

First records of *Myotis ruber* and *Molossus pretiosus* for the state of Ceará, Northeast Brazil

Primeros registros de *Myotis ruber* y *Molossus pretiosus* para el estado de Ceará, noreste de Brasil

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The Chiroptera order ranks second in terms of species richness among mammals. Among its families, Molossidae and Vespertilionidae stand out because they have a cosmopolitan distribution and are found on all continents, comprising 134 and 531 species, respectively. In Brazil, there are currently documented 181 chiropteran species, with 32 belonging to Molossidae and 26 to Vespertilionidae, making them the most abundant families after Phyllostomidae. The aim was to document the first records of *Myotis ruber* and *Molossus pretiosus* in the state of Ceará. Bats were sampled using mist nets for a duration of 6 hr post-sunset, and their identification followed established literature. Sampling was conducted in the municipalities of Pacoti and Guaramiranga in the state of Ceará, northeastern Brazil. This study presents the first records for 2 species of bats, *Molossus pretiosus* and *Myotis ruber*, for the state of Ceará in Serra de Baturité. These records contribute to increasing the species list in the state of Ceará, broaden the distribution of these 2 bat species, and contribute to enhance the understanding of species diversity in northeastern Brazil.

Key words: Chiroptera; Guaramiranga; humid forest; occurrence; Pacoti.

El Orden Chiroptera ocupa el segundo lugar en términos de riqueza de especies entre los mamíferos. Entre sus familias destacan Molossidae y Vespertilionidae que tienen una distribución cosmopolita y se encuentran en todos los continentes, comprendiendo 134 y 531 especies, respectivamente. En Brasil, actualmente hay documentadas 181 especies de quirópteros, de las cuales 32 pertenecen a Molossidae y 26 a Vespertilionidae, lo que las convierte en las familias más abundantes después de Phyllostomidae. El objetivo fue documentar los primeros registros de *Myotis ruber* y *Molossus pretiosus* en el estado de Ceará. Se tomaron muestras de murciélagos utilizando redes de niebla durante 6 hr después de la puesta del sol, y su identificación siguió la literatura establecida. El muestreo se realizó en los municipios de Pacoti y Guaramiranga en el estado de Ceará, del noreste de Brasil. Este estudio presenta los primeros registros de 2 especies de murciélagos, *Molossus pretiosus* y *Myotis ruber*, para el estado de Ceará en la Sierra de Baturité. Estos registros contribuyen a aumentar la lista de especies en el estado de Ceará, amplían la distribución de estas 2 especies de murciélagos, y contribuyen a mejorar la comprensión de la diversidad de especies en el noreste de Brasil.

Palabras clave: Bosque húmedo; Chiroptera; Guaramiranga; ocurrencia; Pacoti.

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The Chiroptera order holds the second-largest number of mammalian species, totaling approximately 1,474 species ([Simmons and Cirranello 2024](#)). In Brazil, a country renowned for its megadiversity, there are 181 recorded bat species, belonging to 68 genera and 9 families ([Garbino et al. 2022](#)). In the Ceará state located in northeastern Brazil, so far, there are 53 bat species documented ([Fernandes-](#)

[Ferreira et al. 2021](#)). The region is predominantly within the Caatinga biome, in addition to the arid coast, and remnants of the Atlantic Forest in highland areas known as brejos de altitude ([Bétard et al. 2007](#); [Moro et al. 2015](#)).

In terms of taxonomic richness, the Vespertilionidae family is the most diverse worldwide, comprising nearly 531 species, with a distribution ranging from tropical to

temperate regions (Simmons and Cirranello 2024). Bats belonging to this family are predominantly insectivorous and characterized by their small eyes and lack prominent facial ornaments or structures such as a distinct nasal leaf, which is a noticeable feature in some other bat families (Reis et al. 2017). The *Myotis* genus, found within the Vespertilionidae family, is one of the most diverse worldwide, currently encompassing 139 recognized species (Simmons and Cirranello 2024). In Brazil, there are 8 *Myotis* species, and 3 of them have been recorded in Ceará: *Myotis lavalii* Moratelli, Peracchi, Dias and Oliveira, 2011, *M. nigricans* (Schinz, 1821), and *M. riparius* Handley, 1960 (da Silva et al. 2015; Fernandes-Ferreira et al. 2021).

The family Molossidae, which represents a significant portion of bat diversity, consists of insectivorous bats (Reis et al. 2017) and encompasses 134 described species worldwide (Simmons and Cirranello 2024). They are primarily found in tropical regions (Loureiro et al. 2018). In Brazil, there are 8 genera and 32 species of Molossidae distributed throughout the country (Garbino et al. 2022). Within the Molossidae family, species belonging to the genus *Molossus* have a Neotropical distribution, ranging from México to southern Argentina, including various Caribbean islands (Loureiro et al. 2018). Currently, there are approximately 15 known species within this genus worldwide (Simmons and Cirranello 2024), of which 7 are found in Brazil and 3 have been recorded in Ceará: *Molossus aztecus* Saussure, 1860, *M. molossus* Pallas, 1766, and *M. rufus* É. Geoffroy, 1805 (da Silva et al. 2015; Fernandes-Ferreira et al. 2021).

Our study presents the first records of *Myotis ruber* (É. Geoffroy, 1806) and *Molossus pretiosus* Miller, 1902 in the state of Ceará. Additionally, we provide detailed morphological descriptions of the voucher specimens and compare them with available descriptions in literature.

The study area encompassing the municipalities of Pacoti (4° 13' 35.25" S, 38° 55' 22.15" W) and Guaramiranga (4° 14' 48.11" S, 38° 56' 29.38" W), resides within the Baturité Ridge ecoregion, representing one of Ceará state's highest and most biodiverse *brejos de altitude* (Bétard et al. 2007; Alvares et al. 2013; Figure 1). The altitude and topographical disposition relative to the sea contribute to a range of average temperatures, varying from 22 °C at higher altitudes to 26 °C at lower altitudes (Bétard et al. 2007; Alvares et al. 2013). These mountains form barriers to moisture-laden winds from the Atlantic, fostering orographic precipitation that results in substantial rainfall (approximately 1,300 mm per year), and this leads to the formation of moisture islands characterized by humid forests surrounded by the Caatinga (Bétard et al. 2007; Alvares et al. 2013).

The northeastern region of Brazil is predominantly characterized as semi-arid, primarily covered by caatinga vegetation (Gois et al. 2019). However, in the higher areas of the mountain ranges, the climate is less arid. The High-Altitude Swamps of the Northeast are relatively more humid regions compared to the surrounding semi-arid areas due to orographic effects influencing precipitation and lead-

ing to reduced temperatures. The mountain forests within these areas are recognized as ecological disjunctions of the Atlantic Forest, isolated by the caatinga vegetation, making them remnants of high biodiversity (Pôrto et al. 2004). This ecosystem can be considered a refuge or a vegetational relic due to its unique floristic, physiognomic, and ecological characteristics compared to the surrounding environment (Veloso et al. 1991). Many similarities can be identified among different high-altitude swamps, with the primary shared characteristic being the high altitude, consistently occurring at peaks above 550 m (Bétard et al. 2007; Gois et al. 2019). Besides altitude, specific combinations of soils and/or rocks interact under different climatic conditions from their immediate surroundings, allowing for the development of distinct vegetation contributing to the existence of more humid mesoclimates (Pinto et al. 2012; Moro et al. 2015; Gois et al. 2019).

The fieldwork involved the use of mist nets, which were set up in clearings within vegetation patches, near rivers, and along trails. The nets remained open for 6 hr after sunset and were checked at 15-min intervals. Captured specimens were initially sorted and identified in the field (Gardner 2007; Reis et al. 2017). The fieldwork followed the guidelines and national provisions of "Sistema de Autorização e Informação em Biodiversidade" (SISBIO; License number 60058 and 84226). All animal procedures and veterinarian assistance agreed with "Conselho Nacional de Controle de Experimentação Animal", recommended by CONCEA (2013), and approved by the "Comissão de Ética no Uso de Animais" (CEUA) of Universidade Estadual do Ceará (UECE), under protocol 10802574/2021. Individuals collected as vouchers were deposited in the Mammals Collection of the Museu de História Natural do Ceará Professor Dias da Rocha (MHNCE/UECE), Pacoti, Ceará, Brazil. The taxonomic identification was confirmed in the laboratory using relevant literature sources (LaVal 1973; Jennings et al. 2000; López-González et al. 2001; Reis et al. 2017; Loureiro et al. 2018; Díaz et al. 2021).

The following measurements were obtained using a digital caliper (0.01 mm): 1) external measurements: forearm length (FL), dorsal fur length (FUR), length of 3rd metacarpal (MCIII); 2) cranio-dental measurements: greatest length of skull (GLS), depth of braincase (DB), condylocanine length (CCL), condylobasal length, including incisors (CBL), mastoid breadth (MAB), zygomatic breadth (ZYG), breadth of the braincase (BBC), postorbital constriction (POC), breadth across upper canines (BAC), breadth across upper molars (BAM), length of rostrum (LNR), length of maxillary tooththrow (MAX), length of upper molariform tooththrow (UML), length of mandibular tooththrow (MTR), length of lower molariform tooththrow (LML). The acronyms followed Sbragia and Pessôa (2008), and Nogueira et al. (2008).

The *M. ruber* voucher MHNCE-MAM 00420 was captured at Sítio Nova Olinda, in the municipality of Guaramiranga, approximately 505.66 km from the closest known record of the species in the municipality of Brejo da Madre de Deus,

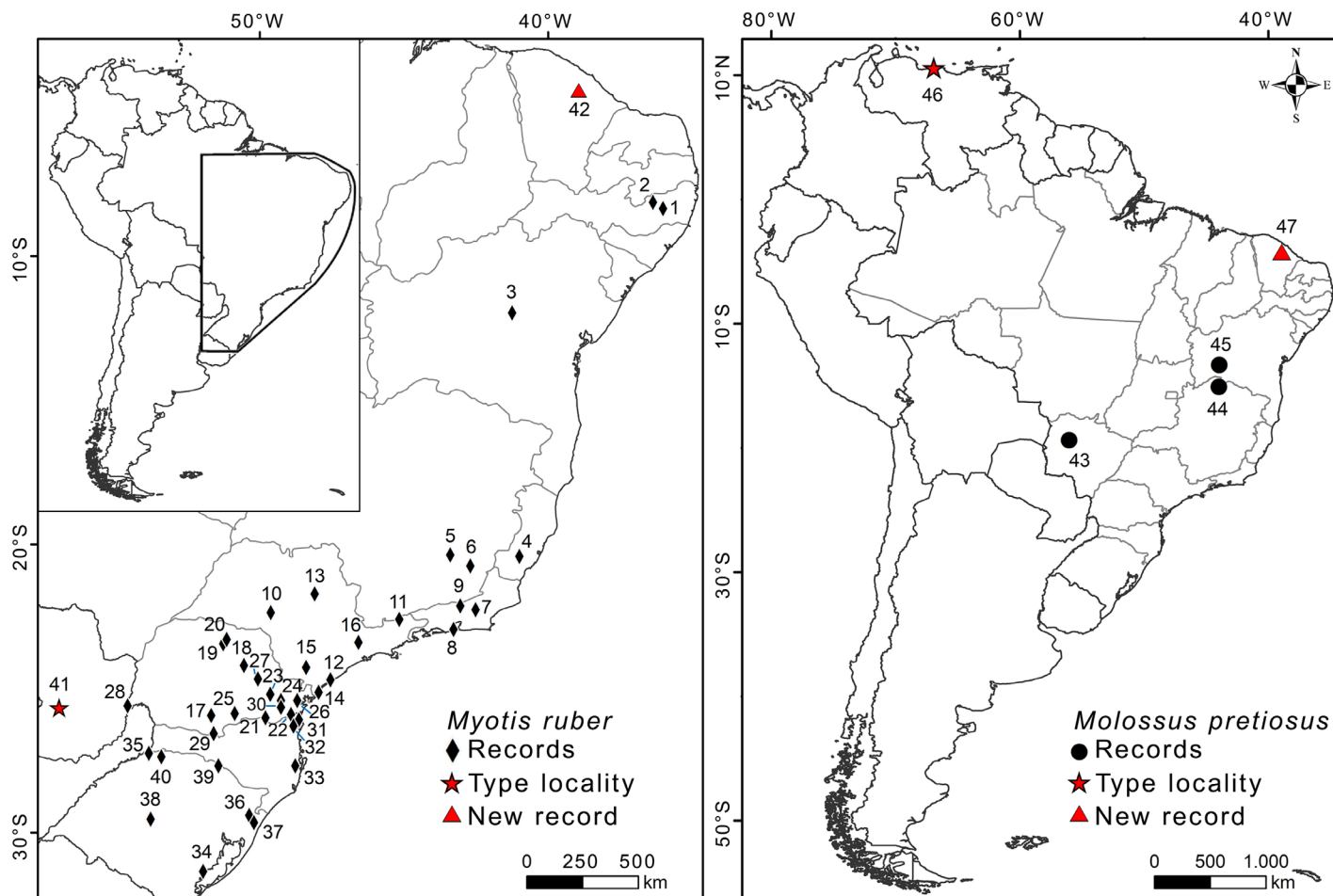


Figure 1. Geographic records of *Myotis ruber* and *Molossus pretiosus* in Brazil. For locations corresponding to the numbers see Appendix 1.

Pernambuco state (Figure 1). The individual is an adult and inactive female, caught on May 30, 2022 (Figure 2a-d). It has a monicolor reddish dorsal color with hairs measuring 5.5 mm, bicolor ventral hairs with a dark brown base, and an orange apex, measuring 3 mm (Figure 2d). The forearm measured 39.61 mm, the third metacarpal measured 36.04 mm, and body weight 7g (Table 1).

The specimen of *M. pretiosus* MHNCE-MAM 00218 was captured at the MHNCE headquarters, in the municipality of Pacoti, approximately 1,148 km from the nearest known record of the species in the municipality of São Félix do Coribe, Bahia state (Figure 1). The individual is an adult and inactive female caught on October 20, 2021 (Figure 2e-h). The forearm measured 45.42 mm in the observed specimen. Describing its characteristics, the general color is blackish and slightly reddish, the face and membranes are dark, although not completely black. Hair on the uropatagium reaches the proximal third and dense ventral hair on the wings in the region close to the body and forearm. Dorsal hair is darker than ventral, short (3 mm), and slightly bicolored with a light basal stripe and slightly darker tips. The ventral fur is bicolored, and short (4 mm), with a white basal stripe and brownish tips. The skull is short and wide, with a well-developed sagittal crest and prominent braincase (Figure 2f; Table 1). The upper incisors are long and

pointed (Figure 2e), and M3 has a V-shaped cusp pattern (Figure 2g).

Endemic to South America, *M. ruber* has its type locality in Sapucay, Ñeembucú, Paraguay (Gardner 2007; Sbragia and Pessôa 2008). Its distribution spans Argentina, Uruguay, and Brazil. In Brazil, it has been documented in the states of Alagoas, Bahia, Espírito Santo, Minas Gerais, Paraná, Pernambuco, Rio Grande do Sul, Rio de Janeiro, Santa Catarina, and São Paulo (López-González et al. 2001; Miretzki 2003; Gardner 2007; Weber et al. 2007; Sbragia and Pessôa 2008; Weber et al. 2010; Reis et al. 2017).

Descriptions and measurements of *M. ruber* are available in some publications. Therefore, according to what has been described for the species, *M. ruber* can be characterized by its generally monicolor cinnamon coat, with a silky texture, dorsal hair averaging 4 mm, and ventral hairs dark brown at the base, changing to orange-yellowish at the tips (LaVal 1973). Its membranes are brownish or blackish, practically naked, except for the dorsal surface where the hairs slightly exceed knee height (LaVal 1973; Reis et al. 2017). The uropatagium hair extends to or beyond the knees, but no more than halfway between the knee and the foot (LaVal 1973). It has a relatively large skull when compared to other *Myotis* and sagittal crests present and well developed (LaVal 1973). *Myotis ruber* differs from its conge-

Table 1. Mean, standard deviation, minimum, maximum and number of specimens (*n*) from Brazil, used for comparison in the present study. *Myotis ruber* – Ceará (CE, MHNCE-MAM 00420, present study) and Bahia (BA, [Sbragia and Pessoa 2008](#)). *Molossus pretiosus* – Ceará (CE, MHNCE-MAM 00218, present study), Mato Grosso do Sul (MS, [Gregorin and Taddei 2000](#)), Minas Gerais (MG, [Nogueira et al. 2008](#)) and Bahia (BA, [Cláudio et al. 2018](#)). The external and cranial measurements are in mm, and for acronyms see material and methods.

Sex	<i>Myotis ruber</i>				<i>Molossus pretiosus</i>			
	Guaramiranga (CE)	Bonito (BA)	Pacoti (CE)	Aquidauana (MS)	Jaíba (MG)		São Félix do Coribe (BA)	
	Female	Male	Female	Male	Female	Male	Female	
FL	39.61	39.30	45.51	46.45±1.76 45.20-47.70 (2)	43.63±1.46 42.60-45.50 (3)	46.10±0.80 44.90-46.80 (5)	45.00±1.00 43.60-47.20 (12)	46.30
FUR	5.50	4.30	-	-	-	-	-	-
GLS	15.02	15.10	19.78	21.10±0.21 21.00-21.30 (2)	19.40±0.20 19.20-19.60 (3)	20.60±0.50 19.90-21.40 (5)	19.60±0.50 19.10-20.40 (12)	19.80
DB	5.54	5.40	-	-	-	-	-	-
CCL	12.01	13.30	-	-	-	-	-	-
CBL	13.00	14.30	18.00	-	-	18.70±0.50 18.10-19.50 (5)	17.90±0.30 17.50-18.50 (12)	18.20
MAB	7.75	7.80	10.01	-	-	12.80±0.50 12.10-13.40 (5)	12.30±0.40 11.90-13.50 (12)	10.80
ZYG	9.93	9.50	12.67	13.05±0.35 12.80-13.30 (2)	12.43±0.15 12.30- 12.60 (3)	13.30±0.30 12.80-13.50 (5)	12.50±0.30 12.20-13.20 (12)	12.30
BBC	7.07	7.00	9.99	10.30±0.00 (2)	9.83±0.11 9.70-9.90 (3)	10.30±0.20 10.00-10.60 (5)	10.10±0.20 9.80-10.50 (12)	10.00
POC	3.67	3.80	4.14	-	-	4.30±0.20 4.10-4.60 (5)	4.30±0.20 4.10-4.60 (12)	4.00
BAC	4.60	4.10	5.13	-	-	5.60±0.10 5.50-5.80 (5)	5.20±0.20 5-5.60 (12)	4.80
BAM	5.96	6.00	9.49	9.25±0.21 9.10-9.40 (2)	9.00±0.20 8.80-9.20 (3)	9.50±0.30 8.90-9.80 (5)	9.00±0.30 8.50-9.70 (12)	8.80
LNR	6.00	6.30	-	-	-	-	-	-
MAX	6.78	6.00	7.16	7.65±0.07 7.60-7.70 (2)	7.30±0.17 7.20-7.30 (3)	7.60±0.20 7.30-7.80 (5)	7.20±0.10 7.00-7.50 (12)	7.00
UML	4.04	4.90	-	-	-	-	-	-
MTR	6.04	6.20	-	-	-	-	-	-
LML	3.73	5.30	-	-	-	-	-	-
MCIII	36.04	35.70	-	-	-	-	-	-

ners *M. nigricans*, *M. levis*, and *M. albescens*, mainly due to the presence of a sagittal crest on the skull, and exceeds in size *M. nigricans*, *M. albescens* and *M. riparius*. Despite the similarities in size and color with *M. simus*, they differ mainly by the arrangement of the upper premolars ([López-González et al. 2001](#); [Sbragia and Pessoa 2008](#); [Reis et al. 2017](#)).

Little is known about the natural history of *M. ruber*, which is considered rare throughout its range. Its records suggest that it occurs in rainforest habitats, being rare in isolated patches outside the southern Atlantic Forest ([Sbragia](#)

[and Pessoa 2008](#); [Weber et al. 2010](#)). The existence of humid forests may be one of the determinant factors for the occurrence of this species ([Weber et al. 2010](#)), and its populations may not be isolated, but rather connected by patches of Atlantic Forest or associated formations ([Weber et al. 2010](#)). It has been assessed as Near Threatened (NT) by the IUCN Red List of Threatened Species ([Solari 2019](#)), while in Brazil, its assessment status is least concern (LC; [ICMBio 2023](#)).

The type locality of *M. pretiosus* is La Guaira in Venezuela ([Gardner 2007](#)), and its distribution extends from México



Figure 2. *Myotis ruber*: a) dorsal, b) ventral and c) lateral view of the skull and mandible, and d) voucher MHNCE-MAM 00420. *Molossus pretiosus*: e) frontal view, f) dorsal, g) ventral and h) lateral view of the skull and mandible. Arrows are signaling cranio-dental morphological features that helped the identification of the specimens: black arrows – sagittal crest (a and f), and white arrows – long and pointed upper incisors (e), and v-shaped M3 (g). The white bars represent 5 mm scale of skull.

to Nicaragua, Costa Rica, Panamá, Colombia, Venezuela, Guyana, and Brazil (Gardner 2007; Cláudio et al. 2018). In Brazil, this species has been recorded in the municipalities of Aquidauana in Mato Grosso do Sul, Jaíba in Minas Gerais, and São Félix do Coribe in Bahia (Gregorin and Taddei 2000; Nogueira et al. 2008; Cláudio et al. 2018).

Molossus pretiosus shares overlapping characteristics with some of its congeners; however, it can be distinguished by observing certain differences among them. *Molossus pretiosus* can be distinguished from *M. rufus*, which typically exhibits a forearm length generally greater than 46.7 (Loureiro et al. 2018). Cranial measurements are also larger in *M. rufus* (Gregorin and Taddei 2000; Jennings et al. 2000; Gregorin and Taddei 2002; Nogueira et al. 2008; Loureiro et al. 2018). Furthermore, *M. rufus* has short, spatulate upper incisors with converging tips (Jennings et al. 2000; Gregorin and Taddei 2002; Nogueira et al. 2008; Loureiro et al. 2018); from *M. currentium* due to the size of the forearm, which is smaller than 44.7 mm (Loureiro et al. 2018), and spatulate upper incisors (Díaz et al. 2021); and from *M. molossus*, which is smaller in size (Gregorin and Taddei 2002), with forearm length between 36.2 and 42.6 mm (Loureiro et al. 2018).

The distribution of *M. pretiosus* is the most restricted and disjunctive of all its congeners (Gardner 2007). However, the scarcity of data on the species in Brazil may be associated with a sampling gap and not be associated with geographic barriers (Nogueira et al. 2008).

Baturité Ridge is known for having records of species that only inhabit humid enclaves, including endemic species such as the rodent *Rhipidomys baturiteensis*, the frog *Rhinella casconi*, and the snake *Apostolepis thalesdelemai* (Borges-Nojosa et al. 2016; Roberto and Loebmann 2016; Campos et al. 2022). In addition, it is considered a remnant of a past connection between Amazon and Atlantic Forest. Therefore, the conservation of this wetland is important for the persistence of many species over time.

These recent findings increase the list of bat species in Ceará to 55, highlighting the importance and necessity of conducting further inventories within the state, even in relatively well-studied regions like Baturité Ridge. It is essential to include *M. ruber* and *M. pretiosus* in the forthcoming state red list evaluations (SEMA 2022), especially due to the presence of an internationally threatened species (*M. ruber*). Management and conservation plans are crucial,

particularly considering human activities that increase habitat degradation and loss.

In this study, the generated data is preserved in scientific collections, providing invaluable long-term information, crucial for understanding regional biodiversity. Therefore, we emphasize on the need for greater investment in natural history museums and scientific institutions. This investment also holds significance for environmental education and research purposes ([Marinoni and Peixoto 2010](#)).

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Appendix 1

List of localities of *Myotis ruber* and *Molossus pretiosus* records in Brazil, type locality and new records (present study; Figure 1).

Myotis ruber: Brazil - Pernambuco: 1 - Caruaru, Parque Ecológico Municipal Professor João Vasconcelos Sobrinho (Sousa et al. 2004), 2 - Brejo da Madre de Deus (Sousa et al. 2004); Bahia: 3 - Bonito (Sbragia and Pessôa 2008); Espírito Santo: 4 - Domingos Martins, Parque Estadual Pedra Azul (Vieira et al. 2008); Minas Gerais: 5 - Mariana (Vieira 1942), 6 - Viçosa (López-González et al. 2001); Rio de Janeiro: 7 - Nova Friburgo (Vieira 1942), 8 - Rio de Janeiro, Parque Nacional da Tijuca (Esbérard 2003), 9 - Parque Nacional da Serra dos Orgãos (Moratelli and Peracchi 2007); São Paulo: 10 - Gália, Estação Ecológica de Caetetus (Pedro et al. 2001), 11 - Piquete (Vieira 1955), 12 - Iguape (Vieira 1955), 13 - Américo Brasiliense (Species Link 2008), 14 - Cananéia, Parque Estadual da Ilha do Cardoso (Alves 2008), 15 - Ribeirão Grande, Parque Estadual Intervales (Passos et al. 2003), 16 - Parque Estadual da Cantareira (Bertola et al. 2005); Paraná: 17 - Faxinal do Ceu, Fazenda Iguazu (Persson and Lorini 1990), 18 - Telêmaco Borba, Fazenda Monte Alegre (Reis et al. 1999), 19 - Londrina, Parque Estadual Mata dos Godoy (Reis and Muller 1995), 20 - Londrina, Parque Municipal Arthur Thomas (Reis et al. 2003), 21 - Rio Negro (Miretzki 2003), 22 - Guaratuba, Serra do Araçatuba (Miretzki 2003), 23 - Campo Largo, Três Córregos (Miretzki 2003), 24 - Curitiba (Margarido and Braga 2004), 25 - São Mateus do Sul, Fazenda Durgo (Margarido and Braga 2004), 26 - Antonina, Reserva Natural do Cachoeira (Margarido and Braga 2004), 27 - Castro, Parque Estadual de Caxambu (Margarido and Braga 2004), 28 - Foz do Iguaçu, Parque Nacional do Iguaçu (Sekizawa et al. 2001), 29 - Palmas, Campos de Palmas (Miranda et al. 2008), 30 - Curitiba, Fazenda Rio Grande, Fazenda Gralha Azul (Graciolli and Bianconi 2007); Santa Catarina: 31 - Itapoá, RPPN de Volta Velha (Sipinski and Reis 1995), 32 - Joinville (Cherem et al. 2004), 33 - Santo Amaro da Imperatriz (Cherem et al. 2004); Rio Grande do Sul: 34 - São Lourenço do Sul (Vieira 1955), 35 - Derrubadas, Parque Estadual do Turvo (Wallauer and Albuquerque 1986), 36 - São Francisco de Paula (Pacheco and Freitas 2003), 37 - Maquiné (Pacheco and Freitas 2003), 38 - Itaara (Weber et al. 2007), 39 - Barracão (Pacheco and Freitas 2003), 40 - Vila Faguense, Frederico Wesphalen (Bernardi et al. 2009); Paraguay - Type locality: 41 - Sapucay, Ñeembucu (Reis et al. 2017); Present study, Brazil - Ceará: 42 - Guaramiranga, Sitio Nova Olinda.

Molossus pretiosus: Brazil - Mato Grosso do Sul: 43 - Aquidauana, Pantanal da Nhecolândia (Gregorin and Taddei 2000); Minas Gerais: 44 - Jaíba (Nogueira et al. 2008); Bahia: 45 - São Félix do Coribe (Cláudio et al. 2018); Venezuela - Type locality: 46 - La Guaira (Miller 1902); Present study, Brazil - Ceará: 47 - Pacoti, Sede do Museu de História Natural do Ceará Prof. Dias da Rocha.