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PENSOFT

New records of Pygmy Round-eared Bat, *Lophostoma brasiliense* Peters, 1867 (Chiroptera, Phyllostomidae), and updated distribution in Colombia

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Abstract
Lophostoma brasiliense Peters, 1867 has a wide distribution in the Neotropical region, with records extending from southern Mexico to central Paraguay and Brazil. In Colombia the distribution of this species seems to be discontinuous, due to a scarcity of records, which also makes it difficult to know about its threats and conservation status. Here, we report three new localities from Amazonia, Andean and Orinoquia regions. We updated the distribution and performed ecological niche modelling that suggest a wider presence of this species on the Caribbean and the Orinoquia region. Finally, we added some ecological notes about this species.

Keywords
Bats, biogeography, ecological niche modelling, geographical distribution, Phyllostominae.

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Introduction

The Neotropical bat genus *Lophostoma* d'Orbigny, 1836 (Phyllostomidae, Phyllostominae) has a wide distribution from southern Mexico to southwestern Paraguay (Simmons 2005). This genus includes seven species, of which four occur in Colombia: *Lophostoma silvicolum* d'Orbigny, 1836 distributed throughout the country at an elevational range from 10 to 940 m a.s.l.; *Lophostoma occidentale* (Davis & Carter, 1978) recorded in Cauca, Valle del Cauca and Chocó departments in the Pacific region in western Colombia between 10 and 100 m a.s.l.; *Lophostoma carrikeri* (Allen, 1910) in the Orinoquia and Amazonia regions, between 45 and 700 m a.s.l., and *Lophostoma brasiliense* Peters, 1867 with records in different regions at elevations between 10 and 1100 m a.s.l. (Mantilla-Meluk et al. 2009; Solari et al. 2013).

Lophostoma brasiliense is an insectivorous bat widely distributed in the Neotropical region, with records from southern Mexico to central Paraguay and Brazil (Simmons 2005). In Colombia, it has been recorded in the Caribe region: Cesar (Muñoz-Saba 2009), La Guajira (Mantilla-Meluk et al. 2009) and Sucre (Galván-Guevara 2010); the Pacific region: Choco (Asprilla-Aguilar et al.

2016); the Andean region: Antioquia (Muñoz 2001), Caldas (Castaño et al. 2003), Cundinamarca, Huila (Mantilla-Meluk et al. 2009) and Valle del Cauca (Solari et al. 2013). In the Orinoquia region it has been reported in Casanare (Estrada-Villegas and Ramírez 2013), Meta (Lemke et al. 1982; Muñoz-Saba et al. 1997) and finally, in the Amazonia region it has been recorded in Caquetá, Vaupés (Mantilla-Meluk et al. 2009), Guainía (Cadena and Ángel 1998), and Putumayo (Ramírez-Chaves et al. 2013).

Despite its wide distribution, this species is poorly represented in biological collections, with 36 records for the country of which 29 have voucher specimens in collections (Table 1). Aellen (1970) made the first record of this species in Colombia, citing the species as *Tonatia minuta* Goodwin, 1942 from a southwestern locality near Ecuador; however, he did not include voucher specimens. Lemke et al. (1982) later reported the occurrence of the species in "Finca El Buque" (Villavicencio, Meta) as *Tonatia brasiliense* (Peters, 1867). The voucher specimen was deposited at the Field Museum of Natural History, Chicago, USA (FMNH 121251). Alberico et al. (2000) summarized information from museum specimens on the species' distribution and Mantilla-Meluk et al. (2009) and Solari et al. (2013) later increased the number of records but some regions continued to be underrepresented.

Table 1. Localities of occurrence of *L. brasiliense* in Colombia. Asterisks indicate new records and the circle indicates an extension of elevational range for the country. Acronyms: Colección de Mamíferos Instituto Alexander von Humboldt (IAvH), Colección Zoológica Universidad del Tolima (CZUT), Colección de Mamíferos Universidad del Valle (UV), Museo de Historia Natural Universidad de Caldas (MHNUCa), Instituto de Ciencias Naturales (ICN), Colección de Mamíferos Universidad del Choco (CMCH), Museo de Historia Natural Universidad Distrital Francisco José de Caldas (MUD), Museo de Ciencias Naturales de La Salle-Medellín (CSJ-M), Colección Zoológica Universidad de Nariño (PSO-CZ), Colección de Mamíferos Universidad Industrial de Santander (UIS-M), Colección de Mastozoología Museo de Historia Natural Universidad de los Andes (ANDES-M), National Museum of Natural History (NMNH), and Field Museum Natural History (FMNH).

	Latitude	Longitude	Department	Locality	Altitude a.s.l. (m)	Author	Collection acronym and catalog number
1*	03.865	−070.206	Amazonas	Natural Park Reserve	100	This work	ANDES-M 2324
2	08.385	−076.733	Antioquia	Turbo: Lomas aisladas "El 40"	70		CZUT 1731
3	07.483	−074.833	Antioquia	Zaragosa: La Tirana	520	Muñoz 2001	NMNH 499293,499294
4*	06.812	−071.076	Arauca	Finca La Tormenta, Caño Salas	130	This work	IAvH-M-9459
5	05.343	−074.738	Caldas	La Dorada: Corregimiento Guarinocito	260		UV 14967
6	05.567	−074.883	Caldas	Norcasia: Vereda Riomanso, Hacienda Riomanso	240	Castaño et al. 2003	MHN-UCa 129
7	05.367	−074.793	Caldas	Victoria-La Dorada, Hacienda La Española	280	Garcés et al. 2016	
8	01.317	−075.967	Caquetá	San José del Fragua: Hacienda Tres Esquinas	540	Mantilla-Meluk et al. 2009	UV 11448
9	04.989	−072.717	Casanare	Aguazul: Buenos Aires	370	Estrada-Villegas and Ramírez 2013	
10	04.895	−072.403	Casanare	Aguazul: Tinije	190	Estrada-Villegas and Ramírez 2013	
11	05.330	−072.552	Casanare	Aguazul: Volcán Blanco	660	Estrada-Villegas and Ramírez 2013	
12	05.606	−070.261	Casanare	Paz de Ariporo: Finca Nicaragua	330		IAvH 7858
13	05.433	−071.583	Casanare	Trinidad: Vereda El Banco de La Cañada, Finca La Palmita	165		ICN 19336
14	05.467	−071.417	Casanare	Trinidad: Vereda Los Chochos, Finca Las Plumas	150		ICN 19335
15	08.063	−073.424	Cesar	Serranía del Perijá: Vereda Alto de la Raya, Finca La Lomita	300	Muñoz-Saba 2009	ICN 19048
16	07.833	−077.083	Choco	Riosucio: P.N.N. Katios, Vereda Sautatá	50–250	Muñoz-Saba and Alberico 2004	IAvH 4493
17	08.350	−077.100	Choco	San Francisco de Quibdó	50	Asprilla-Aguilar et al. 2016	CMCH 1300, 1575
18°	05.383	−074.150	Cundinamarca	Paime: Vereda El Carmen, Quebrada La Espeleta	1300		MUD 0073
19	04.733	−073.533	Cundinamarca	Ubalá: Vereda Soya	500	Mantilla-Meluk et al. 2009	ICN 15099
20	03.540	−067.856	Guainia	Rio Inírida: Caño Ají; Caño Agujón	100	Cadena and Ángel 1998	
21	02.494	−072.652	Guaviare	San José del Guaviare	220		ICN 22534
22	03.799	−073.864	Meta	Cubarral: Vereda El Vergel, Finca La Estrella	750		ICN 14397
23	03.376	−073.938	Meta	Serranía de La Macarena: Caño Guamalito	550		ICN 12046
24	03.300	−073.950	Meta	Serranía de La Macarena: Sector La Curia	450	Muñoz-Saba et al. 1997	
25	04.153	−073.613	Meta	Villavicencio: Finca El Buque	475	Lemke et al. 1982	FMNH 121251
26	07.900	−072.517	Norte de Santander	Cúcuta: unspecified	215		FMNH 72277
27	07.700	−072.650	Norte de Santander	Durania: Vereda Hato Viejo, Finca San Jacinto	800–900		CSJ-M 735
28	0.667	−076.850	Putumayo	Orito: Rio Caldero		Mantilla-Meluk et al. 2009; Ramírez-Chaves et al. 2013	PSO-CZ
29	06.883	−073.283	Santander	Betulia: Vereda La Putana, Quebrada La Putana	330		UIS-M-0766
30	07.083	−073.067	Santander	Bucaramanga: Vereda Vijagual, Pozo azul	600		UIS-M-0661
31	06.717	−074.135	Santander	Cimitarra: Vereda San Juan, Rio San Juan	110		MHN-UCa 1014, 1016
32	7.067	−073.150	Santander	Girón: Hacienda Casa Roja	600		UIS-M-0764
33	06.017	−074.200	Santander	Bolívar: Vereda La Guinea	240-700		ANDES-M 1863
34	09.519	−075.358	Sucre	Colosó: Montes de María	380	Galván-Guevara 2010	
35*	04.883	−075.023	Tolima	Líbano: Reserva Agroecológica Santa Librada	800-100	This work	MUD 1140,1141
36	01.250	−070.233	Vaupes	Mitú: Hospital San Antonio	180	Mantilla-Meluk et al. 2009	ICN 13120

Ecological niche modelling (ENM) methods can help identifying the most suitable areas for a species in a given range. ENMs have been used extensively in the Neotropics to help with conservation assessments (Prieto-Torres and Pinilla-Buitrago 2017), identifying distributional gaps (Oliveira et al. 2017), and guiding future research and conservation plans (Rheingantz et al. 2014). Field validation of these methods supports their predictions and indicates good utility, especially when resources are limited (West et al. 2016). Given the lack of sampling in some areas of Colombia, ENM techniques may be useful to estimate *L. brasiliense*'s distribution and areas most important for its study and conservation.

Here, we report three new localities for *L. brasiliense* in the Amazonia, Andean and Orinoquia regions through recent captures in: El Vergel, Leticia municipality (Amazonas department), the municipality of El Líbano (Tolima department) and a specimen deposited in the mammal collection at Institute Alexander von Humboldt (IAvH) coming from Arauca (Arauca department). In addition, we update the distribution of *L. brasiliense* in Colombia and we perform ENMs to estimate the potential distribution of this species to guide future field surveys. Finally, we add some ecological notes that contribute to the knowledge of natural history of this species.

Methods

Field collections were carried out by the authors between 2016 and 2019 in Natura Park Reserve, Leticia municipality, Amazonas department and Santa Librada Agroecological Reserve, El Líbano municipality, Tolima department. We used seven mist nets (12 m long) which were randomly located in different microhabitats inside the study areas. The individuals were collected following the procedures described by the American Society of Mammalogists (Sikes et al. 2016), and the specimens were deposited in the Natural History Museum of the Universidad Distrital Francisco José de Caldas (MUD) and in the Natural History Museum of the Universidad de los Andes (ANDES-M), Colombia. Identifications followed Williams and Genoways (2008) and Díaz et al. (2016), and the specimens were compared with others in ANDES-M, IAvH, MHN-UCa, and MUD.

We compiled a database of Colombian occurrence records of *Lophostoma brasiliense* from an exhaustive search in online databases (i.e., Mammal Networked Information System (http://manisnet.org/), Scopus (https://www.scopus.com/), Web of Science (http://webofknowledge.com/), Sistema de Información sobre Biodiversidad de Colombia (https://sibcolombia.net/), Arctos database (https://arctos.database.museum/), Global Biodiversity Information Facility (https://www.gbif.org/), SpeciesLink (http://splink.cria.org.br/), and literature. We also reviewed specimens from national natural history collections (Table 1) and made measurements (following Velazco and Gardner 2012) using digital calipers with an accuracy of 0.01 mm. Colombian ecoregions and biogeographic provinces (Hernández-Camacho et al. 1992; Dinerstein et al. 2017) were determined for all records.

We prepared a map showing the potential distribution of *L. brasiliense* using an ensemble modelling approach in the sdm R package (Naimi and Araujo 2016) with five modelling algorithms: Maxent, GAM, Random Forest, Support Vector Machine, and Boosted Regression Tree. The current distribution map for *L. brasiliense* was downloaded from the International Union for the Conservation of Nature (IUCN 2017; version 2017-1) and buffered to 250 km to act as a training and prediction mask. The occurrence points were spatially filtered by 3 km to reduce spatial autocorrelation using SDMToolbox in ArcGis (Brown 2014). For environmental variables, we used 19 bioclimatic variables (Fick and Hijmans 2017), elevation (Amatulli et al. 2018), distance to freshwater (produced by us), and the approximate percentage of broad-leafed evergreen forest (Tuanmu and Jetz 2014). The variables were then extracted by a mask equivalent to the IUCN distribution map and buffered to 200 km (since some recent records were found to be outside of the previous distribution map). These variables were then imported to R program, version 3.6.2 (R Core Team 2019) and tested for collinearity using the variance inflation factor (Vif) tests (variables with a Vif of 10 or greater were removed in a stepwise fashion, starting with the highest Vif) and pairwise plots. If two or more variables were collinear (Pearson correlation >0.7), the most ecologically relevant was retained and the others were excluded. The remaining variables were then tested using the "get variable importance function" in the sdm package (Naimi and Araujo 2016) in R during initial prototype models, with low-importance variables removed (<5%) to improve model reliability. All models were assessed using the True Skill Statistic [TSS.Stat: True Skill Statistic for predictive accuracy evaluation in the sdm package (Naimi and Araujo 2016)], and 20% of presence points were withheld for testing the models in each run. The models were also weighted by their TSS scores to emphasize the predictions of the most accurate models at the prediction stage. After the final model ensemble was produced, a reclassification was performed using the threshold value (calculated by sdm package based on the value of suitability, which maximises the sum of specificity and sensitivity) to act as an indicator of whether a pixel is suitable or unsuitable.

Results

Family Phyllostomidae
Subfamily Phyllostominae

***Lophostoma brasiliense* Peters, 1867**
Pygmy Round-eared Bat

New records. COLOMBIA • 1 ♂; Amazonas, Leticia municipality, Vereda El Vergel, Natura Park Reserve; 03.8648°S, 070.2060°W; **77** m a.s.l.; 27 Apr. 2019;

Sebastián García-R leg.; ANDES-M 2324. • 1 ♂, 1 ♀; Tolima, El Líbano municipality, Vereda La Honda, Santa Librada Agroecological Reserve; 04.8758°N, 075.0225°W; 800–1100 m a.s.l.; 25 Jan. 2016; Diego A. Esquivel, Sergio Peña, and Carlos Aya-Cuero leg.; MUD 1140, MUD 1141. • 1 ♀; Arauca, Arauca municipality, Finca La Tormenta, Caño Salas; 06.8121°N, 071.0755°W; 136 m a.s.l.; Gabriel Pantoja leg.; IAvH 9459.

Identification. *Lophostoma brasiliense* is easily to recognized from other species of *Lophostoma* by its overall size, forearm (34–40.5 mm) and greatest length of skull (18.7–21.6 mm), which are diagnostic characters described by Williams and Genoways (2008), Díaz et al. (2016), Solari et al. (2019) and shared by other specimens from ANDES-M, IAvH, MHN-UCa, and MUD collections (Appendix 1). The specimens presented blackish-brown coloration on the dorsum and pale brown ventral fur (Fig. 1), which contrasts with the white abdominal fur of other species, such as *L. carrikeri* and *L. kalkoae* (Velazco and Gardner 2012). The individuals lack the small wart-like granulations on head, wings, and legs, which are typical of *L. schulzi* Genoways & Williams, 1980. *Lophostoma brasiliense* is unlikely to be confused with *L. occidentale* or *L. silvicolum*, as both species are moderately large (AB > 50, GLS > 25). *Lophostoma brasiliense* can be confused with some species of *Micronycteris* Gray, 1866 that have dark abdominal fur. However, *Lophostoma* presents a pair of lower incisors and *Micronycteris* presents two pairs, and the chin in *Lophostoma* has a row of dermal papillae arranged in a "U" shape, while in *Micronycteris* the dermal papillae are arranged in a "V". *Lophostoma brasiliense* has a short and robust skull, an undeveloped sagittal crest, a weak post-orbital constriction, and a straight dental arch (Fig. 2). We present a table of external and craniodental measurements of the new records (Table 2).

Distribution. We update the distribution of *L. brasiliense* in Colombia and confirm its occurrence from 36 records in 18 departments in six biogeographic provinces (Hernández-Camacho et al. 1992): Peri-Caribbean Arid Belt, Chocó-Magdalena biogeographic province, Nor-Andean, Orinoco, Guyana, and Amazonia. The distribution of *L. brasiliense* includes six Colombian ecoregions (Fig. 3), with the largest number of records occurring in Montane forests of the Andean mountain range and in the Orinoquia region (Fig. 3; Table 1).

Potential distribution. Environmental data to build the models were reduced to four variables: elevation, distance to freshwater, precipitation of driest month (Bio14), and percentage broad-leaved evergreen forest cover. The model accuracy was acceptable with TSS values for all models being > 0.45 and all AUC > 0.75 (Table 3). The model predicts areas with a high suitability of habitat and those areas with suitability above a calculated threshold (Fig. 4A, B) in the Caribbean and the Orinoquia region and some areas in the inter-Andean valleys of Colombia.

Ecological notes. Our specimens were captured in primary and secondary forests. We collected the MUD 1140 and MUD 1141 specimens in a humid tropical forest where the vegetation includes *Lafoensia acuminata* (Ruiz and Pav.), *Ochroma pyramidale* (Cav. ex Lam.), *Carludovica palmata* Ruiz and Pav., *Annona cherimola* (Miller), *Cecropia peltata* Loefl, *Heliconia bihai* Linnaeus, *Theobroma cacao* Linnaeus, and the fruit trees *Mangifera* Linnaeus and *Citrus* Linnaeus. Other bat species collected with *L. brasiliense* were *Anoura geoffroyi* (Gray, 1838), *Glossophaga soricina* (Pallas, 1766), *Phyllostomus hastatus* (Pallas, 1767), and *Peropteryx macrotis* (Wagner, 1843). The ANDES-M 2324 specimen

Figure 1. Individual of *Lophostoma brasiliense* (MUD 1140) captured in El Líbano-Tolima, Colombia. **A.** Ventral view. **B.** Lateral view. Scale bars = 1 cm.

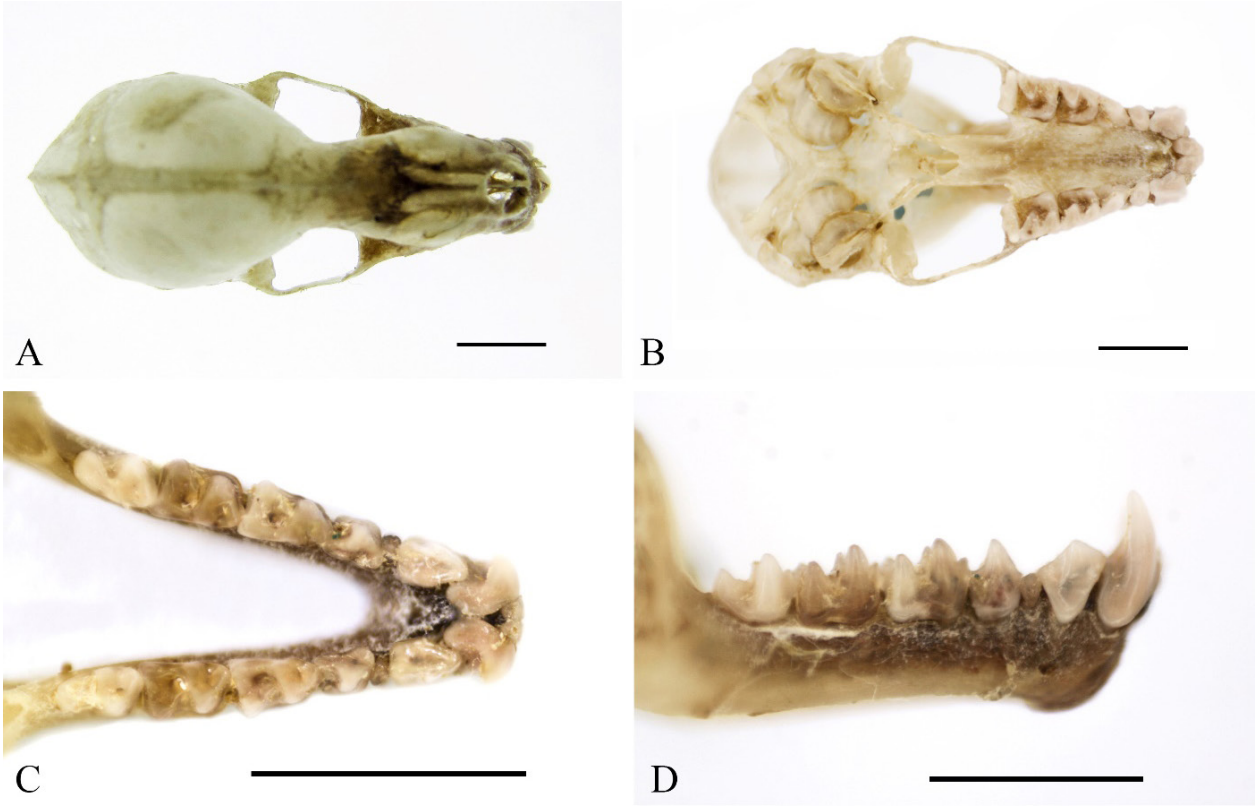

Figure 2. A. Dorsal view. **B.** Ventral skull view. **C.** Mandible occlusal view. **D.** Mandible lateral view of *Lophostoma brasiliense* skull. Scale bars = 5 mm.

Table 2. Sex, external and craniodental measurements (in millimeters) of the holotype of *Lophostoma brasiliense* and the new records from Colombia.

Measurements	Holotype BMNH 1849.11.7.14	Amazonas Andes-M 2324	Arauca IAvH 9459	Tolima	
				MUD 1140	MUD 1141
Sex	F	M	F	F	M
Total length	—	51.7	61.1	60	63
Hind foot length	11.5	8.9	7.6	9.64	9.7
Ear length	18.6	20.7	20.3	23.33	22.22
Forearm length	38.8	36.1	37.4	35.6	35.99
Greatest length of skull	19.5	19.1	20.65	19.6	19.15
Condyle-Incisive length	17	—	16.95	16.88	16.62
Postorbital constriction	3.6	—	3.58	3.21	3.02
Maxillary toothrow length	6.9	—	—	5.78	5.53
Mandibular toothrow length	7.5	—	—	6.93	6.8

Table 3. Models accuracy values. Mean true skill statistic (TSS) and mean area under the receiver operating curve (AUC) are showed.

Modelling algorithm	Mean TSS	Mean AUC
Random Forest	0.49	0.77
GAM	0.47	0.75
SVM	0.46	0.75
BRT	0.47	0.75
Maxent	0.49	0.77

was captured in a primary forest near Mocagua Island in the Amazonas River. Other bat species collected were *Artibeus gnomus* (Handley, 1987), *Gardnerycteris crenulatum* (É. Geoffroy Saint Hilaire, 1803), *Lophostoma silvicolum* (d'Orbigny, 1836), *Phyllostomus elongatus* (É. Geoffroy Saint Hilaire, 1810), and *Rhinophylla pumilio* (Peters, 1865).

In the Andean region, some specimens reviewed by us (MHNU-Ca 1014, MHNU-Ca 1016, and MUD 0073) were captured in areas with secondary vegetation and with strong human intervention, while others occupied Andean humid forest relicts (ANDES-M 1863 and CZUT 1731). In the Orinoquia region, *L. brasiliense* has been reported in gallery forests and in wetlands near primary and secondary forests (Estrada-Villegas and Ramírez 2013) and open savanna (IAvH 9459). Information about habitats in the Chocó and Caribbean regions of the country is scarce.

Discussion

Previous studies showed *L. brasiliense* with a heterogeneous and discontinuous distribution, associated mainly with the eastern mountain range in Colombia (Mantilla-Meluk et al. 2009; Solari et al. 2013). However, we fill the gap for this species in southern Colombian Amazonia, East Orinoco, and the Andes mountain range, which is one of the most sampled regions in Colombia. The small number of records from Amazonia (n = 6), Chocó (n = 2), and the Caribbean (n = 2) regions may be due to the lack of inventories in these areas. In Colombia, there is little information

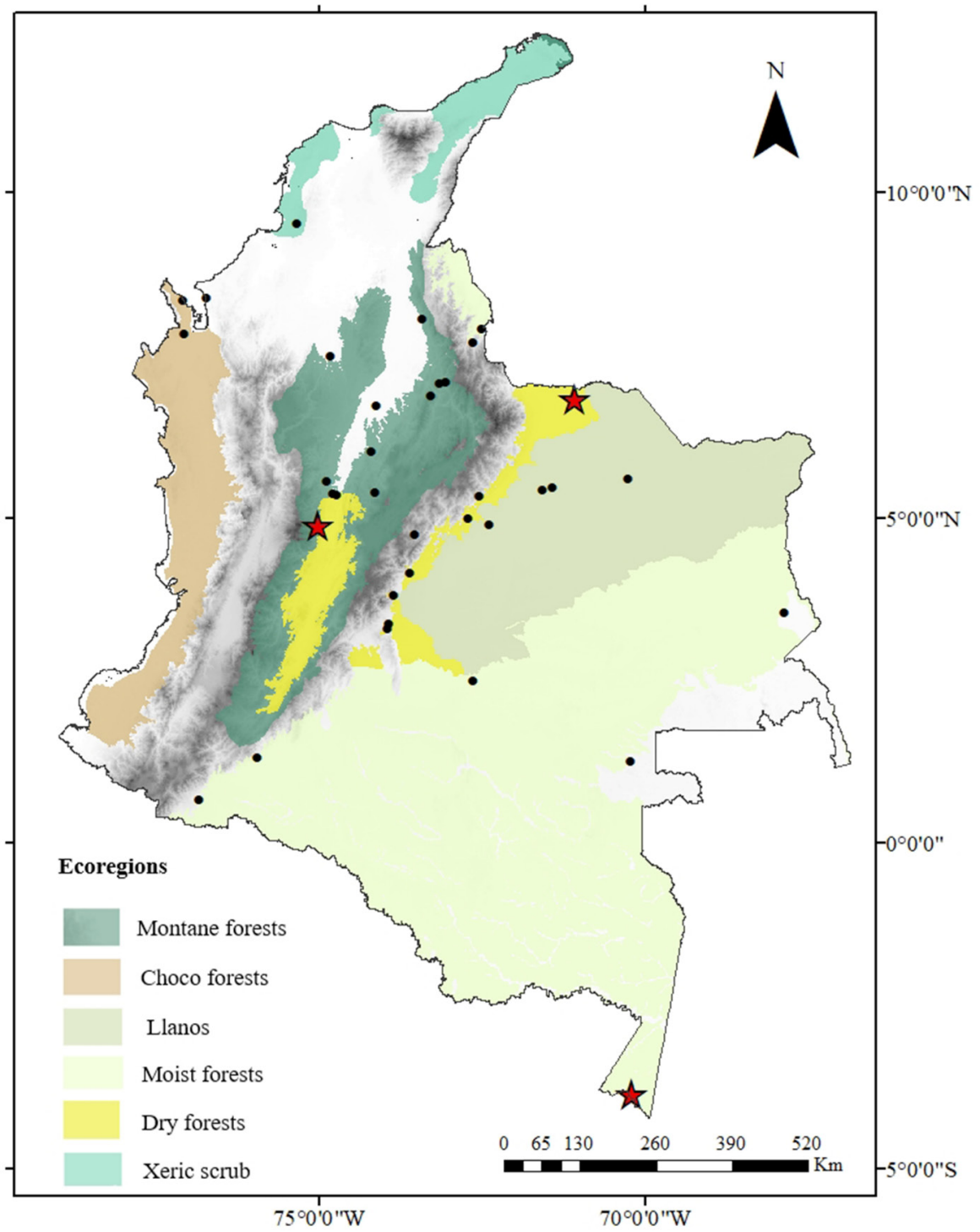

Figure 3. Records of *Lophostoma brasiliense* in Colombia. The circles show previous records; the red stars show the new records from the present study.

about the ecosystems occupied by *L. brasiliense*; herein, we recognize it in diverse ecosystems such as primary and secondary forests (Lemke et al. 1982; Muñoz-Saba 2009), tropical dry forest (Galván-Guevara 2010; Garcés et al. 2016), savanna in the eastern plains (Estrada-Villegas and Ramírez 2013), and rainforest (Asprilla-Aguilar et al. 2016). Some records are from lands used for crops and extensive livestock (Garcés et al. 2016), suggesting a possible adaptation to anthropic environments.

The records reported here not only represent the first records of the species for the Amazonas, Tolima, and Arauca departments but also represents a short elevational range extension of the species in Colombia. Previous records indicated that *L. brasiliense* is present at elevations from 100–1100 m a.s.l.; however, the MUD 0073 specimen was found at 1300 m a.s.l., in Paime, Cundinamarca department, which increases the elevational range by 200 m, with most records (83%; $n = 29$) below 600 m. Our record in the Amazonia region increases the range of *L. brasiliense* by approximately 510 km from the nearest and previously southernmost known locality. Distributional limits in the northern part of Colombia

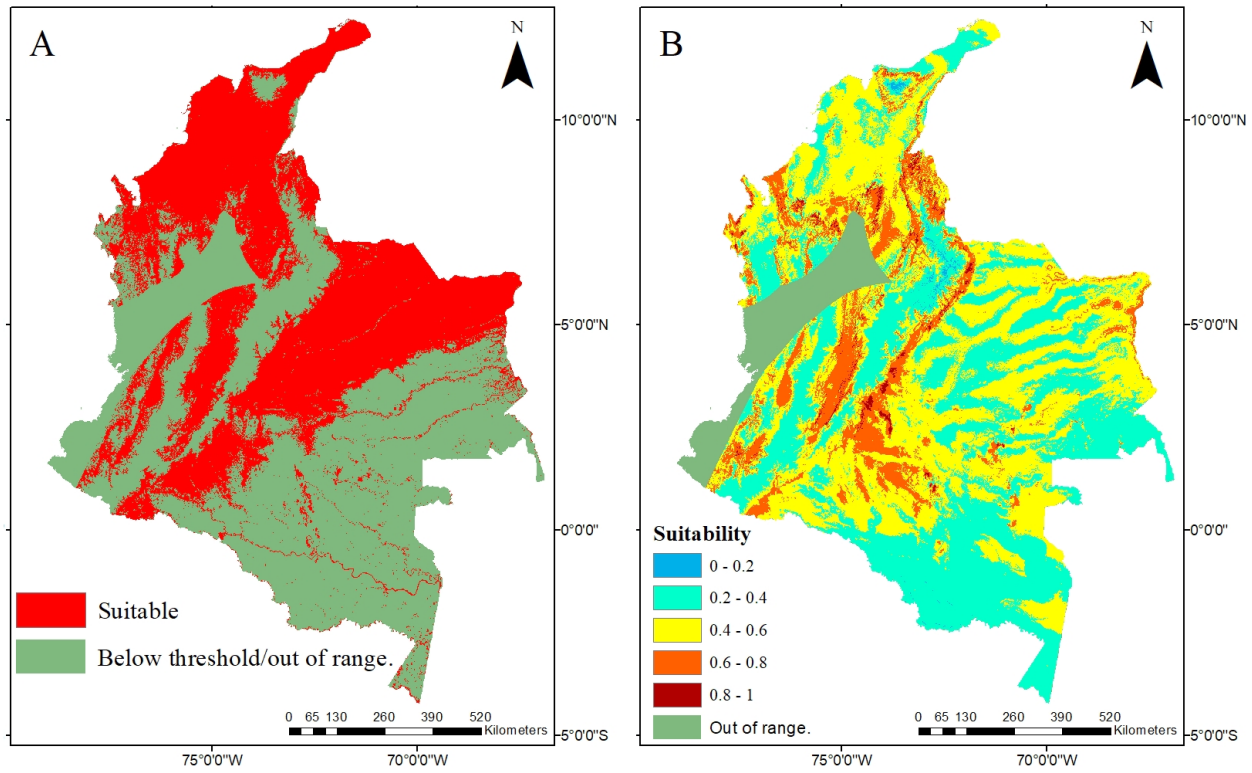

Figure 4. A. Presence/absence prediction map based on threshold values. **B.** Predicted habitat suitability for *Lophostoma brasiliense* in Colombia. Blue to red colour scales indicate less to greater suitability area for the species.

are unknown, but curiously, this area (Colombian Caribbean) is predicted to have the most habitat suitability for the species but presents very few records.

Other records in La Guajira, Huila (Mantilla-Meluk et al. 2009) and Valle del Cauca (Solari et al. 2013) could not be confirmed from the literature or voucher specimens. Therefore, these locations were not considered in this study and still need to be confirmed.

The ENM-based potential distribution maps have some innate uncertainties. Firstly, we modelled the distribution across the IUCN distribution map buffered to 250 km. This may prove to be an underrepresentation of the true distribution of this species if new specimens are found outside this zone, and by contrast it may be overly generous (areas predicted as environmentally suitable may not be inhabited by *L. brasiliense* due to biogeographic and stochastic processes, local factors, or dispersal limitations). Also, although extremely useful, online databases such as GBIF can include misidentified specimens. Secondly, ENM methods themselves have some statistical weaknesses, (even when all precautions, such as spatial rarefaction are taken into account) and our prediction may change if more records are discovered. Variable selection can also impact ENM results (Velez-Liendo et al. 2014), although our model used both climatic and resource/shelter proxy (distance to freshwater and percentage broadleaved forest cover) variables to alleviate this issue. Therefore, our maps should only be used as estimations and not considered perfect representations of the potential distribution of *L. brasiliense* in Colombia.

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Authors' Contributions

DAE, APL, SGR, DB examined and identified the specimens from collections and wrote the manuscript.

References

Aellen V (1970) Catalogue raisonné des chiroptères de la Colombie. Revue Suisse de Zoologie 77: 1–37. https://doi.org/10.5962/bhl.part.75877

Alberico M, Cadena A, Muñoz-Saba Y (2000) Mamíferos (Synapsida: Theria) de Colombia. Biota Colombiana 1 (1): 43–75. https://doi.org/10.21068/bc.v1i1.56

Allen JA (1910) Mammals from the Caura district of Venezuela, with description of a new species of *Chrotopterus*. Bulletin of the American Museum of Natural History 28: 145–149.

Amatulli G, Domisch S, Tuanmu MN, Parmentier B, Ranipeta A, Malczyk J, Jetz W (2018) A suite of global, cross-scale topographic variables for environmental and biodiversity modeling. Scientific data 5: 180040.

Arctos (2019) Arctos database: collaborative collection management solution. https://www.arctos.database.museum. Accessed on: 2019-10-07.

Asprilla-Aguilar A, Jiménez-Ortega A, Mantilla-Meluk H (2016) Murciélagos (Chiroptera) del departamento del Chocó, occidente colombiano. Revista Biodiversidad Neotropical 6 (2): 188–211. https://doi.org/10.18636/bioneotropical.v6i2.494

Brown JL (2014) SDMtoolbox: a python-based GIS toolkit for landscape genetic, biogeographic and species distribution model analyses. Methods in Ecology and Evolution 5 (7): 694–700. https://doi.org/10.1111/2041-210X.12200

Cadena A, Ángel DC (1998) Mamíferos, Componente Faunístico. In: Rudas-Ll A (Ed.) Caracterización ecológica preliminar de las riberas del río Inírida (Guainía), en el área de influencia de la comunidad de La Ceiba. Instituto de Ciencias Naturales, Universidad Nacional de Colombia, Corporación para el Desarrollo Sostenible del Norte y el Oriente Amazónico, Bogotá D.C., 50–66.

Castaño JH, Muñoz-Saba Y, Botero JE, Vélez JH (2003) Mamíferos del departamento de Caldas-Colombia. Biota Colombiana 4 (2): 247–259.

Davis WB, Carter DC (1978) A review of the round-eared bats of the *Tonatia silvicola* complex, with descriptions of three new taxa. Occasional Papers Museum of Texas Tech University 53: 1–12. https://doi.org/10.5962/bhl.title.156526

Díaz MM, Solari S, Aguirre LF, Aguiar LM, Barquez RM (2016) Clave de identificación de los murciélagos de Sudamérica – Chave de identificação dos morcegos da America do Sul. Publicación Especial 2, Programa de Conservación de los Murciélagos de Argentina, Tucumán, 160 pp.

Dinerstein E, Olson D, Joshi A, et al (2017) An ecoregion-based approach to protecting half the terrestrial realm. BioScience 67: 534–545.

d'Orbigny A (1836) Mammifères. In: d'Orbigny A (Ed.) Voyage dans l'Amérique méridionale (le Brésil, la République orientale de l'Uruguay, la République Argentine, la Patagonie, la République du Chili, la République de Bolivia, la République du Pérou), exécuté pendant les années 1826, 1827, 1828, 1829, 1830, 1831, 1832 et 1833, Plate 6. P. Bertrand Paris, Strasbourg, 1–32.

Estrada-Villegas S, Ramírez B (2013) Bats of Casanare, Colombia. Chiroptera Neotropical 19 (3): 1–13.

Fick SE, Hijmans RJ (2017) WorldClim 2: new 1-km spatial resolution climate surfaces for global land areas. International Journal of Climatology 37 (12): 4302–4315. https://doi.org/10.1002/joc.5086

Galván-Guevara S (2010) Mamíferos y aves silvestres registrados en una zona de los Montes de María, Colosó, Sucre, Colombia. Revista Colombiana de Ciencia Animal 2 (1): 45–57. https://doi.org/10.24188/recia.v2.n1.2010.327

Garcés MF, Quintero A, Cuéllar N, Giraldo A (2016) Mammal diversity in an area with relicts of Dry Forest in the Mid-Magdalena Valley (Caldas, Colombia). Revista de Ciencias 20 (2): 147–160.

Genoways HH, Williams SL (1980) Results of the Alcoa Foundation-Suriname Expeditions. I. A new species of bat of the genus *Tonatia* (Mammalia: Phyllostomidae). Annals Carnegie Museum 49: 203–11.

Geoffroy SHÉ (1803) Catalogue des mammiféres du Muséum National d'Histoire Naturelle. Muséum National d'Histoire Naturelle, Paris, 272 pp.

Geoffroy SHÉ (1810) Description des rousettes et des céphalotes, deux nouveaux genres de la famille des chauve-souris. Annals Museum History Natural 15: 86–108.

GBIF (2019) Global Biodiversity Information Facility. http://www.gbif.org. Accessed on: 2019-10-10.

Goodwin G (1942) A summary of recognizable species of *Tonatia* with descriptions of two new species. Journal of Mammalogy 23: 204–09. https://doi.org/10.2307/1375074

Gray JE (1838) A revision of the genera of bats (Vespertilionidae) and the description of some new genera and species. Magazine of Zoology and Botany 12: 484–505.

Gray JE (1866) Revision of the genera of Phyllostomidae or leaf-nosed bats. Proceedings of the Zoological Society of London 1866: 111–118.

Handley JR (1987) New species of mammals from northern South America: Fruit-eating bats, genus *Artibeus* Leach. In: Timm RM, Patterson BD (Eds.) Studies in Neotropical mammalogy, essays in honor of Philip Hershkovitz. Fieldiana: 163–172.

Hernández-Camacho JA, Hurtado R, Ortiz Y, Walschburger T (1992) Unidades biogeográficas de Colombia. In: Halffter G (Ed) La diversidad biológica de Iberoamérica I. Instituto de Ecología, Xalapa, 105–151.

IUCN (2017) The IUCN Red List of threatened species. Version 2017-1. http://www.iucnredlist.org. Accessed on: 2019-10-21.

Lemke TO, Cadena A, Pine RH, Hernández-Camacho JI (1982) Notes on opossums, bats, and rodents new to the fauna of Colombia. Mammalia 46 (2): 225–234. https://doi.org/10.1515/mamm.1982.46.2.225

Manis (2019) Mammal Networked Information System. http://www.manisnet.org. Accessed on: 2019-10-05.

Mantilla-Meluk H, Jiménez-Ortega AM, Baker JR (2009) Phyllostomid bats of Colombia: annotated checklist, distribution, and biogeography. Special Publications Museum of Texas Tech University 56: 1–44. https://doi.org/10.5962/bhl.title.142854

Muñoz J (2001) Los murciélagos de Colombia: sistemática, distribución, descripción, historia natural y ecología. Editorial Universidad de Antioquia, Medellín, 391 pp.

Muñoz-Saba Y (2009) Fauna de mamíferos de la Serranía de Perijá, Colombia. In: Rangel-Ch JO (Ed.) Colombia Diversidad Biótica VIII: media y baja montaña de la Serranía de Perijá. Impresiones ARFO Editores e Impresores Ltda, Instituto de Ciencias Naturales, Universidad Nacional de Colombia, Bogotá D.C., 475–488.

Muñoz-Saba Y, Alberico M (2004) Mamíferos en el Chocó biogeográfico. In: Rangel-Ch JO (Ed.) Colombia Diversidad Biótica IV. El chocó Biogeográfico/Costa Pacífica. Conservación Internacional, Instituto de Ciencias Naturales, Universidad Nacional de Colombia, Bogotá, D.C., 559–598.

Muñoz-Saba Y, Cadena A, Rangel-Ch JO (1997) Ecología de los murciélagos antófilos del sector La Curia, Serranía La Macarena (Colombia). Revista de la Academia Colombiana de Ciencias 21 (81): 473–486.

Naimi B, Araujo MB (2016) sdm: a reproducible and extensible R platform for species distribution modelling. Ecography 39 (4): 368–375.

Oliveira U, Soares-Filho BS, Paglia AP et al (2017) Biodiversity conservation gaps in the Brazilian protected areas. Scientific Reports 7: 9141. https://doi.org/10.138/s41598-017-08707-2

Pallas PS (1766) Miscellanea zoologica quibus novae imprimis atque obscurae animalium species describuntur etobservationibus iconibusque illustrantur. P. van Cleef, Hague Comitum, xii + 224 pp., 14 pls.

Pallas PS (1767). Vespertiliones in genre. In: Berolini GA (Ed) Spicilegia zoologica quibus novae et obscurae animalium species iconibus, descriptionibus atque commentariis illustrantur. Fasc. 3. Lange, Berlin, 35 pp., 4 pls.

Peters W (1865) Uber Flederthiere (*Vespertilio soricinus* Pallas, *Choeronycteris* Lichtenst., *Rhinophylla pumilio* nov. gen., *Artibeus fallax* nov. sp., *A. concolor* nov. sp., *Dermanura quadrivittatum* nov. sp., *Nycteris grandis* n. sp.). Monatsbericht der Königlich-Preussischen Akademie der Wissenschaften zu Berlin 1865: 351–59.

Peters W (1867) Fernere Mittheilungen zur Kenntniss der Flederthiere, namentlich über Arten des Leidener und Britischen Museums. Monatsbericht der Königlich-Preussischen Akademie der Wissenschaften zu Berlin 1867: 672–681.

Prieto-Torres DA, Pinilla-Buitrago G (2017) Estimating the potential distribution and conservation priorities of *Chironectes minimus* (Zimmermann, 1780) (Didelphimorphia: Didelphidae). Therya 8 (2): 131-144. https://doi.org/10.12933/therya-17-478

R Core Team (2019) R: a language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. http://www.R-project.org/

Ramírez-Chaves HE, Noguera-Urbano EA, Rodríguez-Posada ME (2013) Mamíferos (Mammalia) del departamento de Putumayo, Colombia. Revista de la Academia Colombiana de Ciencias Exactas, Físicas y Naturales 37 (143): 263–286. https://doi.org/10.18257/raccefyn.9

Rheingantz ML, Menezes JFS, Thoisy B (2014) Defining Neotropical Otter *Lontra longicaudis* distribution, conservation priorities and ecological frontiers. Tropical Conservation Science 7 (2): 214–229. https://doi.org/10.1177/194008291400700204

Scopus (2019) Elsevier's abstract and citation database. http://www.scopus.com. Accessed on: 2019-10-05.

Sikes RS, Gannon WL, Animal Care, Use Committee of the American Society of Mammalogists (2016) Guidelines of the American Society of Mammalogists for the use of wild animals in research. Journal of Mammalogy 92 (1): 235–253. https://doi.org/10.1644/10-MAMM-F-355.1

Simmons NB (2005) Order Chiroptera. In: Wilson DE, Reeder DM (Eds) Mammal species of the world: a taxonomic and geographic reference. Johns Hopkins University Press, Baltimore, 312–529.

SIB Colombia (2019) Sistema de Información sobre Biodiversidad de Colombia. http://www.sibcolombia.net. Accessed on: 2019-10-05.

SpeciesLink (2019) http://www.splink.cria.org.br. Accessed on: 2019-10-05.

Solari S, Muñoz-Saba Y, Rodríguez-Mahecha JV, Defler TR, Ramírez-Chaves HE, Trujillo F (2013) Riqueza, endemismo y conservación de los mamíferos de Colombia. Mastozoología Neotropical 20 (2): 301–365.

Solari S, Medellín R, Rodríguez-Herrera B, da Cunha Tavares V, Garbino G, Camacho MA, Tirira D, Lim B, Arroyo-Cabrales J, Rodríguez-Duran A, Dumont E, Burneo S, Aguirre-Urioste LF, Tschapka M, Espinosa D (2019) Family Phyllostomidae (New World Leaf-nosed Bats). In: Wilson DE, Mittermeier RA (Eds.) Handbook of the mammals of the world. Lynx Editions, Barcelona, 1008 pp.

Tuanmu M, Jetz W (2014) A global 1-km consensus land-cover product for biodiversity and ecosystem modeling. Global Ecology and Biogeography 23 (9): 1031–1045.

Velazco PM, Gardner AL (2012) A new species of *Lophostoma* (Chiroptera: Phyllostomidae) from Panama. Journal of Mammalogy 93 (2): 605–614. https://doi.org/10.1644/11-MAMM-A-217.1

Velez–Liendo X, Strubbe D, Matthysen E (2014) Effects of variable selection on modelling habitat and potential distribution of the Andean bear in Bolivia. Ursus 24 (2): 127–139. https://doi.org/10.2192/ursus-d-12-00027r4.1

Wagner JA (1843) Diagnosen neuer Arten brasilischer Handflugler. Archiv für Naturgeschichte 9 (1): 365–68.

Web of Science (2019) http://www.webofknowledge.com. Accessed on: 2019-10-07.

West AM, Kumar S, Brown CS, Stohlgren TJ, Bromberg J (2016) Ecological informatics field validation of an invasive species Maxent model. Ecological Informatics 36: 126–134. https://doi.org/10.1016/j.ecoinf.2016.11.001

Williams S, Genoways H (2008) Subfamily Phyllostominae Gray, 1825. In: Gardner A (Ed.) Mammals of South America. marsupials, xenarthrans, shrews, and bats. The University of Chicago Press, Chicago, 255–300.

Appendix

Specimens used for comparisons. Sex: female (f), male (m).

Lophostoma carrikeri (*n* = 1): COLOMBIA: **Casanare:** Munchia, Vereda Piedecuesta, Finca Las Canarias, 1 m (IAvH 7112).

Lophostoma brasiliense (*n* = 4): COLOMBIA: **Casanare:** Paz de Ariporo, Corregimiento La Hermosa, Finca Nicaragua, 1 m (IAvH 7858); **Choco:** Riosucio, Parque Nacional Natural Los Katios, Vereda Sautatá, 1 m (IAvH 4493); **Santander:** Bolívar, Serranía de las Quinchas, Caño La Guinea, 1 f (ANDES-M 1863); Cimitarra, Vereda San Juan, Rio San Juan, 1 m (MHN-UCa 1016).

Lophostoma silvicolum (*n* = 2): COLOMBIA: **Caldas:** Norcasia, Vereda El Jagual, Finca Venecia, 1 m (MHN-UCa 745); **Meta:** Parque Nacional Natural La Macarena, 1 f (IAvH 1991).

Micronycteris megalotis (*n* = 1): COLOMBIA: **Meta:** Acacías, Vereda San Cristóbal, 1 m (MUD 1011).