

New records of disk-winged bats *Thyroptera tricolor* Spix, 1823 and *T. devivoi* Gregorin, Gonçalves, Lim & Engstrom, 2006 (Chiroptera: Thyropteridae) for the Brazilian Amazonia and Cerrado
Novo registro de morcegos-de-ventosa *Thyroptera tricolor* Spix, 1823 e *T. devivoi* Gregorin, Gonçalves, Lim & Engstrom, 2006 (Chiroptera: Thyropteridae) para a Amazônia brasileira e Cerrado

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Abstract: We present new records for the disk-winged bats *Thyroptera tricolor* and *T. devivoi* in central and northern Brazil. Records of *T. tricolor* are from Aripuanã, Usina Hidrelétrica (UHE) Colíder (both in the northern Mato Grosso state) and Santana do Araguaia (southern Pará state). New records of *T. devivoi* are from a Cerrado area in the Rio Manso, Rio Quilombo (both in Mato Grosso state) and from an Amazon rainforest area at Juruti (Pará state). The records of *Thyroptera devivoi* for Pará and Mato Grosso are the first ones for these states and the records from the latter are based on two specimens previously identified as *T. discifera*. Based on the new identifications, we argue that *T. discifera* does not occur in the Cerrado.

Keywords: Geographic distribution. Mato Grosso. Pará. Range extension.

Resumo: Apresentamos novos registros para as espécies de morcegos *Thyroptera tricolor* e *Thyroptera devivoi* no Brasil central e norte. Os registros de *T. tricolor* são de Aripuanã, Usina Hidrelétrica (UHE) Colíder (ambos no norte do estado do Mato Grosso) e Santana do Araguaia (sul do estado do Pará). Os novos registros de *T. devivoi* são de área de Cerrado nos rios Manso e Quilombo (ambos no estado do Mato Grosso) e em uma área de floresta amazônica em Juruti (estado do Pará). Estes são os primeiros registros de *Thyroptera devivoi* para os estados do Pará e Mato Grosso, sendo os registros do Mato Grosso baseados em dois exemplares previamente identificados como *T. discifera*. Com base na nova identificação, sugerimos que *T. discifera* não ocorre no Cerrado.

Palavras-chave: Distribuição geográfica. Mato Grosso. Pará. Extensão de distribuição.

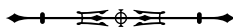
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INTRODUCTION

The genus *Thyroptera* Spix, 1823 includes five extant species of disk-winged bats: *Thyroptera devivoi* Gregorin, Gonçalves, Lim & Engstrom, 2006; *Thyroptera discifera* (Lichtenstein & Peters, 1854); *Thyroptera lavalii* Pine, 1993; *Thyroptera tricolor* Spix, 1823; and *Thyroptera wynneae* Velazco, Gregorin, Voss & Simmons, 2014 (Velazco *et al.*, 2014; Lee Jr., 2019). Disk-winged bats are insectivores that usually capture prey directly from the substrate and use foliage as day roost (Dechmann *et al.*, 2006; Wilson, 2008). They inhabit humid lowland forests, including gallery forests in some Neotropical savannas (Gregorin *et al.*, 2006; Tavares & Mantilla-Meluk, 2015). Four species, *T. devivoi*, *T. discifera*, *T. lavalii*, and *T. wynneae*, are restricted to South America, occurring in savannas and in the Amazonia and Atlantic rainforests (Wilson, 2008; Lee Jr., 2019). The species with the widest range, *T. tricolor*, occurs in lowland rainforests from southern Mexico to southeastern Brazil (Lee Jr., 2019).

Thyroptera tricolor is distributed in southern Mexico, Central America and South America, where it has been recorded on the island of Trinidad, in Venezuela, Guyana, French Guiana, Surinam, Colombia, Ecuador, Peru, Bolivia, and Brazil (Wilson, 2008; Lee Jr., 2019). In Brazil, it has an apparent disjunct distribution, with records in the Amazonia (Amazonas, Acre, Maranhão, Rondônia, Roraima, and Pará states) and in the Atlantic Forest (Bahia, São Paulo, Paraná, Rio de Janeiro, and Espírito Santo states) (Esbérard *et al.*, 2007; Wilson, 2008; Passos *et al.*, 2010; Castro & Michalski, 2015; Tavares *et al.*, 2017). It has been reported in sympatry with *T. discifera* and *T. lavalii* in several areas within its range of distribution, especially in the Amazonia (Wilson, 2008; Velazco *et al.*, 2014). *Thyroptera tricolor* commonly roosts in the young rolled leaves of *Heliconia* (Heliconiaceae) and may occasionally use leaves of other plants as roosts, such as *Calathea* (Marantaceae), *Phenakospermum* (Strelitziaceae), and *Musa* (Musaceae) (Goodwin & Greenhall, 1961; Wilson & Findley, 1977; Lee Jr., 2019).

Thyroptera devivoi is known from six localities: one in the Colombian llanos, one in the Guyanan Rupununi savanna, and four in the Brazilian Cerrado (Maranhão, Tocantins, and Piauí states) (Gregorin *et al.*, 2006; Santos, C. *et al.*, 2013; Rodríguez-Posada *et al.*, 2017; Rosa *et al.*, 2020). There is scarce information on the ecology of this recently-described species: one individual from Guyana was captured 'under and eaté palm leaf' (Gregorin *et al.*, 2006); in Colombia, a specimen was caught in a *Mauritia flexuosa* L. f. grove (Rodríguez-Posada *et al.*, 2017); and in Maranhão state, Brazil, a roosting group was found in a dead palm leaf sheath (Rosa *et al.*, 2020).

In this paper, we present six new records of *Thyroptera tricolor* and *T. devivoi* for the southern Brazilian Amazonia, extending the known distribution of both species, and we also comment on the presence of *T. discifera* in the Cerrado.

MATERIALS AND METHODS

We examined six specimens of *Thyroptera* preserved as fluid and taxidermied. The specimens are housed in the following institutions: *Coleção da Universidade do Estado de Mato Grosso* (CZAFMA), campus Alta Floresta, Alta Floresta; *Museu Paraense Emílio Goeldi* (MPEG), Belém; *Museu de Zoologia da Universidade de São Paulo* (MZUSP), São Paulo; *Universidade Federal de Mato Grosso* (UFMT), Cuiabá; *Universidade de Brasília* (UNB), Brasília. To identify the specimens, we analyzed qualitative characters of pelage, integument, and dentition based on Gregorin *et al.* (2006) and Velazco *et al.* (2014). The external and cranial measurements were taken and are described in the following lines and summarized in Table 1. External measurements were obtained directly from the labels, or were measured by us (GSTG, NA, and PFCR) while preparing the specimens using digital calipers (0.01 mm precision), and include: total length (TL) – distance from the tip of the snout to the tip of the last caudal vertebra; length of the tail (T) – measured from the point of dorsal flexure of the tail with the sacrum to the tip of the last caudal vertebra;

Table 1. External and cranial measurements (in mm) and body mass (grams) of *Thyroptera devivoi* and *Thyroptera tricolor*. See Material and Methods for abbreviations.

Measurements	<i>Thyroptera devivoi</i>			<i>Thyroptera tricolor</i>	
	UnB 982	UnB 989	MPEG 45677	UFMT 4881	MZUSP 36011
Sex	Male	Male	Male	Male	Male
Age	Adult	Adult	Adult	Sub-adult	Adult
W	-	-	6	5	3.6
Ear	-	-	9.97	9.62	14
FA	34.99	34.27	37.6	36.91	-
HF	6.12	-	6.28	5.79	3
T	24.68	21.59	25.13	26.16	33
TL	-	-	42.58	41.14	46
GLS	14.80	14.05	14.95	14.44	-
CIL	12.82	-	13.92	12.51	-
BB	6.50	6.19	6.90	6.76	-
ROL	4.71	5.05	5.48	4.32	-
ZB	6.90	-	7.82	7.57	-
PB	2.85	3.03	2.38	2.91	-
MTRL	5.76	5.33	5.78	6.03	-
M3-M3	2.66	2.12	2.98	2.62	-
LMA	10.75	9.85	10.86	10.90	-
MANDL	5.69	5.07	5.88	4.94	-

hind foot length (HF) – measured from the anterior edge of the base of the calcar to the tip of the claw of the longest toe; ear length (Ear) – measured from the ear notch to the fleshy tip of the pinna; forearm length (FA) – distance from the elbow (tip of the olecranon process) to the wrist (including the carpals, this measurement made with the wing at least partially folded); and mass (W) in grams.

Ten cranial measurements were taken from the specimens using digital calipers (0.01 mm precision), followed Velazco *et al.* (2014) are described as follows: greatest length of the skull (GLS) – distance from the posteriormost point on the occiput to the anteriormost point on the premaxilla (excluding the incisors); condyloincisive length (CIL) – distance between the anteriormost point on the upper incisor and a line connecting the posteriormost margins of the occipital condyles; braincase breadth (BB)

– greatest breadth of the globular part of the braincase, excluding mastoid and paraoccipital processes; rostral length (ROL) – distance from the alveolar process of the premaxilla above the first upper incisor to the ipsilateral postorbital constriction; zygomatic breadth (ZB) – greatest breadth across the zygomatic arches; postorbital breadth (PB) – least breadth at the postorbital constriction; maxillary tooththrow length (MTRL) – distance from the anteriormost surface of the upper canine to the posteriormost surface of the crown of M3; width at M3 (M3–M3) – greatest width of palate across labial margins of the M3s; length of the mandible (LMA) – distance from the anteriormost point on the first lower incisor to the posteriormost point on the ipsilateral coronoid process; mandibular tooththrow length (MANDL) – distance from the anteriormost surface of the lower canine to the posteriormost surface of M3.

Thyropterids are easily distinguished from all other Neotropical bats by the presence of a circular adhesive disk on the sole of the foot and an oval or circular disk attached by a short pedicle to the base of the thumb (Figure 1). The species of this genus are characterized by their small size (forearm length between 31 and 41 mm); an elongate, slender muzzle; circular and well-separated nares; and funnel-shaped ears. The skull has a rounded braincase elevated above the slender rostrum, with complete premaxillae and no postorbital processes (Wilson, 2008).

To determine the identity of the *T. devivoi* specimens, we observed a bicolored ventral pelage (Figures 1A-1B and 2) (unicolored in *T. discifera* and *T. tricolor*, tricolored in *T. wynneae*), with frosted tips (Figure 1A) (non-frosted in *T. livali*), oblong adhesive disks on the thumb (Figure 1C) (circular in *T. tricolor* and *T. discifera*), absence of lappets on the calcar (present in the other species or faintly developed in *T. devivoi*) (Figure 1B); I2 with transversely oriented buccal and labial cusps (obliquely oriented in *T. discifera* and *T. tricolor*) (Figures 3A and 4); and the i3 with twice the buccolingual width of i1 and i2 (Figures 3B and 4) (1.5 times the buccolingual width of i1 and i2 in *T. discifera*, *T. tricolor*, and *T. wynneae*) (Gregorin *et al.*, 2006; Velazco *et al.*, 2014; Rodríguez-Posada *et al.*, 2017).

The characters used to identify the *T. tricolor* specimens were: unicolored 'pure white' ventral pelage (Figure 5) (ventral pelage not conspicuously contrasting with dorsum in the other species), circular adhesive disks on the thumb (oblong in *T. devivoi*, *T. livali*, and *T. wynneae*), calcar with two lappets projecting posterolaterally from the shaft (single lappet in *T. discifera* and *T. livali*, or poorly developed in *T. devivoi*), and smaller dimension when compared with *T. devivoi* and *T. livali* (Table 1).

RESULTS

Thyroptera tricolor SPIX, 1823

The records of *Thyroptera tricolor* are based on three specimens. The first is from Aripuanã (10° 04' 22" S,

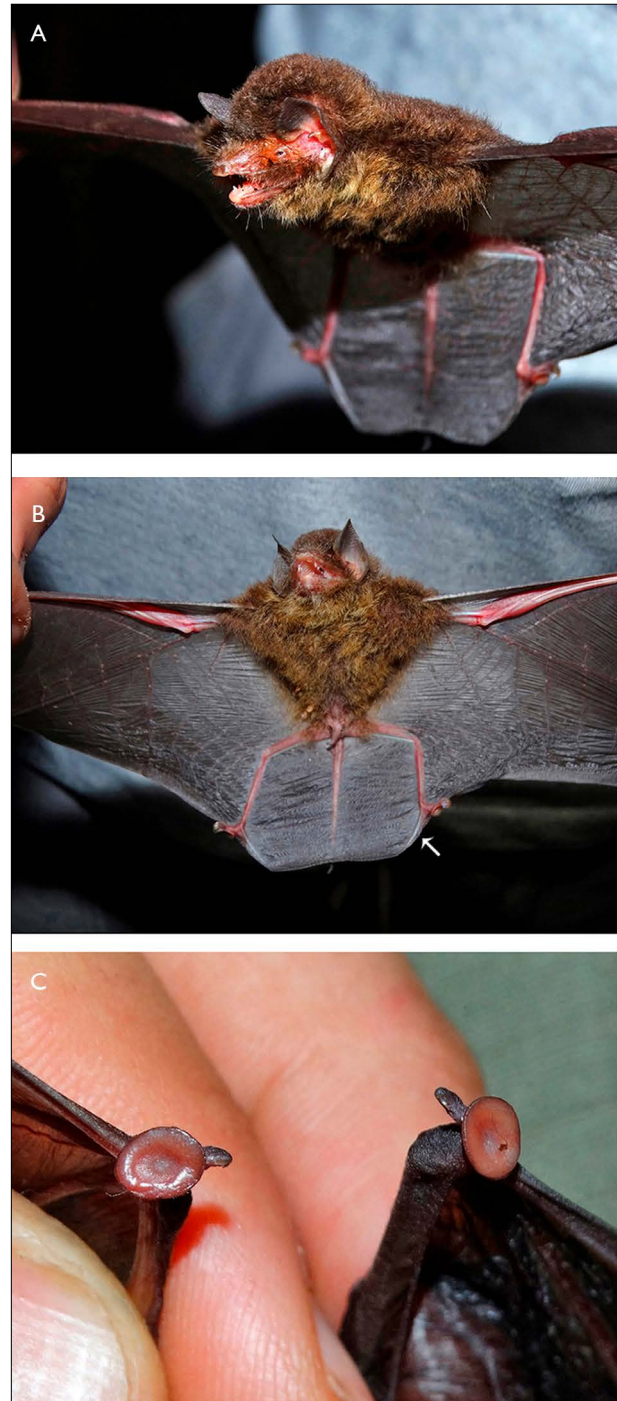


Figure 1. Specimen of *Thyroptera devivoi* MPEG 45677 collected in Juruti, Pará state, Brazil. Note the frosted ventral pelage (A, B), absence of lappets on the calcaneum (B), and oblong adhesive disks of wing (C). The calcaneum is indicated by a white arrow. Photos: Paul François Colas-Rosas (2015).

59° 30' 41" W, 175 m), Mato Grosso state, and is a sub-adult male weighing 5 g, captured at 18.30 h on 29 May, 2019, in a ground-level mist net set across a trail of forested *habitat*, during the dry season. It is fluid-preserved and had its skull removed, and it is deposited at the *Coleção Zoológica da Universidade Federal de Mato Grosso* under the collection number UFMT 4881 (Figures 5 and 6). The second specimen of *T. tricolor* is from *Fazenda Fartura* in Santana do Araguaia (9° 37' 41" S, 50° 29' 42" W, 180 m), Mato Grosso state. It is an adult male, hand-caught by GSTG while roosting during the day inside a rolled leaf of *Heliconia*, on 13 April, 2017. The capture area was in a swampy area in a mature lowland Amazon rainforest, approximately 5-8 meters from a dirt road. It is preserved as a taxidermied skin with separated skull and partial skeleton, and it is deposited at the *Museu de Zoologia da Universidade de São Paulo* (MZUSP 36011). The third specimen of *T. tricolor* was captured at UHE Colíder (10° 49' 08" S, 55° 27' 03" W, 265 m), Pará state. It is a fluid-preserved specimen deposited at the *Universidade do Estado de Mato Grosso, campus Alta Floresta*, under the collection number CZAF MA 08. The specimen CZAF MA 08 was previously mentioned in a checklist of mammals from Mato Grosso (Brandão *et al.*, 2019), but no locality information was given. These records expand the distribution of *T. tricolor* in the southern Amazonia, filling a wide gap in the southern part of the distribution of this species in this ecoregion (Figure 7A).

Thyroptera devivoi GREGORIN, GONÇALVES, LIM & ENGSTROM, 2006

The records of *Thyroptera devivoi* are based on three specimens. The first specimen is from Rio Manso, Chapada dos Guimarães (14° 50' 43.03" S, 55° 34' 47.30" W, 274 m), Mato Grosso state. It is fluid-preserved with the skull removed, and is deposited at the *Coleção Zoológica da Universidade de Brasília* under the collection number UnB 982 (Figures 2, 3, 4). The second specimen is from Rio Quilombo, Chapada dos Guimarães



Figure 2. Specimen of *Thyroptera devivoi* (UnB 982) collected in Rio Manso, Chapada dos Guimarães, Mato Grosso state, Brazil.

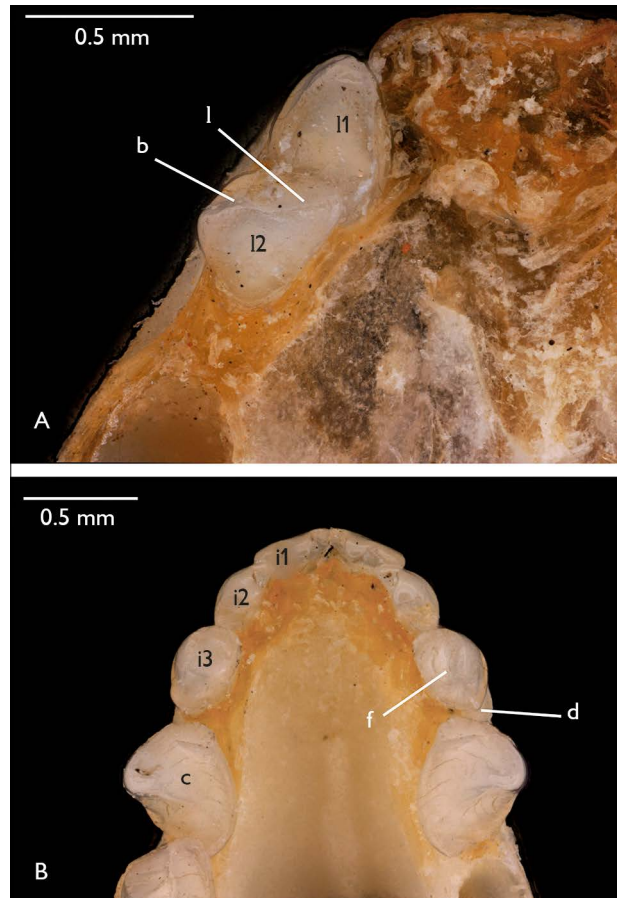


Figure 3. A) Upper incisors, in occlusal view, of *Thyroptera devivoi* (UnB 982) from Rio Manso, Mato Grosso state, Brazil; B) lower incisors and canine, in occlusal view of the same specimen. Legends: i1 = first upper incisor; i2 = second upper incisor; i1 = first lower incisor; i2 = second lower incisor; i3 = third lower incisor; c = lower canine; b = buccal cusp; d = distostyle; f = fossalike concavity; l = lingual cusp.

(15° 4' 17.96" S, 55° 42' 51.86" W, 287 m), Mato Grosso state. It is fluid-preserved with the skull removed, and deposited at the *Coleção Zoológica da Universidade de Brasília* under the collection number UnB 989. Both UnB specimens were previously identified as *T. discifera* by Bezerra *et al.* (2005) and considered to be the only known records of the species for the Cerrado. The third record of *T. devivoi* is from Juruti (2° 15' 46.28" S, 56° 04' 55.51" W, 132 m),

Pará state. It is fluid-preserved and had its skull removed, and it is deposited at the *Museu Paraense Emílio Goeldi* (MPEG 45677, field number PF 4809). The specimen from Juruti is an adult male, captured with understory mist net in a fragment of mature lowland Amazon rainforest with developed vertical stratification in the dry season. Close to the fragment there are pastures and a railway (Figure 7B).



Figure 4. Dorsal, ventral, and lateral views of skull and superior view of mandible of *Thyroptera devivoi* (UnB 982) collected in Rio Manso, Chapada dos Guimarães, Mato Grosso state, Brazil.



Figure 5. Specimen of *Thyroptera tricolor* (UFMT 4881) collected in southern Amazonia, Aripuanã, Mato Grosso state, Brazil. Note the pure white ventral fur. Photos: Thiago Semedo (2019).

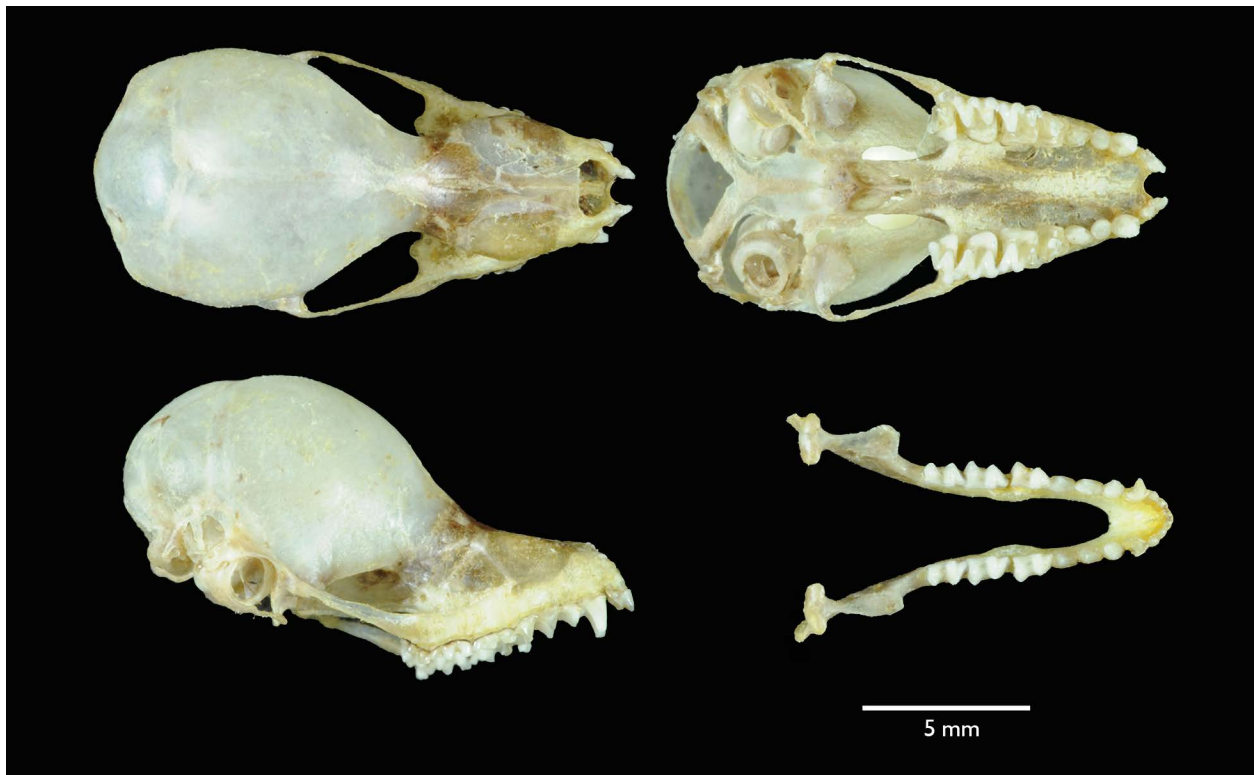


Figure 6. Dorsal, ventral and lateral views of skull of *Thyroptera tricolor* (UFMT 4881), collected in southern Amazonia, Aripuanã, Mato Grosso state, Brazil.

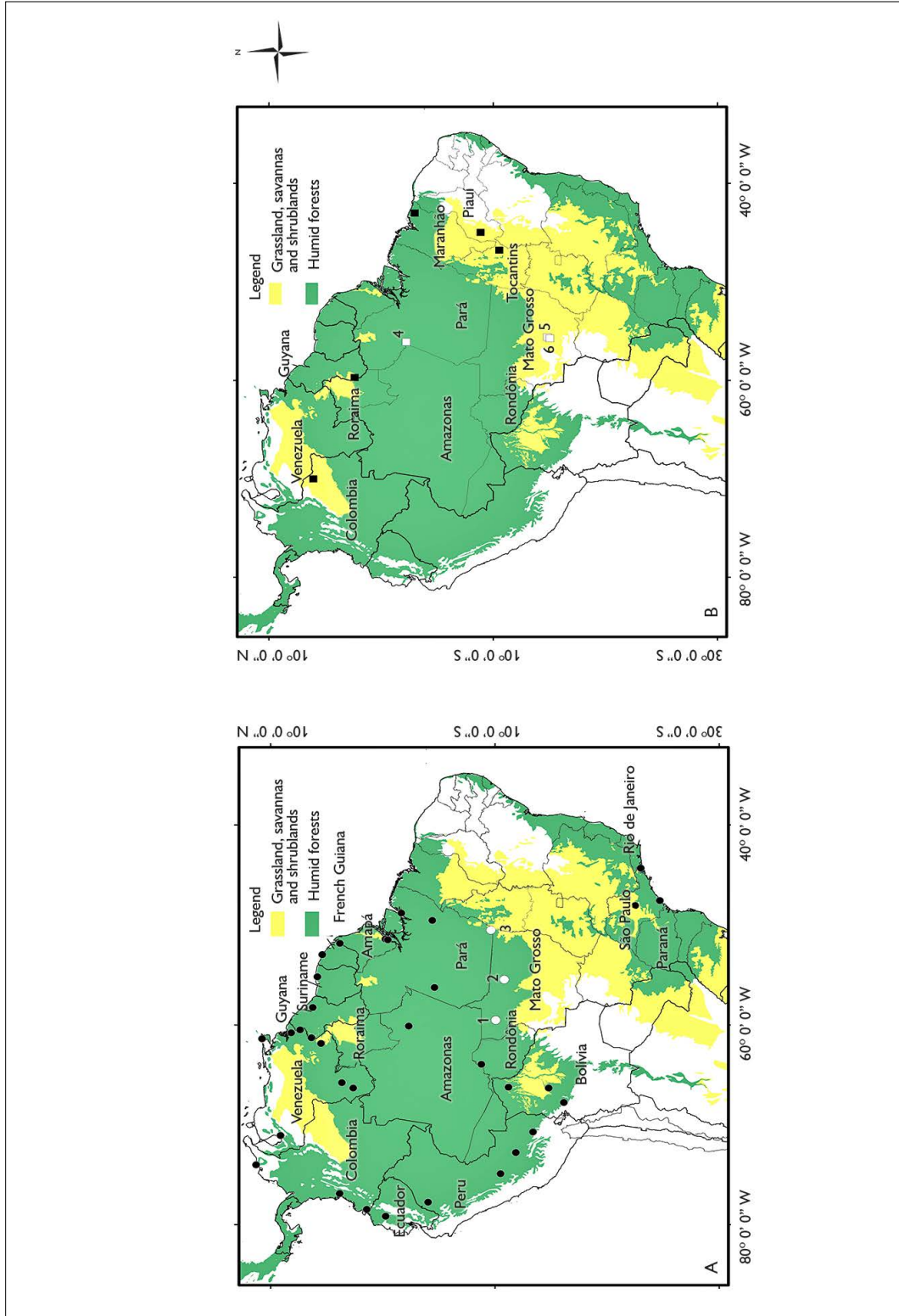


Figure 7. A) Localities of *Thyroptera tricolor*. Solid circles correspond to marginal South American localities reported by Wilson (2008) with the addition of Esbérard et al. (2007), Passos et al. (2010), Castro & Michalski (2015), Garbino et al. (2017), and Tavares et al. (2017). Empty circles correspond to new records reported here: 1 = Aripuanã, Mato Grosso state; 2 = UJE Colêder, Mato Grosso state; 3 = Fazenda Faturá, Santana do Araguaia, Pará state; B) localities of *Thyroptera devioi*. Solid squares correspond to localities previously reported by Gregorin et al. (2006), Santos, C. et al. (2013), Rodríguez-Posada et al. (2017), and Rosa et al. (2020). Empty squares correspond to new records reported here: 4 = Juruti, Pará state; 5 = Rio Quilombo, Mato Grosso state; 6 = Rio Manso, Mato Grosso state. The green and yellow areas correspond to the ecoregions of Olson et al. (2001). Map: Thiago Sernedo.

DISCUSSION

With the verification that the specimens from the Cerrado of Mato Grosso, previously identified as *T. discifera* by Bezerra *et al.* (2005), are in fact *T. devivoi*, we suggest that the distribution of *T. discifera* is restricted to the Amazonia and Atlantic Forest (Gregorin *et al.*, 2006; Bocchiglieri *et al.*, 2016). It is important to note, however, that the '*T. discifera*' records of Bezerra *et al.* (2005) were published before the taxonomic reassessment of *Thyroptera* that resulted in the description of the *T. devivoi* by Gregorin *et al.* (2006).

The records of *T. devivoi* are the first for Pará and Mato Grosso states and for southern Amazonia, filling a distribution gap in this biome, as this species was previously reported in the Rupununi savannas, Guyana (Wilson, 2008), approximately 650 km to the NW from our record in locality 4, Pará state, and our records in localities 5 and 6, Mato Grosso state, are ca. 1,100 to 2,000 km NE from previous records in Maranhão, Piauí, and Tocantins states (Wilson, 2008) (see Figure 7B). The new records extend the distribution of the species southwestward and establish a new southern limit for the taxon (Figure 7B). The records from Mato Grosso are from a 'cerrado' *sensu stricto* area (i.e. savanna woodland with 10-60% tree cover), with the occurrence of typical Amazonian taxa, as attested by the presence of the slender mouse opossum *Marmosops noctivagus* (Tschudi, 1845) (Lacher Jr. & Alho, 2001) and the Southern Amazon red squirrel *Hadroskiurus spadiceus* (Olfers, 1818) (Vivo & Carmignotto, 2015). Our records fit a recent pattern of published range expansions of Amazonian bats for central and southern Amazonia due to increased sampling efforts in these regions and also from review of zoological specimens. Some of these range expansions include records of the molossid *Cynomops planirostris* (Peters, 1866) (Santos, T. *et al.*, 2015); the emballonurids *Centronycteris maximiliani* (Fischer, 1829) (Rocha *et al.*, 2015), *Peropteryx kappleri* Peters, 1867, and *Peropteryx leucoptera* Peters, 1867 (Dalponte *et al.*, 2016), the vespertilionid *Histiotus diaphanopterus* Feijó, Rocha & Althoff, 2015 (Semedo & Feijó, 2016); and the

phyllostomids *Glyphonycteris sylvestris* (Thomas, 1896), *Lonchorhina inusitata* Handley & Ochoa, 1997, *Phyllostomus latifolius* (Thomas, 1901), *Tonatia saurophila* Koopman & Williams, 1951, and *Artibeus concolor* Peters, 1865 (Miranda *et al.*, 2015; Dalponte *et al.*, 2016).

CONCLUSION

Our paper clarifies the geographical distributions of *T. tricolor* and *T. discifera*, the latter which, according to us is restricted to the Amazonia and Atlantic rainforest. We also report a major range extension of *T. devivoi*, highlighting that the distribution of this taxon is still poorly known. The records presented here reinforce the notion, expressed in recent papers, that the large Brazilian states of Mato Grosso and Pará are still under sampled in relation their mammalian diversity, especially regarding small species (Bernard *et al.*, 2011; Brandão *et al.*, 2019). Thyropterids are rare in scientific collections, but we suggest that new records of disk-winged bats will be obtained, and distributional gaps will be filled, as more attention is given to active search in diurnal roosts.

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