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RESEARCH ARTICLE

Bat species diversity from Reserva Ecológica de Guapiaçu, Rio de Janeiro, Brazil: a compilation of two decades of sampling

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ABSTRACT. Reserva Ecológica de Guapiaçu (REGUA) is a private, protected area inside a remnant of the Atlantic Forest with high biodiversity. Although the bats of the reserve have been sampled for more than two decades, few studies have been published about them. Based on a compilation of data from several surveys, we present an updated list of the bat species there and compare it with surveys from other locations in the Atlantic Forest. From August 1998 to September 2021, at least 194 sampling nights were carried out at REGUA by different research groups from various institutions, totaling 448,092 m^2.h of sampling. A total of 4,069 individuals were captured, belonging to 47 species and six families. Additionally, our results indicate that it is possible that some species that occur at REGUA have not been recorded yet. REGUA has the greatest number of bat species known for the Atlantic Forest. This most likely results from the fact that the reserve includes large areas of mature, continuous forest connected with other protected areas in the State of Rio de Janeiro. Another factor contributing to the high diversity of bat species at REGUA is that the area has been intensely sampled for many years. Given that the bat assemblage there appears to be a good proxy to ascertain the ecological patterns of biodiversity in well-preserved forests, we consider REGUA to be an important area for long-term ecological research. The basic knowledge about the ecological interactions of bats with different food resources and zoonotic microorganisms offers a unique opportunity to carry out research in several areas of knowledge, making it possible to address questions about bat assemblage structure, bat-parasite ecology, competition, niche partitioning, and other related studies.

KEY WORDS. Atlantic Forest, Chiroptera, long-term monitoring, bat assemblage.

INTRODUCTION

Biodiversity surveys are essential to understand regional patterns of biological diversity, and to define the geographic distribution of specific taxa (Soulé and Wilcox 1980). These efforts are also necessary to support the implementation of conservation strategies for species and their habitats (Silveira et al. 2010, Visconti et al. 2016). The results of long-term inventories are a good estimate of the actual faunal community, and enhance our ability to understand the temporal aspects that can affect population dynamics and species diversity due to natural or anthropogenic events (Gannon and Willig 1998, Meyer et al. 2010).

A few long-term (> 5 years) bat inventories have been carried out in the Neotropics (Meyer et al. 2010). Bat surveys in Brazil have been mostly based on rapid faunal assessments and insufficient sampling effort, resulting in species lists that barely represent the real local diversity, and fail to add any information about the ecological dynamics of bat assemblages (Bernard et al. 2011). With less than 10% of the Brazilian territory minimally sampled (Bernard et al. 2011), it is necessary to increase long-term research efforts in strategic areas, to generate useful scientific knowledge for bat conservation.

In Brazil, most of the long-term bat surveys were carried out in the Atlantic Forest biome, including Southern Bahia (Faria et al. 2006), southern coast of Rio de Janeiro (Gomes and Esbérard 2017), Ilha Grande (Costa et al. 2021), Tijuca Forest (Esbérard 2003), and Pedra Branca Forest (Tavares et al. 2021). These and other efforts have made the Atlantic Forest into the most studied Brazilian biome when it comes to bat diversity. There are more than 100 species currently recorded for the Atlantic Forest, which represents about 35% of the mammal richness known for this biome (Bernard et al. 2011, Paglia et al. 2012, Graipel et al. 2017, Muylaert et al. 2017).

The Reserva Ecológica de Guapiaçu (REGUA) is an important private reserve at the central portion of the state of Rio de Janeiro. The reserve stands out for its high biodiversity (Pimentel and Olmos 2011, Almeida-Gomes et al. 2014, Carvalho et al. 2014, Silva et al. 2014) and conservation management actions, which include ecological restoration projects. Several research groups have conducted bat-capturing campaigns there since 1998, as part of ecology and parasitology research projects (e.g., Souza et al. 2015, 2016, Novaes et al. 2015a, Rangel et al. 2019, Oelbaum et al. 2022), but no one has compiled a list of species from these efforts.

The main goal of this study is to present an updated list of bat species occurring at REGUA, from the results of fieldwork conducted over two decades. Additionally, we discuss knowledge gaps and propose new objectives and methodological designs to that may result in the addition of new species to the current species list.

MATERIAL AND METHODS

Study area

The Reserva Ecológica de Guapiaçu (Guapiaçu Ecological Reserve; REGUA) is a private property, partially protected by a private reserve (Reserva Particular do Patrimônio Natural – RPPN). It is located in the eastern portion of the Guanabara Bay, in the Guapiaçu River sub-basin, Cachoeiras de Macacu municipality, state of Rio de Janeiro, southeastern Brazil (administrative headquarters: 22°27’10”S, 42°46’13”W; Fig. 1). It is part of the Atlantic Forest Mosaic of Corredor Central Fluminense, where it connects with Parque Estadual dos Três Picos and Parque Nacional da Serra dos Órgãos, and it is located in the central portion of Serra do Mar, one of the largest continuous remnants of the Atlantic Forest in Brazil. The climate in the region is tropical, classified as Köppen’s Af (Alvares et al. 2014), with rainy and hot summers (from October to March) and cold dry winters (April to September). The average annual temperature is 23 °C, and the average annual rainfall is 2,560 mm (Kurtz and Araújo 2000).

REGUA covers an area of 7,400 hectares. The dominant vegetation there is classified as Dense Ombrophilous Forest,

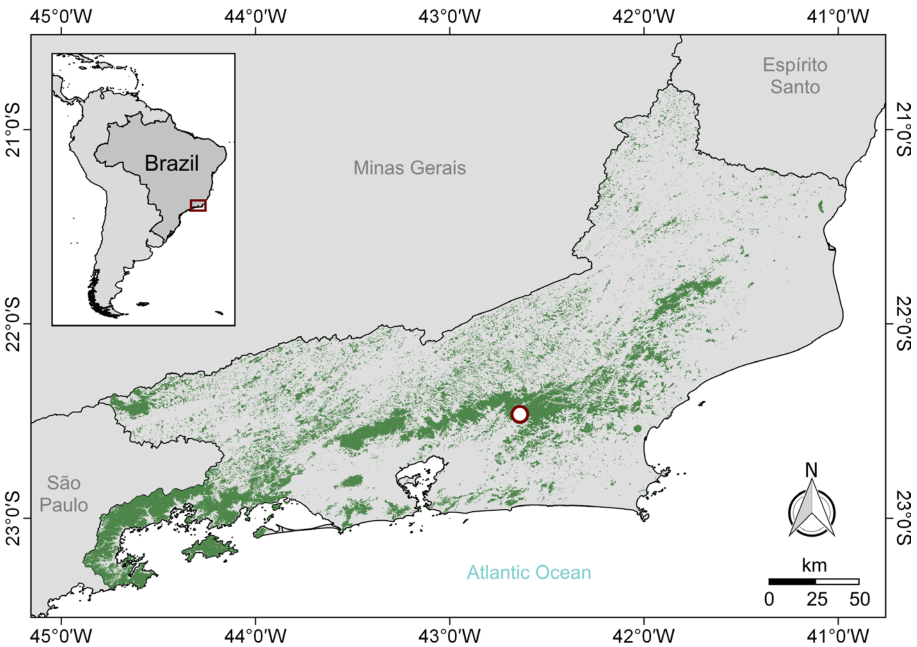
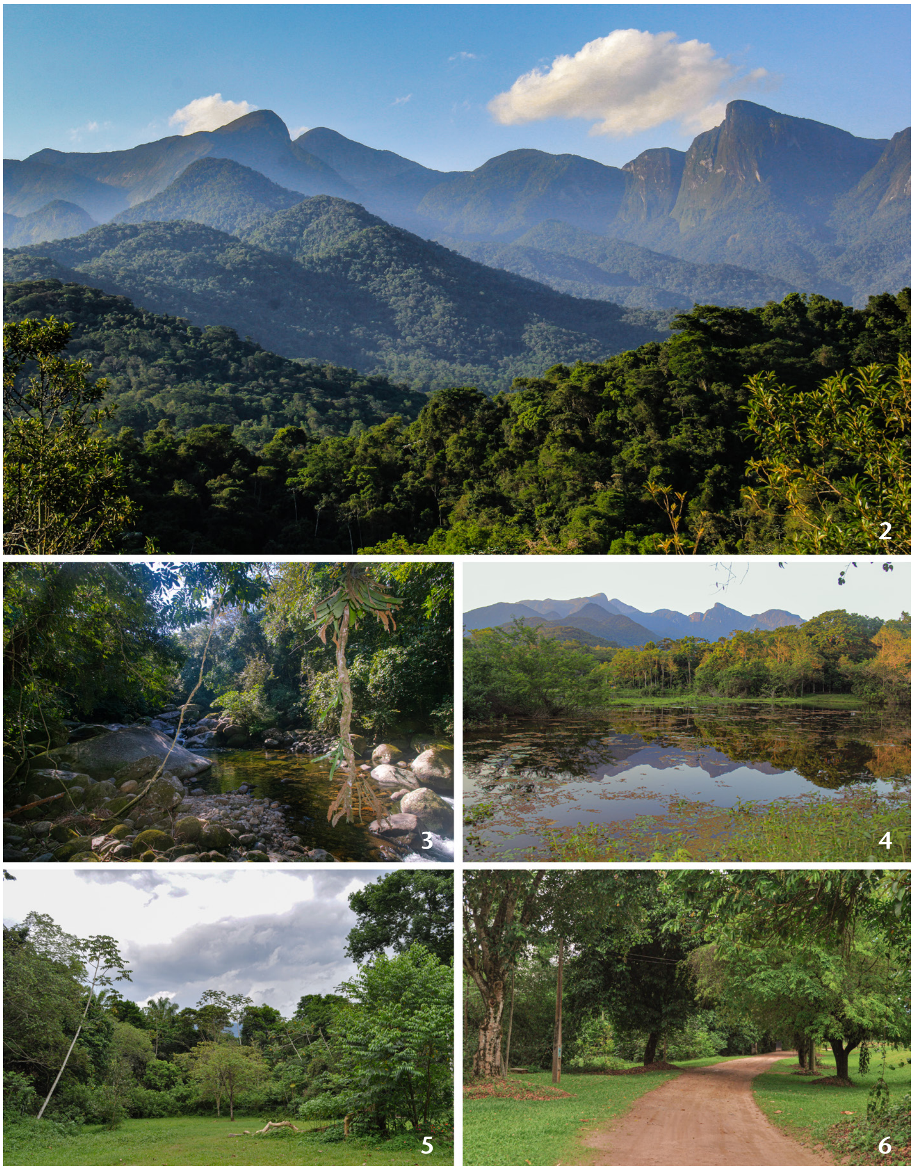


Figure 1. Location of Reserva Ecológica de Guapiaçu (red/white circle) in the context of the Atlantic Forest remnants of Rio de Janeiro (green), Southeastern Brazil. Shapefile of forest coverage is from the Brazilian NGO SOS Mata Atlântica database.

with different structures and typologies such as: Dense Alluvial Ombrophilous Forest in flat relief; Lowland Dense Ombrophilous Forest in soft undulating relief; and Submontane Dense Ombrophilous Forest in highland undulating relief. REGUA has a mosaic of Atlantic Forest at different levels of conservation (Figs 2–6), from secondary forests in their initial stages of succession, to mature and undisturbed forests located at higher altitude areas of difficult access (Rocha et al. 2007). In the surroundings of REGUA there are forest fragments of various sizes, monocultures, and pastures. Since the year 2000, vast areas of anthropic fields have been reforested, and native vegetation was planted on more than 200 ha of the reserve.

Data collection

Different research groups have surveyed the bat fauna at REGUA. Here, we compile data from fieldwork carried out from August 1998 to September 2021 by Laboratório de Ecologia de Mamíferos at Universidade do Estado do Rio de Janeiro (LEMA, UERJ), Laboratório de Diversidade de Morcegos at Universidade Federal Rural do Rio de Janeiro (LADIM, UFRRJ), Fiocruz Mata



Figures 2–6. Forest landscape of Reserva Ecológica de Guapiaçu (2), and some habitat types, as follows: (3) mature forest with riparian vegetation; (4) late secondary forest with lowland flooded areas; (5) patches of initial secondary forest ('capoeira') in abandoned pastures; (6) open environment in peridomicile with exotic and native fruit trees. Photographs by Roberto Leonan M. Novaes.

Atlântica at Fundação Oswaldo Cruz (FMA, Fiocruz) and Bat Lab from Queen Mary University of London (QMUL). Most of these results are unpublished, except for two partial species' lists presented by Souza et al. (2015, 2016).

The data presented here originates from different projects and was obtained with different sampling designs over time. The common elements of these studies are: the bats were captured by 5–12 mist-nets (sizes ranging from 6 × 2.5 m to 12 × 3 m) at night, installed only at the ground level. Mist-nets remained open for either 6 or 12 hours each night after sunset and were set on trails and clearings in the vegetation, close to water bodies and near bat day roosts. Bats were baited in areas varying from initial secondary vegetation to mature native forest, under varying weather conditions and during all seasons and phases of the lunar cycle.

The captured bats were kept in cotton bags and identified in the field based on morphological characters. After triage, biometrics, and other biological information necessary for each project (e.g., sex, reproductive stage, age), the bats were released back at the capture site. Few specimens were collected (N = 74) to confirm their identifications or to obtain biological samples, and these specimens are deposited as vouchers at the Museu Nacional, Universidade Federal do Rio de Janeiro (Appendix 1). Two occasional observations of species that were not sampled in mist nets were recorded: one individual of *Noctilio leporinus* (Linnaeus, 1758) foraging on a lake, and three *Thyroptera tricolor* Spix, 1823 individuals roosting in a rolled leaf of a banana tree. In this study, these species were included in the species list, but they were not included in the total number of individuals captured and in ecological analyses. All field and laboratory procedures followed ethical precepts (q.v., Sikes and Animal Care and Use Committee of the ASM 2016) and were authorized by governmental agencies under research licenses (1985/89-DIFAS/DEVIS; SISBio 3893-1/28717; SISBio 19037-1; SISBio 74191-3; SISBio 12548-1; SisGen A46B0E1; CEUA/IBRAG/UERJ nº 009/2021; CEUA/Fiocruz LM-2/18).

Data analysis

We followed the taxonomic arrangement in Garbino et al. (2020). Genera and species are presented in alphabetical order. The classification into trophic guilds followed Kalko et al. (1996). We calculated the sampling effort following Straube and Bianconi (2002) and capture efficiency was calculated by dividing the number of captures by the sampling effort employed. To test the effect of sampling effort and number of captures on accumulated bat species richness, we performed linear regression analyses using the 'Stats v.3.5.0' package in the R platform (R Core Team 2021).

We built a species accumulation curve and from it we extrapolated an estimate of the species richness following Chao et al. (2014). This approach uses rarefaction and extrapolation in an integrated way, based on the first three Hill numbers ($q = 0$, species richness; $q = 1$, Shannon diversity; $q = 2$, Simpson diversity; q.v., Chao et al. 2014). We used the extrapolation curve to predict how much the number of species could increase if we doubled the sampling effort. We also estimated a 95% confidence interval using the bootstrap method. These analyses were performed using the 'iNEXT' package in R platform (Hsieh et al. 2016). We estimated the maximum species richness that could be recorded using the Chao-1 index, implemented in the PAST 4 software (Hammer et al. 2001)

We estimated the species diversity with the Shannon index (H') and species dominance with the 1-Simpson index (D') using the PAST 4 software (Hammer et al. 2001) in order to compare the bat assemblage structure in REGUA with assemblages from other localities in the Brazilian Atlantic Forest. In these analyses, we excluded all captures that were made in roosts, to avoid bias in the results. Although aerial insectivorous bats are more difficult to capture using ground-level mist-nets (Mancini et al. 2022)—the main method used in this study— we chose to keep them in the analyses because the capture probabilities of bats in this guild were the same throughout the entire sampling.

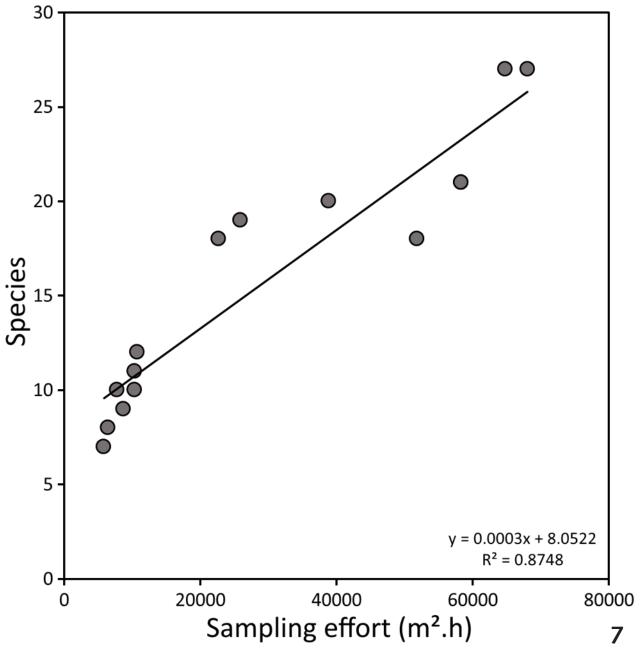
To test the significance of differences in species composition between the bat assemblage from REGUA and other localities, we used an analysis of variance (ANOVA) with a binary matrix of presence or absence. Pairwise comparisons were performed using the Mann-Whitney test and the p-value was corrected by the Bonferroni procedure (Kaufmann and Schering 2014) on the PAST 4 software (Hammer et al. 2001).

RESULTS

The bat samplings carried out at REGUA between 1998 and 2008 were sporadic, and the sampling effort of each study was relatively low. In 2011, a continuous sampling using a comparatively high sampling effort (Table 1) was initiated. The total number of sampling nights carried out at REGUA was at least 194, and the total sampling effort was 448,092 m^2.h (Table 2). As a result, 4,069 individuals of 47 species and six families were captured. Linear regressions recover a positive correlation between the accumulated species richness and number of captures ($r^2 = 0.669$) or sampling effort ($r^2 = 0.874$). However, this last metric performed better (Figs 7, 8).

The species accumulation curve has not reached its asymptote, despite showing a tendency to stabilization (Fig. 9). Looking at the extrapolation from this curve, we expect that four additional species will be recorded if we double the sampling effort (Fig. 9). The estimated richness at REGUA is 53 species, according to the Chao-1 index. Our analysis shows that the number of species in our list represents about 89% of the estimated bat richness for this area.

Phyllostomidae was the richest family at REGUA, with 30 species, followed by Vespertilionidae (10 spp.), Molossidae (3 spp.), Emballonuridae (2 spp.), Noctilionidae (1 sp.), and Thyropteridae (1 sp.). The most abundant species were *Carollia perspicillata* (Linnaeus, 1758) (49% of all captures), *Artibeus*



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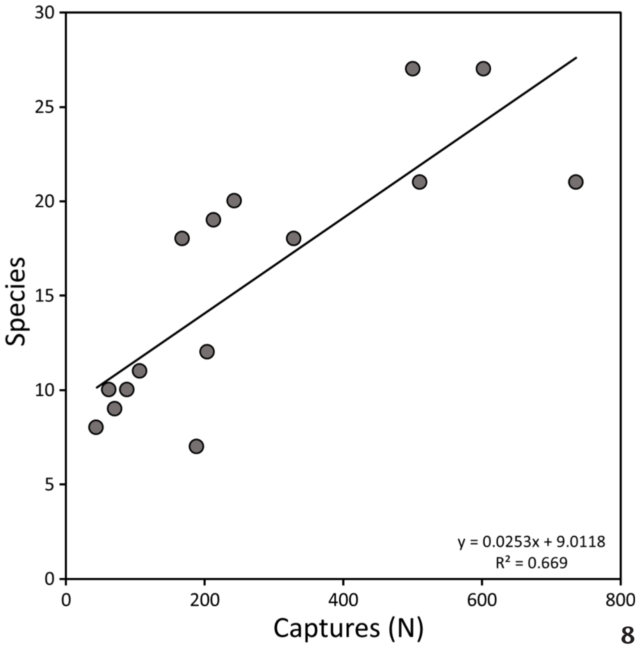

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Figures 7–8. Linear regressions of the accumulated species on: the sampling effort (7), and number of captures (8) in bat inventories at Reserva Ecológica de Guapiaçu, Brazil.

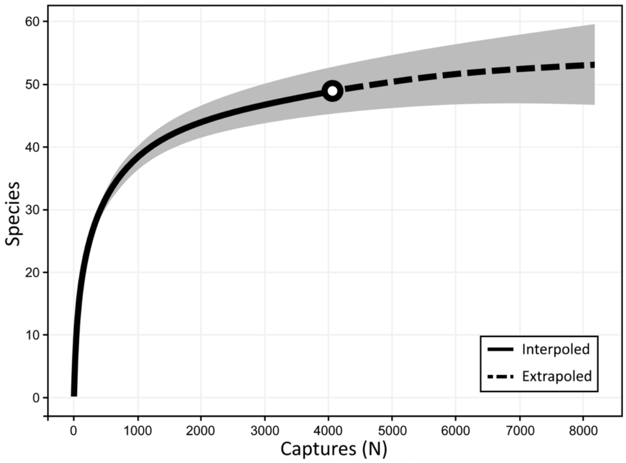

Figure 9. Estimated species accumulation curves (solid line) and extrapolated (dotted line) of bat assemblage at the Reserva Ecológica de Guapiaçu. The dotted line is a representation of the doubled number of captures. The shaded area represents the 95% confidence interval.

Table 1. Bat sampling conducted at Reserva Ecológica de Guapiaçu during almost two decades, including a detailed information of sampling effort, number of species recorded, and the total accumulated species throughout the research periods.

Year	Sampling		Number		Species accumulated
	Nights	Effort (m².h)	Captures	Species	
1998	6	5,832	189	7	7
2004	9	8,748	71	9	15
2006	6	7,776	62	10	15
2008	5	6,480	44	8	16
2011	18	58,320	511	21	21
2012	18	58,320	736	21	23
2013	16	51,840	329	18	32
2014	20	64,800	501	27	34
2015	12	38,880	243	20	36
2016	32	68,040	603	27	44
2017	14	22,680	168	18	45
2018	16	25,920	213	19	47
2019	8	10,368	107	11	47
2020	8	10,368	88	10	47
2021	9	10,740	204	12	48
Total	197	449,112	4,069	–	48

lituratus (Olfers, 1818) (23%), and *Sturnira lilium* (É. Geoffroy, 1810) (11%). All trophic guilds recognized for Neotropical bats were recorded, with a marked dominance of frugivorous species (86% of all captures). Excluding individuals captured in roosts, aerial insectivorous bats accounted for only 1.6% of all captures. The aerial insectivorous bats *Peropteryx macrotis* (Wagner, 1843), *Saccopteryx leptura* (Schreber, 1774), *Eumops glaucinus* (Wagner, 1843), and *Molossus* sp. were captured exclusively while leaving their roosts. Three species are endemic to the Atlantic Forest (*Lonchophylla peracchii* Dias, Esbérard & Moratelli, 2013, *Platyrrhinus recifinus* (Thomas, 1901), and *Myotis ruber* (É. Geoffroy, 1806)) and another three are strongly associated with the Atlantic Forest

Table 2. Bats from Reserva Ecológica de Guapiaçu, including a simplified trophic guild classification; type of record (RC = roost capture; MN = mist net capture; FO = foraging observation); and number of individuals captured (N).

Family/Subfamily/Species	Trophic guild	Record	N
Emballonuridae			
Emballonurinae			
Peropteryx macrotis (Wagner, 1843)	Aerial insectivore	RC	7
Saccopteryx leptura (Schreber, 1774)	Aerial insectivore	RC	1
Phyllostomidae			
Micronycterinae			
Micronycteris microtis Miller, 1898	Gleaning insectivore	MN	10
Micronycteris minuta (Gervais, 1856)	Gleaning insectivore	MN	24
Micronycteris sp.	Gleaning insectivore	MN	1
Desmodontinae			
Desmodus rotundus (E. Geoffroy, 1810)	Sanguivore	MN	216
Diaemus youngii (Jentink, 1893)	Sanguivore	MN	1
Diphylla ecaudata Spix, 1823	Sanguivore	MN	9
Lonchorhininae			
Lonchorhina aurita Tomes, 1863	Gleaning insectivore	MN	3
Phyllostominae			
Chrotopterus auritus (Peters, 1856)	Carnivore	MN	6
Mimon bennettii (Gray, 1838)	Gleaning insectivore	MN	9
Phyllostomus hastatus (Pallas, 1767)	Omnivore	MN	78
Tonatia bidens (Spix, 1823)	Omnivore	MN	13
Trachops cirrhosus (Spix, 1823)	Carnivore	MN	6
Glossophaginae			
Anoura caudifer (E.Geoffroy, 1818)	Nectarivore	MN	41
Anoura geoffroyi Gray, 1838	Nectarivore	MN	62
Glossophaga soricina (Pallas, 1766)	Omnivore	MN	153
Lonchophyllinae			
Lonchophylla peracchii Dias, Esbérard & Moratelli, 2013	Nectarivore	MN	8
Carolliinae			
Carollia brevicauda (Schinz, 1821)	Frugivore	MN	6
Carollia perspicillata (Linnaeus, 1758)	Frugivore	MN	937
Stenodermatinae			
Artibeus cinereus (Gervais, 1856)	Frugivore	MN	15
Artibeus fimbriatus Gray, 1838	Frugivore	MN	451
Artibeus lituratus (Olfers, 1818)	Frugivore	MN	656
Artibeus obscurus (Schinz, 1821)	Frugivore	MN	235
Chiroderma doriae Thomas, 1891	Frugivore	MN	4
Chiroderma villosum Peters, 1860	Frugivore	MN	7
Platyrrhinus lineatus (É. Geoffroy, 1810)	Frugivore	MN	14
Platyrrhinus recifinus (Thomas, 1901)	Frugivore	MN	79
Pygoderma bilabiatum (Wagner, 1843)	Frugivore	MN	10
Sturnira lilium (É. Geoffroy, 1810)	Frugivore	MN	699
Sturnira tildae de la Torre, 1859	Frugivore	MN	55
Vampyressa pusilla (Wagner, 1843)	Frugivore	MN	47
Vampyrodes caraccioli (Thomas, 1889)	Frugivore	MN	5
Noctilionidae			
Noctilio leporinus (Linnaeus, 1758)	Piscivore	FO	–
Thyropteridae			
Thyroptera tricolor Spix, 1823	Aerial insectivore	RC	3
Molossidae			
Molossinae			
Eumops glaucinus (Wagner, 1843)	Aerial insectivore	RC	1

Continues

Table 2. Continued.

Family/Subfamily/Species	Trophic guild	Record	N
Molossus molossus (Pallas,1766)	Aerial insectivore	MN/RC	102
Molossus fluminensis Lataste, 1891	Aerial insectivore	MN/RC	16
Molossus sp.	Aerial insectivore	RC	2
Vespertilionidae			
Vespertilioninae			
Eptesicus brasiliensis (Desmarest, 1819)	Aerial insectivore	MN	6
Eptesicus diminutus Osgood, 1915	Aerial insectivore	MN	10
Eptesicus furinalis (d'Orbigny, 1847)	Aerial insectivore	MN/RC	9
Histiotus velatus (I. Geoffroy, 1824)	Aerial insectivore	MN	2
Lasiurus blossevillii ([Lesson, 1826])	Aerial insectivore	MN	1
Myotinae			
Myotis albescens (É. Geoffroy, 1806)	Aerial insectivore	MN	2
Myotis levis (I. Geoffroy, 1824)	Aerial insectivore	MN	1
Myotis nigricans (Schinz, 1821)	Aerial insectivore	MN/RC	24
Myotis riparius Handley, 1960	Aerial insectivore	MN/RC	19
Myotis ruber (É. Geoffroy, 1806)	Aerial insectivore	MN	1
Myotis sp.	Aerial insectivore	MN	2
Total			4,069

Table 3. Localities in the Atlantic Forest with long-term studies of bat assemblage, including the sampling effort (SE – m^2.h), number of species recorded (Nsp), number of captures (Ncap), species diversity by Shannon index (H'), species dominance by 1-Simpson index (D'), and the reference of the published study (Source). REGUA = Reserva Ecológica de Guapiaçu.

Localities	SE	N_{sp}	N_{cap}	H'	D'	Source
Tijuca Forest	496,200	40	4,043	2.49	0.11	Esbérard (2003)
Ilha Grande	490,444	32	2,763	2.38	0.14	Costa et al. (2021)
REGUA	448,092	47	4,069	2.46	0.13	Present study
Pedra Branca Forest	114,180	29	1,644	2.09	0.20	Tavares et al. (2021)
Itacuruça Island	89,400	25	1,502	1.97	0.23	Gomes & Esbérard (2017)
REBIO Tinguá	35,154	28	655	2.46	0.12	Dias et al. (2008)

(*Vampyressa pusilla* (Wagner, 1843), *Molossus fluminensis* Lataste, 1891, and *Myotis levis* (I. Geoffroy, 1824)), although there are sporadic records of them in other ecoregions. Some species in our list have been rarely recorded in the Atlantic Forest, such as *S. leptura*, *Lonchorhina aurita* Tomes, 1863, *Vampyrodes caraccioli* (Thomas, 1889), and *E. glaucinus*.

REGUA has a highly diverse bat assemblage, with low species dominance when compared with other locations in the Atlantic Forest, while very similar to other large Atlantic Forest remnants, such as Tijuca Forest, Ilha Grande, and Tinguá Biological Reserve (Table 3). However, there is a significant difference in species composition between the bat assemblage of REGUA and other localities, except Tijuca Forest and Ilha Grande ($F = 5.123$, $p < 0.0001$; Table 4).

DISCUSSION

REGUA is among the richest places for bat species in the Atlantic Forest (Esbérard 2003, Faria et al. 2006, Dias et al. 2008, Gomes and Esbérard 2017, Delciellos et al. 2018, Cronemberguer

Table 4. P-values from ANOVA pairwise comparisons between six bat assemblages. Values statistically significant ($p < 0.05$) are in boldface indicating differences in species composition from different areas. REGUA = Reserva Ecológica de Guapiaçu.

Locality	REGUA	Ilha Grande	Pedra Branca Forest	Itacuruça Island	REBIO Tinguá
Ilha Grande	0.27	–	–	–	–
Pedra Branca Forest	**0.03**	1.00	–	–	–
Itacuruça Island	**0.00**	0.54	1.00	–	–
REBIO Tinguá	**0.00**	1.00	1.00	1.00	–
Tijuca Forest	1.00	1.00	1.00	0.06	0.49

et al. 2019, Hoppe et al. 2020, Costa et al. 2021, Tavares et al. 2021), with 47 species, which is equivalent to about 46% of the bat richness known for the Brazilian Atlantic Forest (Graipel et al. 2017, Muylaert et al. 2017). It is possible that this high bat diversity there can be explained by the large area of continuous mature forest connected with other forested areas, and by the time span of the sampling effort, over two decades. However, some results indicate that the species list has not yet reached its maximum, as the species accumulation curve has yet to reach its asymptote. Furthermore, some specimens sampled were not identified to species, and it is possible that they represent unrecorded taxa.

In almost 20 years of research with bats at REGUA, the only sampling method used in a standardized way was ground level mist-nets. Therefore, it is most likely that the bat assemblage at REGUA is undersampled, since aerial insectivorous bats, especially molossids, vespertilionids and embalonurids are not efficiently captured by ground-level mist-nets, because they are able of more accurate echolocation, and they fly at the highest strata of the forest (Portfors et al. 2000, Kalko and Handley 2001, Mancini et al. 2022). The number of species in this guild recorded from REGUA are lower when compared to other areas where alternative methods were used (q.v., Mancini et al. 2022). Consequently, future studies with bats should consider the adoption of new sampling methods, such as bioacoustics and active search of bat roosts. We expect that these methods will increase the number of species from REGUA and its surroundings, especially when we consider the occurrence of different bat species in localities close to REGUA (e.g., *Micronycteris hirsuta*, *Macrophyllum macrophyllum, Myotis izecksohni*; Novaes et al. 2015b, Cronemberger et al. 2019, Louzada et al. 2021).

The number of specimens from REGUA deposited as vouchers in biological collections (N = 74) is low, considering that bats were sampled for a number of years, and that not all species are represented. Some individuals were not identified to species level during the fieldwork, nor were they collected for further examination. This raises questions about the real number of bat species in the region. Future studies should increase the representation of local species in biological collections, particularly those not yet represented (see Moratelli 2014).

Long-term studies are valuable for a better characterization of the local biodiversity, but it can also provide accurate information about population fluctuations in response to climatic variations, landscape modifications, and other ecological disturbances (Callahan 1984, Havstad and Herrick 2010). In relation to tropical bats, Meyer et al. (2010) indicated that long-term monitoring programs of bat assemblages for more than 20 years can potentially detect a 5% annual change in abundance for a suite of bat species from different ensembles. Nevertheless, this requires a rigorous sampling design and conceptual framework to allow robust statistical modeling to answer long-term ecological questions (Lindenmayer and Likens 2009). In this sense, REGUA is a great candidate to host long-term bat monitoring programs, considering all basic knowledge about its bat fauna accumulated in these two decades of research. We suggest that new research projects should be based on a collaborative and multi-institutional protocol that aims to standardize efforts on a temporal and geographic scale that can meet short-term objectives, while aggregating data for continuous and long-term monitoring.

Because of its high bat diversity, associated with large forest remnants in an agricultural matrix and its location close to the urban center of Rio de Janeiro city, REGUA is an important area for long-term research. Studies there can potentially address questions about bat assemblage structure, populational fluctuations, bat-parasite ecology, competition, niche partitioning, effects of habitat quality, and other related topics. In addition, basic knowledge about the ecological interactions of bats with different food resources (Novaes et al. 2015a, Oelbaum et al. 2022) and zoonotic microorganisms (Rangel et al. 2019, Speer et al. 2022) offers a unique opportunity to carry out research in several areas of knowledge, with direct implications for biodiversity conservation and public health management. Therefore, we suggest that bat sampling in REGUA continues in the form of a new bat monitoring program.

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Appendix 1. Bats from Reserva Ecológica de Guapiaçu deposited in the mammal collection of Museu Nacional da Universidade Federal do Rio de Janeiro (MN, Rio de Janeiro).

Phyllostomidae: *Anoura caudifer* (MN 79859, 83041, 83044); *Anoura geoffroyi* (MN 79860, 79918, 83042); *Artibeus cinereus* (MN 79875); *Artibeus fimbriatus* (MN 79861, 79862, 79919, 79920); *Artibeus lituratus* (MN 78125, 78126, 79863, 79864, 79865); *Artibeus obscurus* (MN 79866); *Carollia perspicillata* (MN 79867, 79868, 79869, 79870, 79871, 79872, 80334); *Chiroderma villosum* (MN 79873); *Chrotopterus auritus* (MN 79874); *Desmodus rotundus* (MN 79876, 80349); *Diaemus youngii* (MN 79877); *Glossophaga soricina* (MN 79882, 79883, 83043); *Lonchophylla peracchii* (MN 78404); *Micronycteris minuta* (MN 79884, 79885, 79886, 79887, 79888, 79889, 79890, 79917); *Mimon bennettii* (MN 79891; 79892); *Phyllostomus hastatus* (MN 79903); *Platyrrhinus recifinus* (MN 79904, 79905, 79921); *Sturnira lilium* (MN 79906, 79907, 79908, 79922); *Sturnira tildae* (MN 79909); *Tonatia bidens* (MN 80343, 80350); *Trachops cirrhosus* (MN 79911); *Vampyressa pusilla* (MN 79912, 79913); *Vampyrodes caraccioli* (MN 79914, 79915).

Molossidae: *Eumops glaucinus* (MN 79881); *Molossus fluminensis* (MN 79894); *Molossus molossus* (MN 79893, 79916).

Vespertilionidae: *Eptesicus diminutus* (MN 79878, 79879); *Eptesicus furinalis* (MN 79880); *Myotis nigricans* (MN 79895, 79896, 79897, 79898, 79900, 79901, 79902); *Myotis riparius* (MN 79899).

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The conception and sample design were made by RLMN and RFS; data generation was made by RSAP, GS, TSMT, PSMA, ECL, HGB, LMC, CELE, RTS, RM, and RLMN; data compilation and analyses were made by RSAP and RLMN; RSAP, RFS, and RLMN wrote the first draft of the manuscript; all authors contributed to the text and approved final version.

Competing Interests

The authors have declared that no competing interests exist.

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