

## Short Note

Adrià López-Baucells\*, Ricardo Rocha, Ileana García-Mayes, Kevina Vulinec and Christoph F.J. Meyer

# First record of *Micronycteris sanborni* (Chiroptera: Phyllostomidae) from Central Amazonia, Brazil: range expansion and description of its echolocation

**Abstract:** This note reports the first record of *Micronycteris sanborni* in Amazonas State, Brazil. It extends the species' known range >2000 km northwestward and represents the first record of *M. sanborni* in a humid tropical ecosystem, suggesting that the species might not be exclusive to dry areas, as previously thought. The individual was captured in *Vismia*-dominated secondary forest within the fragmented landscape of the Biological Dynamics of Forest Fragments Project. We present morphometric data and provide the first description of the echolocation calls of this poorly known species.

**Keywords:** echolocation; *Micronycteris sanborni*; Phyllostomidae; range expansion; secondary forest.

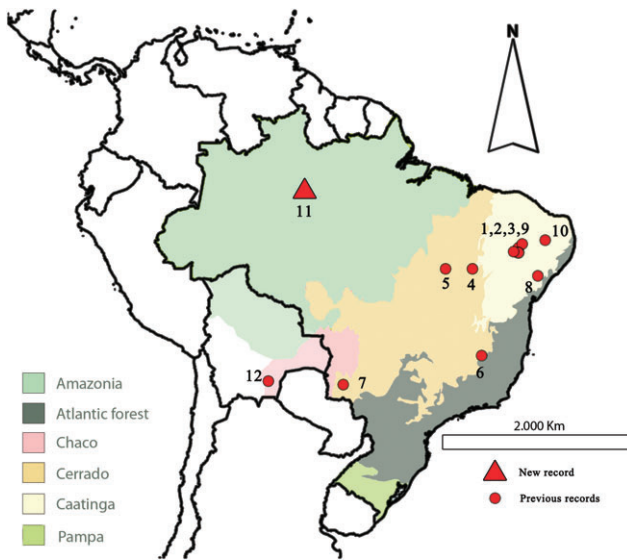
\*Corresponding author: **Adrià López-Baucells**, Centre for Environmental Biology, Science Faculty, Animal Biology Department, C2 Campo Grande, 1749-016, Lisbon, Portugal; Biological Dynamics of Forest Fragments Project, National Institute for Amazonian Research (INPA) and Smithsonian Tropical Research Institute, C.P. 478, Manaus, AM 69011-970, Brazil; and Granollers Museum of Natural Science, Chiroptera Research Area, Av. Francesc Macià 51, 08402 Granollers, Catalonia, e-mail: adria.baucells@gmail.com

**Ricardo Rocha:** Centre for Environmental Biology, Science Faculty, Animal Biology Department, C2 Campo Grande, 1749-016, Lisbon, Portugal; Biological Dynamics of Forest Fragments Project, National Institute for Amazonian Research (INPA) and Smithsonian Tropical Research Institute, C.P. 478, Manaus, AM 69011-970, Brazil; and Metapopulation Research Group, Faculty of Biosciences, University of Helsinki, PO Box 65 (Viikinkaari 1), FI-00014 Helsinki, Finland  
**Ileana García-Mayes:** Department of Agriculture and Natural Resources, Delaware State University, 1200 N. DuPont Hwy. Dover, DE 19901, USA  
**Kevina Vulinec:** Biological Dynamics of Forest Fragments Project, National Institute for Amazonian Research (INPA) and Smithsonian Tropical Research Institute, C.P. 478, Manaus, AM 69011-970, Brazil; and Department of Agriculture and Natural Resources, Delaware State University, 1200 N. DuPont Hwy. Dover, DE 19901, USA

**Christoph F.J. Meyer:** Centre for Environmental Biology, Science Faculty, Animal Biology Department, C2 Campo Grande, 1749-016, Lisbon, Portugal; and Biological Dynamics of Forest Fragments Project, National Institute for Amazonian Research (INPA) and Smithsonian Tropical Research Institute, C.P. 478, Manaus, AM 69011-970, Brazil

The recently described Sanborn's big-eared bat *Micronycteris sanborni* Simmons 1996 is a rare and largely unknown member of the genus *Micronycteris*, a diverse group of small to medium-sized gleaning animalivorous of the family Phyllostomidae. According to Simmons (1996), body and tail lengths of *M. sanborni* vary between 55.5 and 65 mm and 12–14 mm, respectively, and body mass varies between 5.5 and 8 g. The dorsal fur is bicolored with white bases and brownish-orangish tips, whereas the venter is bright white. Together with *Micronycteris minuta* (Gervais, 1856), *M. sanborni* is the only member of the genus to have short fur (5–7 mm) between the shoulders. The calcar is approximately the same size as the hindfoot. There is an apparent diastema between the upper canines and incisors (I2 is present but very small). Lower P2 and P4 are also separated by a small gap (Nogueira et al. 2007, Williams and Genoways 2007). Its similarity with other congeneric species may lead to its misidentification in the field; however, *M. sanborni* can be effectively distinguished by its white ventral fur that extends onto the throat and chin and also by its shorter thumb (<7 mm) compared with the most similar species [*Micronycteris schmidtorum* (Sanborn, 1935) and *M. minuta*].

The species has only been previously recorded in the mesic habitats of cerrado and caatinga where it is thought to be typically associated with dry open areas such as savannahs and pastures (Simmons 1996, Brooks et al.



**Figure 1** Distribution of *Micronycteris sanborni* in South America. Brazil: Ceará and Pernambuco (Simmons 1996 [1], Peracchi unpublished [2], Nogueira 1998 [3]), Piauí (Gregorin et al. 2008 [4]), Tocantins (Gregorin et al. 2011 [5]), Minas Gerais (Nogueira 1998 [6]), Mato Grosso do Sul (Cunha et al. 2009 [7]), Sergipe (Mikalauskas et al. 2005 [8]), Paraíba (Feijó et al. 2010, Beltrão et al. 2011 [9]), Bahia (Nogueira et al. 2007 [10]), and Manaus (present study) [11]; Bolivia: Depto. Santa Cruz (Brooks et al. 2002 [12]).

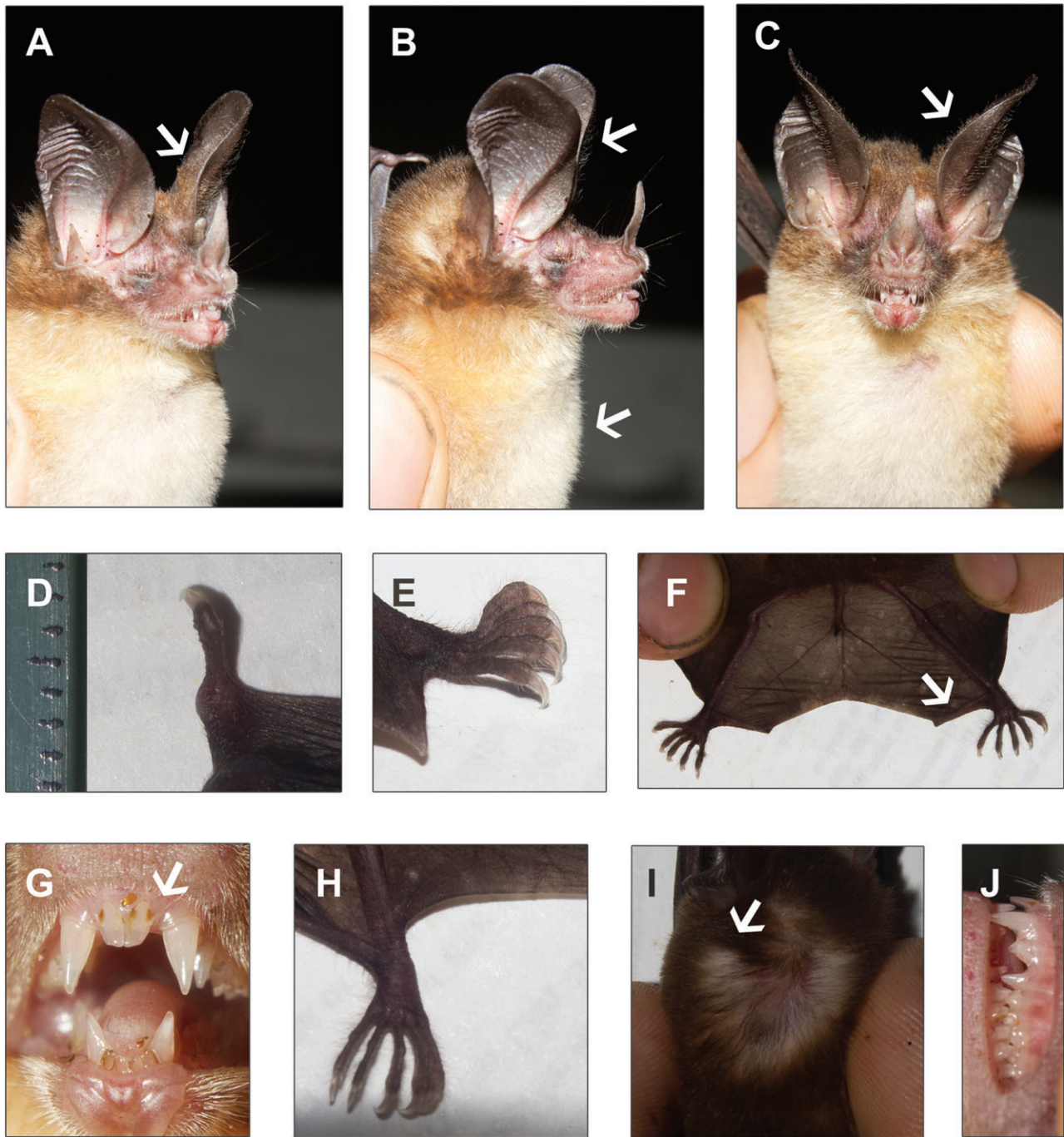
2002, Simmons 2002, Gregorin et al. 2008, Nogueira et al. 2008, Rocha 2010, Santos et al. 2010, Gregorin et al. 2011). Eleven of the 12 records of the species are from Brazil. The dearth of records throughout the species' known range and the general lack of information about the species ecology and population trends has led to its classification as International Union for Conservation of Nature data deficient (Tavares and Aguirre 2008). The lack of available samples resulted in the species being discarded from a recent phylogenetic revision of the genus (Porter et al. 2007). Herein, we report the first record of *Micronycteris sanborni* from the Central Amazon, extending the species' known range >2000 km northwestward, and present the first description of the species echolocation call characteristics.

Bat mist-netting was conducted at the Biological Dynamics of Forest Fragmentation Project (BDFFP; <http://batspdbff.scienceontheweb.net>), ca. 100 km north of Manaus, Amazonas State, Brazil (2°25'S, 59°50'W; altitude of 30–125 m a.s.l.), from August 2011 to November 2012. The annual rainfall in this area varies between 1900 and 3500 mm per year, with a rainy season between October and May (Laurance et al. 2011). The predominant habitat in this region of the Amazon basin is lowland terra firme

forest. On July 13, 2012, around 19:00, one female *Micronycteris sanborni* was captured in Dimona Reserve (2°20'8"S, 60°6'8"W, Figure 1) 1 m from the ground in a mist-net set across a trail. Within the BDFFP landscape, we mist-netted several sites in terra firme and abandoned cattle ranges that contain forest fragments embedded in a matrix of mostly *Cecropia*- and *Vismia*-dominated regrowth. The captured *M. sanborni* was photographed in detail on a graph paper background with a Raynox macro lens mounted on a Canon 550D camera. External morphological images were taken and saved in maximum quality format raw (Figure 2).

To record the echolocation calls, we simultaneously used Pettersson D500X and D240X bat detectors. The captured *Micronycteris sanborni* was first released tethered with an elastic cord (<0.25 mm) attached to a thin elastic collar of the same lightweight material. It flew to a maximum distance of 20 m attached to the cord, and after a waiting period of 10 min (with the bat inside a capture bag) it was released by hand in an open area. During both flight situations, the detectors were placed at different orientations 10 m from the bat. Recordings were both automatically and manually triggered, and calls were measured using Avisoft v9.2 and Sonobat v3.1.1.p software using a sampling frequency of 44.1 kHz, with 16 bits/sample for mono file output. For spectrograms and power spectra, a 512-point fast Fourier transform with a Hanning window was used, which gave a frequency resolution of 1206 Hz in real time. Real-time recording was used for a maximum sampling rate of 500 kHz. Five main call parameters were measured from each pulse (18 pulses): peak frequency (frequency of maximum energy; kHz), start and end frequency (kHz), bandwidth (kHz), and pulse duration (ms). We calculated the call parameters for both the main harmonic (the most intense) and the second harmonic (higher).

All the diagnostic characters that separate *Micronycteris sanborni* from the other pale-bellied *Micronycteris* were carefully checked, confirming the correct identification of the captured individual (Figure 2): a high and deeply notched interauricular skin band; an apparent gap between outer upper incisors and canines (different in *M. minuta* and *M. schmidtorum*); short fur on the leading edge of the ear [different in *M. homezi* (Pirlot, 1967)]; first phalanx of IV finger approximately the same size as the second [different in *M. schmidtorum*, *M. brosetti* (Simmons & Voss, 1998) and *M. homezi*]; calcar approximately the same size as foot (different in *M. homezi* and *M. minuta*); hairless fossa or pit on top of the head (different in *M. homezi*); thumbs <7 mm;



**Figure 2** Morphological characteristics of the Amazonian specimen of *Micronycteris sanborni*.

(A, B, C) Frontal and side body views (fur on leading edges of the ears), (D) thumb, (E) feet and claws, (F) uropatagium and insertion of the patagium on the foot, (G) incisors and canines, (H) union of the patagium with the leg, (I) dorsally tricolored fur, and (J) tooththrow side view.

and whitish fur up onto the throat (Simmons 1996, Santos et al. 2010). In Table 1, we present all the measurements from this individual, comparing them with other specimen data from Simmons (1996) and Santos et al. (2010).

Echolocation call characteristics obtained from released bats are presented in Table 2. *Micronycteris*

*sanborni* presents a typical phyllostomid call structure, emitting multiharmonic, downward frequency-modulated signals. The main harmonic is characterized by a peak frequency around 74 kHz, but variable start and end frequencies. The main harmonic is longer and an overlap is usually evident between the end of the first



**Table 1** External and skull measurements (mm) of the captured *Micronycteris sanborni*. For comparison, published measurements for the two most similar species, *Micronycteris minuta* and *Micronycteris schmidtorum*, are also given.

Source	<i>Micronycteris sanborni</i>		<i>Micronycteris minuta</i>	<i>Micronycteris schmidtorum</i>	
	Present study	Santos et al. (2010)	Simmons (1996)	Simmons (1996)	
	Brazil (Central Amazon)	Brazil (West)	Brazil (Northeast)	Simmons (1996)	
Total body length	53.2	51.7	57.5 (55.5–65.0)	59.9 (55.0–69.0)	61.1 (54.5–67.0)
Tail length	9.9	12.7	12.5 (12.0–14.0)	11.2 (9.0–14.0)	13.1 (11.0–17.0)
Hind foot length	7.9	9.1	8.7 (8.0–9.0)	11.8 (9.0–13.0)	9.7 (8.0–11.0)
Calcar length	7.8	9.5	–	–	–
Tibia length	16.3	15.8	13.1 (12.6–14.0)	14.3 (13.3–15.2)	16.1 (14.0–17.7)
Thumb length	4.9	7.6	7.1 (7.0–7.3)	8.5 (7.7–9.1)	10.2 (9.3–11.1)
Ear length	20	20.3	20.2 (19.0–23.0)	21.1 (19.5–23.0)	19.2 (16.0–21.0)
Tragus length	6.3	–	–	–	–
Noseleaf length	7.9	–	–	–	–
Noseleaf width	3.9	–	–	–	–
Forearm length	34.6	33.9	33.6 (32.0–34.0)	35.4 (33.0–36.8)	35.3 (33.0–37.8)
Third metacarpal length	33.53	28.9	–	–	–
Length of first phalanx (digit III)	10.98	12.4	–	–	–
Length of second phalanx (digit III)	9.3	12.6	–	–	–
Fourth metacarpal length	25.19	29.5	–	–	–
Length of first phalanx (digit IV)	7.43	9.5	–	–	–
Length of second phalanx (digit IV)	7.63	9.0	–	–	–
Fifth metacarpal length	28.22	30.5	–	–	–
Length of first phalanx (digit V)	9.24	10.7	–	–	–
Length of second phalanx (digit V)	8.47	7.9	–	–	–
Greatest length of skull	–	17.9	–	–	–
Condylolincisive length	–	15.9	15.16 (14.91–15.39)	16.64 (15.62–17.54)	17.56 (16.34–18.32)
Condylolcanine length	–	15.4	–	–	–
Interorbital breadth	–	4.0	3.92 (3.70–4.07)	4.12 (3.84–4.37)	4.12 (3.98–4.29)
Braincase breadth	–	7.3	7.41 (7.32–7.48)	7.59 (7.23–8.04)	7.88 (7.42–8.24)
Mastoid breadth	–	8.1	–	–	–
Maxillary tooth row length	–	6.1	5.76 (5.64–5.92)	6.65 (6.37–6.94)	7.51 (7.10–7.97)
Breadth across molars	–	5.7	–	–	–
Breadth across canines	–	3.9	–	–	–
Mandibular tooth row length	–	6.7	–	–	–
Mandibular length	–	10.9	–	–	–

and the second harmonics. Our first description of the species' echolocation call characteristics confirmed highly frequency-modulated multiharmonic pulses, as have been documented for other phyllostomid bats (frequencies >100 kHz and around 1 ms in duration) (Barclay et al. 1981, Kalko and Condon 1998, Corine and Kalko 2005). These call characteristics can be considered as an adaptation for foraging in a cluttered forest environment (Russo and Jones 2002, Broders et al. 2004). It is widely

accepted that highly modulated pulses are not effective in extensive open areas because they attenuate rapidly with distance, whereas these calls can give more precise information in cluttered habitats (Patriquin and Barclay 2003, Broders et al. 2004). The use of acoustic sampling is increasingly being used for monitoring aerial insectivorous bat populations worldwide (Stahlschmidt and Brühl 2012). In contrast, acoustic monitoring of phyllostomid bats is complicated owing to their clearly directional

**Table 2** Characteristics of release calls from the captured *Micronycteris sanborni*.

		Peak Fq (kHz)	Start Fq (kHz)	End Fq (kHz)	Bandwidth (kHz)	Duration (ms)
First harmonic	Mean±SD	74.03±4.59	86.47±8.66	62.75±3.97	23.72±10.73	1.36±0.63
	Range	67.4–84.3	75.6–104	51.8–68.8	14.0–52.2	0.56–2.50
Second harmonic	Mean±SD	100.47±3.32	109.17±2.67	88.29±5.17	20.88±4.67	0.96±0.37
	Range	95.9–107.8	106.4–115.0	81.3–96.4	16.00–27.2	0.31–1.50

pulses (usually considered as faint), thus leading to potential biases in assessments of bat activity (Brinkløv et al. 2009, 2011). Nevertheless, their echolocation can reflect the adaptation and persistence of these species in different habitats.

The current known distribution range and habitat preferences of *Micronycteris sanborni* were based on only 11 records worldwide. This new record constitutes the first report of the species in the Central Amazon and represents the northernmost record of its known distribution. We caught the species in *Vismia*-dominated regrowth surrounded by continuous lowland rainforest. The area where the capture occurred was first deforested in 1984 (Sampaio et al. 2003), whereas by 2012 secondary regrowth had already reached a height of 10–20 m (authors' personal observation). *Micronycteris sanborni* is known to occur in extreme habitats (cerrado and caatinga) in terms of water availability, and thus a tropical forest, even secondary, with higher vegetation cover, may provide a good habitat for the species to forage and commute. It is the first record for the Amazon biome and provides evidence that the species might not be restricted to dry habitats, savannahs, and caatingas (rocky outcrops and rolling terrain), as had

previously been suggested (Brooks et al. 2002). There is still very little information on its extent of occurrence, status, threats, and ecological requirements (Tavares and Aguirre 2008).

New occurrence data and natural history information are therefore of most importance to a better understanding of this largely unknown species.

**Acknowledgments:** We would like to thank Prof. Jorge Palmeirim and Dr. Paulo D.E. Bobrowiec for their assistance during all phases of the project, and José L.C. Camargo, Rosely Hipólito, and Ary Jorge Ferreira for logistic support. Financial support was provided by the Portuguese Foundation for Science and Technology (FCT) through the grants PTDC/BIA-BIC/111184/2009 and SFRH/BD/80488/2011, and to KV through a Delaware State University Academic Enhancement Grant. We are grateful to Stephane Aulagnier and two anonymous reviewers for insightful suggestions that greatly improved the manuscript. This manuscript is number 625 of the BDFFP technical series.

Received January 15, 2013; accepted June 12, 2013

## References

- Barclay, R.M.R., M.B. Fenton, M.D. Tuttle and M.J. Ryan. 1981. Echolocation calls produced by *Trachops cirrhosus* (Chiroptera: Phyllostomidae) while hunting for frogs. *Can. J. Zool.* 59: 750–753.
- Beltrão, M.G., M.P.A. Fracasso and J.S. Mourão. 2011. Morcegos da RPPN Fazenda Almas, São José do Cordeiros, Paraíba. Centro de Ciências Biológicas e da Saúde, Universidade Estadual da Paraíba, Paraíba, Brazil. pp. 43.
- Brinkløv, S., E.K.V. Kalko and A. Surlykke. 2009. Intense echolocation calls from two 'whispering' bats, *Artibeus jamaicensis* and *Macrophyllum macrophyllum* (Phyllostomidae). *J. Exp. Biol.* 212: 11–20.
- Brinkløv, S., L. Jakobsen, J.M. Ratcliffe, E.K.V. Kalko, and A. Surlykke. 2011. Echolocation call intensity and directionality in flying short-tailed fruit bats, *Carollia perspicillata* (Phyllostomidae). *J. Acoust. Soc. Am.* 129: 427–435.
- Broders, H.G., C. Scott Findlay and L. Zheng. 2004. Effects of clutter on echolocation call structure of *Myotis septentrionalis* and *M. lucifugus*. *J. Mammal.* 85: 273–281.
- Brooks, D.M., J.M. Rojas, H. Aranibar, R.J. Vargas and T. Tarifa. 2002. A preliminary assessment of the mammalian fauna of the eastern Bolivian panhandle. *Mammalia* 65: 509–520.
- Corine, C. and E.K.V. Kalko. 2005. Fruit detection and discrimination by small fruit-eating bats (Phyllostomidae): echolocation call design and olfaction. *Behav. Ecol. Sociobiol.* 59: 12–23.
- Cunha, N.L., E. Fischer, L.F.C. Carvalho and C.F. Santos. 2009. Bats of Buraco das Araras natural reserve, Southwestern Brazil. *Biota Neotrop.* 9: 189–195.
- Feijó, J.A., P. Araujo, M.P.A. Fracasso and K.R.P. dos Santos. 2010. New records of three bat species for the Caatinga of the state of Paraíba, northeastern Brazil. *Chiropt. Neotrop.* 16: 723–727.

- Gregorin, R., A.P. Carmignotto and A.R. Percequillo. 2008. Quirópteros do Parque Nacional da Serra das Confusões, Piauí, nordeste do Brasil. *Chiropt. Neotrop.* 14: 366–383.
- Gregorin, R., E. Gonçalves, C. Aires and A.P. Carmignotto. 2011. Morcegos (Mammalia: Chiroptera) da Estação Ecológica Serra Geral do Tocantins: composição específica e considerações taxonômicas. *Biota Neotrop.* 11: 300–311.
- Kalko, E.K.V. and M. Condon. 1998. Echolocation, olfaction and fruit display: how bats find fruit of flagelliferous cucurbits. *Funct. Ecol.* 12: 364–372.
- Laurance, W.F., J.L.C. Camargo, R.C.C. Luizão, S.G. Laurance, S.L. Pimm, E.M. Bruna, P.C. Stouffer, G.B. Williamson, J. Benítez-Malvido, H.L. Vasconcelos, K.S. Van Houtan, C.E. Zartman, S.A. Boyle, R.K. Didham, A. Andrade and T.E. Lovejoy. 2011. The fate of Amazonian forest fragments: a 32-year investigation. *Biol. Conserv.* 144: 56–67.
- Mikalauskas, J., C. Carvalho and J.C. Vilar. 2005. Morcegos. In: (C.M. Carvalho and J.C. Vilar, eds.) *Parque Nacional Serra de Itabaiana-Levantamento da Biota*. IBAMA, UFS, Aracaju, Brazil. pp. 93–103.
- Nogueira, M.R. 1998. Aspectos sistemáticos e bionômicos dos quirópteros da Região de Jaíba, Norte de Minas Gerais. Universidade Federal Rural do Rio de Janeiro, Rio de Janeiro, Brazil. pp. 168.
- Nogueira, M.R., A.L. Peracchi, R. Moratelli, N. Reis, A. Peracchi, W. Pedro and I. Lima. 2007. Subfamília Phyllostominae. In: (N.R. Reis, A.L. Peracchi, W.A. Pedro and I.P. Lima, eds.), *Morcegos do Brasil*. Nélio Roberto dos Reis, Londrina, Brazil. pp. 61–97.
- Nogueira, M.R., A. Pol, L.R. Monteiro and A.L. Peracchi. 2008. First record of Miller's mastiff bat, *Molossus pretiosus* (Mammalia: Chiroptera), from the Brazilian Caatinga. *Chiropt. Neotrop.* 14: 346–353.
- Patriquin, K.J. and R.M.R. Barclay. 2003. Foraging by bats in cleared, thinned and unharvested boreal forest. *J. Appl. Ecol.* 40: 646–657.
- Porter, C.A., S.R. Hooper, C.A. Cline, F.G. Hoffmann and R.J. Baker. 2007. Molecular phylogenetics of the phyllostomid bat genus *Micronycteris* with descriptions of two new subgenera. *J. Mammal.* 88: 1205–1215.
- Rocha, P.A. 2010. Diversidade, composição e estrutura de comunidade de morcegos (Mammalia: Chiroptera) em habitats de caatinga e brejo de altitude do Estado de Sergipe. MSc dissertation. São Cristóvão, Brazil. Programa de Pós Graduação em Ecologia e Conservação, Universidade Federal de Sergipe, São Cristóvão, Brazil, pp. 1–82.
- Russo, D. and G. Jones. 2002. Identification of twenty-two bat species (Mammalia: Chiroptera) from Italy by analysis of time-expanded recordings of echolocation calls. *J. Zool.* 258: 91–103.
- Sampaio, E.M., E.K.V. Kalko, E. Bernard, B. Rodriguez-Herrera and C.O. Handley. 2003. A biodiversity assessment of bats (Chiroptera) in a tropical lowland rainforest of central Amazonia, including methodological and conservation considerations. *Stud. Neotrop. Fauna Environ.* 38: 17–31.
- Santos, C.F., M.R. Nogueira, N.L. Cunha, L.F.A.C. Carvalho and E. Fisher. 2010. Southernmost record of the Sanborn's big-eared bat, *Micronycteris sanborni* (Chiroptera, Phyllostomidae). *Mammalia* 74: 457–460.
- Simmons, N.B. 1996. A new species of *Micronycteris* (Chiroptera, Phyllostomidae) from northeastern Brazil: with comments on phylogenetic relationships. *Am. Mus. Novit.* 3158: 1–35.
- Simmons, N.B. 2002. A new Amazonian species of *Micronycteris* (Chiroptera: Phyllostomidae) with notes on the roosting behavior of sympatric congeners. *Am. Mus. Novit.* 3358: 1–14.
- Stahlschmidt, P. and C.A. Brühl. 2012. Bats as bioindicators – the need of a standardized method for acoustic bat activity surveys. *Methods Ecol. Evol.* 3: 503–508.
- Tavares, V. and L. Aguirre. 2008. *Micronycteris sanborni*. In: IUCN 2012. IUCN Red list of threatened species. Version 2012.1. [www.iucnredlist.org](http://www.iucnredlist.org). Downloaded on 16 October 2012.
- Williams, S.L. and H.H. Genoways. 2007. Subfamily Phyllostominae Gray 1825. In: (A.L. Gardner, ed.) *Mammals of South America*, Vol. 1: marsupials, xenarthrans, shrews, and bats. University of Chicago Press, Chicago, IL. pp. 255–300.