


Chiropterofauna (Mammalia: Chiroptera) from the Altamiro de Moura Pacheco State Park, Goiás, Brazil

Quiropterofauna (Mammalia: Chiroptera) del Parque Estatal Altamiro de Moura Pacheco, Goiás, Brasil

Erica Santos de Carvalho ^a, Simone Almeida Pena  ^b, Rafaela Jemely Rodrigues Alexandre ^c
Karina Dias-Silva ^d, Rogério Pereira Bastos ^a, Monik Oprea ^e, Daniel Brito ^d
Jessica Conceição da Silva ^f, Thiago Bernardi Vieira ^d

^a Laboratório de Herpetologia e Comportamento Animal, Departamento de Ecologia, Universidade Federal de Goiás, Brazil

^b Programa de Pós-Graduação em Ecologia, Universidade Federal do Pará, Brazil

^c Programa de Pós-Graduação em Zoologia, Universidade Federal do Pará, Brazil

^d Laboratório de Ecologia, Universidade Federal do Pará, Brazil

^e Laboratório de Ecologia Aplicada e Conservação, Departamento de Ecologia, Universidade Federal de Goiás, Brazil

^f Programa de Pós-Graduação em Biodiversidade e Conservação, Universidade Federal do Pará, Brazil

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Abstract

The Brazilian Cerrado is undergoing important changes. It is estimated that 70% of its natural area has converted to human use. The loss and fragmentation of natural habitats is considered the main cause of species loss in ecosystems. However, the lack of knowledge of biodiversity makes it difficult to design effective conservation measures. This article presents a list and an estimate of the richness of bats in the Parque Estadual Altamiro de Moura Pacheco (PEAMP) in Goiás. All collected bats belong to the Phyllostomidae family, with *Carollia perspicillata* (67%) and *Artibeus planirostris* (18%) representing 86% of the captured individuals.

Keywords: biodiversity, Cerrado, Chiroptera, bats, mammals.

Resumen

El Cerrado brasileño está experimentando cambios importantes. Se estima que el 70 % de su área natural se ha transformado para uso humano. La pérdida y fragmentación de hábitats naturales se considera la principal causa de pérdida de especies en los ecosistemas. Sin embargo, la falta de conocimiento de la biodiversidad dificulta la creación de medidas de conservación efectivas. Este artículo presenta una lista y un estimado de la riqueza de especies de murciélagos en el Parque Estadual Altamiro de Moura Pacheco (PEAMP) en Goiás. Todos los murciélagos colectados pertenecen a la familia Phyllostomidae. *Carollia perspicillata* (67%) y *Artibeus planirostris* (18%) representaron el 86% de los individuos capturados.

Palabras clave: biodiversidad, cerrado, quirópteros, murciélagos, mamíferos.

Introduction

In general, the conservation of diversity is against human activities, whether economic or recreational (Camacho-Sandoval & Duque, 2001). This conflict occurs when areas of economic interests overlap with those of value for conservation (Camacho-Sandoval & Duque, 2001; Palheta et al., 2020) and is aggravated by the lack of knowledge about species (Linnean deficit) (Lewis, 2006; Rose et al., 2018) and their geographic distribution (Wallaceano deficit) (Whittaker et al., 2005), which, in turn, represent barriers to conservation.

Chiroptera is the second largest order of mammals, comprising more than 1400 species in the world (Reis et al., 2007; Solari et al., 2019). In Brazil, there are 181 species distributed in 68 genera and 9 families (Garbino et al., 2020). Of these, 80 species, 42 genera and all 9 families occur in the Brazilian Cerrado (Emballonuridae, Noctilionidae, Mormoopidae, Furipteridae, Vespertilionidae, Molossidae, Natalidae, Thyropteridae and Phyllostomidae). This diversity corresponds to about 40% of bat species in South America (Bording, 2006), 60% of bat species in Brazil (Garbino et al., 2020) and nearly 50% of Cerrado mammal species (Aguiar & Machado, 2010).

Bats represent the group of mammals with the greatest diversity of feeding habits, including insectivorous, nectarivorous, frugivorous, carnivorous and hematophagous species (Kunz & Pierson, 1994; Peixoto et al., 2018). These animals are important pollinators and seed dispersers (Fleming,

1988; Mickleburgh et al., 2002; Vieira et al., 2021), and are considered key species in tropical forests, due to their effects on the structuring of plant communities (Fleming & Heithaus, 1981; Sritongchuay et al., 2019). They also play a role in insect control (Kalka et al., 2008; Williams-Guillén et al., 2008; Costa et al., 2018) of many species considered agricultural pests (Cleveland et al., 2006; Ghanem & Voigt, 2012).

Despite the great diversity of this group and its ecological importance, knowledge about the Cerrado bat fauna is still insufficient (Aguiar & Zortéa, 2008; Muylaert et al., 2016). It is estimated that about 70% of the original Cerrado extension has been converted to pasture and agriculture, being the last agricultural frontier in the world, and only 2.5% is protected by conservation units (Machado et al., 2004; Falcão et al., 2020). Thus, considering the importance of bats for the maintenance of ecosystem services, the anthropic pressure observed in the Cerrado and the scarcity of information on the diversity of bats in this biome, our objective is to present a list of bat species from the Altamiro de Moura Pacheco State Park, Goiás, Brazil and infer about species richness.

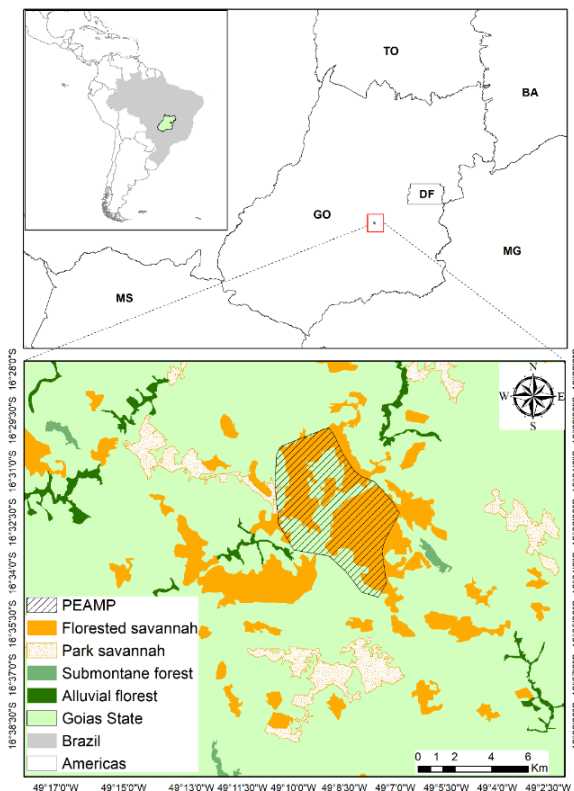
Material and methods

Study area

The study was carried out in the Altamiro de Moura Pacheco State Park (PEAMP), in the municipalities of Goianópolis, Nerópolis and Goiânia, state of Goiás (Figure 1). The PEAMP's main objective is to protect

the João Leite spring that supplies the metropolitan region of Goiânia. According to the Köppen classification, the region's climate is "Aw". It is characterized by two seasons: hot and rainy from October to March and cold and dry from April to September (Falcão et al., 2020). The PEAMP is a state conservation unit of integral protection created in 1992 and has an area of 3,183 hectares. The vegetation is typical of the Cerrado biome and consists of patches of Mata Seca, Mata de Galeria, Cerrado in the strict sense, Cerradão, Capoeira (Consolaro et al., 2019) and areas that were used for grazing.

Figure 1. Altamiro de Moura Pacheco State Park (PEAMP).



Bat sampling

Ten collections were carried out (Table 1) at night between September 2015 and April 2016, all during waning or new moon phases to avoid the effect of lunar phobia on sampling (Lang et al., 2006). The sampling was performed with ten mist nets (9 x 3 m) that remained open for six hours after sunset and

checked every 30 minutes. The nets were set up on existing trails inside the vegetation or on the edge of the vegetation when it was inaccessible (Vieira et al., 2010, 2021; Mendes et al., 2014; Palheta et al. 2020; Silva et al. 2020; Alencastre-Santos et al., 2022).

Table 1. Dates of collection and geographic coordinates of points sampled in the Altamiro de Moura Pacheco State Park.

Point	Date	Latitude	Longitude
P1	9/5/2015	-16.54397	-49.15783
P2	9/6/2015	-16.54306	-49.15575
P3	9/12/2015	-16.54572	-49.15608
P4	9/13/2015	-16.54267	-49.16000
P5	11/14/2015	-16.54628	-49.1785
P6	4/1/2016	-16.54333	-49.17111
P7	4/2/2016	-16.54081	-49.16478
P8	4/3/2016	-16.54828	-49.17831
P9	4/9/2016	-16.52531	-49.12217
P10	6/5/2016	-16.56494	-49.16414

After capture, the bats were placed in cotton bags and identified to species level. One individual of each species was euthanized by cervical dislocation (complying with CEUA guidelines on bat work and Ethics Committee on Animal Use, Universidade Federal de Goiás, CEUA UFG n° 004-21), fixed in 10% formalin, preserved in 70% ethanol, and registered in the Zoological Collection of the Universidade Federal de Goiás (UFG) (RE01-RE21). Uncollected captured individuals were marked with numbered rings and released in the same location. Species richness was estimated with the Jackknife procedure (Heltshe & Forrester, 1983) in EstimateS (V. 8.0) (Colwell, 2005), with 1,000 randomizations and using mist nets as replicas, totaling 100 replicas (10 nets x 10 nights). The species were classified into trophic guilds following Kalko (1998).

All procedures were performed following the guidelines and authorization of the Biodiversity Authorization and Information System (SISBIO) n° 64075-1. The voucher specimen is in the Chiroptera Collection of ChiroXingu in the Universidade Federal of Pará, Campus Altamira, Pará, Brazil (ChiroXingu-UFPA-Altamira) under code CX128.

Results

With a sampling effort of 16,200 hm² (*sensu* Straube & Bianconi, 2002), 150 individuals of 9 species (all from the Phyllostomidae family) were captured (Table 2). Furthermore, 11.97 species were estimated with the Jackknife method, with the estimated richness being greater than the observed richness (Figure 2). The most abundant species were *Carollia perspicillata* (Linnaeus, 1758) and *Artibeus planirostris* (Spix, 1823). *Sturnira lilium* (É. Geoffroy, 1810), *Phyllostomus discolor* (Wagner, 1846) and *Phyllostomus hastatus* (Pallas, 1767) had only one specimen sampled. The guild with the highest representation was that of frugivores, with five species (Table 2).

Discussion

All species captured belong to the Phyllostomidae family, which is a common result in studies carried out in the Cerrado and other localities in the Neotropical region, since it is the most diverse and abundant family in the Neotropics (Fenton et al., 1992; Gardner, 2019; Zachos et al., 2020). The collection method used (mist net) further supports this result, since it tends to be selective for species of this family (Pedro & Taddei, 1997; Medellín et al., 2000). This selectivity of Phyllostomidae occurs because species of this family move using spatial memory more than echolocation (Pedro & Taddei, 1997; Thiagavel et al., 2020).

The wealth estimator curve did not stabilize with the sampling performed, since many rare species are not easily sampled (Bergallo et al., 2003). With continued sampling in the area, new species will likely be added to the existing list.

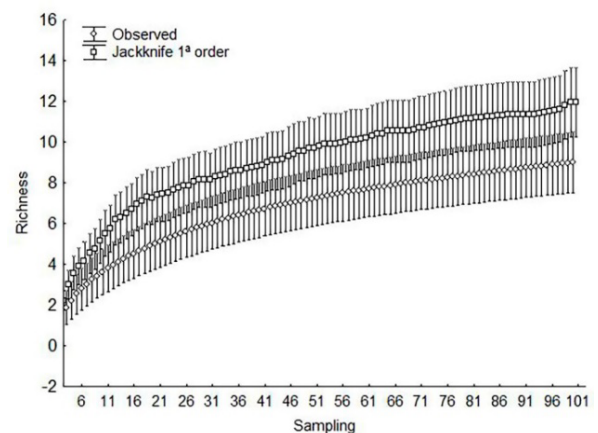
The predominant species was *C. perspicillata*, a species widely distributed in the Neotropical region (Fleming, 1988; Lino et al., 2021), and one of the most abundant in the Brazilian Cerrado (Aguiar & Zórtea, 2008). *C. perspicillata* is a frugivorous species that can feed on a variety of fruits of pioneer species (Pedro & Taddei, 2002; Bobrowiec & Gribel, 2010), which occur mainly in clearings, regenerating areas and forest

edges (Mello et al., 2004; Carrasco-Rueda & Loiselle, 2019).

Table 2. List of species in the Altamiro de Moura Pacheco State Park.

FAMILY	Guild	Abundance
Subfamily		
<i>Species</i>		
PHYLLOSTOMIDAE		150
Carollinae		101
<i>Carollia perspicillata</i> (Linnaeus, 1758)	Frugivore	101
Stenodermatinae		36
<i>Artibeus lituratus</i> (Olfers, 1818)	Frugivore	3
<i>Artibeus planirostris</i> (Spix, 1823)	Frugivore	28
<i>Platyrrhinus lineatus</i> (É. Geoffroy, 1810)	Frugivore	4
<i>Sturnira lilium</i> (É. Geoffroy, 1810)	Frugivore	1
Glossophaginae		5
<i>Glossophaga soricina</i> (Pallas, 1766)	Nectarivore	5
Phyllostominae		2
<i>Phyllostomus discolor</i> (Wagner, 1846)	Omnivore	1
<i>Phyllostomus hastatus</i> (Pallas, 1767)	Omnivore	1
Desmodontinae		6
<i>Desmodus rotundus</i> (É. Geoffroy, 1810)	Hematophagous	6

Figure 2. Observed and estimated richness of bats in the Altamiro de Moura Pacheco State Park.



Notes. The bars represent the 95% confidence interval.

In the sampled area, we observed the occurrence of frugivorous, nectarivorous and hematophagous species, guilds usually associated with regenerating areas (Martínez-Ferreira et al., 2020). On the other hand, carnivorous and larger bats were not sampled. Studies indicate that these bats are the most sensitive to environmental changes and the first to disappear in the face of environmental changes (Fenton et al. 1992; Medellín et al., 2000; Rocha et al., 2017; Castro et al., 2022).

Although this place is protected, it is important to emphasize the need to preserve not only this area, but also its surroundings. New samplings and the use of additional methods tend to increase the knowledge of bat diversity and register new species for the state of Goiás. Such information is important to support decisions regarding the management of areas and bat communities in conservation units.

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References

Aguiar, L. M. S., & Machado, R. B. (2010). Áreas prioritárias para a pesquisa de morcegos no domínio do cerrado. *Cerrado: conhecimento científico quantitativo como subsídio para ações de conservação* (pp. 425-440). Thesaurus.

Aguiar, L. M. S., & Zortéa, M. (2008). A diversidade de morcegos conhecida para o Cerrado. *II Simpósio Internacional Savanas Tropicais*.

http://simposio.cpac.embrapa.br/simposio_pc210/trabalhos_pdf/00768_trab2_ap.pdf

Alencastre-Santos, A. B., Correia, L. L., Sousa, L. M., Silva, C. R., & Vieira, T. B. (2022). Opportunistic predation of *Carollia brevicauda* (Schinz, 1821) (Chiroptera: Phyllostomidae) by *Marmosa demerarae* (Thomas, 1905) (Marsupialia: Didelphidae) in the Brazilian Amazon. *Mammalia*, 86(4), 347-350.

<https://doi.org/10.1515/mammalia-2021-0083>

Bergallo, H. G., Esbérard, C. E., Mello, M. A. R., Lins, V., Mangolin, R., Melo, G. G., & Baptista, M. (2003). Bat species richness in Atlantic Forest: what is the minimum sampling effort? *Biotropica*, 35(2), 278-288. <https://doi.org/10.1111/j.1744-7429.2003.tb00286.x>

Bobrowiec, P. E. D., & Gribel, R. (2010). Effects of different secondary vegetation types on bat community composition in Central Amazonia, Brazil. *Animal Conservation*, 13(2), 204-216.

<https://doi.org/10.1111/j.1469-1795.2009.00322.x>

Bording, M. O. (2006). Bat Diversity (Mammalia, Chiroptera) from Aporé-Sucuriú's complex, Mato Grosso do Sul, Brazil. *Revista Brasileira de Zoologia*, 23(4), 1002-1009.

<https://doi.org/10.1590/S0101-81752006000400004>

Camacho-Sandoval, J., & Duque, H. (2001). Indicators for biodiversity assessment in Costa Rica. *Agriculture, Ecosystems & Environment*, 87(2), 141-150.

[https://doi.org/10.1016/S0167-8809\(01\)00274-2](https://doi.org/10.1016/S0167-8809(01)00274-2)

Carrasco-Rueda, F., & Loiselle, B. A. (2019). Do riparian forest strips in modified forest landscapes aid in conserving bat diversity? *Ecology and Evolution*, 9(7), 4192-4209.

<https://doi.org/10.1002/ece3.5048>

Castro, A. B., Bobrowiec, P. E. D., Castro, S. J., Rodrigues, L. R. R., & Fadini, R. F. (2022). Influence of reduced-impact logging on Central Amazonian bats using a before-after-control-impact design.

- Animal Conservation*, 25(2), 311-322. <https://doi.org/10.1111/acv.12739>
- Cleveland, C. J., Betke, M., Federico, P., Frank, J. D., Hallam, T. G., Horn, J., Lopez Jr., J. D., McCracken, G. F., Medellín, R. A., & Moreno-Valdez, A. (2006). Economic value of the pest control service provided by Brazilian free-tailed bats in south-central Texas. *Frontiers in Ecology and the Environment*, 4(5), 238-243. [http://doi.org/10.1890/1540-9295\(2006\)004\[0238:EVOTPC\]2.0.CO;2](http://doi.org/10.1890/1540-9295(2006)004[0238:EVOTPC]2.0.CO;2)
- Colwell, R. K. (2005). *EstimateS: Statistical estimation of species richness and shared species from samples*. Version 7.5. <https://ci.nii.ac.jp/naid/10030256605/>
- Consolaro, H., Alves, M., Ferreira, M., & Vieira, D. (2019). *Sementes, plântulas e restauração no sudeste goiano*. Athalaia.
- Costa, W. F., Ribeiro, M., Saraiva, A. M., Imperatriz-Fonseca, V. L., & Giannini, T. C. (2018). Bat diversity in Carajás National Forest (Eastern Amazon) and potential impacts on ecosystem services under climate change. *Biological Conservation*, 218, 200-210. <https://doi.org/10.1016/j.biocon.2017.12.034>
- Falcão, K. S., Panachuki, E., das Neves Monteiro, F., da Silva Menezes, R., Rodrigues, D. B., Sone, J. S., & Oliveira, P. T. S. (2020). Surface runoff and soil erosion in a natural regeneration area of the Brazilian Cerrado. *International Soil and Water Conservation Research*, 8(2), 124-130. <https://doi.org/10.1016/j.iswcr.2020.04.004>
- Fenton, M. B., Acharya, L., Audet, D., Hickey, M. B. C., Merriman, C., Obrist, M. K., Syme, D. M., Adkins, B. (1992). Phyllostomid bats (Chiroptera: Phyllostomidae) as indicators of habitat disruption in the Neotropics. *Biotropica*, 24(3), 440-446. <https://doi.org/10.2307/2388615>
- Fleming, T. H. (1988). *The short-tailed fruit bat: a study in plant-animal interactions*. University of Chicago Press.
- Fleming, T. H., & Heithaus, E. R. (1981). Frugivorous bats, seed shadows, and the structure of tropical forests. *Biotropica*, 13(2), 45-53. <https://doi.org/10.2307/2388069>
- Garbino, G. S. T., Gregorin, R., Lima, I. P., Loureiro, L., Moras, L. M., Moratelli, R., Nogueira, M. R., Pavan, A. C., Tavares, V. C., & Peracchi, A. L. (2020). Updated checklist of Brazilian bats (Versão 2020) [Checklist]. Comitê da Lista de Morcegos do Brasil. <https://www.sbeq.net/lista-de-especies>
- Gardner, A. L. (Ed.) (2019). *Mammals of South America* (Vol. 1). University of Chicago Press.
- Ghanem, S. J., & Voigt, C. C. (2012). Increasing awareness of ecosystem services provided by bats. *Advances in the Study of Behavior*, 44: 279-302. <https://doi.org/10.1016/B978-0-12-394288-3.00007-1>
- Heltsh, J., & Forrester, N. E. (1983). Estimating Species Richness Using the Jackknife Procedure. *Biometrics*, 39(1), 1-11. <https://doi.org/10.2307/2530802>
- Kalka, M. B., Smith, A. R., Kalko, E. K. (2008). Bats limit arthropods and herbivory in a tropical forest. *Science*, 320(5872), 71. <https://doi.org/10.1126/science.1153352>
- Kalko, E. K. V. (1998). Organisation and diversity of tropical bat communities through space and time. *Zoology*, 101, 281-297.
- Kunz, T. H., & Pierson, E. D. (1994). *Bats of the world: an introduction*. Johns Hopkins University.
- Lang, A. B., Kalko, E. K., Römer, H., Bockholdt, C., & Dechmann, D. K. (2006). Níveis de atividade de morcegos e katydids em relação ao ciclo lunar. *Ecologia*, 146, 659-666.
- Lewis, O. T. (2006). Climate change, species-area curves and the extinction crisis. *Phil. Trans. R. Soc. B*, 361, 163-171. <https://doi.org/10.1098/rstb.2005.1712>
- Lino, A., Ferreira, E., Fonseca, C., Fischer, E., & Pereira, M. J. R. (2021). Species-genetic diversity correlation in phyllostomid bats of the Bodoquena plateau, Brazil. *Biodiversity and Conservation*, 30,

- 403-429. <https://doi.org/10.1007/s10531-020-02097-0>
- Machado, R. B., Ramos-Neto, M. B., Pereira, P. G. P., Caldas, E. F., Gonçalves, D. A., Santos, N. S., Tabor, K., Steininger, M. (2004). *Estimativas de perda da área do Cerrado brasileiro*. <http://cmbbc.cpac.embrapa.br/RelatDesmatamCerrado%20CIBrasil%20JUL2004.pdf>
- Martínez-Ferreira, S. R., Alvarez-Añorve, M. Y., Bravo-Monzón, A. E., Montiel-González, C., Flores-Puerto, J. I., Morales-Díaz, S. P., Chiappa-Carrara, X., Oyama, K., & Avila-Cabadilla, L. D. (2020). Taxonomic and functional diversity and composition of bats in a regenerating neotropical dry Forest. *Diversity*, 12(9), 1-22. <https://doi.org/10.3390/d12090332>
- Medellín, R. A., Equihua, M., & Amin, M. A. (2000). Bat diversity and abundance as indicators of disturbance in Neotropical rainforests. *Conservation Biology*, 14(6), 1666-1675. <https://doi.org/10.1111/j.1523-1739.2000.99068.x>
- Mello, M. A. R., Schittini, G. M., Selig, P., & Bergallo, H. G. (2004). Seasonal variation in the diet of the bat *Carollia perspicillata* (Chiroptera: Phyllostomidae) in an Atlantic Forest area in southeastern Brazil. *Mammalia*, 68, 49-55. <https://doi.org/10.1515/mamm.2004.006>
- Mendes, P., Vieira, T. B., Oprea, M., Pimenta, V. T., & Ditchfield, A. D. (2014). Diferentes métodos de regeneração florestal podem interferir na comunidade local de morcegos? *Mastozoología Neotropical*, 21(2), 231-240. https://www.researchgate.net/publication/271211357_Diferentes_metodos_de_regeneracao_florestal_podem_interferir_na_comunidade_local_de_morcegos
- Mickleburgh, S. P., Hutson, A. M., & Racey, P. A. (2002). A review of the global conservation status of bats. *Oryx*, 36(1), 18-34. <https://doi.org/10.1017/S0030605302000054>
- Muylaert, R. L., Stevens, R. D., & Ribeiro, M. C. (2016). Threshold effect of habitat loss on bat richness in cerrado-forest landscapes. *Ecological Applications*, 26(6), 1854-1867. <https://doi.org/10.1890/15-1757.1>
- Palheta, L. R., Urbietta, G. L., Brasil, L. S., Dias-Silva, K., Da Silva, J. B., Graciolli, G., Aguiar, L., & Vieira, T. B. (2020). The effect of urbanization on bats and communities of bat flies (Diptera: Nycteribiidae and Streblidae) in the Amazon, northern Brazil. *Acta Chiropterologica*, 22(2), 403-416. <https://doi.org/10.3161/15081109ACC2020.22.2.014>
- Pedro, W. A., & Taddei, V. A. (1997). Taxonomic assemblage of bats from Panga Reserve, southeastern Brazil: abundance patterns and trophic relations in the Phyllostomidae (Chiroptera). *Bol. Mus. Biol. Mello Leitão*, 6, 3-21.
- Pedro, W. A., & Taddei, V. A. (2002). Temporal distribution of five bat species (Chiroptera, Phyllostomidae) from Panga Reserve, southeastern Brazil. *Revista Brasileira de Zoologia*, 19(3), 951-954. <https://doi.org/10.1590/S0101-81752002000300033>
- Peixoto, F. P., Braga, P. H. P., & Mendes, P. (2018). A synthesis of ecological and evolutionary determinants of bat diversity across spatial scales. *BMC Ecology*, 18, 1-14. <https://doi.org/10.1186/s12898-018-0174-z>
- Reis, N. R., Shibatta, O. A., Peracchi, A. L., Pedro, W. A., & Lima, I. P. (Eds.) (2007). *Morcegos do Brasil*. Universidade Estadual de Londrina.
- Rocha, R., López-Baucells, A., Farneda, F. Z., Groenenberg, M., Bobrowiec, P. E., Cabeza, M., Palmeirim, J. M., & Meyer, C. F. (2017). Consequences of a large-scale fragmentation experiment for Neotropical bats: disentangling the relative importance of local and landscape-scale effects. *Landscape Ecology*, 32, 31-45. <https://doi.org/10.1007/s10980-016-0425-3>
- Rose, D. C., Sutherland, W. J., Amano, T., González-Varo, J. P., Robertson, R. J., Simmons, B. I., Wauchope, H. S., Kovacs, E., Durán, A. P., & Vadrot, A. B. (2018). The major barriers to evidence-informed conservation policy and

- possible solutions. *Conservation Letters*, 11(5), 1-12. <https://doi.org/10.1111/conl.12564>
- Silva, J. B., Da Silva, L. C., Dias-Silva, K., de Oliveira Júnior, A. P., Da Silva, B. T. S., Veloso, G. K. O., Moy, K. M., Santana, P. da C. P., Rezende, R. F., Martins, T. S., De Sousa, L. M., & Vieira, T. B. (2020). Nota sobre morcegos (Mammalia, Chiroptera) e moscas ectoparasitas (Insecta, Diptera) do Parque Nacional da Serra do Pardo, estado do Pará, Brasil. *Boletim do Museu Paraense Emílio Goeldi. Ciências Nat.*, 15(3), 829-841. <https://doi.org/10.46357/bcnaturais.v15i3.263>
- Solari, S., Sotero-Caio, C. G., & Baker, R. J. (2019). Advances in systematics of bats: towards a consensus on species delimitation and classifications through integrative taxonomy. *Journal of Mammalogy*, 100(3), 838–851. <https://doi.org/10.1093/jmammal/gyy168>
- Sritongchuay, T., Hughes, A. C., & Bumrungsri, S. (2019). The role of bats in pollination networks is influenced by landscape structure. *Global Ecology and Conservation*, 20, 1-13. <https://doi.org/10.1016/j.gecco.2019.e00702>
- Straube, F. C., & Bianconi, G. V. (2002). Sobre a grandeza e a unidade utilizada para estimar esforço de captura com utilização de redes-deneblina. *Chiroptera Neotropical*, 8, 150-152.
- Thiagavel, J., Brinkløv, S., Geipel, I., & Ratcliffe, J. M., (2020). Sensory and Cognitive Ecology. In T. H. Fleming, L. M. Dávalos, & M. A. R. Mello (Eds.), *Phyllostomid Bats* (pp. 187-204). University of Chicago Press.
- Vieira, T. B., Mendes, P., & Oprea, M. (2010). Quirópteros (Mammalia, Chiroptera) do município de Alfredo Chaves, Estado do Espírito Santo. *Revista Brasileira de Zoociências*, 12(1), 95-102.
- Vieira, T. B., Silva, L. C. N. D., Aguiar, L. M. de S., Oprea, M., Mendes, P., & Ditchfield, A. D. (2021). Bat species composition associated with restinga lagoons from the Paulo César Vinha State Park, Espírito Santo, Brazil. *Papéis Avulsos de Zoologia*, 61, 1-9. <https://doi.org/10.11606/1807-0205/2021.61.32>
- Whittaker, R. J., Araújo, M. B., Jepson, P., Ladle, R. J., Watson, J. E., & Willis, K. J. (2005). Conservation biogeography: assessment and prospect. *Diversity and Distributions*, 11(1), 3-23. <https://doi.org/10.1111/j.1366-9516.2005.00143.x>
- Williams-Guillén, K., Perfecto, I., & Vandermeer, J. (2008). Bats limit insects in a neotropical agroforestry system. *Science*, 320(5872), 70. <https://doi.org/10.1126/science.1152944>
- Zachos, F. E., Wilson, D. E., & Mittermeier R. A. (Eds.). (2020) *Handbook of the Mammals of the World* (Vol. 9). Lynx Edicions.