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New records for Brazil and revised distribution of *Lionycteris spurrelli* (Phyllostomidae: Lonchophyllinae), with notes on its morphological diagnosis

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ABSTRACT
We report ten new localities for the nectar-feeding bat *Lionycteris spurrelli* Thomas, 1913 in Brazil. Records are from Amazonia, Atlantic Forest, and Cerrado biomes. The new records from Minas Gerais state clarify the southern limits of the species. We also report the second known locality of the species in Mato Grosso state, and third for Amazonas state. We provide the first records from the southeastern region of Pará state. We present morphometric data and discuss key diagnostic discrete characters for the species, comparing them with published data.

Keywords: Amazonia, Atlantic Forest, Cerrado, *Glossophaga soricina,* nectar-feeding bat

RESUMO – Novos registros para o Brasil e revisão da distribuição de *Lionycteris spurrelli* (Phyllostomidae: Lonchophyllinae), com comentários sobre sua morfologia. Nós reportamos dez novas localidades para o morcego nectarívoro *Lionycteris spurrelli* Thomas, 1913 no Brasil, com novas ocorrências para a Amazônia, Mata Atlântica e Cerrado. Novos registros para o estado de Minas Gerais representam os limites de distribuição austral para a espécie. Ainda reportamos a segunda localidade conhecida de *L. spurrelli* para o estado do Mato Grosso, a terceira para o estado do Amazonas e os primeiros registros para a região sudeste do estado do Pará. Apresentamos dados morfométricos e discutimos os caracteres diagnósticos da espécie, comparando-os com dados publicados.

Palavras-chave: Amazônia, Cerrado, *Glossophaga soricina,* Mata Atlântica, Morcego nectarívoro

Among the 11 subfamilies of phyllostomid bats, Lonchophyllinae is one of the two subfamilies of obligate nectar-feeders (Solari et al. 2019). Lonchophylline bats are distributed from Central to South America, south into Brazil, where they are represented by four genera: *Lonchophylla* Thomas, 1903, *Xeronycteris* Gregorin & Ditch-

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field, 2005, *Hsunycteris* Parlos, Timm, Swier, Zeballos & Baker, 2014 and *Lionycteris* Thomas, 1913 (Griffiths & Gardner 2008; Abreu et al. 2021).

Genus *Lionycteris* currently comprises a single species, *L. spurrelli* Thomas, 1913 (Griffiths & Gardner 2008), which occurs in Panama, Colombia, Venezuela, French Guiana, Suriname, Guyana, Ecuador, Peru, Bolivia and Brazil. In Brazil, the species has been documented in the states of Amazonas (e.g., Sampaio et al. 2003), Amapá (e.g., Taddei et al. 1978), Pará (e.g., Genelhú et al. 2022), Rondônia (Tavares et al. 2017), Tocantins (e.g., Nunes et al. 2005), Mato Grosso (Miranda et al. 2015), Mato Grosso do Sul (Bordignon 2006), Goiás (e.g., Coimbra-Filho Jr. et al. 1982), Pernambuco (Lira et al. 2009), Bahia (e.g., Gregorin & Mendes 1999), Minas Gerais (Trajano & Gimenez 1998), and Espírito Santo (e.g., Woodman & Timm 2006).

Along its wide range, *L. spurrelli* is rarely sampled using ground-level mist nets, but it can be locally common in some areas (Handley 1976; Simmons & Voss 1998). The species has been captured in a wide variety of habitats, including rainforests and savannas, where it is associated with caves and other rock cavities, such as crevices (Trajano & Gimenez 1998; Voss et al. 2016). Due to its wide distribution *L. spurrelli* is currently classified as Least Concern in the latest assessment of the IUCN Red List (Solari 2018).

Here, we report new occurrence records of *L. spurrelli* for Brazil, clarifying the southernmost distribution limits of the taxon. We also present morphometric data for the species in Brazil, comparing our samples with the original description of *L. spurrelli*, and morphologically similar species.

The examined specimens of *L. spurrelli* are deposited in the collections of the Centro de Coleções Taxonômicas, Universidade Federal de Minas Gerais (CCT UFMG), Belo Horizonte, and in the Museu de Zoologia João Moojen (MZUFV), Viçosa. Both collections are in the state of Minas Gerais, Brazil. This study is part of an ongoing project on the review of bat specimens housed at the Mammal Collection of the CCT-UFMG.

To assess morphometric variation, we took 12 cranio-mandibular measurements with a digital caliper (precision 0.01 mm) following Woodman & Timm (2006), as follows: greatest length of the skull (GLS), breadth of braincase (BB), condylobasal length (CBL), height of coronoid process of mandible (HCP), mastoid breadth (MB), length of mandible (ML), breadth across upper molars (MM), palatal length (PL), breadth at postorbital constriction (PO), length of maxillary toothrow, C1–M3 (TR), length mandibular toothrow, c1–m3 (TRL) and zygomatic breadth (ZB). We also measured the length of the forearm (FA).

We plotted the occurrence records of *L. spurrelli* using exact or approximated geographical coordinates. Exact coordinates were obtained from the original publications and specimen labels. When the exact location was not available, we used the coordinates of the administrative center of the municipality. Records of *L. spurrelli* were compiled after a bibliographic review on Google Scholar, Web of Science and ResearchGate using the term "*Lionycteris spurrelli*".

We found 76 locations of *Lionycteris spurrelli* along its entire distribution range (Fig. 1, Appendix I). From the total number of localities, ten are new occurrence re-

cords for Brazil (Fig. 1B). Two of the new localities reported here are among the southernmost records for the species, in the municipalities of Manhuaçu and Igarapé, both in the state of Minas Gerais. We also provide the second record of the species for Mato Grosso state, the second record for Amazonas state, and confirm the species occurrence in southeast Pará state.

Among the new records, two are from the Atlantic Forest biome (localities 1 and 3 in Fig. 1), significantly increasing the number of records from this biome (Woodman & Timm 2006; Lira et al. 2009; Abreu et al. 2021). Two other records are from a transitional area between the Cerrado and Atlantic Forest biomes (localities 2 and 4 in Fig. 1), one from a transitional area between the Cerrado and the Caatinga biomes (locality 5 in Fig. 1), and five are from the Amazon biome (localities 6, 7, 8, 9 and 10 in Fig. 1). Therefore, of the seven new records, six are from forested and humid habitats, and only the one from the Caatinga/Cerrado ecotone is from a drier and more seasonal habitat.

Considering also the previously known records of *L. spurrelli*, it is evident that the species is relatively common in more humid areas such as the Amazon rainforest, and more rarely sampled in drier biomes such as the Caatinga. In fact, the species has not been recorded in core Caatinga areas, so far.

Besides precipitation and vegetation types, presence of rock cavities also seems to be important for the species. Of the 18 individuals reported here, five were collected in karst regions. Locality 4 is a small cave (Gruta do Salitre) and locality 7 (Mina do Sossego) is a copper mine. This pattern suggests that *L. spurrelli* prefers more humid habitats and roosts preferentially in cavities formed by rocks.

Our new records are based on 18 specimens: UFMG 4657, UFMG 4685, UFMG 4692, UFMG 4946, UFMG 4947, UFMG 5324, UFMG 5459, UFMG 5460, UFMG 5461, UFMG 5464, UFMG 5782, UFMG 6800, UFMG 6801, UFMG 6917, UFMG 6918, UFMG 6990 UFMG 6991, MZUFV 4178 (Appendix II). Although the skull and dentition of *L. spurrelli* is very distinct from other Lonchophyllinae or Glossophaginae bats (Griffiths & Gardner 2008), we have found five cases of *L. spurrelli* specimens misidentified as *Glossophaga soricina* (Pallas, 1766); such was the case of specimens MZUFV 4178, UFMG 4657, UFMG 4946, UFMG 4947, and UFMG 5324. Therefore, a comparison between the two taxa is warranted.

Lionycteris spurrelli has a smaller forearm length (33.73 mm in males, 34.51 mm in females; Table 1), on average, when compared to *G. soricina* (34.6 mm in males and 35.1 mm in females; Simmons & Voss 1998). Cranial dimensions are also smaller in *L. spurrelli*. The skull length, for example, has a mean of 19.57 mm (males) and 19.92 mm (females) in *L. spurrelli* (Table 1) while in *G. soricina* the skull has a mean length of 20.23 mm (males) and 20.31 mm (females) (Simmons & Voss 1998). Compared with *G. soricina*, the skull of *L. spurrelli* has a shorter palate, the upper canines have a relatively lower crown, the inner and outer upper incisors are approximately the same size, the inner incisors are square-like, with a small diastema between the tips of the inner and outer incisors (Fig. 2C), and there is a relatively larger diastema between the canine and the first upper premolar (Fig. 2). The mandible of *L. spurrelli*

has a poorly developed angular process, when compared to *G. soricina* (Fig. 2). Furthermore, *G. soricina* has a protruding "chin" on the anterior region of the mandible that is not as evident in *L. spurrelli* (Fig. 2).

Externally, *L. spurrelli* can be differentiated by the plagiopatagium attaching to the distal third of the tibia, in contrast to the plagiopatagium attaching to the base of the foot, as in *G. soricina* (Fig. 2D). Taddei et al. (1978) correctly described the plagiopatagium of *L. spurrelli* as attached to the distal third of the tibia, whereas the identification key of Díaz et al. (2016) and Díaz et al. (2021) erroneously indicates that the plagiopatagium is attached at the base of the toes.

In the original description of *L. spurrelli*, Thomas (1913: pag. 271) described the pelage as: "Colour above bistre, the bases of the hairs darker and greyer, the ends paler, neat "snuff-brown"; under surface rather paler, near "olive-brown."" The specimens that Taddei et al. (1978) examined had the same pattern. However, the specimens that we have examined (Appendix II) had a base paler than the tip on the dorsal fur and a reverse pattern on ventral fur, with darker base (Figs. 2E and F). To understand if the observed differences reflect individual variation or if they are evidence of species-level differences, a wider taxonomic evaluation is needed.

The new records presented here expand and clarify the distribution of *Lionycteris spurelli*. We add two new records for the Atlantic Forest, significantly increasing from three to five records for this region, and confirm that species occur in transitional areas between the Atlantic Forest and the Cerrado. When compared to the original description of the species, specimens in our sample had different banding patterns in both dorsal and ventral pelage. To better understand the morphological variation and natural history of *L. spurrelli* a geographically wider assessment of the species is needed.

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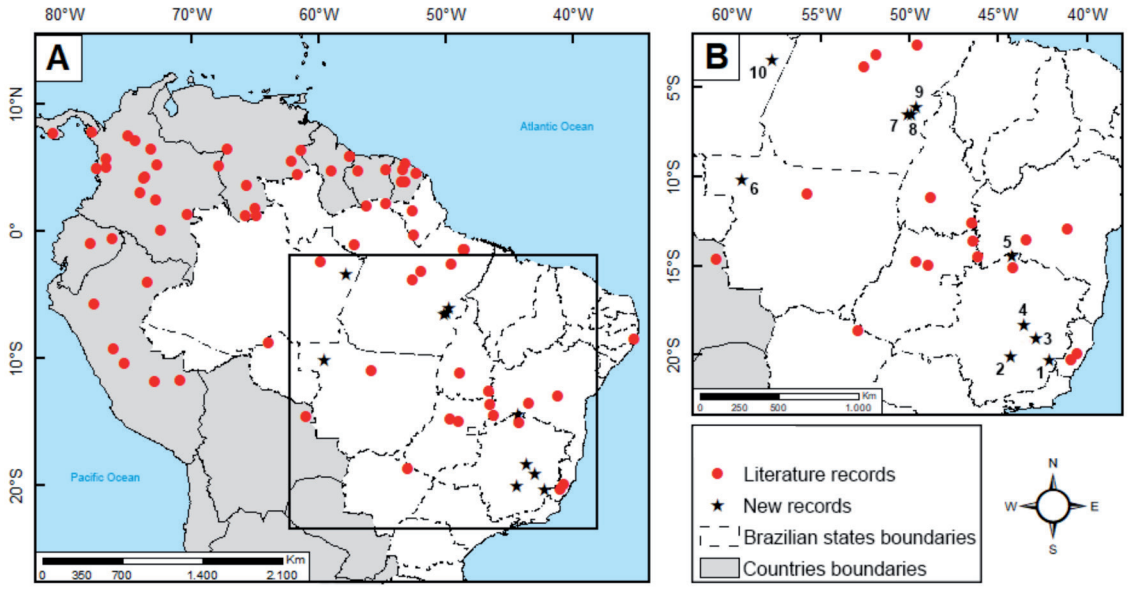

Figure 1. A) Occurrence records of *Lionycteris spurrelli* in Central and South America with emphasis on Brazil (white); B) Detail of the area in Brazil (white) where the new records are located. 1: Manhuaçu; 2: Igarapé; 3: Dores de Guanhães; 4: Diamantina; 5: Juvenília; 6: Aripuanã; 7: Mina do Sossego (Canaã dos Carajás); 8: Canaã dos Carajás; 9: Curionópolis; 10: Maués (approximated to the admnistrative center of municipality). Detailed locality information is available in Appendix I.

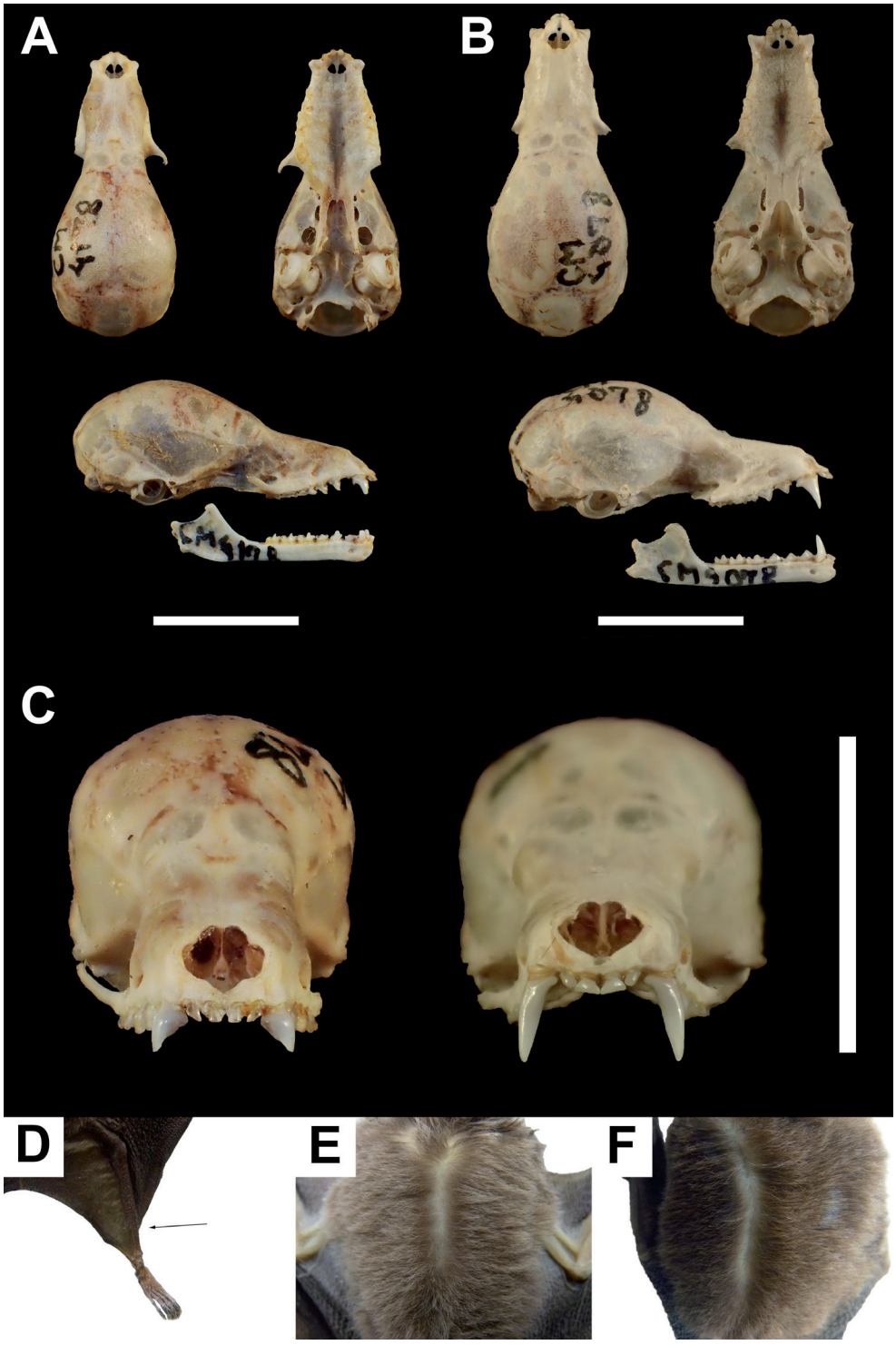

Figure 2. Compared views of the skull, right foot, dorsal and ventral fur of *Lionycteris spurrelli* and skull of *Glossophaga soricina*. A) Dorsal, ventral and lateral view of the cranium and lateral view of the mandible of *L. spurrelli* (MZUFV 4178); B) Dorsal, ventral and lateral view of the cranium and lateral view of mandible of *G. soricina* (MZUFV 4078); C) Compared frontal views of the crania of *L. spurrelli* (MZUFV 4178, left) and *G. soricina* (MZUFV 4078, right); D) Right foot and tibia of *L. spurrelli* (UFMG 5460) showing plagiopatagium insertion (arrow); E) ventral fur (separated at midline) of *L. spurrelli* (UFMG 4657), showing darker bases; F) dorsal fur (separated at midline) of *L. spurrelli* (UFMG 4657) showing pale bases. Scale bar = 10 mm.

Appendix I. Records and geographic coordinates of *Lionyteris spurrelli* arranged alphabetically by country and state/department/province. New records from this study are marked in bold.

COUNTRY/LOCALITY	COORDINATES (latitude; longitude)	REFERENCE
BOLIVIA (n= 1)		
Santa Cruz: Parque Nacional Noel Kempff Mercado	-14.6; -60.85	Azurduy & Emmons 2005
BRAZIL (n= 35)		
Amapá: Floresta Nacional do Amapá	1.6; -52.483	Martins et al. 2006
Amapá: Igarapé Novo	-0.333; -52.383	Taddei et al. 1978
Amapá: Parque Nacional Montanhas do Tumucumaque	2.183; -54.583	Martins et al. 2006
Amazonas: Barcelos	1.2; -64.783	Hoppe & Ditchfield 2016
Amazonas: Gavião	-2.417; -59.733	Sampaio et al. 2003
Amazonas: Maués	-3.394; -57.721	**This study (UFMG 6917, 6918)**
Bahia: Bom Jesus da Lapa	-13.517; -43.383	Sá-Neto & Marinho-Filho 2013
Bahia: Caverna Poço Encantado, Chapada Diamantina	-12.95; -41.1	Gregorin & Mendes 1999
Espírito Santo: Domingos Martins	-20.292; -40.883	Abreu et al. 2021
Espírito Santo: Santa Teresa	-19.933; -40.567	Woodman & Timm 2006
Goiás: Barro Alto	-14.972; -48.916	Zortéa & D'arc 2019
Goiás: Mambaí	-14.467; -46.117	Coimbra-Filho Jr. et al. 1982
Goiás: Parque Estadual de Terra Ronca, São Domingos	-13.6; -46.383	Bichuette et al. 2018
Goiás: Pilar de Goiás	-14.769; -49.572	Zortéa & D'arc 2019
Mato Grosso: Aripuanã	-10.15; -59.433	**This study (UFMG 5324)**
Mato Grosso: Itaúba	-10.967; -55.75	Miranda et al. 2015
Mato Grosso do Sul: Fazenda Pouso Frio, Costa Rica	-18.65; -52.883	Bordignon 2006
Minas Gerais: Caverna Olhos d'Água, Itacarambi	-15.117; -44.167	Trajano & Gimenez 1998
Minas Gerais: Dores de Guanhães	-19.033; -42.85	**This study (UFMG 6990, 6991)**
Minas Gerais: Fazenda Bethânea, Juvenília	-14.383; -44.25	**This study (UFMG 5782)**
Minas Gerais: Gruta do Salitre, Diamantina	-18.267; -43.533	**This study (UFMG 4946, 4947)**
Minas Gerais: Igarapé	-20.067; -44.3	**This study (MZUFV 4178)**
Minas Gerais: Manhuaçu	-20.283; -42.083	**This study (UFMG 6800, 6801)**
Pará: Bosque Rodrigues Alves, Belém	-1.45; -48.483	Taddei et al. 1978
Pará: Cachoeira do Espelho, Altamira	-3.8; -52.533	Trajano & Gimenez 1998
Pará: Cachoeira Porteira, Oriximiná	-1.067; -57.033	Trajano & Gimenez 1998
Pará: Canaã dos Carajás	-6.45; -49.883	**This study (UFMG 5459, 5460, 5461)**
Pará: Curionópolis	-6.067; -49.883	**This study (UFMG 4657)**
Pará: Mina do Sossego, Canaã dos Carajás	-6.467; -50.05	**This study (UFMG 4685, 4692, 5464)**
Pará: Utinga, Belém	-1.417; -48.417	Handley 1976
Pará: Vitória do Xingu	-3.133; -51.817	Zortéa et al. 2015
Pernambuco: Usina Salgado, Ipojuca	-8.517; -35.05	Lira et al. 2009
Rondônia: Porto Velho	-8.75; -63.883	Tavares et al. 2017
Tocantins: Aliança do Tocantins	-11.133; -48.8	Nunes et al. 2005
Tocantins: Aurora do Tocantins	-12.567; -46.5	Felix et al. 2016
COLOMBIA (n= 13)		
Antioquia: Zaragoza	7.483; -74.867	Griffiths 1982
Bolívar: Serranía de San Lucas	7.1; -74.35	Solari et al. 2020
Caquetá: Mesay River	0.083; -72.333	Jiménez-Ortega & Mantilla-Meluk 2011
Casanare: Aguazul	5.167; -72.567	Jiménez-Ortega & Mantilla-Meluk 2011
Chocó: Condotó	5.067; -76.633	Thomas 1913 (Type locality of *Lionycteris spurrelli*)
Chocó: Pacurita	5.667; -76.567	Jiménez-Ortega & Mantilla-Meluk 2011
Chocó: Terron	4.967; -77.35	Mantilla-Meluk & Jiménez-Ortega 2006
Guaviare: Serranía de La Lindosa	2.467; -72.733	Morales-Martínez et al. 2019
Meta: Serrania de La Macarena	2.983; -73.9	Sánchez-Palomino et al. 1993
Meta: Upín Mine	4.267; -73.583	Jiménez-Ortega & Mantilla-Meluk 2011

COUNTRY/LOCALITY	COORDINATES (latitude; longitude)	REFERENCE
Meta: Villavicencio	4.133; -73.617	Sánchez 2017
Santander: Valle de San José	6.433; -73.1	Angarita-Sierra et al. 2019
Vaúpes: Mitu	1.267; -70.183	Jiménez-Ortega & Mantilla-Meluk 2011
ECUADOR (n= 1)		
Orrellana: Estación de Biodiversidad Tiputini	-0.633; -76.15	Rex et al. 2008
FRENCH GUIANA (n= 5)		
Cayenne: La Montagne de Kaw	4.55; -52.2	Brosset & Charles-Dominique 1990
Cayenne: Piste de St. Elie	5.3; -53.067	Guerrero et al. 2002
Cayenne: Réserve Naturelle Nationale des Nouragues	3.883; -53.117	Brosset & Charles-Dominique 1990
Cayenne: Saint-Élie	4.817; -53.267	Brosset & Charles-Dominique 1990
Saint-Lauren: Saül	3.917; -53.367	Webster & McGillivray 1984
GUYANA (n= 2)		
East Berbice-Corentyne: East Berbice-Corentyne	5.833; -57.467	Jiménez-Ortega & Mantilla-Meluk 2011
Potaro–Siparuni: Iwokrama Reserve	4.767; -58.867	Parlos et al. 2014
PANAMA (n= 2)		
Darién: Cana	7.767; -77.7	Velazco et al. 2017
Herrera: El Montuoso Forest Reserve	7.733; -80.783	Méndez-Carvajal et al. 2020
PERU (n=6)		
Cusco: Bajo Urubamba	-11.817; -72.817	Solari et al. 2001
Huánuco: Tingo María	-9.3; -75.983	Parlos et al. 2014
Madre de Dios: Reserva Madre de Dios	-11.733; -70.8	Dávalos & Jansa 2004
Loreto: Iquitos-Nauta Autopista	-3.983; -73.4	Díaz 2011
Pasco: Nevati	-10.367; -75.167	Koopman 1978
San Martín: El Diamante	-5.75; -77.517	Velazco & Patterson 2019
SURINAME (n= 3)		
Sipaliwini: Grassalco	4.767; -56.767	Williams & Genoways 1980
Sipaliwini: Nassaugebergte	4.817; -54.6	Solari & Pinto 2016
Sipaliwini: Sipaliwinisavanne Nature Reserve	2.017; -56.083	Williams & Genoways 1980
VENEZUELA (n= 8)		
Amazonas: Duida-Marahuaca	3.617; -65.567	Handley 1976
Amazonas: Porto Ayacucho	5.1; -67.717	Handley 1967
Amazonas: Sierra de Unturan	1.783; -64.933	Delgado-Jaramillo et al. 2016
Amazonas: Serrania de La Neblina	1.233; -65.65	Gardner 1988
Bolívar: Canaima	5.483; -61.983	Delgado-Jaramillo et al. 2016
Bolívar: El Dorado	6.333; -61.233	Handley 1976
Bolívar: Icabarú	4.483; -61.6	Handley 1967
Bolívar: Villacoa	6.483; -61.983	Gettinger 2018

Appendix II. Detailed information on sex, localities (Brazilian states: locality) and measurements (in millimeters) of the 18 specimens of *Lionycteris spurrelli* reported here. GLS: greatest length of the skull; BB: breadth of braincase; CBL: condylobasal length; HCP: height of coronoid process of mandible; MB: mastoid breadth; ML: length of mandible; MM: breadth across upper molars; PL: palatal length; PO: breadth at postorbital constriction; TR: length of maxillary toothrow, C1-M3; TRL: length mandibular toothrow, c1-m3; ZB: zygomatic breadth; FA: length of the forearm.

Specimens	Sex	Localities	GLS	BB	CBL	HCP	MB	ML	MM	PL	PO	TR	TRL	ZB	FA
MZUFV 4178	M	Minas Gerais: Igarapé	19.7	8.3	18.6	3.65	8.4	13.1	5.4	9.6	4.2	6.5	6.3	7.89	33.4
UFMG 4657	F	Pará: Curionópolis	19.96	8.44	17.85	3.66	8.55	12.76	4.91	9.18	4.11	6.21	6.51	–	34.25
UFMG 4685	F	Pará: Mina do Sossego. Canaã dos Carajás	20.11	8.11	18.05	3.52	8.23	12.98	4.81	9.42	3.98	6.51	6.56	–	34.31
UFMG 4692	F	Pará: Mina do Sossego. Canaã dos Carajás	19.84	8.23	17.85	3.92	8.28	12.73	5.04	8.84	4.12	6.26	6.50	8.35	33.53
UFMG 4946	F	Minas Gerais: Gruta do Salitre. Diamantina	–	–	–	–	–	–	–	–	–	–	–	–	36.76
UFMG 4947	M	Minas Gerais: Gruta do Salitre. Diamantina	–	–	–	–	–	–	–	–	–	–	–	–	34.21
UFMG 5324	F	Mato Grosso: Aripuanã	20.12	7.90	18.41	3.41	8.00	12.60	4.82	9.51	3.93	6.32	6.47	–	34.12
UFMG 5459	F	Pará: Canaã dos Carajás	19.45	8.10	17.90	–	8.33	12.61	5.15	8.98	3.85	6.31	6.49	–	32.82
UFMG 5460	F	Pará: Canaã dos Carajás	19.35	7.76	17.89	3.80	8.24	12.97	5.05	9.11	3.82	6.26	6.58	8.59	34.74
UFMG 5461	M	Pará: Canaã dos Carajás	19.71	8.01	17.79	3.44	8.21	12.51	5.03	8.93	3.94	6.31	6.50	8.37	33.32
UFMG 5464	F	Pará: Mina do Sossego. Canaã dos Carajás	19.76	8.02	18.01	3.68	8.25	12.80	5.14	9.46	3.98	6.43	–	8.47	35.84
UFMG 5782	M	Minas Gerais: Fazenda Bethânea. Juvenília	20.34	7.62	18.70	3.43	7.92	13.19	5.11	9.80	4.06	6.61	6.75	–	34.27
UFMG 6800	M	Minas Gerais: Manhuaçu	19.41	7.88	17.59	3.46	8.39	12.57	4.78	8.66	3.91	6.14	6.38	8.44	33.19
UFMG 6801	M	Minas Gerais: Manhuaçu	19.13	8.10	17.23	3.07	7.90	12.23	4.89	8.92	3.75	5.99	–	7.94	33.82
UFMG 6917	F	Amazonas: Maués	20.38	7.90	18.21	3.59	8.26	12.91	5.09	9.73	3.80	6.39	6.64	–	33.85
UFMG 6918	M	Amazonas: Maués	19.43	8.01	18.10	3.56	8.24	12.90	4.89	9.19	4.01	6.05	6.41	–	34.10
UFMG 6990	F	Minas Gerais: Dores de Guanhães	19.56	7.96	17.96	3.35	7.94	12.54	4.65	9.10	3.75	5.96	6.25	–	33.06
UFMG 6991	F	Minas Gerais: Dores de Guanhães	20.62	8.19	18.75	3.66	8.46	13.30	4.86	9.43	4.02	6.59	6.76	8.69	36.31

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