Occurrence of *Sturnira tildae* De La Torre, 1959 (Chiroptera: Phyllostomidae) in the state of Maranhão, Brazil

Amanda Cristiny da Silva Lima¹; Cleison Luís da Silva Costa²; Samira Brito Mendes³; Fabio Henrique Souza Cardoso¹; Bruno Augusto Torres Parahyba Campos²; Elmary Costa Fraga⁴ & Maria Claudene Barros⁴

¹ Universidade Estadual do Maranhão (UEMA), Programa de Pós-Graduação em Ciência Animal. São Luís, MA, Brasil.
² Universidade Estadual do Maranhão (UEMA), Centro de Estudos Superiores de Caxias (CESC), Programa de Pós-Graduação em Biodiversidade Meio Ambiente e Saúde. Caxias, MA, Brasil.
³ Universidade Estadual do Maranhão (UEMA), Programa de Pós-Graduação da Rede de Biodiversidade e Biotecnologia da Amazônia Legal – BIONORTE. São Luís, MA, Brasil.
⁴ Universidade Estadual do Maranhão (UEMA), Centro de Estudos Superiores de Caxias (CESC), Departamento de Química e Biologia (DQB), Laboratório de Genética e Biologia Molecular. Caxias, MA, Brasil.
⁵ ORCID: http://orcid.org/0000-0001-6202-8058. E-mail: amanda01cristiny@outlook.com
⁶ ORCID: http://orcid.org/0000-0003-1717-9994. E-mail: cleison-costa@outlook.com
⁷ ORCID: http://orcid.org/0000-0003-0291-6859. E-mail: mendesbrito25@gmail.com
⁸ ORCID: http://orcid.org/0000-0001-6446-1031. E-mail: fabiohenrique16s@hotmail.com
⁹ ORCID: http://orcid.org/0000-0001-5586-2597. E-mail: atpcampos@gmail.com
¹⁰ ORCID: http://orcid.org/0000-0001-8062-0338. E-mail: elmaryfraga@yahoo.com.br
¹¹ ORCID: http://orcid.org/0000-0001-9055-1911. E-mail: mbdene@yahoo.com.br (corresponding author)

Abstract. The bat genus *Sturnira* is widely distributed in the Neotropical region, from northwestern Mexico to northern Argentina, and four species occur in Brazil: *Sturnira lilium, Sturnira giannae, Sturnira magna,* and *Sturnira tildae*. The present study is the first to record *Sturnira tildae* in the state of Maranhão, Brazil, based on morphological and molecular diagnoses. The specimen was identified based on its cranial and morphometric traits. The diagnostic traits include discreetly bilobed inner upper incisors with a broad base, lower first and second molars with lingual cusps separated by shallow grooves, and forearm longer than 45 mm. The molecular sequences of Cytochrome C Oxidase Subunit 1 (COI) and 16S rRNA genes confirmed the morphological identification and thus the occurrence of *Sturnira tildae* in the Amazon biome of Maranhão. This record represents an eastward extension of the known distribution of the species in the Amazonia, to Cândido Mendes, Maranhão, within an area dominated by dense rainforest and influenced by tides.

Keywords. 16S rRNA; Amazon; COI; DNA barcode; Range extension; Stenodermatinae.

INTRODUCTION

Brazil has is the country with the third richest bat fauna in the world, with 181 species (including eight endemics) representing 68 genera and nine families (Garbino et al., 2020; Velazco 2021). Much of this diversity is found in the Amazon biome, which is home to most of the species known to occur in Brazil (Bernard et al., 2011). In this scenario, the Amazon of Maranhão, in the eastern extreme of the biome, is one of the Amazonian regions that have a fragmented distribution of bat species records, but which are gradually a number of recent studies have provided important insights into the distribution of chiropterans in this region (Bernard et al., 2011; Oliveira et al., 2011; Olimpio et al., 2016; Lima et al., 2018; Olimpio et al., 2018; Mendes et al., 2020).

Bats of the family Phyllostomidae are the most ecologically diverse group of mammals, and the second most speciose mammalian family, with 216 recognized species (Taylor & Tuttle, 2019). In recent years, a number of studies reporting the fauna of poorly-known areas associated with phylogenetic analyses, have advanced the scientific understanding of phyllostomid diversity, including the discovery of new species and the expansion of the inventories available for many genera, such as *Sturnira* (Miretzki et al., 2002).

The phyllostomid genus *Sturnira* has a wide distribution in the Neotropical region, occurring from Mexico to northern Argentina (Gardner,
2008). *Sturnira* is the most speciose phyllostomid genus, with 23 recognized species (Fleming et al., 2020), of which, four occur in Brazil – *Sturnira lilium* (Geoffroy, 1810), *Sturnira giannae* Velazco & Patterson, 2019, *Sturnira magna* De La Torre, 1966 and *Sturnira tildae* De La Torre, 1959 (Garbino et al., 2020). *Sturnira tildae* is found in Brazil, Colombia, Ecuador, the Guianas, Peru, Bolivia, Trinidad and Tobago, and Venezuela (Simmons, 2005; Gardner, 2008). In Brazil, this species has been recorded in the states of Amapá, Amazonas, Pará, Acre, Tocantins, Ceará, Pernambuco, Bahia, Mato Grosso, Goiás, Mato Grosso do Sul, Espírito Santo, Rio de Janeiro, São Paulo, Paraná, and Santa Catarina (Martins et al., 2020).

Relatively few data are available on the diet or reproductive patterns of *S. tildae*, but this bat is assumed to be an important seed disperser, which contributes to the regeneration of forested areas (Simmons, 2005; Gardner, 2008). *S. tildae* shares a number of external characteristics with the other members of the genus, such as the lack of a tail, narrow and hairy intermembrane, small ears, a small, broad nose leaf, and posterior members and feet hairy, as far as the claws (Peracchi et al., 2011). The color of the pelage varies from tones of yellow to brown, with some males having tufts of orangish or dark reddish-brown hair on the shoulders (Reis et al., 2017).

The external measurements of *S. tildae* are similar to *S. lilium*, although *S. lilium* tends to be smaller (Gardner, 2008). Some studies point to the possibility of identification errors of identification related to the morphological similarities of these species and the overlap in their geographic distributions (Miretzki et al., 2002; Sampaio et al., 2016; Velazco & Patterson, 2017; Martins et al., 2020). In areas that are in sympatry, *S. lilium* differs from *S. tildae* only by dental and morphometric characteristics (Simmons & Voss, 1988; Martins et al., 2020). The present study uses morphological and molecular data to report on a new record of *S. tildae* from the state of Maranhão, which extends the known geographic distribution of the species in Brazil.

**MATERIAL AND METHODS**

Bats were collected in June 2016 in a fragment of forest located within the Amazon biome of the Brazilian state of Maranhão, in the municipality of Cândido Mendes. Specimen collection followed the protocol of Pacheco (2004) and permits were duly provided by the Brazilian federal agency for the environment (IBAMA/SISBIO permit number 42670-3). The vegetation of the study region is dense rainforest typical of the Amazon biome, and it has a humid equatorial climate, as well as being influenced by the tides of the Maracaçumé River, which crosses the town of Cândido Mendes (Bandeira, 2013).

The specimen described here was collected using a 3 m high and 12 m long mist-net, with a 25 mm mesh. The age of the specimen was determined in the field based on the ossification of the phalangeal epiphyses, and its sex and reproductive status were also recorded (Brunet & Austad, 2004). The specimen was photographed, euthanized, labeled, and stored on ice for transportation to the Genetics and Molecular Biology Laboratory (GENBIMOL) of Universidade Estadual do Maranhão (UEMA) in Caxias, Maranhão, where it was weighed and measured, and a sample of a muscle tissue was extracted, which was stored in ethanol 70% for the molecular analyses.

The skull was extracted through the buccal aperture. Once clean, the skull was clarified with 10% peroxide and dried in a stove at 30°C, after which, it was labeled and stored in a clean recipient. The specimen was fixed in formaldehyde and preserved in ethanol at UEMA’s Laboratory of Genetics and Molecular Biology, on the campus of Caxias, and then transferred to the mammal collection of the Federal University of Paraiba, in João Pessoa, Brazil, where is it deposited. The specimen was identified based on its external traits and craniometric measurements, following Vizzoto & Taddei (1973), Simmons & Voss (1998), and Reis et al. (2013, 2017). Measurements taken include the length of right and left forearms, ear, tragus, foot, greatest length of the skull, basal length and condylobasal length, width of the brain case and the mastoid, zygomatic width, the length of the upper tooth row, and the width across the molars (Table 1). Body mass, after the specimen had been dead for hours, was determined using a precision balance after euthanasia of the specimen.

The total DNA was extracted from the muscle tissue using Promega’s Wizard Genomic DNA Purification kit, following the default protocol. Two mitochondrial genes, Cytochrome C Oxidase Subunit 1 (COI) and rRNA 16S, were amplified by Polymerase Chain Reaction (PCR) using the primers LCO-1490 and HCO-2198 for the COI gene (Folmer et al., 1994) and L1987 and H2609 for the rRNA 16S (Palumbi et al., 2002). The samples were sequenced by the dideoxyterminal method of Sanger et al. (1977) in an ABI Prism™ 3500 (Applied Biosystems, USA) automatic DNA sequencer, using the Big Dye kit. The sequences were edited and aligned in BIOEDIT 7.0 (Hall, 1999), with the genetic divergence matrices being compiled in MEGA X (Kumar et al., 2018) using the Kimura 2-parameter algorithm. The sequences were plotted in the BOLD Systems v4 (www.boldsystems.org) and BLAST (https://blast.ncbi.nlm.nih.gov/Blast.cgi) platforms to confirm their identification and determine their degree of similarity with sequences of other *Sturnira* species.

**RESULTS**

We collected an adult female *S. tildae* (field number: RRM 117, voucher: UFPEB 11757) in June 2016 from a farm located within the urban perimeter of the town of Cândido Mendes (01°27′21″S, 45°43′32″W), in the Amazon biome, within an area containing remnants of rainforest. The length of the right forearm was 45.77 mm, while its left forearm was 46.34 mm. The length of ear of the specimen was 12.95 mm, the tragus 5.46 mm, and the foot 12.45 mm. The specimen was a non-lactating...
which had ectoparasites, orange-brown pelage, with the venter paler than the dorsum, and dark hairs around the eyes (Fig. 1).

*Sturnira tildae* was also identified based on the following set of morphological cranial traits: small brain case and broad, high rostrum, slightly bilobed upper incisors with a wide base and narrower points, and first and second lower molars with lingual cusps separated by shallow grooves with no vertical border (Fig. 2A-D and Table 1).

The present study provides the first record of *S. tildae* from the Brazilian state of Maranhão, and only the fifth for the Brazilian Northeast geographic region (two from Bahia state – Faria & Baumgarten, 2007; Faria, 2006, one from Pernambuco; Martins et al., 2020 and one from Ceará – Novaes & Laurindo, 2014). The geographically closest locality to Cândido Mendes with records of *S. tildae* is Santa Barbara, in the neighboring state of Pará, which is ca. 280 km due west ( Fonseca, 2006). There is also a record from the municipality of Muñá, in Pará ( Marques-Aguiar et al., 2002), which is 402 km west of Cândido Mendes. Both these localities are within the Amazon biome. South of Maranhão, the nearest locality is in the municipality of Goiatins, in Tocantins state (Maas et al., 2018), which is 724 km to the south, in the Cerrado savanna biome, while the nearest record to the east is from the municipality of Barbalha, in Ceará state, at a distance of 967 km, in the Caatinga biome ( Novaes & Laurindo, 2014) (Fig. 3). The present study extends the known distribution of *S. tildae* to the eastern extreme of the Amazon biome.

The sequence of the rRNA 16S gene obtained from the specimen analyzed in the present study diverged by 0.4% from those of *S. tildae* from French Guiana and by 4.8% from *S. lilium*. The BLAST search identified a genetic similarity of 100% with *S. tildae* from French Guiana. In the case of the COI gene sequences, intraspecific genetic divergence between the study specimen and sequences from French Guiana, Surinam, Ecuador, and Guyana was 0.92-1.58%, while it was 11.8% in relation to *S. lilium*. In the BOLD Systems platform, the sequence returned a similarity of 99.09% with *S. tildae* from French Guiana (Table 2). These results are consistent with the morphological and craniometric identification of the specimen, and confirm the occurrence of *S. tildae* in the Amazon biome of Maranhão state.

### DISCUSSION

In the present study, the cranial and morphological measurements of the specimen, are typical of *S. tildae*, as defined by De La Torre (1959), Simmons & Voss (1998), Miretzki et al. (2002), López-Baucells et al. (2016), Velazco & Patterson (2019), and Martins et al. (2020). The cranial and dental measurements of the specimen (skull, basal, and condylobasal lengths, the length of the upper tooth row, and the postorbital and zygomatic widths, the width of the braincase, and the width across the molars) are all very similar to those of the *S. tildae* specimens collected in Recife, Pernambuco (Martins et al., 2020) and Morretes, Paraná (Miretzki et al., 2002). This indicates that differences due to the geographic or sexual variation are negligible.

The species *S. tildae* has great morphological similarities with *S. lilium*, making identification difficult. (Simmons & Voss, 1998). A number of diagnostic traits can nevertheless be used to distinguished the two taxa, including the length of the forearm, which exceeds 45 mm in *S. tildae*, but never exceeds this value in *S. lilium* (Simmons & Voss, 1998; Reis et al., 2013, 2017; Martins et al., 2002). In the present study, the cranial and morphological similarities with *S. lilium* were negligible. (Simmons & Voss, 1998). The examination of the specimen and the comparison of the measurements to other published data indicate that the specimen analyzed in the present study is *S. tildae*.

### Table 1. Craniometric measurements (in mm) of the *Sturnira tildae* specimen from Cândido Mendes, Maranhão, Brazil (present study), together with the values recorded from specimens of the same species from Recife (Pernambuco), Morretes (Paraná), and French Guiana.

| Measurements (mm)       | Present study | Martins et al. (2020) | Miretzki et al. (2002) | Simmons & Voss (1998) |
|-------------------------|---------------|-----------------------|------------------------|------------------------|
|                         | Female (n=1)  | Female (n=1)          | Male (n=1)             | Female (n=13)          | Male (n=11)             |
| Length of the skull     | 23.6          | 23.6                  | —                      | —                      | —                      |
| Basal length            | 18            | —                     | 18.5                   | —                      | —                      |
| Condylar length         | 21.6          | 22.6                  | 21.71                  | 21.26                  | 21.65                  |
| Length of upper tooth row | 7.1          | 7.6                   | 7.10                   | 6.87                   | 6.81                   |
| Postorbital width       | 6.2           | 6.5                   | 6.55                   | 6.16                   | 6.21                   |
| Width of the maxilla    | 11.9          | —                     | 12.92                  | 12.76                  | 12.96                  |
| Zygomatic width         | 14            | 14.0                  | 14.80                  | 14.15                  | 14.37                  |
| Width of the braincase  | 10.1          | 10.2                  | 10.96                  | 10.80                  | 10.94                  |
| Width across the molars | 8             | 7.9                   | —                      | 8.21                   | 8.02                   |

*Figure 1. Sturnira tildae* (female, RRM 117) collected em Cândido Mendes, in the Amazon biome of Maranhão state, Brazil.*
Figure 2. Skull of *Sturnira tildae* (RRM 117). (A) dorsal view showing the small braincase; (B) lateral view showing the broad, elongated rostrum; (C) lateral view of the mandible showing the first and second molars with lingual cusps separated by shallow grooves; (D) frontal view of the upper incisors, showing the slightly bilobed internal incisors with a wide base. Scale bar: 5 mm. Source: Olímpio, A.P.M.; Lima, A.C.S.

Figure 3. Geographic distribution of *Sturnira tildae* in Brazil. The locality reported in the present study in the state of Maranhão is shown by a star. The Brazilian biomes are shaded in black (Pantanal), darker to lighter gray (Pampas, Atlantic Forest, Cerrado, and Caatinga, in this order), and white (Amazon). Source: adapted from Martins et al. (2020).
et al., 2020); the lighter coloration of the pelage of the venter in S. tildae in comparison with S. lilium, and the larger lengths of the ear, tibia, wing, and condylobasal length in S. tildae (Fazzolari-Correa, 1995; Davis, 1980). All these differences were also observed in the S. tildae specimen analyzed in the present study.

The dentition provides the most reliable evidence for the differentiation of the two species, given the presence of bilobed internal superior incisives and wider in S. tildae, than observed in S. lilium (Eisenberg, 1989), as well as the lingual cusps of the first and second molars of the mandible, S. lilium has high lingual cusps, separated by a deep vertical notch between the first and second molars and in S. tildae these cusps are low and separated by shallow notches (Miretzki et al., 2002). These authors considered the differences in the configuration of the cusps of the mandibular molars to be completely reliable for the distinction of the specimens of S. lilium and S. tildae from Paracou, in French Guiana, and this conclusion was further confirmed in the present study.

The analyses of the 16S rRNA and COI genes revealed a high degree of similarity, in both cases, between the specimen presented here and S. tildae from French Guiana, with a genetic divergence of less than 2% in comparison with the specimens from of different localities, which is consistent with the 2% intraspecific threshold of the COI marker established for bats by Clare et al. (2011). Despite the fact that S. lilium and S. tildae present major morphological similarities, the analysis of the rRNA 16S sequences indicated a divergence of 4.8% between the S. tildae specimen presented here and S. lilium, increasing to 11.8% for the COI gene. The genetic data thus support conclusively the morphological and craniometric analyses, and confirm the occurrence of S. tildae in Maranhão.

As for distribution, S. tildae is considered a common species within its geographic distribution (Wilson 1996; Miretzki et al., 2002), with a distinct preference for more humid forest environments (Trajano, 1984; Marques, 1985; Brosset et al., 1996; Simmons & Voss, 1998; Miretzki et al., 2002; Novaes & Laurindo, 2014), such as the locality surveyed during the present study. Even so, S. tildae has been captured relatively infrequently in most bat field studies, in all different biomes (Oliveira, 2000; Marques-Aguiar et al., 2002; Miretzki et al., 2002; Carvalho et al., 2013; Luz et al., 2013; Menezes et al., 2015; Maas et al., 2018; Cláudio et al., 2020; Martins et al., 2020).

In Brazil, S. tildae has been recorded in the Amazon, Atlantic Forest, Cerrado, and Caatinga biomes. In the Amazon biome (IBGE, 2019), there are records from the Brazilian states of Amazons, Acre, Rondônia, Pará, Amapá, Roraima, and Mato Grosso (Tavares et al., 2008; Reis et al., 2013; Novaes & Laurindo, 2014; Reis et al., 2017), and the closest locality to the present study site is 280 km west, in Pará. This is the fifth record of the occurrence of S. tildae in the Brazilian Northeast. The previous records included one from the Caatinga biome, in Barbalha, Ceará state (Novaes & Laurindo, 2014), and three from the Atlantic Forest, in Ilhéus (Faria & Baumgarten, 2007) and Una (Faria, 2006), both in Bahia, and Recife in Pernambuco state (Martins et al., 2020). Barbalha is very close – about 20 km – to Floresta Nacional do Araripe. The area is considered to be a relict of Atlantic Forest in the middle of the Caatinga (Silveira et al., 2019).

**CONCLUSIONS**

The present study recorded the occurrence of S. tildae in the Amazon biome of the Brazilian state of Maranhão, based on both morphological and molecular evidence. This is the first record of the species for the state, and the fifth for the Brazilian Northeast, and extends the known distribution of the species to the municipality of Cândido Mendes, 280 km east of the nearest locality in the Amazon biome. The findings of the study reinforce the need for attention when identifying the species of the genus *Sturnira*, in particular in areas where *S. lilium* and *S. tildae* are likely to be captured together and then released, given that the considerable morphological similarities of these sympatric taxa may result in errors of identification. As *S. tildae* occurs more frequently in moist
ACKNOWLEDGMENTS

ACSL and FHSC were supported by postgraduate fellowships and BATPC was supported by Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) postdoctoral fellowships. CLSC was supported by a postgraduate grant from the Universidade Estadual do Maranhão (UEMA). This study was financed in part by CAPES – Financial Code 001 and the Foundation for Research and Scientific and Technological Development of Maranhão (FAPEMA).

AUTHORS’ CONTRIBUTIONS

ACSL: Conceptualization, Writing – original draft, Visualization, Investigation, Data curation, Formal Analysis, Validation. CLSC: Conceptualization, Visualization, Writing – review & editing. SBM: Visualization, Methodology, Data curation, Writing – review & editing. FHSC: Visualization, Methodology, Writing – review & editing. BATPC: Supervision, Data curation, Writing – review & editing. ECF: Supervision, Writing – review & editing, Funding acquisition, Project administration, Validation. MCB: Supervision, Writing – review & editing, Formal Analysis, Validation, Data curation, Funding acquisition, Project administration. All the authors actively participated in the discussion of the results, they reviewed and approved the final version of the paper.

CONFLICT OF INTEREST

Authors declare that there is no conflict of interest.

REFERENCES

Bandeira, I.C.N. 2013. Geodiversidade do estado do Maranhão. Programa Geologia do Brasil. Levantamento da Geodiversidade. Teresina, CPRM. 294p.

Bernard, E.; Tavares, V.C. & Sampaio, E. 2011. Compilação atualizada das espécies de morcegos (Chiroptera) para a Amazônia Brasileira. Biota Neotropical, 11(1): 35-46. DOI

Brosset, A.; Charles-Dominique, P.; Cockle, A.; Cossen, J.F. & Masson, O. 1996. Bat communities and deforestation in French Guiana. Canadian Journal of Zoology, 74(11): 1974-1982. DOI

Brunet, A.K. & Austad, S.N. 2004. Aging studies on bats: a review. Biogerontology, 5(4): 211-222. DOI

Carvalho, F.; Fabián, M.E. & Meneghetti, J.O. 2013. Vertical structure of an assemblage of bats (Mammalia: Chiroptera) in a fragment of Atlantic Forest in Southern Brazil. Zoologia, 30(5): 491-498. DOI

Clare, E.L.; Lim, B.K.; Fenton, M.B. & Hebert, P.D.N. 2011. Neotropical bats: estimating species diversity with DNA barcodes. PloS ONE, 6(7): 322-648. DOI

Cláudio, V.C.; Barbosa, G.P.; Rocha, V.J.; Moratelli, R. & Rasy, F.B. 2020. The bat fauna (Mammalia: Chiroptera) of Carlos Botelho State Park, Atlantic Forest of Southeastern Brazil, including new distribution records for the state of São Paulo. Zoologia, 37(e36514): 1-32. DOI

Davis, W.B. 1980. New Sturnira (Chiroptera, Phyllostomidae) from Central and South America, with key to currently recognized species. Occasional Papers of the Museum of Texas Tech University, 93: 1-16. DOI

De La Torre, L. 1959. A new species of bat of the genus Sturnira (Phyllostomidae) from the Island of Trinidad, West Indies. Natural History Miscellaneous, Chicago, 166: 1-6.

Eisenberg, J.F. 1989. Mammals of the Neotropics: the northern Neotropics. Chicago, The University of Chicago Press. v. 1, 449p.

Faria, D. 2006. Phyllostomid bats of a fragmented landscape in the northeastern Atlantic forest, Brazil. Journal of Tropical Ecology, 22(5): 531-542. DOI

Faria, D. & Baumgarten, J. 2007. Shade cacao plantations (Theobroma cacao) and bat conservation in southern Bahia, Brazil. Biodiversity and Conservation, 16(2): 291-312. DOI

Fazzolari-Correia, S. 1995. Aspectos sistematicos, ecologicos e reprodutivos de morcegos na Mata Atlantica. Doctoral thesis. São Paulo, Universidade de São Paulo, Instituto de Biociências. 168p.

Fleming, T.H.; Dávalos, L.M. & Mello, M.A.R. 2020. Phyllostomid bats: a unique mammalian radiation. Chicago, The University of Chicago Press. 489p.

Folmer, O.; Black, M.; Hoeh, W.; Lutz, R. & Vrijenhoek, R. 1994. DNA primers for amplification of mitochondrial Cytochrome C Oxidase Subunit 1 from diverse metazoan invertebrates. Molecular Marine Biology and Biotechnology, 3(5): 294-299.

Fonseca, R.T.D. 2006. Diversidade da quiopterofauna (Mammalia) no Parque Ecológico de Gunna, Santa Bárbara do Pará. Master thesis. Belém, Universidade Federal do Pará. 120p.

Garbin, G.S.T.; Gregorin, R.; Lima, I.P.; Loureiro, L.; Moras, L.M.; Moratelli, R.; Nogueira, M.R.; Pavan, A.C.; Tavares & Peracchi, V.C. 2020. Updated checklist of Brazilian bats: versão 2020. Comité da Lista de Morcegos do Brasil – CLMB. Sociedade Brasileira para o Estudo de Quiopteros (SBEQ). Available: https://www.sbeq.net/lista-de-especies. Access: 01/05/2021.

Gardner, A.L. 2008. Tribe Sturnirini. In: Gardner, A.L. (Ed.). Mammals of South America. Volume 1: Marsupials, Xenarthrans, Shrews, and Bats. Chicago, The University of Chicago Press. p. 363-376

Hall, T.A. 1999. BioEdit: a user-friendly biological sequence alignment editor and analysis program for Windows 95/98/NT. Nucleic acids symposium, 41: 95-98.

Instituto Brasileiro de Geografia e Estatística (IBGE). 2019. Biomas e sistema costeiro-marinho do Brasil: compatível com a escala 1:250.000. Rio de Janeiro. Coordenção de Recursos Naturais e Estudos Ambientais, Relatórios metodológicos (IBGE), ISSN 0101-2843, 164pp.

Kumar, S.; Stecher, G.; Linn, Knyaz & Tamura, K. 2018. MEGA X: Molecular Evolutionary Genetics Analysis across computing platforms. Molecular Biology and Evolution, 35(6): 1547-1549.

Lima, A.C.S.; Cardoso, F.H.S.; Mendes, S.B.; Fraga, E.C. & Barros, M.C. 2018. New records of Niceforo's big-eared bat, Triniteris nicefori (Sanborn, 1949) (Chiroptera, Phyllostomidae), from the state of Maranhão, Brazil. ZooKeys, 787: 127-134. DOI

López-Baucells, A.; Rocha, R.; Bobroviec, P.D.; Palmeirim, J.M. & Meyer, C.F.J. 2016. Field guide to amazonian bats. Manaus, Editora INPA. 173p.

Luz, J.L.; Costa, L.M.; Jordão-Nogueira, T.; Esbérard, C.E.L. & Bergallo, H.G. 2013. Morcegos em área de floresta montana, Visconde de Mauá, Resende, Rio de Janeiro. Biota Neotropical, 13(2): 190-195. DOI

Maas, A.C.S.; Gomes, L.; Martins, M.A.; Dias, D.; Pol, A.; Chaves, G.F.; Schutte, M.; Araújo, R. & Peracchi, A.L. 2018. Bats in a Cerrado landscape of Northern Brazil: species occurrence, influence of environmental
heterogeneity and seasonality, and eight new records for the state of Tocantins. *Mammalia, 82*(5): 469-480. DOI

Marques, S.A. 1985. Novos registros de morcegos do Parque Nacional da Amazônia (Tapajós), com observações do período de atividade noturna e reprodução. *Boletim do Museu Paraense Emílio Goeldi Zoologia, 2*(1): 71-83. Available: https://repositorio.museu-goeldi.br/handle/mgoeldi/401

Marques-Aguiar, S.A.; Melo, C.C.S.; Aguiar, G.F.S. & Queiroz, J.A.L. 2002. Levantamento preliminar da mastofauna da região de Anajás-Muaná, Ilha de Marajó, Pará, Brasil. *Revista Brasileira de Zoolo gia, 19*(3): 841-854. DOI

Martins, T.C.S.; Leal, E.S.B.; Neves, C.H.C.B.; Ferreira, A.F.; Silva, L.G.; Garcia, A.C.L. & Montes, M.A. 2020. First record of *Sturnira tildae* de La Torre, 1859 (Chiroptera, Phyllostomidae) for the state of Pernambuco, Brazil. *Oecologia Australis, 24*(1): 223-234. DOI

Mendes, S.B.; Lima, A.C.S.; Reis, T.S.; Fraga, E.C. & Barros, M.C. 2020. First record of *Gynomops planiransistris* (Peters, 1865) (Chiroptera, Molossidae) from Maranhão state, Brazil, based on morphological and molecular data. *Brazilian Journal of Biology, 80*(2): 405-409. DOI

Menezes, L.F.; Pinto, A.C.D.C; Contildes, M.D.R. & Peracchi, A.L. 2015. Lista de morcegos (Mammalia Chimptera) do Parque Natural Municipal da Serra do Mendanha, Municipio do Rio de Janeiro, RJ, Brasil. In: Pontes, J.A.L. (Ed.). *Biodiversidade carioca*. Rio de Janeiro, Technical Books. p. 238-245

Miretzki, M.; Perrach, A.L. & Biancon, G.V. 2002. Southernmost records of *Sturnira tildae* de La Torre, 1959 (Chiroptera: Phylllostomidae) in Brazil. *Mammalia, 66*(2): 306-309

Novaes, R.L.M. & Laurindo, R.S. 2014. Morcegos da Chapada do Araripe, Nordeste do Brasil. *Papéis Avulsos de Zoologia, 54*(22): 1-13. DOI

Olimpio, A.P.M.; Cardoso, F.H.S.; Costa, C.L.S.; Fraga, E.C. & Barros, M.C. 2018. Expansion of the known range of the lesser bulldog bat, *Noctilio albiventris* Desmarest, 1818 (Chiroptera, Noctilionidae) in the Brazilian Cerrado. *Check List, 14*(2): 313-317. DOI

Olimpio, A.P.M.; Ventura, M.C.S.; Mascarenhas, M.J.O.; Nascimento, D.C.; Andrade, F.A.G.; Fraga, E.C. & Barros, M.C. 2016. Bat fauna of the Cerrado savanna of eastern Maranhão, Brazil, with new species occurrences. *Biotia Neotropica, 16*(3), e20150089. DOI

Oliveira, E.R. 2000. Espaco ecomorfológica da fauna de quirópteros da região do Alto Tocantins, GO: uma perspectiva através da análise da morfologia oral. Master thesis. Rio de Janeiro, Universidade Federal do Rio de Janeiro. 82p.

Oliveira, T.G.; Júnior, J.S.S. & Dias, P.A. 2011. Mamíferos da Amazônia carioca. In: Martins, M.B. & Oliveira, T.G. (Eds.). *Amazônia Maranhense: Diversidade e conservação*. Belém, Museu Paraense Emilio Goeldi. p. 251-267

Pacheco, S.M. 2004. Técnicas de campo empregadas no estudo de quirópteros. *Caderno La Salle XI, Canoa, 1*(2): 195-202.

Palumbi, S.; Martin, A.; Romano, S.; McMillan, W.O.; Stice, L.; Grabowski, G. & MacMillan, W.O. 2002. *The simple fool’s guide to PCR, version 2.0*. University of Hawaii, Honolulu

Peracchi, A.L.; Lima, I.P.; Reis, N.R.; Nogueira, M.R. & Filho, H.O. 2011. Ordem Chiroptera. In: Reis, N.R.; Peracchi, A.L.; Pedro, W.A. & Lima, I.P. *Mamíferos do Brasil*. 2. ed. Londrina. p. 153-234

Reis, N.R.; Fregonezi, M.N.; Peracchi, A.L. & Shibatta, A.O. 2013. *Morcegos do Brasil: guia de campo*. Rio de Janeiro, Technical Books. 225p.

Reis, N.R.; Peracchi, A.L.; Batista, C.B.; Lima, I.P. & Pereira, A.D. 2017. *História natural dos morcegos brasileiros: chave de identificação de espécies*. Rio de Janeiro, Technical Books. 416p

Sampaio, E.; Lim, B. & Peters, S. 2016. *Sturnira tildae*. The IUCN Red List of Threatened Species 2016: e.T29060A22050501. DOI

Sanger, F.; Nichlen, S. & Coulson, A.R. 1977. DNA sequencing with chain termination inhibitors. *Proceedings of the National Academy of Sciences Cambridge, 74*(12): 5463-5467

Silveira, M.H.B.; Mascarenhas, R.; Cardoso, D. & Batalha-Filho, H. 2019. Pleistocene climatic instability drove the historical distribution of forest islands in the northeastern Brazilian Atlantic Forest. *Paleoecography, Paleoclimatology, Paleoecology, 527*: 67-76

Simmons, N.B. 2005. Order Chiroptera. In: Wilson, D.E. & Reeder, D.M. (Eds.). *Mammals species of the world: a taxonomic and geographic reference*. 3. ed. Baltimore, Johns Hopkins University Press. v. 1, p. 312-529

Simmons, N.B. & Voss, R.S. 1998. The mammals of Paracou, French Guiana: a neotropical lowland rainforest fauna. Part I. *Bats. Bulletin of the American Museum of Natural History, 237*: 1-219

Tabarelli, M. & Santos, A.M.M. 2004. Uma Breve Descrição Sobre a História Natural dos Brejos Nordestinos. In: Pórtio, K.C.; Cabral, J.J.P.; Tabarelli, M. (Eds.). *Brejos de Altitude em Pernambuco e Paraíba — História Natural, Ecologia e Conservação*. 17-24pp

Tavares, V.C.; Gregorin, R. & Peracchi, A.L. 2008. Diversidade de morcegos no Brasil: lista atualizada com comentários sobre distribuição e taxonomia. In: Pacheco, S.M.; Marques, R.V. & Esberard, C.E.L. (Eds.). *Morcegos no Brasil: Biologia, Sistemática, Ecologia e Conservação*. Armazém Digital Comunicação Ltda., Porto Alegre, 25-58.

Taylor, M. & Tuttle, M.D. 2019. *BATS: an illustrated guide to all species*. (4ª ed.), China: science editor & photographer, 403pp

Trajano, E. 1994. Ecologia de populações de morcegos cavernícolas em uma região cárstica do sudeste do brasil. *Revista Brasileira de Zoologia, 2*(5): 255-320. DOI

Velazco, P.M. & Patterson, B.D. 2017. *Sturnira lilium*. The IUCN Red List of Threatened Species 2017: e.T88159688A22049384. DOI

Velazco, P.M. & Patterson, B.D. 2019. Small mammals of the Mayo river basin in northern Peru, with the description of a new species of Sturnira (Chiroptera: Phyllostomidae). *Bulletin of the American Museum of Natural History, 429*: 1-67

Velazco, P.M. 2021. Murielagatos del Perú/Bats of Peru. Available: http://www.paulvelazco.com/murielagatos_peru.html. Access: 10/07/2021

Vizzoto, L.D. & Tatdei, V.A. 1973. Chave para determinação de quirópteros brasileiros. Revista da Faculdade de Filosofia, Ciências e Letras. *Boletim de Ciências, São José do Rio Preto, 1*: 1-72

Wilson, D.E. 1996. Neotropical bats: a checklist with conservatian status. In: Simmons, N.B. (Eds.). *Chiroptera*. *Order Chiroptera*. *In: Wilson, D.E. & Reeder, D.M. (Eds.)*. *Mammals Species of the world: a taxonomic and geographic reference*. 3. ed. Baltimore, Johns Hopkins University Press. v. 1, p. 312-529

Marques-Aguiar, S.A.; Melo, C.C.S.; Aguiar, G.F.S. & Queiroz, J.A.L. 2002. Técnicas de campo empregadas no estudo de quirópteros. *Caderno La Salle XI, Canoa, 1*(2): 195-202.

Palumbi, S.; Martin, A.; Romano, S.; McMillan, W.O.; Stice, L.; Grabowski, G. & MacMillan, W.O. 2002. *The simple fool’s guide to PCR, version 2.0*. University of Hawaii, Honolulu

Peracchi, A.L.; Lima, I.P.; Reis, N.R.; Nogueira, M.R. & Filho, H.O. 2011. Ordem Chiroptera. In: Reis, N.R.; Peracchi, A.L.; Pedro, W.A. & Lima, I.P. *Mamíferos do Brasil*. 2. ed. Londrina. p. 153-234

Reis, N.R.; Fregonezi, M.N.; Peracchi, A.L. & Shibatta, A.O. 2013. *Morcegos do Brasil: guia de campo*. Rio de Janeiro, Technical Books. 225p.

Reis, N.R.; Peracchi, A.L.; Batista, C.B.; Lima, I.P. & Pereira, A.D. 2017. *História natural dos morcegos brasileiros: chave de identificação de espécies*. Rio de Janeiro, Technical Books. 416p.