) 18
Length of Mandible (LMA)	11.0	10.9 (10.6 - 11.3) 3	11.3	10.2 (9.9 - 10.6) 3	10.4 (10.0 - 10.6) 3	10.4 (9.6 - 10.7) 15
Mandibular Toothrow Length (MANDL)	6.9	6.1 (5.8 - 6.3) 3	6.3	5.8 (5.5 - 6.2) 3	6.0 (5.9 - 6.1) 3	6.1 (5.8 - 6.3) 15
Weight	—	—	4.0	3.3 (2.6 - 3.8) 3	—	4.4 (3.4 - 5.1) 11

Table 2. Measurements of the echolocation calls of *Thyroptera devivoi* recorded in 2015 at Chapada das Mesas, Maranhão state, Brazil (this study), and measurements obtained from the literature for other species of the genus. Measurements of the fundamental harmonic (HF), first harmonic (H1), and second harmonic (H2).

Measurements	*T. devivoi* (*this study*)			*T. tricolor*[1]		*T. tricolor*[2]	*T. tricolor*[3]	*T. discifera*[3]		*T. discifera*[4]		
Harmonics	HF	H1	H2	HF	H1	H1	H1	HF	H1	HF	H1	H2
Number of pulses analyzed	27	125	150	9	61	—	30	5	10	52	—	—
Duration (ms)	2.1 ± 0.4	2.2 ± 0.3	2.2 ± 0.2	6.0 ± 0.9	8.5 ± 1.5	1.1	3.2 ± 0.4	2.9 ± 0.5	2.5 ± 0.3	0.9 ± 0.2	—	—
Pulse interval (ms)	12.0 ± 2.3	11.7 ± 2.4	11.7 ± 2.4	—	*102.0 ± 4.0	—	—	—	—	10.7 ± 1.7	—	—
Start frequency (kHz)	56.2 ± 3.5	137.6 ± 3.6	162.1 ± 6.1	—	—	123.2	—	—	—	—	—	—
End frequency (kHz)	46.7 ± 1.4	116.3 ± 3.6	136.9 ± 3.8	20.8 ± 0.9	41.6 ± 2.1	92.0	—	—	—	—	—	—
Peak frequency (kHz)	51.2 ± 2.3	127.3 ± 3.0	146.6 ±4.6	—	—	103.1	51.0 ± 2.2	53.0 ± 2.7	112.5 ± 7.3	50.0	100.0	150.0
Bandwidth	9.5 ± 3.9	21.4 ± 4.1	25.2 ± 5.7	22.6 ± 0.9	45.8 ± 0.7	31.31	27.0 ± 5	39.0 ± 8.5	35.5 ± 4.4	—	—	—

* Data here come from only one of the sequences

[1] Fenton et al. 1999, [2] Rivera-Parra & Burneo 2013, [3] Barataud et al. 2013, [4] Tschapka et al. 2000

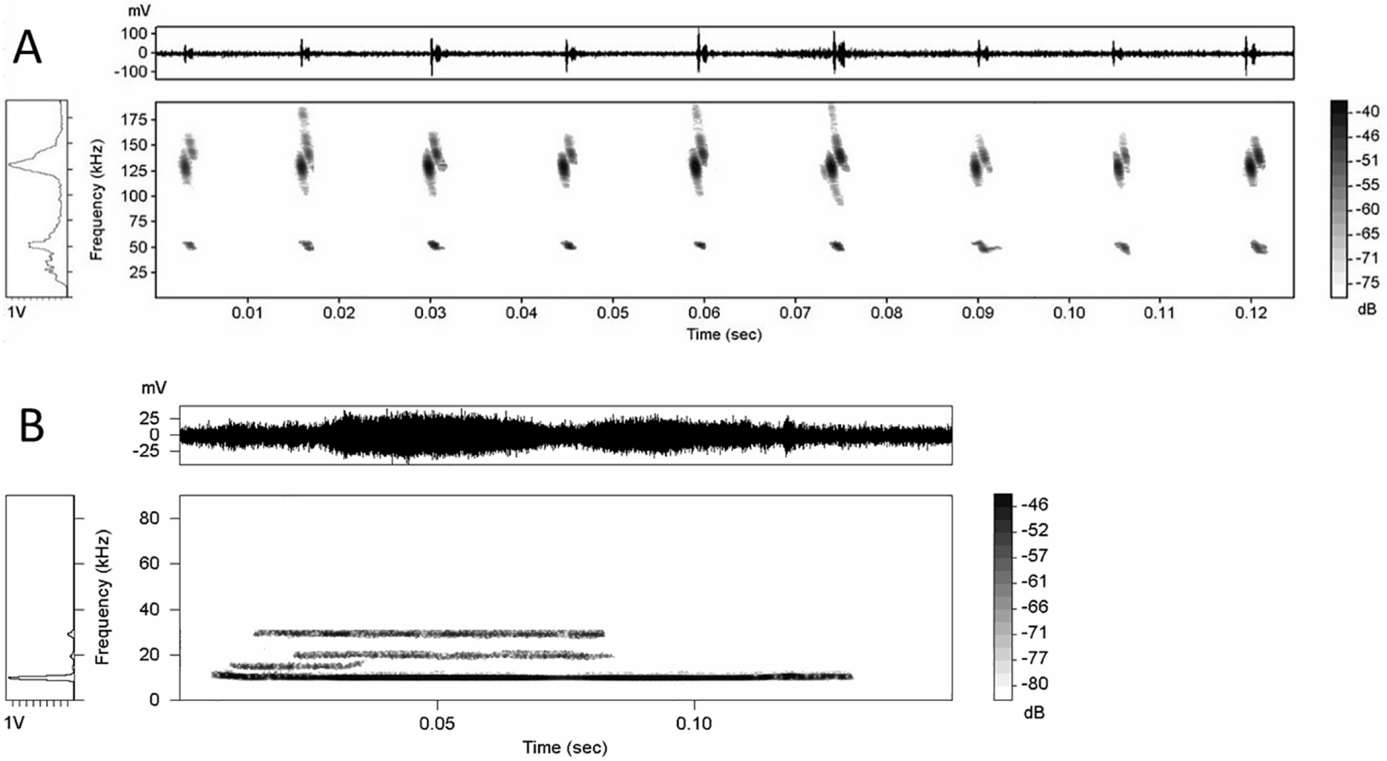

Figure 4. Sequence of search phase echolocation calls (A) and social calls (B) of *Thyroptera devivoi* recorded in 2015 at Chapada das Mesas, Maranhão state, Brazil. Power spectrum (left), oscillogram (top) and spectrogram (center), dB = loudness volume.

One type of social call was also recorded. These were multiharmonic with fundamental frequencies at 10 kHz, 20 kHz and 30 kHz. Calls had long duration and were emitted at extended intervals. Social calls were emitted throughout the night with the first registration at 18:24 and the last at 05.22.

Discussion

Our new geographical record reinforces the presence of *T. devivoi* in the northern portion of the Cerrado, being the sixth known location for this species (Gregorin et al. 2006, Rodriguez-Posada et al. 2017). *Thyroptera devivoi* is one of the lesser known species of this family (Gregorin et al. 2006, Velazco et al. 2014), and has a disjunct distribution, with populations in the northern Brazilian Cerrado and other populations inhabiting the savannas of Colombia and Guiana, in northern South America (Gregorin et al. 2006, Rodriguez-Posada et al. 2017) (Figure 1). In a personal communication to the IUCN, B. Lim (Royal Ontario Museum, Toronto) suggests that populations occurring in the Cerrado can be separated from those occurring in the other savannas of northern South America (Llanos and Rupununi savannas), so that they may be two different species (Solari 2015). As with previous records, the studied *T. devivoi* colony was found in a forest enclave naturally embedded in a savanna matrix, confirming that *T. devivoi* a thyropterid endemic to savanna areas (Gregorin et al. 2006, Santos et al. 2013, Velazco et al. 2014, Rodriguez-Posada et al. 2017), and the only one known with such preferences.

When disturbed, the bats of the colony flew into the woods within a radius of approximately 5-10 meters near the roost, even during the day, which allowed us to estimate the number of individuals using the roost. The studied colony represents a relatively large group when compared to another species of the genus (*T. tricolor*), where groups may contain up to 11, with a mode of 4 to 7, individuals (Findley & Wilson 1974, Vonhof & Fenton 2004). The roost was large (Figure 2) and despite its ephemeral nature (i.e. it would soon transform into a structure not suitable for roosting), it was a multi-day roost, compared to the more commonly used furled *Heliconia* spp. leaf roots that are occupied for only one night (Vonhof & Fenton 2004). The use of a larger roost allows a colony to contain more individuals, and the roost durability allows the colony to stay for several days.

Because they depend on ephemeral and specific roosts (i.e. smooth unfurled leaves, dead leaves), roosts may often be a limiting resource and the local abundance of *Thyroptera* species is associated with the availability of such roosts (Findley & Wilson 1974, Vonhof & Fenton 2004). Current knowledge on thyropterid roost use is largely based on studies of a single species (*T. tricolor*). However, Velazco et al. (2014) suggest that there is a strong selection in *Thyroptera* to diversify the type of roosts used, with species using smoother (e.g., *Heliconia* spp. and *Musa* spp.) or rougher roosts (e.g., dry leaves of *Cecropia* spp. or palm trees). These differences on roost preference may allow the sympatric occurrence of congeneric (2 up to 4) in some localities (Velazco et al. 2014) and could also explain the generalist approach of *T. devivoi* by its capacity to use roosts with more rugged surfaces, like dead dried leaves recorded here and previously (Gregorin et al. 2006, Velazco et al. 2014). Another hypothesis raised by Velazco et al. (2014) is that *Thyroptera* species with a light or whitish venter would roost on leaves that permits light entrance through the leaves, while darker venter species would roost in dead leaves. Though, it is interesting to call the attention that *T. devivoi* from Jalapão was collected in a "vereda" rich in *Heliconia* (Gregorin et al. 2006) while we found the species in dead leaves.

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As with most of the available information about the family, little is known about the acoustic biology of Thyropteridae, and that which exists mainly refers to two species (*T. discifera* and *T. tricolor*), with some studies focused on social calls (Chaverri et al. 2010, 2013, Chaverri & Gillam 2013, 2015, Montero & Gillam 2015), while others concentrated on echolocation calls (Fenton et al. 1999, Tschapka et al. 2000, Barataud et al. 2013, Rivera-Parra and Burneo 2013). Echolocation calls of *T. devivoi* recorded by us are of low intensity, which make them difficult to detect (Fenton et al. 1999, Dechmann et al. 2006). This seems to be a characteristic of the bats of the genus *Thyroptera,* since similar calls were identified by Fenton et al. (1999), Tschapka et al. (2000), Barataud et al. (2013) and Rivera-Parra and Burneo (2013). Echolocation characteristics of *T. devivoi* recorded in this study are more similar to those of *T. discifera* recorded by Tschapka et al. (2000) (Table 2). However, they are different from *T. discifera* calls registered by Fenton et al. (1999), which had low bandwidth and long duration (5 to 8 ms). The results of Dechmann et al. (2006) on *T. discifera* echolocation show strong contrasts to those calls of *T. discifera* recorded by Fenton et al. (1999) and Tschapka et al. (2000). The kind of high-frequency and low-intensity calls recorded dissipate rapidly in space and are used for short-range detection in areas with many obstacles. This allows the bats to obtain high-quality detailed information on their surroundings (Schnitzler and Kalko 2001). We recorded a social call similar to that described by Montero and Gillam (2015) for *T. tricolor*, who qualified it as SQCF (short quasi-constant frequency). We do not know the purpose of this call for *T. devivoi*, but it is present during certain times of the night between periods of echolocation and, therefore, may possibly be emitted in flight.

There are few data on the echolocation of bats of the *Thyroptera* family. Acoustic data are from only three of the five species, being *T. tricolor* (Fenton et al. 1999, Rivera-Parra and Burneo 2013, Barataud et al. 2013), *T. discifera* (Tschapka et al. 2000 and Barataud et al. 2013 e) and *T. devivoi* (this study). Despite the scarcity of data, we believe that echolocation calls of the Thyropteridae bats can be identified by the presence of three FM harmonics, the first about 50 kHz, the other about 100 kHz and the last about 150 kHz, with pulses of short duration, small interval between pulses and large bandwidth. Except for Fenton et al. (1999) that recorded quasi-constant frequency (QCF) calls, long duration, and low bandwidth, all other studies have identified similar multi-harmonic calls (although not all have recorded the three harmonics.), with short duration and interval between the pulses, and large bandwidth (see table 2). The absence of a third harmonic may be due to the difference between the recording equipment as they may restrict the sample rate of the recordings (Biscardi et al. 2004). All acoustic parameters analyzed in this study overlap with literature data, except for the bandwidth that is lower in *T. devivoi* in all harmonics when compared with other species. However, as there are few samples of other species, we suggest caution in the acoustic identification of species of the family *Thyroptera*. The data that exists so far is not robust enough to identify any of the species with certainty.

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Authors Contributions

Renato O. L. Rosa and Ludmilla M. S. Aguiar: Substantial contribution in the concept and design of the study.

Renato O. L. Rosa and Thiago F. Oliveira: Contribution to data collection.

Renato O. L. Rosa, Claysson H. A. Silva, Thiago F. Oliveira, Mauricio Silveira and Ludmilla M. S. Aguiar: Contribution to data analysis and interpretation.

Renato O. L. Rosa, Claysson H. A. Silva, Thiago F. Oliveira, Mauricio Silveira and Ludmilla M. S. Aguiar: Contribution to manuscript preparation.

Mauricio Silveira and Ludmilla M. S. Aguiar: Contribution to critical revision, adding intellectual content.

Conflicts of interest

The authors declare no conflicts of interest. Neither part of this manuscript has financial interest or other matter that could potentially influence the authors.

Ethics

The recordings and collections in this work were made as part of the Rede de Pesquisa project Biota do Cerrado under the license number 46596-1 ICMBio/MMA.

Data availability

All primary data of this manuscript are in the tables and supplementary material.

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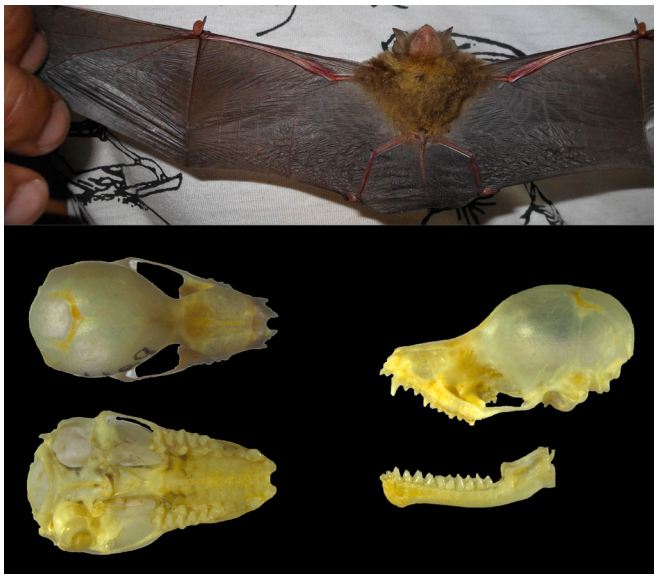
Erratum

Erratum: Type of shelter and first description of the echolocation call of disk-winged bat (*Thyroptera devivoi*)

In the article "Type of shelter and first description of the echolocation call of disk-winged bat (Thyroptera devivoi)", with the DOI code number: http://dx.doi.org/10.1590/1676-0611-BN-2019-0821, published at Biota Neotropica 20(2): e20190821, on page 4:

Where it was written:

Should read:



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