



RANGE EXTENSION OF CARRIKER'S ROUND-EARED BAT, *Lophostoma carrikeri* (ALLEN, 1910) (CHIROPTERA: PHYLLOSTOMIDAE) IN THE CERRADO AND CAATINGA

Fred Victor de Oliveira^{1*}, Rodolfo Stumpp², Alaine Prado², João Gabriel Mota Souza³, Luiz Dolabela Falcão³, Maria Clara do Nascimento¹ & Fernando Araújo Perini⁴

¹ Universidade Federal de Minas Gerais, Instituto de Ciências Biológicas, Departamento de Zoologia, Laboratório de Evolução de Mamíferos, Avenida Antônio Carlos, nº 6627, CEP 31270-901, Pampulha, Belo Horizonte, MG, Brasil.

² Universidade Federal de Minas Gerais, Instituto de Ciências Biológicas, Departamento de Genética, Ecologia e Evolução, Laboratório de Ecologia e Conservação, Avenida Antônio Carlos, nº 6627, CEP 31270-901, Pampulha, Belo Horizonte, MG, Brasil.

³ Universidade Estadual de Montes Claros, Departamento de Biologia Geral, Laboratório de Ecologia Evolutiva, Avenida Rui Braga, S/N, CEP 39401-089, Vila Mauricéia, Montes Claros, MG, Brasil.

⁴ EcoDes Ambiental. Rua Flávio Maurício, 596, Bairro Jardim Panorama. Montes Claros, MG. CEP 39.401-097.

E-mails: fredvictor97@gmail.com (*corresponding author); rastumpp@gmail.com; alaine.masto@gmail.com; joaogabriel@ecodesambiental.com.br; luizdolabelafalcao@gmail.com; lonchophylla@gmail.com; faperini@ufmg.br

Abstract: *Lophostoma carrikeri* is a bat species widely distributed in the northern portion of South America and has been reported in a great variety of forested habitats. However, it is still poorly represented in scientific collections and wildlife surveys. In Brazil, *L. carrikeri* is known mainly for the Amazon basin and few localities in the Cerrado and Caatinga biomes. Here we report the first records of *Lophostoma carrikeri* from the states of Minas Gerais and Ceará based on specimens examined in taxonomic collections and collected during fieldwork. These new records represent the easternmost limits on the distribution of *L. carrikeri* and expand its known geographic range in approximately 488 km southeast and 490 km east of the nearest known records (São Domingos, state of Goiás and Teresina, state of Piauí). We also provide measurements, comments on morphological variation and an overall review of the species geographic distribution.

Keywords: geographic distribution; Phyllostominae; new records.

The genus *Lophostoma* d'Orbigny, 1836 currently comprises seven species of small to medium-sized neotropical leaf-nosed bats: *L. silviculum* d'Orbigny, 1836; *L. brasiliense* Peters, 1866; *L. carrikeri* (Allen, 1910); *L. occidentale* (Davis & Carter, 1978); *L. evotis* (Davis & Carter, 1978); *L. schulzi* (Genoways & Williams, 1980); and *L. kalkoae* Velazco & Gardner, 2012 (Williams & Genoways 2008, Velazco & Cadenillas 2011,

Velazco & Gardner 2012, Camacho *et al.* 2016). Four of these species are currently recorded in Brazil: *L. silviculum*, *L. brasiliense*, *L. carrikeri* and *L. schulzi* (Garbino *et al.* 2020). *Lophostoma silviculum* and *L. brasiliense* are widespread in Central and South America while *L. schulzi* is restricted to northern South America (French Guiana, Guyana, Suriname and northern Brazil) (Barquez *et al.* 2016, Sampaio *et al.* 2016a, Sampaio *et al.* 2016b;

Sampaio *et al.* 2016c). *Lophostoma carrikeri* has been reported in tropical rainforests, mesic and riparian forests, semideciduous savanna, and dry forests in southeastern Colombia, eastern Ecuador, southern Amazonas state in Venezuela, the Guianas, and north to central Brazil, adjacent to Peru and Bolivia (Sampaio *et al.* 2016a, Sampaio *et al.* 2016b, Camacho *et al.* 2016). In Brazil, most records of *L. carrikeri* are within the Amazon biome, but in the last decade it was recorded for the first time in the Cerrado and reported in the Caatinga after 28 years since it was previously collected in this biome (Vizotto *et al.* 1980, Gregorin *et al.* 2008, Zortéa *et al.* 2009, Gregorin *et al.* 2011). Recently, Brandão *et al.* (2020) have also recorded *L. carrikeri* for transitional areas between Cerrado and southwestern Amazon in the state of Mato Grosso, but records outside the Amazon are still scarce.

Herein we report new records of *L. carrikeri* for the Cerrado and Caatinga biomes, with range extension to the eastern portion of the Brazilian territory. We also provide measurements, comments on morphological variation, and an overall review of its distribution.

One specimen of *L. carrikeri* (Figure 1) was collected using mist nets on 28 April 2017 in the municipality of Grão Mogol, north of the state of Minas Gerais, southeastern Brazil, in an area characterized by Cerrado *sensu stricto*, with low and sparse vegetation (16°29'8" S; 43°7'4.60" W) (Figure 2). The specimen was collected under the license SEMAD 102.003/2017 and is deposited at the Mammal Collection of the Centro de Coleções Taxonômicas, Universidade Federal de Minas Gerais (CCT-UFMG) under the catalog number UFMG 6829. We also examined specimens of *Lophostoma* from two collections located in Belo Horizonte, state of Minas Gerais: the Mammal Collection of the CCT-UFMG and the Museu de Ciências Naturais, Pontifícia Universidade Católica de Minas Gerais (MCN). At the MCN we examined a specimen (MCN-MQ 091) collected on 01 December 2007 at the Pecém Thermoelectric Power Plant area, in the district of Pecém, municipality of São Gonçalo do Amarante, state of Ceará, Brazil (approximate coordinates: 3°33' S; 38°50' W) (Figure 2). The area is located within the vegetation complex from the Brazilian northeastern septentrional coast, an ecotone



Figure 1. *Lophostoma carrikeri* (UFMG 6829) from Grão Mogol, Minas Gerais.

between semi-arid and sub-humid climatic regimes within the Caatinga biome, including floristic elements from different Brazilian phytogeographic domains such as Caatinga, Cerrado and coastal restinga (Nimer 1972, Castro *et al.* 2012).

The specimens were identified based on diagnostic characters of external, cranial and dental morphology of *L. carrikeri* proposed by Allen (1910), Williams & Genoways (2008) and Camacho *et al.* (2016). We also compared the examined individuals with other specimens of the genus housed at CCT-UFMG (see Appendix 1). Thirteen cranial and eleven external measurements were taken using a digital caliper accurate to 0.01 mm (Table 1 and 2). An updated list of known localities for *L. carrikeri* was compiled from literature and natural history museums databases (See supplementary material).

The specimen from Pecém (MCN-MQ 091) represents the first record of *L. carrikeri* for the state of Ceará, northeastern Brazil, approximately 490 km east from the nearest known record in Teresina, state of Piauí (Vizotto *et al.* 1980). This is the third record of *L. carrikeri* for the Caatinga biome (Gregorin *et al.* 2008). The specimen from Grão Mogol (UFMG 6829) represents the first

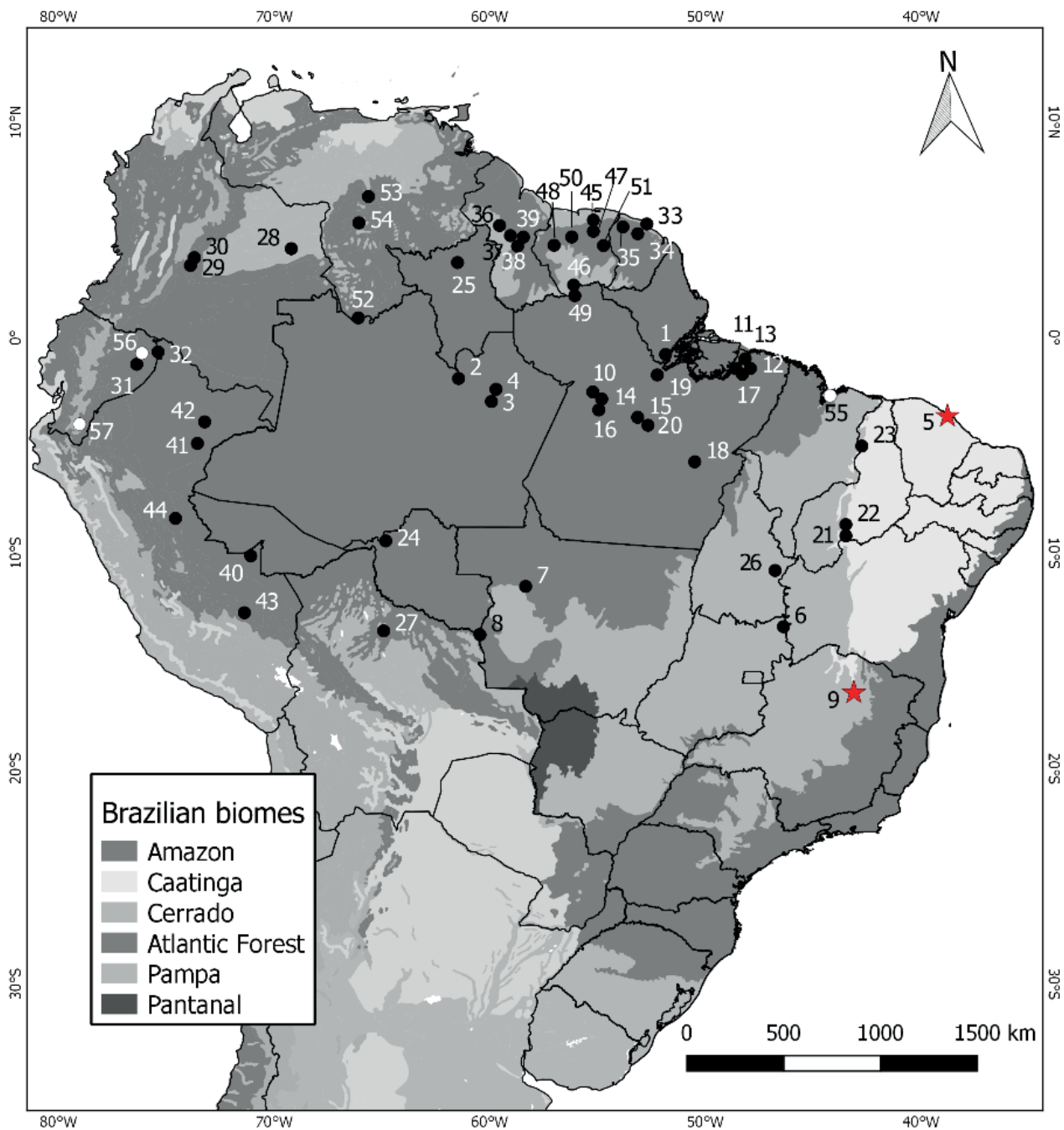


Figure 2. Distribution of *Lophostoma carrikeri* in South America. Red stars: new records reported in this study. Black dots: previously known records. White dots: doubtful records. See Supplementary material for details.

record of *L. carrikeri* for the state of Minas Gerais and the third record of the species for the Cerrado, extending its range 488 km southeast to the nearest known record in São Domingos, state of Goiás (Zortéa *et al.* 2009, Gregorin *et al.* 2011). Together, these new records currently represent the eastern limits of the distribution of *L. carrikeri*.

Both specimens reported here are adult females with skins preserved in ethanol. UFMG 6829 had its skull removed and cleaned (Figure 3), while the

skull of MCN-MQ 091 is lost. The two specimens could be properly identified as *L. carrikeri* by the following set of external traits: ventral fur (from the throat through the abdomen) entirely white, except in the chin and sides of abdomen; tricolored dorsal fur with whitish bases, brownish middle bands and frosted tips; blackish brown face, nose-leaf, chin and ears; absence of small wart-like granulations on ears, nose-leaf, wings and legs; proximal third of the dorsal surface of the forearm

Table 1. External measurements (in mm) of the *Lophostoma carrikeri* specimens from Grão Mogol, Minas Gerais (UFMG 6829) and Pecém, Ceará (MCN MQ 091), other specimens from Brazil, the holotype of *L. carrikeri*, the holotype of *L. yasuni*, and other specimens from South America. Total length (TL); tail length (TaL); forearm length (FA); third metacarpal length (3ML); fourth metacarpal length (4ML); fifth metacarpal length (5ML); tibia length (TiL); hind foot length (HF); calcar length (CL); ear length (EL); tragus length (TrL).

Reference	Locality	Vouchers	TL	Tal	FA	3ML	4ML	5ML	TiL	HF	CL	EL	TrL
This study	Minas Gerais, Brazil	UFMG 6829	67.48	10.14	49.49	39.6	42.7	43.78	21.55	13.44	13.94	23.82	8.22
This study	Ceará, Brazil	MCN MQ 091	59.64	11.04	43.94	35.94	36.26	37.44	20.22	14.17	14.66	24.71	7.62
Gregorin <i>et al.</i> 2008	Piauí, Brazil	MZUSP 33554,33555	-	-	44.3-46.2	-	-	-	-	-	-	-	-
Zórtea <i>et al.</i> 2009	Goiás, Brazil	UFG	68.8	12.8	48.3	42	43.2	45	-	12.3	14.9	-	-
Brandão <i>et al.</i> 2020.	Pará, Brazil	MZUSP 22707	-	-	47	36	-	-	-	-	-	-	-
Allen 1910	Rio Mocho, Venezuela	AMNH 30181 (Holotype)	90	9	47	39	41	47	23	15	18	24	7.5
Camacho <i>et al.</i> 2016	Ecuador	QCAZ4935 (<i>L. yasuni</i> holotype)	82.8	14.9	43.9	37.3	-	-	16.4	14	13.1	22.5	-
Camacho <i>et al.</i> 2014	Ecuador	QCAZ 13578, 13994	86.4-84	16-14	42.8-44	34.1-35.4	36-37.5	37.9-39.5	20.1-20.8	12.2-15	13.3-14.7	24.4-25	-
Genoways & Williams 1980; 1984	Suriname	CM 63668, 68400	-	-	45.8-46.7	-	-	-	-	-	-	-	-
Simmons & Voss 1998	French Guiana	AMNH 267918	80	17	48.5	-	-	-	-	14	-	27	-
Lim <i>et al.</i> 1999	Guyana	Females/ Males	77-95 (n=7)/74-88 (n=2)	9-16 (n=7)/15 (n=2)	46-51 (n=7)/49-52 (n=2)	-	-	-	-	15-17 (n=7)/16-17 (n=2)	-	26-30 (n=7)/27-29 (n=2)	10-11 (n=7)/10 (n=2)
Camacho <i>et al.</i> 2016	South America, several localities (n=15)	Females and Males	-	-	45.7±1.5 (42.2-47.7)	-	-	-	-	-	-	-	-

Table 2. Cranial measurements (in mm) of the *Lophostoma carrikeri* specimens from Grão Mogol, Minas Gerais (UFMG 6829) and Pecém, Ceará (MCN MQ 091), other specimens from Brazil, the holotype of *L. carrikeri*, the holotype of *L. yasuni*, and other specimens from South America. Greatest length of skull (GLS); condyloincisive length (CIL); condylocanine length (CCL); condylocanine length (CCL); zygomatic breadth (ZB); zygomatic breadth (ZB); postorbital breadth (POB); maxillary toothrow length (MTL); molariform toothrow length (P3-M3); breadth across upper molars (BAM); mandibular length (ML); mandibular toothrow length (MaTL) and coronoid process height (CPH).

Reference	GLS	CIL	CCL	ZB	MB	BB	POB	MTL	P3-M3	BAM	ML	MaTL	CPH
This study	23.69	20.66	20.07	11.00	10.94	9.47	3.90	8.18	6.45	7.53	14.26	9.03	6.18
This study	-	-	-	-	-	-	-	-	-	-	-	-	-
Gregorin <i>et al.</i> 2008	23.4-23.6	-	-	-	-	-	-	-	-	-	-	-	-
Zórtea <i>et al.</i> 2009	24.3	21.6	20.6	11.5	11.6	9.5	3.7	8.6	-	7.8	15.3	9.5	-
Brandão <i>et al.</i> 2020.	23.9	20	19.1	10.7	11.2	9.5	3.2	7.7	5	-	-	9	5.6
Allen 1910	26	-	-	12	12.8	9.8	4	9	-	-	16	10	7
Camacho <i>et al.</i> 2016	26.6	23	21	12.7	12	10	4	9.4	6	8.8	16.9	11	7
Camacho <i>et al.</i> 2014	23.2-24.1	19.8-20.3	19-19.4	10.5-10.9	11.1-11.5	9.2-9.7	3.4-3.9	7.7-8	6.5-6.5	-	13.9-14.6	8.6-8.9	-
Genoways & Williams 1980; 1984	25-26	-	-	11.2-11.6	12.2-12	9.7-9.8	3.8-3.7	8.1-8.7	-	7.6-7.7	14.6-	9.2-	-
Simmons & Voss 1998	-	-	-	-	-	-	-	-	-	-	-	-	-
Lim <i>et al.</i> 1999	23.9-25.4 (n=4)/25.6- 26.7 (n=2)	-	-	11.0-11.5 (n=4)/12.0- 12.2 (n=2)	11.4-12.2 (n=4)/12.0- 13.4 (n=2)	-	3.5-4.0 (n=4)/3.9- 4.1 (n=2)	7.9-8.6 (n=4)/8.7- 8.8 (n=2)	-	7.4-7.9 (n=4)/7.7- 8.3 (n=2)	-	-	-
Camacho <i>et al.</i> 2016	24.2±0.9 (23.0-25.3)	20.9±0.6 (19.8- 21.9)	20.2±0.6 (19.0- 21.3)	11.1±0.4 (10.3-12.1)	11.5±0.5 (10.8-12.8)	9.6±0.3 (9.0-10.3)	3.7±0.2 (3.3-4.1)	8.2±0.2 (7.7-8.6)	6.9±0.3 (6.5-7.3)	7.5±0.3 (7.1-7.9)	14.9±0.6 (13.8-15.9)	9.2±0.3 (8.6- 9.7)	5.5±0.3 (5.0-6.0)

sparsely haired; forearm and adjacent membrane covered with short grayish hairs in ventral view (Figure 1). In addition to external features, UFMG 6829 present the following cranial traits: skull constricted in the post-orbital region and slightly concave in the orbital region; moderate lateral development of the mastoid region; short palate, with posterior margin aligned with second molars; upper medial incisors well developed and convergent; shallow indentation on the lingual cingulum of the upper canine; P3 well developed; posterior lingual cusp on P4 cingulum weakly developed; M1 and M2 parastyles absent; lingual cingulum on both M1 and M2 absent; and p3 well developed and aligned with toothrow.

The external and cranial traits of UFMG 6829 and MCN-MQ 091 fit the diagnosis of *L. carrikeri* (Allen 1910, Camacho *et al.* 2016) and measurements taken from both specimens are within the range known for the species (Table 1). UFMG 6829 has a slightly developed sagittal crest, in accordance to the often overlooked observations of Allen (1910) that adult males have highly developed sagittal crest, while in females and young males the crest is absent or poorly developed. Besides the diagnostic features of the species, MCN-MQ 091 has a distinct narrow white margin on the ears and a calcar slightly curved on its distal third, with a small lobe projecting on its posterior margin. Both features are absent in UFMG 6829, which has a straight calcar and no white margin on its ears. The lack of a distinct narrow white margin on the ears of UFMG 6829 was previously described by Zortéa *et al.* (2009) in a specimen from São Domingos, Goiás and also the holotype of *L. yasuni* (junior synonym of *L. carrikeri*), whereas the presence of this feature (as seen in MCN-MQ 091) is described for the holotype and other specimens of *L. carrikeri* from northern South America (Allen 1910, McCarthy *et al.* 1992). The calcar slightly curved on its distal third and with a small lobe projecting on its posterior margin observed in MCN-MQ 091 is not cited in the literature. Due to the rarity with which *L. carrikeri* is sampled in wildlife inventories throughout South America, its morphometric range and morphological variation is not well known and can lead to taxonomic misconceptions.

The new records presented here increase to eleven the number of Brazilian states where the

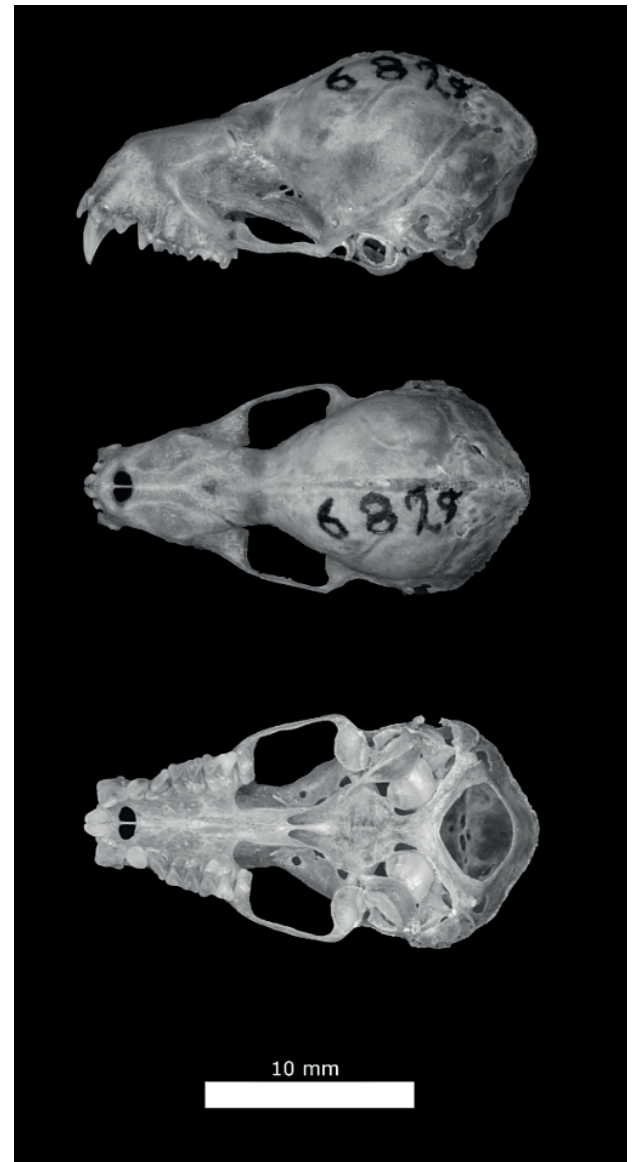


Figure 3. Top to bottom: lateral, dorsal and ventral views of the skull of *Lophostoma carrikeri* (UFMG 6829) from Grão Mogol, Minas Gerais.

species is currently known: Amazonas, Amapá, Roraima, Rondônia, Pará, Tocantins, Piauí, Mato Grosso, Goiás, Ceará and Minas Gerais (Vizotto *et al.* 1980, Gribel & Taddei 1989, Sampaio *et al.* 2003, Gregorin *et al.* 2008, Zortéa *et al.* 2009, Gregorin *et al.* 2011, Silva *et al.* 2013, Brandão *et al.* 2020) (Figure 2). In addition, it is possible that *L. carrikeri* may also occur the state of Acre, since it was collected in Rio Curanja, Peru, near the border of this Brazilian state (Fonseca & Pinto 2004).

Santos *et al.* (2009) reported *L. carrikeri* for the state of Maranhão, but the bats were released after handled and there is no voucher specimen mentioned for this record in the original publication. Although *L. carrikeri* is usually

distinguished from its Brazilian congeners by the white ventral fur, *L. schulzi* can present an almost white venter (Simmons & Voss 1998) and overlaps in morphometric characters with *L. carrikeri* (Camacho *et al.* 2016). Therefore, the record of *L. carrikeri* from Maranhão (Santos *et al.* 2009) is here considered doubtful.

Although *L. carrikeri* is widely distributed throughout South America, it is still a rare species (Camacho *et al.* 2016, Sampaio *et al.* 2016b). The paucity of records of *L. carrikeri* and some other bat species in Brazil is in part justified by the relative small number of wildlife surveys in the country: less than 10% of the Brazilian territory can be considered minimally surveyed, and in nearly 60% there is no record of a single bat species (Bernard *et al.* 2011). Our new records of *L. carrikeri* in the Cerrado and Caatinga are within or close to areas of major knowledge gaps about the Brazilian bat fauna (Bernard *et al.* 2011), and new wildlife inventories in central and northeastern Brazil should contribute to improve the knowledge on the distribution and natural history of this species.

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Appendix 1. Specimens examined

Lophostoma brasiliense: BRAZIL: MINAS GERAIS: Fazenda Brejão, Brasilândia de Minas (UFMG 3362), Santa Vitória (UFMG 5441), Grupiara (UFMG 5445); MARANHÃO: Parque Estadual do Bacanga (UMG 3595, 3596); PARÁ: Fazenda São Luís, Parauapebas (UFMG 3600), Canaã dos Carajás, Mina do Sossego (UFMG 4694, 4698, 4704, 5941); RIO DE JANEIRO: Rosal (UFMG 6511). ***Lophostoma carrikeri***: BRAZIL: MINAS GERAIS: Grão Mogol (UFMG 6829); CEARÁ: UTE Setentrional, Pecém, Fortaleza (MCN MQ 091). ***Lophostoma silvicolum***: BRAZIL: MARANHÃO: Godofredo Viana, São José do Piruacauã (UFMG 3436, 3440); PARÁ: Floresta Nacional Saracá-Taquera, Porto Trombetas, Oriximiná (UFMG 3201, 3218, 3324, 3604, 3605, 3606, 3607), Porto Trombetas, Oriximiná (UFMG 3601), Floresta Nacional dos Carajás, Canaã dos Carajás (UFMG 3602, 3610, 3611, 3612), Bocaina Capão, Canaã dos Carajás (UFMG 3603), Canaã dos Carajás, Mina do Sossego (UFMG 5935), Serra dos Carajás (UFMG 5713, 5714), Parauapebas (UFMG 3608, 3609); MATO GROSSO: Aripuanã (UFMG 3384). ***Lophostoma schulzi***: BRAZIL: AMAZONAS: Reserva Florestal Adolpho Ducke (UDC 28, 60 – *field numbers*).