Biota Neotropica 18(4): e20180537, 2018
www.scielo.br/bn

biotaneotropica
ISSN 1676-0611 (online edition)

Inventory

Bats of the Serra da Bocaina National Park, southeastern Brazil: an updated species list and a distribution extension for *Trinycteris nicefori* (Sanborn, 1949)

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DELCIELLOS, A.C., MOTTA, A., DIAS, D., ALMEIDA, B., ROCHA-BARBOSA, O. **Bats of the Serra da Bocaina National Park, southeastern Brazil: an updated species list and a distribution extension for *Trinycteris nicefori* (Sanborn, 1949)**. Biota Neotropica. 18(4): e20180537. http://dx.doi.org/10.1590/1676-0611-BN-2018-0537

Abstract: The Serra da Bocaina National Park (SBNP) is a large remnant of Atlantic Forest located within an endangered biodiversity hotspot, which contributes to the connectivity among protected areas in the region. Despite the ecological importance of the SBNP, its bat fauna is poorly-known, and no comprehensive inventory is available. The present study provides an updated list of the bat species found in the SBNP. The four-year study was based on a capture-mark-recapture approach at four sites within the park, in the municipality of Paraty, Rio de Janeiro state, Brazil. A total of 22 bat species were recorded, representing two families, Phyllostomidae (n = 19 species) and Vespertillionidae (n = 3). This added 14 species to the known bat fauna of the SBNP, which is hereby updated to 24 species, including *Dermanura cinerea* Gervais, 1856, *Platyrrhinus recifinus* (Thomas, 1901), and *Myotis ruber* (É. Geoffroy, 1806), which are listed as endangered in Rio de Janeiro state. The specimen of *Trinycteris nicefori* (Sanborn, 1949) captured in the present study is the first record of the occurrence of this species in Rio de Janeiro state. This record extends the geographic range of the species by approximately 650 km to the southeast. Additional inventories, in particular at poorly-studied Atlantic Forest sites, combined with environmental suitability analyses, and taxonomic and biogeographic data, are urgently required to elucidate the distribution of many Brazilian bat species, such as *T. nicefori*.
Keywords: *Atlantic Forest, Chiroptera, faunistic inventory, species richness.*

Morcegos do Parque Nacional da Serra da Bocaina, sudeste do Brasil: lista de espécies atualizada e expansão de distribuição para *Trinycteris nicefori* (Sanborn, 1949)

Resumo: O Parque Nacional da Serra da Bocaina (PNSB) é um grande remanescente de Mata Atlântica localizado em um *hotspot* de biodiversidade ameaçado, que contribui para a conectividade entre áreas protegidas na região. Apesar da importância ecológica do PNSB, a sua quiropterofauna é pobremente conhecida e nenhum inventário abrangente está disponível. O presente estudo fornece uma lista atualizada das espécies de morcegos do PNSB. O estudo de quatro anos foi baseado em uma abordagem de captura-marcação-e-recaptura em quatro localidades dentro do parque, no município de Paraty, estado do Rio de Janeiro, Brasil. Um total de 22 espécies de morcegos foi registrado, representando duas famílias, Phyllostomidae (n = 19 espécies) e Vespertillionidae (n = 3). Isso adiciona 14 espécies à quiropterofauna conhecida do PNSB, que é atualizada para 24 espécies, incluindo *Dermanura cinerea* Gervais, 1856, *Platyrrhinus recifinus* (Thomas, 1901) e *Myotis ruber* (É. Geoffroy, 1806), que são listadas como ameaçadas de extinção no estado do Rio de Janeiro. O espécime de *Trinycteris nicefori* (Sanborn, 1949) capturado no presente estudo representa o primeiro registro da espécie no estado do Rio de Janeiro. Esse registro expande a distribuição geográfica da espécie aproximadamente 650 km a sudeste. Inventários adicionais, particularmente em localidades de Mata Atlântica pobremente estudadas, combinados com análises de adequação, e estudos taxonômicos e biogeográficos, são urgentemente necessários para esclarecer a distribuição de muitas espécies de morcegos brasileiras, como *T. nicefori*.
Palavras-chave: *Chiroptera, inventário faunístico, Mata Atlântica, riqueza de espécies.*

Introduction

Bats play fundamentally important functional roles in ecosystems, including seed dispersal and the pollination of an enormous variety of plant species (e.g., Bolívar-Cimé et al. 2017). In this context, frugivorous bats may make a major contribute to the succession and regeneration of tropical forests (Muscarella & Fleming 2007). Bats also provide humans with a number of ecosystem services. Insectivorous bats may help to limit the populations of arthropods in agricultural landscapes, for example, and frugivores and nectarivores may contribute to the dispersal and reproduction of many crops (e.g., Williams-Guillén et al. 2016).

With *ca.* 180 species (Reis et al. 2017), Brazil has one of the most diverse bat faunas of any country in the world (Bernard et al. 2011). Most of these species (66.7%) occur in the Atlantic Forest biome (Graipel et al. 2017). In this biome, seasonal variation in temperature appears to be the principal factor influencing the distribution of bats species (Stevens 2013). Local species richness varies considerably along the latitudinal gradient of the Atlantic Forest, ranging from nine species in a seasonal forest in Rio Grande do Sul state (Weber et al. 2011) to 40 species in a regenerated forest in Rio de Janeiro state (Esbérard 2003).

The Serra da Bocaina National Park (SBNP) is located in southeastern Brazil, and encompasses approximately 104,000 ha of Atlantic Forest (http://www.icmbio.gov.br/parnaserradabocaina/). This large remnant of Atlantic Forest is part of the "Bocaina Mosaic", which contributes to the connectivity among the region's protected areas (http://www.icmbio.gov.br/portal/mosaicosecorredoresecologicos/moscaicos-reconhecidos-oficialmente/1869-mosaico-bocaina). Despite being located in an endangered biome recognized as a biodiversity hotspot (Galindo-Leal & Câmara 2003), the bat fauna of the SBNP is poorly-known, as no comprehensive inventory is available, although Delciellos et al. (2012) did record 10 species in the park, including the endangered *Lonchorhina aurita* Tomes, 1863, in a snapshot survey of its southern extremity. This is likely an underestimate of the bat species richness of the SBNP, given the enormous diversity of habitat types found along the park's altitudinal gradient (http://www.icmbio.gov.br/parnaserradabocaina/).

Data on the abundance, occurrence, and geographic distribution of species are of fundamental importance for the understanding of macroecological patterns (Rahbek 2005), the assessment the conservation status of species (Jenkins et al. 2015) and the management of conservation units (e.g., Silva et al. 2018). Six years on from Delciellos et al.'s (2012) survey of the mammalian fauna of the SBNP, which recorded 48 species belonging to nine orders, no additional studies of the park's mammals appear to have been published. During the four-year study presented here, an additional 14 bat species were recorded in the park, updating the total to 24 species, including *Trinycteris nicefori* (Sanborn, 1949), which was recorded in the Brazilian state of Rio de Janeiro for the first time.

Material and Methods

1. Study area

Twelve capture-mark-recapture sampling sessions were conducted between June 2013 and December 2016 at four sites distributed along the RJ-165 state highway, which traverses the SBNP in the municipality of Paraty, Rio de Janeiro state, Brazil (Figure 1). Site 1 (23°12′19″ S, 44°50′17″ W, Datum WGS84; 1193 m a.s.l.; Figure 1) is on an old hunting trail with secondary vegetation at an advanced stage of succession, including some *Pinus* trees and vegetation of low stature characteristic of flooded areas, adjacent to a small perennial watercourse. Site 2 (23°11′39″ S, 44°50′27″ W, Datum WGS84; 1122 m a.s.l.; Figure 1) is also located on an old trail, *ca.* 2 m wide, which starts at the margin of the RJ-165 highway. This trail is also surrounded by secondary vegetation at an advanced stage of succession, with a closed canopy. As at site 1, there is a small perennial watercourse. Site 3 (23°11′06″ S, 44°49′47″ W, Datum WGS84; 800 m a.s.l; Figure 1) also has secondary vegetation at an advanced stage of succession, with a much larger perennial watercourse, steep terrain, several rocky outcrops, and a small plantation of banana (Musaceae: *Musa paradisiaca* L.) located next to a house. Site 4 (23°11′28″ S, 44°50′39″ W, Datum WGS84; 1050 m a.s.l.; Figure 1) is located *ca.* 800 from site 2 on the same trail, which terminates at a river. The samples were collected on the trail near this river, which is surrounded by secondary vegetation at an advanced stage of succession, with an open canopy. The region's climate has two seasons, a super-humid rainy season between October and April, and a drier season from May to September, but with no months of water deficit (https://pt.climate-data.org/). The sampling sessions were divided equally between the two seasons, with six sessions being conducted during the rainy season and six in the dry season. The mean annual temperature in the region is 23.3ºC and mean annual precipitation 2284 mm (https://pt.climate-data.org/). The vegetation is classified as dense montane rainforest (IBGE 2012).

2. Bat sampling

Bats were sampled using mist-nets on one to three nights at each site during each sampling session. The sampling effort varied due to climatic conditions, with no mist-netting taking place under heavy rainfall. On each night of sampling, eight mist-nets (9.0 m x 2.5 m, with a 33 mm mesh) were set at ground level along trails and clearings within the forested habitat. The mist-nets remained open during the first six hours of the night, after sunset. Capture effort was calculated following Straube & Bianconi (2002). Trapping and handling conformed to the guidelines of the American Society of Mammalogists (Sikes & A.C.A.U.C. of the A. S. of Mammalogists 2016). This study was part of the Mammal Monitoring Program of the RJ-165 highway construction project (IBAMA/MMA process no. 02001.003937/2008-18, authorization numbers 248/2013 and 610/2015).

The specimens captured were identified from their external characters, such as length of the forearm, coloration pattern, the morphology of the ears, tragus and patagium, and dental traits, following field guides and identification keys (Simmons & Voss 1998, Gardner 2007, Reis et al. 2013). The sex and reproductive condition of all captured specimens were verified, and they were weighed (in grams) using a spring balance, measured (heady-body, tail and forearm lengths) with a digital calliper (0.01 mm precision), and marked with a numbered collar at first capture. The specimens that could not be identified in the field or died in mist-nets were retrieved, prepared, and conserved in 70° alcohol. The skull was extracted through the mouth opening and the specimens were deposited in the mammal collection of the National Museum (MN) at the Federal University of Rio de Janeiro (UFRJ). These specimens were identified through the detailed analysis of the external and cranial measurements, and the qualitative evaluation of

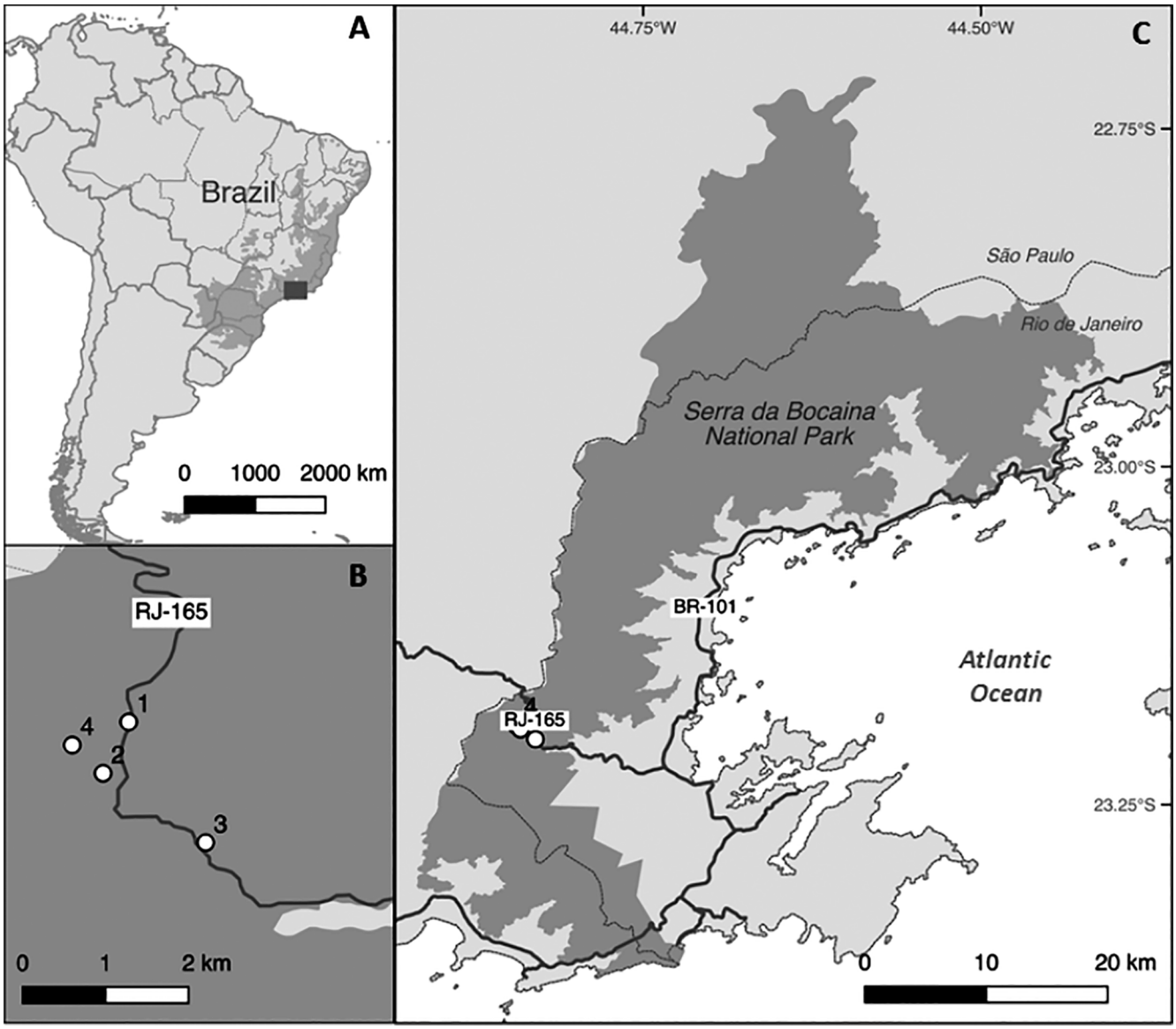

Figure 1. (A) South America, showing the Atlantic Forest in dark gray, with the study area in Brazil being indicated by the square; (B) The four study sites (circles) distributed along the RJ-165 state highway, which traverses the Serra da Bocaina National Park (C) in the municipality of Paraty, Rio de Janeiro state, Brazil.

diagnostic traits. Nomenclature followed Nogueira et al. (2014). Species richness was estimated using Chao2, an incidence-based nonparametric estimator (Colwell & Coddington 1994), using EstimateS 9.1 software (Colwell 2013).

In the specific case of the *Trinycteris nicefori* specimen, 22 cranial and external measurements were obtained, as in Vizotto & Taddei (1973), and compared with values found for the species in the literature (Sanborn 1949, Simmons & Voss 1998, Williams & Genoways 2007, Rocha et al. 2013). The geographic distribution of *T. nicefori* was defined as in the review of Rocha et al. (2013). Two new localities for *T. nicefori* have been published since Rocha et al. (2013), one in the Carboneras Reserve in the municipality of Livingston, Guatemala (Pérez et al. 2012) and the other from the Teles Pires River, in the municipalities of Nova Canaã do Norte and Itaúba, in the state of Mato Grosso, Brazil (Miranda et al. 2015). As this species has an ample geographic range in the Americas, but a disjunct distribution in Brazil, where it is found separately in the Amazon region and the northern half of the Atlantic Forest biome, on the eastern Brazilian coast (see Williams & Genoways 2007, Perez et al. 2012, Rocha et al. 2013, Miranda et al. 2015), the distribution map presented here focuses only on the Atlantic Forest, in which the present study was conducted.

Results

Over the four years of the study period, the total sampling effort was 129,600 m^2.h (Site 1 = 28,080 m^2.h; Site 2 = 33,480 m^2.h; Site 3 = 35,640 m^2.h; Site 4 = 32, 400 m^2.h), resulting in 557 captures of 505 different individuals (Table 1). These individuals represented 22 bat species belonging to two families, the Phyllostomidae (n = 19 species) and Vespertillionidae, n = 3 (Table 1; Figures 2 and 3). Three of the species are endangered in Rio de Janeiro state, based on the classification of Bergallo et al. (2000). Total abundance per site ranged from 103 to

Table 1. Bat species captured in the Serra da Bocaina National Park (SBNP) in Rio de Janeiro, Brazil. Abundance per site and total abundance of each species. Previous records in the SBNP obtained from Delciellos et al. (2012). Number of voucher specimens deposited at the mammal collection of the National Museum (MN) at the Federal University of Rio de Janeiro (UFRJ). † Endangered with extinction at national (ICMBio 2016) or state (Bergallo et al. 2000) level.

Species	Site				Total abundance	Previous record	Voucher specimens
	1	2	3	4			
FAMILY PHYLLOSTOMIDAE							
Subfamily Micronycterinae							
Micronycteris minuta (Gervais, 1856)	0	0	1	0	1		MN81509
Subfamily Desmodontinae							
Desmodus rotundus (É. Geoffroy, 1810)	0	1	0	4	5		MN81501
Diphylla ecaudata Spix, 1823	0	1	3	0	4		MN81506
Subfamily Lonchorhininae							
†*Lonchorhina aurita* Tomes, 1863	0	0	0	1	1	X	MN78128, MN78131
Subfamily Phyllostominae							
Chrotopterus auritus (Peters, 1856)	0	0	0	0	0	X	MN78127
Tonatia bidens (Spix, 1823)	0	0	0	0	0	X	MN77799
Subfamily Glossophaginae							
Anoura caudifer (É. Geoffroy, 1818)	2	1	3	3	9	X	MN78129
Anoura geoffroyi Gray, 1838	0	2	17	3	22	X	MN78132
Subfamily Carolliinae							
Carollia perspicillata (Linnaeus, 1758)	33	19	65	30	147	X	MN781130, MN78133, MN81515
Subfamily "Glyphonycterinae"							
Trinycteris nicefori (Sanborn, 1949)	0	0	1	0	1		MN81510
Subfamily Stenodermatinae							
Artibeus fimbriatus Gray, 1838	10	8	51	12	81	X	MN77796, MN81516, MN81517
Artibeus lituratus (Olfers, 1818)	9	1	3	3	16		MN81504, MN81511
Artibeus obscurus (Schinz, 1821)	0	0	3	1	4	X	MN77797
Artibeus planirostris (Spix, 1823)	0	1	0	0	1		
†*Dermanura cinerea* Gervais, 1856	0	0	1	2	3		MN81502
Platyrrhinus lineatus (E. Geoffroy, 1810)	0	0	1	0	1		
†*Platyrrhinus recifinus* (Thomas, 1901)	0	0	2	1	3		MN81507
Pygoderma bilabiatum (Wagner, 1843)	1	4		1	6		MN81518
Sturnira lilium (É. Geoffroy, 1810)	42	36	28	28	134	X	MN78134, MN78135
Sturnira tildae de la Torre, 1959	9	11	4	12	36	X	MN77799
Vampyressa pusilla (Wagner, 1843)	0	0	4	1	5		MN81505
FAMILY VESPERTILLIONIDAE							
Subfamily Myotinae							
Myotis nigricans (Schinz, 1821)	0	1	0	0	1		MN81513
Myotis riparius Handley, 1960	0	2	0	0	2		MN81508, MN81512
†*Myotis ruber* (É. Geoffroy, 1806)	0	16	5	1	22		MN81500
Total abundance	106	104	192	103	505		
Total richness	7	14	16	15	22		

 http://dx.doi.org/10.1590/1676-0611-BN-2018-0537

Figure 2. Bat species recorded in the Serra da Bocaina National Park, in the municipality of Paraty, Rio de Janeiro state, Brazil. a) *Anoura caudifer*; b) *Anoura geoffroyi*; c) *Artibeus fimbriatus*; d) *Artibeus lituratus*; e) *Artibeus obscurus*; f) *Artibeus planirostris*; g) *Carollia perspicillata*; h) *Dermanura cinerea*; i) *Desmodus rotundus*; j) *Diphylla ecaudata*; k) *Lonchorhina aurita*; l) *Micronycteris minuta*. Photographs: Adarene Motta.

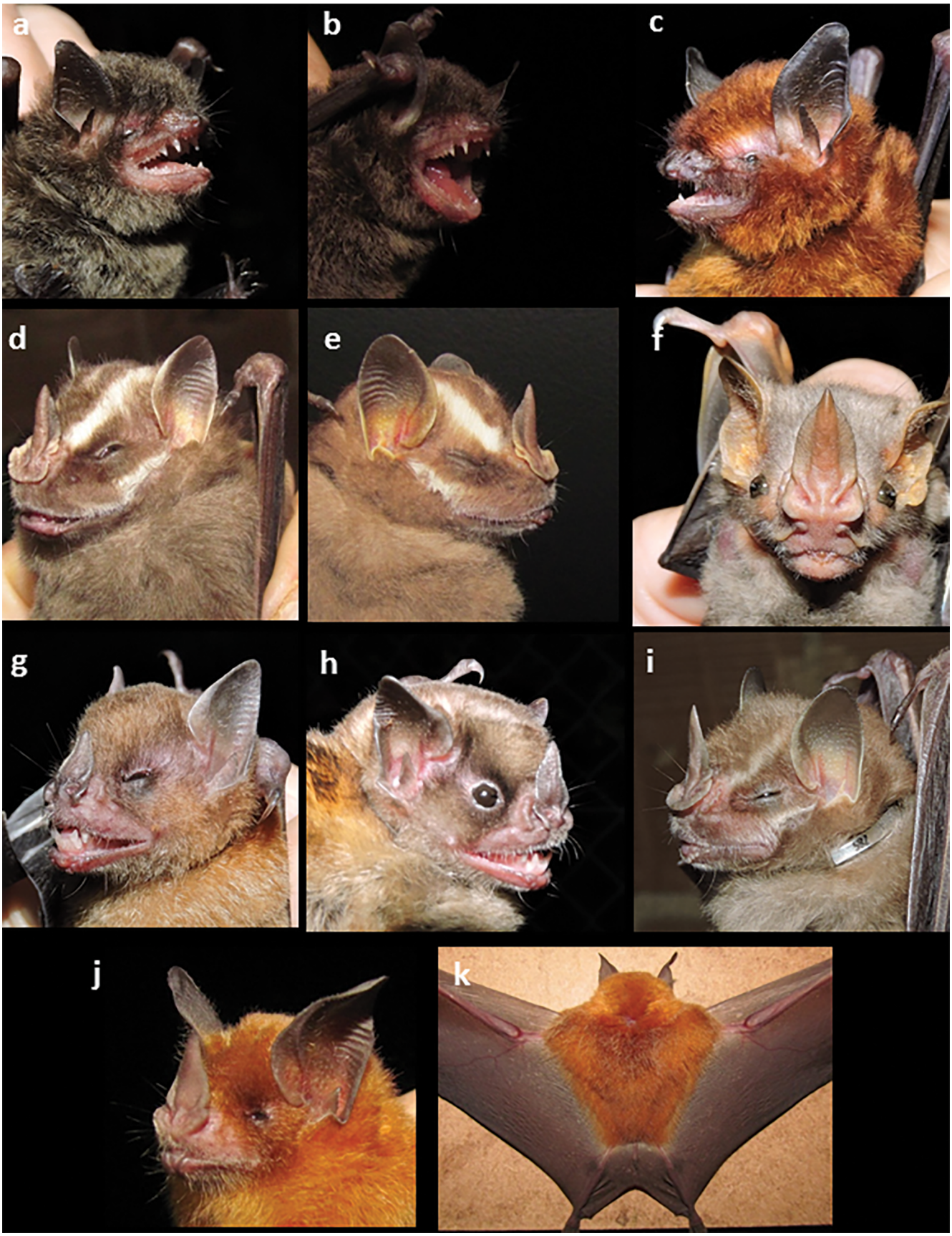

Figure 3. Bat species recorded in the Serra da Bocaina National Park, in the municipality of Paraty, Rio de Janeiro state, Brazil. a) *Myotis nigricans*; b) *Myotis riparius*; c) *Myotis ruber*; d) *Platyrrhinus lineatus*; e) *Platyrrhinus recifinus*; f) *Pygoderma bilabiatum*; g) *Sturnira lilium*; h) *Sturnira tildae*; i) *Vampyressa pusilla*; j) *Trinycteris nicefori*; k) *Trinycteris nicefori* (dorsal view). Photographs: Adarene Motta.

192 individuals captured, while between seven and 16 species were captured at each site (Table 1), with abundance and species richness being highest at site 3. *Carollia perspicillata* (Linnaeus, 1758) and *Sturnira lilium* (É. Geoffroy, 1910) were the most abundant species (Table 1). The species accumulation curve (observed richness) and the species richness estimated by Chao 2 both reached the asymptotes at the sixth trapping session (Figure 4).

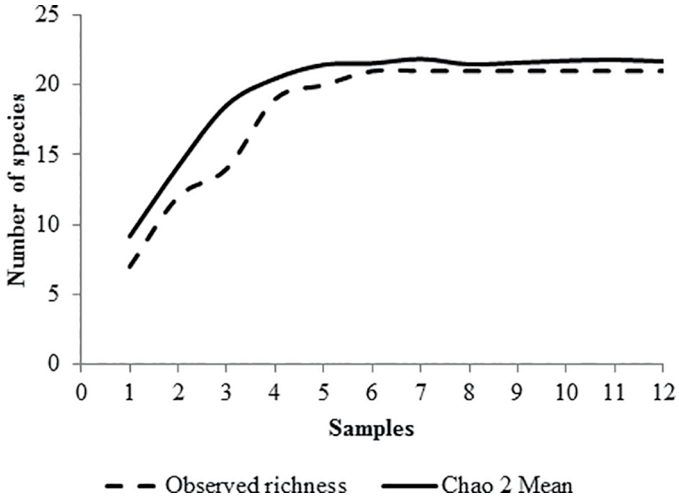

Figure 4. Species accumulation curve and estimated species richness based on the Chao 2 index for the bat species recorded in the Serra da Bocaina National Park in Rio de Janeiro, Brazil. Samples: 1 – June 2013, 2 – September 2013, 3 – December 2013, 4 – April 2014, 5 – June 2014, 6 – September 2014, 7 – December 2014, 8 – September 2015, 9 – November 2015, 10 – January 2016, 11 – July 2016, 12 – November 2016.

An adult male *Trinycteris nicefori* with scrotal testes (MN 81510) was captured at 18:30 h on April 12 2014, at site 3. This record extends the known geographic range of the species approximately 650 km to the southeast, and represents the first record of *T. nicefori* in the Brazilian state of Rio de Janeiro (Figure 5). The pelage of the *T. nicefori* specimen was reddish brown or in a "red phase", with four bands in dorsal pelage, a first (basal) band which was pale, narrow, and inconspicuous, a second band dark brown, a third band, broad and light reddish, and a fourth band (hair tip) darker brown. The ventral pelage was slightly paler and tricolored. No dorsal stripe was observed. Externally the specimen lacked an interauricular band, the ears were pointed with broadly concave outer margins; the noseleaf had a narrow, pointed tip and its lower margin was smoothly confluent with the upper lip; the chin had a pair of smooth tubercles divided by a median groove; the third metacarpal was longer than the other metacarpals (IV<V<III); the second phalanx of wing digits III and IV were longer than the first phalanx of the same digits; the calcar markedly shorter than the foot (less than half the length of the foot with claws). In the cranium, the specimen had the rostrum not inflated; deep basisphenoid pits separated by a high and narrow septum; zygomatic breadth larger than that of the mastoid; inner upper incisors not chisel-shaped; lower incisors trifid; and both P3 and p3 reduced in size with crown almost flat and small anterior cusp (Table 2; Figure 6). The specimen also had a small, supernumerary central lower incisor, totalling five lower incisors and 35 teeth (Figure 6).

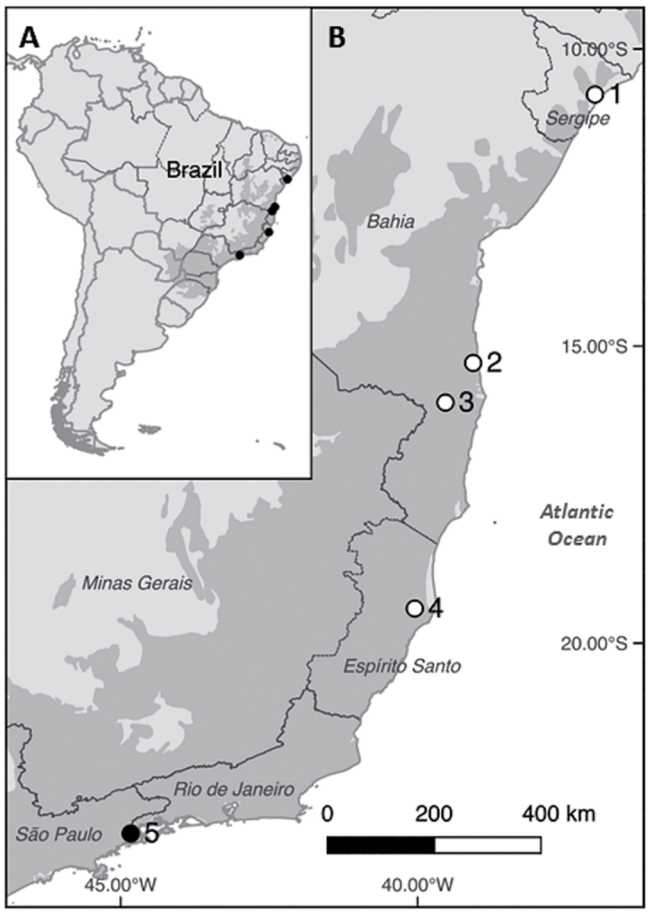

Figure 5. (A) South America, showing the Atlantic Forest in dark gray. (B) The portion of the geographical distribution of *Trinycteris nicefori* (Chiroptera, Phyllostomidae) located in the Brazilian Atlantic Forest. White circles: 1 = municipality of Capela, state of Sergipe (Brito & Bocchiglieri 2012); 2 = municipality of Una, Bahia (Faria et al. 2006); 3 = municipality of Itapebi, Bahia (Faria et al. 2006); 4 = municipality of Linhares, Espírito Santo (Peracchi & Albuquerque 1993). Black circle: 5 = Serra da Bocaina National Park, municipality of Paraty, Rio de Janeiro (present study). See Appendix 1 for details of the localities. For a review of the species' current distribution in the Americas, see Pérez et al. (2012), Rocha et al. (2013), and Miranda et al. (2015).

Discussion

The 24 bat species now known to occur in the SBNP correspond to 20.7% of the Atlantic Forest species that may potentially occur in the region (Graipel et al. 2017). As both the species accumulation curve and the estimated richness reached their asymptotes by the middle of the present study, however, additional species are unlikely to be recorded in the study area. Species richness was highest at site 3, which was the lowest in altitude, and had a small banana plantation. Banana is a resource rich in sugar (fruit) or nectar (flowers), and its availability can influence the presence and abundance of certain bat species, and consequently, their capture rates (Luz et al. 2015).

The bat species richness recorded in the SBNP in the present study (n = 22 species; sampling effort [SE] = 129,600 m^2.h) is consistent with the review of Costa (2014), who found a mean number of 20.84 bat species in the conservation units of the state of Rio de Janeiro. Specifically, the number of species recorded here in the SBNP was

Table 2. Selected measurements of the *Trinycteris nicefori* specimen (MN81510) captured in the Serra da Bocaina National Park in Rio de Janeiro, Brazil, and comparisons with the specimens collected at other localities within its geographic range. All measurements are given in millimeters (mm), except for body mass, given in grams (g). * Holotype.

	Present study	**Sanborn (1949)***	**Rocha et al. (2013)**	**Simmons & Voss (1998)**	**Genoways & Williams (1986)**
Locality	Serra da Bocaina, Paraty, RJ, Brazil	Cúcuta, Colômbia	Porto Velho, Rondônia State, Brazil	Paracou, French Guyana	Various localities
N/Sex	♂	♂	2♂, 2 ♀	3♂, 2 ♀	5♂, 4 ♀
Forearm length	37.00	37.90	–	36.00–41.00	35.30–38.60
Third metacarpal	34.50	35.70	–	–	–
First phalanx of wing digit III	12.50	11.80	–	–	–
Second phalanx of wing digit III	17.40	16.80	–	–	–
Third phalanx of wing digit III	8.90	8.10	–	–	–
Fourth metacarpal	32.90	34.30	–	–	–
First phalanx of wing digit IV	10.30	9.80	–	–	–
Second phalanx of wing digit IV	12.40	11.80	–	–	–
Fifth metacarpal	33.80	34.60	–	–	–
First phalanx of wing digit V	10.20	9.90	–	–	–
Second phalanx of wing digit V	11.10	8.60	–	–	–
Calcar length	5.00	4.70	–	–	–
Length of hind foot	11.70	12.00	–	12.00–14.00	12.00–14.00
Greatest length of the skull (excluding incisors)	19.40	20.50	19.48–20.05	19.54–20.49	20.10–20.80
Condyloincisive length	18.20	18.50	18.03–18.22	17.99–19.07	18.00–18.60
Upper toothrow length	7.10	7.30	5.69–7.40	6.99–7.56	7.10–7.50
Breadth across the cingula of upper canines	3.40	3.30	3.13–3.44	–	–
Postorbital breadth	4.20	–	4.12–4.36	3.92–4.21	3.90–4.50
Breadth across the upper molars	6.10	6.20	6.35–6.56	5.84–6.13	5.80–6.20
Braincase breadth	8.30	8.20	7.78–8.06	7.92–8.26	–
Zygomatic breadth	10.00	9.60	9.37–9.85	8.84–9.51	9.10–9.50
Mastoid breadth	9.30	8.90	8.35–8.78	8.43–9.05	8.50–8.80
Length of the mandible	12.80	–	12.81–13.52	–	–
Lower toothrow length	7.70	7.60	–	–	–

similar to that found in the Araras Biological Reserve (n = 23), in the municipalities of Petrópolis and Miguel Pereira (Costa 2014: 1100 m a.s.l.; SE = 66,297 h.m^2), and slightly higher than the numbers recorded in Desengano State Park (n = 16), in eastern Rio de Janeiro (Modesto et al. 2008: 1240 m a.s.l.; SE = 15,510 h.m^2), and in Itatiaia National Park (n = 15), in the municipality of Itatiaia (Martins et al. 2015: 500–1000 m a.s.l.; SE = 12,135 h.m^2). In Rio das Pedras Biological Reserve, which is near the SBNP in the municipality of Mangaratiba, however, Luz et al. (2011) recorded a much higher number of species (n = 30), with a sampling effort of 242,424 net.h. The species richness recorded in the present study was also higher than that recorded in non-protected areas at similar altitudes, such as Dores do Rio Preto municipality in Espírito Santo state (725-1422 m a.s.l.), where Lopes et al. (2017) recorded 14 species (SE = 1500 h.m^2), and in Rio Preto and Santa Bárbara do Monte Verde municipalities (800–1200 m a.s.l.) in Minas Gerais, where Nobre et al. (2009) recorded 15 species (SE = 22,140 h.m^2). It is important to note, however, that any such comparisons between sites are influenced by a series of factors, ranging from the type of site (protected versus non-protected areas) and total sampling effort to the type of habitat and forest strata sampled, as well as the climatic conditions and moon phases during the trapping sessions (e.g., Aguiar & Marinho-Filho 2004, Peracchi & Nogueira 2010, Mello et al. 2013).

The present study adds 14 species to the inventory of bats in the SBNP, including three species listed as endangered in Rio de Janeiro state by Bergallo et al. (2000): *Dermanura cinerea* Gervais, 1856, *Platyrrhinus recifinus* (Thomas, 1901), and *Myotis ruber* (É. Geoffroy, 1806). *Dermanura cinerea* is a common frugivore that occurs in several habitat types, such as primary and successional forests, and forest fragments (Zortéa 2007). *Platyrrhinus recifinus* is also a frugivore, and is found in primary and successional habitats in the Atlantic Forest, and in patches of humid forest in the Caatinga and Cerrado biomes (Tavares & Velazco 2010). *Myotis ruber* is an insectivore found in a range of habitat types, including well-preserved and secondary forests, and forest remnants in urban areas (Reis et al. 2017). The study also obtained the

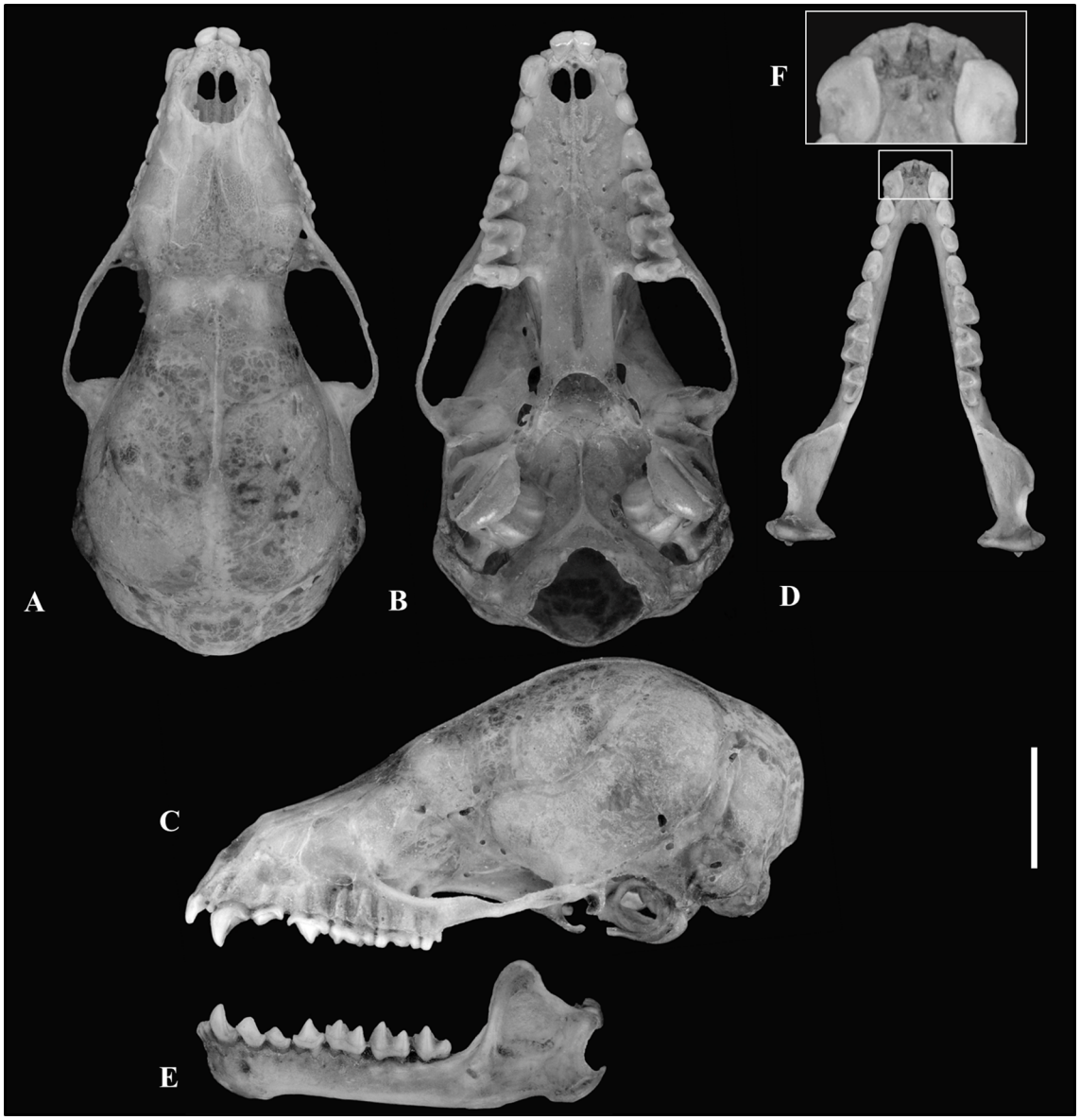

Figure 6. Dorsal (A), ventral (B) and lateral (C) views of the skull, and the dorsal (D) and lateral (E) views of the mandible of the *Trinycteris nicefori* specimen (MN81510) from the Serra da Bocaina National Park in Rio de Janeiro, Brazil. The detail (F) shows the small supernumerary central lower incisors. Scale bar: 5 mm.

first record of *T. nicefori* for the Brazilian state of Rio de Janeiro. This species is known to occur in several different habitat types, ranging from forests to farmland, but is normally captured at low rates in most faunal inventories (e.g., Genoways & Williams 1986, Simmons & Voss 1998, Rocha et al. 2013), as in the present study, given that only one individual was captured. All the species recorded in the previous study in the SBNP (Delciellos et al. 2012) were captured again, except by *Chrotopterus auritus* (Peters, 1856) and *Tonatia bidens* (Spix, 1823). Delciellos et al. (2012) recorded 10 species with a sampling effort of 2592 h.m^2 in a single session in May 2011 (dry season). As the same areas (sites 2 and 3) and habitat types were resampled in the present study, new records of the species recorded by Delciellos et al. (2012) were expected, although it is unclear why neither *C. auritus* nor *T. bidens* were captured in the present study. The absence of these species here may nevertheless be related to specific features of their population dynamics or distribution within the study area. In particular, *C. auritus* appears to be more common in undisturbed forest habitats (Gorresen & Willing 2004), rather than the types of environment sampled in the present study, given the proximity of the RJ-165 highway.

The most abundant species were *C. perspicillata* and *S. lilium*, which is consistent with the results of previous studies (e.g., Fleming et al. 1972, Bernard & Fenton 2002, Sampaio et al. 2003), that have found a predominance of phyllostomid species in the Neotropics, in particular frugivores, such as *C. perspicillata* and *S. lilium* (e.g., Baptista & Mello 2001, Mello & Schittini 2005, Moratelli & Peracchi 2007, Nobre et al. 2009, Costa 2014). The relative abundance of *S. lilium* in the SBNP may also be accounted for by the altitude of the sampled areas, given that this species tends to be more abundant at higher altitudes (e.g., Nobre et al. 2009, Costa 2014, Martins et al. 2015). As for species richness, total abundance (n = 505) recorded in the present study was relatively

higher than that recorded in non-protected areas at similar altitudes (e.g., Nobre et al. 2009: n = 246), but lower than that recorded in the Rio das Pedras Biological Reserve, which is near the SBNP (Luz et al. 2011: n = 1228).

The characteristics of the *T. nicefori* specimen captured in the SBNP were highly consistent with the description of the species in previous studies (Sanborn 1949, Simmons 1996, Simmons & Voss 1998, Williams & Genoways 2007, Rocha et al. 2013), except for the lack of a lightly-colored dorsal stripe. This trait nevertheless varies considerably among individuals, and is barely discernible or even absent in some individuals, while it is highly conspicuous in others (Starret 1976, Simmons & Voss 1998, Williams & Genoways 2007). The specimen from the SBNP had reddish hair, which is consistent with the typical "red phase", rather than the rarer "gray phase" (Sanborn 1949, Starret 1976), and tetracolored dorsal fur, which is consistent with the description of Williams & Genoways (2007). Some studies mention that the dorsal pelage of *T. nicefori* is tricolored (Sanborn 1949, Goodwin & Greenhall 1961, Simmons 1996, Simmons & Voss 1998), but this is probably due to the presence of a narrow, inconspicuous pale basal band that may not be observed by all authors. All the cranial and external measurements are within the range of those reported previously for the species (Sanborn 1949, Simmons & Voss 1998, Williams & Genoways 2007, Rocha et al. 2013).

Trinycteris nicefori can be distinguished from other phyllostomid genera by a set of morphological traits (see descriptions in Sanborn 1949, Simmons & Voss 1998, Williams & Genoways 2007, Rocha et al. 2013). This species is most often confused with *Lampronycteris brachyotis* (Dobson, 1879) and *Glyphonycteris sylvestris* Thomas, 1896, which are similar species in size and morphology. However, in *L. brachyotis* (forearm length 38.3–42.5 mm), the fifth metacarpal is the shortest (V<IV<III), the calcar is similar in length or slightly shorter than the foot with claws, the inner upper incisors are markedly chisel-shaped and in line with canines, the basisphenoid pits are shallow, and the dorsal pelage is not banded (Simmons 1996, Simmons & Voss 1998, Wetterer et al. 2000). In *G. sylvestris* (forearm length 37.0–44.0 mm), the fifth metacarpal is the longest (IV<III<V), the rostrum is notably inflated, P3 is not reduced in size, as it is in *T. nicefori*, but is slightly larger than or is similar in height to P4, and both P3 and P4 have slightly curved anterior cusps (Sanborn 1949, Simmons & Voss 1998). Similar to *T. nicefori*, however, the dorsal hairs of *G. sylvestris* have three (Genoways & Williams 1986, Simmons 1996, Simmons & Voss 1998, Williams & Genoways 2007) or four (Sanborn 1949, Goodwin & Greenhall 1961) bands.

Trinycteris nicefori has an ample geographical distribution, ranging from Mexico to Brazil (see Williams & Genoways 2007, Perez et al. 2012, Rocha et al. 2013, Miranda et al. 2015). In Brazil, the species has a disjunct distribution, occurring in the north (Amazon) and on the east coast (Atlantic Forest) from Sergipe to Espírito Santo states (Rocha et al. 2013, Miranda et al. 2015). In addition to being the first record of *T. nicefori* from Rio de Janeiro, the specimen collected in the present study now represents the southernmost record of the species (Figure 5). The known distribution of *T. nicefori* indicates that it is totally absent from the Brazilian Caatinga and Cerrado biomes, indicating a preference for mesic environments, which may reflect an intolerance of arid habitats or, possibly, the reduced bat sampling effort in these environments (Rocha et al. 2013).

The present study has updated the list of bat species known to occur in the Serra da Bocaina National Park, which is part of one of the largest remaining continuous tracts of Brazilian Atlantic Forest. Additional inventories, especially at poorly-studied Atlantic Forest sites, combined with environmental suitability analyses, and taxonomic and biogeographic studies, are urgently needed to elucidate the distribution of many Brazilian bat species, such as *T. nicefori*.

Supplementary material

The following online material is available for this article:
Appendix 1

Author Contributions

Ana Cláudia Delciellos: Substantial contribution in the concept and design of the study; Contribution to data analysis and interpretation; Contribution to manuscript preparation; Contribution to critical revision, adding intelectual content.

Adarene Motta: Contribution to data collection; Contribution to manuscript preparation.

Brunna Almeida: Contribution to data collection; Contribution to data analysis and interpretation; Contribution to manuscript preparation; Contribution to critical revision, adding intelectual content.

Daniela Dias: Contribution to data analysis and interpretation; Contribution to manuscript preparation; Contribution to critical revision, adding intelectual content.

Oscar Rocha-Barbosa: Substantial contribution in the concept and design of the study.

Conflicts of interest

The authors declare that they have no conflict of interest related to the publication of this manuscript.

References

AGUIAR, L.M.D.S. & MARINHO-FILHO, J. 2004. Activity patterns of nine phyllostomid bat species in a fragment of the Atlantic Forest in southeastern Brazil. Rev. Bras. Zool. 21:385-390.

BAPTISTA, M. & MELLO, M.A.R. 2001. Preliminary inventory of the bat species of the Poço das Antas Reserve, RJ. Chirop. Neotrop. 7:133-135.

BERGALLO, H.G., GEISE, L., BONVICINO, C.R., CERQUEIRA, R., D'ANDREA, P.S. ESBÉRARD, C.E., FERNANDEZ, F.A.S., GRELLE, C.E., PERACCHI, A. L., SICILIANO, S. & VAZ, S.M. 2000. Mamíferos. In A fauna ameaçada de extinção do estado do Rio de Janeiro (H.G. Bergallo, C.F.D. Rocha, M.A.S. Alves & M. Van Sluys, eds.). Editora da Universidade do Estado do Rio de Janeiro, Rio de Janeiro, pp.125-135.

BERNARD, E., AGUIAR, L. & MACHADO, R.B. 2011. Discovering the Brazilian bat fauna: a task for two centuries? Mammal Rev. 41:23-39.

BERNARD, E. & FENTON, M.B. 2002. Species diversity of bats (Mammalia: Chiroptera) in forest fragments, primary forests, and savannas in Central Amazonia, Brazil. Can. J. Zoolog. 80:1124–1140.

BOLÍVAR-CIMÉ, B., ALFARO-BATES, R., ORTÍZ-DÍAZ, J.J., CLARKE, F.M. & RACEY, P.A. 2017. Pollen movement by the bat *Artibeus jamaicensis* (Chiroptera) in an agricultural landscape in the Yucatan Peninsula, Mexico. Mammal Res. 62:189-193.

BRITO, D.D.V. & BOCCHIGLIERI, A. 2012. Bats community (Mammalia, Chiroptera) in Refúgio de Vida Silvestre Mata do Junco, Sergipe, northeastern Brazil. Biota Neotrop. 12(3):254-262

COLWELL, R.K. 2013. EstimateS 9.1. 0 user's guide. University of Connecticut, Connecticut.

COLWELL, R.K. & CODDINGTON, J.A. 1994. Estimating terrestrial biodiversity through extrapolation. Philos. T. R. Soc. B. 345:101-118.

COSTA, L.M. 2014. Conservação de morcegos no Estado do Rio de Janeiro: como e onde já foram amostrados e que locais merecem atenção. Tese de Doutorado, Universidade do Estado do Rio de Janeiro, Rio de Janeiro.

DELCIELLOS, A. C., NOVAES, R.L.M., LOGUERCIO, M.F.C., GEISE, L., SANTORI, R.T., SOUZA, R.F., PAPI, B. S., RAÍCES, D., VIEIRA, N.R., FELIX, S., DETOGNE, N., SILVA, C.C.S., BERGALLO, H.G. & ROCHA-BARBOSA, O. 2012. Mammals of Serra da Bocaina National Park, state of Rio de Janeiro, southeastern Brazil. Check List 8:675-692.

ESBÉRARD, C.E. 2003. Diversidade de morcegos em área de Mata Atlântica regenerada no sudeste do Brasil. Rev. Bras. Zoociências 5:189-204.

FARIA, D., SOARES-SANTOS, B. & SAMPAIO, E. 2006. Bats from the Atlantic rainforest of southern Bahia, Brazil. Biota Neotrop. 6(2):1-13.

FLEMING, T.H., HOOPER, E.T. & WILSON, D.E. 1972. Three Central American bat communities: structure, reproductive cicles and moviment patterns. Ecology 53:555-569.

GALINDO-LEAL, C. & CÂMARA, I.D.G. 2003. Atlantic Forest hotspot status: an overview. The Atlantic Forest of South America: biodiversity status, threats, and outlook. Center for Applied Biodiversity Science at Conservation International.

GARDNER, A.L. 2007. Mammals of South America: marsupials, xenarthrans, shrews, and bats. Volume 1. The University of Chicago Press, Chicago, Illinois.

GENOWAYS, H.H. & WILLIAMS, S.L. 1986. Results of the Alcoa Foundation-Suriname Expeditions. XI. Bats of the genus *Micronycteris* (Mammalia: Chiroptera) in Suriname. Ann. Carnegie Mus. 55: 303-324.

GOODWIN, G.G. & GREENHALL, A.M. 1961. A review of the bats of Trinidad and Tobago: descriptions, rabies infection, and ecology. Am. Mus. Nat. Hist. 122.

GORRESEN, P.M. & WILLIG, M.R. 2004. Landscape responses of bats to habitat fragmentation in Atlantic forest of Paraguay. J. Mamm. 85: 688-697.

GRAIPEL, M.E., CHEREM, J.J., MONTEIRO-FILHO, E.L. & CARMIGNOTTO, A.P. 2017. Mamíferos da Mata Atlântica. In Revisões em Zoologia: Mata Atlântica E.L.A. Monteiro-Filho & C.E. Conte, org). Editora UFPR.

IBGE. 2012. Manual técnico da vegetação brasileira. Instituto Brasileiro de Geografia e Estatística, Rio de Janeiro.

ICMBio - INSTITUTO CHICO MENDES DE CONSERVAÇÃO DA BIODIVERSIDADE. 2016. Sumário executivo - Livro vermelho da fauna brasileira ameaçada de extinção.

JENKINS, C.N., ALVES, M.A.S., UEZU, A. & VALE, M.M. 2015. Patterns of vertebrate diversity and protection in Brazil. PloS one 10:e0145064.

LOPES, V.C., MARTINS, R.L., FERREGUETTIi, A.C., LAGE, S.B., CIPRIANO, R.S. & PAULA, K.F. 2017. Diversidade de morcegos ao longo do gradiente altitudinal na bacia do rio Itabapoana, Espírito Santo, Brasil. Biotemas 30:59-71.

LUZ, J.L., COSTA, L. & ESBÉRARD, C. 2015. Changes in food resource and bat abundance in banana plantations. Oecol. Aust. 19:244-260.

LUZ, J. L., COSTA, L.D.M., LOURENÇO, E.C. & ESBÉRARD, C.E.L. 2011. Bats (Mammalia, Chiroptera) from Reserva Rio das Pedras, Rio de Janeiro, Southeastern Brazil. Biota Neotrop. 11:95-101.

MARTINS, M.A., CARVALHO, W.D.D., DIAS, D., FRANÇA, D.D.S., OLIVEIRA, M.B.D. & PERACCHI, A.L. 2015. Bat species richness (Mammalia, Chiroptera) along an elevational gradient in the Atlantic Forest of Southeastern Brazil. Acta Chiropterol. 17:401-409.

MELLO, M.A., KALKO, E.K. & SILVA, W.R. 2013. Effects of moonlight on the capturability of frugivorous phyllostomid bats (Chiroptera: Phyllostomidae) at different time scales. Zoologia 30:397-402.

MELLO, M.A.R. & SCHITTINI, G.M. 2005. Ecological analysis of three bat assemblages from conservation units in the Lowland Atlantic Forest of Rio de Janeiro, Brazil. Chirop. Neotrop. 11:206-210.

MIRANDA, J.M., ZAGO, L., CARVALHO, F., RUBIO, M.B. & BERNARDI, I.P. 2015. Morcegos (Mammalia: Chiroptera) da região do Médio Rio Teles Pires, Sul da Amazônia, Brasil. Acta Amazon. 45:89-100.

MODESTO, T.C., PESSÔA, F.S., ENRICI, M.C., ATTIAS, N., JORDÃO-NOGUEIRA, T., COSTA, L.D.M., ALBUQUERQUE, H.G. & BERGALLO, H.D.G. 2008. Mammals of Desengano State Park, Rio de Janeiro, Brazil. Biota Neotrop. 8:153-159.

MORATELLI, R. & PERACCHI, A.L. 2007. Morcegos (Mammalia, Chiroptera) do Parque Nacional da Serra dos Órgãos. In Ciência e conservação na Serra dos Órgãos (C. Cronemberger & E.B.V.Castro, eds). Instituto Chico Mendes de Conservação da Biodiversidade.

MUSCARELLA, R. & FLEMING, T.H. 2007. The role of frugivorous bats in tropical forest succession. Biol. Rev. 82:573-590.

NOBRE, P.H., RODRIGUES, A.S., COSTA, A.I., MOREIRA, A.E.S. & MOREIRA, H.H. 2009. Similaridade da fauna de Chiroptera (Mammalia), da Serra Negra, municípios de Rio Preto e Santa Bárbara do Monte Verde, Minas Gerais, com outras localidades da Mata Atlântica. Biota Neotrop. 9:151-156.

NOGUEIRA, M.R., LIMA, I.P., MORATELLI, R., TAVARES, V.C., GREGORIN, R. & PERACCHI, A.L. 2014. Checklist of Brazilian bats, with comments on original records. Check List 10:808-821.

PERACCHI, A.L. & ALBUQUERQUE, S.T. 1993. Quirópteros do município de Linhares, Estado do Espírito Santo, Brasil (Mammalia, Chiroptera). Rev. Bras. Biol. 53:575-581.

PERACCHI, A.L. & NOGUEIRA, M.R. 2010. Lista anotada dos morcegos do Estado do Rio de Janeiro, sudeste do Brasil. Chirop. Neotrop. 16:508-519.

PÉREZ, S.G., LÓPEZ, J.E. & MCCARTHY, T.J. 2012. Five new records of bats for Guatemala. Chirop. Neotrop. 18(1), 1106-1110.

RAHBEK, C. 2005. The role of spatial scale and the perception of large-scale species-richness patterns. Ecology Letters 8:224-239.

REIS N.R., FREGONEZI, M.N., PERACCHI, A.L. & SHIBATTA, O.A. 2013. Morcegos do Brasil – Guia de Campo. Technical Books editora, Rio de Janeiro.

REIS, N.R., PERACCHI, A.L., BATISTA, C.B., LIMA, I.P. & PEREIRA, A.D. (ORGS.). 2017. História natural dos morcegos brasileiros – chave de identificação de espécies. 1st edition. Technical Books Editora Ltda., Rio de Janeiro.

ROCHA, P.A., GARBINO, G.S.T. & AIRES, C.C. 2013. Update on the distribution of *Trinycteris nicefori* Sanborn, 1949 (Chiroptera: Phyllostomidae): New record for the Amazonia of Brazil. Check List 9:785-789.

SAMPAIO, E.M., KALKO, E.K.V., BERNARD, E., RODRIGUEZ-HERRERA, B. & HANDLEY, C.O. 2003. A biodiversity assessment of bats (Chiroptera) in a tropical lowland rainforest of Central Amazonia, including methodological and conservation considerations. Stud. Neotrop. Fauna E. 38:17-31.

SANBORN, C.C. 1949. Bats of the genus *Micronycteris* and its subgenera. Fieldiana Zoology 31: 215-233.

SIKES, R.S. & THE ANIMAL CARE AND USE COMMITTEE OF THE AMERICAN SOCIETY OF MAMMALOGISTS. 2016. Guidelines of the American Society of Mammalogists for the use of wild mammals in research and education. J. Mamm. 97:663–688.

SILVA, M.X., PAVIOLO, A., TAMBOSI, L.R. & PARDINI, R. 2018. Effectiveness of Protected Areas for biodiversity conservation: mammal occupancy patterns in the Iguaçu National Park, Brazil. J. Nat. Conserv. 41:51–62.

SIMMONS, N.B. 1996. A new species of *Micronycteris* (Chiroptera: Phyllostomidae) from Northeastern Brazil, with comments on phylogenetic relationships. Am. Mus. Novit. 3158:1-34.

SIMMONS, N.B. & VOSS, R.S. 1998. The mammals of Paracou, French Guiana: A Neotropical lowland rainforest fauna, Part 1. B. Am. Mus. Nat. Hist. 237:1-219.

STARRET, A. 1976. Comments on bats newly recorded from Costa Rica. Contributions in Science, Los Angeles County Museum 277:1–5.

STEVENS, R.D. 2013. Gradients of bat diversity in Atlantic Forest of South America: environmental seasonality, sampling effort and spatial autocorrelation. Biotropica 45:764-770.

STRAUBE, F.C. & BIANCONI, G.V. 2002. Sobre a grandeza e a unidade utilizada para estimar esforço de captura com utilização de redes-deneblina. Chirop. Neotrop. 8:150-152.

TAVARES, V.D.C. & VELAZCO, P.M. 2010. *Platyrrhinus recifinus* (Chiroptera: Phyllostomidae). Mammalian Species 42:119-123.

VIZOTTO, L.D. & TADDEI, V.A. 1973. Chave para determinação de quirópteros brasileiros. Revista da Faculdade de Filosofia, Ciências e Letras de São José do Rio Preto1:1-72.

WEBER, M.M., ARRUDA, J.L.S., AZAMBUJA, B.O., CAMILOTTI, V.L. & CÁCERES, N.C. 2011. Resources partitioning in a fruit bat community of the southern Atlantic Forest, Brazil. Mammalia 75:217-225.

WETTERER, A.L., ROCKMAN, M.V. & SIMMONS, N.B. 2000. Phylogeny of phyllostomid bats (Mammalia: Chiroptera): data from diverse morphological systems, sex chromosomes, and restriction sites. B. Am. Mus. Nat. Hist. 248:1-200.

WILLIAMS, S.L. & GENOWAYS, H.H. 2007. Subfamily Phyllostominae Gray, 1825. In Mammals of South America, Volume 1: marsupials, xenarthrans, shrews, and bats. (A. L. Gardner, ed). The University of Chicago Press, Chicago.

WILLIAMS-GUILLÉN, K., OLIMPI, E., MAAS, B., TAYLOR, P.J. & ARLETTAZ, R. 2016. Bats in the anthropogenic matrix: challenges and opportunities for the conservation of Chiroptera and their ecosystem services in agricultural landscapes. In Bats in the Anthropocene: conservation of bats in a changing world (C. Voigt & T. Kingston, eds). Springer International Publishing.

ZORTÉA, M. 2007. Subfamília Stenodermatinae. In Morcegos do Brasil (N.R. Reis, A.L. Peracchi, W.A. Pedro & I.P. Lima, eds). Univesidade Estadual de Londrina, p. 107-128.

Received: 06/03/2018
Revised: 15/05/2018
Accepted: 01/08/2018
Published online: 23/08/2018