Therya Notes

Volumen 5 Número 1 Enero 2024

AMMAC
Asociación Mexicana de Mastozoología A.C.

THERYA NOTES tiene como propósito difundir exclusivamente notas científicas con información original e inédita relacionada con el estudio de los mamíferos en todas las disciplinas que contribuyen a su conocimiento. Es un foro abierto para profesores, investigadores, profesionales y estudiantes de todo el mundo, en el que se publican notas académicas en español e inglés. THERYA NOTES es una revista digital de publicación cuatrimestral (tres fascículos por año) que recibe propuestas para publicación durante todo el año. Tiene un sistema de evaluación por pares a doble ciego y es de acceso abierto.

En la Portada

A pesar de su abundancia y el importante papel que juegan en los ecosistemas, la dieta del conejo serrano, *Sylvilagus cunicularius*, no se ha estudiado lo suficiente. Los estudios previos solamente reportan el consumo de especies de la familia Poaceae por parte de este conejo. En esta nota se reporta el consumo de *Eryngium proteiflorum* por el conejo serrano en el Pico del Águila, localizado en la cima del volcán Ajusco, Ciudad de México, México. Los conejos comen las hojas de *E. proteiflorum* empezando por la base para evitar sus espinas y usan este recurso durante todo el año. Por lo tanto, *E. proteiflorum* podría ser una importante fuente de nutrientes para los conejos y éstos parecen ser importantes consumidores de la planta.
(Fotografía de los autores, 2024)

El logo de la AMMAC: "Ozomatli"

El nombre de "Ozomatli" proviene del náhuatl, se refiere al símbolo astrológico del mono en el calendario azteca, así como al dios de la danza y del fuego. Se relaciona con la alegría, la danza, el canto, las habilidades. Al signo decimoprimero en la cosmogonía mexica. "Ozomatli" es una representación pictórica del mono araña (*Ateles geoffroyi*), la especie de primate de más amplia distribución en México. "Es habitante de los bosques, sobre todo de los que están por donde sale el sol en Anáhuac. Tiene el dorso pequeño, es barrigudo y su cola, que a veces se enrosca, es larga. Sus manos y sus pies parecen de hombre; también sus uñas. Los Ozomatin gritan y silban y hacen visajes a la gente. Arrojan piedras y palos. Su cara es casi como la de una persona, pero tienen mucho pelo."

THERYA NOTES, Volumen 5, fascículo 1, enero - abril 2024, es una publicación digital cuatrimestral editada por la Asociación Mexicana de Mastozoología A. C. Hacienda Vista Hermosa 107, Colonia Villa Quietud, Coyoacán C. P. 04960. Ciudad de México, México, www.mastozoologiamexicana.org. Editora responsable: Dra. Consuelo Lorenzo Monterrubio (therya_notes@mastozoologiamexicana.com). Reservas de Derechos al Uso Exclusivo No. 04-2022-031012413800-102. ISSN 2954-3614. Responsable de la última actualización de este número, Unidad de Informática de la Asociación Mexicana de Mastozoología A.C. Dra. Consuelo Lorenzo Monterrubio, El Colegio de la Frontera Sur, Carretera Panamericana y Periférico Sur s/n, C. P. 29290, San Cristóbal de Las Casas, Chiapas. Fecha de la última actualización: 1 de enero de 2024.

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THERYA NOTES 2024, Vol. 5 : 1-4 DOI: 10.12933/therya_notes-24-139 ISSN 2954-3614

Felis catus preying on a *Megasorex gigas*, an endemic and threatened shrew from México

Felis catus depredando a *Megasorex gigas*, musaraña endémica y amenazada de México

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The proliferation of cats (*Felis catus*) has dramatically increased, leading to a worldwide serious conservation issue. In tropical and megadiverse regions, their impact on wildlife has still been poorly documented. The objective of this note was to report a shrew potentially hunted by a cat in Colima, México. On January 30, 2022, we took a recently hunted shrew off a cat at the Centro Universitario de Gestión Ambiental (CEUGEA). We initially detected the predator about 25 m away playing with a prey. We approached the cat and scared it to examine the shrew, which was fresh and had an open wound on one of its flanks. After carefully examining the specimen, we identified it as the Mexican shrew *Megasorex gigas* based on external and cranial characteristics. *Megasorex* is a monotypic genus endemic to western México. It is considered Threatened by the Mexican government and has been determined rare. Cats have been sighted hunting the fauna of CEUGEA, whereas the report of cats hunting shrews has been historically typical in temperate zone countries. In tropical regions, anecdotal records of cats leaving dead shrews in homes are not uncommon. However, there has not been an accurate and formal record of these events that would allow documenting the possible impact of such predators on shrews. We hope that this note might serve to begin a systematization of cat predation records on shrews for enhancing the comprehension of the effect of invasive exotic species on native fauna in megadiverse countries.

Key words: Cat; Colima; exotic fauna; invasive species; predation; Soricidae.

Los gatos (*Felis catus*) han proliferado de forma dramática, generando un serio problema de conservación mundial. En regiones tropicales y megadiversas, su impacto sobre la vida silvestre ha sido pobremente documentado. El objetivo de esta nota fue reportar la captura de una musaraña presuntamente cazada por un gato en Colima, México. En enero 30, 2022, le quitamos una musaraña a un gato en el Centro Universitario de Gestión Ambiental (CEUGEA). Detectamos inicialmente al gato a 25 m mientras jugaba con una presa. Nos aproximamos y lo espantamos para examinar la musaraña, la cual estaba fresca y presentaba una herida en uno de sus flancos. Tras una revisión minuciosa del espécimen, se identificó como musaraña gigante mexicana, *Megasorex gigas*, con base en características externas y craneales. *Megasorex* es un género monotípico endémico del oeste de México. Está considerada como Amenazada por el gobierno mexicano y se le considera rara. Los gatos han sido observados cazando la fauna de CEUGEA, mientras que los reportes de gatos depredando musarañas han sido históricamente típicos en países de zonas templadas. En regiones tropicales, las anécdotas de gatos llevando musarañas a casas no son desconocidas. Sin embargo, no existe un registro preciso ni formal de estos eventos que permita documentar el impacto de estos depredadores sobre las musarañas. Esperamos que esta nota contribuya a iniciar la sistematización de los registros asociados a la depredación de musarañas por gatos para mejorar la comprensión del efecto de especies exóticas invasoras sobre la fauna nativa de países megadiversos.

Palabras clave: Colima; depredación; gato; especie invasora; fauna exótica; Soricidae.

Cats (*Felis catus*) represent a significant threat to wildlife (Trouwborst *et al.* 2020). They are efficient predators of diverse fauna, including invertebrates, birds, reptiles, amphibians, and other mammals (Medina *et al.* 2011). In recent decades, their proliferation worldwide has dramatically increased, leading to a serious conservation issue (Trouwborst *et al.* 2020). For example, cats are the main source of anthropogenic mortality for birds and mammals in the United States of America (Loss *et al.* 2013). Their introduction to islands has become a major concern, as feral populations have contributed to the extinction of endemic species (*e.g.*, indefatigable Galapagos mouse, *Nesoryzomys indefessus*; Darwin's Galápagos mouse, *Nesoryzomys darwini*; little swan Island Hutia, *Geocapromys thoracatus*), whereas huge efforts and resources are required to control those (Medina *et al.* 2011). Moreover, in human settlements, cats are popular pets that menace the city wildlife (Goddard *et al.* 2010). Thus, urgent measures are needed to reduce the negative impacts of cats on the global fauna (Trouwborst *et al.* 2020). In tropical and

megadiverse regions, the impact of cats on wildlife has still been poorly documented (Orduña-Villaseñor *et al.* 2023). Here we aim to report a shrew potentially hunted by a cat in Colima, western México.

On January 30, 2022, we took a recently hunted shrew off a cat at the gardens of the Centro Universitario de Gestión Ambiental (CEUGEA) of the Universidad de Colima. We initially detected the cat about 25 m away playing with a prey. The cat was laying down on the bare ground; it was an adult, grey body colored with a pattern of dark stripes. We approached the cat and scared it to examine the shrew, which was fresh and had an open wound on one of its flanks. CEUGEA is at the Ex-Hacienda Nogueras in the Municipality of Comala, Colima, western México (Figure 1). The site coordinates are 19° 19' 23.041" N, 103° 44' 23.452" W, at 650 m of elevation. The gardens where we took the shrew from the cat mainly included ornamental and medicinal plants; moreover, a small botanical garden was on the site. Remnants of tropical deciduous and sub-deciduous forests, orchards, a human settlement, and agricultural fields were observed in the surrounding areas (González-Alonso 2016). Whether the shrew specimen was hunted in this area or brought by the cat from a more distant place is still being determined.

After carefully examining the shrew specimen, we identified it as a lactating female of the Mexican shrew *Megasorex gigas* (Merriam 1897) based on external and cranial characteristics following Carraway (2007). It had a light gray–lights brown dorsal pelage and visible ears; a considerable total length of 128 mm; head and body of 81 mm long (Figure 2). Skull robust; 3 unicuspids in the upper toothrow and all teeth unpigmented; the area between condylar processes deeply emarginate. We did not include a photograph of the skull as it was severely damaged. The specimen of *M. gigas* is cataloged at the National Mammal Collection (CNMA) at Universidad Nacional Autónoma de México (catalog number: CNMA50346).

Megasorex is a monotypic genus endemic to México and distributed from sea level to 1,800 m west of the country (Woodman *et al.* 2016). It is considered Threatened by the Mexican government (SEMARNAT 2010) and has been determined rare (Armstrong and Jones 1972). The general biology of the species is poorly understood (Guevara *et al.* 2015; Woodman *et al.* 2016). Other shrews recorded in this region of western México are *Cryptotis alticola*, *C. berlandieri*, *Sorex altoensis*, *S. oreopolus*, and *S. saussurei* (Cervantes *et al.* 2008; Guevara *et al.* 2015), with which it can co-exist but can be easily distinguished. Confirming that the cat killed the shrew and did not take it dead from the field is undoubtedly tricky; however, cats have been sighted hunting the fauna of CEUGEA (*e.g.*, green iguana, *Iguana iguana*). Because local people usually provide food for cats in the site, but do not control their movements, we suggest that the cat might be a free-ranging individual, as described by Crowley *et al.* (2020). Further studies within and around CEUGEA might aid to have a more complete comprehension about the

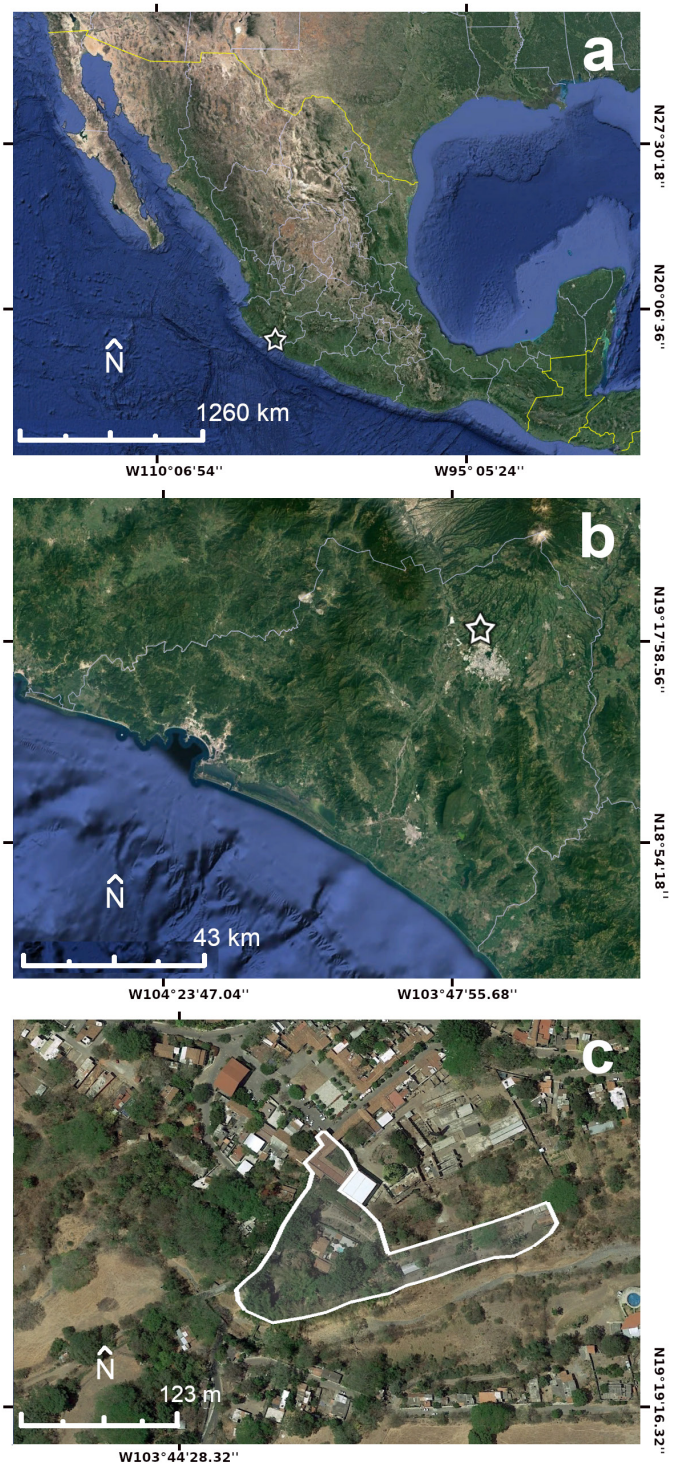

Figure 1. Location where we took *Megasorex gigas* from the cat. The star in the figure depicts a) Colima, western México, b) the location of CEUGEA and c) polygon of CEUGEA at the Ex-Hacienda Nogueras in the Municipality of Comala.

local biodiversity in order to implement actions for its conservation. In this sense, a cat management plan, in which local people participate, should be needed to reduce the negative impact of these animals on other species.

Cats hunting shrews has been historically typical in temperate zone countries (Osgood 1943). It is important to note that these descriptions mention that such felids rarely eat them, presumably because of the shrew's unpleasant

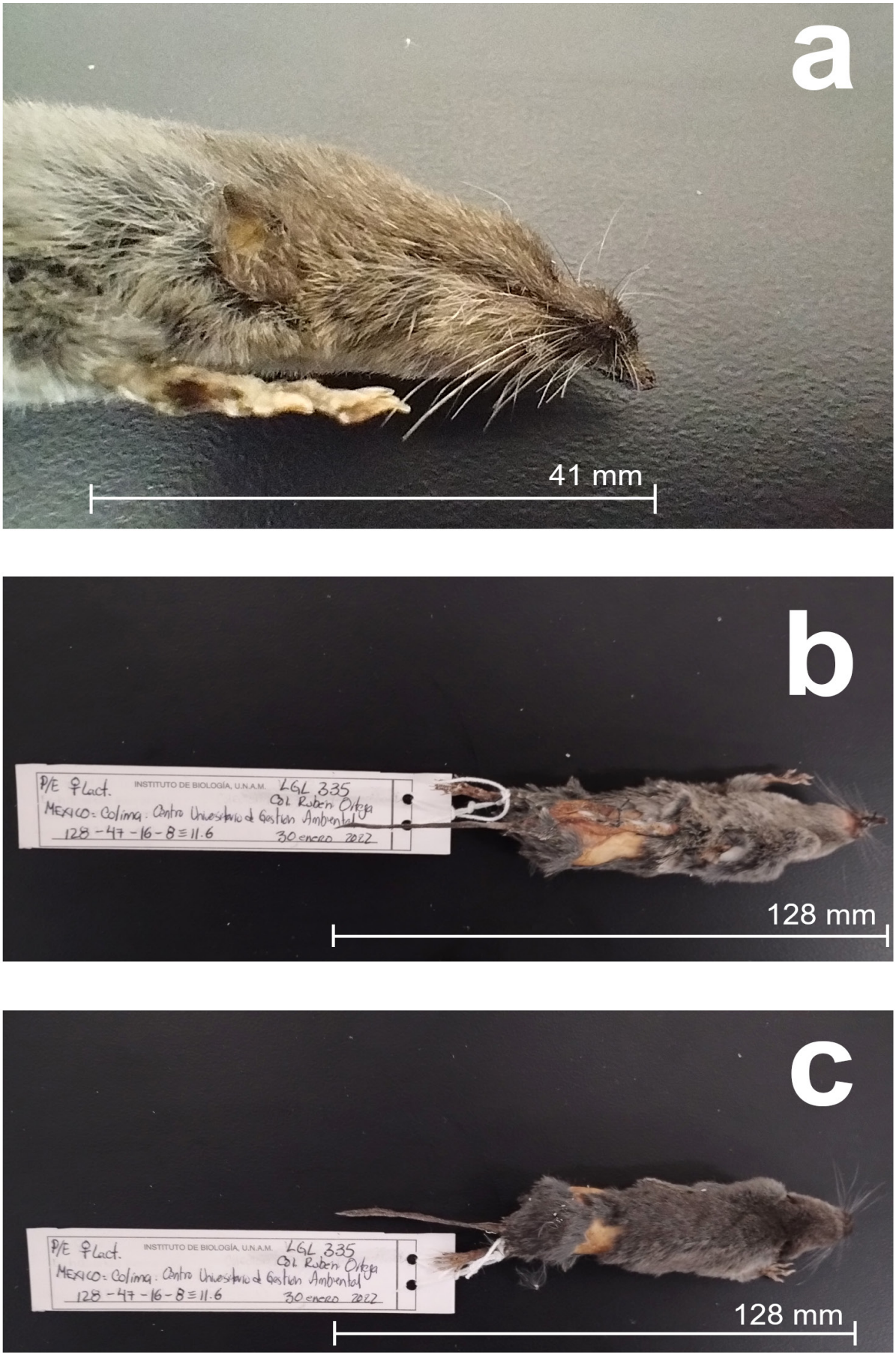

Figure 2. An adult female of *Megasorex gigas* predated by a cat in Colima, western México. Photographs depict a) a lateral view of the head, b) the ventral region, and c) the dorsal region of the specimen deposited at the National Mammal Collection in the Universidad Nacional Autónoma de México (catalog number: CNMA50346).

smell and taste (Osgood 1943; Nagorsen 1996). In tropical regions like México, anecdotal records of cats leaving dead shrews in homes are not uncommon. However, there has not been an accurate and formal record of these events that would allow documenting the possible impact of these predators on shrews, one of the country's poorly known mammals (Guevara *et al.* 2015). We hope that this note might serve as a motivation to begin a systematization of cat predation records on shrews, with the intention of enhancing the comprehension of this particular ecological interaction in megadiverse countries such as México. Documenting and systematizing this type of events might be fostered by including the participation of the general public through citizen science projects, like iNaturalist (https://www.inaturalist.org/).

Acknowledgements

We thank D. A. Paz for her aid during specimen collection and transportation, and 2 anonymous reviewers for their comments that helped improve the first version of the note.

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Associated editor: Beatriz Bolívar Cimé.
Submitted: September 21, 2023; Reviewed: January 12, 2024.
Accepted: January 19, 2024; Published on line: February 9, 2024.

THERYA NOTES 2024, Vol. 5 : 5-10 DOI: 10.12933/therya_notes-24-140 ISSN 2954-3614

First record of *Cyttarops alecto* in Ecuador

Primer registro de *Cyttarops alecto* en Ecuador

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Cyttarops alecto Thomas, 1913 is one of the rarest Neotropical bat species found in biological collections. Here we report the first record of *C. alecto* for Ecuador, which represents a new genus and species of Emballonuridae for the country. This record is based on an adult male specimen from Yasuní National Park, Orellana, Northeastern Ecuador, which was held in a national mammal collection previously misidentified as *Peropteryx macrotis*. We provide a detailed description of the specimen and an updated distribution map for the species. We show the importance of reviewing and verifying identifications of voucher specimens in biological collections as they contribute to historical knowledge of distributions and biodiversity.

Key words: Distribution update; northeastern Ecuador; Orellana; preserved specimen; short-eared bat.

Cyttarops alecto Thomas, 1913 es una de las especies neotropicales más raras de encontrar en las colecciones biológicas. En el presente estudio reportamos el primer registro de *C. alecto* para Ecuador, que representa un nuevo género y especie de Emballonuridae para el país. Este registro se realizó a partir de un espécimen de macho adulto proveniente del Parque Nacional Yasuní, Orellana, al noreste de Ecuador, preservado en una colección nacional de mamíferos y que estaba previamente mal identificado como *Peropteryx macrotis*. Presentamos una descripción detallada del espécimen y un mapa de distribución actualizado de la especie. Nuestro trabajo demuestra la importancia de revisar y verificar las identificaciones de los ejemplares en colecciones biológicas pues estos contribuyen al conocimiento histórico de las distribuciones y a la biodiversidad.

Palabras clave: Actualización de distribución; espécimen preservado; murciélago de orejas cortas; noreste de Ecuador; Orellana.

Cyttarops alecto Thomas, 1913, also known as the short-eared bat, is an Emballonurid bat belonging to the Neotropical subtribe Diclidurini and the monotypic genus *Cyttarops* (Simmons and Cirranello 2023). Although it is considered widespread ranging from Nicaragua to Brazil, Perú and north of Bolivia (Baker and Jones 1975; Aguirre *et al.* 2010; Bonaccorso 2019), it appears to be patchily distributed with records in South America from only a few individuals or single locations (*e. g.*, Velazco *et al.* 2011; Rivas and Ferrer 2012; Ludeña and Medina 2017). The distributional gaps suggest that the range may be underestimated and may be more widespread than thought (Ochoa *et al.* 1994).

The species inhabits humid lowland forests and riparian gallery forests below 500 m where it roosts in relatively open areas in groups of 1 to 10 individuals (Bonaccorso 2019). It is insectivorous and forages near creeks, small rivers and forests (Jung *et al.* 2007). There is scarce information about its biology, ecology and natural history (Nunes *et al.* 2006; Hood and Gardner 2008). It is considered a least concern species by the International Union for Conservation of Nature and Natural Resources (IUCN; Lim *et al.* 2016). The species generally detects and avoids traditional capture methods, such as ground mist nets, resulting in low representation within biological collections (Francis 1989; Bonaccorso 2019). Currently, there are less than 40 specimens in collections, from Brazil, Colombia, Costa Rica, Guyana, Nicaragua and Suriname (Global Biodiversity Information Facility (GBIF; https://www.gbif.org/es/species/2433138). The presence of *C. alecto* in Colombia (Ochoa *et al.* 1994; Calderón-Capote *et al.* 2016), Perú (Velazco *et al.* 2011) and other countries within the Amazon basin (Masson and Cosson 1992; Lim 2007; Aguirre *et al.* 2010; Rivas and Ferrer 2012; Tavares *et al.* 2012) suggests it could also occur in Ecuador. However, to date there are no voucher specimens available for verification. Herein, we present the first documented record of *C. alecto* for Ecuador, which was identified from a specimen preserved in a national biological collection.

The specimen of *C. alecto* was discovered in the Colección de Mastozoología del Museo de Zoología de la Pontificia Universidad Católica del Ecuador (QCAZ). It was previously misidentified as *Peropteryx macrotis.* The speci-

men was captured on July 31, 1999 by P. Jarrín at the Yasuní scientific station, Yasuní National Park, Orellana, Ecuador (0° 40' 41.484'' S, 76° 23' 47.76'' W, 200 m; Figure 1).

Yasuní National Park is the largest protected area in continental Ecuador (Ministerio del Ambiente 2015). It is located in the Amazon basin, in the Napo Moist Forest ecoregion (Olson *et al.* 2001) and is part of the Napo-Curaray lowland evergreen forest, according to the Ecuadorian Ministry of Environment's Ecosystem Classification System (Ministerio del Ambiente 2012). It is characterized by low hills, heavily dissected hills with steep slopes, flat terraces, and small valleys, from marine, lacustrine, and fluvial sediments, between 250 and 400 m of elevation (Guevara *et al.* 2013).

External and cranial measurements were taken using a digital caliper with 0.01 mm precision following Simmons and Voss (1998) and Van Cakenberghe *et al.* (2002). We were unable to obtain accurate measurements of the ears and tragus because they were partially folded. In the same way, the total body length could have been altered due to the taxidermic work and consequently was not measured. Since there were no records of these measurements on the specimen label either, we did not consider them.

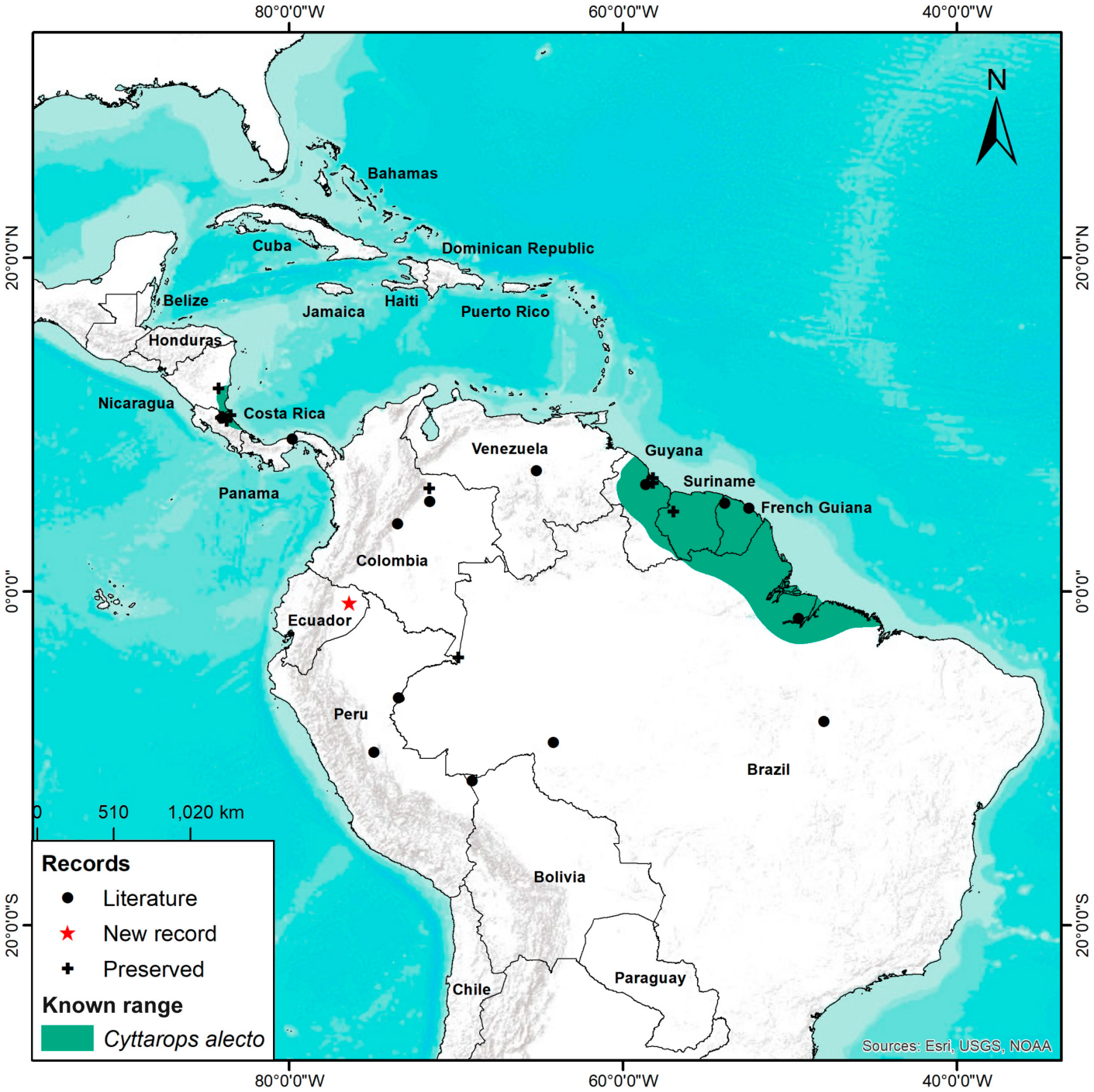

Figure 1. Location of new record of *Cyttarops allecto* (star); circles and crosses are occurrences from GBIF (GBIF, https://www.gbif.org/es/species/2433138), Masson and Cosson 1992, and Ludeña and Medina 2017; green polygon represents the known range excluding locations with only one record (edited from Marsh *et al.* 2022).

We verified the identification, based on published descriptions (Starrett and de la Torre 1964; Hood and Gardner 2008; Díaz *et al.* 2021) and comparing morphological measurements to those in current publications (Starrett and de la Torre 1964; Tavares *et al.* 2012; Calderón-Capote *et al.* 2016; Ludeña and Medina 2017; see Table 1). Some measurements were not comparable due to the lack of historical data (mandible length, toothrow length, skull height from bullae, tibia). The skull was photographed in its original state of preservation to avoid deterioration because of its delicate condition. Finally, we present an updated distribution map for *C. alecto*, which incorporates published and verified records, including our recent discovery in Ecuador.

The specimen QCAZM 3298 correspond to an adult male. It was assigned as *C. alecto* based on the following diagnostic characters: low rounded ears, broad antebrachial membrane which extends to the base of the distal phalanx of the thumb, absence of antebrachial sac, long strong calcar (±16 mm, 16.21 mm in this study), silky fur (Starrett and de la Torre 1964) and a patch of bare skin on the forehead (Velazco *et al.* 2011). The skull has a deep cuplike depression in the rostrum and long postorbital processes that are not fused to the supraorbital ridge (Hood and Gardner 2008; Díaz *et al.* 2021; Figure 2).

Measurements are within the range reported for the species across its distribution (Table 1). Other measures taken but not compared are: skull height from bullae = 7.5 mm; tibia = 19 mm; mandible toothrow = 6.04 mm. The Ecuadorian specimen has almost uniform grayish-brown fur and is ventrally slightly lighter, which is somewhat different to the smoky gray fur that has been recently reported for the species in Colombia or Nicaragua (Calderón-Capote *et al.* 2016; Medina-Fitoria *et al.* 2016). The specimen also presents a diastema between the upper premolars, similar to that reported in specimens from Brazil (Tavares *et al.* 2012), Colombia (Calderón-Capote *et al.* 2016), Perú (Velazco *et al.* 2011; Ludeña and Medina 2017) and Venezuela (Rivas and Ferrer 2012), as well as a well-developed posterior ventral process in the mandible.

This voucher specimen QCAZ 3898 was misidentified as *P. macrotis*. However, despite their similar size, distinguishing *C. alecto* from *P. macrotis* is straightforward, as *P. macrotis* has a small glandular sac near the anterior edge of the antebrachial membrane, larger ears (Hood and Gardner 2008), and free thumbs. Another significant difference between these two species is that *C. alecto* has a skull with a cup-shaped depression, a feature lacking in *P. macrotis* (Díaz *et al.* 2021).

Table 1. Selected external and cranial measurements of *Cyttarps alecto*. Comparison of measurements between the Ecuadorian specimen (QCAZ 3898) and other recorded specimens along its distribution. TBL = Total body length, TL = Tail length, HF = Hind foot length, EAR = Ear length, FA = Forearm length, GLS = Greatest length of the skull, CBL = Condylobasal length, ZB = Zygomatic breadth, MB = Mastoid breadth, BBC = Braincase breadth, TR = Maxillary toothrow length, C-M3 = Canine-molar length, M3-M3 = Breadth across molars, Mand = Mandible length. Values between parentheses represent range values of that measurement. The numbers before each sex mean the number of specimens from which the average values were obtained for each case. Global average does not include this study specimen. *Measures from a single specimen.

Measurement	Ecuador	Colombia	Perú	Brazil	Global Average	
	Orellana	Meta and Casanare	Panguana	Belem (holotype)		
Sex	Male	4 Male	Male	Male	12 Male	11 Female
TBL	-	70.5 (63-78)	-	-	69.25 (63-78)	74 (71-75)
TL	16.2	22 (15-26)	-	20	21 (15-26)	21 (18-25)
HF	6.58	8 (7-9)	10	8	7.8 (5-10)	8.62 (7-9.90)
EAR	-	14 (13-15)	11	10	11.83 (10-15)	12.35 (10-13.40)
FA	41.16	42.87 (41.60-44.15)	45	46	44.46 (40-46)	46.76 (44-57)
GLS	13.35	13.22 (13.12-13.33)	13.52	12.6	13.33 (13.12-13.60)	13.68 (13.48-13.90)
CBL	12.57	12.02 (11.80-12.33)	12.8	-	12.64 (11.8-12.8)	12.75 (12.30-13.20)
ZB	8.38	8.27 (8.15-8.44)	8.28	8	8.36 (8-8.80)	8.50 (8-8.88)
MB	7.20	7.23 (7.10-7.45)	7.36	-	7.43 (7.10-7.70)	7.52 (7.4-7.60)
BBC	6.66	6.62 (6.46-6.89)	6.79	7	6.86 (6.46-7.10)	6.99 (6.70-7.10)
TR	5.60	-	5.21	-	5.21 (5.21)*	5.26 (5.10-5.37)
C-M3	5.20	5.24 (5.13-5.36)	-	5.5	5.38 (5.24-5.50)	5.50 (5.40-5.60)
M3-M3	5.91	5.77 (5.69-5.93)	-	6	6.02 (5.77-6.30)	5.90 (5.90)*
Mand	9.42	-	-	-	9.90 (9.90)*	9.96 (9.90-10)
tr	5.90	-	-	-	-	5.80 (5.80)*
Weigh	-	5.5 (5-6)	8	-	6.56 (5.50-8)	6.72 (5.6-9)
Source	This study	Calderón-Capote *et al.* 2016	Ludeña and Medina 2017	Thomas 1913	Thomas 1913; Starrett and Casebeer 1968; Masson and Cosson 1992; Reid and Langtimm 1993; Ochoa *et al.* 1994; Velazco *et al.* 2011; Calderón-Capote *et al.* 2016	Starrett and de la Torre 1964; Baker and Jones 1975; Reid and Langtimm 1993; Rivas and Ferrer 2012; Tavares *et al.* 2012; Calderón-Capote *et al.* 2016; Luñeda and Medina 2017

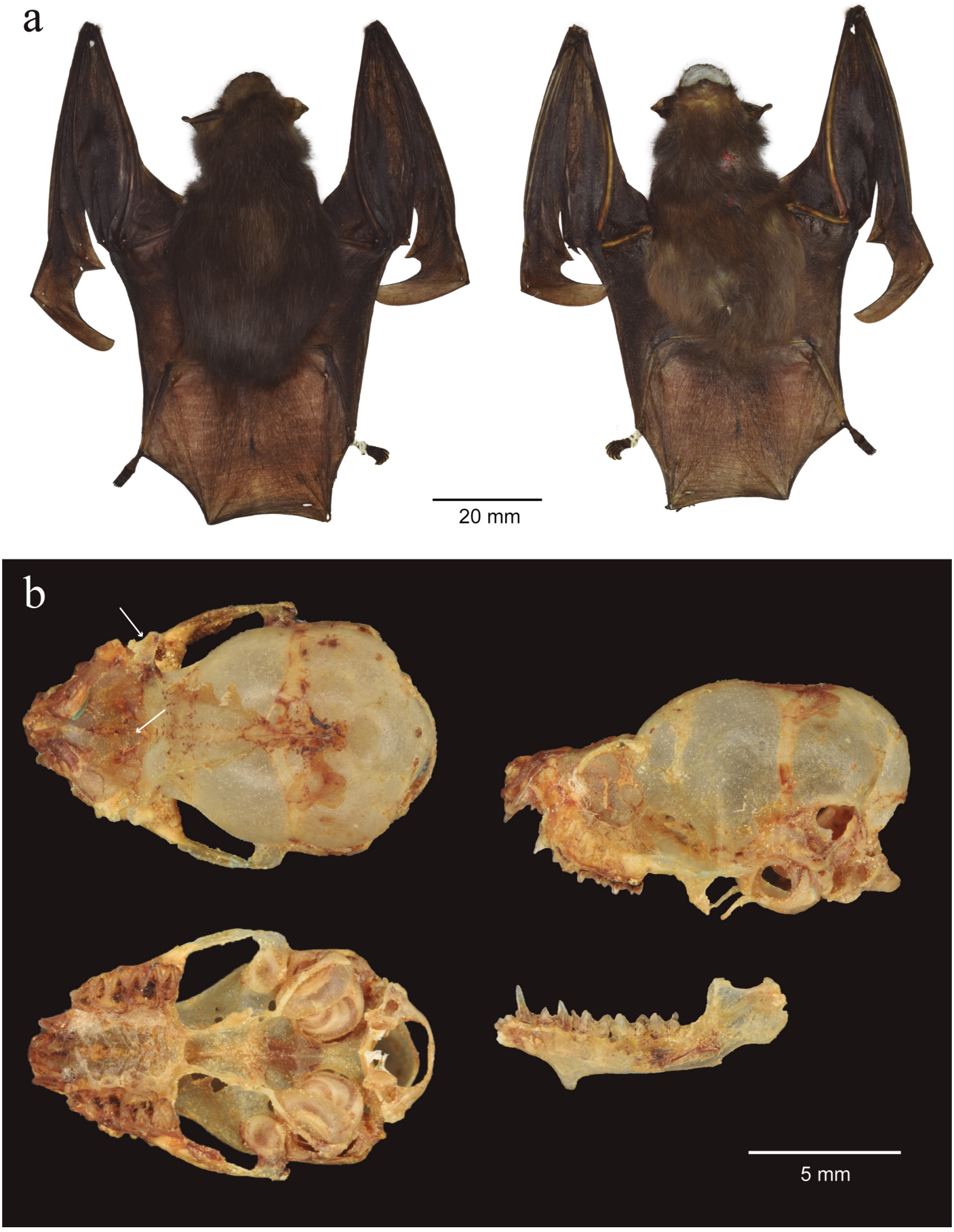

Figure 2. Skin and skull of an adult male of *Cyttarops alecto* (QCAZM 3298). a) Preserved skin, dorsal and ventral view. b) Skull, dorsal, ventral and lateral view, and lateral view of the mandible. White arrows show two diagnostic characters: cuplike depression in the rostrum; long postorbital processes.

This new record of *C. alecto* confirms the presence of the bat in Ecuador, increasing the known genera and species of the Emballonuridae family for the country, for a total of 8 genera and 13 species (Tirira *et al.* 2023). It also expands the distribution of the *C. alecto* in northwestern South America by 920 km to the south of the Colombian locations and, 810 km to the west and 950 km to the north of the Peruvian reported locations, confirming the prediction of occurrence in other areas within the Amazon basin (Bonaccorso 2019). Yasuní National Park is one of the most biodiverse ecosystems in the world, and is considered a site of global conservation significance (Bass *et al.* 2010). The presence of *C. alecto* in the region reveals that much remains to be explored and discovered in this vast protected area. Our work demonstrates the relevance of biological collections as a research source and the importance of reviewing preserved specimens for the identification and knowledge of biodiversity.

We detected some differences in the fur color of *C. alecto* from Ecuador in relation with recently recorded specimens, although it seems to be within the color range reported for the species according to Hood and Gardner (2008) and older descriptions (Starrett and de la Torre 1964). The general morphological measurements of the specimen QCAZM 3298 are also within the historical ranges reported for the species, although it should be noted that several of these measures have wide range values (*e. g.*, forearm and tail length; Table 1). Similar to what was reported for Colombia (Calderón-Capote *et al.* 2016), we also observed a diastema between the upper premolars in the Ecuadorian specimen. This trait, along with the level of development of the posterior ventral process of the mandible, seem to be variable within the species and do not follow an apparent geographic pattern. It is evident that gaps still exist in the current distribution of *C. alecto* and additional surveys are required for a better understanding of its range and morphological variation.

Mist nets have proven less effective for emballonurids and other insectivorous bats since high rates of net avoidance and/or above-canopy foraging preferences are common among these groups (Berry *et al.* 2004; Kalko *et al.* 2008). Mist netting near roosts or foraging areas seems to improve capture rate (Díaz and Linares García 2012), although it has the drawback that finding roosts can be challenging. Although *C. alecto* is adept at avoiding mist nets, its vocal signatures are readily identified (Jung *et al.* 2007; Barataud *et al.* 2013), implementing combined strategies such as acoustic sampling, harp traps and mist netting at different heights could improve detection of these elusive bats.

Acknowledgements

We thank M. A. Pilatasig for her assistance at QCAZ and L. León Paniagua for financing part of this work. To Consejo Nacional de Humanidades Ciencias y Tecnologías (CONAHCyT) for partial financing through a scholarship for doctoral students granted to I. Vivas-Toro. This note is derived from the studies of I. Vivas-Toro aimed to obtaining the Ph. D. degree in Biological Sciences, in the field of Evolutionary Biology of the Posgrado en Ciencias Biológicas of Universidad Nacional Autónoma de México. We thank N. Muchhala, from the University of Missouri, St. Louis, for his comments and suggestions on drafts of this paper. Finally, we thank to the anonymous reviewers for the improvement of this manuscript.

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Associated editor: Jorge Ayala Berdón.
Submitted: November 3, 2023; Reviewed: January 3, 2024.
Accepted: January 22, 2024; Published on line: February 9, 2024.

THERYA NOTES 2024, Vol. 5 : 11-15 DOI: 10.12933/therya_notes-24-141 ISSN 2954-3614

Record of alopecia in the bat *Artibeus jamaicensis* in Córdoba, Veracruz, México

Registro de alopecia en el murciélago *Artibeus jamaicensis* en Córdoba, Veracruz, México

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Alopecia is the partial or total loss of hair in a mammal. This condition has been reported in 38 species of bats from 6 families. This report documents the presence of alopecia in an individual of *Artibeus jamaicensis* in the state of Veracruz, southeastern México. On September 25, 2022, during a field trip as part of a project to assess areas of zoonotic risk in the Mexican Neotropics, rodents and bats were captured in a medium semi-evergreen forest with shaded coffee plants in the peri-urban town of Berlín, municipality of Córdoba, Veracruz, México. Forty bats of different species were captured, including 1 adult male of *A. jamaicensis* with no evidence of reproductive activity and with alopecia in the head, neck, right shoulder, and chest. The area of the chest with alopecia also had a gelatinous lesion with a yellowish crust at the edges. This report represents the first record of alopecia in bats in Veracruz and the second for *A. jamaicensis* in México. In the *A. jamaicensis* individual examined, alopecia probably occurred as a result of a thoracic injury that spread to other parts of the body, likely due to a bacterial or fungal infection.

Key words: Chiroptera; hair loss; injury; Phyllostomidae.

La alopecia es la pérdida parcial o total del pelo de un mamífero. Esta condición ha sido reportada en 38 especies de murciélagos de 6 familias. El objetivo de este reporte es documentar la presencia de alopecia en un individuo de *Artibeus jamaicensis* en el estado de Veracruz, sureste de México. El 25 de septiembre de 2022, durante una salida de campo, dentro de un proyecto para evaluar áreas de riesgo zoonótico en el Neotrópico mexicano, se capturaron roedores y murciélagos en la selva mediana subperenifolia con cafetal bajo sombra en la localidad periurbana de Berlín en el municipio de Córdoba, Veracruz, México. Se capturaron 40 murciélagos de distintas especies, de ellos, un *A. jamaicensis* macho adulto sin evidencia de actividad reproductiva presentó alopecia en la zona de la cabeza, cuello, hombro derecho y tórax. El área del tórax con alopecia estaba acompañada de una lesión de aspecto gelatinoso que en su margen presentaba una costra de color amarillento. Este reporte representa el primer registro de alopecia en murciélagos en Veracruz y el segundo de *A. jamaicensis* en México. Es probable que la alopecia en el individuo *A. jamaicensis* se haya presentado como consecuencia de una lesión en el tórax que se extendió a otras partes de su cuerpo; también es posible que se deba a una infección bacteriana o fúngica.

Palabras clave: Lesión; pérdida de pelo; Phyllostomidae; quiróptero.

Alopecia, or alopecic syndrome, is defined as partial or total hair loss in mammals (Corrales-Escobar and Saavedra-Rodríguez 2020). This condition has been reported in several species of domestic mammals such as dogs and cats (Mecklenburg 2006), captive mammals such as the spectacled bear, *Tremarctos ornatus,* and the pronghorn antelope, *Antilocapra americana* (Barbon 2013; Velez *et al.* 2018), and wild mammals such as the ring-tailed coati, *Nasua nasua,* and the kinkajou, *Potos flavus* (Grajales-Suaza *et al.* 2023). The causes of alopecia can be intrinsic to the affected individual (*e.g.*, reproductive condition, hormonal fluctuations) or extrinsic (*e.g.*, environmental conditions, environmental stress, natural infections, and ectoparasites; Olsson and Barnard 2009). Alopecia has been reported in 38 bat species of the families Pteropodidae, Emballonuridae, Molossidae, Vespertilionidae, Phyllostomidae, and Mormoopidae (Martin-Regalado *et al.* 2022; Hernández-Aguilar *et al.* 2023).

The Mexican fruit bat, *Artibeus jamaicensis,* is a phyllostomid species distributed from Sinaloa, Michoacán, and Tamaulipas, México, to northwest Colombia, Major and Minor Antilles (south of Granada), and southern Bahamas (Miller *et al.* 2016). There are reports of *A. jamaicensis* with alopecia in the Lesser Antilles and México. Chronologically, the first record of *A. jamaicensis* with alopecia was reported on Nevis Island, the Lesser Antilles (Pedersen *et al.* 2003); subsequently, in St. Martin and St. Maarten, the

Table 1. Records of alopecia reported in *Artibeus jamaicensis* in the Lesser Antilles and México. n. d.: data not available; M: male; F: female.

State, Country	Sex		Affected area	Possible cause	Reference
	M	F			
Nevis, Antillas Menores	0	3	Chest, abdomen and chin	n. d.	Pedersen *et al*. (2003)
Saint Martín, Saint Maarten, Antillas Menores	0	1	Chest, abdomen and chin	Lactation	Genoways *et al*. (2007)
Tabasco, México	73, n. d.		Chest, abdomen and head	Endocrine or nutritional deficiencies	Bello-Gutiérrez *et al*. (2010)
Monserrat, Antillas Menores	434, n. d.		Head, neck, abdomen, back	Ingestion of volcanic ash, zinc deficiency, physiological stress and parasitism	Pedersen *et al*. (2012)
Veracruz, México	1	0	Chest, neck, head and right shoulder	Injury, possible fungal or bacterial infection	This study

Lesser Antilles, alopecia was again recorded in this species (Genoways *et al.* 2007). Alopecia was also reported in 73 individuals of *A. jamaicensis* on Villahermosa City, Tabasco, México (Bello-Gutiérrez *et al.* 2010) and in 434 individuals on Montserrat Island, Lesser Antilles (Pedersen *et al.* 2012; Table 1). This report documents the presence of alopecia in an individual of *A. jamaicensis* captured in the state of Veracruz, southeastern México.

During a field trip that was part of a project to assess areas of zoonotic risk in the Mexican Neotropics, rodents and bats were captured in a medium semi-evergreen forest with shaded coffee plants in Córdoba city and the Porvenir and Berlín peri-urban towns, municipality of Córdoba, Veracruz. Berlín is located at 882 m above sea level and has approximately 942 inhabitants (INEGI 2020). On September 25, 2022, 4 mist nets measuring 2 m x 12 m were placed in a shaded coffee plantation with medium semi-evergreen forest (18° 55' 11.05" N, 96° 55' 0.26" W, 923 m) from 17:00 hr to 22:30 hr. The sampling site was located approximately 100 m from a cave that probably serves as a shelter for the captured bats (Figure 1). Each captured bat was weighed (W, in g), and conventional body metrics (in mm) were recorded: total length (LT), tail length (LC), right leg length (LP), right ear length (LO), and forearm length (LA). The reproductive status and age were also recorded. Bats were identified at the species level using the keys of Medellin *et al.* (2007) and Álvarez-Castañeda *et al.* (2017); additionally, the article by Wilson and Mittermeier (2019) was reviewed for recent taxonomic changes. Afterward, the bats were released at the capture site. All specimens were collected under scientific collection license FAUT-0143 from C. Lorenzo, provided by SEMARNAT.

Forty bats belonging to 7 species were captured: *Artibeus jamaicensis* ($n = 11$), *A. phaeotis* ($n = 3$), *A. lituratus* ($n = 2$), *Carollia sowelli* ($n = 5$), *Choeroniscus godmani* ($n = 2$), *Platyrrhinus helleri* ($n = 1$), and *S. parvidens* ($n = 16$). Of the 11 *A. jamaicensis* individuals captured (3 males with descended testicles, 2 pregnant females, 5 males and 1 female with no signs of reproductive activity), 1 had alopecia. The alopecic individual was an adult male with no evidence of reproductive activity and with hair loss in the chest, head, neck, and right shoulder (Figure 2). The area of the chest with no hair showed a gelatinous injury with a yellowish crust at the edges. The hairless skin in the chest, head, and neck areas was reddened. The remaining areas of the skin and hair appeared normal. The alopecic bat had body weight and size within the range reported for the species according to Wilson and Mittermeier (2019): LT = 81, LC = 0, LP = 16, LO = 15.3, LA = 60.2, and W = 30. Because the bat with alopecia had an active injury in the chest and could pose a risk of contagion for other members of his resting group, the alopecic individual was sacrificed and deposited in the Mammal Collection of El Colegio de la Frontera Sur, San Cristóbal de las Casas, Chiapas, México (ECO-SC-M 10238).

This report is the first record of alopecia in *A. jamaicensis* in the state of Veracruz and the second in México, after those reported by Bello-Gutiérrez *et al.* (2010). Several factors that can cause alopecia in animals have been mentioned. In captive bats, this condition can be caused by injuries, malnutrition, contamination, and poor ventilation in resting rooms. In captive bats, alopecia can be treated by cleaning and ventilating resting rooms or with a supplemented diet (Olsson and Barnard 2009). In free-living bats, alopecia may be related to mycosis or fungal infections (De Souza-Suguiura *et al.* 2023), ectoparasites (Corrales-Escobar and Saavedra-Rodríguez 2020), environmental stress associated with urbanization (Acosta 2016; Martin and Wolters 2022), hormonal fluctuations related to reproduction (Haarsma and Van Alphen 2009; Hernández-Aguilar *et al.* 2023), and even to the intake of volcanic ash (Pedersen *et al.* 2012).

Pedersen *et al.* (2003) described the diversity of bats on Nevis Island, Lesser Antilles, and briefly reported having captured 3 individuals of *A. jamaicensis* with alopecia but did not explain the causal agent of this condition. Genoways *et al.* (2007) also described the diversity of bats on St. Martin and St. Maarten Island, Lesser Antilles, and reported that a lactating female of *A. jamaicensis* had alopecia in the chest, abdomen, and chin. Subsequently, Bello-Gutiérrez *et al.* (2010) captured 73 *A. jamaicensis* individuals with alopecia in the chest, abdomen, and head in Villahermosa City, Tabasco, México; these authors concluded that this condition may be caused by endocrine or nutritional deficiencies

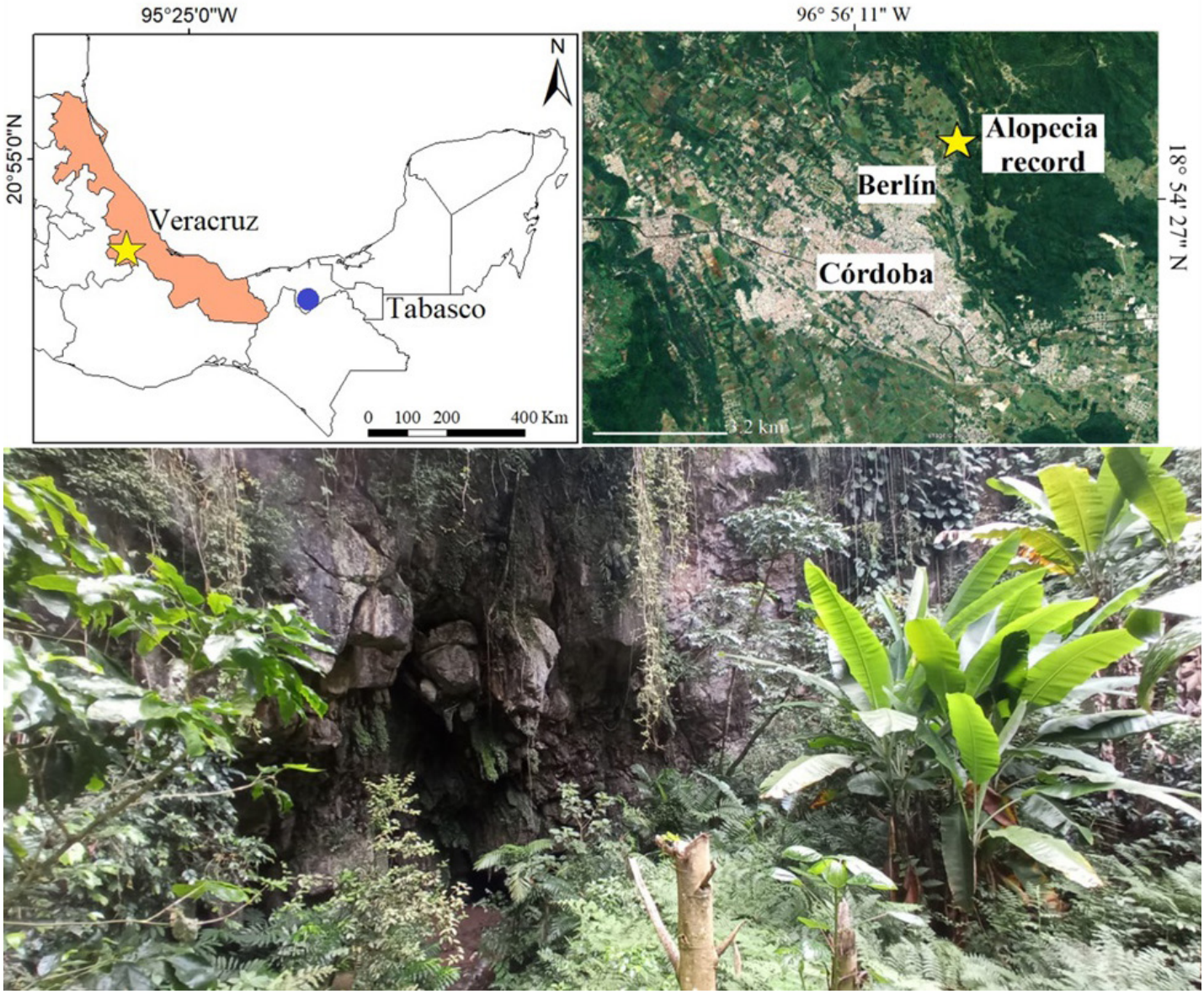

Figure 1. Geographic location of the new record of alopecia in *Artibeus jamaicensis* in Veracruz, México (yellow star), and the previous record reported in México (blue dot). The bottom image shows the vegetation at the sampling site. Photograph: J. Bolaños-Citalán.

associated with urbanization. On Montserrat Island, Less Antilles, Pedersen *et al.* (2012) captured 344 *A. jamaicensis* bats with mild alopecia (absence of hair in small patches on the head and chest) and some individuals with almost 100 % alopecia in the body (the only hair in the animal were small patches between the shoulders or head); these authors concluded that this condition was probably related to volcanic ash ingestion, zinc deficiency, physiological stress, and parasitism (Table 1). At the time of the capture of *A. jamaicensis* with alopecia in Veracruz, we did not have the material and equipment required to take a sample for a histopathological study or fungal and bacterial cultures; therefore, we were unable to identify the etiological agent of hair loss. However, since the hairless area also showed a lesion in the center of the chest, alopecia was probably secondary to this lesion and spread to other adjacent areas of the body of *A. jamaicensis*; furthermore, since the lesion had a gelatinous appearance, it is also possible that alopecia was due to a bacterial or fungal infection.

The body areas frequently affected by alopecia in *A. jamaicensis* are the chest, abdomen, head, chin, neck, and dorsum (Pedersen *et al.* 2003, 2012; Genoways *et al.* 2007; Bello-Gutiérrez *et al.* 2010). This could indicate that *A. jamaicensis* has areas of the body that are more susceptible to hair loss, probably because the hair follicles in these areas are less resistant than in other areas.

Specific studies are needed to search for bats with alopecia to help better understand the etiological agents involved in this condition. This is suggested because most of the literature reports have been incidental observations in studies not focused on alopecia, so researchers generally do not have the material and equipment required to perform histopathological studies or fungal, bacterial, and parasitic cultures when bats with alopecia are captured.

Figure 2. Alopecia in an adult male of *Artibeus jamaicensis* (ECO-SC-M 10238) captured in Ejido Berlín, municipality of Córdoba, Veracruz, México. Alopecia affected a) and b) the chest and neck, and c) the head and right shoulder. Photographs: J. Bolaños-Citalán, I. Hernández-Aguilar.

Acknowledgements

The record reported here occurred during the data collection of the 320315 project funded by the Consejo Nacional de Humanidades, Ciencias y Tecnologías (National Council of Humanities, Sciences and Technologies; CONAHCYT) in 2022. The authors thank R. Serna Lagunes and N. Mora Collado for their support in searching and accessing collection sites in Córdoba City, Veracruz, and its surroundings. The authors also thank J. M. Beristain Ruiz and D. Jimeno Sevilla for accompanying us as guides during the samplings and the local authorities of Berlín for allowing us access to their territory. Two anonymous reviewers provided comments that contributed to improving this note. M. E. Sánchez-Salazar translated this note into English.

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Submitted: August 10, 2023; Reviewed: December 9, 2023.
Accepted: January 22, 2024; Published on line: February 12, 2024.

THERYA NOTES 2024, Vol. 5 : 16-19 DOI: 10.12933/therya_notes-24-142 ISSN 2954-3614

New record of the Neotropical otter (*Lontra longicaudis*) in the forests of the Río Sapo basin, El Salvador

Nuevo registro de la nutria neotropical (*Lontra longicaudis*) en los bosques de la cuenca de Río Sapo, El Salvador

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The Neotropical otter *Lontra longicaudis* is an understudied species in El Salvador and our knowledge about it is scarce. The aim of this contribution was to record the occasional presence of *L. longicaudis* in the Río Sapo basin, El Salvador. The fieldwork was carried out between August and September 2022 using 20 camera traps in the Río Sapo basin. We recorded the first photographs and video of 2 individuals of *L. longicaudis* within the forest in the Río Sapo basin. We confirmed the occurrence of *L. longicaudis* in the Río Sapo basin using the forest, showing the importance of considering adjacent forests of body waters for the study and monitoring of this species.

Key words: Biological corridor; camera traps; citizen science; conservation; endangered species.

La nutria neotropical *Lontra longicaudis* es una especie poco estudiada en El Salvador y nuestro conocimiento sobre la especie es escaso. El objetivo de esta investigación fue registrar la presencia ocasional de *L. longicaudis* en la cuenca de Río Sapo, El Salvador. El trabajo de campo se llevó a cabo entre agosto y septiembre de 2022 usando 20 cámaras trampa en la cuenca de Río Sapo. Reportamos las primeras fotografías y video de 2 individuos de *L. longicaudis* dentro del bosque en la cuenca de Río Sapo. Confirmamos la ocurrencia de *L. longicaudis* en la cuenca de Río Sapo utilizando el bosque, mostrando la importancia de considerar bosques adyacentes a cuerpos de agua para el estudio y monitoreo de esta especie.

Palabras clave: Cámaras trampa; ciencia ciudadana; conservación; corredor biológico; especie en peligro.

El Salvador is one of the countries with less forest cover in América and has been severely deforested in the last decades (Carr *et al.* 2006; Dull 2008), and now, most of their cover is a secondary forest in private land and coffee plantations (Blackman *et al.* 2012; MARN 2018). In our study area, at the northern Morazán department, many forests were resurged by natural succession on abandoned agricultural and ranching lands during 12 Civil War years (Hecht *et al.* 2006; Hecht and Saatchi 2007; Valencia *et al.* 2011; Redo *et al.* 2012) and now have connected secondary forest (degraded forest) under no protection status where many endangered species live such as Neotropical otter (*Lontra longicaudis*) and other wildlife species (Morales-Rivas *et al.* 2020; Rivera *et al.* 2020). However, these forests are undergoing deforestation due to the rapid development of tourism projects and new human settlements due to the return of owners claiming their lands after the war.

In El Salvador, due to the loss and fragmentation of the landscape, *L. longicaudis* is classified as endangered (MARN 2015). Also, it is considered a Near Threatened species by the International Union for Conservation of Nature, IUCN (Rheingantz *et al.* 2021). Despite this species being considered has priority of conservation in El Salvador, *L. longicaudis* has been little studied, a widespread problem for this species in many countries within its distribution (de Almeida and Pereira 2017). However, to our knowledge, there are only 3 scientific papers published with 14 *L. longicaudis* records in El Salvador (Owen and Girón 2012; Funes and Pocasangre-Orellana 2020; Rivera *et al.* 2020) and 1 unpublished record in the online portal of Global Biodiversity Information Facility (GBIF; http://www.gbif.org). This shows gaps in information that make it difficult to understand the basic aspects of the ecology of *L. longicaudis* and make it difficult to make decisions for the conservation of this species. Therefore, herein we contributed to the knowledge of *L. longicaudis* in El Salvador and reported the first Neotropical otter record using camera traps in the Río Sapo basin. Also, we make notes on habitat use and make recommendations for the study and protection of the species.

The fieldwork was carried out in the Río Sapo basin, municipality of Arambala, near the town of Arambala (13° 55' 13.34" N; 88° 8' 1.01" W), department of Morazán, El Salvador. The area has a well-defined dry season from November to April and a rainy season from May to October. The biophysical characteristics of the Central American Dry Corridor influence the area. Therefore, it is susceptible to drastic changes such as low precipitations or prolonged periods of drought (Quesada-Hernández *et al.* 2019). The

study area has secondary forests that have resulted from a natural forest recovery process on abandoned agricultural and livestock lands. The predominant vegetation is pine-oak forest and deciduous forest. The fieldwork was part of an exploratory study on mammal activity in the study area and as part of local community people training for biodiversity monitoring in the Río Sapo forests under a citizen science approach. Also, 5 unstructured interviews of local people were carried out to identify wildlife activity in the area. The fieldwork was carried out between August and September 2022. Twenty camera traps were placed within the forest at a minimum distance of 300 m between each camera. The records were added to the database of the National Mammal Collection of the Institute of Biology of Universidad Nacional Autónoma de México (UNAM 2023).

Herein, 3 photographs and 1 video of *L. longicaudis* were recorded for the first time using camera traps in the Río Sapo basin with catalog number of the video IBUNAM-CFB-78952. The records were taken in the forest (Figure 1), not near the banks of the rivers, streams, or burrows, sites where usually put camera traps in specific otter studies. Two individuals of *L. longicaudis* of unknown sex were recorded on August 18, 2022, during daylight hours (15:19 hr) at 13° 56' 3.36" N and 88° 6' 22.19" W at an elevation of 720 m. The individuals were recorded moving within the forest at 740 m from the main river, 325 m from a seasonal stream, and 115 m from another small seasonal stream. The individuals did not leave traces of excrement or food scraps. Probably, this record corresponds to 1 female and her cub, evidencing parental care and reproductive activity in the Río Sapo basin. We identified *L. longicaudis* by the morphological characteristics of the body of a semi-aquatic mammal such as an elongated body, uniformly dark brown fur above and slightly lighter below, long pointed tail, and short ears (Kruuk 2006).

This is the first photographed record of *L. longicaudis* using the forest within the Río Sapo basin. According to local people, this species has been seen occasionally crossing the forest between rivers. Previous studies in El Salvador about this species only recorded feces, sightings, and photographs in main rivers and streams, but not in the forest (Funes and Pocasangre-Orellana 2020). It is well known that *L. longicaudis* can use riparian zones for scent marking, holt areas, grooming, or foraging activities (Kruuk 2006; Rheingantz *et al.* 2017). However, the interactions of this species inside the forest, outside the water, or outside of riverbanks are little understood. Therefore, it is imperative to know the interaction of this species with the forests to formulate better conservation strategies.

Lontra longicaudis distribution has been restricted to a few rivers in El Salvador (Funes and Pocasangre-Orellana 2020). Our record confirms the activity of the species in the Río Sapo basin within the upper Lempa River basin (transboundary basin) near the borders with Honduras (Figure 2), therefore this record can be relevant for the southeastern region of Honduras, a region where not have records yet. Factors such as seasonality probably contribute to the movement patterns of *L. longicaudis* in our study area (Are-

Figure 1. New record of 2 individuals of *Lontra longicaudis* of unknown sex within the forest in the Río Sapo basin municipality of Arambala, department of Morazán, El Salvador. Collection of Biological Photocollections; catalog number of the video: IBUNAM-CFB-78952.

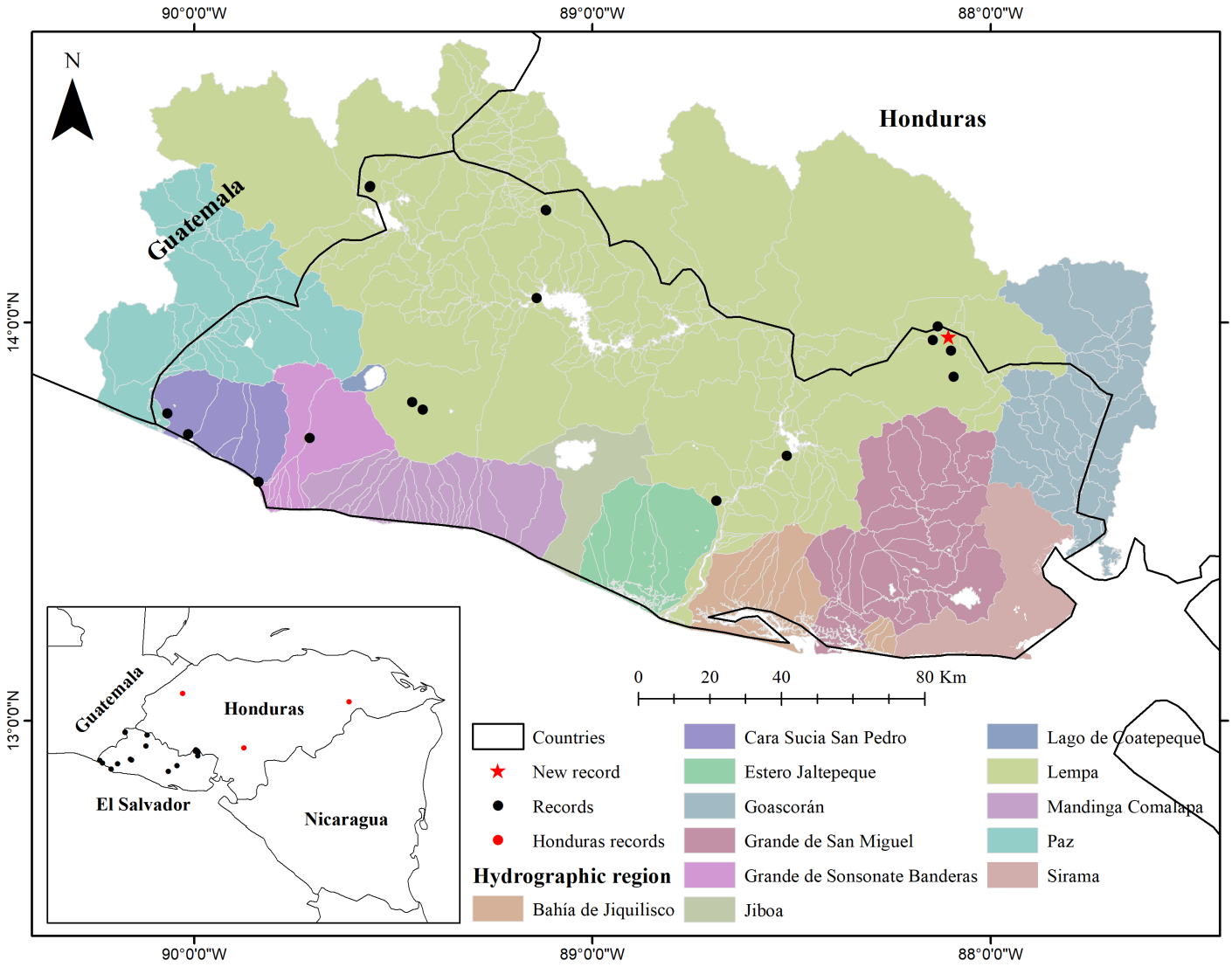

Figure 2. *Lontra longicaudis* records distribution map in El Salvador. Black and red points show *L. longicaudis* records in El Salvador and Honduras, respectively (see Funes and Pocasangre-Orellana 2020; GBIF.org 2023).

llano Nicolás *et al.* 2012; Santiago-Plata *et al.* 2013; Cianfrani *et al.* 2018). Probably during the rainfall season, the otter moves through the forest between rivers and small streams to search for food or shelter or such as activities for parental care. However, more studies will be necessary to determine the factors that affect the movement patterns of this species in the basin. On the other hand, many rivers and streams dry up during the dry season in our study area, then the main river is often used for water extraction and tourism, which is a potential threat to the availability of habitat for the species during the dry season. Also, our study area is located within the Central American Dry Corridor, therefore it is susceptible to drastic changes in precipitation and temperature (Quesada-Hernández *et al.* 2019). Additionally, climatic phenomena such as ENSO (El Niño–Southern Oscillation) and climate change can influence the habitat availability of the species by reducing river flow due to prolonged periods of drought, decreased precipitation, and increased temperature (Cianfrani *et al.* 2018). Therefore, it is probable that the species can use forests as a temporary refuge or feeding site during these less favorable conditions.

Therefore, the conservation of adjacent forests and their connectivity will be a key strategy for the conservation of *L. longicaudis* in El Salvador, specifically in the Río Sapo basin, and will be necessary to create strategies that encourage forest owners to protect these lands and avoid deforestation. Due to the small percentage of Salvadorean protected areas (UNEP-WCMC 2023), conservation strategies based strictly on protected areas will not guarantee the conservation of species such as the Neotropical otter, where the most of records do not occur in protected areas (Funes and Pocasangre-Orellana 2020). Therefore, will be necessary to create conservation strategies that include not only the protection of riparian forests but also the expansion of these areas that allow the establishment of biological corridors (Crespin and García-Villalta 2014) that connect basins and conserve areas that have critical ecological requirements for developing and conserving *L. longicaudis* (Latorre-Cardenas *et al.* 2021).

Acknowledgements

We thank Fundación Naturaleza El Salvador for providing camera traps for this research project. Also, we are grateful to S. Amaya, E. Chica, and A. Ramírez for their support in the fieldwork, and we are grateful to private landowners who allowed us to carry out this study on their properties, and 2 anonymous reviewers for their comments that helped improve the first version of the note.

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Associated editor: Jesus R. Hernández Montero.
Submitted: July 11, 2023; Reviewed: December 11, 2023.
Accepted: January 23, 2024; Published on line: February 12, 2024.

THERYA NOTES 2024, Vol. 5 : 20-23 DOI: 10.12933/therya_notes-24-143 ISSN 2954-3614

Geographic distribution of tropical cacomixtle (*Bassariscus sumichrasti*) in Puebla, México

Distribución geográfica del cacomixtle tropical (*Bassariscus sumichrasti*) en Puebla, México

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The tropical cacomixtle (*Bassariscus sumichrasti*) a rare neotropical carnivore with a geographic distribution restricted to the southern tropical part of the México and Central America. There have been 2 records of this species in the state of Puebla, specifically in the vicinity of Tehuitzingo and Acatlán. During a routine assessment of the Mammal Collection at the Universidad Autónoma Metropolitana, we found a specimen with the characteristics of *B. sumichrasti*. The specimen was collected near Zacapala, in the southwestern extreme of Puebla in a tropical deciduous forest. Our specimen along with previous records of *B. sumichrasti* in Puebla, are concentrated in the northern part of the Balsas Basin, where sympatry with *B. astutus* is possible. Given the limited available information on the species, this new specimen is a valuable addition to the knowledge of the distribution that can contribute to a better understanding of the species.

Key words: Carnivore; distribution; procyonid; Puebla; tropical cacomixtle.

El cacomixtle tropical (*Bassariscus sumichrasti*) es un carnívoro neotropical raro con una distribución geográfica restringida a la parte tropical sur de México y Centroamérica. En Puebla esta especie se ha registrado en 2 ocasiones, específicamente en las cercanías de Tehuitzingo y Acatlán. Durante una revisión cotidiana de la Colección de Mamíferos de la Universidad Autónoma Metropolitana encontramos un ejemplar con las características de *B. sumichrasti*. El ejemplar fue colectado cerca de Zacapala, en el extremo suroeste de Puebla en una selva tropical caducifolia. Nuestro espécimen junto con los registros anteriores de *B. sumichrasti* en Puebla, se encuentran en la parte norte de la Cuenca del Balsas, donde es posible la simpatría con *B. astutus*. Dada la limitada información disponible sobre la especie, este nuevo espécimen es una valiosa adición al conocimiento de la distribución que puede contribuir a una mejor comprensión de la especie.

Palabras clave: Cacomixtle tropical; carnívoro; distribución, prociónido; Puebla.

The tropical cacomixtle (*Bassariscus sumichrasti*) is a rare neotropical carnivore species, characterized by specific morphological features. It has a long, slender body with a total length ranging from 790 to 1,003 mm (Goodwin 1969). The tail is generally longer than its head and body, measuring between 396 to 508 mm, and displays alternating bands of black and light buff (Goodwin 1969; Hall 1981). Although it shares a general resemblance with northern cacomixtle (*B. astutus*), it can be distinguished by certain characteristics, including nearly indistinct tail rings toward the distal end, and finer, soft and laxer fur. This species also has long, curved, compressed, and non-retractable claws, and the second and third digits of both the forelimbs and hindlimbs lack fur on the undersurface behind the digital pads. In addition, the skull of *B. sumichrasti* exhibits connected lower ridges on its molariform teeth, and its upper carnassial tooth is triangular without a deuterocone (Nelson and Goldman 1932; Goodwin 1969; Hall 1981).

The tropical cacomixtle is known for its nocturnal, solitary, and arboreal habits, although it can descend to the ground when necessary (Emmons and Feer 1990; Nava 2005; Aranda 2012). Its diet, although not extensively studied is believed to consist of a variety items, including fruits, insects, and small vertebrates (Aranda 1981; Emmons and Feer 1990; Nava 2005). Unlike its sister species, *B. astutus*, the tropical cacomixtle is primarily observed in tropical and subtropical forests, as well as mountain cloud forests (Nava 2005; Emmons and Feer 1990).

Despite its rarity and scarcity of records, the *B. sumichrasti* is not considered to face significant conservation problems. It falls under the "least concern" category according to the International Union for Conservation of Nature (IUCN; Pino *et al.* 2020) and it is listed in Appendix III by the Convention on International Trade in Endangered Species of Wildlife and Flora (CITES 2014); while

in México, it is considered subject to special protection (SEMARNAT 2018).

The distribution of *B. sumichrasti* extends from southeastern México to Panamá (Hall 1981), including countries such as Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, and Panamá. In México, its range covers the Yucatán Península, southern Campeche, Quintana Roo, and western Yucatán, along with most of Chiapas and Oaxaca. It extends as far north as central Veracruz along the Gulf of México and south to Guerrero along the Pacific coast (Hall 1981; Emmons and Feer 1990; Wozencraft 2005; Pino *et al.* 2020).

However, records and the distribution of *B. sumichrasti* in the state of Puebla have been somewhat confusing. The first specimen recorded in Puebla is attributed to López-Wilchis and López Jardínez (1999) corresponding to a specimen from the Moore Mastozoological Collection Laboratory of Zoology collected in Rancho Papayo, 10 mi S Tehue[i]tzingo, Puebla, in July 1943 (http://vertnet.org/). It is on the basis of this record, further publications referring to the species occurring in Puebla include Ramírez-Pulido *et al.* (2000); Martínez-Vázquez *et al.* (2011); Ramírez-Bravo and Hernández-Santin (2016). There is another record from "La Azuchilera", in the Municipality of Acatlán (Villarreal-Eb *et al.* 2012), which features a skull photograph. However, it exhibited characteristics more consistent with *B. astutus* than with *B. sumichrasti*, including well-marked temporal ridges and a deuterocone on the upper carnassial tooth, with cranial measurements aligning more with *B. astutus* (Goodwin 1956, 1969; Davis and Lukens 1958; Hall 1981; Poglayen-Neuwall and Toweill 1988). Thus, the specimen requires further examination to clarify its identification.

A recent discovery in the Mammal Collection of the Universidad Autónoma Metropolitana (UAMI) revealed a specimen from Puebla, which exhibited all the external characteristics of *B. sumichrasti*. Locality and the collecting date reported here were taken directly from the specimen tags. Habitat, and vegetation type data were obtained from the collector's field notes, and some data on its biology were taken from the preparation diary. The *B. sumichrasti* specimen was compared with other specimens of *B. astutus* (Figure 1). All specimens, preparation diary, collector's field notes are found in the same collection of mammals.

The specimen was collected 3 km from Zacapala, Puebla, on January 13, 1989 (UAMI 17277). This specimen does not have the skull and the skin does not have the legs and the end of the tail. Although the skull was not available for examination, notable features such as the tetracolor dorsal hair, with pelage long and soft, while the dorsal hair of *B. astutus* is tricolor, with pelage comparatively short and coarse. The hair on the cheek is light cream, and short and rounded ears, with the dorsal part of the ear covered with longer and more abundant hair, while in *B. astutus* has more darker cheeks, the ears are slightly larger and comparatively more pointed, with the short and less abundant hair. Despite the absence of the skull these features provide sufficient evidence to consider this specimen a clear representative of *B. sumichrasti*.

The records of *B. sumichrasti* in Puebla, including those of Tehuitzingo (López-Wilchis and López Jardínez 1999; Ramírez-Bravo and Hernández-Santin 2016), Acatlán (Villarreal-Eb *et al.* 2012), and the latest finding near Zacapala, are concentrated in the northern part of the Balsas Basin (Figure 2). The atypical characteristics of this region, including higher elevations not typically associated with the species and the presence of deciduous forests rather than the typical tropical forest and mountain cloud forests where *B. sumichrasti* is usually found (Emmons and Feer 1990; Nava 2005), raise questions about this population unique nature.

It is speculated that the species may have entered the Balsas Basin region from localities in the southern part of Oaxaca, belonging to *B. s. sumichrasti*, although not from Guerrero, which corresponds to *B. s. latrans*. Additionally, *B. sumichrasti* was found in the mountain cloud forests in the center of Veracruz (Jalapa [Xalapa]; Hall and Dalquest 1963; Hall 1981) and the similarity of certain regions in the Sierra Norte de Puebla to Jalapa, Veracruz suggests a potential distribution in these areas. It is also possible that the tropical cacomixtle can be found in the extreme southeast of Puebla in tropical rain forest in the Zacacoapan region because there are localities with records of *B. sumichrasti* that are very close in Oaxaca and Veracruz (Hall and Dalquest 1963; Goodwin 1969; Figure 2). The 3 records of *B. sumichrasti* in Puebla are no more than 10 km apart together, but they are separated by more than 190 km from the nearest locality in Jalapa, Veracruz.

Figure 1. Comparisons of skin of *Bassariscus sumichrasti* and *B. astutus* from Puebla, México. From left to right *B. astutus* (534 UAMI; 535 UAMI; 536 UAMI), and *B. sumichrasti* (17277 UAMI).

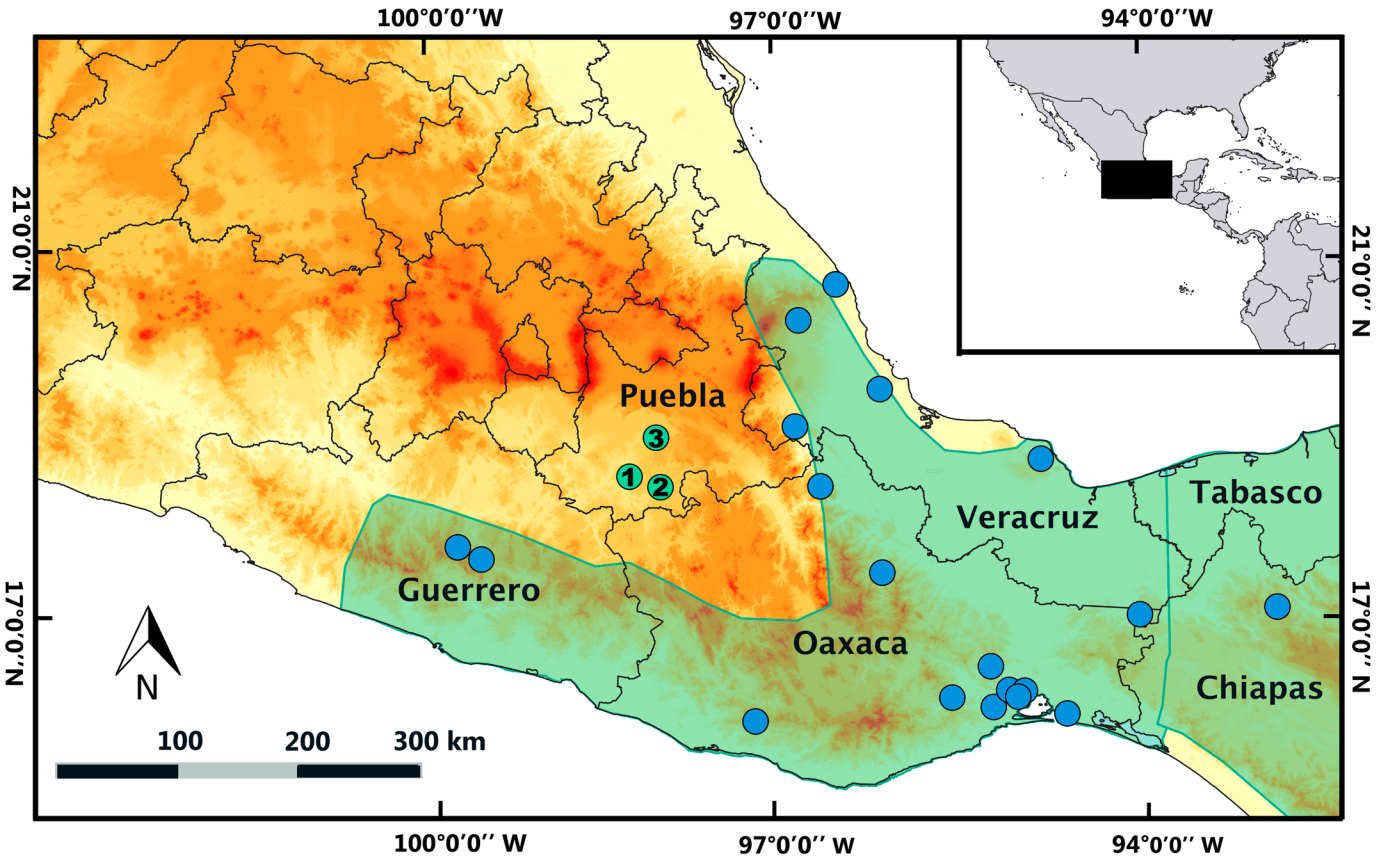

Figure 2. Geographic distribution of *Bassariscus sumichrasti* in México according by the International Union for Conservation of Nature (green area; Pino *et al.* 2020). The records (blue dots) correspond to Oaxaca and Guerrero (Goodwin 1969; Hall 1981; Cervantes and Yépez Mulia 1995; Lira-Torres *et al.* 2012), Veracruz (Hall and Dalquest 1963; Hall 1981; González Christen 2008; Astiazarán Azcárraga *et al.* 2020; Mezhua-Velázquez *et al.* 2022), Guerrero (Davis and Lukens 1958; Hall 1981). The localities of Puebla correspond to 1) Tehuitzingo (López–Wilchis and López Jardínez 1999; Ramírez-Bravo and Hernández-Santín 2016), 2) Acatlán (Villarreal-Eb *et al.* 2012), and 3) Zacapala (in this work).

The records from Puebla indicate that *B. sumichrasti* is sympatric with *B. astutus* in the southern part of Puebla in the Balsas Basin. While the 2 species may coexist in this region, it is unclear whether they are truly syntopic, meaning they occupy the same region with an abundance of resources that can sustain both species. Further research and observations are needed to better understand the distribution, behavior, and ecological interactions of these 2 species in sympatric areas.

Acknowledgements

We thank D. López for preparing figures. The authors would like to especially thank 2 anonymous reviewers for comments and correction on the manuscript.

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Associated editor: José F. Moreira Ramírez.
Submitted: November 24, 2023; Reviewed: January 29, 2024.
Accepted: February 6, 2024; Published on line: February 19, 2024.

THERYA NOTES 2024, Vol. 5 : 24-27 DOI: 10.12933/therya_notes-24-144 ISSN 2954-3614

Consumption of *Eryngium proteiflorum* by the Mexican cottontail (*Sylvilagus cunicularius*)

Consumo de *Eryngium proteiflorum* por el conejo serrano (*Sylvilagus cunicularius*)

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Despite its abundance and important role in ecosystems, the diet of the Mexican cottontail, *Sylvilagus cunicularius*, has not been studied enough. Previous studies report only the consumption of Poaceae species by this cottontail. In this note, we report the consumption of *Eryngium proteiflorum* by the Mexican cottontail at Pico del Águila located on top of the Ajusco volcano, México City, México. Cottontails consume *E. proteiflorum* leaves from the base to avoid spikes, and they use this source of food all year. Therefore, *E. proteiflorum* could be an important source of nutrition for cottontails, and they appear to be important consumers of this plant.

Key words: Alpine grasslands; Apiaceae; camera traps; diet; mountain.

A pesar de su abundancia y el importante papel que juegan en los ecosistemas, la dieta del conejo serrano, *Sylvilagus cunicularius*, no se ha estudiado lo suficiente. Los estudios previos solamente reportan el consumo de especies de la familia Poaceae por parte de este conejo. En esta nota reportamos el consumo de *Eryngium proteiflorum* por el conejo serrano en el Pico del Águila, localizado en la cima del volcán Ajusco, Ciudad de México, México. Los conejos comen las hojas de *E. proteiflorum* empezando por la base para evitar sus espinas y usan este recurso durante todo el año. Por lo tanto, *E. proteiflorum* podría ser una importante fuente de nutrientes para los conejos y éstos parecen ser importantes consumidores de la planta.

Palabras clave: Apiaceae; cámaras trampa; dieta; montaña; pastizal alpino.

Alpine grasslands in the Mexican volcanic belt are home to a great variety of species, many of which are endemic (Steinmann *et al.* 2021). However, these ecosystems are endangered due to their small size (they can only be found on the tops of a few mountains), the fact that they are located close to the most heavily populated areas of México (therefore the anthropogenic pressure is high), and climate change (Steinmann *et al.* 2019, 2021). At the same time, our knowledge of the natural history of plants and animals that live there is scarce (Steinmann *et al.* 2019, 2021).

One example of this is the endemic Mexican cottontail (*Sylvilagus cunicularius*) that inhabits the Mexican volcanic belt (Cervantes *et al.* 1992). Although it is common across several ecosystems in central México, there are few studies concerning this rabbit, and in particular, information on its diet is scarce and mostly based on occasional observations (Ceballos and Galindo 1984; Cervantes *et al.* 1992). In natural areas, this cottontail consumes grasses like *Muhlenbergia macroura, Stipa ichu* and *Festuca amplissima* (Cervantes *et al.* 1992), and in cultivated areas, the young leaves of oats, maize, and barley (Ceballos and Galindo 1984). Notice that all those species belong to the Poaceae family. Therefore, this work aims to report the consumption of *Eryngium proteiflorum* (an herb of the Apiaceae family) by the Mexican cottontail in a high-altitude environment.

We monitored the fauna on top of El Pico del Águila (approximately 3,850 m) on the Ajusco Mountain, south of México City (Figure 1) for 1 year (May 2022-May 2023) using 5 camera traps. One of the traps was pointing directly at an individual of *E. proteiflorum* and all the data presented here was collected by this trap. The camera trap used was a HC801A Trail Camera set to take 2 pictures when the motion sensor was activated and a delay of 5 sec before the next activation. The camera trap was active 24 hr a day and checked once a month. The vegetation in the location consists predominately of grasses, some spatially located *Pinus* trees, and the herb *E. proteiflorum* is common. Two seasons are distinguishable: the dry from October to April and the rainy from May to September.

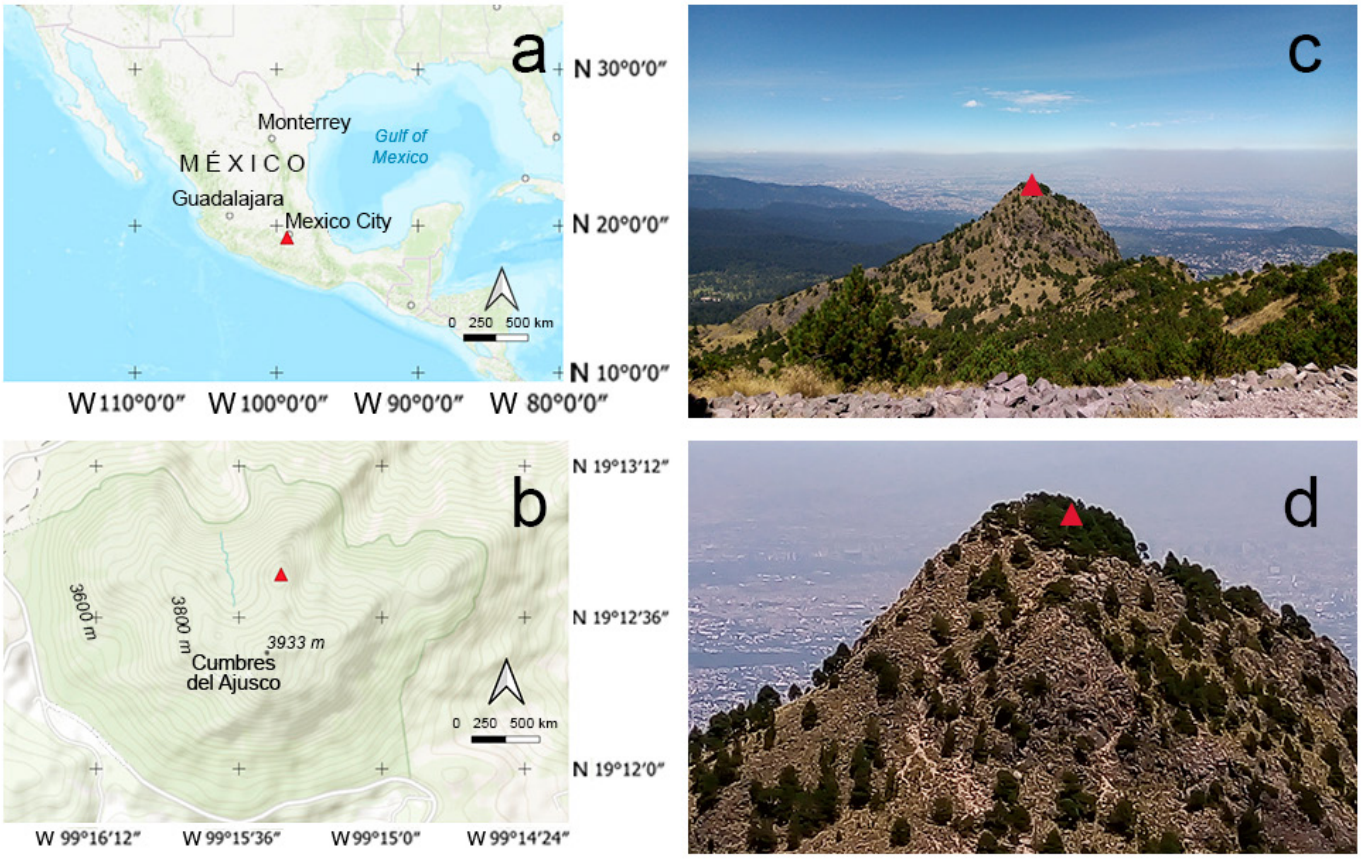

Figure 1. Location where the Mexican cottontail (*Sylvilagus cunicularius*) was observed consuming *Eryngium proteiflorum* a) general location map, b) map of the mountain (the red triangle represents the sampling point), c) general view of the Pico del Águila, south of México City, d) view of the forest where traps were located (the red triangle shows exact location of the trap).

We observed 3 events of *E. proteiflorum* consumption by Mexican cottontails on August 20, 2022, at 19:17 hr; on September 15, 2022, at 17:19 hr, and on April 21, 2023, at 16:40 hr. The pattern of consumption was the same in all observations: the Mexican cottontail bites a leaf in its mid-section and pulls it away, dividing the leaf longitudinally in half, and then proceeds to consume it, starting with the basal portion (Figure 2). In all 3 events, the duration of the interaction was short (1-2 min), and rabbits consumed 1 to 2 leaves per event. Based on the photographs before and after predation *E. proteiflorum* did not seem to be heavily damaged by the consumption (since it´s apparent biomass and coverage experienced little change).

Identification of the rabbit species is tricky since the Mexican cottontail is sympatric with the morphologically similar Eastern cottontail (*S. floridanus*), the main external difference between the 2 is their size; Mexican cottontail is larger (Ceballos and Galindo 1984; Chapman and Ceballos 1990). Our photographs suggest that the species present in this region is *S. cunicularius* because it appears to be larger than individuals of *S. floridanus* found in nearby locations, and the fecal pellets found in the study site are bigger than 1 cm in diameter and have a regular shape, matching the description of the Mexican cottontail (Aranda 2012).

The consumption pattern is explained by the leaf morphology: *E. proteiflorum* leaves are serrated with small spikes pointing forward; therefore, Mexican cottontails eat them from behind to avoid getting hurt. As for the importance of *E. proteiflorum* for the Mexican cottontail, its main food source is likely the grasses (Cervantes *et al.* 1992) that dominate alpine grasslands; however, previous studies have suggested that food variety is important for rabbits. For example, Gidenne *et al.* (1998) conclude that having a single origin of fiber (particularly wheat) is detrimental to the domestics' rabbit (*Oryctolagus cuniculus*) health. Therefore *E. proteiflorum* could be important as a source of nutrients and diet variation for the cottontail. Another advantage that *E. proteiflorum* provides is that, unlike most vegetation at Pico del Águila, this plant does not completely dry up even at the end of the dry season, providing the Mexican cottontail with fresh vegetation when it is scarce.

From *E. proteiflorum* point of view, the Mexican cottontail appears to be the main herbivore that consumes it since we did not register any other mammal consumers or see signs of insect predation, although further studies are needed to confirm this observation. Visually the plant does not appear to be heavily affected by predation (only a small portion of the biomass is taken) and in this case it was able

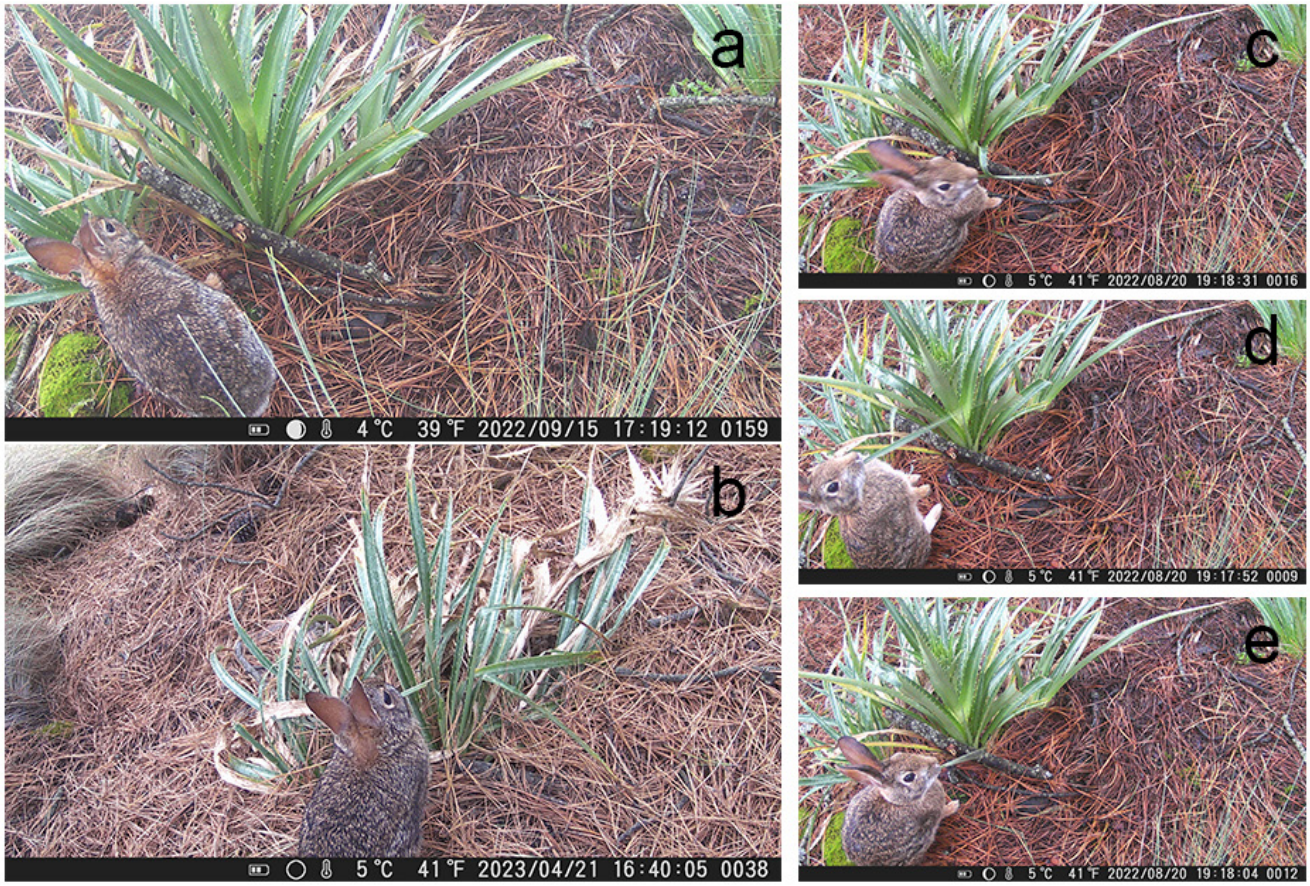

Figure 2. Consumption of *Eryngium proteiflorum* by the Mexican cottontail, *Sylvilagus cunicularius* in El Pico del Águila on the Ajusco Mountain, México City. a) In September 2022, b) in April 2023, notice that the plant lost part of its leaves during the dry season, c) separating the leaf from the plant, d, e) consumption of the leaf. Images available at agloti@ciencias.unam.mx.

to complete reproduction. In Figure 2, the emerging flower could be observed in pictures c, d and e (in the center of the plant), and 8 months later the already dead flower is seen in picture b. This suggests that the damage by herbivory was not enough to prevent this plant reproduction. Although since 3 events of herbivory were performed on the same plant, the cumulative effect could be significant and further studies are needed to better understand the impact of the Mexican cottontail on *E. proteiflorum*.

In conclusion, we observed a previously unknown interaction between *E. proteiflorum* and Mexican cottontail, contributing to the knowledge of this animal diet. At the same time, further studies are needed about the Mexican cottontail diet.

Acknowledgements

We are thankful to I. Castellanos-Vargas for technical support, and to M. Glebskaya, and C. Martinez-Calderon for their help in the field work. This project was financially supported by the CONAHCYT scholarship to Y.G. (CVU 817316) and a PAPIIT grant IN212121 (El efecto de la urbanización sobre el tlacuache *Didelphis virginiana* en un matorral xerófilo de la Ciudad de México) to Z. Cano-Santana. Two anonymous reviewers provided comments that contributed to improving this note.

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Associated editor: Beatríz Bolívar Cimé.
Submitted: November 24, 2023; Reviewed: January 23, 2024.
Accepted: February 6, 2024; Published on line: February 19, 2024.

THERYA NOTES 2024, Vol. 5 : 28-31 DOI: 10.12933/therya_notes-24-145 ISSN 2954-3614

Cotton rat (*Sigmodon toltecus*) as part of the diet of the Neotropical otter (*Lontra longicaudis annectens*)

Rata algodonera (*Sigmodon toltecus*) como parte de la dieta de la nutria neotropical (*Lontra longicaudis annectens*)

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There are few records of rodents in the diet of *Lontra longicaudis annectens* in México; only 2 references report the species. The objective of this note was to analyze the feeding habits of the Neotropical otter in Las Coloradas Lagoon, adjacent to the Palizada River, Campeche, and report the occasional consumption of cotton rats (*Sigmodon toltecus*). A distance of 6.63 km was traveled in a boat with an outboard motor along the west side of the lagoon (2.21 km / 2017–2018 climate season). Spraints and food remains from feeding sites were collected. Subsequently, the percentage of occurrence (PO) of the prey species consumed was determined. Ten zoological groups were identified from 176 spraints and 4 feeding sites: fish had the highest PO (36.74 %), followed by gastropods (26.17 %), prawns (11.58 %), crabs (8.56 %), insects (8.05 %), reptiles (5.37 %), birds (2.85 %), mammals (0.34 %), and bivalves and isopods (0.17 % each). Two skulls and 2 mandibles of *S. toltecus* were recorded in the 2018 dry season. Ten of the 14 species of cotton rats, *Sigmodon*, are recognized in México, of which 1 species (*S. toltecus)* is reported for the state of Campeche. This note reports the first record of rodent predation by *L. l. annectens* in the river-lagoon systems of Campeche. This occasional record expands the trophic spectrum of the Neotropical otter and the distribution of *S. toltecus* in the Laguna de Términos Natural Wildlife Protection Area (APFFLT, in Spanish) and the state of Campeche.

Key words: Cotton rat; eating habits; Laguna de Términos Natural Wildlife Protection Area; Neotropical otter.

En México existen pocos registros de roedores en la dieta de *Lontra longicaudis annectens*, sólo hay 2 referencias con especies. El objetivo de esta nota fue analizar los hábitos alimentarios de la nutria neotropical, en la laguna Las Coloradas, adyacente al río Palizada, Campeche y evidenciar el consumo ocasional de rata algodonera (*Sigmodon toltecus*). Se recorrieron 6.63 km en una embarcación con motor fuera de borda en el borde poniente de esta laguna (2.21 km / temporada climática 2017-2018). Se colectaron heces y comederos, determinando el porcentaje de aparición (PA) de las especies presas consumidas para su identificación. De 176 heces y 4 comederos se identificaron 10 grupos zoológicos: los peces presentaron el mayor PA (36.74 %), seguido por gasterópodos (26.17 %), langostinos (11.58 %), cangrejos (8.56 %), insectos (8.05 %), reptiles (5.37 %), aves (2.85 %), mamíferos (0.34 %), bivalvos e isópodos (0.17 %, respectivamente). En la temporada de secas (2018), se registraron 2 cráneos y 2 dentarios de *S. toltecus*. En México se reconocen 10 de las 14 especies de ratas algodoneras, *Sigmodon*, de las cuales se conoce 1 especie para el estado de Campeche (*S. toltecus*). Este es el primer registro de depredación de roedores por parte de *L. l. annectens* en los sistemas fluvio-lagunares de Campeche. Este registro ocasional, amplía el espectro alimentario de la nutria neotropical y la distribución de *S. toltecus* dentro del Área de Protección de Flora y Fauna Laguna de Términos (APFFLT) y del estado.

Palabras clave: Área de Protección de Flora y Fauna Laguna de Términos; hábitos alimentarios; nutria neotropical; rata algodonera.

The feeding habits of the Neotropical otter, *Lontra longicaudis annectens* (Major, 1897), are generalistic and varied, so it is at the top of the food web of riparian ecosystems (Macías-Sánchez and Aranda 1999). It is an opportunistic predator whose diet includes a wide range of species available in its habitat (Gallo-Reynoso *et al.* 2008), so this species is considered key to the study of these ecosystems (Rheingantz *et al.* 2017). In México, the consumption of some mammals by *L. l. annectens* has been documented; however, these mammal preys were identified at the specific level only in 2 studies, one by Gallo-Reynoso (1997) in the Sierra Madre del Sur, Chiapas, and the other in the Bavispe-Yaqui River, Sonora (Rangel-Aguilar and Gallo-Reynoso 2013).

Although efforts have been made to know the feeding habits of the Neotropical otter in several river-lagoon systems in the state of Campeche, the mammals included in its diet have not been recorded at the species level. In the lagoon La Lagartera (adjacent to the Palizada River),

Mariano-Mendoza *et al.* (2022) recorded mammal hair and bone and muscle fragments. However, these could only be identified at the class level, with a percentage of occurrence of 4.0 %, because the material found did not allow identification at the species level. In La Sangría Lagoon (adjacent to the Palizada River), Vázquez-Maldonado and Delgado-Estrella (2022) identified rodents at the order level, with a percentage of occurrence of 6.84 %. In the present work, we considered it important to identify the mammals found in the diet of the Neotropical otter at the species level and describe some ecological aspects in the Las Coloradas Lagoon, Palizada, Campeche.

Las Coloradas Lagoon, located between 18° 19' 58.86" and 18° 20' 53.07" N and between 91° 20' 24.23" and 91° 54' 15.76" W, is a water body adjacent to the Palizada River, one of the main branches of the Usumacinta River Delta, which is part of the Palizada-Del Este River-Lagoon Deltaic System (Coll de Hurtado 1975; Figure 1 a-d). Las Coloradas Lagoon is located within the Laguna de Términos Natural Wildlife Protection Area (APFFLT, in Spanish), Campeche, México.

The west side of the lagoon is covered predominantly by riparian mangrove mainly composed of black mangrove (*Avicennia germinans)*, with red mangrove (*Rhizophora mangle*) and, to a lesser extent, white mangrove (*Laguncularia racemosa;* Jardel *et al.* 1987); wetland vegetation dominates in the east side, with associations of wetland species locally called *popal* (*Thalia geniculata* and *Calathea lutea*) and reeds (*Cladium jamaicense* and *Typha augustifolia*; Coll de Hurtado 1975).

Fieldwork was carried out during the 3 climatic seasons that characterize the region: the rainy season and "nortes" (winter storm) season in 2017 and the dry season in 2018. In total, 6.63 km were traveled, 2.21 km along the western edge of Las Coloradas Lagoon in each climatic season. Surveys were traveled aboard a boat of 7.6 m in length (IMEMSA) with an outboard engine (60 HP). During these surveys, indirect evidence (latrines, spraints, feeding sites or sites where prey remains are found, burrows, vocalizations, footprints, genital exudates) was recorded that confirmed the presence of *L. l. annectens* in the study area. The spraints and food remains found at feeding sites were collected in self-sealable bags labeled with the date, collection site, sample number, and GPS-referenced geographic coordinates (GARMIN map 78s). In the laboratory, the samples were washed and dried, and the non-digestible components were analyzed following the method of Vázquez-Maldonado and Delgado-Estrella (2022). The percentage of occurrence (PO) of each prey was calculated according to the method of Macías-Sánchez and Aranda (1999), and the species richness and its distribution in the study area were determined. During this analysis, 2 skulls and 2 mandibles of rodents were found, which were identified at the species level using taxonomic keys (Álvarez-Castañeda *et al.* 2015) and by comparison with voucher specimens deposited in the National Collection of Mammals (CNMA) of the *Pabellón Nacional de la Biodiversidad* (National Biodiversity Hall), Institute of Biology, Ciudad Universitaria, Universidad Nacional Autónoma de México (UNAM), México City, México.

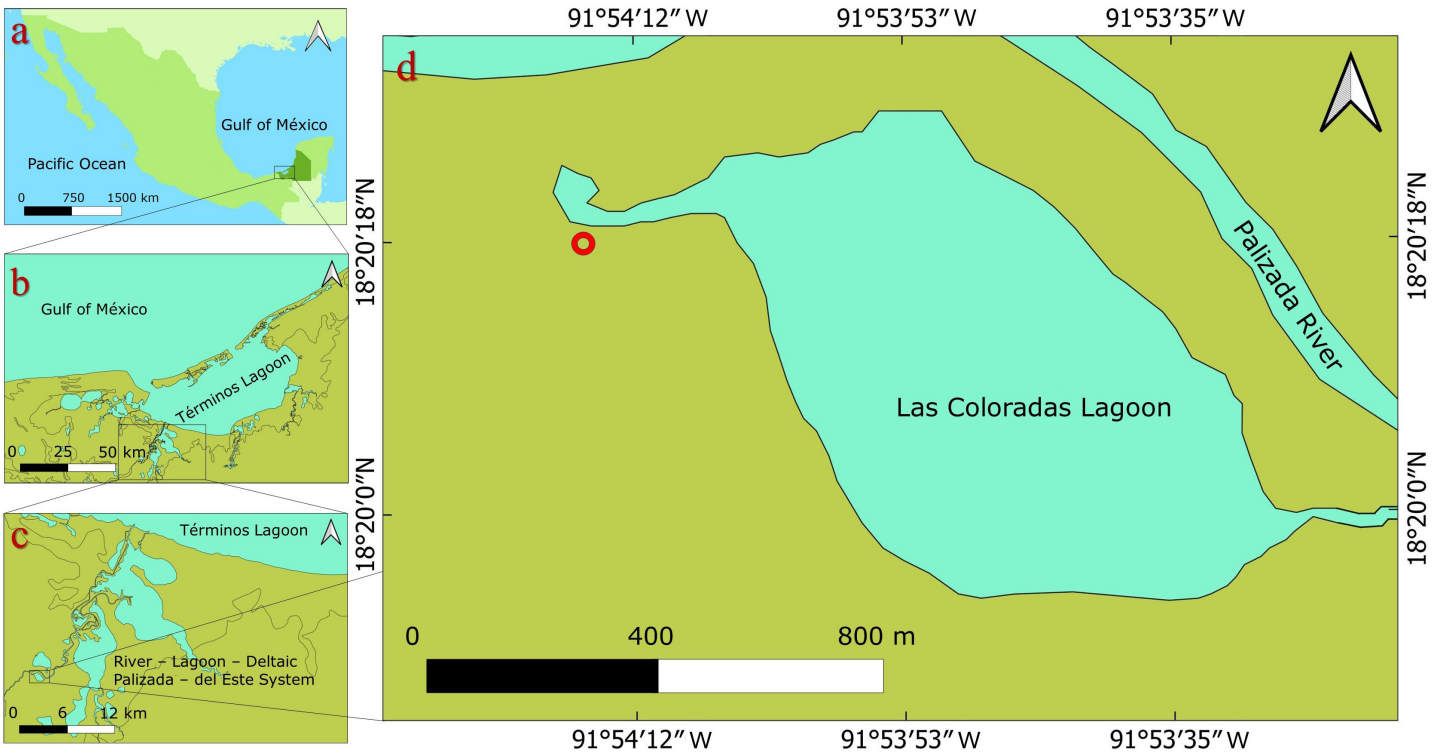

Figure 1. Geographic location of the study area. a) State of Campeche, south of the Gulf of México; b) demarcation of the River-Lagoon-Deltaic Palizada-del Este System; c) Las Coloradas Lagoon, adjacent to the Palizada River. The red circle indicates the geographic location of the spraint of *Lontra longicaudis annectens* collected in the 2018 dry season that contained the bone material of *Sigmodon toltecus*.

A total of 176 spraints and 4 feeding sites were analyzed from 2017 to 2018. Ten main zoological groups were identified; fish had the highest percentage of occurrence (PO; 36.74 %), followed by gastropods (26.17 %), prawns (Decapoda: Palaemonidae, 11.58 %), crabs (Decapoda: Brachyura, 8.56 %), insects (8.05 %), reptiles (5.37 %), birds (2.85 %), mammals (Rodentia, 0.34 %), and bivalves and isopods (0.17 % each).

In the 2018 dry season, we recorded the highest number of identifiable taxonomic groups (9 groups, $Z = 32$). In this season, we found 2 skulls and 2 mandibles of the cotton rat, *Sigmodon toltecus*, contained in a spraint located on the roots of a fallen trunk on the northwest shore of Las Coloradas Lagoon (18° 20' 18.0" N, 91° 54' 12.7" W; Figure 1d). These bone structures were deposited in the National Mammalian Collection (CNMA) with catalog numbers 50313 and 50314 (National Biodiversity Hall, México City, México).

Fourteen species of cotton rats of the genus *Sigmodon* are recognized worldwide (Lessmann *et al.* 2011; Pardiñas *et al.* 2017; MDD 2023); of these, 10 are recorded in México according to Pardiñas *et al.* (2017): *S. alleni, S. arizonae, S. fulviventer, S. hirsutus, S. hispidus, S. leucotis, S. mascotensis, S. ochrognathus, S. toltecus*, and *S. zanjonensis*.

Until recently, *S. toltecus* was assigned as a subspecies (*S. hispidus toltecus*), but molecular studies determined large genetic divergences with other subspecies, so it was raised to the species level (Peppers *et al.* 2002). This species is distributed in eastern México, from the southeast of the state of Tamaulipas southward to the Isthmus of Tehuantepec in Oaxaca; from there, 1 branch to the west of the state of Chiapas and the other to the Yucatán Península, including the state of Campeche (Vargas-Contreras *et al.* 2014, 2016; Pardiñas *et al.* 2017), but it had not been found in the municipality of Palizada (study area), so the present record expands the distribution of the genus *Sigmodon* in the state. The nearest record is in the municipality of El Carmen (Sánchez-Cordero *et al.* 2020), 62.5 km southeast of the study area (calculated in a straight line between the 2 geographic points).

In the Management Program of the Laguna de Términos Natural Wildlife Protection Area (INE 1997), 27 families with 134 species of mammals are mentioned as part of the terrestrial fauna; however, rodents are mentioned without referring to any particular species. Annex 1 of the amendment to this Program (CONANP 2018) lists the mammals that live in APFFLT (page 145), mentioning 9 species of rodents: tepezcuintle or lowland Paca (*Agouti paca* = *Cuniculus paca*), Mexican tree porcupine or Mexican hairy dwarf porcupine (*Coendou mexicanus* = *Sphiggurus mexicanus*), hispid pocket gopher (*Orthogeomys hispidus*), fulvous pygmy rice rat (*Oryzomys fluvescens* = *Oligoryzomys fulvescens*), Hatt's vesper rat (*Otonyctomys hatti*), Yucatán deer mouse (*Peromyscus yucatanicus*), slender harvest mouse (*Reithrodontomys gracilis),* Deppe's squirrel (*Sciurus deppei*), and Yucatán gray squirrel (*Sciurus yucatanensis*), but *Sigmodon* is not mentioned as present in the protected area.

Figure 2. Skulls and mandibles (CNMA Catalog Numbers 50313 and 50314) of the cotton rat, *Sigmodon toltecus*.

Sigmodon toltecus is found in continental environments, with a distribution restricted to tropical coastal zones, and is endemic to Mesoamerica (Pardiñas *et al.* 2017). This species is not listed in any conservation category by México's Secretariat of Environment and Natural Resources (NOM-059-SEMARNAT-2010) nor by the International Union for the Conservation of Nature (IUCN 2022).

There are few records of the presence of mammals in the diet of the Neotropical otter in México; of these, only 2 studies have identified these preys at the species level: Gallo-Reynoso (1997) in the Sierra Madre del Sur, Chiapas, recorded the consumption of field rat (*Neotoma* spp.), squirrel (*Spermophilus mexicanus*), and raccoon (*Procyon lotor*); in the Bavispe-Yaqui River, Sonora, Rangel-Aguilar and Gallo-Reynoso (2013) reported the consumption of field mouse (*Peromyscus eremicus*) and other unidentified rodents.

In the state of Campeche, México, this is the third record of rodent predation by the Neotropical otter in river-lagoon systems but the first record of predation on the cotton rat, *S. toltecus*. This incidental record broadens the trophic spectrum of the Neotropical otter, as it shows the diversity of its prey (Gallo-Reynoso *et al.* 1989; Macías-Sánchez and Aranda 1999). Additionally, it expands the distribution of this prey species; although the prey could have been consumed in a place other than the collection site, it is assumed that the hunting site is nearby (approximately 7 km, according to Gallo-Reynoso *et al.* 2008). Thus, the present work highlights the importance of *L. l. annectens* in the study area, given the variability of its food, documenting the consumption of species not previously recorded in the

area. Therefore, efforts to collect and identify the prey species of the Neotropical otter should continue.

Acknowledgements

The work is part of the activities of 2 scientific research projects registered with the *Dirección General de Investigación y Posgrado* (General Directorate of Research and Postgraduate Studies; DGIyP, in Spanish) of UNACAR, with code numbers FCN/2016/07 and FCN/1ERP2022/02. Fieldwork was carried out under the scientific collection licenses for wildlife teaching purposes, DGVS-SEMARNAT: SGPA/DGVS/05057/17, SGPA/DGVS/09274/17, SGPA/DGCV/007600/18, and SGPA/DGVS/10652/19. We thank P. de la Rosa Barbosa for photographing the skulls and mandibles. Comments from 2 anonymous reviewers contributed to improving this note. M. E. Sánchez-Salazar translated the manuscript into English.

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Associated editor: José F. Moreira Ramírez.

Submitted: December 5, 2023; Reviewed: January 17, 2024.

Accepted: February 19, 2024; Published on line: February 29, 2024.

THERYA NOTES 2024, Vol. 5: 32-38 DOI: 10.12933/therya_notes-24-146 ISSN 2954-3614

Diversity of phyllostomid bats in four caves in the Dominican Republic

Diversidad de murciélagos filostómidos en cuatro cuevas de República Dominicana

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The Dominican Republic is the second country in the Greater Antilles with the widest variety of bats; however, the knowledge we have about these species is precarious, so this research focused on studying the diversity and conservation of the Phyllostomidae family in 4 caves in the country. One sampling was carried out every 3 months between December 2021 and December 2022. Three mist nets measuring 15 m long x 3 m wide were used to capture the bats. Diversity was analyzed through the Margalef, Shannon, Simpson, and Pielou indices. 545 bats of the Phyllostomidae family were captured. According to the Margalef index, the highest richness was recorded in the La Chepa cave (5.81), with 6 of the 7 species with distribution in the country. Los Patos cave presented the highest diversity (H´ = 1.50), and the abundances of the species were more uniform (J´= 0.31). The La Chepa cave presented the highest abundance of bats with 35.2 % of the total captures. The differences in the diversity of bats in the studied caves may be due to the availability of food near the caves and the fragmentation of the surrounding habitat since the good state of the ecosystem is directly related to the presence and abundance of this family.

Key words: Bats; biodiversity; fragmentation; Hispaniola; shelters.

República Dominicana es el segundo país de las Antillas mayores con mayor diversidad de murciélagos; no obstante, el conocimiento que se tiene sobre estas especies es limitado, por lo que esta investigación se centró en estudiar la diversidad de murciélagos de la familia Phyllostomidae en 4 cuevas de República Dominicana. Se realizó 1 muestreo cada 3 meses entre diciembre de 2021 y diciembre de 2022. Se utilizaron 3 redes de niebla de 15 m de largo x 3 m de ancho para capturar a los murciélagos. La diversidad fue analizada a través de los índices de Margalef, Shannon, Simpson, y Pielou. Se capturaron 545 murciélagos de la familia Phyllostomidae. De acuerdo con el índice de Margalef, la riqueza más alta se registró en la cueva La Chepa (5.81) con 6 de las 7 especies con distribución en el país. La cueva Los Patos presentó la diversidad más alta (H´ = 1.50) y las abundancias de las especies fueron más uniformes (J´= 0.31). La cueva La Chepa presentó las abundancias más altas de murciélagos con el 35.2 % del total de las capturas. Las diferencias en la diversidad de murciélagos en las cuevas estudiadas pueden deberse a la disponibilidad de alimento cercanas a las cuevas y a la fragmentación del hábitat circundante, ya que el buen estado del ecosistema se relaciona directamente con la presencia y abundancia de esta familia.

Palabras clave: Biodiversidad; Española; fragmentación; quirópteros; refugios.

Bats are the second most diverse group of mammals with 1,460 species in the world (ASM 2023). The Dominican Republic is the country with the second highest richness of Chiroptera in the Caribbean region, with 18 species distributed in 6 families (Núñez-Novas *et al.* 2019), within which, the Phyllostomidae family stands out, a group of microchiropterans that occupy diverse niches and present highly specialized adaptations in a diversity of trophic strategies (Jiménez 2013), which is why it has been recognized as an indicator group of the conservation status of ecosystems (Torres-Flores *et al.* 2012; Ramos-Rodríguez *et al.* 2018). The family Phyllostomidae is distributed in the Neotropical region from the southwestern United States to northern Argentina (Bracamonte 2018).

In the Dominican Republic, bats represent 90 % of the mammals; however, knowledge about them remains limited. Caves in the Dominican Republic are indispensable refuges for bats, and their study and research are imperative to ensure their conservation and effective management. Several important studies have been conducted, including those of Núñez-Novas and León (2011) who examined 723 collection specimens, with the phyllostomids *Artibeus jamaicensis*, *Macrotus waterhousii* and the molossid *Molossus molossus* being the most abundant. Another notable study of cave bats in the Dominican Republic is that of Núñez-Novas *et al.* (2014), who evaluated the migratory and seasonal patterns of 12 bat species including 6 of

the 7 phyllostomid species recorded in the country: *A. jamaicensis*, *Brachyphylla pumila*, *Erophylla bombifrons*, *M. waterhousii*, *Monophyllus redmani* and *Phyllonycteris poeyi*. Finally, Núñez-Novas *et al.* (2019) developed an identification guide to the bats of Hispaniola, which represented a significant advance in the knowledge of the families and species of bats in the study area.

Despite the important advances in the knowledge of the bats of the Dominican Republic, much remains to be explored and understood. Therefore, this study presents the diversity of bats of the family Phyllostomidae in 4 caves in the Dominican Republic.

Study area. This research was conducted in the Dominican Republic, located in the central Antilles, in the insular Caribbean, which has a territorial extension of 48,000 km^2 divided from southeast to northwest by the Cordillera Central. The highest point is located at Pico Duarte, at 3,089 m. The Dominican Republic is marked by valleys and mountain ranges, its geomorphology and different bioclimates favor a great biodiversity of flora and fauna (MIMARENA 2015). To determine the species diversity of the Phyllostomidae family, we first explored the known refugia in the literature. To do this, a search for reports of occurrence in GBIF and a search for new refugia sites was conducted. The final set of refugia consisted of 4 caves (Figure 1) which are described below:

1. El Pomier Cave: It is located in the paraje of the same name (18° 28' 0.90" N, 70° 8' 9.60" W) in the foothills of the Cordillera Central, in the province of San Cristóbal. It has an area of 4 km^2 and is surrounded by subtropical secondary rainforest and riparian forests (Figure 2). The average annual temperature is 25.9 °C and precipitation is 1,756 mm (MIMARENA 2015). The vascular flora in the area near the cave includes royal palm (*Roystonea regia*), ceiba (*Ceiba pentandra*), saman (*Samanea saman*), mango (*Mangifera indica*), guayuyo (*Piper aduncum*), pringamosa (*Urera baccifera*), almacigo (*Burcesa simaruba*), caoba (*Swetenia mahagoni*), savanna (*Petitia domingensis*), cedar (*Cedrela odorata*), coralillo (*Hamelia patens*), guava (*Psidium guajava*) and tabacon (*Solanum rugosum*).

2. Los Patos Cave: It is located in Barahona province (17° 57' 35.05" N, 71° 10' 59.80" W), measures about 290 m in linear extension, has 3 entrances and 8 chambers with heights of 3 and 15 m. The Los Patos River emerges from the flooded area of the cave. Around the cave, there is an altered low montane rainforest (Figure 2) with fruit plants

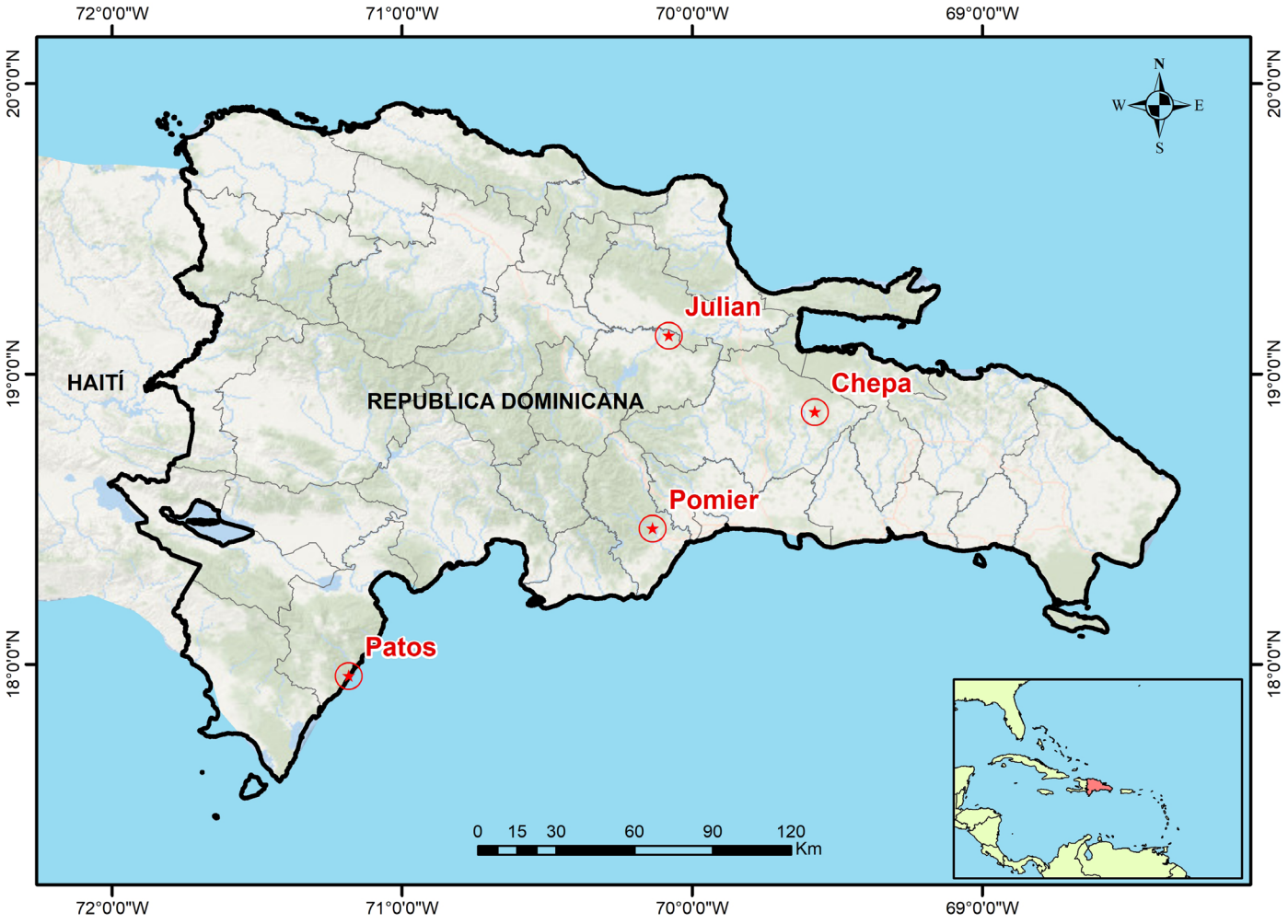

Figure 1. Location map of the 4 caves sampled for phyllostomid bats in the Dominican Republic.

such as guanabana (*Annona muricata*), lemongrass (*Melicoccus bijugatus*) and almond (*Terminalia catappa*).

3. Cueva Honda Julián: Located in the Platanal area (18° 52' 8.80" N, 69° 34' 34.70" W) in Sánchez Ramírez province. The cave is located in the northern part of a karst valley, measures more than 100 m in linear extension, and has 8 chambers and 3 entrances, 2 of which measure approximately 1 m in diameter (Tejedor *et al.* 2005). Around the cave there is a modified subtropical rainforest and pastures used for livestock (Figure 2). Around the cave there is a modified subtropical rainforest and pastures used for cattle grazing. Among the most representative flora species are guacima (*Guazuma tomentosa*), coralillo (*Hamelia patens*) and escobilla (*Sida acuta*).

4. La Chepa Cave: Located in Valle Grande (18° 52' 09" N, 69° 34' 34.70" W) in Bayaguana. The cave is in a karst complex, has a length of 500 m, with areas up to 25 m high. Nearby, several streams from other caves flow into the Comatillo River. In the surrounding area there are riparian forests (Figure 2) dominated by dragon trees (*Pterocarpus officinalis*) and fruit plants.

Data capture and collection methods. The methodology of Bracamonte (2018) was followed for the sampling protocol, which consists of the use of mist nets to capture bats prioritizing their welfare. Each cave was sampled on 4 occasions (every 3 months) between December 2021 and December 2022. In total, 24 hr of sampling were devoted to each cave (1 sampling in each season of the year), adding up to a total sampling effort of 96 hr. In each cave, 3 mist nets 15 m long by 3 m wide were placed at the entrance from 18:00 hr to 24:00 hr. The nets were checked every 15 min and the captured bats were identified with the dichotomous key of

Figure 2. Characteristics of the caves of the Dominican Republic and surrounding vegetation. a) La Chepa Cave; b) vegetation surrounding the La Chepa cave; c) Honda Julián Cave; d) vegetation surrounding the Honda Julián cave; e) vegetation surrounding Los Patos cave; f) vegetation surrounding El Pomier cave.

Núñez-Novas *et al.* (2019). Sex and sexual maturity were determined for each individual. Subsequently, each individual of the family Phyllostomidae was marked on the forearm with a plastic celluloid ring (AVINET, Portland, Maine) with a unique combination code of 2 to 4 digits depending on the species. Finally, the bats were released.

Data analysis. To analyze diversity in the 4 caves, the indices of 1) Margalef (Margalef 1951) were used to assess species richness in relation to the total number of individuals in the sample; 2) Shannon (H') (Shannon and Weaver 1949) for diversity; 3) Simpson (D) (Simpson 1949) for dominance; and 4) Pielou's Equity (J') (Magurran 1988) to assess evenness in the distribution of abundances. To determine the degree of threat of the bat species, a literature review was conducted on their conservation status in the Red List of Threatened Fauna Species of the Dominican Republic (MIMARENA 2018) and the International Union for Conservation of Nature Red List (IUCN 2020).

A total of 545 individuals of 7 species of the Phyllostomidae family were captured: *A. jamaicensis, Brachyphylla nana, E. bombifrons, M. waterhousii, M. redmani, P. falcatus* and *P. poeyi*. The season with the most captures was in the summer, with 175 individuals (32.11 % of the total captures; Appendix 1). The highest expected species richness, according to the Margalef index, was in La Chepa (5.81) while the lowest was in Honda Julián (2.78). The highest abundance occurred in La Chepa cave (n = 196, 35.9 % of the total catches). *Erophylla bombifrons* was the most abundant species in all caves (n = 106, 19.4 % of all individuals captured), followed by *A. jamaicensis* (n = 100, 18.3 %) and *M. redmani* (n = 92, 16.8 %), while *P. falcatus* was the least abundant species (n = 3; Table 1). The Shannon index showed that the highest diversity occurred in Los Patos cave (H' = 1.50), while the lowest occurred in El Pomier (H' = 0.62; Table 2). The highest value of Simpson's index occurred in Los Patos cave (D = 0.74), while the lowest occurred in Honda Julián (D = 0.55; Table 2). Pielou's equity index showed that the cave with the most uniform species abundance was Los Patos (J'= 0.31), while the least uniform was El Pomier (J' = 0.12).

Of the species recorded in this study, 85.7 % are listed as of Least Concern in the IUCN (2020), with the exception of *B. nana*, for which no assessment is available. On the other hand, in the Dominican Republic Red List (MIMARENA 2018), *P. poeyi*, *E. bombifrons* and *B. nana* are classified as Vulnerable (Table 3).

Table 1. Bat species of the Phyllostomidae family and their abundance in 4 caves in the Dominican Republic.

Species	Los Patos	El Pomier	Honda Julián	La Chepa	Total
Artibeus jamaicensis	19	0	0	81	100
Brachyphylla nana	15	4	0	67	86
Erophylla bombifrons	0	50	39	17	106
Macrotus waterhousii	34	11	0	22	67
Monophyllus redmani	24	0	62	6	92
Phyllops falcatus	0	0	0	3	3
Phyllonycteris poeyi	3	79	9	0	91
Total	95	144	110	196	545

Table 2. Values of the diversity and equity indices of bats of the Phyllostomidae family in 4 caves in the Dominican Republic.

Caves	Margalef	Shannon	Simpson	Pielou
Los Patos	4.780	1.504	0.742	0.317
El Pomier	3.799	0.625	0.571	0.126
Honda Julián	2.787	0.896	0.550	0.191
La Chepa	5.810	1.327	0.685	0.252

The 7 species of phyllostomid bats recorded in this study had been previously recorded in the Dominican Republic (Núñez-Novas *et al.* 2016). However, the findings of this research reinforce and expand the available information about the diversity of phyllostomid bats. This contribution not only makes it possible to evaluate possible changes in the populations and distributions of these species but also contributes to understanding the factors that influence the distribution of phyllostomid bats in karst environments.

The difference in bat species richness between caves could be influenced by extrinsic factors such as shelter shape, temperature, humidity, airflow, light intensity, safety from predators, and distribution and abundance of food resources (Kunz and Lumsden 2003; Brigham *et al.* 1997; Kerth 2008). Larger, more complexly structured caves have also been observed to provide a wide variety of microhabitats, which influences shelter choice by bats (Barquez *et al.* 2022). In our study, differences in species richness could be attributed to the availability and distribution of food resources, as well as habitat fragmentation and destruction in the vicinity of caves. These factors have a significant impact on the availability of roosts and optimal environmental conditions for bat life.

On the other hand, it has been mentioned that disturbance and fragmentation of forests and conversion to pasture to feed cattle have a negative effect on the presence of bat species (Núñez-Novas *et al.* 2016). In our study, La Chepa was the cave that presented the highest species richness and abundance, which may be directly related to the location and availability of food, since the surrounding area of the cave is dominated by rainforest where there is a great variety of fruit plants that serve as food for these species. The richness results of this study are similar to those obtained by Núñez-Novas *et al.* (2016), who also found the highest diversity in La Chepa cave.

In contrast, the Honda Julián cave had the lowest species richness and the lowest Shannon diversity for the Phyllostomidae family. In 2021, this cave was certified as a Site of Importance for the Conservation of Bats (SICOM). The low diversity of bats in this cave could be due to the change in land use that the area surrounding the cave has undergone, as the forest has been converted to pasture fields where the availability of fruits, on which phyllostomid spe-

Table 3. Conservation status of bat species of the Phyllostomidae family in 4 caves in the Dominican Republic. N/A: None.

Species	Category according to the IUCN Red List	Category according to the Red List of the Dominican Republic
Artibeus jamaicensis	Least Concern	N/A
Brachyphylla nana	Least Concern	Vulnerable
Erophylla bombifrons	Least Concern	Vulnerable
Macrotus waterhousii	Least Concern	N/A
Monophyllus redmani	Least Concern	N/A
Phyllops falcatus	Least Concern	N/A
Phyllonycteris poeyi	Least Concern	Vulnerable

cies feed, could be lower. These results coincide with those reported by Oporto *et al.* (2015) who mention that the low diversity of fruit bats they found in secondary forests in Tabasco, México could be due to the loss of conserved forests or the lack of forest fragments close to the sampling sites. Previously, it has been mentioned that conserved forest fragments play an important role in biodiversity conservation as they function as a source for colonizing other fragments (Bennett 1998; Numa *et al.* 2005).

The high abundances of *E. bombifrons* and *A. jamaicensis* are not noteworthy, since it is known that they are species that frequently take refuge in caves and tend to form groups of several dozen individuals (Silva-Taboada 1979). In the case of *P. falcatus,* only 3 individuals were captured in La Chepa cave during the spring, and it was absent in the rest of the caves. The low abundance may be due to the fact that during the day this species seeks refuge in the dense foliage of broad-leaved trees, where they gather in compact clusters in the shadiest areas (Silva-Taboada 1979).

Current knowledge about bats in the Dominican Republic shows great gaps in information, especially about their ecology, habitat, distribution patterns and the conservation status of their populations, so it is necessary to understand and know the requirements of these organisms in relation to their habitat, which is key to guaranteeing their conservation. It has already been shown that the decline of bat populations results in serious consequences on the interaction networks they form, so conservation measures must be a priority, not only because they are essential for the reproductive success of many plants that contribute to our food and economy, but also because of their key role in ecosystems.

Acknowledgements

We thank Professor B. F. Reinoso for his support and help in each of the samplings carried out. J. Leandro for his valuable collaboration and support. To the PUCMM for its unconditional support for the development of this research and to all the people who in one way or another contributed to the culmination of this research work. And to the anonymous reviewers who improved the note with their comments.

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Associated editor: Itandehui Hernández Aguilar.
Submitted: May 21, 2023; Reviewed: February 6, 2024.
Accepted: February 27, 2024; Published on line: March 8, 2024.

Appendix 1

Number of individuals captured in 4 caves in the Dominican Republic. Sp: spring; Su: summer, F: fall; W: winter.

Phyllostomidae Family	**Los Patos**				**El Pomier**				**Honda Julián**				**La Chepa**			
	Sp	Su	F	W	Sp	Su	F	W	Sp	Su	F	W	Sp	Su	F	W
Artibeus jamaicensis	2	9	7	1	0	0	0	0	0	0	0	0	15	28	23	13
Brachyphylla nana	11	4	0	0	0	3	1	0	0	0	0	0	11	31	19	5
Erophylla bombifrons	0	0	0	0	12	21	11	6	16	7	10	6	0	5	12	0
Macrotus waterhousii	11	9	7	7	0	3	5	3	0	0	0	0	6	2	11	3
Monophyllus redmani	5	10	2	6	0	0	0	0	14	19	20	9	0	0	4	2
Phyllops falcatus	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0
Phyllonycteris poeyi	0	3	3	0	17	21	23	18	6	0	0	3	0	0	0	0
Total	29	35	19	14	29	48	40	27	36	26	30	18	36	66	69	23

THERYA NOTES 2024, Vol. 5 : 39-43 DOI: 10.12933/therya_notes-24-147 ISSN 2954-3614

Notable gray fox (*Urocyon cinereoargenteus*) record in southern México City

Registro notable de zorra gris (*Urocyon cinereoargenteus*) en el sur de la Ciudad de México

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The study of wildlife in cities and their urbanized areas of influence is essential for long-term conservation. The presence of wild mammals in natural vegetation patches and urban parks of México City (CDMX) was evaluated to determine the current state of wild mammals in the area. Twenty camera-trap stations were placed to record wild mammals inhabiting green areas in southern México City as part of the project "Mammal Diversity in Modified Landscapes of southern México City: Importance of Green Areas and Connectivity in Urban Contexts". Gray foxes were only recorded in Bosque de Tlalpan. A total of 38 photographic records of the gray fox (*Urocyon cinereoargenteus*) were captured at 2 sites in Bosque de Tlalpan. These records were obtained from August 5, 2021 to March 29, 2022. The period of activity of this species was mainly nocturnal, with records from 22:00 hr to 01:00 hr. The new records of gray foxes in southern México City are relevant because they show that, despite the high degree of fragmentation of the green areas within the city, there are still medium-sized wild carnivorous mammals inhabiting these patches. These records are crucial for understanding the degree of connectivity between green areas in the south of the city.

Key words: Bosque de Tlalpan; camera-trap sampling; conservation; mesocarnivore; wildlife.

El estudio de la vida silvestre que permanece dentro de las ciudades y en sus zonas de influencia con urbanización es fundamental para su conservación a largo plazo. Se evaluó la presencia de mamíferos dentro de los parches de vegetación natural y parques urbanos de la Ciudad de México (CDMX) con la finalidad de conocer el estado actual de los mamíferos presentes en la zona. Se colocaron 20 estaciones de fototrampeo para el registro de los mamíferos presentes en áreas verdes del sur de la CDMX como parte del proyecto "Diversidad de mamíferos en paisajes modificados del sur de la Ciudad de México: importancia de las áreas verdes y la conectividad en contextos urbanos". Sin embargo, los registros de la zorra gris solo se hicieron en el Bosque de Tlalpan. Se obtuvieron 38 registros fotográficos de la zorra gris (*Urocyon cinereoargenteus*) en 2 sitios ubicados en el bosque de Tlalpan. Los registros se obtuvieron en un periodo que abarcó del 5 de agosto de 2021 al 29 de marzo de 2022. El horario de actividad para la especie fue principalmente nocturno con registros que abarcan de las 22:00 hr a la 01:00 hr. Los nuevos registros de la zorra gris para el sur de la CDMX son importantes ya que demuestran que, a pesar de los altos grados de fragmentación en la ciudad, aún se mantienen mamíferos carnívoros de tamaño medio. Estos registros son trascendentales para entender el grado de conectividad que puede existir entre las áreas verdes del sur de la ciudad.

Palabras clave: Bosque de Tlalpan; conservación; fototrampeo; mesocarnívoro; vida silvestre.

Urbanization, especially when there is poor planning, is one of the major causes of habitat deterioration and fragmentation, as it tends to eliminate natural vegetation and homogenize the environment (McKinney 2008). One of the most vulnerable wildlife groups to habitat transformation due to urbanization are carnivores, given their low population densities and extensive areas of activity (Riley *et al.* 2003), which may be jeopardized by urban expansion. However, depending on the body size of the species and the flexibility of their diets, they may be tolerant and adapt to fragmentation and the continued presence of human activities (Crooks 2002). For example, some species of mesocarnivores such as the coyote (*Canis latrans*), cacomixtle (*Bassariscus astutus*), and gray fox (*U. cinereoargenteus*) are generalists and display a certain tolerance to habitat fragmentation, so they may be favored by the absence of top predators or competitors (Leopold 1990; Hidalgo-Mihart *et al.* 2006).

The gray fox is a medium-sized canid with a widespread distribution from southern Canadá to Colombia and Venezuela (Fritzell and Haroldson 1982). In México, it can be found in virtually all environments, ranging from temperate forests, tropical forests, and arid zones to agricultural and peri-urban areas (Servín and Chacón 2005). The species is a generalist with a broad diet that includes

birds, small mammals, reptiles, invertebrates, and even different types of plants and fruits (Ceballos and Oliva 2005; Villalobos-Escalante *et al.* 2014). This species can adapt to various environments, depending on vegetation cover and food availability (Leopold 1990; Servín and Chacón 2005). In urban and periurban areas such as México City, where there are records of the gray fox in the south and north of the city (Hortelano-Moncada *et al.* 2009; Coronel-Arellano *et al.* 2021), the presence of the gray fox can be affected by habitat modifications that impact their populations and even favor exotic competitors such as feral dogs and cats (Mella-Méndez *et al.* 2019; Coronel-Arellano *et al.* 2021), which can also transmit zoonotic diseases (Harrison 1993; Hernández-Camacho *et al.* 2011).

Due to the flexible diet and habitat plasticity of the gray fox, this species is not listed in any risk or protection category in México (SEMARNAT 2019) and is classified as Least Concern (LC) at the international level (Roemer *et al.* 2016). However, it is important to know the distribution and current status of gray fox populations that inhabit urban areas to contribute to their conservation in these environments. For this reason, this study aimed to determine the presence of the gray fox in the urban area of southern México City.

As part of the project entitled "Mammal Diversity in Modified Landscapes in the south of México City: Importance of Green Areas and Connectivity in Urban Contexts", 20 simple camera-trap stations (1 camera trap per station) were established in different green and natural areas in the south of México City (México City Ecological Park, Fuentes Brotantes, Cerro Zacáteptl, Bosque de Tlalpan, Jardines de la Montaña, Los Encinos, and Fuentes del Pedregal). The sampling was carried out from May 2021 to April 2022. Camera traps were set to operate 24 hr for 8 months (115,200 trap-hr), capturing 1 to 3 photographs for each event (photographic records), with a 5-min interval between events. The camera traps were placed at the base of trees, near footpaths or wildlife crossings. Additionally, records of gray foxes were surveyed on the Naturalista platform (Naturalista 2022).

No records of gray foxes were captured from the sites where camera traps were placed, except for Bosque de Tlalpan (BT), a 252.86 ha vegetation patch growing on land of volcanic origin, mainly lava terrains called screes at sites such as Los Encinos and Pedregal de San Ángel Reserve (REPSA; Figure 1). Its natural vegetation is dominated by xeric scrub-grassland associations and temperate oak forest

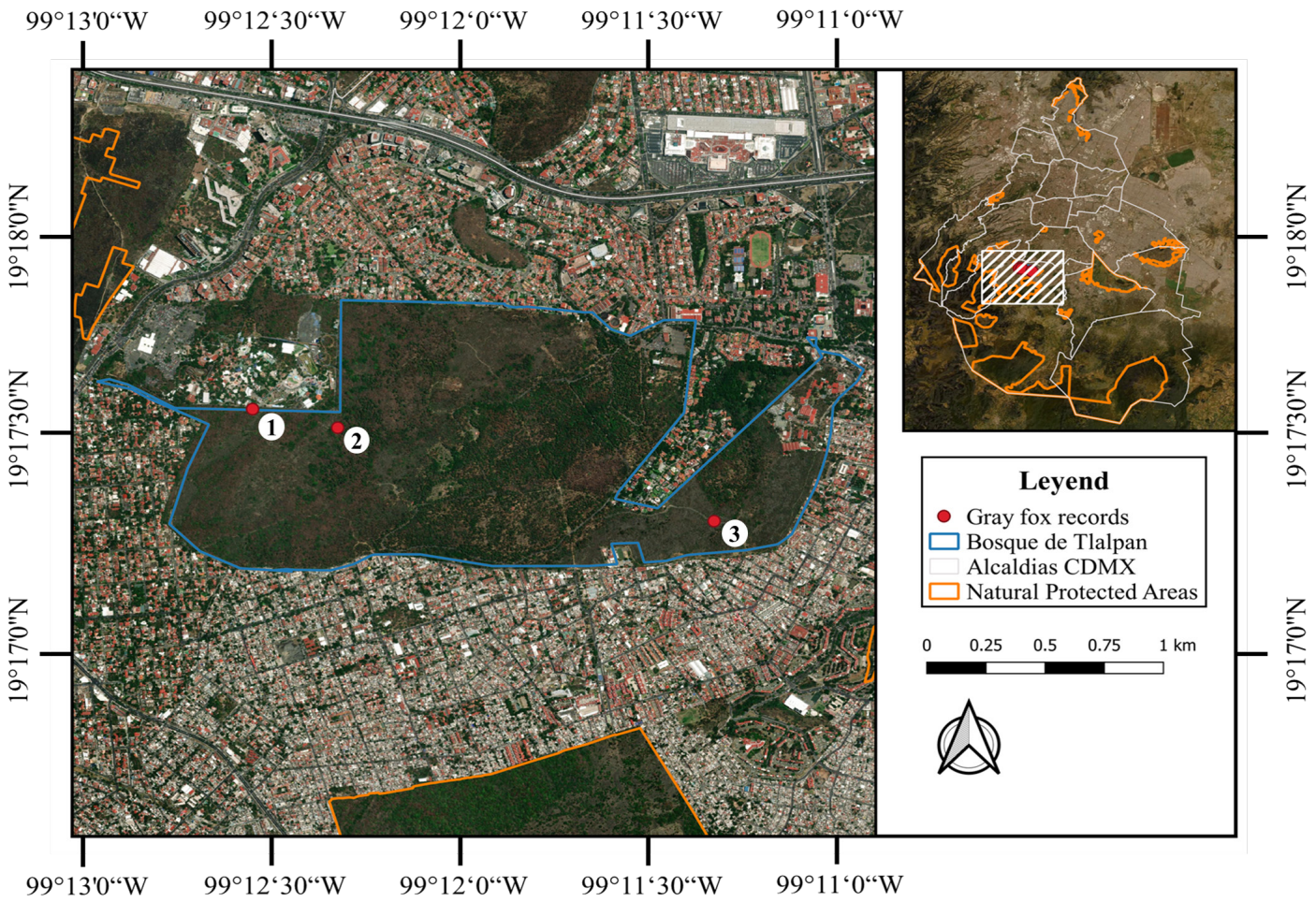

Figure 1. Area of Bosque de Tlalpan in southern México City where gray fox (*Urocyon cinereoargenteus)* was recorded (red dots) in 2021 and 2022. Numbers 1 and 2 mark the location of camera traps and number 3 shows the location of fox excreta on a footpath.

(Rzedowski 1954; Castillo-Argüero *et al.* 2004; Cervantes-Ayuso 2021; CONABIO 2021). Despite conserving remnants of native vegetation, the BT is immersed in the urban area of the Tlalpan municipality, so it plays a major role in mammal conservation due to its biodiversity and ecological connectivity. However, this area is under constant threat due to urban growth, the introduction of invasive species, and the isolation from other natural areas within the México City urban area.

Gray fox records were only obtained in one of the green areas sampled in the urban south of México City, BT, where 38 photographic records of the species were captured at 2 monitoring stations from August 5, 2021 to March 29, 2022 (Figure 1). The few captured images are insufficient to establish an accurate period of activity of the gray fox in the area but suggest that the species may prefer nighttime hours (20:00 hr–4:00 hr), with the peak of activity from 22:00 hr to 1:00 hr. The site where the first records were captured ($n = 34$) is located at 2,450 m (Figure 2a) on a footpath with scrub vegetation located next to the stone fence that demarcates the BT adjacent to an amusement park (19° 17' 34.55" N, 99° 12' 28.96" W). The second site where records were captured ($n = 4$) is located at 2,448 m (Figure 2b) and is covered by dense forest vegetation dominated by pines (*Pinus* sp.) and cypress (*Cupressus* sp.), located 326 m from the first site (19° 17' 31.47" N, 99° 12' 18.18" W). The records captured at both sites may correspond to the same individual due to the spatial and temporal proximity between them. In addition, we found 2 gray fox excreta in the eastern area of the BT (19° 17' 19.32" N, 99° 11' 31.02" W; 19° 17' 19.49" N, 99° 11' 31.02" W); both excreta were found on a path little traveled by humans (Figure 1) and identified using the Manual for Tracing México's Wild Mammals by Aranda (2012).

The new records of gray foxes captured in the BT are important, as they document that despite the high degree of fragmentation of protected natural areas in the study zone, these are still home to medium-sized wild mammals. These records, together with those obtained in 2018 and reported by staff of the CDMX Secretariat of the Environment through the Naturalista website (Naturalista 2022), suggest that the gray fox has remained in the study area for 4 years; however, these records, have been produced by citizen science activities and have not been published, of its presence in the Bosque de Tlalpan area. The records on the Naturalista website are close to those of the present study and are insufficient to determine whether there is an established gray fox population in the BT. It is interesting that in this case, the gray fox lives in 2 protected natural areas with different intensities of human activities: on the one hand, the Pedregal de San Ángel Reserve (REPSA) of UNAM, an area with activity of people and vehicles, where there have been records of gray fox during the day in sites with relatively less human inflow (Coronel-Arellano *et al.* 2021); on the other hand, the BT, where the gray fox has been observed at night in sites with a high inflow of visitors on foot (Padilla *et al.* 2014; Palacio-Prieto and Guilbaud 2015). These results suggest that human activity levels may be causing changes in the activity patterns of the species, which appears to be more active at night in sites with higher human presence.

Figure 2. Photographic records of gray fox (*Urocyon cinereoargenteus*) in Bosque de Tlalpan in southern México City. a) 19° 17' 34.55" N, 99° 12' 28.96" W; b) 19° 17' 31.47" N, 99° 12' 18.18" W. The images belong to the database of spatio-temporal diversity records maintained by the Laboratorio de Biodiversidad y Cambio Global of the FES-Iztacala, UNAM, catalog numbers: LABIOCG-Mammals-0347, LABIOCG-Mammals-0348, LABIOCG-Mammals -0349, LABIOCG-Mammals-0351, LABIOCG-Mammals-0353, LABIOCG-Mammals-0379.

The presence of the species in the study area is important, as there could be connectivity between the BT and REPSA, where the species has been previously recorded (García 2007; Hortelano-Moncada *et al.* 2009; Coronel-Arellano *et al.* 2021). The BT could serve as a corridor between REPSA and other natural areas in the south, such as the CDMX Ecological Park. The BT would promote functional connectivity, essential for maintaining wildlife populations in urban areas in the mid and long term (McKinney 2008; Benito *et al.* 2019), not only for the gray fox but also for other wild mammals in the area. This highlights the relevance of maintaining and conserving the green areas of southern México City to support the persistence of the gray fox and other wild mammal species in México City and represents an excellent site for carrying out studies about the ecology of these carnivores in urban environments.

In addition to the gray fox, other species that may be potential prey for this carnivore species were also found, such as ground squirrels, birds, rodents, rabbits, and various species of fruit-bearing trees and shrubs (Villalobos-Escalante *et al.* 2014). Food availability is essential for the gray fox as it is one of the key factors for its presence in a landscape (Vázquez and Gastón 2006). Additionally, garbage can also be a source of food for foxes (Coronel-Arellano *et al.* 2021), and the BT has both food types that appear to be supporting a small population of gray foxes. Furthermore, the dense tree and shrub vegetation of the BT and areas of volcanic soil with rugged terrain, where access to people is restricted, represent suitable refuge sites for the fox and its prey, which are necessary conditions to maintain the species (Fritzell and Haroldson 1982; Servín and Chacón 2005). These conditions have allowed the gray fox to remain in an area immersed within a densely populated urban center but could change in the future due to land-use change scenarios and the lack of sensitivity towards conserving vegetation areas and their associated fauna.

Acknowledgements

The authors wish to thank the Consejo Nacional de Humanidades, Ciencias y Tecnologías (CONAHCYT project CF-2023-I-1078) for the financial support received to carry out these investigations, as well as to the "Estancias Posdoctorales por México, Modalidades 3 y 4" CONAHCYT program for the academic scholarship awarded to P. C. Hernández Romero for his stay at the Facultad de Estudios Superiores Iztacala. Thanks also to the municipio de Tlalpan and the Secretaría del Medio Ambiente de la Ciudad de México for the permits granted, and to the Jardines de la Montaña inhabitants for their support in the placement of camera traps. IdeaWild supported the study with donated equipment. Anonymous reviewers provided comments that helped improve this note. M. E. Sánchez-Salazar translated the manuscript into English.

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Associated editor: José F. Moreira Ramírez.
Submitted: January 12, 2023; Reviewed: February 13, 2024.
Accepted: March 5, 2024; Published on line: March 15, 2024.

THERYA NOTES 2024, Vol. 5 : 44-50 DOI: 10.12933/therya_notes-24-148 ISSN 2954-3614

Hematological profile of wild vicuñas (*Vicugna vicugna*) from the Apolobamba National Natural Integrated Management Area, Bolivia

Perfil hematológico en vicuñas silvestres (*Vicugna vicugna*) en el Área Natural de Manejo Integrado Nacional Apolobamba, Bolivia

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This study established the hematological profile of vicuñas (*Vicugna vicugna*) in the wild. This species represents a sustainable natural resource for local communities, and considering management practices and animal welfare is fundamental for one of the most successful species conservation experiences in the country and the region. Blood samples were taken from 78 vicuñas in 14 communities during capture and shearing efforts in the 2021 season in the Apolobamba National Natural Integrated Management Area (ANMIN), located in the Franz Tamayo and Bautista Saavedra provinces of the department of La Paz, Bolivia. The results obtained from the hematological profile were: total erythrocyte count 15.2 X 10^{12} L, hematocrit 42 L/L, total solids 5.6 g/dl, hemoglobin 11.8 g/L, mean corpuscular volume 28.1 fL, mean corpuscular hemoglobin 9.2 pg, mean corpuscular hemoglobin concentration 33 g/L, total leukocyte count 10.3 x 10^{9} L, neutrophils 62 %, fallen neutrophils 5 %, basophils 0 %, eosinophils 0.09 %, lymphocytes 31 %, monocytes 2 % and platelet count 65 x 10^{3} L. The parameters obtained are within the values recorded for the species. Certain changes in a few communities were observed, such as elevated hematocrit, leukocytosis and the ratio of neutrophils and lymphocytes associated with physiological changes due to the stress of the vicuñas, which might be related to the inadequate implementation of animal welfare practices.

Key words: Harvest; hematology; La Paz; management; vicuñas.

En el presente estudio se estableció el perfil hematológico de vicuñas (*Vicugna vicugna*) silvestres. Esta especie representa para las comunidades locales un recurso natural sostenible y considerar las prácticas de manejo y bienestar animal es fundamental para una de las experiencias de conservación de una especie con mayor éxito a nivel país y la región. Se tomaron muestras sanguíneas de 78 vicuñas en 14 comunidades aprovechando el arreo, captura y esquila de la temporada 2021, en el Área Natural de Manejo Integrado Nacional (ANMIN) Apolobamba, ubicada en las provincias Franz Tamayo y Bautista Saavedra del departamento de La Paz, Bolivia. Los resultados obtenidos del perfil hematológico fueron: recuento total de eritrocitos 15.2 x 10^{12} L, hematocrito 42 L/L, sólidos totales 5.6 g/dl, hemoglobina 11.8 g/L, volumen corpuscular media 28.1 fL, hemoglobina corpuscular media 9.2 pg, concentración de hemoglobina corpuscular media 33 g/L, recuento total de leucocitos 10.3 x 10^{9}/L, neutrófilos 62 %, neutrófilos cayados 5 %, basófilos 0 %, eosinófilos 0.09 %, linfocitos 31 %, monocitos 2 % y recuento plaquetario 65 x 10^{3} L. Los parámetros obtenidos se encuentran dentro de los valores conocidos para la especie, aunque se observan ciertas alteraciones en pocas comunidades, como la elevación del hematocrito, la leucocitosis y la relación de neutrófilos y linfocitos asociados a cambios fisiológicos por la deshidratación y el esfuerzo muscular y el estrés de las vicuñas, los cuales estarían relacionados con una inadecuada implementación de las prácticas de bienestar animal.

Palabras clave: Aprovechamiento; cosecha; hematología; La Paz; vicuñas.

The vicuña (*Vicugna vicugna*), along with the guanaco (*Lama guanicoe*), alpaca (*Vicugna pacos*) and llama (*Lama glama*), play a key role as the herbivorous camelids with the highest biomass "in the Andean region of South America" (Quispe 2011), and have a cultural value in the cosmovision of Andean peoples (Rojo *et al.* 2012). The vicuña inhabits the Andean steppes of Ecuador, Perú, Bolivia, Chile, and Argentina, between 3,800 and 5,000 m, and produces one of the finest and most sought-after fibers in the world (Vilá *et al.* 2010; Concha *et al.* 2013). In Bolivia, the conservation

and use of the vicuña is a valuable resource for the communities where this species is present, which, through protection and monitoring efforts together with the government sector, have managed to increase their populations (MMAyA *et al.* 2021).

According to the International Union for Conservation of Nature (IUCN), globally the vicuña is currently categorized as Least Concern (Acebes *et al.* 2018), and in Bolivia it has a similar categorization (Tarifa and Aguirre 2009). One of the places with the highest number of vicuñas in Bolivia is the Apolobamba National Natural Integrated Management Area (ANMIN) in the department of La Paz with a population of 15,278 vicuñas (SERNAP 2023), where the main threats to the species are mining and forage competition between wild animals and domestic livestock, which impacts overgrazing for prairies and high altitude peatlands or *bofedales* (Alberto 2020; Alberto and Barrera 2022).

Studies conducted on vicuñas in Apolobamba have focused on monitoring pathogens and exposure to diseases such as bovine viral diarrhea, bluetongue, pseudotuberculosis, vesicular stomatitis, leptospirosis, foot-and-mouth disease and brucellosis, in all cases with negative results (Nallar *et al.* 2005). In another study, hematological parameters were recorded, as well as sero-exposure to brucellosis and foot-and-mouth disease with negative results (Beltrán-Saavedra *et al.* 2011). Evaluations of vicuña ectoparasites and endoparasites were also conducted (Beltrán-Saavedra *et al.* 2011; Ruiz 2016) in Apolobamba.

Currently, vicuña protection, management and use are carried out by the communities, framed within a set of organizational, technical and operational activities according to the Technical Guidelines for the Management and Conservation of the Vicuña (MDRyT-MMAyA 2013) established at the national level. Vicuñas are captured, sheared, and released to obtain the fiber following established protocols, which have improved fiber production yields, generated knowledge on the status of the population, and developed sustainable use with good animal welfare practices according to the IUCN South American Camelid Specialist Group (GECS 2012) and the World Organization for Animal Health (OMSA 2018).

The handling, capture and transport of ungulates, carnivores and birds can cause stress to the animals (Grigor *et al.* 1998). In the case of the vicuña, its exploitation (herding, capture, shearing) affects animal welfare criteria regarding nutrition, environment, health, behavior and mental state (Zapata 2023). These alterations can be measured by changes in hematological and biochemical parameters in the blood (Grigor *et al.* 1998; Bonacic and Macdonald 2003). Studies on the effects of vicuña herding methods, herding distance, and restraint, showed that vicuñas increase cortisol concentration when herded with vehicles, and increase blood creatine kinase when under restraint (Bonacic *et al.* 2006).

Sustainable management of vicuñas includes a series of components (MDRyT-MMAyA 2013), and during the harvesting season they are herded, captured, and handled to harvest fiber under established protocols, but in some communities these protocols are not fully complied with. In this study, we compare the management carried out by the communities and report the hematological parameters of wild vicuñas managed in Apolobamba and evaluate the physiological changes with respect to animal welfare practices.

The Apolobamba ANMIN is located to the west of the department of La Paz and includes the municipalities of Curva, Charazani, Pelechuco and Mapiri, with an altitudinal range of 800 to 6,200 m, including a low or humid *yungas* zone, an intermediate zone of inter-Andean valleys and a high Andes zone including extensive prairies known as the *altiplano*. Apolobamba covers 483,743.8 ha, bordered to the west by Perú, to the north by Madidi National Park and Natural Integrated Management Area (PNANMI), to the east by the municipality of Apolo and to the south by the Moco Moco, Ayata and Tacacoma municipalities (MMAyA-SERNAP 2016). The present study was conducted in 14 communities that make up the regional association of vicuña handlers of Apolobamba (Figure 1), who harvest vicuña independently and have implemented the protocol for good animal welfare practices and sanitary measures in the sustainable use of vicuña fiber (MMAyA *et al.* 2021).

Taking advantage of the vicuña shearing season between September and December following Bolivia's national vicuña management plan (MDRyT-MMAyA 2013), when local communities schedule herding, capture and shearing days approved by the national authority, the General Directorate of Biodiversity and Protected Areas (DGBAP) and coordinated with the Regional Association of Vicuña Management Communities, we collected biological samples from wild vicuñas (blood).

Once vicuñas were captured in the corral, data was taken on each vicuña selected for shearing, including biometric measurements, as well as an external examination, and a hood placed on the head to obstruct its visibility. Subsequently, they were transferred one by one to the shearing area, where they were held in a latero-ventral position for sampling. Sampling was random and occurred between 10:00 and 12:00 hr.

Between September and November 2021, blood samples (5 ml) were collected in tubes with ethylenediaminetetraacetic acid (EDTA) from 78 vicuñas (49 females and 29 males) by puncture of the jugular vein, under permits issued by the national authority (N°717/09 MMAyA-VMABCC-DGBAP). The samples were stored in preservers and kept at a temperature of 0 to 4 °C with ice packs until they were sent to the laboratory. Whole blood was processed by manual hemogram (Reagan *et al.* 1999; Alvarez 2021) and parameters such as total erythrocyte and leukocyte count, hematocrit, total solids, platelet count, differential neutrophil count, increased neutrophils, basophils, eosinophils, lymphocytes and monocytes were established in the labo-

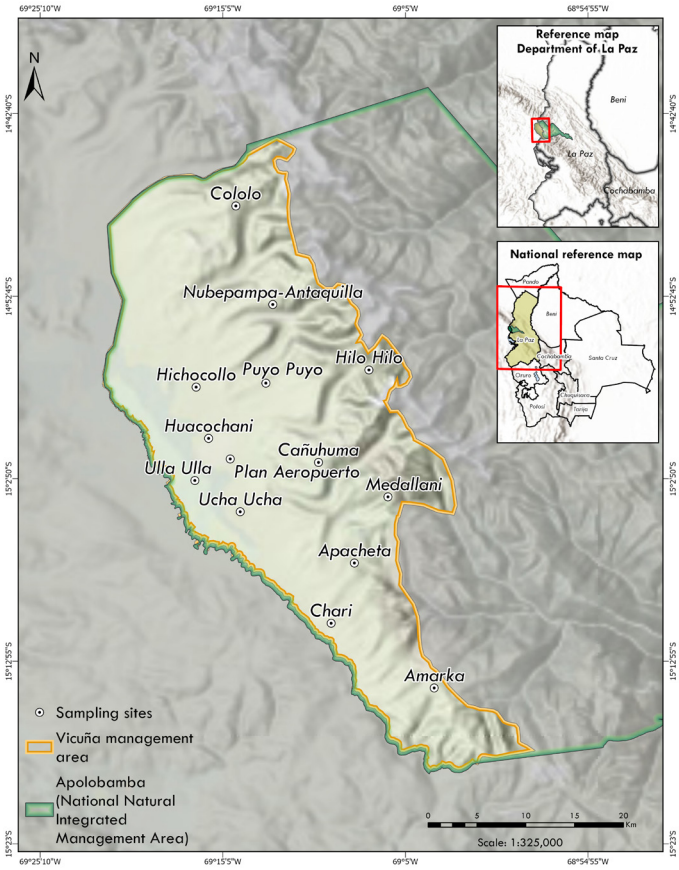

Figure 1. Map of communities and vicuña (*Vicugna vicugna*) sampling sites in the Apolobamba National Natural Integrated Management Area, La Paz, Bolivia.

ratory of Wildlife Conservation Society (WCS) and Specialized Laboratories (LabGenetics) in La Paz, Bolivia.

The significance of differences in the parameters evaluated was analyzed using a one-way ANOVA, with community as a fixed factor. All graphs and statistical analyses were performed in the R programming environment (R Development Core Team 2022).

The hematological parameters of wild vicuñas from Apolobamba are presented in Table 1 including values from previous studies. Changes were observed in hematocrit levels, as well as in the differential neutrophil and lymphocyte counts and total leukocyte count. There were significant differences in the percentage of hematocrit across communities ($F_{13,63} = 3.094$, $P = 0.0013$), with vicuñas from the Chari and Cololo communities having a higher hematocrit percentage than the Puyo Puyo and Puyo Puyo Japu communities (Puyo Puyo-Chari $P = 0.048$, Puyo Puyo Japu-Cololo $P = 0.0042$, Puyo Puyo-Cololo $P = 0.010$; Figure 2a). The result suggests that the vicuñas of the Chari and Cololo communities were more dehydrated due to increased muscle activity, possibly related to the activity of herding and capture.

According to the differential white cell count, the neutrophil/lymphocyte ratio showed a significant difference ($F_{13,63} = 5.365$, $P < 0.0001$). This parameter shows that the vicuñas of the Cañuhuma, Hilo Hilo and Cololo communities were the most stressed by having higher values (neutrophilia and lymphocytosis).

The Hilo Hilo community had significantly higher values than Amarka ($P = 0.0071$), Apacheta ($P < 0.0001$), Chari ($P < 0.0001$), Hichocollo ($P = 0.0001$), Huacochani ($P = 0.0006$), Plan Aeropuerto ($P = 0.0068$), Puyo Puyo ($P = 0.0008$) and Ulla Ulla ($P = 0.0011$). Similarly, Cololo has higher values than Apacheta ($P = 0.0197$) and Chari ($P = 0.00962$). Finally, Cañuhuma was significantly higher than Chari ($P = 0.0356$; Figure 2b).

Total leukocyte count, which is also a stress-related parameter, showed a significant difference between communities ($F_{13,63} = 3.067$, $P = 0.0015$). Vicuñas from the Huacochani community showed significantly higher leukocyte counts than Puyo Puyo Japu ($P = 0.002$) and Hichocollo ($P = 0.0345$; Figure 2c).

The average hematological values for most parameters in this study are similar to those previously recorded for vicuñas in Perú (Table 1: Copaira 1949; Fowler 1998; Quispe 2011; Titi-Pacosoncco *et al.* 2017; Esteban 2019). However, for hematocrits and the neutrophil-lymphocyte ratio, higher values of the recorded range may indicate certain physiological consequences (Bonacic and Macdonald 2003).

A previous study in Apolobamba on hematology in vicuñas recorded similar values to the present study (Beltrán-Saavedra *et al.* 2011). However, the values for total erythrocyte and leukocyte counts were lower than those recorded in this study possibly due to the Unopette cell counting method for mammals and the marked morphological difference in camelid blood cells. This technique may have marginalized a significant proportion of red and white blood cells, so these values are not reliable for comparison.

Other studies also determined differing hematocrit values, such as Copaira (1949) from 31 to 43 L/L, and Fowler (1998) who recorded 36 L/L, Quispe (2011) recorded 35.5 to 38 L/L, and Titi-Pacosoncco *et al.* (2017), who recorded 39 to 41 L/L. The values recorded in our study (32 to 53 L/L), are high in some cases, mainly in the vicuñas of the Chari and Cololo communities, which may indicate that during the activity of herding, capture and shearing, the vicuñas register physiological effects, such as dehydration due to intense exercise, fear, or stress.

The recorded effects are consistent with vicuña management in the Chari and Cololo communities, where deficiencies in the application of good animal welfare practices during herding such as use of motorcycles in Chari, as well as the capture, handling and restraint of the vicuñas was observed, for example, the lack of use of hoods to protect eyes and limit awareness, causing the vicuñas to suffer greater stress. In addition, the vicuñas were herded over longer distances, between 7 to 10 km, which could lead to dehydration.

Similar results were obtained by Bonacic *et al.* (2006), who evaluated the capture of vicuñas and measured factors such as herding methods, herding distance and restraint,

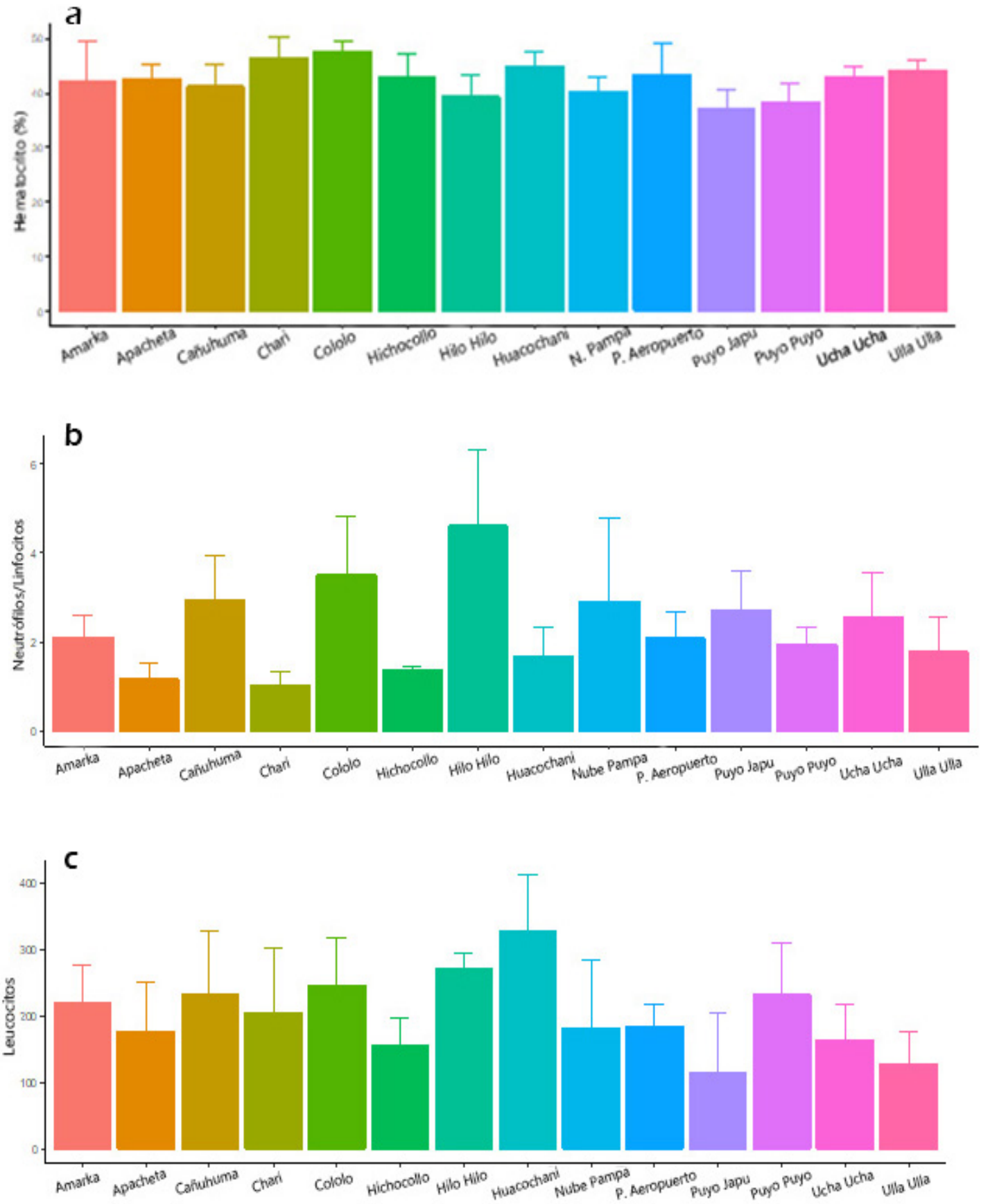

Figure 2. a) Percentage of hematocrit; b) ratio of neutrophil/lymphocyte count; c) total leukocyte count in vicuñas (*Vicugna vicugna*) from the Apolobamba National Natural Integrated Management Area, La Paz, Bolivia, according to the communities sampled, the error bars represent the standard deviation of the average.

Table 1. Hematological values found in 78 vicuñas (*Vicugna vicugna*) from the Apolobamba National Natural Integrated Management Area, La Paz, Bolivia.

Hematological parameter	Units	Mean	Range	Other studies	Source
Total erythrocyte count (RBC)	($x10^{12}$ L)	15.2	11.1 – 21.1	15.42	Copaira 1949; Fowler 1998
Hematocrit (Ht)	(L/L)	42	32 - 53	37	Copaira 1949; Fowler 1998; Quispe 2011; Titi-Pacosoncco *et al*. 2017
Total solids	(g/dl)	5.6	4.5 - 6.5		
Hemoglobin (Hb)	(g/L)	11.8	10.6 – 12	13.07	Fowler 1998; Quispe 2011
Mean Corpuscular Volume (MCV)	(fL)	28.1	18 – 39	27.4	Fowler 1998
Mean Corpuscular Hemoglobin (MCH)	(pg)	9.2	6 – 12	10.2	Fowler 1998
Mean Corpuscular Hemoglobin Concentration (MCHC)	(g/L)	33	33	37.5	Fowler 1998
Total white blood cell count (WBC)	($x10^{9}$ L)	10.3	2.05 - 20.9	15.42	Copaira 1949; Fowler 1998
Neutrophils	%	62	40 - 82	53.5	Copaira 1949; Fowler 1998; Esteban 2019
Increased neutrophils	%	5	1 - 9		
Basophils	%	0		0.75	
Eosinophils	%	0.09	0 - 1	11.25	Copaira 1949; Fowler 1998; Esteban 2019
Lymphocytes	%	31	12 - 56	34	Copaira 1949; Fowler 1998; Esteban 2019
Monocytes	%	2	0 - 6	13.5	Copaira 1949; Fowler 1998; Esteban 2019
Platelet count (PLT)	($x10^{3}$ L)	65	45 - 81	116	

and their results showed that vicuñas increase cortisol concentration when herded with vehicles, compared to those herded on foot; herding distance did not show significant changes in physiological parameters; and restraint after which vicuñas showed increases in creatine kinase in the blood.

Neutrophil and lymphocyte parameters previously recorded for the species are 41 to 67 % and 17.5 to 42.5 %, respectively (Copaira 1949). Fowler (1998) recorded 46.8 % for neutrophils and 33.8 % for lymphocytes, and Ruiz *et al.* (2019) recorded 40 to 67 % for neutrophils and 27 to 51 % for lymphocytes. Our records are higher, 40 to 82 % for neutrophils and 12 to 56 % for lymphocytes. The differential white cell count showed a significant difference in the neutrophil/lymphocyte ratio in vicuñas from the Cañuhuma, Hilo Hilo and Cololo communities. These values could indicate that the vicuñas are more stressed. The herding, capture and shearing in these communities was delayed until the afternoon (4 to 6 pm) due to climatic factors (snowfall), which also affected the time of rest before shearing.

Hurtado (2020) indicates that acute stress in vicuñas is related to cases of neutrophilia and lymphocytosis, as well as biochemical changes such as increased glucose, alkaline phosphatase (ALP), alanine transaminase (ALT), and severe infections. Previous studies (Bonacic and Macdonald 2003; Bonacic *et al.* 2006) evaluated blood glucose parameters, cortisol, neutrophil-lymphocyte ratio in vicuñas sheared immediately at the capture site versus vicuñas transferred to another site and sheared 12 days after capture, showing an increase in creatine kinase levels in vicuñas sheared immediately as compared to those sheared later.

The leukocytosis observed in the vicuñas of the Hichocollo community may also be associated with acute stress. Our results agree with previous studies where increased values in the total leukocyte count and the neutrophil/lymphocyte ratio were observed (Bonacic *et al.* 2003). In addition, they evaluated the neuroendocrine response to stress, through the application of adrenocorticotropic hormone (ACTH) in groups of vicuñas during shearing (Bonacic *et al.* 2003). Their results indicate a 4.5-fold increase of cortisol in blood after 1 hour of application, as well as leukocyte values and the neutrophil/lymphocyte ratio at 5 hours post-application.

The effects observed in the hematological parameters of the vicuñas could be associated with dehydration events due to intense muscular exercise, as well as deficiencies by some management communities in the application of the capture and handling methods carried out during herding, capture, and shearing. These effects could also be associated with acute stress events, but in the present study no biochemical tests were performed to corroborate this physiological change in the vicuñas.

Recently, manuals of animal welfare best practices and sanitary measures for the sustainable use of vicuña fiber were implemented (MMAyA *et al.* 2021), to apply these practices in the wild vicuña harvesting activities in Bolivia. The results obtained are in line with the parameters obtained in most communities; however, it is necessary to continue strengthening in other communities and regions for adequate application. Likewise, similar studies should continue to monitor this situation, and understand other factors such as habitat destruction, carrying capacity for animals on the *altiplano*, and the presence of sarcoptic mange, and thereby further improve vicuña conservation efforts.

Acknowledgements

We thank the Dirección General de Biodiversidad y Áreas Protegidas and the Instituto de Ecología of the Universidad Mayor de San Andrés for the permits granted, the Servicio

Nacional de Áreas Protegidas, the Área Natural de Manejo Integrado Nacional Apolobamba, the Asociación Comunitaria para la Comercialización de Fibra de Vicuña de Bolivia and the Asociación Regional de Comunidades Manejadoras de Vicuñas Apolobamba. This publication was made possible by the Wildlife Conservation Society's Great Madidi-Tambopata Landscape Conservation Program and financial support from the Government of the United Kingdom, through the Darwin Initiative, the Welttierschutzgesellschaft e.V., the Gordon and Betty Moore Foundation, and Laguntza. To Z. Porcel, A. Reinaga, and 3 anonymous reviewers for their review and comments to improve this work.

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Associated editor: Tamara M. Rioja Paradela.
Submitted: September 27, 2023; Reviewed: February 6, 2024.
Accepted: March 6, 2024; Published on line: March 19, 2024.

THERYA NOTES 2024, Vol. 5 : 51-55 DOI: 10.12933/therya_notes-24-149 ISSN 2954-3614

Urocyon cinereoargenteus predating to *Canis lupus familiaris* in an anthropized tropical environment

Urocyon cinereoargenteus depredando a *Canis lupus familiaris* en un ambiente tropical antropizado

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Although the gray fox, *Urocyon cinereoargenteus* (Carnivora: Canidae), is an omnivorous, opportunistic, and generalist carnivore, its predating or scavenging on domestic canids has not been reported. This report documents a predation event a domestic dog (*Canis lupus familiaris*) for gray fox in an anthropized tropical environment. During a project to evaluate the impact on habitat and wildlife populations in forested areas where dynamite is used to fragment stone and limestone rock in Cuauhtémoc, Córdoba, Veracruz, 2 camera traps were installed from August 2021 to May 2022 in areas with coffee cultivations, sugarcane, citrus, banana, palm, secondary vegetation, and tropical forest. The videos reviewed showed an adult female gray fox carrying a domestic dog puppy in her snout. Considering this report, the second on this topic for México, there are 14 species of wild carnivores that prey on domestic dogs. This unusual event could have resulted from several factors, including intraspecific competition with domestic canids or other mesopredators, food scarcity, and habitat anthropization.

Key words: Anthropic pressure; Canidae; Carnivora; diet; domestic dog; gray fox.

Aunque la zorra gris, *Urocyon cinereoargenteus* (Carnívora: Canidae), es un carnívoro omnívoro, oportunista y generalista, no se había reportado la depredación o el carroñeo de cánidos domésticos. El objetivo de este reporte es documentar el registro de depredación de un perro doméstico (*Canis lupus familiaris*) por una zorra gris en un ambiente tropical antropizado. Durante un proyecto que pretende evaluar el impacto del uso de dinamita para extraer piedra y roca caliza sobre el hábitat y las poblaciones de fauna silvestre en áreas boscosas en Cuauhtémoc, Córdoba, Veracruz, se instalaron 2 cámaras trampa, de agosto de 2021 a mayo de 2022 en zonas con cultivos de café, caña, cítricos, plátanos, palma camedor, vegetación secundaria y bosque tropical. Durante la revisión de los videos, se observó a una hembra adulta de zorra gris que lleva en su hocico a un cachorro de un perro doméstico. Con este reporte, son 14 especies de carnívoros silvestres que depredan perros domésticos. Este es el segundo reporte para México. Este evento inusual pudo ser resultado de diversos factores, entre ellos, la competencia intraespecífica con los cánidos domésticos, con otros mesodepredadores, la escasez de alimento y la antropización del hábitat.

Palabras clave: Canidae; Carnívora; dieta; perro doméstico; presión antrópica; zorra gris.

The gray fox (*Urocyon cinereoargenteus* Schreber 1775) is a wild canid belonging to the order Carnivora with an omnivorous diet; that is, it feeds on plants and animals. It is also considered an opportunistic species (it adapts its diet to the available resources) and a generalist species (able to thrive in different environments where it uses a wide variety of resources as part of its diet; Metz *et al.* 2023). The composition of its diet is highly variable, depending on the resources available within and between localities, the season of the year (spring, summer, autumn, or winter), the climatic season (rainy or dry; Arnaud and Acevedo 1990), and its interaction with other mesopredators. Depending on the local availability of food, which in turn is determined by habitat characteristics and ecosystem conditions, such as in mixed forest areas of the department of Huehuetenango, Guatemala, this species consumes seeds of cypress (*Juniperus comitana*) and plants of the family Asteraceae, small mammals such as rodents (*Peromyscus mexicanus* and *P. aztecus*), shrews (Soricidae), opossums (Didelphidae), birds (Columbiformes), and insects (Coleoptera, Carabidae and Orthoptera; Viteri-Pasch and Mármol-Kattán 2019).

On the coast of Oaxaca, México, its diet includes seeds, vertebrates, and invertebrates (Villalobos-Escalante *et al.* 2014). In habitats with changes in land use in Tamaulipas, México, its diet consists of plants, invertebrates and vertebrates (Wong-Smer *et al.* 2022). In southern California, USA, it consumes seeds, fruit pulp, shoots, leaves, and stems of coffee berries (*Rhamnus californica* and *R. illicifolia*), Eastwood's manzanita (*Arctostaphylos glandulosa*), California Christmas berry (*Heteromeles arbutifolia*) and grasses (Gramineae), representative of a vegetation type called chaparral. Rodents of the genera *Perognathus*, *Microtus*, *Neotoma*, and *Peromyscus*, and species such as *Sigmodon hispidus*, *Neotoma fuscipes*, and *Microtus californicus*, as well as rabbits of the genus *Sylvilagus*; gastropods and insects of the order Orthoptera, millipeds, and species of the genus *Stenopelmatus*; reptiles such as *Sceloporus occidentalis* (Wilson and Thomas 1999) and the hunting

tigra flying snake (*Spilotes pullatus*), green iguana (*Iguana iguana*) and the northern alligator lizard (*Gerrhonotus infernalis*; Peláez-Cruz *et al.* 2022). In Baja California, México, the species feeds on mammals, birds, reptiles, and invertebrates, as well as plants of the family Leguminosae (*Prosopis articulata* and *Lysyloma candida*), Cactaceae (*Pachycereus pringlei*, *Opuntia cholla* and *Ferocactus* spp.) and Gramineae, typical of the southern region.

In anthropized environments such as Maine, USA, where the gray fox has expanded its geographic distribution and competes for resources with other canids such as the red fox (*Vulpes vulpes*) and the coyote (*Canis latrans*), the gray fox consumes food of anthropogenic origin such as food waste (Masters and Maher 2022). In the Appalachians and foothills of Maryland, USA, in areas where it coexists with the red fox (*Vulpes vulpes*), the gray fox tends to consume plants such as persimmon fruits (*Diospyros virginiana*), corn (*Zea maize*), and insects (Hockman and Chapman 1983). In the dry season in the Petén area, Belize, the species consumes fruits and arthropods, and is a potential predator of other vertebrates (Novaro *et al.* 1995). Interaction with other canids such as coyotes and felines such as lynx (*Lynx rufus*) may lead the gray fox to expand or reduce food consumption; it was reported that the gray fox consumed ungulates and lagomorphs less frequently, and fruit consumption was higher in the rainy season (Neale and Sacks 2001). In tropical deciduous ecosystems where it interacts with coyotes, raccoons (*Procyon lotor*), and jaguarondis (*Herpailurus yagouaroundi*), the gray fox can diversify its diet and feed on other potential prey, although these have not been reported as part of its diet yet (Guerrero *et al.* 2002). In anthropized areas, gray foxes probably interact with domestic dogs more frequently, directly competing for common areas and resources, which influences the behavior, habitat use, and diet of gray foxes (Sánchez-Londoño 2014) and also involves a higher possibility of zoonotic disease transmission (Hughes and Macdonald 2013).

The negative ecological impact of domestic dogs on biodiversity is well known. However, reports are scarce in megadiverse countries such as México (Orduña-Villaseñor *et al.* 2023), and the effect of predation of and competition with domestic dogs on the native fauna has not yet been evaluated, despite the potential risk of transmission of zoonotic diseases. During a project to evaluate the impact of the use of dynamite to extract stone and limestone on wildlife populations and their habitats in a forested area in Córdoba, Veracruz, México, an unusual record of a gray fox preying on a domestic dog pup was obtained. Since predation events of this type had not previously been reported for this species in México, the objective of this note is to document an event of a gray fox (*Urocyon cinereoargenteus*) predating on a domestic dog pup (*Canis lupus familiaris*) in an anthropized tropical environment.

The project was carried out in the town of Cuauhtémoc, municipality of Córdoba, Veracruz, México (Figure 1), an area that shows different land use covers, including cultivations of sugarcane (*Saccharum officinarum*), coffee (*Coffea arabiga*), citrus (*Citrus lemon* and *C. sinensis*), palm (*Chamedorea tepejilote*), and banana (*Musa paradisiaca*) crops, secondary vegetation, urban settlements, and fragments of tropical forest (medium semi-evergreen forest) that have been isolated as a result of extraction operations in "Las Caleras" (forest areas where dynamite is used to fragment and extract limestone rock, machinery for its crushing to convert it into lime and gravel as a building material; Figure 2). The local climates in the municipality are semi-warm humid with abundant rainfall in summer (87 %), warm humid with abundant rainfall in summer (8 %), and semi-warm humid with rainfall throughout the year (5 %), with a temperature range of 18 to 24 °C and precipitation of 1,900 to 2,100 mm (Cuadernillos Municipales 2021).

Two camera traps were installed from August 2021 to May 2022, separated by 200 m to 500 m at a height of 40 cm and attached to a tree trunk; these cameras were set in photo and video mode and operated 24 hr per day. One camera trap was placed in an area encompassing the interaction spaces or ecotones between coffee crops, sugarcane plots and secondary vegetation, while the other was placed between tropical forest fragments and coffee, banana, and citrus crops. The camera traps were monitored every 15 days to review the photo and video captures. These were deposited for academic safeguarding at the Laboratorio de Bioinformática y Bioestadística de la Facultad de Ciencias Biológicas y Agropecuarias, Orizaba-Córdoba region, Universidad Veracruzana (project ID: mammals2024-Cuauhtémoc).

An event of a female gray fox carrying a domestic dog puppy in her snout was recorded on May 7, 2022 at 19:33 hr and 23 °C. The site where this event occurred is located approximately 800 m from the town of Cuauhtémoc, in the ecotone between the tropical forest and coffee, banana, and citrus fruit plantations. The video (available at https://youtu.be/6xrjQH6XndU) shows a gray fox carrying with its snout a puppy dog by the back. It leaves it on the ground, then grabs it by the belly, and heads towards a path that leads to another area covered by coffee, palm, and citrus crops (Figure 2a, 2b).

At least 13 species of wild carnivores have been reported worldwide preying on domestic dogs, including the gray wolf (*Canis lupus*), leopard (*Panthera pardus*), puma (*Puma concolor*), coyote (*C. latrans*), spotted hyena (*Crocuta crocuta*), tiger (*Panthera tigris altaica*), lion (*Panthera leo*), dingo (*Canis lupus dingo*), striped hyena (*Hyaena hyaena*), jaguar (*Panthera onca*), black-backed jackal (*Canis mesomelas*), polar bear (*Ursus maritimus*) and Asiatic black bear (*U. thibetanus*; Butler *et al.* 2014). In the Americas, there are several reports of dogs predated by wild carnivores, including gray wolf and cougar in the United States, coyote and polar bear in Canadá, cougar in Brazil and Venezuela (Butler *et al.* 2014) and jaguar in México (Carral-García *et al.* 2021). There are no previous records of predation of domestic dogs by the gray fox (Figure 2c). This report brings the list of wild carnivores that prey on dogs to 14 species worldwide.

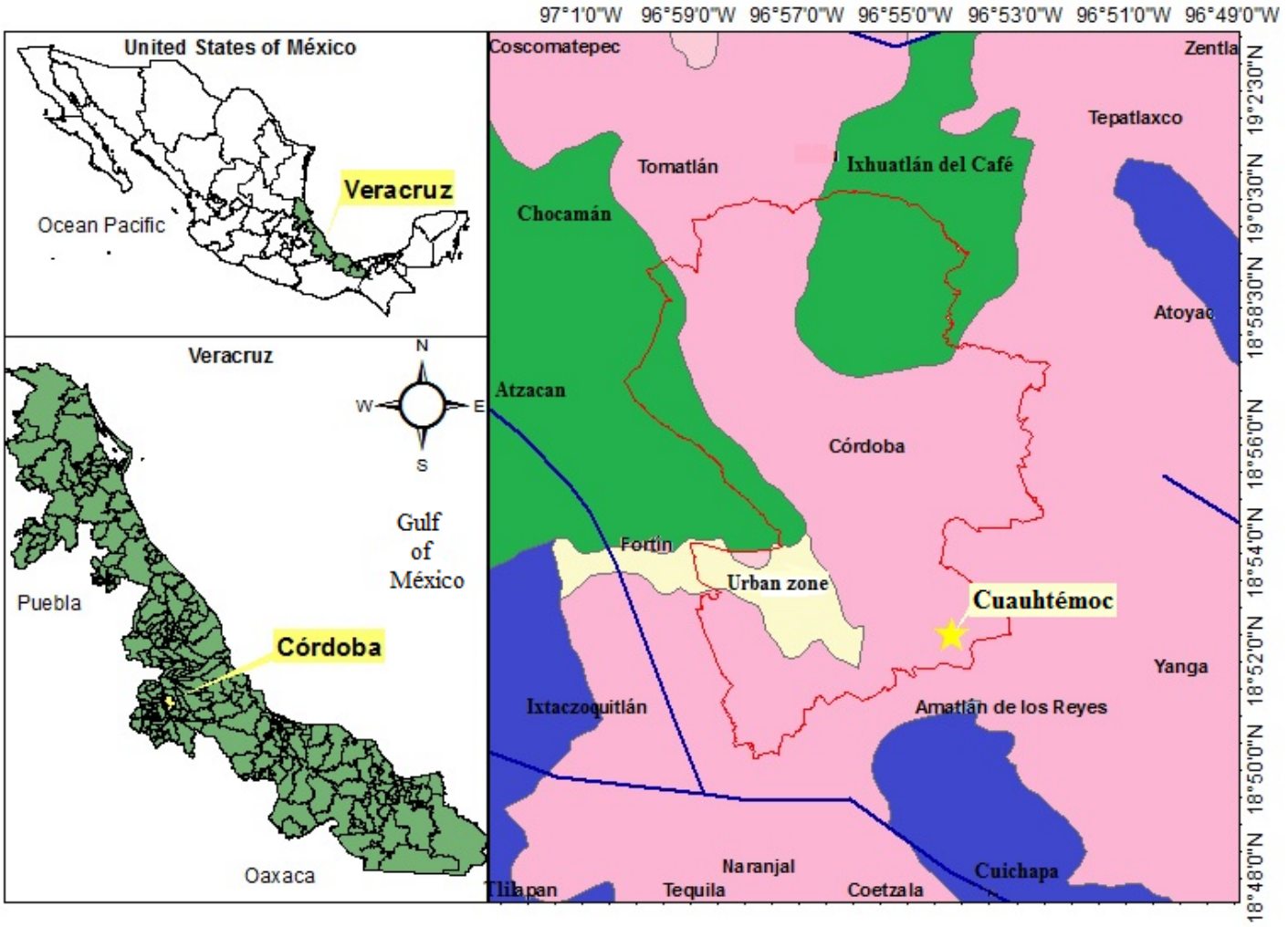

Figure 1. Geographic location of the Cuauhtémoc town (yellow star), municipality of Córdoba, Veracruz, México where predation of a domestic dog pup by a gray fox was recorded. The CONABIO types of land use and vegetation are shown as follows: mountain cloud forest is marked in green, rainfed agriculture in pink, and high evergreen forest in blue. The red line shows the limits of the municipality of Córdoba, and the blue line delineates the rivers. Constructed in ArcMap© version 10.8; 1 cm = 0.5 km.

In addition, this report increases our knowledge about the feeding ecology of the gray fox in anthropized environments. According to Butler *et al.* (2014), the consumption of domestic dogs by wild carnivores results from ecological pressure on the habitat and the scarcity of wild resources in times of low water availability and intraspecific competition with other mesopredators and domestic dogs. In the study area, there is photographic evidence of 1 male gray fox (Figure 2d) and 4 other domestic dogs coexisting in the same area, which probably increases the frequency of encounters between the gray fox and domestic dogs. In addition, competition with other mesopredators in the same locality, such as raccoons (*P. lotor*), coatis (*Nasua narica*), and skunks (Mephitidae), may increase the competition for food resources with domestic dogs. Food scarcity in the dry season (from January to May), together with environmental pressure, could force the gray fox to feed on other types of prey available in its habitat. This may be a consequence of the environmental impact generated by "Las Caleras", which probably decreases the availability and quality of food resources for the gray fox and other species. Future studies should increase the monitoring of locations in different anthropized environments during the 2 climatic seasons of the year.

Elsewhere in the Americas, for example, in the dry forest of San José-Pacasmayo, Perú, a high degree of overlap has been reported between the habitats of the domestic cat (*Felis silvestris catus*), the domestic dog (*C. l. familiaris*), the Sechura fox (*Lycalopex sechurae*), the grassland cat (*Leopardus garleppi*), and the white-backed skunk (*Conepatus semistriatus*), but no consumption events have been reported among these carnivores (Pereda-Sánchez *et al.* 2023). This challenges the event recorded in the anthropized area of the present study, so it is important to continue monitoring to identify the drivers that make the gray fox prey on domestic dog pups.

No evidence was found that the gray fox actually ate the domestic dog pup recorded in the photographs or videos, the debris near the camera trap, or the path that the gray fox followed with the dog pup. Therefore, we cannot be certain that the gray fox feeds on domestic dogs. It is necessary to continue biological monitoring to confirm this hypothesis and obtain additional information on the

Figure 2. Representative photographs of the ecotone between sugarcane, coffee, and banana crops and the medium evergreen forest (a) and the environment impacted by "Las Caleras" (b); photographs captured of a female gray fox (*Urocyon cinereoargenteus*) holding a dog pup (*Canis lupus familiaris*) in the snout (c) and a male gray fox (d) in an anthropized environment in Córdoba, Veracruz, México. Images available at rserna@uv.mx.

interaction between humans, domestic animals, and wildlife (Serna-Lagunes *et al.* 2022).

Information on the consumption of domestic dogs by gray foxes is also relevant from a medical perspective since in areas with anthropic interaction where domestic species reach agricultural zones and wildlife habitats, zoonotic diseases are more frequent (Coronel-Arellano *et al.* 2021). An issue in the interaction of domestic dogs with wildlife is the transmission of diseases and parasites, such as Lyme disease (*Borrelia burgdorferi*), rabies (Rhabdoviridae: *Lyssavirus*), infectious diseases by *Mycoplasma* spp. and *Rickettsia* spp., brucellosis (*Brucella* spp.), foot-and-mouth disease and cysticercosis, mange or scabies transmitted by mites (*Sarcoptes scabiei*), chewing louse (*Trichodectes canis*), and other species of nematodes, cestodes, protozoa, and ticks that cause zoonotic diseases (Valenzuela-Sánchez and Medina-Vogel 2014). Photo trapping provides relevant information for public health programs for human populations, the control of domestic dogs, and information on the interactions between wildlife and exotic and domestic carnivores (Gompper 2014).

Acknowledgements

The authors wish to thank the Finca Nazar Centro de Agroturismo-Córdoba staff for the facilities granted to carry out the monitoring. We also thank the 4 anonymous reviewers whose comments improved the informative presentation of this note. M. E. Sánchez-Salazar translated the manuscript into English.

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Associated editor: Itandehui Hernández Aguilar.
Submitted: December 4, 2023; Reviewed: February 26, 2024.
Accepted: March 12, 2024; Published on line: March 22, 2024.

THERYA NOTES 2024, Vol. 5 : 56-59 DOI: 10.12933/therya_notes-24-150 ISSN 2954-3614

Smell fruits selection behavior by a Geoffroy's spider monkey (*Ateles geoffroyi*) in Quintana Roo, México

Comportamiento olfativo de selección de frutos por un mono araña de Geoffroy (*Ateles geoffroyi*) en Quintana Roo, México

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In primates, sensory systems play an important role in the detection and selection of resources. Here, we report a neglected ecological behavior, olfactory fruit selection in a Geoffroy's spider monkey (*Ateles geoffroyi*), a primate species found in the Mesoamerican to northern South American region. We directly observed, videotaped, and described a fruits selection behavior using the sense of smell by a free-ranging Geoffroy's spider monkey during a foraging feeding event in a *Manilkara zapota* tree, in a tropical semi-evergreen forest area of south of Quintana Roo, México. During the observations, the spider monkey examined the sapodilla (*Manilkara zapota*) fruits one by one by bringing them close to its nose, apparently allowing it to distinguish between ripe and unripe fruits. Fruits that appeared unripe, were released from the branches without tearing them. Fruits that appeared to be ripe, as the observation suggests, were picked and eaten one at a time. This olfactory-driven selection challenges the common belief that vision, and taste govern food choices. Our findings underscore the vital role of olfaction in frugivore foraging, particularly in discriminating the palatability of cryptic-ripe fruit. This has wider implications for understanding ecosystem interaction networks, encompassing the evolution of distinct odors in fleshy-fruited plant species and the role of sniffing in food discrimination.

Key words: Frugivory; olfactory perception; primates; sensory systems.

En primates, los sistemas sensoriales juegan un papel importante en la detección y selección de recursos. Aquí, reportamos un comportamiento ecológico poco estudiado, la selección olfativa de frutos en el mono araña de Geoffroy (*Ateles geoffroyi*), una especie de primate que se encuentra desde las regiones de Mesoamérica hasta el norte de Sudamérica. Observamos directamente, grabamos en video y describimos un comportamiento de selección de frutas usando el sentido del olfato por un mono araña de Geoffroy silvestre durante un evento de forrajeo en un árbol de *Manilkara zapota,* en una zona de selva tropical semi perennifolia al sur de Quintana Roo, México. Durante las observaciones, el mono araña examinó uno por uno los frutos de *Manilkara zapota* acercándolos a su nariz, lo que aparentemente le permitía distinguir entre frutos maduros e inmaduros. Los frutos que parecían inmaduros los soltaba de las ramas sin arrancarlos. Los frutos que parecían maduros, como sugiere la observación, eran arrancados y consumidos uno en uno. Este mecanismo de selección basado en el olfato hace frente a la creencia de que la visión y el gusto son los principales impulsores en la elección de alimentos para primates frugívoros. Destaca la relevancia de las señales sensoriales, especialmente el olfato, en la discriminación de la palatabilidad y subraya la influencia en la evolución de olores distintivos en plantas con frutas carnosas y crípticos.

Palabras clave: Frugivoría; percepción olfativa; primates; sistemas sensoriales.

It has been suggested for some time that the evolution of trichromacy in some New World monkeys was linked to frugivory, as fruits frequently consumed by primates tend to be yellow or red in color, suggesting a visual selection mechanism (Glaser 1989; Laska *et al.* 1996; Riba-Hernández *et al.* 2004). However, in other primate species found in the New World, such as *Alouatta palliata*, a non-visual selection mechanism controlled primarily by the sense of smell has been proposed (Sánchez-Solano *et al.* 2022).

Geoffroy's spider monkey (*Ateles geoffroyi* Kuhl 1820) is one of the most studied primates in the Mesoamerican region. Its range spans continuously from southern México through Guatemala and Belize to Costa Rica and Panamá, reaching the limits of Colombia, restricted by the Baudó Mountains (Cortés-Ortiz *et al.* 2021). Various aspects of the feeding ecology and dietary preferences have been documented across this distribution range. For example, this primate species spends between 57 % and 83 % of its total feeding time foraging for fruits (Cant 1990; Riba-Hernández *et al.* 2003; Di Fiore *et al.* 2008; González-Zamora *et al.* 2009; Cortés-Ortiz *et al.* 2021). Therefore, sensory systems play a crucial role in detecting and evaluating food items (Valenta *et al.* 2015; Cunningham *et al.* 2021; Sánchez-Solano *et al.* 2022).

The theory suggests, spider monkeys feed on a diverse range of fruits, and their selection indicates a potential use of sweetness in appraising nutritional value and toxin levels in available food sources (Laska *et al.* 1996; Chapman *et al.* 2012; Pablo-Rodríguez *et al.* 2015). Therefore, the species must evaluate these nutritional values through sensory cues to obtain valuable and precise information about the taste, aroma, and quality of the fruits it will consume (Pablo-Rodríguez *et al.* 2015). However, the method by which the species selects fruits as part of its feeding habits in the wild has been poorly understood. Here we described a fruits selection behavior using the sense of smell by a free-ranging Geoffroy's spider monkey during a foraging event in a forest area in Quintana Roo, México.

Direct observation and video recording were used to register the selection behavior of a wild Geoffroy's spider monkey foraging in a *Manilkara zapota* tree in a forest area south Quintana Roo from May 21 to 23, 2016. Specifically, the observations were carried out in the area known as Laguna Om (18° 39′ 44.70″ N, 89° 07′ 53.53″ W). Physiographically, the region is predominantly flat with some hills. The climate is classified as warm sub-humid with medium to high humidity, the mean annual precipitation ranges from 1,000 to 1,300 mm, and the average annual temperature is 22 °C. The region experiences 2 well-defined seasons, a dry season from March to June and a rainy season from July to November (INEGI 2017). The dominant vegetation type in the area is broadleaved evergreen or semi-deciduous forest and in some areas is present a mixed of broadleaved and needle-leaved forest (Figure 1). The broadleaved evergreen or semi-deciduous forest is characterized by species such as piñon de oreja (*Enterolobium cyclocarpun*), chechén prieto (*Metopium brownie*), ceiba pentandra (*Ceiba pentandra*), and huevo de ratón (*Vitex gaumeri*; Flores and Espejel 1994). On the other hand, the mixed broadleaved and needle-leaved forest is dominated by palo de Campeche (*Haematoxylum campechianum*), naranjillo (*Hyperbaena winzerlingii*), manzanilla (*Coccoloba cozumelensis*), and sakitsa (*Neomillspaughia emarginata*; Palacio *et al.* 2002).

This behavior was observed on all 3 days, but it was only recorded once (on May 21). The total observation time over the 3 days was 21 min, with 10 min on May 21, 3 min on May 22, and 8 min on May 23. The Geoffroy's spider monkey picked up each fruit individually with 1 hand and brought it about 2 to 3 cm away from its nose to smell it (Figure 2; see video link in figure). Fruits that appeared unripe were released without tearing them from the branches, and the remaining fruits were evaluated in the same way. Fruits that appeared to be ripe were picked and eaten one at a time. It is noteworthy that sometimes some fruits were picked in the same way as before, but instead of being eaten they were dropped to the ground.

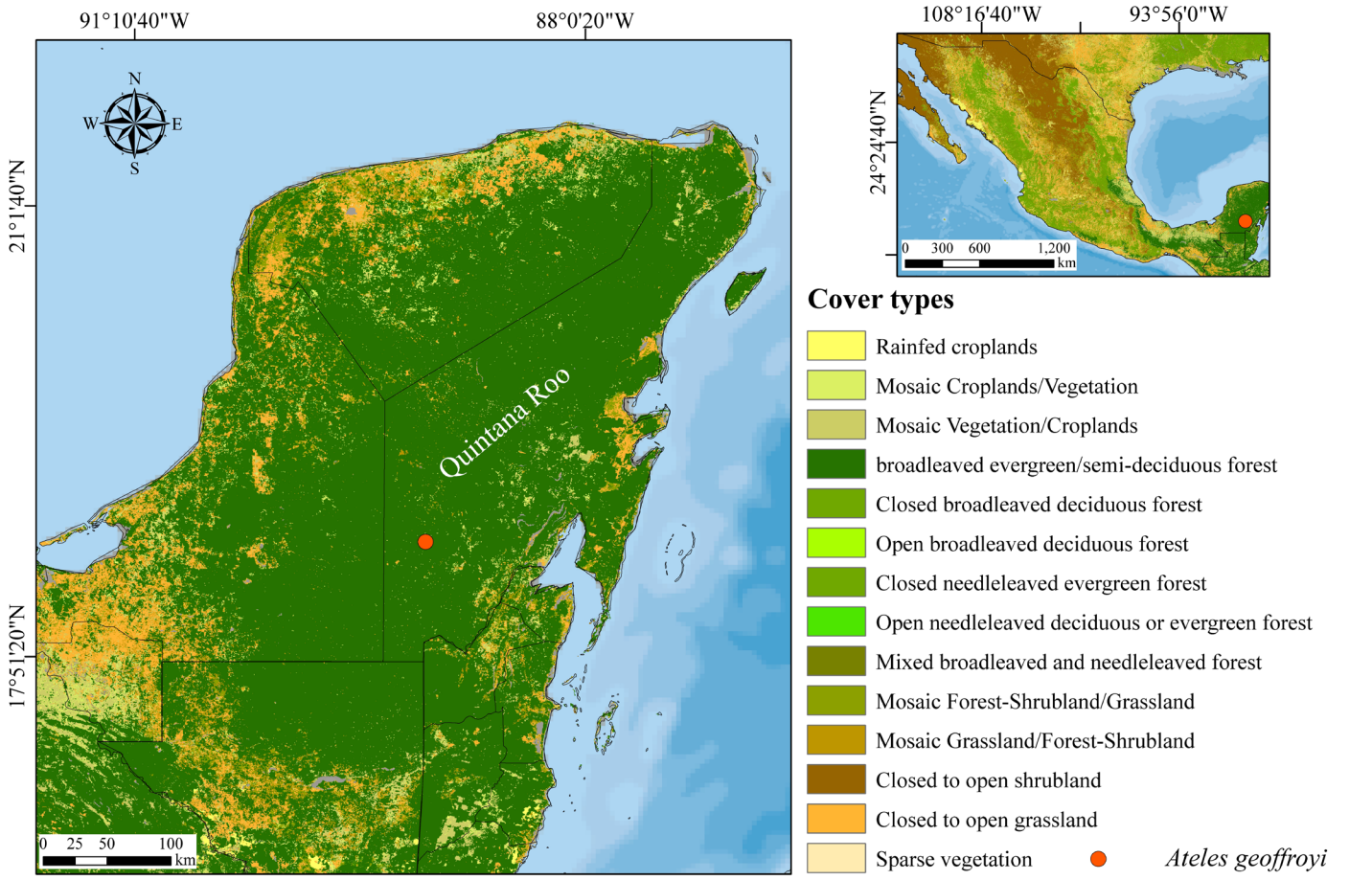

Figure 1. Wild Geoffroy's spider monkey (*Ateles geoffroyi*) observation locality in a tropical semi-evergreen forest in Quintana Roo, México (Datum WGS 84). Cover types are from Arino *et al.* (2022).

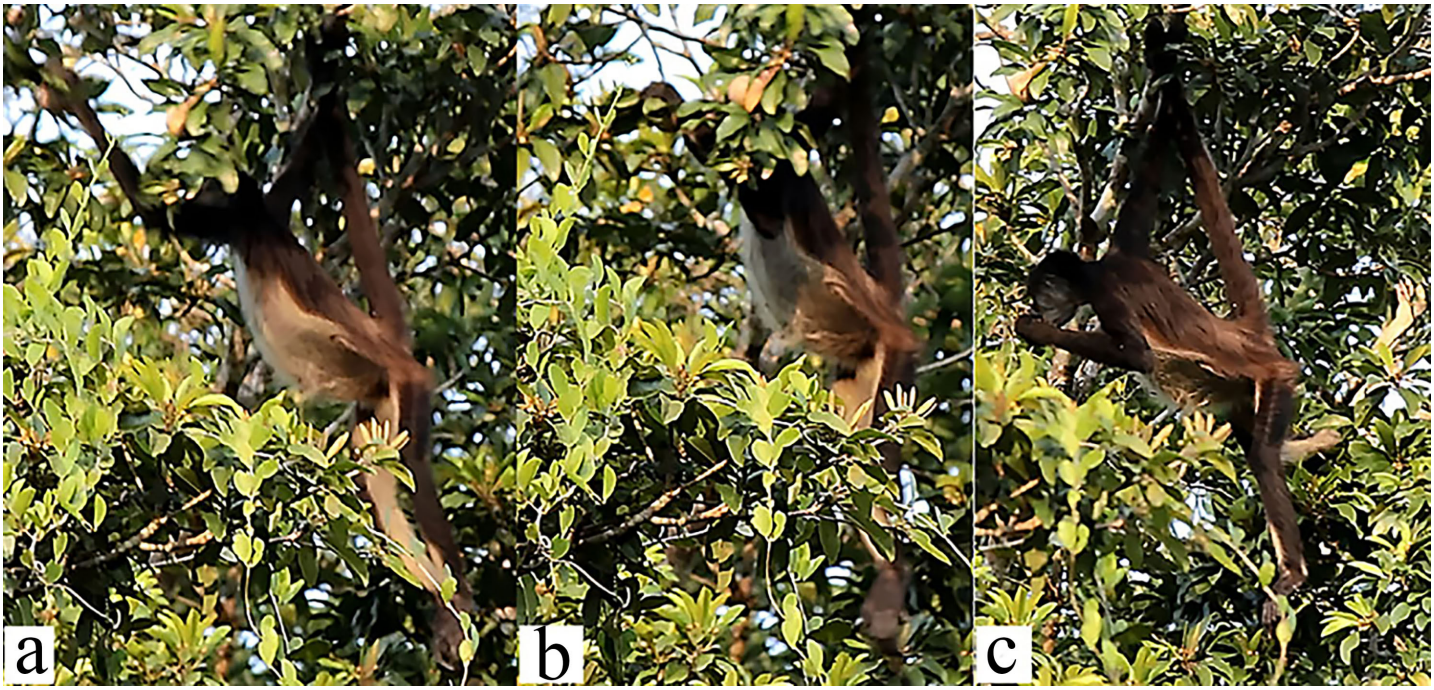

Figure 2. Wild Geoffroy's spider monkey (*Ateles geoffroyi*), a) foraging, b) displaying the smell fruits selection behavior and c) eating the fruit of *Manilkara zapota* tree. The video can be seen in the following link: https://youtu.be/AoCpxZAGakQ.

Here we present evidence of the smell fruit selection behavior of Geoffroy's spider monkey in its natural habitat, shedding light on its integral role within the species' foraging ecology. This skill it is known as the olfactory conditioning paradigm (Nevo *et al.* 2015).

Frugivorous primates such as Geoffroy's spider monkey primarily rely on carbohydrates for metabolic energy (Simmen and Sabatier 1996). Therefore, the species require precise detection of these resources while avoiding potential toxins. Research suggests that in various non-human primate species, particularly in New World monkeys including Geoffroy's spider monkey, the primary mechanisms for food selection are vision and taste (Glaser 1989; Laska *et al.* 1996; Riba-Hernández *et al.* 2004).

However, only a limited number of studies have investigated these mechanisms but has not been thoroughly described in wild individuals (Dominy 2004; Nevo *et al.* 2015; Pablo-Rodríguez *et al.* 2015; Melin *et al.* 2019). Nevo *et al.* (2015) propose that Geoffroy's spider monkey learn to associate certain scents with ripe fruits and rewards through chemical recognition. Sánchez-Solano *et al.* (2022) also suggested this non-visual selection mechanism in *A. palliata*. Furthermore, this behavior has also been observed in Old World species as ring-tailed lemurs (*Lemur catta*) and pig-tailed macaque (*Macaca nemestrina*; Hübener and Laska 1998; Cunningham *et al.* 2021).

Our observations suggest that selection by monkeys may have driven the evolution of distinct odors in plant species with fleshy fruits (Nevo *et al.* 2015). This may be an honest reward signal related to the nutritional value of the resource. Thus, the importance of behavioral patterns in resource selection by frugivores will help to understand the mechanisms that give rise to the structural and functional patterns of interaction networks (Jordano *et al.* 2003; Acevedo-Quintero *et al.* 2020). Further research is needed to evaluate this behavior and to determine whether this selection strategy is common to other populations of Geoffroy's spider monkey along its geographic range and to other Neotropical primate species.

Acknowledgements

We would like to thank D. A. Molina, and 2 anonymous reviewers for his insightful comments on the manuscript.

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Associated editor: Beatríz Bolívar Cimé.
Submitted: January 12, 2024; Reviewed: March 5, 2024.
Accepted: March 22, 2024; Published on line: April 22, 2024.

THERYA NOTES 2024, Vol. 5 : 60-68 DOI: 10.12933/therya_notes-24-151 ISSN 2954-3614

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.

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 lavali* 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 leading 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), mastoidal 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 toothrow (MAX), length of upper molariform toothrow (UML), length of mandibular toothrow (MTR), length of lower molariform toothrow (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,

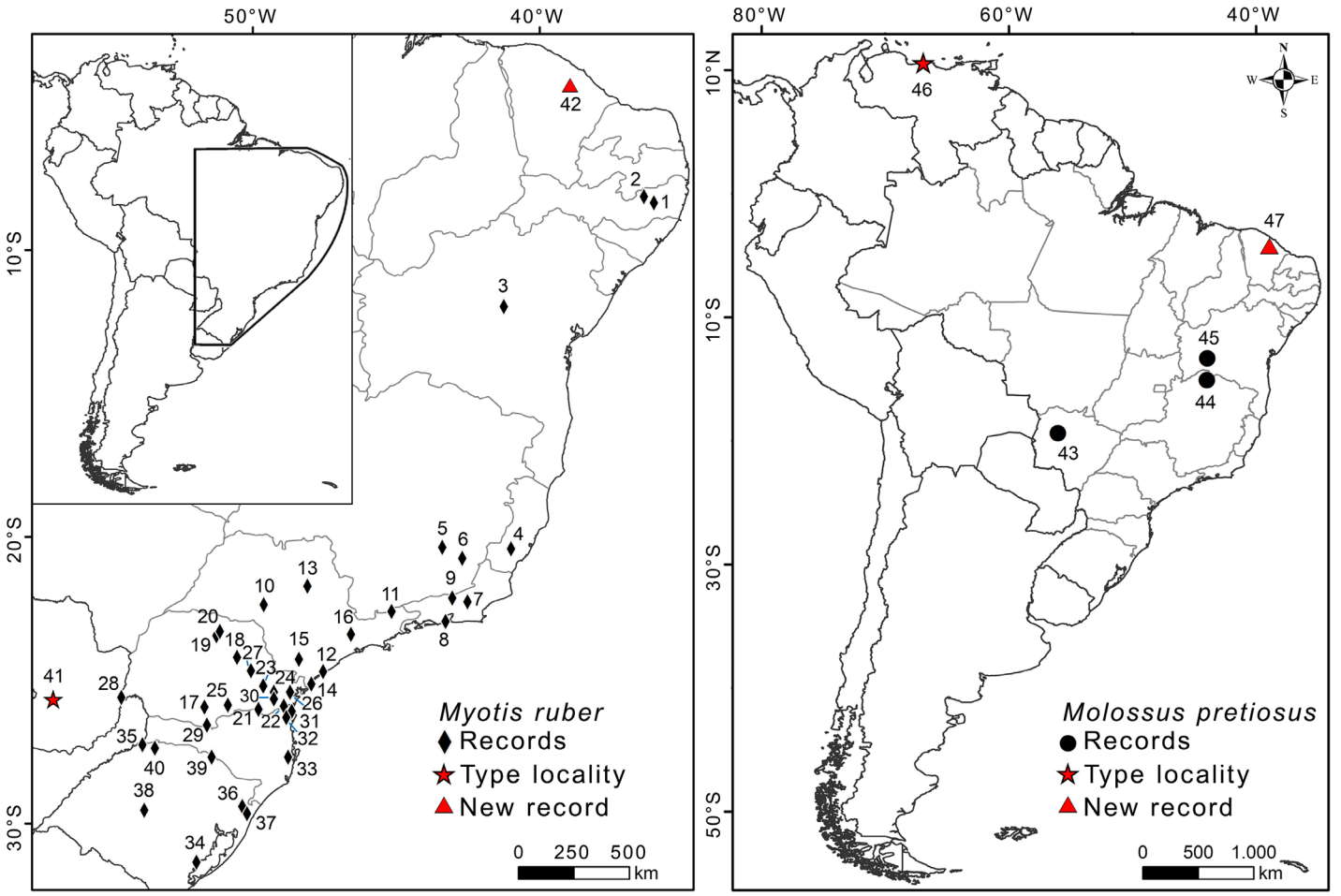

Figure 1. Geographic records of *Myotis ruber* and *Molossus pretiosus* in Brazil. For locations corresponding to the numbers see Appendix 1.

Pernambuco state (Figure 1). The individual is an adult and inactive female, caught on May 30, 2022 (Figure 2a-d). It has a monocolor 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 monocolor 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 Pessôa 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.

	Myotis ruber		***Molossus pretiosus***					
	Guaramiranga (CE)	**Bonito (BA)**	**Pacoti (CE)**	**Aquidauana (MS)**		**Jaíba (MG)**		**São Félix do Coribe (BA)**
Sex	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**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 Pessôa 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 Pessôa 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

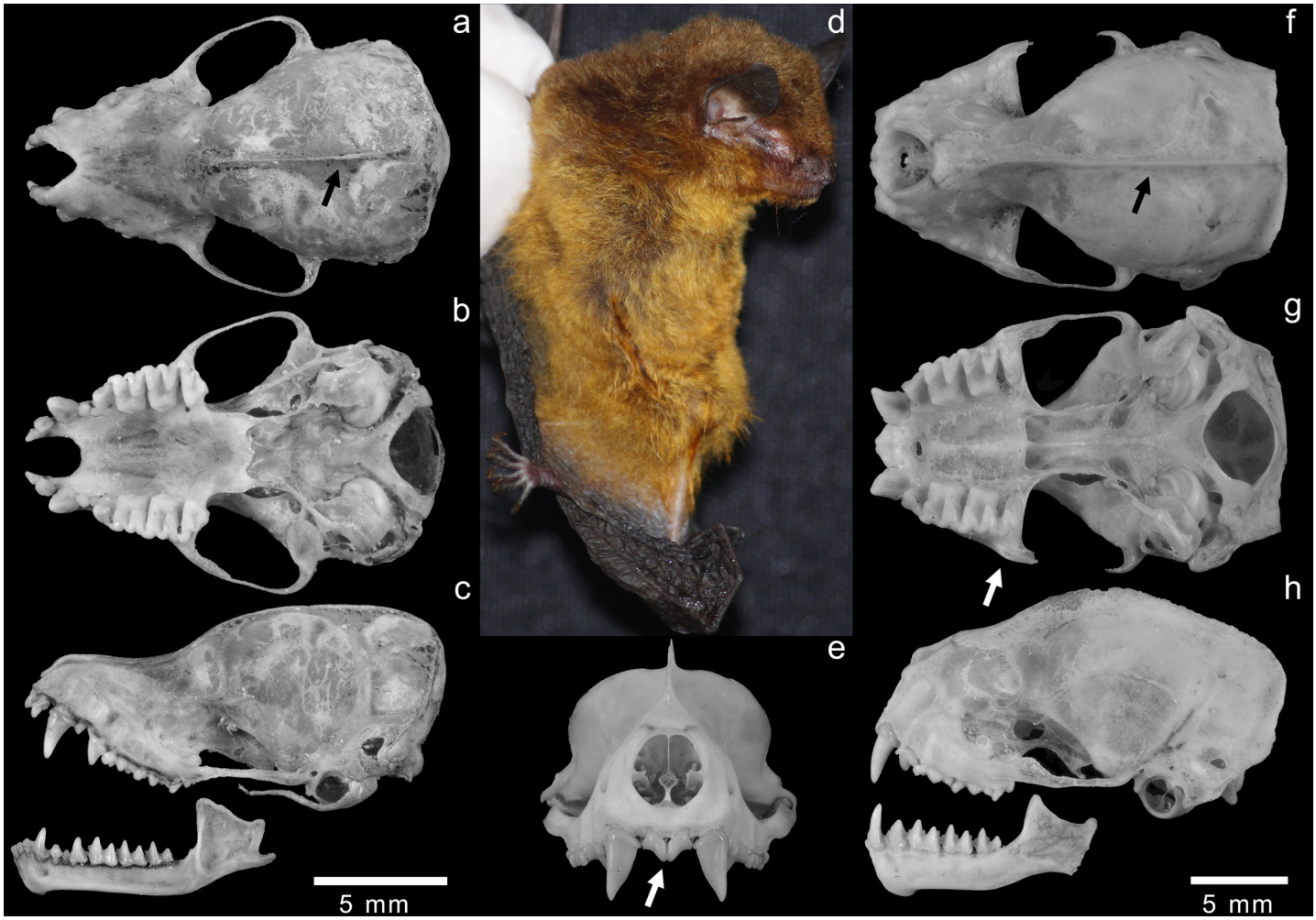

Figure 2. *Myotis ruber*: a) dorsal, b) ventral and c) lateral view of the skull and mandible, and d) voucher MHNCE-MAM 00420. *Molossus pretiosus*: e) frontal view, f) dorsal, g) ventral and h) lateral view of the skull and mandible. Arrows are signaling cranio-dental morphological features that helped 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).

Acknowledgements

We would like to thank the janitors of the properties where we carried out some of the field samplings, specifically F. G. A. Soares and M. V. F. Batista Alves. Also, to the researchers who somehow contributed with field sampling: A. Teles, A. Júnior, B. Almeida, C. Nobre, C. Velasquez, F. Pessoa, I. Gutierrez, K. Morgana, L. Firmino, M. A. Crozariol, M. Duarte, P. Moura, R. Freire-Filho, R. Gonzalez, T. Cavalcante and T. Pinto. We thank student M. A. Gentil for her assistance in obtaining photos of the skulls in the Museu Nacional (UFRJ). A. Caccavo has received financial support from the Fundação Carlos Chagas Filho de Amparo à Pesquisa do Estado do Rio de Janeiro (FAPERJ; E-26/204.472/2021). We appreciate the funding from the Programa INOVA Fiocruz Ceará, FUNCAP (Fundação Cearense de Apoio ao Desenvolvimento Científico e Tecnológico) Edital 01/2020 (Processo FIO-0167-00017.01.00/20), to the Programa Cientista Chefe Meio Ambiente do Governo do Estado do Ceará, to FUNCAP (Processo nº 10618021/21), to the Secretaria do Meio Ambiente (SEMA), Universidade Federal do Ceará (UFC), and Museu de História Natural do Ceará Prof. Dias da Rocha and the Universidade Estadual do Ceará (UECE). Finally, we would like to thank the 2 anonymous reviewers, who helped improve this scientific note.

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Associated editor: Cristian Kraker Castañeda.
Submitted: September 21, 2023; Reviewed: January 31, 2024.
Accepted: March 22, 2024; Published on line: April 22, 2024.

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 Iguaçu (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 (Sekiama *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.

THERYA NOTES 2024, Vol. 5 : 69-78 DOI: 10.12933/therya_notes-24-152 ISSN 2954-3614

Diversity of mammals in Cerro Páramo Miraflores Regional Park, Huila, Colombia: analysis of structure and composition

Diversidad de mamíferos del Parque Regional Cerro Páramo Miraflores, Huila, Colombia: análisis de su estructura y composición

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The lack of field studies on the biodiversity of the Cerro Páramo de Miraflores Regional Park (PRCPM), Colombia, highlights the importance of obtaining reliable information to improve its management as a protected natural area. To this end, we evaluated the structure and composition of the assemblage of terrestrial and flying mammals of the high Andean and sub-páramo. For the recording of terrestrial and flying small, medium, and large mammals, we set transects of 100 Sherman traps, 8 mist nets, and 39 camera traps in the high Andean and sub-páramo zones of the PRCPM. With the records obtained and indirect traces, we calculated the alpha and beta diversity indices (Fisher's Alpha, Simpson, Shannon-Wiener, Whittaker, and Morisita-Horn). We recorded 21 species; the most abundant species were *Thomasomys dispar* (22.5 %), *T. baeops* (13.75 %), and *Sturnira erythromos* (8.75 %). We also documented flagship species such as *Tremarctos ornatus* and *Puma concolor*, as well as new geographic distribution records of *Neomicroxus bogotensis*, *T. prínceps, Cryptotis squamipes*, and *Histiotus montanus* for the department of Huila. Both zones showed medium diversity (*H'* = 2.317 and 1.885), with species dominance (*D* = 0.8612 and 0.8209) and high species turnover (*B*w = 0.75; I_{M-H} = 0.32). The PRCPM highlands are home to species typical of conserved environments and diverse trophic guilds, which indicate a good state of conservation. The highest similarity in species richness was found with the Perijá and Chingaza mountain ranges, with less than 50 % of species shared among the 11 Colombian Andean páramos. Although its species composition partially matches other páramopáramos, it differs in the mammal assemblage structure.

Key words: Biodiversity; high Andean; mammals; páramo; protected areas.

La falta de estudios en campo sobre la biodiversidad del Parque Regional Cerro Páramo de Miraflores (PRCPM), en Colombia, resalta la importancia de obtener información confiable para mejorar su gestión como área natural protegida. Para esto, evaluamos la estructura y composición del ensamblaje de mamíferos terrestres y voladores de la franja altoandina y de subpáramo. Para el registro de micromamíferos terrestres y voladores, y mamíferos medianos y grandes instalamos transectos de 100 trampas Sherman, 8 redes de niebla y 39 cámaras trampa en las franjas altoandina y de subpáramo del PRCPM. Con los registros obtenidos junto con los rastros indirectos calculamos los índices de diversidad alfa y beta (Alfa de Fisher, Simpson, Shannon-Wiener, Whittaker y Morisita-Horn). Registramos 21 especies, de las cuales *Thomasomys dispar* (22.5 %), *T. baeops* (13.75 %) y *Sturnira erythromos* (8.75 %) fueron las más abundantes. También documentamos la presencia de especies bandera como *Tremarctos ornatus* y *Puma concolor*, además de nuevos registros de distribución geográfica para el departamento del Huila de *Neomicroxus bogotensis*, *T. prínceps, Cryptotis squamipes* e *Histiotus montanus*. Ambas franjas presentaron una diversidad media (H' = 2.317 y 1.885), con dominancia de especies (D = 0.8612 y 0.8209) y alto recambio de especies (B_w = 0.75 I_{M-H} = 0.32). Las tierras altas del PRCPM albergan especies propias de ambientes conservados y diversidad de gremios tróficos, lo que indica su buen estado de conservación. La mayor similitud de riqueza se encontró con la serranía del Perijá y Chingaza, con menos del 50 % de especies compartidas entre los 11 páramos andinos colombianos. Aunque coincide parcialmente en composición de especies con otros páramos, difiere en la estructura del ensamblaje.

Palabras clave: Altoandino; áreas protegidas; biodiversidad; mamíferos; páramo.

Mammals are frequently considered umbrella species because of their habitat needs and ecological functions, which ensure the subsistence of other organisms (Kattan *et al.* 2014; Díaz-Pulido *et al.* 2015). In Colombia, 543 mammal species belonging to 14 orders are reported (Ramírez-Chaves *et al.* 2021), of which 70 species thrive in high-mountain ecosystems (Muñoz-Saba 2015). These ecosystems are classified as high Andean, sub-páramo, páramo, and super páramo, according to the plant cover of the biotope (Rangel-Ch 2000).

Fourty-nine percent of the world's páramos are located in Colombia, covering 1.7 % of the territory with a total area of 1, 932. 395 ha (IAvH 2013; Cabrera and Ramírez 2014; Jiménez-Rivillas *et al.* 2018). Páramos are considered wildlife endemism and diversification centers, as well as one of the most vulnerable biomes due to the heavy exploitation of their resources, which is why they have been called "hotspots" (Garavito Rincón 2015). Although research and conservation efforts have been made in the páramos of central and northern Colombia (López-Arévalo *et al.*

1993; Vargas Ríos and Pedraza 2004; Corredor-Carrillo and Muñoz-Saba 2007; Medina *et al.* 2015; Muñoz-Saba 2015), there are little-explored areas in the south of the country (Trujillo *et al.* 2014). The study of mammal assemblages in high Andean forests and páramos of Colombia has yielded crucial information for the conservation of these unique ecosystems (Moreno 2001; Ramírez and Gutiérrez-Fonseca 2015). One of these areas corresponds to the Cerro Páramo de Miraflores Regional Park (PRCPM, in Spanish), located on the convergence of Amazonian, Andean, and Magdalena basin ecosystems (Armenteras *et al.* 2003).

As of the date of this study, no field research has been published on any aspect of PRCPM biodiversity. In particular, mammal diversity in high-mountain areas above 2,000 m has not been addressed, given the presence of armed groups over the past decades. Management plans and delimitation processes for these areas have been planned from secondary sources (Hofstede 2013; CAM 2017). These approaches have revealed the orders of greatest biological richness, mainly rodents, carnivores, and bats (Mena *et al.* 2012).

The present study, pioneering in the study area, was carried out under the framework of the PRCPM management plan update within the cooperation agreement between the Alto Magdalena Regional Autonomous Corporation (CAM, in Spanish) and the Francisco José de Caldas District University. This study will provide information to infer the conservation status of the high Andean and sub-páramo zones of the PRCPM in the municipality of Garzón, Huila, Colombia, based on the evaluation of the structure and composition of terrestrial and flying mammals.

The PRCPM is located on the western slope of the department of Huila's eastern mountain range, in the municipalities of Algeciras, Garzón, and Gigante. This park has Andean forest and páramo ecosystems, with an annual precipitation of 2,000 mm to 4,000 mm and an altitude of 2,200 m to 3,470 m (Figure 1; Tovar Lizcano and Olaya Amaya 2014). During the sampling carried out in February 2017, we identified 2 sampling zones in the study area, according to the vegetation cover observed in the field: the high Andean zone (2,700 m–3,100 m) and the sub-páramo zone (3,100 m–3,400 m). In this month, we sampled terrestrial and flying mammals in both ranges.

For the recording of small terrestrial mammals, we used 100 Sherman traps that operated 24 hr and were checked at 06:00 hr each day. The traps were placed along 4 linear transects traced on the edge and interior of the forest, scrubland, ravines, and open areas of each zone. For bat sampling, we installed 8 mist nets (2 of 6 m long; 2 of 9 m long, and 4 of 12 m long), which remained open from 06:00 hr to 18:00 hr.

Medium and large mammals were recorded with camera traps and indirect traces. We used 39 Bushnell Trophy Cam traps (Vista Outdoor, Overland Park, Kansas) installed 0.5 m to 1.5 m above the ground at different points between 2,500 m and 3,380 m. Traps were placed on trails, inside the forest, and adjacent to water bodies where mammal footprints or traces were observed. Camera traps were set to operate for 24 hr, recording a 31-sec video and a sequence of 3 photos with a 1-sec interval between photos. Indirect traces were obtained during the surveys and trap installation tours. All traps were marked with reflective tape and georeferenced with a Garmin GPSmap 62s handheld navigator.

Each captured individual was measured following the guidelines by DeBlase and Martin (1975), Simmons and Muñoz-Saba (2005), and Brito (2013). We collected data on sex, age, and reproductive status, and captured a photographic record of each individual. To avoid recounting individuals, the rodents and bats captured were marked with a rabbit tattoo on the ear and at the base of the dactylopathagium, respectively. Since there are no previous studies on mammals in the PRCPM and as per the recommendations of Barquez *et al.* (2021), advocating the collection of at least 1 specimen to document the systematic identity of the species studied in a site of ecological interest, we carried out the first collections of skin, skull, and liver (preserved in Eppendorf tubes and 96 % alcohol, as needed) of small mammals, under the collection permit provided by the cooperation agreement No. 352 of 2016 between the Alto Magdalena Regional Autonomous Corporation and the Francisco José de Caldas District University. All specimens from this study were deposited in the Natural History Museum at Francisco José de Caldas District University (MUD).

We assessed the representativeness of the sampling effort and success for each type of collection. For Sherman traps, sampling effort was calculated as the number of traps times the number of days, and success as the number of individuals captured divided by sampling effort, expressed as a percentage (Llaven-Macías 2013). For mist nets, these parameters were calculated as the sum of the total net meters times the number of sampling hours per night (Medellín 1993), and the number of individuals captured per square meter divided by the number of sampling hours, respectively (Pérez-Torres 2004). For camera traps, sampling effort was calculated as the number of hours times the number of days in operation, and success as the number of photographs per individual divided by the number of sampling days (Dillon 2005).

Regarding the individualization of the records obtained through indirect traces and camera traps, we assumed that the records were of different individuals whenever records were captured more than 2 hr apart (Díaz-Pulido and Payán 2012). For the analysis of mammal diversity, we tested the data for normality with the Shapiro-Wilk test using the Paleontological Statistics Software Package (PAST) v 4.0 (Hammer and Ryan 2001). As the data were not normally distributed ($P < 0.05$), we used non-parametric methods. To compare different sampling efforts, we plotted rarefaction, extrapolation, and sampling cover curves with the iNEXT function in R with a 0.95 confidence interval and 100 replicates. To assess alpha diversity in terms of composition and evenness, we calculated Fisher's alpha, Simpson's dominance, and evenness within the structure with the

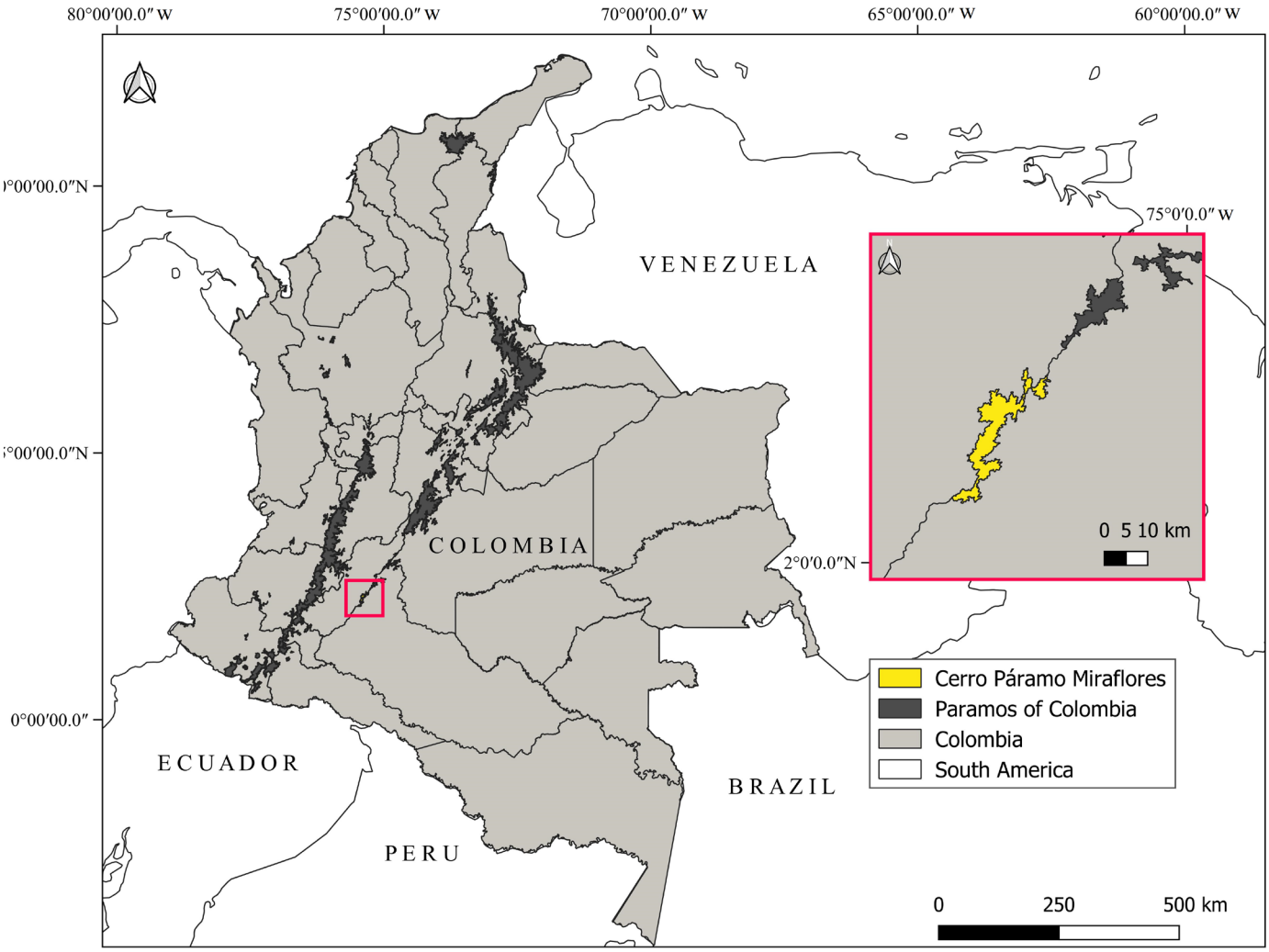

Figure 1. Geographic location of the Cerro Páramo Miraflores Regional Natural Park, Huila, Colombia.

Shannon-Wiener index. Beta diversity was estimated with the Whittaker and Morisita-Horn indices to analyze the species exchange and similarity between the zones. Alpha and beta diversity indices were estimated with the Vegan package in R (Oksanen *et al.* 2022; R Core Team 2023). We tested for statistically significant differences (95 %) between the alpha diversity of each stipe using a Mann-Whitney U test in the PAST v 4.0 program (Hammer and Ryan 2001).

We recorded a total of 80 specimens of mammals in the PRCPM, belonging to 21 species in 11 families and 8 orders (Table 1). Seven species correspond to small terrestrial mammals, 7 to small flying mammals, and 7 to medium and large mammals (6 captured with camera traps and only 1 was detected through indirect traces). The most abundant species were *Thomasomys dispar* (22.5 %), *T. baeops* (13.75 %), and *Sturnira erythromos* (8.75 %). The total sampling effort for small terrestrial mammals was 1,780 traps/day with a success rate of 2.2 %; for flying mammals, it was 15,984 net-m/hr, with a success rate of 0.12 %; and for medium and large mammals, it was 1,248 camera trap-hr/day, with a success rate of 14.38 %.

We obtained 39 captures of 38 individuals belonging to the orders Eulipotyphla, Paucituberculata, Rodentia, and Didelphimorphia, and 20 captures without recapture of the order Chiroptera. As for medium and large mammals, we recorded the orders Carnivora, Cetartiodactyla, Lagomorpha, and Rodentia by camera traps and indirect traces (Table 1).

The rarefaction and extrapolation curves show a higher species diversity associated with larger numbers of individuals captured. In the high Andean zone, a larger number of species were recorded (16 species, 59 individuals). Since the curve does not reach the expected asymptote, this can be interpreted as a positive relationship, *i.e.*, a large number of individuals recorded would be associated with a larger number of species in the area (Figure 2a). In the sub-páramo zone, although a smaller number of species was observed (8 species, 21 individuals), this number would not tend to increase with a larger number of individuals recorded (Figure 2a). Thus, sampling completeness was 88 % for the high Andean zone and 92 % for the sub-páramo zone; accordingly, the sampling effort should be increased in this former zone (Figure 2b).

Table 1. Species, type of capture, IUCN threat category, number of individuals captured, and relative abundance of each species of terrestrial and flying mammals recorded in the Cerro Páramo Miraflores Regional Natural Park. IUCN: International Union for Conservation of Nature. TS: Sherman Trap. RN: mist net. CT: camera trap. RI: indirect record. LC: Least Concern. DD: Data Deficient. VU: Vulnerable. CA: Near Threatened.

	Order	Family	Species	Capture method/ record	IUCN threat category	High Andean zone	Sub-páramo zone	Total	Total relative abundance
Small terrestrial mammals	Didelphimorphia	Didelphidae	*Marmosops sp*	TS		1	0	1	0.01
	Paucituberculata	Caenolestidae	*Caenolestes fuliginosus*	TS	LC	4	0	4	0.05
	Eulipotyphla	Soricidae	*Cryptotis squamipes*	TS	LC	1	0	1	0.01
			Neomicroxus bogotensis	TS	LC	1	0	1	0.01
			Thomasomys baeops	TS	DD	11	0	11	0.14
			Thomasomys dispar	TS	LC	16	2	18	0.23
	Rodentia	Cricetidae	*Thomasomys princeps*	TS	DD	3	0	3	0.04
			Anoura latidens	RN	LC	2	0	2	0.03
			Platyrrhinus nigellus	RN	LC	3	0	3	0.04
			Sturnira bidens	RN	LC	0	2	2	0.03
Flying mammals			*Sturnira erythromos*	RN	LC	6	1	7	0.09
		Phyllostomidae	*Sturnira ludovici*	RN	LC	4	0	4	0.05
			Histiotus montanus	RN	LC	1	0	1	0.01
	Chiroptera	Vespertilionidae	*Myotis nigricans*	RN	LC	1	0	1	0.01
			Leopardus pardalis	CT	LC	1	0	1	0.01
			Leopardus tigrinus	CT	VU	0	1	1	0.01
		Felidae	*Puma concolor*	RI	LC	1	2	3	0.04
Medium and large mammals		Ursidae	*Tremarctos ornatus*	CT	VU	3	0	3	0.04
	Carnívora	Cervidae	*Mazama rufina*	CT	VU	0	6	6	0.08
	Rodentia	Cuniculidae	*Cuniculus taczanowskii*	CT	CA	0	5	5	0.06
	Lagomorpha	Leporidae	*Sylvilagus brasiliensis*	CT	LC	0	2	2	0.03
					Total	59	21	80	1.0

Fisher's alpha index showed similar richness values for the high Andean (8.82) and sub-páramo (7.82) zones. The Simpson dominance index showed values close to unity for both zones (high Andean zone = 0.8612, sub-páramo zone = 0.8209), indicating a marked dominance of some species in both areas (Moreno 2001). In the high Andean zone, this dominance may be represented by the number of catches of *Thomasomys dispar* (n = 16) *versus* the average number of catches for the remaining species (n = 3.5). On the other hand, the Shannon-Wiener index yielded intermediate diversity values according to Magurran (1988), of 2.317 for the high Andean zone and 1.885 for the sub-páramo zone. Despite the differences in species richness and abundance recorded between zones, these were not statistically significant (Z = -0.43, P = 0.66).

The Whittaker index showed a high species turnover between the zones (0.75). Only *T. dispar, S. erythromos,* and *P. concolor* were found in both zones. The Morisita-Horn index calculated a similarity of 0.32, given the relative abundance of the 3 common species across the zones studied. Similarly, the Morisita-Horn index indicates that, due to the number of records of common species in both zones, the probability of finding *S. erytrhormos* and *T. dispar* is higher in the high Andean zone than in the sub-páramo, while the opposite occurs with *P. concolor*. We also highlight the presence of the substitute species *Tremarctos ornatus, Puma concolor, Leopardus pardalis*, and *L. tigrinus,* as well as new geographic records of *Neomicroxus bogotensis* (MUD-M1370), *Thomasomys princeps* (MUD-M1371), *Cryptotis squamipes* (MUD-M1374), and *Histiotus montanus* (MUD-M1367) for the department of Huila.

The 21 species recorded in the PRCPM represent about 40 % of the species that thrive above 2,700 m in the department of Huila (Solari *et al.* 2013). The higher richness observed in the orders Chiroptera, Rodentia, and Carnivora is not entirely usual in the tropical Andes, where rodent richness is usually higher than bat richness with increasing height (Mena *et al.* 2012). Nonetheless, small terrestrial mammals were the most abundant group.

The diversity of rodents can be associated with their use of different plant covers where they can move without making much noise and which serve as camouflage (Barnum *et al.* 1992; López-Arévalo *et al.* 1993). Likewise, the presence of the remaining small terrestrial mammals is worth highlighting, as they are species that live in inhospitable regions and are difficult to capture, so they are also scarcely represented in biological collections (Guevara 2019).

The presence of insectivores, frugivores, and nectarivores of the order Chiroptera has been related to the availability and abundance of food resources for all these trophic

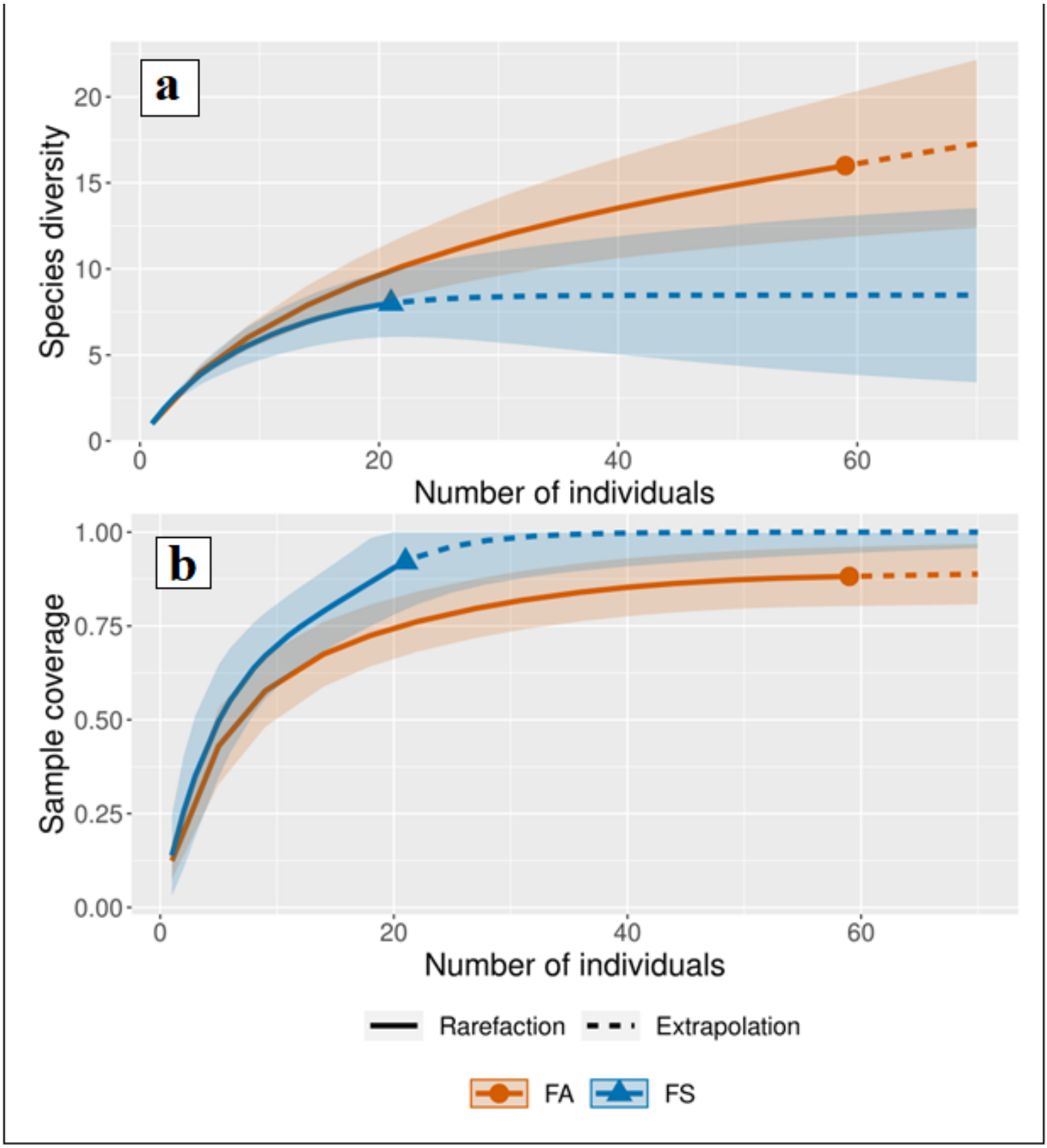

Figure 2. Rarefaction and extrapolation curves of terrestrial and flying mammals recorded in the high Andean and sub-páramo Belt of Cerro Páramo Miraflores Regional Park, Huila, Colombia, based on sample size (a) and sample cover (b). FA: high Andean zone. FS: Sub-páramo zone.

guilds (Pérez-Torres 2004; Loayza *et al.* 2006). On the other hand, the presence of carnivores in high Andean forests and sub-páramo areas has been associated with the availability of large prey such as *Mazama rufina* and *Cuniculus taczanowskii,* in addition to small vertebrates such as rodents and marsupials (Chinchilla 1997; Pacheco Jaimes *et al.* 2018). Therefore, we also highlight the presence of the order Carnivora, since its species are also frequently used as a conservation badge (Beschta and Ripple 2009; Kattan *et al.* 2014).

The low abundance and richness of the sub-páramo zone agrees with Muñoz-Saba (2015), according to whom this zone is the least diverse of the páramo ecosystems, partly due to the change in the heterogeneity of niches and habitats (Suárez del Moral and Chacón-Moreno 2011).

Species similarity between 2 localities may be positively related to distances of 2 to 3 km that can be easily traveled (Rodríguez *et al.* 2003). In the PRCPM, both sampled zones are contiguous and the abundance of small mammals suggests that these species are dispersed over an area larger than the one delimited for each zone or are able to travel distances that include both zones (Galindo-González 1998). Likewise, the wide displacement exhibited by large carnivores makes it feasible for them to move across the 2 zones, even if their presence in the sub-páramo zone is temporary (Muñoz-Saba 2015).

By contrasting our results with those obtained in 10 páramos of the Andes (López-Arévalo *et al.* 1993; Pérez-Torres and Correa 1995; Vargas Ríos and Pedraza 2004; Mejía Correa 2009; Tirira and Boada 2009; Viancha Sánchez *et al.* 2012; Brito 2013; Díazgranados 2015; Medina *et al.* 2015; Muñoz-Saba 2015), the southernmost points in the El Carchi region of Ecuador (Tirira and Boada 2009; Brito 2013) show the most similar conditions within the reference group. However, the lowest similarity in the composition of mammals was observed relative to these and other surrounding areas. As a northernmost point, we considered the Serranía del Perijá (Corredor-Carrillo and Muñoz-Saba 2007), where bats were captured at lower altitudes, similar to other studies. However, it represents one of the sites with the highest number of species shared with the PRCPM, along with the Chingaza National Natural Park, also north of the Andes (Appendix 1).

The PRCPM is home to species typical of conserved environments, rodents associated with a high shrub density, bats of various trophic guilds, large carnivores, and medium-sized prey. This diversity of mammal groups can be a positive indicator of the conservation status of its highlands and the importance of preserving this area. For this reason, it is recommended to carry out conservation actions to protect the diversity of the area, along with a greater research effort.

Acknowledgements

This study was funded as part of a cooperation agreement signed between the Alto Magdalena Regional Autonomous Corporation (CAM, in Spanish) and the Francisco José de Caldas District University, within the framework of the project to update the management plan of the Cerro Páramo Miraflores Regional Natural Park. We would like to thank the High Mountain Biodiversity Laboratory for facilitating the equipment for fieldwork. We also thank the local communities and ranchers of Garzón, Huila, as well as the Cacique Pigoanza #24 battalion for their assistance and efforts to optimize the search for mammals. The comments from 2 anonymous reviewers contributed to improving this note. M. E. Sánchez-Salazar translated the manuscript into English.

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Associated editor: Jorge Ayala Berdón.
Submitted: September 16, 2023; Reviewed: February 15, 2024.
Accepted: April 16, 2024; Published on line: April 29, 2024.

Appendix 1

Terrestrial and flying mammal species reported in 11 páramos of the Andes. PNR: Regional National Park. PNN: Natural National Park. Mi: Cerro Páramo Miraflores PNR. Ca: Carpanta Biological Reserve. Ch: Chingaza PNN. Su: Sumapaz PNN. Pu: Puracé PNN. Mu: Munchique. Sp: Serranía de Perijá. Pr: Rabanal páramo. Ra: Ranchería-Paipa PNR. Ec: El Carchi Province, Ecuador. An: El Angel Ecological Reserve.

Order	Species	Mi	Ca	Ch	Su	Pu	Mu	Sp	Pr	Ra	Ec	An
Didelphimorphia	*Didelphis marsupialis*			x				x				
	Didelphis pernigra							x	x			
	Didelphis albiventris		x	x		x						
	Marmosa sensu lato									x		
Paucituberculata	*Marmosops sp.*	**x**										
	Caenolestes fuliginosus	**x**	x	x		x				x	x	x
	Caenolestes obscurus		x									
Cingulata	*Cabassous unicinctus*							x				
	Dasypus novemcinctus							x	x			
Pilosa	*Bradypus variegatus*							x				
	Tamandua mexicana							x				
Eulipotyphla	*Cryptotis squamipes*	**x**										
	Cryptotis thomasi		x	x				x	x	x		
Chiroptera	*Mormoops megalophylla*										x	
	Anoura geoffroyi			x							x	
	Anoura latidens	**x**										
	Dermanura bogotensis							x				
	Platyrrhinus nigellus	**x**						x				
	Platyrrhinus vittatus							x				
	Sturnira bidens	**x**		x							x	
	Sturnira bogotensis			x								
	Sturnira erythromos	**x**		x	x	x		x			x	
	Sturnira ludovici	**x**										
	Eptesicus andinus										x	
	Histiotus montanus	**x**					x	x	x		x	
	Myotis nigricans	**x**					x	x				
	Myotis oxyotus										x	
Carnívora	*Leopardus pardalis*	**x**						x				
	Leopardus tigrinus	**x**	x	x	x							
	Leopardus wiedii							x				
	Puma concolor	**x**		x	x	x		x				
	Puma yagouaroundi			x								
	Cerdocyon thous			x				x				
	Lycalopex culpaeus					x						
	Urocyon cinereoargenteus		x						x			
	Conepatus semistriatus							x				
	Eira barbara		x					x				
	Mustela frenata			x		x			x			
	Bassaricyon gabbii							x				
Perissodactyla	*Nasua nasua*		x		x		x					
	Nasuella olivacea		x	x	x	x	x	x				
	Tremarctos ornatus	**x**	x		x		x	x				
	Tapirus pinchaque			x		x						
Artiodactyla	*Tayassu pecari*							x				
	Mazama rufina	**x**	x	x	x	x	x	x	x			
	Odocoileus virginianus		x	x	x			x				
Primates	*Pudu mephistophiles*					x	x					
	Alouatta seniculus		x				x					

	Sciurus granatensis		x	x				x				
	Reithrodontomys mexicanus					x						
	Reithrodontomys soderstromi										x	x
	Akodon laterbricola											x
	Akodon mollis										x	x
	Chilomys instans									x		
	Microryzomys altissimus											x
	Microryzomys minutus		x	x				x	x	x		
	Neomicroxus bogotensis	**x**	x	x	x			x	x	x		
	Nephelomys albigularis									x	x	
	Oligoryzomys fulvescens									x		
	Oryzomys albigularis		x					x				
	Rhipidomys caucensis						x					
	Rhipidomys fulviventer									x		
	Rhipidomys latimanus			x								
	Thomasomys aureus		x							x		x
Rodentia	*Thomasomys baeops*	**x**									x	x
	Thomasomys cinereiventer					x						
	Thomasomys cinnameus										x	
	Thomasomys dispar	**x**										
	Thomasomys laniger		x	x						x		
	Thomasomys niveipes		x	x	x				x	x		
	Thomasomys paramorum										x	x
	Thomasomys princeps	**x**										
	Thomasomys rhoadsi											x
	Cavia aperea								x			
	Cavia porcellus		x	x	x			x				
	Cuniculus paca							x				
	Cuniculus taczanowskii	**x**	x	x				x	x			
	Dasyprocta punctata							x				
	Dinomys branickii		x	x								
	Olallamys albicauda		x	x								
Lagomorpha	*Sylvilagus brasiliensis*	**x**	x	x	x			x	x			

THERYA NOTES 2024, Vol. 5 : 79-83 DOI: 10.12933/therya_notes-24-153 ISSN 2954-3614

Big eyes on the Island: First record of *Chiroderma villosum* of Cozumel Island, México and bat species richness in the Caribbean islands

Grandes ojos en la Isla: Primer registro de *Chiroderma villosum* para Isla Cozumel, México y riqueza de especies de murciélagos en las Islas del Caribe

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The closest record of *Chiroderma villosum* to Isla Cozumel is documented in the city of Playa del Carmen, Quintana Roo. Here we report the first record of *C. villosum* for Cozumel Island, and compile information on the richness of bat species in the Caribbean Islands. Mist nets were deployed on May 5, 2021 at ground level to capture bats in the forest. Each individual was processed as follows: forearm length taken with a caliper to the closest mm, and body mass was taken with a digital scale with 1g precision. Bats were identified following the bat field key of México. In one evening we captured 8 individuals of *Artibeus jamaicensis*. In addition, 1 non-reproductive, adult male of *C. villosum* was captured at 21:45 hr in a mist net crossing a trail in the semideciduous rainforest in the northwest of the San Gervasio archaeological site. So far, 19 species of bats corresponding to 5 families have been documented in Cozumel Island, the record of this specimen increases the number of species of bats present on the island to 20 species and 16 genera. More studies are still needed, but it is very likely that this species is widespread in all forested areas in Cozumel.

Key words: Bats; mist netting; monitoring; semideciduous rainforest; species diversity.

El registro más cercano de *Chiroderma villosum* a Isla Cozumel, está documentado en la ciudad de Playa del Carmen, Quintana Roo. En este trabajo documentamos el primer registro del murciélago *C. villosum* para Isla Cozumel y compilamos la información sobre la riqueza de especies de murciélagos en las Islas del Caribe. El 5 de mayo de 2021 se realizó una salida de campo, se instalaron redes de niebla a nivel del suelo. Posteriormente se tomaron los siguientes datos de cada individuo capturado: medidas del antebrazo con un vernier con una precisión de 1 mm, se tomó el peso con una báscula digital con precisión de 1 g, y se identificó la especie siguiendo la clave de murciélagos de México. Durante la noche de trabajo se capturaron 8 individuos de *Artibeus jamaicensis* y un ejemplar macho adulto no reproductivo de *C. villosum* a las 21:45 hr en una red de niebla colocada cruzando una brecha dentro de la selva mediana en el noroeste de la zona arqueológica de San Gervasio. En Isla Cozumel se han documentado 19 especies de murciélagos correspondientes a 5 familias y 15 géneros. Con el registro de este espécimen, se incrementa a 20 el número de especies y a 16 géneros de quirópteros presentes en la isla. Aunque todavía faltan más estudios, es muy probable que esta especie tenga una distribución amplia en todas las áreas de bosque en Cozumel.

Palabras clave: Diversidad de especies; monitoreos; quirópteros; red de niebla; selva mediana.

Islands are excellent places to study biodiversity, since many of them allow us to examine entire communities of plants and animals where the different factors that shape these groups can be determined. Archipelagos are dynamically affected by climatic, ecological and geological processes showing a variety of habitats and topographic variability, and, in more recent times, the influence of human actions (Fernández-Palacios *et al.* 2021). The Caribbean islands are one of the most significant centers of endemic biodiversity in the world (CienciaPR 2006). In this archipelago, 44 different species of bats are recognized, corresponding to 5 families (6 Mormoopidae, 7 Natalidae, 17 Phyllostomidae, 3 Molossidae and 11 Vespertilionidae). The most bat diverse countries are Cuba and Jamaica, the first with 6 endemics and the second with 5 (Díaz *et al.* 2021).

The genus *Chiroderma* comprises 7 species of bats that live from western and northern México to southern Brazil and west to the Lesser Antilles (da Rocha *et al.* 2015). These bats are characterized by having proportionally very large eyes and the absence of a nasal bone (Medellín *et*

al. 2008; Garbino 2019). In México, 3 of these species are found: *C. salvini* (Dobson, 1878), distributed from México to Bolivia (Garbino *et al.* 2020); *C. scopaeum* (Handley, 1966), a species endemic to western México previously considered as a subspecies of *C. salvini*; and *C. villosum* (Peters, 1860), distributed in the eastern and southeastern region of the country (Medellín *et al.* 2008).

Bats of the genus *Chiroderma* act more as seed predators than as seed dispersers. After extracting juice from the fruit pulp, they chew the seeds thoroughly and spit out small fragments or swallow and digest the seed fragments, excreting four times fewer intact seeds than *Artibeus watsoni* (Thomas, 1901; Wagner *et al.* 2015). Its reproductive cycle corresponds to a bimodal pattern with 2 birth peaks, 1 at the beginning of the rainy season and another towards the end of the season, which is typical of the Stenodermatinae subfamily (Garbino 2019; Fleming *et al.* 2020).

Species of the genus *Chiroderma* are small to medium-sized bats (forearm length = 38–54 mm; weight = 12–26 g). The color of the back varies from pale reddish brown to olive and olive brown on the belly. They have white facial stripes that vary in intensity depending on the species, and some species have a faint white line on their back (Gardner 2007; Díaz *et al.* 2016).

Chiroderma villosum, commonly known as the "hairy eyed bat," can be differentiated from other species of the genus *Chiroderma* by the faint or imperceptible facial and dorsal lines, the tricolor dorsal fur, and the presence of long guard hairs that protrude noticeably from the rest of the fur on the back. The upper central incisors of *C. villosum* are thin and parallel to each other, not convergent as in *C. salvini* (Gardner 2007; Medellín *et al.* 2008; Garbino 2019; York *et al.* 2019).

Chiroderma villosum has been documented in the Dzilam State Reserve located northwest of Yucatán (Sosa-Escalante *et al.* 2001) and in the city of Playa del Carmen, Quintana Roo (Birney *et al.* 1974), being the closest point of land to Cozumel Island, at a distance of ~ 20 km (Orellana *et al.* 2007). In Quintana Roo, on the islands of Holbox and Isla Mujeres there are no published records on the presence of bat species and in Banco Chinchorro there is the only record of a *Rhogeessa aeneus* (Charruau *et al.* 2021). Cozumel Island is the third largest island in México after Tiburón Island and Ángel de la Guarda Island, both in the Sea of Cortés. So far, 19 species of bats corresponding to 5 families have been recorded on Cozumel Island (8 Phyllostomidae, 1 Mormoopidae, 1 Natalidae, 4 Molossidae and 5 Vespertilionidae; Rivas-Camo *et al.* 2020). In this work: 1) we document the first record of the bat *C. villosum* for Isla Cozumel, 2) we update the number of bat species present on the island, and 3) we compile information on the diversity of bat species in the islands of the Caribbean and the area surface that each island has.

Cozumel Island is located 20 km southeast of Playa del Carmen, off the coast of Quintana Roo (20° 26' N, 86° 55' W). It is an oceanic island of coral origin and is the largest in the Mexican Caribbean with an area of almost 480 km^2 (Morales-Contreras *et al.* 2020). The average annual temperature is 25.5 ºC, maximum 39 ºC and minimum 20 ºC. The average annual precipitation is 1,570 mm. The vegetation presents a well-defined gradient, starting from the eastern coastal strip with halophyte vegetation of coastal dunes followed by the savannah, the mangrove, the low deciduous forest and culminates with the medium sub-deciduous forest from the central portion of the island to the west coast, where patches of mangrove forest also persist. The low deciduous and medium sub-deciduous forest cover almost 70 % of the island's surface (CONANP 2007; Duran *et al.* 2010).

In the last 6 years monitoring work under the Directorate of Conservation and Environmental Education of the Foundation of Parks and Museums of Cozumel, which aims to promote development of scientific studies and environmental culture, has been carried out to document the bat fauna in the archaeological area of San Gervasio (20° 30′ 0.82″ N, 86° 50′ 47.89″ W; Figure 1). The forest is composed primarily of 2 arboreal strata between 8 and 20 m in height, and there is a sparse shrub-herbaceous stratum (Reynoso-Campos *et al.* 2015). In this subdeciduous medium forest, there is a predominance of *Manilkara zapota* (zapote), *Esenbeckia pentaphylla* (hoocop), *Cedrela odorata* (red cedar), *Psidium sartorianum* (pichiche), *Bursera simaruba* (chacah), *Metopium brownei* (chechem), *Lysiloma latisiliqua* (tzuk-te), *Pithecellobium platylobum* (chacojo), *Piscidia piscipula* (yellow), *Picramnia andicola* (light yellow), *Pithecellobium* sp. (common name unknown), *Lysiloma latisiliqua* (tsalam), and *Ceiba aesculifolia* (ceiba).

To detect and capture bats we used the direct capture method 1 night a month in the archaeological zone of San Gervasio, where we installed 3 mist nets of 2 m x 2 m, 6 m x 2 and 12 m x 2. The nets were opened at 18:00 hr and

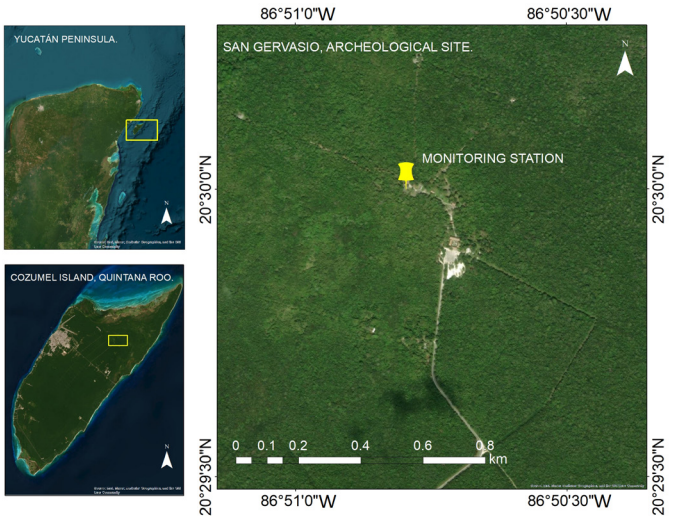

Figure 1. Study area in the San Gervasio Archaeological Zone in the northwest of Isla Cozumel, Quintana Roo, México, where the individual of *Chiroderma villosum* was captured.

closed at 24:00 hr coinciding with the peak of bat activity at the beginning of the night (Turcios-Casco *et al.* 2021). The nets were checked approximately every 10 to 15 min to avoid stress on the captured animals. Subsequently, measurements of the forearm were taken with a Truper CAL-6MP analog vernier caliper and the weight was taken with a digital scale with a precision of 1 g. The captured bats were identified following Medellín *et al.* (2008).

To prepare the list of Caribbean islands and their diversity of bat species, a literature review containing recent information on the bats present on these islands was carried out following Díaz *et al.* (2021) and Caribbean Atlas (2024).

On May 5, 2021, during the monthly monitoring of the Cozumel Island Bat Species Diversity project, 8 individuals of *Artibeus jamaicensis* (Leach, 1821) and a non-reproductive adult male specimen of *C. villosum* were captured (Figure 2) at 21:45 hr in a 12 m mist net placed over a gap within the semideciduous rainforest in the northwest of the San Gervasio archaeological zone (Figure 1). The *C. villosum's* forearm measurement was 47 mm and the weight was 24.3 g. The identification of the species was carried out through the morphometric characteristics of the genus *Chiroderma* by the absence of the nasal bone, the proportionally larger eyes and the measurement of the forearm (Medellín *et al.* 2008; Garbino 2019).

The record of this specimen increases the number of bat species present on the island to 20 and the number of genera to 16 (Table 1; SEMARNAT 2010; Simmons and Cirranello 2024). Biogeographic characteristics, such as different types of habitats, are closely related to the relief, climate, soil, flora and fauna characteristics of the region and, in the case of Cozumel, its proximity to the Yucatán Peninsula and the Antilles, place Cozumel as one of the Mexican islands with the greatest diversity of bat species and the Caribbean islands with the most bat species (Table 1). With 20 species, Cozumel Island has the 4th most bat diversity, following Trinidad and Tobago with 67, Cuba with 26 and Jamaica with 22 (Table 2).

In this study, 20 species of bats corresponding to 16 genera organized into 5 families have been recorded in Cozumel. Among them, 6 species of the Stenodermatinae subfamily are reported, including *Phyllops falcatus* (Gray, 1839) that lives in the Greater Antilles (Rivas-Camo *et al.* 2020) and the new record of *Chiroderma villosum*.

It is very likely that *C. villosum* has a wide distribution in all semideciduous rainforest areas in Cozumel, since 40 % of the flora reported in the state of Quintana Roo is represented on the island (Téllez-Valdez *et al.* 1989). In addition, monitoring efforts have focused solely on the archaeological site of San Gervasio because it is an area managed by the Cozumel Parks and Museums Foundation and because current resources limit study expansion to other points on the island.

Hurricanes appear to have a severe negative effect on bat and bird populations (Pedersen *et al.* 1996; Rodríguez-Durán and Kunz 2001), but for *P. falcatus,* hurricanes have allowed this species to reach and colonize a new area (Rivas-Camo *et al.* 2020). The influence of hurricanes on the dispersion of bat species on other Caribbean islands among other dispersion factors over the sea could suggest that with greater sampling effort and a permanent study program it is likely to continue recording additional species. There is a pattern of increasing richness with proximity to the continent, as is the case with Trinidad and Tobago, which despite being less than half the land area of Cuba, has more than twice as many bat species, presumably related to its proximity to Venezuela.

Bat monitoring in Cozumel is a program that contributes to understanding the functioning of the island's ecosystem and seeing how this large island is linked to the mainland and to other Caribbean Islands. Only by continuing with the research and monitoring projects can we be in a position to prepare a management and conservation plan that is consistent, complete, and with a robust and deep knowledge of the island's biodiversity.

Table 1. Richness of bat species on Cozumel Island, Quintana Roo, México and risk category according to the official Mexican Standard NOM-059-SEMARNAT-2010.

List of Species	NOM-059-SEMARNAT-2010 Status
FAMILY PHYLLOSTOMIDAE	
Artibeus jamaicensis	
Artibeus lituratus	
Artibeus phaeotis	
Centurio senex	
Glossophaga mutica	
Micronycteris microtis	
Mimon cozumelae	Threatened
Phyllops falcatus	
Chiroderma villosum	
FAMILY MORMOOPIDAE	
Pteronotus mesoamericanus	
FAMILY NATALIDAE	
Natalus mexicanus	
FAMILY MOLOSSIDAE	
Eumops bonariensis	
Molossus alvarezi	
Molossus nigricans	
Nyctinomops laticaudatus	
FAMILY VESPERTILIONIDAE	
Eptesicus furinalis	
Lasiurus frantzii	
Lasiurus ega	
Myotis pilosatibialis	
Rhogeessa aeneus	

Table 2. Number of bat species and territorial extension of Caribbean Islands.

Island	Bat species registered	Extension (km²)	Reference
Trinidad and Tobago	67	5,128	Díaz *et al*. 2021
Cuba	26	110,860	Mancina *et al.* 2007
Jamaica	22	10,991	McFarlene 1986; Díaz *et al*. 2021
Cozumel	20	647	This study
Haiti	17	27,750	Díaz *et al*. 2021
Dominican Republic	18	48,670	Díaz *et al*. 2021
Grenada	15	344	Díaz *et al*. 2021
Guadeloupe	13	1,631	Díaz *et al*. 2021
Puerto Rico	13	8,959	Gannon *et al*. 2006
Dominica	12	751	Díaz *et al*. 2021
Martinique	11	1,128	Díaz *et al*. 2021
Montserrat	11	102	Díaz *et al*. 2021
Saint Vincent and the Grenadines	11	389	Díaz *et al*. 2021
Bahamas	10	13,939	Speer *et al.* 2015
Barbados	10	430	Díaz *et al*. 2021
Bonaire	10	288	Díaz *et al*. 2021
Saint Kitts and Nevis	10	269	Díaz *et al*. 2021
Saba	9	13	Díaz *et al*. 2021
Saint Lucia	9	616	Díaz *et al*. 2021
Saint Eustatius	8	21	Díaz *et al*. 2021
Aruba	7	193	Díaz *et al*. 2021
Antigua and Barbuda	7	442	Díaz *et al*. 2021
Curacao	6	444	Díaz *et al*. 2021
Cayman Island	6	250	Díaz *et al*. 2021
Anguilla	5	91	Díaz *et al*. 2021
British Virgin Islands	4	153	Díaz *et al*. 2021
United States Virgin Islands	4	347	Díaz *et al*. 2021
Saint Maarten	4	53	Díaz *et al*. 2021
Bermudas	3	56	Díaz *et al*. 2021
Saint Barth	2	21	Díaz *et al*. 2021
Turks and Caicos Islands	2	430	Díaz *et al*. 2021

Acknowledgements

To Dr. C. Moreno for her technical support, the Cozumel Parks and Museums Foundation, R. Peralta, A. Chale for their support in the field during the monitoring days in the semideciduous rainforest of Cozumel, to C. Selem, C. MacSwiney, B. R. Herrera and J. Cruzado Cortés for their advice. To J. MacRae for the translation of the text into English and to the anonymous reviewers whose comments helped improve this manuscript.

Figure 2. Adult male of *Chiroderma villosum* captured in the San Gervasio Archaeological Zone, Cozumel Island, Quintana Roo, México (Photograph: P. Sabido). Image available at rivas1988@hotmail.com.

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Associated editor: Jorge Ayala Berdón.
Submitted: January 9, 2024; Reviewed: March 29, 2024.
Accepted: April 22, 2024; Published on line: April 30, 2024.