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How do we identify *Micronycteris* (*Schizonycetris*) *sanborni* Simmons, 1996 (Chiroptera, Phyllostomidae) reliably and where we can find this species in Brazil?

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ABSTRACT

Micronycteris *is divided into four subgenera,* Micronycteris, Leuconycteris, Xenoctenes, *and* Schizonycteris. *The latter includes* Micronycteris *(*Schizonycteris*)* minuta, Micronycteris *(*S.*)* schmidtorum, Micronycteris *(*S.*)* sanborni *and* Micronycteris *(*S.*)* yatesi. *Little is known of the biology of* M. *(*S.*)* sanborni, *which is widely distributed in the dry forests of South America, but is known from only few sites. The scarcity of records of* M. sanborni *appears to be at least partly related to the difficulty of differentiating this species from the other members of the subgenus* Schizonycteris. *The present study identifies the key traits that distinguish this species from other* Schizonycteris, *reviews the geographic distribution of the species, and presents some notes on breeding patterns. Six new localities are presented for* M. sanborni, *and are analyzed together with those available in the literature, providing new insights into ecological and zoogeographic patterns. A number of the diagnostic features established by Simmons (1996) in the description of* M. sanborni *proved to have little taxonomic value, especially for the differentiation of* M. minuta *and* M. yatesi, *which it closely resembles. The primary external difference is the pure white color of the ventral pelage and the proportion of the white base (2/3-4/5) of the dorsal hair in* M. sanborni, *in contrast with dirty white or pale gray and a much shorter white base of the dorsal hair in the other species. A number of cranial traits are also important. The distributional data now indicate that* M. sanborni *occurs mainly in mesic and open areas, including disturbed habitats, in the Caatinga scrublands and the Cerrado savannas of northeastern Brazil, especially in areas with rocky outcrops.* Micronycteris sanborni *appears to be monoestrous, with births coinciding with the rainy season.*

Key-Words: *Schizonycteris;* Intraspecific variation; Dry forest; Brazil; Chiroptera.

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INTRODUCTION

The bats of the genus *Micronycteris* Gray, 1866 are found in a variety of habitats, including rainforests, dry forests and savannas, as well as anthropogenic environments such as orchards, pastures, and plantations (Bernard & Fenton, 2002; Nunes *et al.,* 2005; Peracchi *et al.,* 2011; Reid, 1997). Porter *et al.,* (2007), based on molecular data, classify *Micronycteris* in four subgenera – *Micronycteris, Leuconycteris, Xenoctenes* and *Schizonycteris.* The latter includes *Micronycteris* (*Schizonycteris*) *minuta* (Gervais), *Micronycteris* (*S.*) *schmidtorum* Sanborn, *Micronycteris* (*S.*) *sanborni* Simmons and the recently described *Micronycteris* (*S.*) *yatesi* Siles & Brooks.

Micronycteris sanborni is endemic to Brazil, found in mesic habitats within the Cerrado savanna and Brazilian Caatinga scrub (Simmons, 1996). Little is known of the biology of the species, which is classified as "Data Deficient" by Tavares & Aguirre (2008). In fact, while *M. sanborni* appears to have a relatively ample geographic range, it is known from only eight sites in Brazil (Cunha *et al.,* 2009; Feijó *et al.,* 2010; Gregorin *et al.,* 2008; Gregorin *et al.,* 2011; López-Baucells *et al.,* 2013; Santos *et al.,* 2010; Simmons, 1996). It is possible, however, that the scarcity of records of *M. saborni* is at least partly related to the difficulty of differentiating this species from the other members of the subgenus *Schizonycteris* (López-Baucells *et al.,* 2013; Porter *et al.,* 2007; Santos *et al.,* 2010; Siles *et al.,* 2013; Simmons, 1996).

According to Porter *et al.* (2007), the members of the subgenus *Schizonycteris* share a number of diagnostic morphological features which distinguishes it from the other members of the subgenus, such as a moderate to high interauricular membrane with a moderate to deep midline notch, dividing the membrane into two triangular flaps; small size (weight < 9 g, forearm < 38 mm); ventral fur white or pale gray or buff, lighter in color than dorsal fur; and non-hypsodont lower incisors, with crown height no more than twice crown width. On the other hand, there is a clear need for the establishment of more reliable criteria for the discrimination of the different species of the subgenus *Schizonycteris* (Santos *et al.,* 2010; Siles *et al.,* 2013), including the understanding of intraspecific variation.

The present study reviews the morphological and morphometric characters of *M. sanborni* described by Simmons (1996) and identifies the key qualitative characteristics that distinguish this species from the others of the subgenus *Schizonycteris,* including new diagnostic traits. The geographic distribution and habitat preference of the species are also revised, based on new localities from the Brazilian Caatinga scrublands. Information on reproductive patterns is also provided.

MATERIALS AND METHODS

Specimens examined

Forty-eight specimens of *M. sanborni* from six new localities in the Caatinga scrublands of the northeastern Brazil were analyzed in the present study. Three of the localities (described below) were surveyed by the authors in 2012 and 2013, rendering 26 of the specimens analyzed. These specimens were deposited in the mammal collection of the Federal University of Paraiba (UFPB), where the other 22 specimens were found.

Locality 1: municipality of Paripiranga, Brazilian state of Bahia (10°41'S, 37°51'W). In April 2012, five adult specimens, four males (UFPB 6532, 6535, 6543, 6673) and a female (UFPB 6536) were captured at two sites, both anthropogenic open areas adjacent to artificial ponds. Paripiranga is dominated by agricultural landscapes, with cassava and maize plantations, and pastures, interspersed with fragments of shrubby Caatinga, mainly along watercourses. There are numerous caves in this municipality.

Locality 2: Boqueirão da Onça (09°52'30.4"S, 41°6'1.8"W), in the municipality of Sento Sé, Bahia, Brazil. In May and August 2012, two adult males and one female (UFPB 6676, 6793, 6794) were collected in a mist-net set in the understory over a seasonal watercourse. This area is a complex of hills and valleys covered in arboreal Caatinga (*sensu* Mares *et al.,* 1981), characterized by large deciduous trees of 10-12 m in height that form a continuous canopy during the rainy season (December-April). The vegetation is denser and more humid in the valleys, even during the dry season. This area is characterized by the presence of caves.

Locality 3: Aiuaba Ecological Station (ESEC Aiuaba) (06°36'33"S, 40°7'23.45"W) in the municipality of Aiuaba, state of Ceará, Brazil. Eighteen specimens – seven females and 11 males – were captured between August 2012 and December 2013 in a mist-net adjacent to a small pond in an open, disturbed area near banana and corn plantations. Ten of the specimens were collected and deposited at UFPB (UFPB 8838, 8842, 8846, 8847, 8856, 8860, 8863, 8876,

8877, 8878). This protected area encompasses shrub Caatinga habitats with some taller vegetation along the river margins. The surrounding area is essentially agricultural, with plantations of maize, banana, and cassava, as well as cattle ranches and goat farms. A number of caves are located within the region.

The additional 22 specimens of *M. sanborni* obtained from the UFPB collection included three from Loreto, Maranhão state (UFPB 5656, 5789, 5790), 18 from Tamanduá Farm, Patos, Paraiba state (UFPB 3245, 5312-5328) and one from Uruçui, Piaui state (UFPB 5788). The specimen reported by Feijó *et al.* (2010) from São José dos Cordeiros, Paraiba, was also examined. Four specimens of *Micronycteris minuta* (UFPB 7, 6682, 6608, 8695) were also analyzed qualitatively.

Morphological features

We evaluated the diagnostic features listed by Simmons (1996) for the differentiation of *M. sanborni* from the other species of the genus *Micronycteris:* (1) pure white ventral fur that extends anteriorly onto throat and chin; (2) dorsal hairs bicolored, brown with white bases, white base comprises 2/3-4/5 of each hair; (3) high band of skin present between ears, deeply notched in middle; (4) length of calcar approximately the same length as the foot; (5) fur on the uropatagium forms a small, roughly triangular patch whose apex is directed toward the tip of the tail; (6) white hairs on the inside of the pinnae; (7) the leading edge of the pinna covered with short dense fur; (8) gap present between outer upper incisor and canine; (9) P^3 smaller than P^4 in both height and anteroposterior length; (10) P^4 with an unusually large posterolingual cingulum; (11) gap present between posterior edge of cingulum of M^2 hypocone and anterolingual edge of M^3; (12) height of P_2 less than or equal to its length; (13) P_3 tiny, much smaller than P_2 and P_4, and (14) coronoid process low, upper margin of the ascending ramus with shallow slope. We also verified other characteristics that distinguish *M. sanborni* from the other species of the subgenus

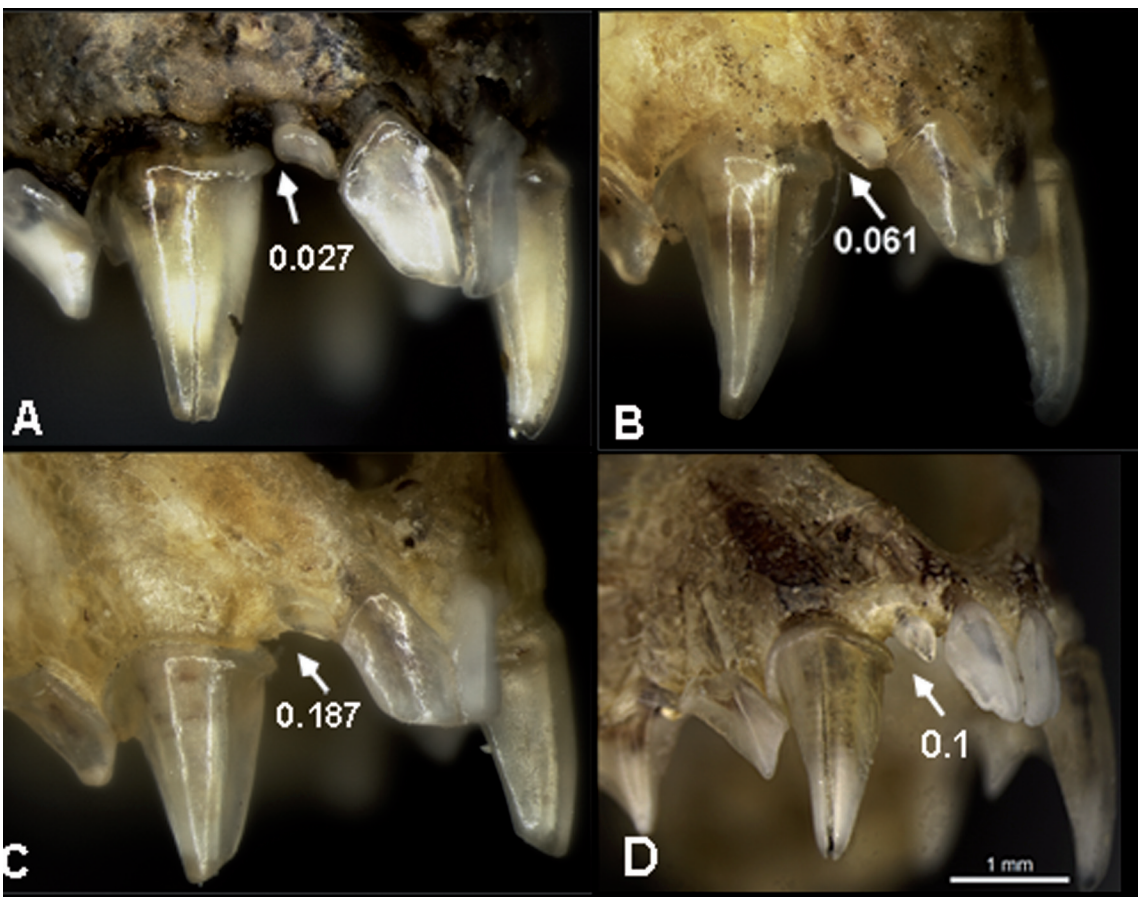

FIGURE 1: Oblique frontal view of the upper dentition in *M. sanborni* (A: UFPB 6793; B: UFPB 6795; C: UFPB 6536) and *M. minuta* (D: UFPB 8695). Note the variation in the gap between the outer upper incisor and the canine (white arrow).

TABLE 1: Morphometric data for the species of the subgenus *Schizonycteris*. All measurements are mean ± standard deviations (minimum-maximum) N.

Parameter	*Micronycteris sanborni*						*Micronycteris yatesi*	*Micronycteris minuta*	*Micronycteris schimdtorum*
	Paripiranga, Bahia	Boqueirão da Onça, Bahia	ESEC Aiuaba, Ceará	Paraiba (Feijó *et al.* 2010)	Simmons (1996)	Total Range (Min-Max; N)	Siles *et al.* (2013)	Simmons (1996)	Simmons (1996)
Sex	4 males, 1 female	2 males, 1 female	11 males, 7 females	1 female	2 males, 4 females	38 males,14 females	2 males, 1 female	29 males, 38 females	16 males, 9 females
Body mass	5.7 ± 0.71 (4.7-6.6) 5	5.1 ± 0.28 (5-5.5) 3	5.8 ± 0.5 (4-6) 18	7.5	6.3 (5.5-8) 6	4-8;33	—	7.3 (6.5-8.5) 11	6.2 (5-7.4) 8
Total length	54 ± 1.12 (52.9-55.8) 5	51 ± 2.43 (48.4-53.2) 3	54.7 ± 2.7 (50.3-61) 18	55.8	57.5 (55.5-65) 6	48.4-65.0; 33	54.7 ± 5.8 (48.5-60.8) 3	59.9 (55-69) 28	61.1 (54.5-67) 21
Head and Body length	40.6 ± 1.87 (37.4-42.2) 5	40.1 ± 1.95 (38.1-42) 3	44.5 ± 2 (42.1-49) 18	—	—	37.4-49; 26	45.8 ± 4.7 (41.5-50.9) 3	—	—
Tail length	13.4 ± 2.93 (11.1-18.4) 5	10.9 ± 0.51 (10.3-11.2) 3	10.1 ± 1.8 (7.2-14.8) 18	12.7	12.5 (12-14) 6	10.3-18.4; 33	8.9 ± 1.9 (7-10.8) 3	11.2 (9-14) 28	13.1 (11-17) 21
Hind foot length	9.1 ± 0.73 (8-9.9) 5	8.4 ± 0.45 (8-8.9) 3	9.8 ± 0.7 (8-11.2) 18	9.6	8.7 (8-9) 6	8-11.2; 33	11.1 ± 0.7 (10.3-11.7) 3	11.8 (9-13) 35	9.7 (8-11) 24
Ear length	21.9 ± 0.70 (21.1-22.9) 5	20.7 ± 0.73 (19.9-21.3) 3	19.9 ± 1.4 (14.9-21.7) 18	17.4	20.2 (19-21) 6	14.9-22.9; 33	16.4 ± 1.5 (15.5-18.2) 3	21.1 (19.5-23) 23	19.2 (16-21) 17
Forearm length	34.2 ± 0.43 (33.7-34.6) 5	32.6 ± 0.8 (31.8-33.4) 3	34.6 ± 1.1 (32.6-37.4) 18	33.6	33.6 (32-34) 6	31.8-37.4; 33	35.9 ± 1.1 (34.5-36.7) 3	35.4 (33-36.8) 33	35.3 (33-37.8) 25
Tragus length	5.8 ± 0.53 (5.1-6.4) 5	6.3 ± 0.78 (5.4-6.8) 3	5 ± 0.4 (4.3-6) 17	—	—	4.3-6.8; 25	—	—	—
Calcar length	8.2 ± 1.1 (6.6-9.1) 5	8.5 ± 0.51 (8.1-9.1) 3	8.6 ± 0.8 (7.1-10.6) 18	—	—	6.6-10.6; 26	9.9 ± 0.5 (9.4-10.5) 3	—	—
Greatest length of skull	17.49 ± 0.30 (16.9-17.7) 5	16.75 ± 0.07 (16.7-16.8) 2	16.4	17.3	—	16.4-17.9; 9	17.8 ± 0.1 (17.6-17.9) 3	—	—
Condyloincisive length	15.46 ± 0.40 (14.8-15.9) 5	14.9 ± 0.28 (14.7-15.1) 2	15,1	15.4	15.16 (14.9-15.3)6	14.7-15.9; 15	15.8 ± 0.1 (15.7-15.9) 3	16.64 (15.62-17.54) 39	17.56 (16-34-18.32) 23
Mastoid breadth	7.93 ± 0.24 (7.5-8.0) 5	7.3 ± 1.31 (6.5-8.1) 2	6,5	8.2	—	6.5-8.4; 9	8.1 ± 0.3 (7.8-8.4) 3	—	—
Zygomatic breadth	8.05 ± 0.19 (7.8-8.2) 5	7.75 ± 0.21 (7.6-7.9) 2	7,6	8.2	8.02 (7.8-8.1)5	7.6-8.2; 9	8.1;1	8.54 (8.02-9) 26	9.36 (8.72-9.87) 23
Breadth of braincase	7.37 ± 0.12 (7.2-7.5) 5	7.15 ± 0.21 (7-7.3) 2	7	7.2	7.41 (7.3-7.4)6	7-7.5; 15	7.4 ± 0.03 (7.4-7.5) 3	7.59 (7.23-8.04) 40	7.88 (7.42-8.24) 22
Postorbital constriction	4.07 ± 0.08 (4-4.1) 5	3.9 ± 0.14 (5.2-5.4) 2	3,8	4	—	3.8-5.4; 9	3.9 ± 0.07 (3.9-4) 3	4.12 (3.84-4.37) 43	4.12 (3.98-4.29) 23
Breadth across upper canines	2.82 ± 0.07 (2.7-2.9) 5	2.75 ± 0.07 (2.7-2.8) 2	2,7	2.7	—	2.7-3.9; 9	—		—

Parameter	*Micronycteris sanborni*						*Micronycteris yatesi*	*Micronycteris minuta*	*Micronycteris schimdtorum*
	Paripiranga, Bahia	Boqueirão da Onça, Bahia	ESEC Aiuaba, Ceará	Paraiba (Feijó *et al.* 2010)	Simmons (1996)	Total Range (Min-Max; N)	Siles *et al.* (2013)	Simmons (1996)	Simmons (1996)
Breadth across upper molars	5.24 ± 0.10 (5.1-5.4) 5	5.3 ± 0.14 (5.2-5.4) 2	5,45	5.2	—	5.1-5.7; 9	5.6 ± 0.5 (5.3-6.3) 3		—
Length of maxillary toothrow	6.02 ± 0.23 (5.6-6.3) 5	5.8 ± 0 (5.8-5.8) 2	5,8	6.1	5.76 (5.6-5.9)6	5.6-6.3; 15	6.2 ± 0.02 (6.2-6.2) 3	6.65 (6.37-6.94)45	7.51 (7.1-7.97) 23
Length of mandible	10.56 ± 0.23 (10.1-10.6) 5	10.55 ± 0.35 (10.3-10.8) 2	10,3	10.7	—	10.1-10.9; 9	—		—
Length of mandibular toothrow	6.50 ± 0.21 (6.1-6.6) 5	6.4 ± 0 (6.4-6.4) 2	6,4	6.4	—	6.1-6.7; 9	—		—
I2-C Diastema	0,11 ± 0,06 (0,07-0,18) 3	0,027	—	—	—	0.027-0.187;4	—		—
P3-P4 Diastema	0,10 ± 0,08 (0,04-0,16) 2	—	0,062	—	—	0.042-0.165;3	—		—
M2-M3 Diastema	0,16 ± 0,08 (0,13-0,19) 3	0,21	0,19	—	—	0.13-0.21;5	—		—

Schizonycteris: (i) dorsal profile of the skull; (ii) anterior portion of the zygomatic arch; (iii) ventral profile of the vertical ramus of the mandible, and (iv) the articular process. The skulls were photographed under a Leica M205C stereomicroscope with an attached DFC295 camera.

Quantitative features

Fourteen cranial and eight body measurements were taken from the specimens using digital calipers (0.01 mm precision) following the criteria described by Simmons (1996) and Vizotto & Taddei (1973), except for the diastemas, which were measured between the external margins of the adjacent cingulae. These measurements were compared with those available in the literature for the other species of the subgenus *Schizonycteris.*

Geographic database

The records collected in the present study were assessed together with those available in the literature on *M. sanborni* in an attempt to define ecological and zoogeographic patterns. For each record, whenever available, data were collected on the characteristics of the habitat, collecting site, type of vegetation, season, and the number of specimens collected.

RESULTS AND DISCUSSION

Qualitative data

The specimens analyzed in this study all presented characteristics 1, 2, 3, 7, 9, 12, 13 and 14 without any marked variation. However, the distances between the incisor and canine (trait 8) and M^2 and M^3 (trait 11) varied considerably (Table 1). The distance between the incisor and canine varied between an almost imperceptible 0.02 mm to a maximum of 0.18 mm (Fig. 1A-C), while those between M^2 and M^3 ranged from 0.13 mm to 0.21 mm. In contrast with the findings of Simmons (1996; Fig. 2), considerable variation was observed in the development of the posterolingual cingulum of the P^4 (trait 10) and the gap between the P^3 and P^4, and traits 5 and 6 were absent or inconspicuous.

The key differences among the species of the subgenera *Schizonycteris* are summarized in Table 2. While *M. schmidtorum* is easily distinguished from

M. sanborni (see Table 2), its external and cranial morphology is very similar to that of *Micronycteris minuta* and *Micronycteris yatesi.*

Simmons (1996: 10) states that "the calcar is approximately the same length as the hind foot in *sanborni*" (trait 4), but provided no measurements. In the present study, the difference recorded between the measurement of the foot and the calcar ranged from 0.1 mm to 1.3 mm (Table 1). In addition, a specimen of *M. minuta* (UFPB 6608) from the Atlantic Forest presents a difference of 0.4 mm between the length of the foot and calcar, which weakens the hypothesis that this trait is useful for the differentiation of the two species. However, the pure white ventral fur found in *M. sanborni* (Fig. 3A) and the proportion (2/3-4/5) of the white base of the dorsal hair (Fig. 3B) were consistent characters. These two traits can be used to reliably distinguish this species from both *M. minuta,* characterized by dirty white or pale gray ventral fur and the much shorter white base (1/4 or 1/2) of the dorsal hair (Simmons, 1996) and *M. yatesi,* which has a pale buff abdomen and an even shorter dorsal hair white base (1/3-1/2) (Siles *et al.* 2013).

Simmons (1996) concludes that the gap between the canine and the adjacent incisor is unique to *M. sanborni.* As noted above, however, there is considerable variation in this characteristic, and some specimens of *M. minuta* (*e.g.,* UFPB 8695) present a small degree of separation between the outer incisor and canine (Fig. 1D). Overall, the teeth of *M. sanborni* are less robust than those of *M. minuta,* so traits 9 and 13 are useful to distinguish these two species (Fig. 4). Furthermore, the height of the coronoid process in relation to the condyloid process (trait 14), the smooth dorsal profile of the skull (i), the narrow anterior portion of the zygomatic arch (ii), the smooth curve of the ventral profile of the vertical ramus of the mandible (iii), and the triangular and less well-

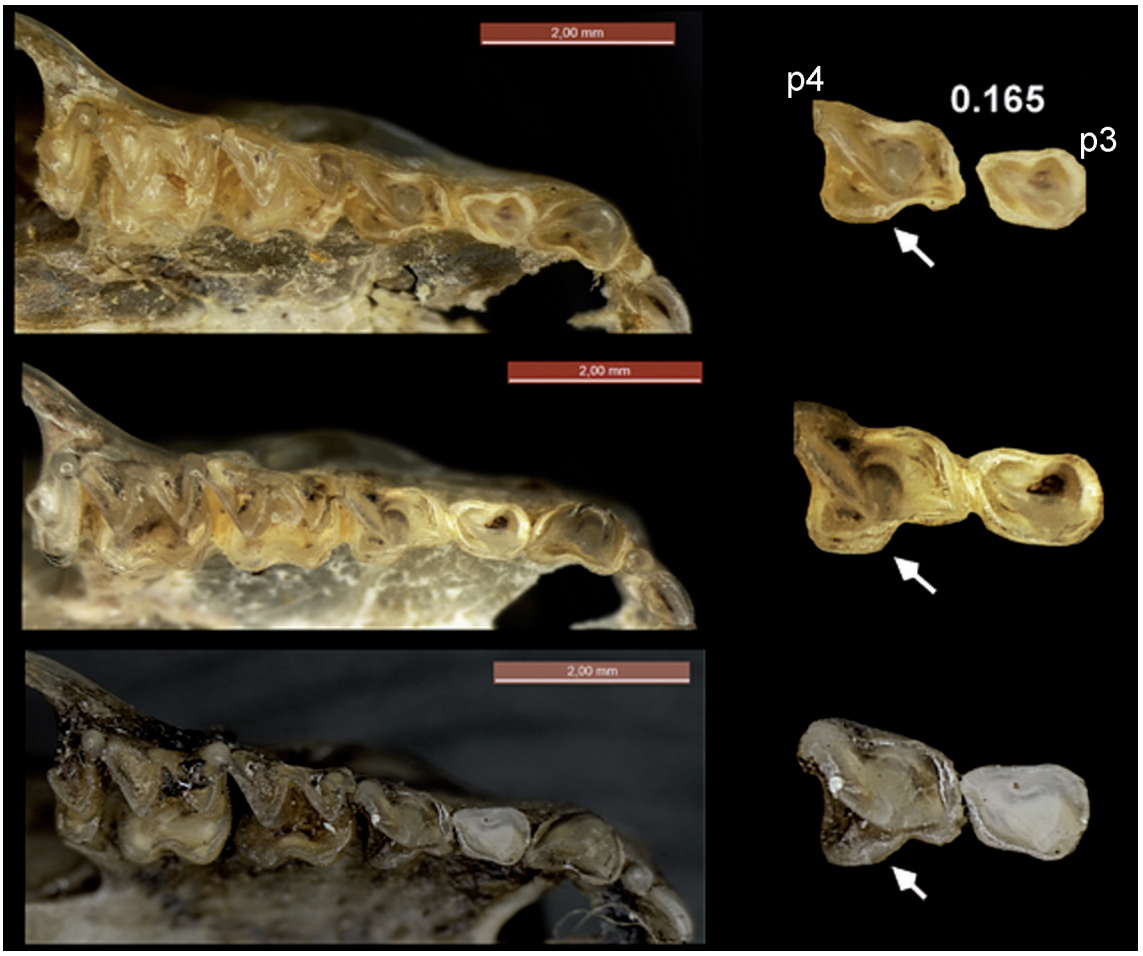

FIGURE 2: Occlusal view of the upper dentition of *M. sanborni* (upper: UFPB 6536; middle: UFPB 6734; lower: UFPB 6793). The insets to the right highlight differences in the spacing of p^3 and p^4 and the variation in the development of the posterolingual cingulum of p^4 (white arrow).

TABLE 2: Comparison of diagnostic traits in the species of the subgenus *Schizonycteris.* Information obtained from *Simmons (1996) and from †Siles *et al.* (2013).

Subgenus *Schizonycteris*	Trait						
Species	**Length of calcar relative to the foot**	**Color of the ventral fur**	**Proportion of White base Dorsal Hair**	**Skin between ears**	**Leading edge of the pinna**	**Gap between upper incisor and canine**	**P^3 in relation to P^4**
Micronycteris sanborni	Similar or Shorter	Pure white	2/3-4/5	High, deep notch	Covered with short fur (< 3 mm)	Absent or Present	Very short
Micronycteris minuta	Shorter or Similar	Dirty white; Pale gray	1/4-1/2	High, deep notch	Covered with short fur (< 3 mm)	Absent or Present	Slightly shorter
*Micronycteris schmidtorum**	Longer	Dirty white; Pale gray	—	Shallow notch	Covered with longer fur (> 5 mm)	Absent	Similar
Micronycteris yatesi†	Shorter or Similar	Throat and sternal region white and abdominal area pale buff	1/2-1/3	High, deep notch	Covered with short or longer fur (3.5-5.5)	Present	Very short

Subgenus *Schizonycteris*	Trait						
Species	**Distance between P^3 and P^4**	**P_3 in relation to P_2 and P_4**	**Height coronoid process in relation to condyloid**	**Dorsal profile of Skull**	**Anterior portion of the zygomatic**	**Articular process**	**Palatine Bone**
Micronycteris sanborni	Short or absent	Thin and Much smaller	Close	Smooth	Narrow	Triangular	Longer, convergent, extends until M1 and M2
Micronycteris minuta	Short or Absent	Slightly shorter	Far	Steep	High	Square	Longer, convergent, extends until M1 and M2
*Micronycteris schmidtorum**	Absent	Slightly shorter	Far	Steep	High	Square	Longer, convergent, extends until M1 and M2
Micronycteris yatesi†	—	Much smaller	Close	Smooth	—	Triangular	Shorter, parallel, extends until M2 and M3

developed articular process (iv), are also all valuable parameters for the recognition of *M. sanborni* (Fig. 4). The palatine bone in *M. sanborni* (as in *M. minuta* and *M. schmidtorum*) is longer, narrower and extends anteriorly to approximately between M^1 and M^2, while in *M. yatesi,* it is short and parallel and extends anteriorly until M^2 and M^3 (Siles *et al.,* 2013).

Quantitative data

The original description of *M. sanborni* was based on the analysis of only six specimens (Simmons, 1996). As the present study includes a greater number of specimens, it is possible to redefine the morphometric parameters for the species (Table 1). Overall, *M. sanborni* presents the smallest dimensions in comparison with the other species, followed by *M. yatesi, M. minuta,* and *M. schmidtorum.* External measurements overlapped considerably among *M. sanborni, M. yatesi,* and *M. minuta.* On the other hand, the cranial measurements of *M. sanborni* overlapped only discreetly with those of *M. yatesi.* These findings corroborate those of Siles *et al.* (2013). The length of the maxillary toothrow, the breadth of the braincase, the condyle-incisive length and the greatest length of the

TABLE 3: Localities for *Micronycteris sanborni.* The code numbers refer to the points shown in Fig. 5. N = number of specimens.

Reference	Locality	Code	N	Biome	Season	Features of the study site
López-Baucells *et al.* (2013)	Biological Dynamics Forest Fragmentation Project in Manaus, Amazonas	1	1	Amazon Forest	Dry	Lowland *terra firme* forest
Cunha *et al.* (2009)	Buraco das Araras Private Reserve, Mato Grosso	2	1	Cerrado	Rainy	Shrubs and trees (3-8 m) near a permanent lake
Gregorin *et al.* (2011)	Serra Geral do Tocantins Ecological Station, Tocantins	3	1	Cerrado	Rainy	Rocky, open savanna adjacent to rocky outcrops
Nogueira (1998)	Jaíba, Minas Gerais	4	4	Caatinga	—	Mistnets placed near Limestone outcrops
Gregorin *et al.* (2008)	Serra das Confusões National Park, Piaui	5	2	Caatinga	Dry	Low scrub with some larger trees in valleys, near rocky outcrops and a watercourse
Feijó *et al.* (2010)	Fazenda Almas Private Reserve, Paraíba	6	1	Caatinga	Dry	Shrubs and trees (3-8 m), near a reservoir
Simmons (1996)	Chapada do Araripe, Ceará	7	2	Caatinga	—	Small canyon with mesic vegetation (trees 12-17 m height with closed canopy), adjacent to a reservoir
Simmons (1996)	Exu, Pernambuco	8	4	Caatinga	—	Small cloud forest with large evergreen trees (10-12 m) and granite outcrops
This study	Boqueirão da Onça, Bahia	9	3	Caatinga	Dry	Shrubs and trees (3-8 m) on the banks of a watercourse in a humid valley
This study	Paripiranga, Bahia	10	5	Caatinga	Dry	Agricultural matrix with trees and shrubs (3-8 m) on hillsides and riverbanks
This study	Aiuaba Ecological Station, Ceará	11	18	Caatinga	Dry/ Rainy	Low scrub on the banks of a watercourse, adjacent to banana, cashew and maize plantations
This study	Tamandua Farm, Santa Terezinha, Patos, Paraiba	12	1	Caatinga	Dry	Unknown
This study	Buritizal Farm,Uruçui, Piaui	13	1	Cerrado	Rainy	Unknown
This study	Barra do Sonhém Farm, Loreto, Maranhão	14	1	Cerrado	—	Unknown

skull are the most important parameters for the differentiation of these species.

Geographic distribution and habitat preferences

A total of 14 localities (Table 3, Fig. 5) are known for *M. sanborni.* Most sites are arranged in a northeast-southwest diagonal across Brazil, corresponding to the scrub and savanna biomes (Caatinga and Cerrado) located between the Amazon and Atlantic Forest biomes (see Mares *et al.,* 1985; Sampaio, 1995).

Cunha *et al.* (2009) and Santos *et al.* (2010) reported the occurrence of *M. sanborni* in the Buraco das Araras Nature Reserve in Mato Grosso do Sul state, and López-Baucells *et al.* (2013) recorded the species in the Biological Dynamics Forest Fragmentation Project in Manaus, Amazonas state, Brazil. Both these records represent extreme outliers in the geographic distribution of the species (Fig. 5), and in fact, both studies describe a beige or dirty white ventral coloration, which is distinct from the pure white coloration described by Simmons (1996), and confirmed in all the specimens analyzed in the present study. Based on this evidence, Siles *et al.* (2013) have already speculated that the specimen reported by Santos *et al.* (2010) may in fact be *Micronycteris yatesi.* In addition to the contradictory coloration and the fact that it represents an extreme outlier, the record from Manaus is also inconsistent with the available evidence on the ecology of the species, *i.e.,* its preference for dry habitats. Unfortunately, López-Baucells *et al.* (2013) do not collect the specimen for further confirmation. Nogueira *et al.* (2014) also do not recognize this record due to the absence of voucher material. Furthermore, as suggested by Siles *et al.* (2013), individuals previously reported as *M. minuta* or *M. schimdtorum* from the Caatinga and Cerrado biomes should also be re-assessed, given the potential ecological differences among species.

Simmons (1996: 17) concluded that *M. sanborni* preferentially uses denser and more humid habitats within the Cerrado and Caatinga, a conclusion reinforced by Nogueira *et al.* (2007). However, the results of the present study indicate that the species also occurs in open areas of the Caatinga, including disturbed habitats (Table 3), as well as open areas of the Cerrado (Gregorin *et al.,* 2011), although this may reflect seasonal factors, in particular the distribution of the rains in the semiarid Caatinga, which tend to be restricted to a three or four-month period (Prado, 2003). During the dry season, many bodies

of water dry up, with the few permanent sites becoming focal points in the distribution of a wide range of fauna, including insects (Vasconcellos *et al.,* 2010). In the present study, most of the *M. sanborni* specimens were collected during the dry season and all were close to bodies of water (Table 3), which may reflect a seasonal ranging pattern related to insect foraging. Nevertheless, these observations indicate that the species occurs in mesic and open habitats, whether preferentially or not, including degraded environments, and that a similar pattern may be observed in the Cerrado savannas.

Nogueira *et al.,* (2007) identified *M. sanborni* as a cave-dwelling species. However the lack of records of this species from surveys of caves (Gregorin & Mendes, 1999; P.A. Rocha, pers. obs.), including those within the areas surveyed in the present study, does not support this conclusion. The available evidence (Table 3) indicates a possible preference for rocky outcrops and cliffs, where the species may roost in crevices.

Reproduction patterns

Based on the two pregnant *M. sanborni* specimens captured in December and another non-pregnant female collected in April, Simmons (1996: 18)

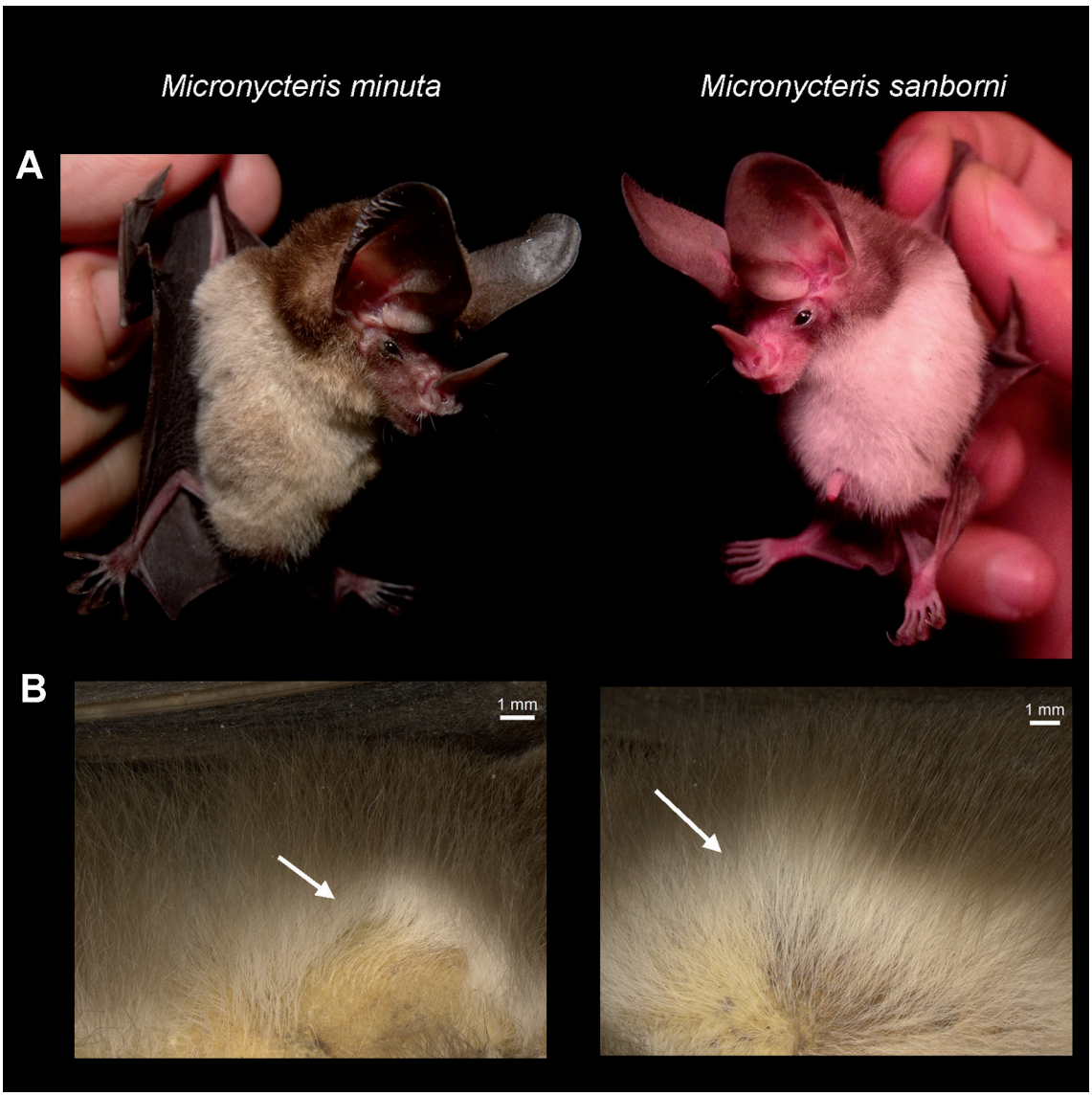

FIGURE 3: Differences in fur color between *M. sanborni* e *M. minuta.* A: Pale gray ventral fur of *Micronycteris minuta* and pure white ventral fur of *Micronycteris sanborni.* B: Short white basal dorsal hair in *M. minuta* and long white basal dorsal hair in *M. sanborni.*

concluded that "many [*M. sanborni*] give birth in the rainy season and wean their young around the beginning of the following dry season". The 18 *M. sanborni* specimens (11 male and seven female) collected at ESEC Aiuaba – the largest series available from a single locality – also reinforce this re-

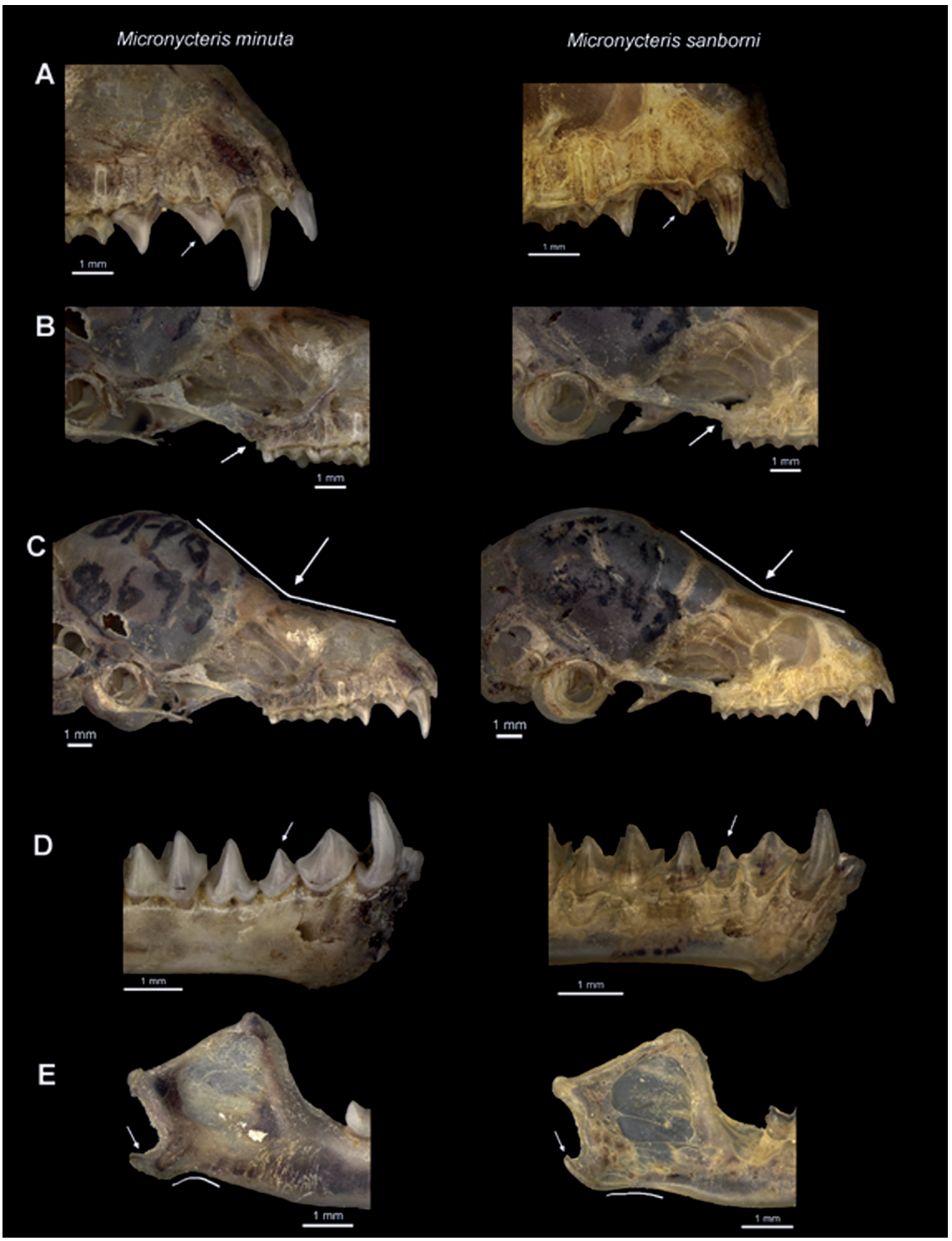

FIGURE 4: Diagnostic cranial traits for the differentiation of *M. minuta* (UFPB 8695) and *M. sanborni* (A, B, C: UFPB 6543, D and E: UFPB 6535). White arrow: A = P^3; B = anterior portion of the zygomatic arch; C = Dorsal profile of skull; D = p_3; E = articular process. See Table 2.

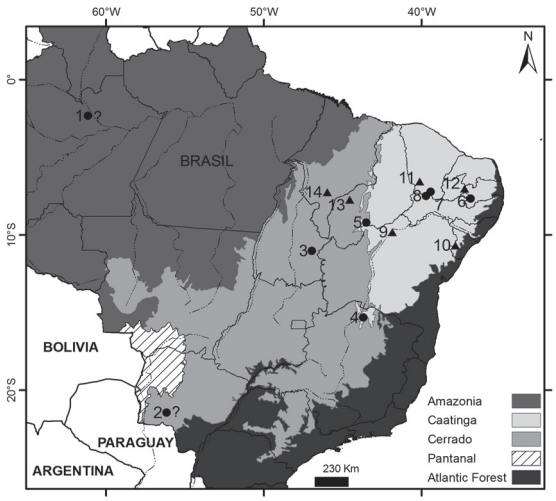

FIGURE 5: Recorded localities for *Micronycteris sanborni* in relation to Brazilian biomes. Circles: previous records; Triangles: new records. The sites are numbered as in Table 3. "?" refers to a doubtful records

productive pattern. Three of the females captured in December (rainy season) were at an advanced stage of gestation, and one collected in April (early dry season) was lactating. The three other females, captured in August and September (dry season) presented no signs of reproductive activity. These findings indicate that the species is monoestrous, which is typical of the gleaning animalivore bats of the subfamily Phyllostominae (Durant *et al.,* 2013), with births coinciding with the rainy season, when insects are more abundant (Vasconcellos *et al.,* 2010).

CONCLUSION

The *M. sanborni* specimens analyzed in the present study provided important new insights into the taxonomy, distribution, and biology of the species. In particular, a number of the traits on which the original description of the species was based were found to be highly variable, and thus of reduced value for taxonomic diagnosis, in particular with regard to the morphologically similar *M. minuta.* Therefore, a careful re-evaluation of the specimens of the subgenus *Schizonycteris* reported previously is strongly recommend, taking into account the diagnostic traits reported here, especially for the specimens from the Caatinga and Cerrado biomes. *Micronycteris sanborni* appears to prefer mesic, arid and disturbed habitats within the dry polygon of tropical South America, in particular those associated with rocky outcrops. The results of this study also indicate that this species may be captured relatively more easily by setting mist-nets over bodies of water, especially during the dry season, when feeding resources become scarce. This may be confirmed by further research in the dry forest and savanna ecosystems of central and northeastern Brazil. The species also appears to be monoestrous, with births coinciding with the rainy season.

RESUMO

Micronycteris *está dividido em quatro subgêneros,* Micronycteris, Leuconycteris, Xenoctenes *e* Schizonycteris. *Este último inclui* Micronycteris *(*Schizonycteris*)* minuta, Micronycteris *(*S.*)* schmidtorum, Micronycteris *(*S.*)* sanborni *e* Micronycteris *(*S.*)* yatesi. *Atualmente pouco se sabe sobre a biologia de* M. *(*S.*)* sanborni, *a qual é amplamente distribuída pelas florestas secas da América do Sul, apesar de ser conhecida de apenas poucas localidades. A escassez de registros de* M. sanborni *parece está parcialmente relacionado a dificuldade de diferenciar esta espécie de outros membros do subgênero* Schizonycteris. *Dessa forma, o presente estudo visa identificar as características diagnósticas que distingue esta espécie dos outros* Schizonycteris, *revisar a distribuição geográfica dessa espécie e apresentar comentários sobre o seu padrão reprodutivo. Seis novas localidades são apresentadas aqui para* M. sanborni *e, juntas com as outras disponíveis na literatura, foram analisadas fornecendo novas abordagens sobre o padrão ecológico e zoogeográfico dessa espécie. Várias características diagnósticas estabelecidas por Simmones (1996) na descrição de* M. sanborni *mostraram-se de pouco valor taxonômico, especialmente para a diferenciação entre* M. minuta *e* M. yatesi, *das quais mais se assemelha. As principais diferenças externas são a coloração branco pura do ventre e a proporção da base branca (2/3-4/5) do pelo dorsal em* M. sanborni, *em contraste com a coloração branco sujo ou acinzentado e a base dorsal branca muito mais curta das outras espécies. Outras características cranianas mostraram-se também importantes para a diferenciação. Os dados de distribuição levantados indicam que* M. sanborni *ocorre principalmente em áreas mésicas e abertas, incluindo ambientes alterados, na Caatinga arbustiva e nas savanas do Cerrado do nordeste do Brasil, especialmente em áreas com afloramentos rochosos.* Micronycteris sanborni *parece ser monoéstrico, com os nascimentos coincidindo com a estação chuvosa.*

Palavras-Chaves: *Schizonycteris;* Variação intraespecífica; Floresta Seca; Brasil; Chiroptera.

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