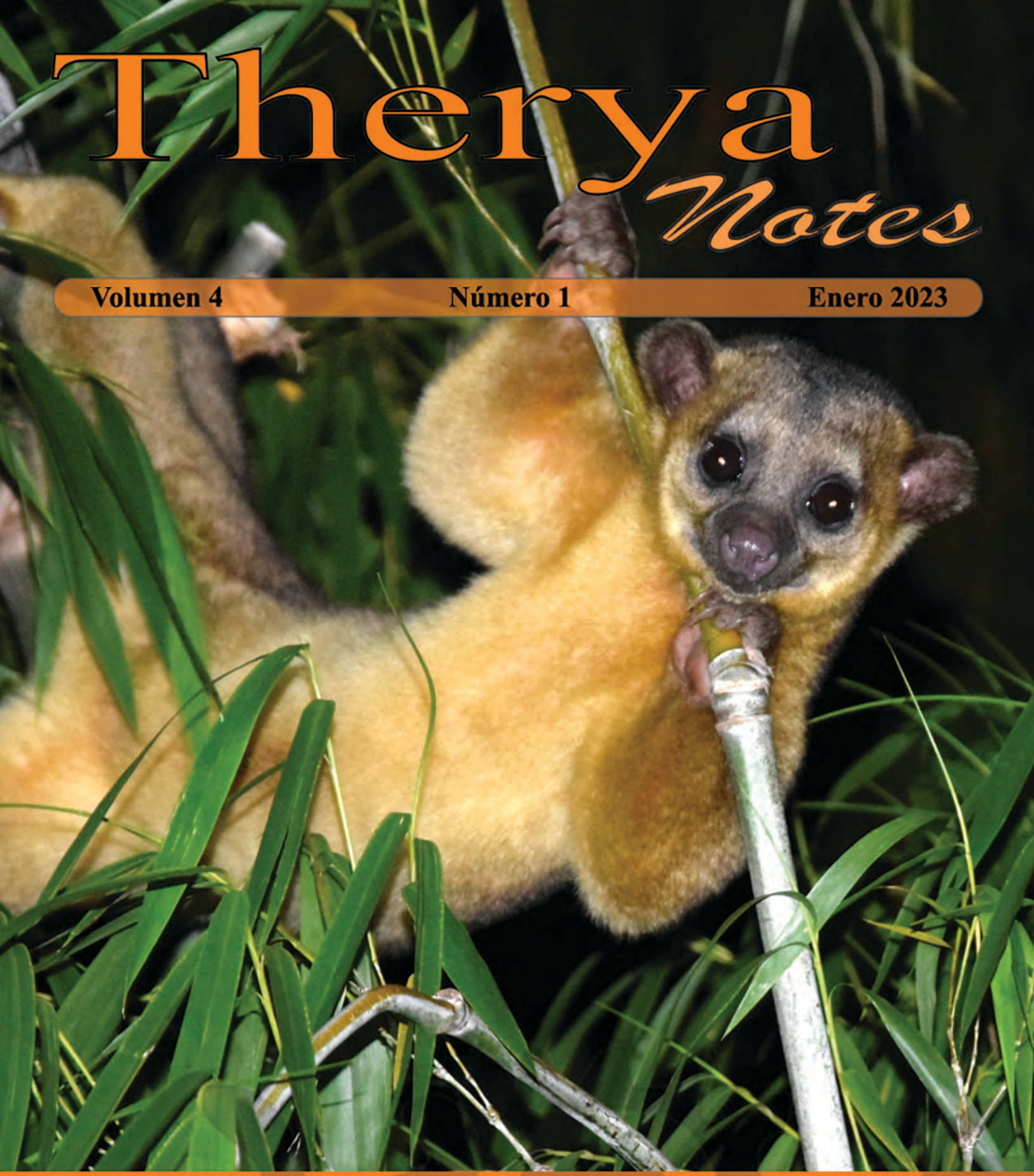
Therya Notes

Volumen 4 Número 1 Enero 2023



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

Los fragmentos de bosques que aún persisten dentro de los ambientes antropizados, juegan un papel fundamental en la conservación de diferentes especies de animales. Diferentes organismos, usan los fragmentos de bosque como hábitats permanentes o como corredores de paso dentro de los agropaisajes. En la imagen se observa un ejemplar de *Potos flavus* en su hábitat.
(Fotografía de Mopan-Chilito et al. 2023)

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 4, fascículo 1, enero - abril 2023, 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 2023.

EQUIPO EDITORIAL

Dra. Beatríz del S. Bolívar Cimé
Universidad Veracruzana, Instituto de Investigaciones Forestales
Parque Ecológico "El Haya", carretera antigua a Coatepec, C.P. 91070. Xalapa, Veracruz, México.

Dra. Dulce Itandehui Hernández Aguilar
Laboratorio de Ecología Animal
Centro Interdisciplinario de Investigación para el Desarrollo Integral Regional
CIIDIR-Unidad Oaxaca, Instituto Politécnico Nacional

Dr. Jesús Rafael Hernández Montero
Departamento de Zoología Aplicada y Conservación de la Naturaleza
Instituto y Museo Zoológico - Universidad de Greifswald
Greifswald, Mecklemburgo-Pomerania Occidental, Alemania

Dr. Cristian Kraker Castañeda
El Colegio de la Frontera Sur, (ECOSUR)
Carretera Panamericana y Periférico Sur s/n, Barrio María Auxiliadora, C. P. 29290. San Cristóbal de Las Casas, Chiapas, México.

Dr. José Fernando Moreira Ramírez
Wildlife Conservation Society, Programa para Guatemala
Avenida 15 de marzo casa número 3, Flores Petén, Dirección alterna: 13 calle A 1-26 zona 3, Finca El Zapote. Ciudad de Guatemala, Guatemala.

Dra. Nicté Ordóñez Garza
Universidad San Francisco de Quito
Laboratorio de Biología Evolutiva, Instituto Biosfera, Colegio de Ciencias Biológicas, Avenida Pampite S/N y Diego de Robles, Campus Cumbayá. Quito, Ecuador.

Dra. Tamara Mila Rioja Paradela
Posgrado en Ciencias en Desarrollo Sustentable y Gestión de Riesgos
Universidad de Ciencias y Artes de Chiapas
Libramiento Norte Poniente, No. 1150, Col. Lajas Maciel, C. P. 29039. Tuxtla Gutiérrez, Chiapas, México.

Dr. Romeo A. Saldaña Vázquez
Instituto de Investigaciones en Medio Ambiente Xavier Gorostiaga, S.J.
Universidad Iberoamericana Puebla, Blvd. del Niño Poblano No. 2901,
Col. Reserva Territorial Atlixcáyotl, C. P. 72820. San Andrés Cholula, Puebla.

CONTENIDO

THERYA NOTES 2023, Vol. 4 : 1-6 DOI: 10.12933/therya_notes-23-97 ISSN 2954-3614

Comments on reproduction of *Myotis dinellii* in San Juan, Argentina

Observaciones sobre la reproducción de *Myotis dinellii* en San Juan, Argentina

Gustavo A. Rivero-Castro[1,2,3,4]*, Elias G. Ruiz-Estebes[2,3,4], Lilen Sánchez-Castro[2,3,4], Nicolás J. Maya[2,3,4], Héctor J. Amoni-Sacchi[2,3,4], and Orlando G. A. Pastrán-López[2,3,4]

[1]Centro de Investigaciones de la Geósfera y la Biósfera (CIGEOBIO), Universidad Nacional de San Juan (UNSJ) – Complejo Universitario Islas Malvinas (CUIM) y Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET). Av. I. de la Roza 590 (O), C. P. J5402DCS, Rivadavia. San Juan, Argentina. E-mail: grivero@unsj-cuim.edu.ar (GAR-C).

[2]Grupo de Investigación y Conservación de Murciélagos de Zonas Áridas (GICMZA). Salta 1737 (N), C. P. 5400. San Juan, Argentina. E-mail: elias16147@gmail.com (EGR-E); lilensanchezcastro3@gmail.com (LS-C); mayanicolasj@gmail.com (NJM); amonih.1993@gmail.com (HJA-S); grabielpl11@gmail.com (OGAP-L).

[3]Programa de Conservación de los Murciélagos de Argentina (PCMA). Miguel Lillo 205, C. P. 4000, San Miguel de Tucumán. Tucumán, Argentina.

[4]Departamento de Biología, Facultad de Ciencias Exactas, Físicas y Naturales. UNSJ-CUIM. Av. I. de la Roza 590 (O), C. P. J5402DCS, Rivadavia. San Juan, Argentina.

*Corresponding author

Myotis dinellii forms groups of 3 to 80 individuals and inhabits natural and anthropic environments. Despite having a wide distribution in Argentina, the information available on its reproduction is scarce, so the aim of this paper is to provide information on its reproductive activity and fill some gaps in the knowledge of its biology. The reproductive activity of a colony of *M. dinellii* inhabiting a bridge (2.26 m high, 9.60 m long, 14 m wide) in the department of Ullum, San Juan, Argentina, was recorded. Two mist nets were placed on both sides of the bridge from 20:00 hr to 06:00 hr. Sex, age and reproductive condition were recorded for each specimen. From March 2018 to January 2020, with a sampling effort of 1,350 net-hr, 49 individuals were captured, consisting of 41 females (29 lactating and 12 non-lactating) and 8 males (4 with scrotal testes and 4 with abdominal testes). There were 29 births in the first days of December and lactation until the first days of January. The colony occupied the bridge from November to the beginning of March. These results constitute the first reproductive data of *M. dinellii* obtained from a systematic study of a colony. These studies are necessary to increase the general knowledge of the reproductive patterns of the species in Argentina.

Key words: Central western Argentina; colony; reproductive status; Vespertilionidae; yellowish bat.

Myotis dinellii forma grupos de 3 a 80 individuos y habita en ambientes naturales y antrópicos. A pesar de tener una amplia distribución en Argentina, la información disponible sobre su reproducción es escasa, por lo que el objetivo de este trabajo es proporcionar información referida a su actividad reproductiva y llenar algunos vacíos en el conocimiento de su biología. Se registró la actividad reproductiva de una colonia de *M. dinellii* que habita en un puente (2.26 m de alto, 9.60 m de largo, 14 m de ancho) en el departamento de Ullum, San Juan, Argentina. Se colocaron 2 redes de niebla en ambos lados del puente desde las 20:00 hr a 06:00 hr. De cada ejemplar se registró el sexo, edad y condición reproductiva. Desde marzo de 2018 a enero de 2020, con un esfuerzo de muestreo de 1,350 hr/red se capturaron 49 individuos, consistentes en 41 hembras (29 lactantes y 12 no lactantes) y 8 machos (4 con testículos escrotales y 4 con testículos abdominales). Se registraron 29 nacimientos en los primeros días del mes de diciembre y lactancia hasta los primeros días de enero. La colonia ocupó el puente desde noviembre hasta principios de marzo. Estos resultados constituyen los primeros datos reproductivos para *M. dinellii* basados en un seguimiento sistemático de una colonia. Estos estudios son necesarios para incrementar el conocimiento general de los patrones reproductivos de las especies en Argentina.

Palabras clave: Centro oeste de Argentina; colonia; estado reproductivo; murciélago amarillento; Vespertilionidae.

The reproductive cycle of bats is influenced by resource availability, rainfall and seasonality (Tuttle and Stevenson 1982; Racey and Entwistle 2000; Altringham 2011). Generally, species from temperate zones have one reproductive cycle with an annual birth peak (monoecious) and those from tropical zones have two annual cycles (polyesters), and may have a uni- or bimodal reproductive period with a long period of sexual inactivity, or they may reproduce continuously throughout the year (Racey and Entwistle 2000; Filho *et al.* 2007; Barclay and Fleming 2020).

Most vespertilionid bats from temperate areas display a seasonal monoestry, generally connected with hibernation (Krutzsch 2000; Araújo *et al.* 2013). They give birth from late spring to early summer, depending on insect

availability, which is in turn determined by rainfall patterns and increased temperature (Happold and Happold 1990; Hoying and Kunz 1998; Racey and Entwistle 2000; Burles *et al.* 2009; Araújo *et al.* 2013). However, resource availability and abundance do not always produce a positive energy effect on females, influencing their gestation stages and the end of the lactating periods (Marques-Aguiar 1986).

The genus *Myotis* includes 139 species distributed worldwide, except at the poles (Mammal Diversity Database 2020; www.mammaldiversity.org). Twenty-two of them are present in South America (Gardner 2008; Moratelli *et al.* 2011, 2013, 2019; Díaz *et al.* 2016), with 12 in Argentina (Barquez and Díaz 2020). In the Neotropics, the genus *Myotis* does not show a unique and constant reproductive pattern (Sosa *et al.* 1996). For instance, *M. keaysi* exhibits a seasonal monoestry, *M. oxyotus* a bimodal poliestry with 2 pregnancy events and *M. nigricans* has 2 or 3 reproductive seasons without postpartum estrus. Moreover, previous studies have reported random ovulatory events and pregnancy periods from 50 to 60 days in some species of this genus (Wilson 1971; Studier and O'Farrell 1972; Myers 1977; Wimsatt 1979; Krutzsch 2009).

Myotis dinellii (yellowish bat) is mainly distributed in Argentina, with scarce records in Bolivia and Brazil (Díaz *et al.* 2016; Barquez and Díaz 2020). This species is categorized as of Least Concern both by the UICN and at a national level (Díaz *et al.* 2013; Díaz and Barquez 2016). It lives in family groups of about 3 to 80 individuals and inhabits both natural and anthropic environments (Barquez and Díaz 2020). It was first described by Thomas (1902) but later, LaVal (1973) considered it as a subspecies of *M. levis*. Finally, Barquez (2006) adopted its traditional designation, considering its valid status as a full species, recognizing that both are in sympatry (Barquez 2006; Miranda *et al.* 2013). Even though it has a widespread distribution in Argentina, there is limited information about its biology, and particularly about its reproduction (Barquez and Díaz 2020). We provide new data about the biology of this species and hence contribute to improving our knowledge about these mammals.

The study area is a refuge located under a bridge over a drainage channel in the dock of Ullum Dam (31° 26′ 37.05″ S; 68° 39′ 31.90″ W; Figure 1) at Ullum department, 20 km northwest of San Juan city, Argentina. The bridge is used for drainage and overhead for the passage of vehicles, it has several cracks in the roof that are used as shelter by bats, the bridge measures: 2.26 m high, 9.60 m long and 14 m wide (Figure 2).

The area's landscape is typical of the ecoregion Monte de Sierras and Bolsones, characterized as an open xeric scrubland dominated by species of the Zygophyllaceae and legume families related to small sized shrubs, cacti and some herbaceous plants (Burkart *et al.* 1999). The climate

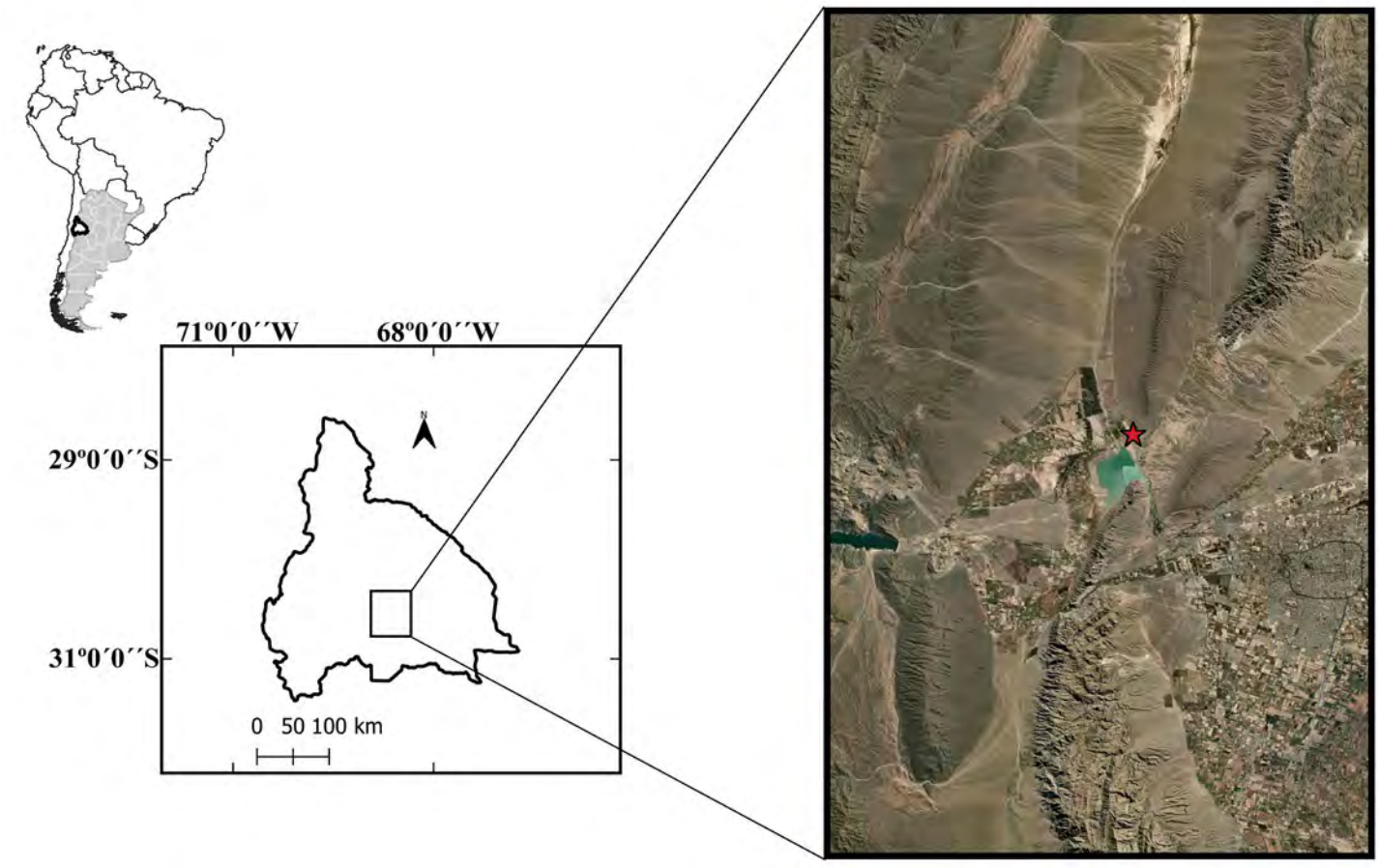


Figure 1. Geographical location of the *Myotis dinellii* colony studied (red star) in Ullum department, province of San Juan Argentina.

Figure 2. Bridge inhabited by *Myotis dinellii* colony in Ullum department, province of San Juan Argentina. Photography: E. G. Ruiz-Estebes.

is of the subtype BWwkb, typical of a hyper-arid desert, according to Köppen's phytoclimate model (Köppen 1931). About 72 % rainfall is concentrated in summer, with an annual average of 84 mm. The effect of water deficit is produced by not only low rainfall but also an annual average temperature of 20 °C, with a minimum average of 16 °C and a maximum average of 40 °C (Atlas Socioeconómico de la provincia de San Juan 1980; www.atlas.unsj.edu.ar).

The *Myotis dinellii* colony was surveyed between March 2018 and January 2020, observations were made once per month, completing a total of 23 days. The captured specimens were identified by comparing its external morphological traits with descriptions provided by Barquez and Díaz (2020) and with the assistance of the specialist Dr. M. Díaz. To determine the occurrence of specimens, we observed the cracks in the bridge at daytime and placed 2 mist nets (12 m x 2.30 m and 15 m x 3 m) on either side when we identified the presence of individuals. The nets were open from 20:00 hr to 6:00 hr and were checked every 30 min with a sampling effort was 1,350 net-hr. We registered sex, age and reproductive state of the captured individuals and one nail was dark-coloured to avoid duplicating information of the same individual. To classify them as juveniles or adults, we analyzed the degree of ossification of the phalangeal epiphyses and pelage colour and texture (Kunz and Parsons 2009). The reproductive state of females was determined by observation and abdominal palpation, identifying active or inactive females according to the presence or absence of milk in their mammary glands. Active females were classified as pregnant (by abdominal palpation) and lactating (by observation of mammary glands enlarged by milk production and nipples without fur around them; Kunz and Parsons 2009). In males, the reproductive state was assessed by the position of the testes. We defined as inactive those males exhibiting abdominal testes, and active those with scrotal testes (Kunz and Parsons 2009).

It is important to highlight that the identification of these external morphological traits does not provide evidence to detect an early pregnancy or the occurrence of spermatogenesis or oogenesis processes. Moreover, information about sperm storage, delayed implantation, embryonic development and some other reproductive events is necessary to determine the reproductive pattern of a species and to describe its reproductive biology (Miotti 2020).

We found no specimens occupying the bridge crevices between early March and late November 2018, in February 2019 and from early April to November 2019. We only recorded specimens during the calving and lactation sea-

son, 8 individuals (2 males with scrotal testes, 1 male with abdominal testes and 5 lactating females) were captured in December 2018, 4 females (1 lactating and 3 non-lactating) in January 2019, 1 lactating female in March 2019, 22 females (21 lactating and 1 non-lactating) in December 2019, and 14 individuals (2 males with scrotal testes, 3 males with abdominal testes, 2 lactating females and 7 non-lactating females) in January 2020 (Table 1). It was confirmed that the specimens occupy the refuge during the last period of pregnancy (end of November) and remain there until lactation ends and the young can fly (beginning of March).

Bats inhabit a wide variety of refugees, both natural and artificial. They can use them temporally, for sheltering, mating or other social interactions, or permanently, for sheltering, reproduction, gestation and care of their offspring until they become independent (Kunz 1982; Kunz and Fenton 2005; Torres-Flores *et al.* 2012). The analyzed *M. dinellii* colony temporally used the bridge cracks to give birth and parental care of offspring development until their independence (Figure 3).

Table 1. Frequency and monthly distribution of the reproductive status of females and males captured at the bridge, Ullum department, province of San Juan Argentina.

Reproductive state	Number of individuals	Month and year
Lactating females	5	December 2018
Males with scrotal testes	2	December 2018
Male with abdominal testes	1	December 2018
Lactating females	1	January 2019
Non-lactating females	2	January 2019
Lactating females	1	March 2019
Lactating females	21	December 2019
Non-lactating females	1	December 2019
Males with scrotal testes	2	January 2020
Male with abdominal testes	3	January 2020
Lactating females	2	January 2020
Non-lactating females	7	January 2020

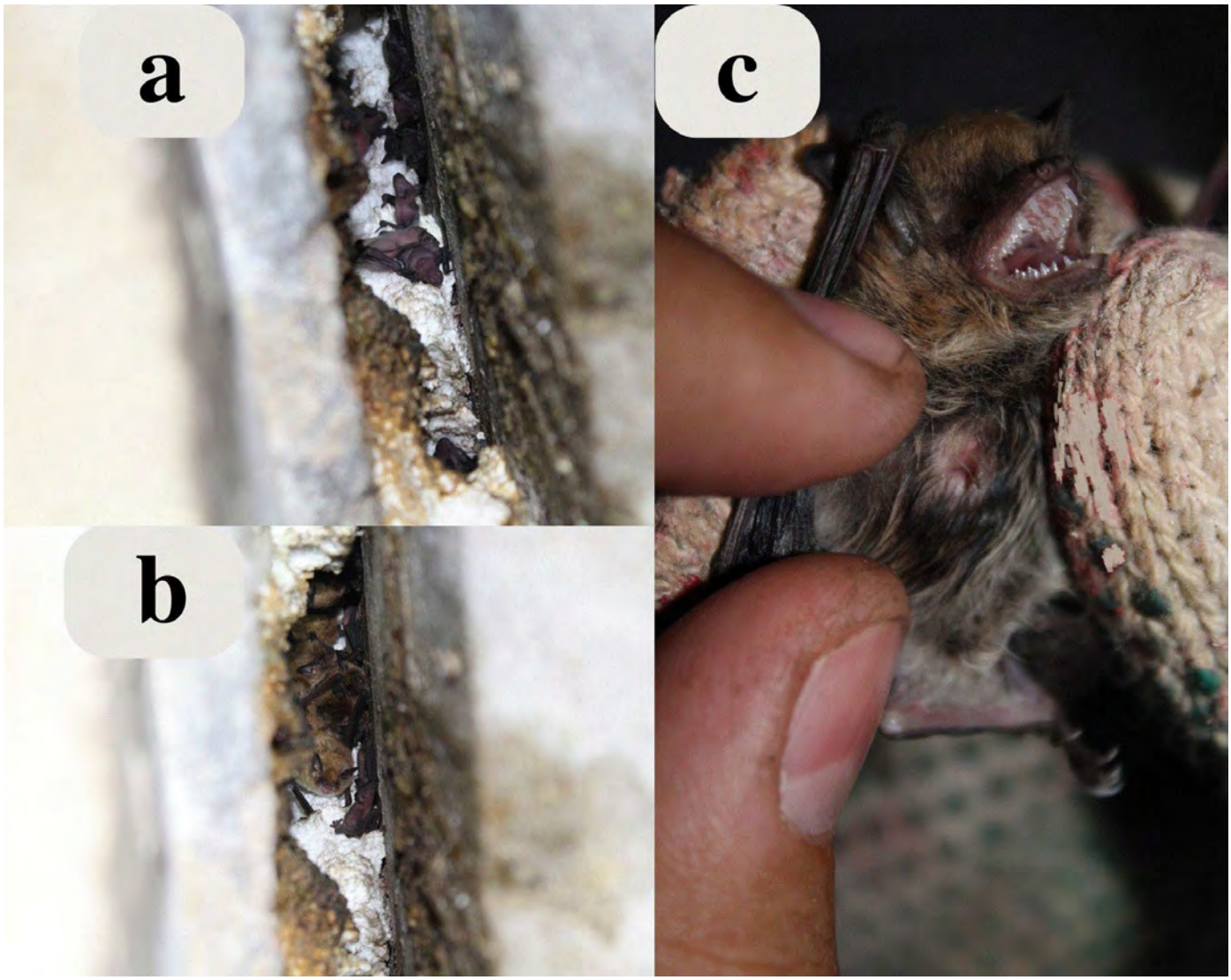


Figure 3. Specimens found in Ullum department, province of San Juan Argentina. a) Juveniles in the shelter. b) Adults and juveniles. c) A lactating female, with a developed mammary gland, shown in detail. Photography: E. G. Ruiz-Estebes.

Some *Myotis* species present in Argentina, such as *M. chiloensis*, *M. levis* and *M. riparius*, display a seasonal monoestry as reproductive pattern (LaVal and Fitch 1977; Pearson and Pearson 1989; Miranda *et al.* 2010; Araújo *et al.* 2013; Farias *et al.* 2015) while others (*e.g.*, *M. albescens*) are polyestric (Myers 1977; Wilkinson and McCracken 2003). Previous studies of *M. dinellii* from other regions of Argentina have provided information about the reproductive season, ranging from spring to summer (Barquez *et al.* 1999). They have reported the occurrence of females with open vaginas in January, February and March, females with closed vaginas in January, February, March and October, males with abdominal testes January, March and October, and males with scrotal testes in March (Alurralde *et al.* 2017).

The colony analyzed in this study comprises a few males and several females sheltering from the end of gestation, when giving birth until the completion of the lactation period of their offspring. Females gave birth in early December and lactation was recorded until early January. Usually, the average lactation length is 40.9 days, a variable condition among species as it depends on the time to grow and become independent required by offspring (Kunz and Fenton 2005). For instance, *Myotis velifer* females have been observed nursing their babies after they have developed the flight ability (Bishop *et al.* 1992; Balmori 1999).

The colony is in an area with high tourist activity, as it is located at the bottom of a bridge at the entrance of a nautical complex. Motorcycles and quad bikes often pass under the bridge, and there have also been attempts to destroy the refuge by setting fires under the bridge near the crevices where the colony lives. To generate protection measures for this colony, it was recently declared a SICOM (Site of Importance for the Conservation of Bats) endorsed by RELCOM (Latin American and Caribbean Network for the Conservation of Bats).

Based on gathered information and considering our study area has a marked seasonality with estimated temperature and rainfall (dry and rainy seasons), we found that *M. dinellii* displays a seasonally monoestrous reproduction, with a short reproductive cycle. Such a pattern, influenced by climate and food resources, is typical of insectivore bats (Bernardi *et al.* 2014).

These results constitute the first reproductive data of *M. dinellii* obtained from a systematic study of a colony. We highlight the importance of carrying out similar studies to improve research methods and increase knowledge about the reproductive patterns of most species in different environments in Argentina.

Literature cited

Altringham, J. D. (ed.). 2011. Bats: From Evolution to Conservation. Oxford University Press. New York, U.S.A.

Alurralde, S. G., R. M. Barquez, and M. M. Díaz. 2017. New records of bats (Mammalia: Chiroptera) for a southern locality of the Argentine Yungas. Check List 13:2105-2105.

Araújo, R. A., *et al.* 2013. Seasonal reproduction of yellowish *myotis*, *Myotis levis* (Chiroptera: Vespertilionidae), from a Neotropical highland. Journal of Morphology 274:1230-1238.

Atlas Socioeconómico de la provincia de San Juan. 1980. www.atlas.unsj.edu.ar. Centro de Fotogrametría, Cartografía y Catastro. Facultad de Ingeniería. Universidad Nacional de San Juan. Accessed on February 17, 2022.

Balmori, A. 1999. La reproducción en los quirópteros. Galemys 11:17-34.

Barclay, R. M., and T. H. Fleming. 2020. Reproduction and life histories. Pp. 205-219 *in* Phyllostomid bats: a unique mammalian radiation (Fleming, T. H., L. M. Davalos, and M. A. R. Mello, eds.). University of Chicago Press. Chicago, U.S.A.

Barquez, R. 2006. Orden Chiroptera. Pp. 56-86 *in* Mamíferos de Argentina: sistemática y distribución (Barquez, R. M., M. M. Díaz, and R. A. Ojeda, eds.). Editorial SAREM. Tucumán, Argentina.

Barquez, R. M., M. A. Mares, and J. K. Braun. 1999. Bats of Argentina. Special publication No. 47 Museum of Texas Tech University. Texas, U.S.A.

Barquez, R., and M. Díaz. 2020. Nueva guía de los murciélagos de Argentina. Con colaboración de Montani M. E. and Perez M. J. Fundación Programa de Conservación de los Murciélagos de Argentina (PCMA). Tucumán, Argentina.

Bernardi, I. P., *et al.* 2014. Reproductive data of a threatened bat, *Myotis ruber* (É. Geoffroy, 1806) (Chiroptera, Vespertilionidae) in a southern Brazilian deciduous seasonal forest. Mammalia 78:123-126.

Bishop, C. M., *et al.* 1992. Discriminate suckling in pipistrelle bats is supported by DNA fingerprinting. Molecular Ecology 1:255-258.

Burkart, R., *et al.* 1999. Eco-regiones de la Argentina. Presidencia de la Nación, Secretaría de Recursos Naturales y Desarrollo Sustentable. Administración de Parques Nacionales. Buenos Aires, Argentina.

Burles, D., *et al.* 2009. Influence of weather on two insectivorous bats in a temperate Pacific Northwest rainforest. Canadian Journal of Zoology 87:132-138.

Díaz, M. M., *et al.* 2013. El estado de conservación de los murciélagos de Argentina. Pp. 273-281 *in* Manejo de fauna silvestre en la Argentina (Porini, G., and D. Ramadori, eds.). Programas de conservación de especies amenazadas-Dirección de Fauna Silvestre de la Secretaría de Ambiente y Desarrollo Sustentable de Nación. Buenos Aires, Argentina.

Díaz, M. M., *et al.* 2016. Clave de identificación de los murciélagos de Sudamérica/Chave de identificação dos morcegos da América do Sul. Publicación Especial No 2, PCMA (Programa de Conservación de los Murciélagos de Argentina). Tucumán, Argentina.

Díaz, M., and R. Barquez. 2016. *Myotis dinellii*. *In*: IUCN 2016. The IUCN Red List of Threatened Species. Version 2016.3. www.iucnredlist.org. Accessed on January 15, 2022.

Farias, T. O., *et al.* 2015. Testis Morphometry and Stages of the Seminiferous Epithelium Cycle in an Epididymal Sperm-storing Neotropical Vespertilionid, *Myotis levis* (Chiroptera). Anatomia, Histologia, Embryologia 44:361-369.

Filho, H. O., *et al.* 2007. Aspectos reprodutivos de *Artibeus lituratus* (Phyllostomidae) em fragmentos florestai na regiao de Porto Rico, Paraná, Brasil. Chiroptera Neotropical 13:313-318.

Gardner, A. L. 2008. Mammals of South America, Volume 1: Marsupials, Xenarthrans, Shrews, and Bats. University of Chicago Press. Chicago, U.S.A.

Happold, D. C. D., and M. Happold**.** 1990. Reproductive strategies of bats in Africa. Journal of Zoology 222:557-583.

Hoying, K. M., and T. H. Kunz. 1998. Variation in size at birth and post-natal growth in the insectivorous bat *Pipistrellus subflavus* (Chiroptera: Vespertilionidae). Journal of Zoology 245:15-27.

Köppen, W. P. 1931. Grundriss der Klimakunde. W. de Gruyter. Berlin, Deutschland.

Krutzsch, P. H. 2000. Anatomy, Physiology and Cyclicity of the Male Reproductive Tract. Pp. 91-155 *in* Reproductive Biology of Bats (Crichton, E. G., and P. H. Krutzsch, eds.). Academic Press. London, England.

Krutzsch, P. H. 2009. The reproductive biology of the cave *myotis* (*Myotis velifer*). Acta Chiropterologica 11:89-104.

Kunz, T. H. 1982. Roosting Ecology of Bats. Pp. 1-55 *in* Ecology of Bats (Kunz, T. H., ed.). Springer US. Boston, U.S.A.

Kunz, T. H., and M. B. Fenton. 2005. Bat Ecology. University of Chicago Press. Chicago, U.S.A.

Kunz, T. H., and S. Parsons. 2009. Ecological and Behavioral Methods for the Study of Bats. The Johns Hopkins University Press. Baltimore, U.S.A.

LaVal, R. K. 1973. A revision of the Neotropical bats of the genus *Myotis*. Los Angeles County Natural History Museum Science Bulletin 15:1-54.

LaVal, R. K., and H. S. Fitch. 1977. Structure, movements and reproduction in three Costa Rican bat communities. Occasional Papers 69:1-28.

Mammal Diversity Database. 2020. www.mammal.diversity.org. American Society of Mammalogist. Accessed on June 19, 2022.

Marques-Aguiar, S. A. 1986. Activity cycle, feeding and reproduction of *Molosus ater* (Chiroptera : Molossidae) in Brazil. Boletim do Museu Paraense Emilio Goeldi. Série Zoologia 2:159-179.

Miotti, M. D. 2020. Variaciones latitudinales en los patrones reproductivos de cuatro especies de murciélagos frugívoros de las yungas argentinas. Publicaciones Especiales No 5, PIDBA (Programa de Investigaciones de Biodiversidad Argentina). Tucumán, Argentina.

Miranda, J. M., *et al*. 2010. Primeiros dados de uma colônia reprodutiva de *Myotis levis* (I. Geoffroy, 1824) nos campos de Palmas, Paraná, Brasil (Vespertilionidae). Chiroptera Neotropical 16:762-768.

Miranda, J. M., *et al*. 2013. The taxonomic status of *Myotis levis levis* and *Myotis levis dinellii* (Mammalia: Chiroptera: Vespertilionidae). Zoologia (Curitiba) 30:513-518.

Moratelli, R., *et al*. 2011. Geographic variation in South American populations of *Myotis nigricans* (Schinz, 1821) (Chiroptera, Vespertilionidae), with the description of two new species. Mammalian Biology 76:592-607.

Moratelli, R., *et al*. 2013. Review of *Myotis* (Chiroptera, Vespertilionidae) from Northern South America, Including Description of a New Species. American Museum Novitates 2013:1-36.

Moratelli, R., *et al*. 2019. A new species of *Myotis* (Chiroptera, Vespertilionidae) from Peru. Special Publications of the Museum of Texas Tech University 71:239-256.

Myers, P. 1977. Patterns of reproduction of four species of Vespertilionid bats in Paraguay. University of California Press. London, England.

Pearson, O. P., and A. K. Pearson. 1989. Reproduction of bats in southern Argentina. Pp. 549-566 *in* Advances in Neotropical Mammalogy (Redford, K. H., and J. F. Eisenberg, eds.). The Sandhill Crane Press. Florida, U.S.A.

Racey, P. A., and A. C. Entwistle. 2000. Life-history and reproductive strategies of bats. Pp. 363–414 *in* Reproductive Biology of Bats (Crichton E. G., and P. H. Krutzsch, eds.). Academic Press. London, England.

Sosa, M., A. D. Ascencao, and P. J. Soriano. 1996. Dieta y patrón reproductivo de *Rhogeessa minutilla* (Chiroptera: Vespertilionidae) en una zona árida de Los Andes de Venezuela. Revista de Biología Tropical 44:867-875.

Studier, E. H., and M. J. O'Farrell. 1972. Biology of *Myotis thysanodes* and *M. lucifugus* (Chiroptera: Vespernlionidae) – I. Thermoregulation. Comparative Biochemistry and Physiology Part A: Physiology 41:567-595.

Thomas, O. 1902. LXVII. - On Azara's "Chauve-souris onzième" (*Myotis ruber*, Geoff.) and a new species allied to it. Annals and Magazine of Natural History 10:493-494.

Torres-Flores, J. W., R. López-Wilchis, and A. Soto-Castruita. 2012. Dinámica poblacional, selección de sitios de percha y patrones reproductivos de algunos murciélagos cavernícolas en el oeste de México. Revista de Biología Tropical 60:1369-1389.

Tuttle, M. D., and D. Stevenson. 1982. Growth and survival of bats. Pp. 105-150 *in* Ecology of Bats (Kunz, T. H., ed.). Springer US. Boston, U.S.A.

Wilkinson, G. S., and G. F. McCracken. 2003. Bats and balls: sexual selection and sperm competition in the Chiroptera. Pp. 128-155 *in* Bat ecology (Kunz, T. H., and M. B. Fenton, eds.). University of Chicago Press Chicago. Chicago, U.S.A.

Wilson, D. E. 1971. Ecology of *Myotis nigricans* (Mammalia: Chiroptera) on Barro Colorado Island, Panama Canal Zone. Journal of Zoology 163:1-13.

Wimsatt, W. A. 1979. Reproductive asymmetry and unilateral pregnancy in Chiroptera. Reproduction 56:345-357.

Associated editor: Romeo A. Saldaña Vázquez.
Submitted: September 5, 2022; Reviewed: January 12, 2023.
Accepted: January 20, 2023; Published on line: January 27, 2023.

THERYA NOTES 2023, Vol. 4 : 7-10 DOI: 10.12933/therya_notes-23-98 ISSN 2954-3614

New records of small mammals in American barn owl, *Tyto furcata* pellets from southeastern Ecuador

Nuevos registros de pequeños mamíferos en egagrópilas de lechuza campanaria americana, *Tyto furcata*, en el sureste de Ecuador

Héctor Cadena-Ortiz[1,2,*], María Cristina Ríos[2], Rocío Vargas[1], Fabián Castillo[2], and Jorge Brito[1]

[1]Instituto Nacional de Biodiversidad (INABIO). Calle Rumipamba 341 y Av. de los Shyris, Casilla: 17-07-8976. Quito, Ecuador. E-mail: fercho_cada@yahoo.es (HC-O); rocio_vargas@hotmail.com (RV); jorgeyakuma@yahoo.es (JB).
[2]Pajareando Ando Ecuador. E-mail: cristina914rios@gmail.com (MCR); pdotmunipaquisha@hotmail.com (FC).
*Corresponding author

Owl pellet analysis is an efficient alternative for assessing small mammal community composition. In Ecuador previous analyses exist of American barn owl, *Tyto furcata*, pellets from the Pacific lowlands and Interandean valleys, underlining high rodent consumption. We describe for first time, the diet of *T. furcata* in the southern Amazonian region of Ecuador, highlighting the abundance and distribution of prey mammals. We collected pellets of a *T. furcata* in the town of Paquisha; located in the western foothills of the mid-Nangaritza River basin of the Cordillera del Cóndor. We disaggregated the pellets, separated bones structures such as skulls and pairs of mandibles to estimate the minimum number of prey individuals. We identified prey using taxonomic keys and by comparison with museum reference material. We found principally small mammals as prey: 2 Didelphidae and 5 Cricetidae. Delicate long-tailed mouse, *Oligoryzomys delicatus*, constitutes the southernmost record of its distribution; Bishop's slender opossum, *Marmosops bishopi*, is the species' first record in Zamora Chinchipe province. Yungas grass mouse, *Akodon aerosus*, and *O. delicatus* were the most abundant prey, so we can suggest that they are both common in this locality. Owl pellets analysis of *T. furcata* was efficient to record small mammal diversity in this previously poorly researched area. Skulls found increase museum material, poorly represented for some species and also in the province. Finally, we highlight *T. furcata* as a predator of these small mammals, an important aspect of the species' natural history and of its prey.

Key words: Natural history; rodents; species diversity; Strigiformes; trophic ecology; Zamora Chinchipe.

El análisis de egagrópilas de búhos es una alternativa eficiente para evaluar la composición de la comunidad de pequeños mamíferos. En Ecuador, existen análisis previos de egagrópilas de la lechuza de campanario americana, *Tyto furcata* en las tierras bajas del Pacífico y en los valles interandinos, resaltando un alto consumo de roedores. Describimos por primera vez la dieta de *T. furcata* en la región amazónica, sureste del Ecuador, resaltando la abundancia y distribución de los mamíferos presa. Colectamos egagrópilas de un individuo de *T. furcata* en Paquisha, cuenca del río Nangaritza, ladera oeste de la Cordillera del Cóndor. Disgregamos las egagrópilas, separamos huesos y otros restos de presas. Usamos las estructuras únicas como los cráneos y pares de mandíbulas para identificar y estimar el número mínimo de individuos de presa. Identificamos las presas usando claves taxonómicas y por comparación con material de referencia museológico. Encontramos principalmente pequeños mamíferos como presas: 2 didelphidos y 5 cricétidos. El ratón colilargo delicado, *Oligoryzomys delicatus*, es el registro más austral de su distribución; la marmosa esbelta de Bishop, *Marmosops bishopi*, es el primer registro en la provincia de Zamora Chinchipe. El ratón campestre de las Yungas, *Akodon aerosus* y *O. delicatus* fueron las presas más abundantes, por lo que podemos sugerir como comunes en la localidad. El análisis de las egagrópilas de *T. furcata* fue eficiente para registrar la diversidad de pequeños mamíferos en esta área previamente poco estudiada. Los cráneos encontrados aumentaron el material museológico, antes poco representado para algunas especies y también en la provincia. Finalmente destacamos a *T. furcata* como depredador de estos pequeños mamíferos, un aspecto importante de la historia natural del ave y de las presas.

Palabras clave: Diversidad de especies; ecología trófica; historia natural; roedores; Strigiformes; Zamora Chinchipe.

Owls (Aves: Strigiformes) usually swallow their prey whole or in large pieces, and then regurgitate a pellet containing indigestible matter such as bones, fur, feathers and other keratinous material (Marti 1973). These regurgitated bones, mainly skulls and jaws, provide ecological and biogeographical information on communities of small mammals. Large set of data about prey species and their frequencies, richness, and diversity with low field effort, can be obtained from these kinds of samples (Ferri *et al.* 2021).

The American barn owl, *Tyto furcata* (Temminck, 1827), has a widespread American distribution, and occupies a broad range of open urban to rural habitats. Its diet is principally made up of small mammals of which most are rodents (Marti *et al.* 2020). In Ecuador, previous work on this species' diet is also based on its pellets and come from rural areas or agricultural habitats in the Pacific lowlands (Moreno 2010; Brito *et al.* 2015), and cities and rural areas in Andean valleys (Moreno and Román

2013; Vásquez-Ávila *et al.* 2018; Cadena-Ortiz *et al.* 2019). All of these underlines the high consumption of rodents. This note describes for first diet records of *T. furcata* in the south Amazonian region of Ecuador, our objective being to document the species' diet composition to fill distributional gaps of mammalian species.

Pellets were collected during 2 periods (November 2019 and November 2022), within the indoor coliseum (3° 55′ 56″ S, 78° 40′ 38″ W; 800 m; Figure 1) in the town of Paquisha, Zamora Chinchipe province. Paquisha lies adjacent to the Nangaritza River in the western foothills of the Cordillera del Cóndor, southeastern Ecuador. Paquisha is an urbanized area of 1 km^2 surrounded by cattle pastures and field crops; remnants of native forest are restricted to riverbanks and in scattered patches. It has a population of 3,854 people; its economy is based principally on mining, and to a lesser extent on agriculture and livestock (INEC 2010). From 2018 to the present, one of the authors of this note, F. Castillo, who lives in Paquisha, has frequently seen an individual of *T. furcata* roosting inside the coliseum and 2 other individuals 200 m from the coliseum, under the bridge that crosses the Nangaritza River, roosting right above the water.

The collected pellets from the coliseum were air dried during 3 days, then soaked them in water, and disaggregated them to separate bones and other prey remains. We used the unique structures, such as skulls and pairs of mandibles, to estimate the minimum number of prey individuals involved. For the identification of prey, we used taxonomic keys (Diaz-Nieto *et al.* 2016; Brito *et al.* 2021) and also, some were compared with reference material deposited at the Instituto Nacional de Biodiversidad (INABIO). In order to identify if *T. furcata* has a preference for prey according to its weight in this locality, we made a spreadsheet on Microsoft Excel ver. 12.0, to estimate a correlation between frequency and weight of species. The weight was averaged from museum specimens available at INABIO, at least two adults of each sex (Table 1).

Figure 1. An American Barn Owl *Tyto furcata* inside of the indoor coliseum of Paquisha, Ecuador. The arrow indicates a pellet just regurgitate.

During our first sampling, we collected 17 pellets and 38 g of pellet debris, and turned up 48 individuals of 6 species: Yungas grass mouse, *Akodon aerosus* (13 ind.), delicate long-tailed mouse, *Oligoryzomys delicatus* (16 ind.), Yungas Amazonian Hylaeamys, *Hylaeamys yunganus* (8 ind.), Western Amazonian water rat, *Nectomys apicalis* (3 ind.); Bishop's slender opossum, *Marmosops bishopi* (5 ind.), Waterhouse's mouse opossum, *Marmosa waterhousei* (3 ind.). The second sampling resulted in 4 pellets and 9 g of pellet debris which contained 14 individuals of 3 species: Alberto Carcelén's spiny mouse, *Neacomys carceleni* (8 ind.), *M. bishopi* (5 ind.) and a bird, not identified (Table 1; Figure 2).

The Cordillera del Cóndor, as an isolated mountain ridge, is a hotspot of species richness and endemism of plants (Schulenberg and Awbrey 1997) and animals (Guayasamin and Bonaccorso 2011). Despite this, few studies on mammals have been carried out there, although these have already made it possible to describe endemic mammals, such as *Caenolestes condorensis* (Albuja and Patterson 1996) or *Neacomys auriventer* (Brito *et al.* 2021). In addition, an expedition in the upper Nangaritza river basin, with a sample effort of 25,680 hr, only 2 cricetids were captured (*A. aerosus* and *Thomasomys* sp.; Boada 2011); this highlight again the value of owl pellet analysis as an efficient alternative for assessing small mammal community composition.

Table 1. Small mammals recovered from *Tyto furcata* pellets, Paquisha, Zamora Chinchipe, Ecuador.

Order/Family/Species	Individuals	Average weight (g)
Didelphimorphia		
Didelphidae		
Marmosops bishopi (Pine, 1981)	10	33.0
Marmosa waterhousei (Tomes, 1860)	3	27.8
Rodentia		
Cricetidae		
Akodon aerosus Thomas, 1913	13	28.5
Oligoryzomys delicatus (J. A. Allen & Chapman, 1897)	16	21.7
Hylaeamys yunganus (Thomas, 1902)	8	40.5
Nectomys apicalis Peters, 1861	3	155.7
Neacomys carceleni Hershkovitz, 1940	8	15.9
Aves	1	?
Total	62	

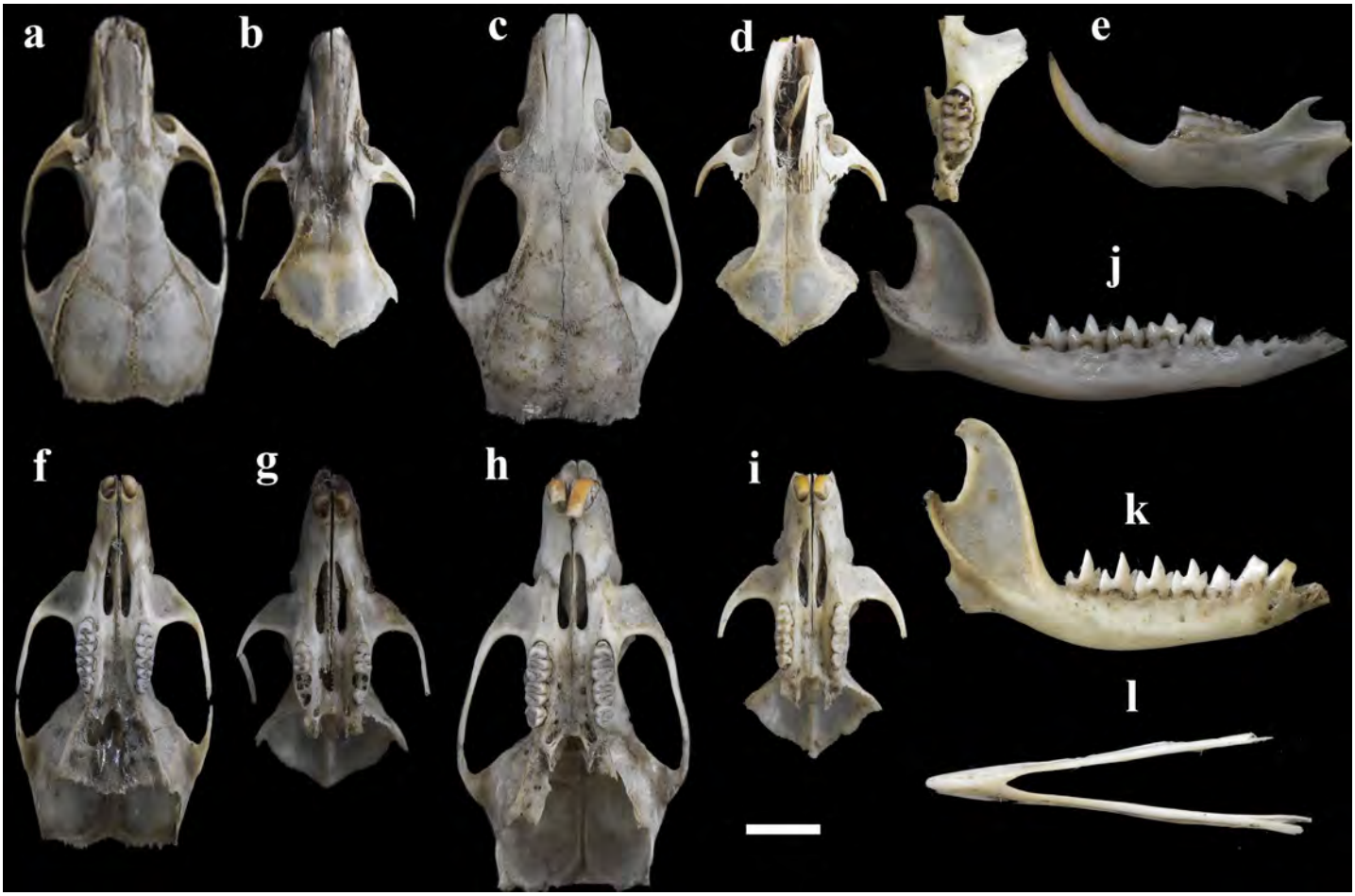


Figure 2. Preys recovered from *Tyto furcata* pellets, Paquisha, Ecuador. Dorsal (upper) and ventral (bottom) views of skull of: *Hylaeamys yunganus* (a, f); *Neacomys carceleni* (b, g); *Nectomys apicalis* (c, h); *Oligoryzomys delicatus* (d, i). Dorsal and lateral views of jaws of *Akodon aerosus* (e). Lateral views of jaws of: *Marmosa waterhousei* (j); *Marmosops bishop* (k). Ventral view of mandible of bird (l). Scale bar = 10 mm.

The prey found in *T. furcata* pellets from Paquisha brought to light biogeographical information as to the southernmost world distribution record for *O. delicatus* and the first record in Zamora Chinchipe province for *M. bishopi*. Also, we can suggest that the most prey recorded herein, *A. aerosus* and *O. delicatus*, are common in Paquisha, considering to *T. furcata* as an opportunist predator with wide trophic niche, *i.e.*, minimum prey selectivity (Cadena-Ortiz *et al.* 2019), and that we found a non-significant correlation between prey frequency and its weight (r2 = 0.246; *P* = 0.257), so in Paquisha *T. furcata* could hunt the most abundant prey regardless of the amount of biomass.

Recovered skulls also increase museum material and become a potential source of DNA (Taberlet and Fumagalli 1996). Previously in INABIO, *N. apicalis* was only represented by 7 specimens; *M. waterhousei*, only by 3, and none from Zamora Chinchipe province; and for *N. carceleni,* only 4 for Zamora Chinchipe. Finally, we provide evidence of the ecological relationship of all the small mammals recorded in these pellets and *T. furcata* as their predator. The present findings unveil the first records of *M. bishopi* and *M. waterhousei* as prey of *T. furcata*. Previously, the only Didelphid recorded was *Marmosops caucae* (Brito *et al.* 2015). Also, from known Cricetidae prey, only *A. aerosus* was previously recorded as prey of *T. furcata* (Brito *et al.* 2015).

Acknowledgements

We thank P. Greenfield for his review of the manuscript, particularly regarding the English grammar. To the anonymous reviewers who enriched this manuscript with their comments.

Literature cited

Albuja, L., and B. D. Patterson. 1996. A new species of northern shrew-opossum (Paucituberculata: Caenolestidae) from the Cordillera del Cóndor, Ecuador. Journal of Mammalogy 77:41–53.

Boada, C. 2011. Mamíferos de los Tepuyes de la Cuenca Alta del Río Nangaritza, Cordillera del Cóndor. Pp. 76–86 *in* RAP Boletín de Evaluación Ecológica Rápida 58 (Guayasamin, J. M., and E. Bonaccorso, eds.). Conservación Internacional. Quito, Ecuador.

Brito, J., *et al.* 2015. Mamíferos pequeños en la dieta de la lechuza *Tyto alba* (Strigiformes: Tytonidae) en dos localidades del occidente de Ecuador, con ampliación distribucional de *Ichthyomys hydrobates* (Rodentia: Cricetidae). Papéis Avulsos de Zoologia (São Paulo) 55:261–268.

Brito, J., *et al.* 2021. A new species of spiny mouse, genus *Neacomys* (Cricetidae: Sigmodontinae) from Cordillera del Cóndor, Ecuador. Mastozoología Neotropical 28:507.

Cadena-Ortiz, H., *et al.* 2019. Diet of barn owls (*Tyto alba*) in two Ecuadorian dry forest locations. Ornitología Colombiana 17:eNB03.

Diaz-Nieto, J. F., *et al*. 2016. DNA sequencing reveals unexpected recent diversity and an ancient dichotomy in the American marsupial genus *Marmosops* (Didelphidae: Thylamyini). Zoological Journal of the Linnean Society 176:914–940.

Ferri, V. P., *et al*. 2021. Small mammals from barn owl *Tyto alba* pellets in a Mediterranean agroforestry landscape of central Italy. Natural History Sciences 8:3–10.

Guayasamin, J. M., and E. Bonaccorso (eds.). 2011. RAP Boletín de Evaluación Ecológica Rápida 58. Conservación Internacional. Quito, Ecuador.

Instituto Nacional de Estadística y Censos (INEC). 2010. Fascículo Provincial Zamora Chinchipe. Resultados de Población y Vivienda de 2010. https://www.ecuadorencifras.gob.ec/wp-content/descargas/Manu-lateral/Resultados-provinciales/zamora_chinchipe.pdf . Accessed on November 9, 2022.

Marti, C. D. 1973. Food consumption and pellet formation rates in four owl species. The Wilson Bulletin 85:178–181.

Marti, C. D., *et al*. 2020. Barn Owl (*Tyto alba*). *In*: Birds of the World (S. M. Billerman, ed.). Version 1.0. Cornell Lab of Ornithology, Ithaca. New York, U.S.A. https://doi.org/10.2173/bow.brnowl.01. Accessed on November 9, 2022.

Moreno, P. 2010. Mamíferos presentes en la dieta de la lechuza de campanario (*Tyto alba*) en Valdivia, provincia de Guayas, Ecuador. ACI Avances en Ciencias e Ingenierías 3:B87–B90.

Moreno, P., and J. L. Román. 2013. Clasificación del género *Reithrodontomys* en el Ecuador y comentarios sobre la alimentación de la lechuza de campanario (*Tyto alba*) en los alrededores de Quito. Boletín Técnico, Serie Zoológica 89:16–23.

Schulenberg, T., and K. Awbrey. 1997. The Cordillera Del Condor Region of Ecuador and Perú: a biological assessment (Rapid Assessment Program Working Papers 7). Conservation International. Washington, D. C., U.S.A.

Taberlet, P., and L. Fumagalli. 1996. Owl pellets as a source of DNA for genetic studies of small mammals. Molecular Ecology 5:301–305.

Vásquez-Ávila, B. E., *et al*. 2018. La lechuza Campanaria, *Tyto alba* (Strigiformes: Tytonidae) como regulador de plagas en un ecosistema urbano altoandino en el sur del Ecuador. ACI Avances en Ciencias e Ingenierías 10:42–51.

Associated editor: José F. Moreira Ramírez.
Submitted: January 24, 2023; Reviewed: February 14, 2023.
Accepted: February 16, 2023; Published on line: March 2, 2023.

THERYA NOTES 2023, Vol. 4 : 11-20 DOI: 10.12933/therya_notes-23-99 ISSN 2954-3614

Acoustics records of three *Pteronotus* species from Vichada, Colombia

Registros acústicos de tres especies de *Pteronotus* en Vichada, Colombia

Angélica V. Yantén[1*], Orlando Fabián Hernández-Leal[1,2], Carlos Restrepo-Giraldo[3], Jefferson Sánchez-Castrillon[4], and Daniela Martínez-Medina[5,6]

[1]Grupo de investigación ECOTONOS, Programa de Biología, Facultad de Ciencias Básicas e Ingeniería, Universidad de los Llanos. Km 12 vía Puerto López. Villavicencio. Colombia. 500017. E-mail: angelicayanten@unillanos.edu.co (AVY).

[2]Bird and Mammal Evolution, Systematics and Ecology Lab, Postgraduate Program of Ecology, Institute of Bioscience, Universidade Federal do Rio Grande do Sul. Av. Bento Gonçalves, 9500, Campus do Vale, Bloco IV, Prédio 43 411 e 43 422 Agronomia, CEP, Porto Alegre. Rio Grande do Sul, Brazil. 91501970. E-mail: orlando.hernandez@unillanos.edu.co (OFH-L).

[3]Laboratorio de Paisajes Antrópicos Sustentables, Doctorado en Ciencias Ambientales, División de Ciencias Ambientales, Posgrado IPICYT, Instituto Potosino de Investigación Científica y Tecnológica, A. C. Camino a la Presa San José 2055, Col. Lomas 4ta Sección, C. P. 78216. San Luis Potosí. San Luis Potosí, México. E-mail: carlos.restrepo@ipicyt.edu.mx (CR-G).

[4]Cuántico Global Eco Services S. A. S. Carrera 80Bis 7a-15. Bogotá, Colombia. 110821. E-mail: jefferson.sanchez1@correo.uis.edu.co (JS-C).

[5]Fundación Reserva Natural La Palmita, Centro de Investigación, Grupo de investigaciones territoriales para el uso y conservación de la biodiversidad. Carrera 4 #58-59. Bogotá, Colombia. 110231.

[6]Instituto de Investigación de Recursos Biológicos Alexander von Humboldt. Carrera 8 #15-08. Villa de Leyva, Colombia. 154001. E-mail: dmartinez@humboldt.org.co (DM-M).

*Corresponding author

Insectivorous bats of the genus *Pteronotus* are considered rare or uncommon because they are difficult to capture with traditional methods (*i.e.*, mist nets and harp traps). However, these bats have a distinct echolocation call design that enables their detection and recognition acoustically. In this note, we report the presence of 3 species of bats of the *Pteronotus* genus based on acoustic records from the department of Vichada in Colombia and we present a brief characterization of the echolocation calls for each species. We conducted passive acoustic monitoring in 3 localities and analyzed echolocation calls of sequences. Additionally, we searched for bat capture records in biological collections and scientific articles to find out the current distribution of the *Pteronotus* genus in Colombia. We recorded 3 species of bats of the *Pteronotus* genus: *P. personatus*, *P. gymnonotus*, and *P.* cf. *rubiginosus*. As for the search of records in biological collections and articles, we found that 8 out of 59 records of *Pteronotus* species in Colombia were from Vichada department. This work provides evidence that acoustic surveys for bats efficiently register elusive and difficult-to-capture insectivorous species, such as those of the genus *Pteronotus*.

Key words: Acoustics; echolocation; insectivorous bats; mormoopids; Orinoquia.

Los murciélagos insectívoros del género *Pteronotus* son considerados raros o poco comunes por su difícil captura con métodos tradicionales (*i.e.*, redes de niebla y trampas arpa). Sin embargo, estos murciélagos emiten señales de ecolocalización distinguibles que facilitan su detección y reconocimiento mediante métodos acústicos. En esta nota, reportamos la presencia de 3 especies de murciélagos del género *Pteronotus* a partir de registros acústicos en el departamento de Vichada, en Colombia y presentamos una breve caracterización de las señales de ecolocalización para cada una de las especies. Realizamos un monitoreo acústico pasivo en 3 localidades y analizamos las secuencias de los pulsos de ecolocalización. Adicionalmente, realizamos una búsqueda de registros de capturas en colecciones biológicas y artículos científicos para conocer la distribución actual de *Pteronotus* en Colombia. Registramos acústicamente 3 especies de murciélagos del género *Pteronotus: P. personatus*, *P. gymnonotus* y *P.* cf. *rubiginosus*. En cuanto a la búsqueda de registros en colecciones y artículos encontramos 59 registros a partir de capturas de especies de *Pteronotus* en Colombia, de los cuales 8 pertenecen al departamento de Vichada. Este trabajo aporta evidencia a la noción de que los estudios con el uso de métodos acústicos en murciélagos son eficientes para el registro de especies insectívoras difíciles de capturar, como las del género *Pteronotus*.

Palabras clave: Acústica; ecolocalización; mormoópidos; murciélagos insectívoros; Orinoquia.

Bats of the genus *Pteronotus* Gray, 1838 are characterized for having a slow and maneuverable flight, adapted for hunting insects in cluttered spaces, like forest interiors and edges (Bateman and Vaughan 1974). *Pteronotus* species have highly distinct echolocation calls from other species of insectivorous bats: calls are multi-harmonics with peak frequencies in the second harmonic, employing different combinations of constant frequency (CF) and modulated frequency (FM) elements in each echolocation call (O'Farrell and Miller 1997). In general, bats of the *Pteronotus* genus broadcast calls with a main FM component coupled with CF components at the beginning and the

end of the call, except for *Pteronotus* cf. *rubiginosus* Wagner, 1843 which emits pulses composed by a short ascendent FM sweep (~ 5 ms), followed by a long CF component (~ 20 ms) and finalize with another short descendent FM sweep (~ 5 ms; Mancina *et al.* 2012). Moreover, *P.* cf. *rubiginosus* and *Pteronotus personatus* Wagner, 1843 have adapted a sophisticated hearing system to compensate for the Doppler effect, which makes them able to shift down the emitted narrowband frequencies in the CF structure of their echolocation calls as they reach top flight speed, ensuring that returning echoes remain within the best auditive sensitivity range of the bat (Smotherman and Guillén-Servent 2008; Schnitzler and Denzinger 2011).

The genus *Pteronotus* is restricted to the Neotropics with distribution from western México, Central America, and the Antilles, to northeastern Brazil on the east portion and Perú on the western part of South America (Gardner 2007; Pavan and Marroig 2016). Currently, 5 species are distributed in Colombia: *Pteronotus davyi* Gray, 1838, *Pteronotus gymnonotus* Natterer, 1843, *Pteronotus fuscus* J. A. Allen, 1911, *P. rubiginosus* and *P. personatus,* and all have been widely observed in the departments of Antioquia, Bolívar, Cauca, Cesar, Cundinamarca, La Guajira, Huila, Magdalena, Sucre, and Tolima under 1,200 m (Alberico *et al.* 2000; Solari *et al.* 2013; Ramírez-Chaves *et al.* 2021). For the department of Vichada, there is only one published record at the Santa Teresita locality for *P. personatus* (Montes *et al.* 2012). However, other non-published records of biological collections hint at a wider distribution of the genus in the eastern regions of Colombia.

Currently, acoustical tools have become more relevant for monitoring the insectivorous bat guild, mainly due to the difficulty of capturing these bats with traditional methods (*i.e.*, mist nets and harp tramps), like species of the *Pteronotus* genus (MacSwiney *et al.* 2008). Since the species of *Pteronotus* have a distinct echolocation call, it is possible to identify them in acoustic surveys. In this note, we report the presence of *P. personatus*, *P. gymnonotus,* and *P.* cf. *rubiginosus* with acoustic methods in the Vichada department in Colombia and we present a brief characterization of the echolocation calls for each one of the 3 species, thus providing more evidence supporting the utility of using acoustic records for the completeness of wildlife inventories, specifically for elusive species difficult to register.

We conducted an acoustic survey in 2 locations, "La Reserva Forestal La Pedregoza" (RFLP) in February 2018 and in the "Caño Negro" farm in November 2020. The 2 study areas are characterized by forest plantations, riparian forests, and natural savannas in the circumscription of Puerto Carreño, Vichada (Figure 1). In the RFLP, we installed an SM4 FS ultrasonic detector with an SMM - U1 microphone (Wildlife Acoustics® Maynard, MA, USA) for 5 nights in pine (1 night) and acacia crops (2 night), natural savannas (1 night) and gallery forests (1 night), from 18:00 hr to 6:00 hr. At Caño Negro farm, we conducted active acoustic monitoring with an Echo Meter Touch 2 Pro ultrasonic detector

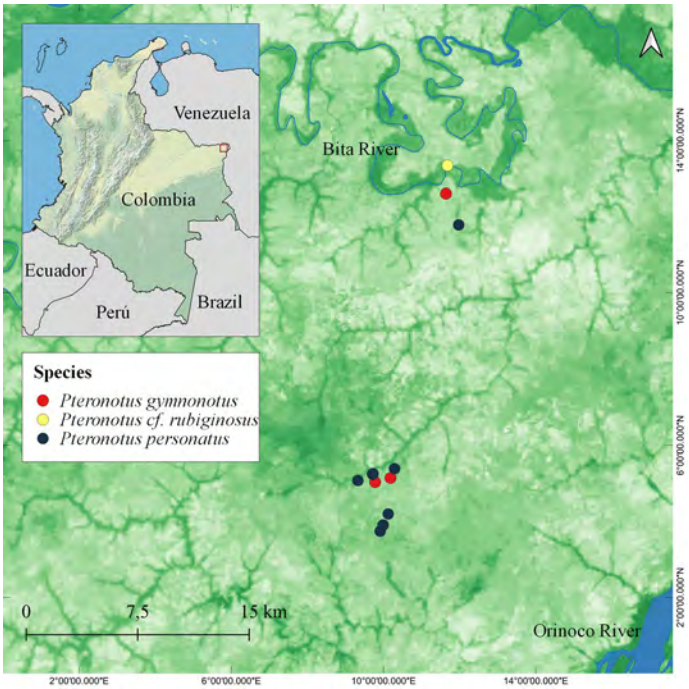


Figure 1. Occurrences of *Pteronotus* cf. *rubiginosus*, *Pteronotus gymnonotus*, and *Pteronotus personatus* in the department of Vichada, Colombia. The red dots correspond to acoustic records of *P. gymnonotus*, the yellow dots of *P.* cf. *rubiginosus*, and the blue dots to *P. personatus*.

for 3 nights in different land cover uses between 18:00 hr - 22:00 hr: forest plantations (acacia crops and pine crops), riparian forests, and natural savannas. We performed 5-min recordings in 30 points per land use cover spaced every 300 m. In both locations, we configured the detectors with a sampling rate of 384 kHz and a gain of 12 dB. We analyzed 337 echolocation calls from 46 echolocation sequences with Bat Explorer software, version 2.1 ©Elekon AG (https://www.elekon.ch/). To generate spectrograms, we used a Hamming window with a fast Fourier transformation (FFT) of 512 points and an overlap of 80 %. We measured the second harmonic for all 3 species, as it concentrates most of the energy of each echolocation call, with very few exceptions. We only used the echolocation pulses of each sequence with the best signal-to-noise ratio and measured the pulses in the search and approach phase. In total, we measured 8 acoustic parameters (Appendix 1), following the recommendations proposed by Martínez-Medina *et al.* (2021a)**.** The 5 recordings corresponding to the 3 species presented in this paper have been deposited in the Environmental Sound Collection "Mauricio Álvarez Rebolledo" of the Alexander von Humboldt Institute under the following numbers IAvH - CSA 18829 to IAvH - CSA 18833.

To know the current distribution of *Pteronotus* in Colombia, we carried out an exhaustive search of public access databases such as the Biodiversity Information System of Colombia (SIB Colombia 2021) and the Global Biodiversity Information Facility (GBIF.org 2021), in biological collection records, and scientific literature (Cuervo-Díaz *et al.* 1986; Alberico *et al.* 2000; Montes *et al.* 2012; Solari *et al.* 2013; Chacón-Pacheco *et al.* 2018). All records from these sources

were obtained through captures in mist nets. Finally, for the scientific literature search, we used the keywords "*Pteronotus* AND Colombia" excluding the records that were not georeferenced.

We obtained a total of 44 sound files with calls of *Pteronotus* distributed by each species as follows: *P. personatus* was recorded in 16 sound files along the riparian forest, 9 in acacia crops, 8 in pine woods, and 3 in savannas, *P. gymnonotus* in 3 recordings of acacia crops and *P.* cf. *rubiginosus* in 5 recordings of riparian forest. Because several recordings did not have a good signal-to-noise ratio, the number of measured sequences did not correspond to the number of recording points (Appendix 1).

The call structure of *P. personatus* and *P. gymnonotus* (Figure 2a, 2b) consisted of a descending FM sweep framed between a short initial CF element and a short terminal descending quasiconstant frequency (QCF) sweep (CF/FMd/QCFd), similar to those reported by O'Farrell and Miller (1997), MacSwiney *et al.* (2008), Briones-Salas *et al.* (2013), Orozco-Lugo *et al.* (2013), Zamora-Gutierrez *et al.* (2016) and Arias-Aguilar *et al.* (2018; Appendix 1). In addition, we recognized variations in some of the temporal and spectral parameters of echolocation calls from reference acoustic records of other neotropical countries for these species.

The average call duration of *P. personatus* was higher than the average of O'Farrell and Miller (1997), Orozco-Lugo *et al.* (2013), and Zamora-Gutierrez *et al.* (2016). However, within the reported variability range of all the references mentioned above. On the other hand, the call duration values of Briones-Salas *et al.* (2013) are lower and do not overlap with any value in the duration range reported in our study. Likewise, the average Maximum Frequency (MaxF) and the Minimum Frequency (MinF) of our study were lower than the average of the references mentioned before but, again, with overlapping bandwidths, being those of O'Farrell and Miller (1997) and MacSwiney *et al.* (2008) closer to our observations, and those of Briones-Salas *et al.* (2013) and Zamora-Gutierrez *et al.* (2016) broader for approximately 3 and 7 kHz, respectively. Concerning the inter-pulse interval found in our study, it is consistent with the range reported by MacSwiney *et al.* (2008) and Orozco-Lugo *et al.* (2013) but much higher than that reported by O'Farrell and Miller (1997; Appendix 1).

For *P. gymnonotus*, the average call duration was higher than the references of Zamora-Gutierrez *et al.* (2016), MacSwiney *et al.* (2008), and Arias-Aguilar *et al.* (2018), but overlapping in the range of the highest values, except for the last reference which fell below the 6 ms of duration. Also, the MaxF and MinF observed in this work were higher than those values reported by MacSwiney *et al.* (2008) and Zamora-Gutierrez *et al.* (2016). Again, the exception was the MinF reported by Arias-Aguilar *et al.* (2018), which was marginally higher than ours. Furthermore, the bandwidths of all references were quite similar (14 - 17 kHz for all the references, including the present work), containing overlapping frequencies. Finally, our average value of the inter-pulse interval was within the range of variation reported by Arias-Aguilar *et al.* 2018 (Appendix 1).

In addition, the call structure for *P.* cf. *rubiginosus* (Figure 2a) consisted of a long-duration CF segment framed between two short ascending and descending FM sweeps (FMa/CF/FMd) and are similar to echolocation signal structures reported for the species complex of *P. parnellii* by O'Farrell and Miller (1997), Macías *et al.* (2006), MacSwiney *et al.* (2008), Pio *et al.* (2010), Briones-Salas *et al.* (2013), Zamora-Gutierrez *et al.* (2016) and Arias-Aguilar *et al.* (2018). The call duration average reported in the present work was higher than those values reported by Macías *et al.* (2006), Pio *et al.* (2010), Briones-Salas *et al.* (2013), Zamora-Gutierrez *et al.* (2016), and Arias-Aguilar *et al.* (2018) and overlapped with those reported by MacSwiney *et al.* (2008) and Orozco-Lugo *et al.* (2013). The MaxF values of our study were lower than those reported in all the references mentioned above, except for those reported by Arias-Aguilar *et al.* (2018), which were lower than ours. The MinF values showed the same pattern of higher frequencies, except for those values reported by Pio *et al.* (2010), Zamora-Gutierrez *et al.* (2016), and Arias-Aguilar *et al.* (2018), which were lower than ours. All the bandwidths of the references, including those reported in this work, overlapped except the one reported by MacSwiney *et al.* (2008), which was the narrowest of the current references and was above the bandwidth reported by us. We reported a higher inter-pulse interval than any of those reported in previous references (Appendix 1).

The search for bat capture records in biological collection and scientific references yielded a total of 59 records of *Pteronotus* species found in Colombia, from which only 8 records belonged to the department of Vichada: 4 records of *P.* cf. *rubiginosus,* 3 records of *P. personatus* and 1 record of *P. gymnonotus* (Appendix 2).

Insectivorous bats inhabiting the understory of forests are adapted to emit short-high frequency FM echolocation calls that render better distance resolution of the objects in their surroundings that are close to each other. Nonetheless, these echolocation calls tend to attenuate also at short distances. Conversely, the bats commonly found in forest edges use these types of FM structures in combination with other call structures such as QCF and CF echolocation calls better suited for long-distance detection, given these concentrate the vast majority of the call energy in a narrowband of frequencies that travels further in space (Neuweiler 1989; Schnitzler *et al.* 2003).

The echolocation call structures of the acoustic records of *P. personatus* and *P. gymnonotus* found in acacia crops, savannas, riparian forests, and pine crops reported in this study are a good example of the combination of call types adapted by bats using spaces like forest edges to forage for flying insects. These types of habitats impose conditions found in forest interiors on one side, along with open spaces on the other side. This combination of call structures

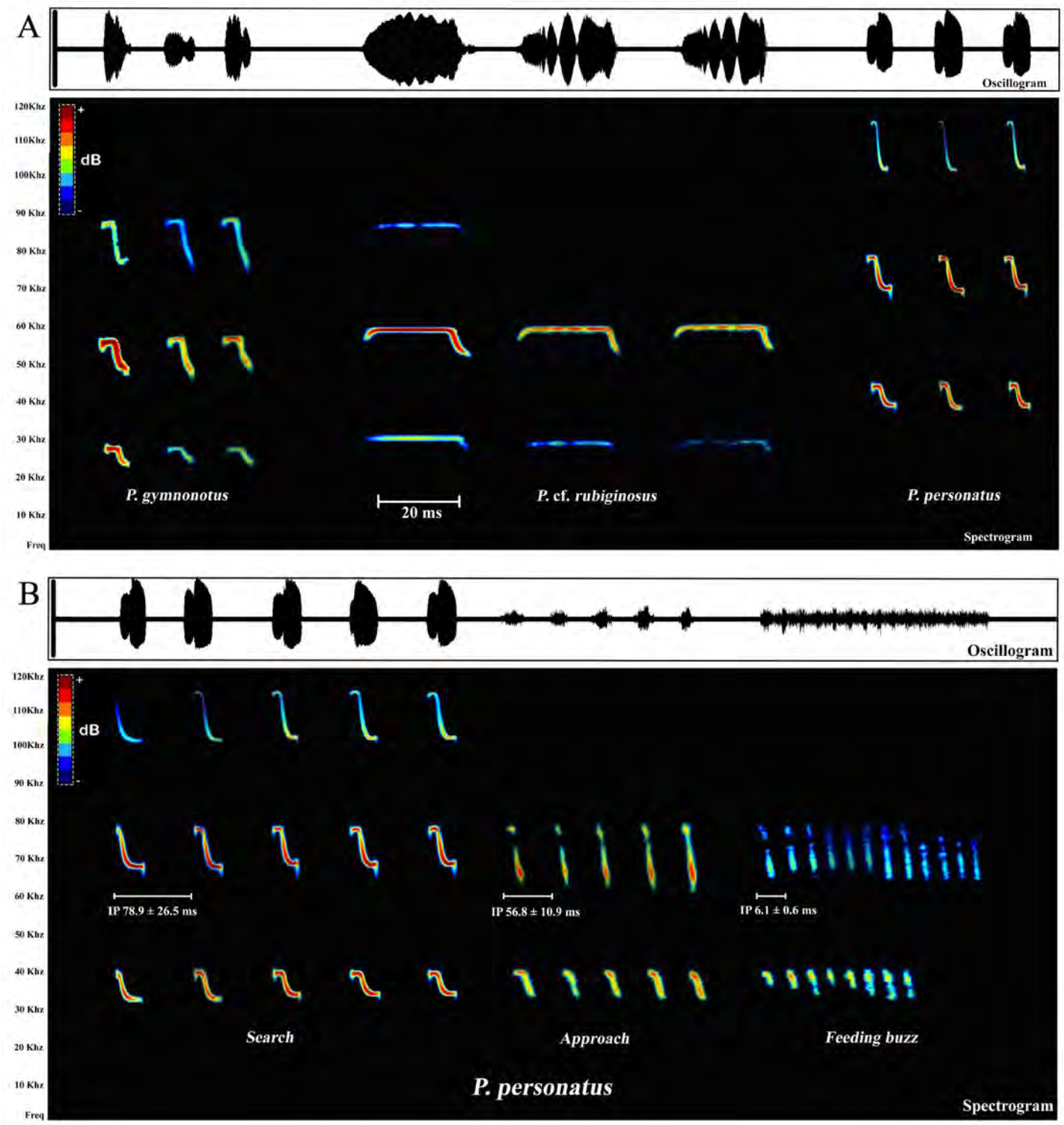


Figure 2. Spectrograms and oscillograms of echolocation signals emitted by mormoopid species in Vichada, Colombia. A) Echolocation calls emitted during search flight by *Pteronotus gymnonotus, Pteronotus* cf. *rubiginosus*, and *Pteronotus personatus.* B) Representation of echolocation signals emitted by *P. personatus* during the search phase, approach phase, and feeding buzz. Pulse intervals are not scaled.

can also explain the observations of *P. personatus* using water streams and rivers associated to dense vegetation, representing a combination of cluttered and less cluttered spaces (Kober and Schnitzler 1990; O'Farrell and Miller 1997; Guillén-Servent 2005; de la Torre and Medellín 2010; Pavan and Tavares 2020). The echolocation call structure observed in the recordings of *P.* cf. *rubiginosus* found in the forest is also consistent with its capability of flying through cluttered sites with dense vegetation in search of fluttering insects. This structure consists of high frequency-long narrowband CF calls that are compensated for the Doppler shifts in the echo frequency, allowing bats with the recognition of amplitude and frequency micro modulations in the returning echoes, typically induced by moving prey (Kober

and Schnitzler 1990; Von der Emde and Schnitzler 1990; Kalko *et al.* 2008; de Oliveira *et al.* 2015).

Recently, Clare *et al.* (2013) proposed a change in the taxonomic level of continental populations of the subspecies of *P. parnelli* complex, *P. parnelli fuscus*, and *P. parnelli rubiginosus* would now be upgraded to species level. Hence, *P. parnelli* becomes an exclusive species of insular distribution and the Colombian populations of the new *P. fuscus* would be distributed on the Caribbean coast, while the *P. rubiginosus* populations would be distributed in the eastern part of Colombia (Pavan and Marroig 2016). Therefore, the sonotype (*i.e.*, the group of sounds with the same characteristics and that are assumed to correspond to the same species; Bader *et al.* 2015) we recorded in this study was determined by the proposed geographic distribution as *P.* cf. *rubiginosus*. Something similar happens with the *P. personatus* complex, so we use the references of *P. personatus* from México for comparison, currently known as *P. psilotis* Dobson, 1878 (Zárate-Martínez *et al.* 2018; Arias-Aguilar and Ramos-Pereira 2022).

It is noteworthy that the recent "Clave de Identificación de los Murciélagos Neotropicales" published by Díaz *et al.* (2021) proposed a discrimination between species of *P. rubiginosus* and *P. fuscus,* based on echolocation call of the characteristic frequency. Nevertheless, there's not sufficient acoustic evidence in Colombia supporting this discrimination. Since the *P. parnellii* complex exhibits Doppler shift compensation (Smotherman and Guillén-Servent 2008; Schnitzler and Denzinger 2011), discrimination based on small differences in peak frequencies (~ 3 kHz) of the CF component of its echolocation calls are not straightforward. To fulfill proper discrimination between species, there must be reference recordings of identified individuals obtained under controlled conditions regarding flight spaces, flight speed, body size, sex, and development condition, given that these factors can alter the frequency in the emission of echolocation calls for most bats (Jones 1997; Jacobs *et al.* 2007; Jones and Holderied 2007).

Through the search of biological collection records and scientific references, we found that the Vichada department is one of the places with the fewest records of mammals we found in the country, and remarkably the only record of *P. gymnonotus* in this department was in 1967, that is, approximately 50 years ago (GBIF.org. 2021). So far, the records of *Pteronotus* species that have been published for the department of Vichada (Montes *et al.* 2012; Páez-Vásquez *et al.* 2020) or the Orinoco River basin (Ferrer-Pérez *et al.* 2009a) are based on captures with mist nets or specimens from scientific collections. However, using acoustic methods, we recorded 3 species of *Pteronotus* for the department of Vichada: *P.* cf. *rubiginosus*, *P. gymnonotus*, and *P. personatus*.

Studies of bats using acoustic methodologies have shown that they are efficient in recording rare insectivorous bat species, such as those of the family Mormoopidae (MacSwiney *et al.* 2008). Using acoustic tools can increase the richness of Chiroptera sets by up to 40 % (MacSwiney *et al.* 2008). Therefore, the complementary use of these methodologies is necessary to register species of insectivorous bats that are not commonly obtained by traditional methodologies. In Colombia, the studies on bat acoustics are still relatively new (Martínez-Medina *et al.* 2021b), and this field of knowledge has been increasing in recent years. Bat echolocation call descriptions of Colombian species are key for the conservation of their communities since these characterizations contribute to the identification capacity of bat monitoring programs, aiming to assess the impacts of different human activities on the spatial-temporal patterns of bat activity (Walters *et al.* 2013). Furthermore, knowledge of the bat reference acoustic parameters is fundamental to understanding the intra-and-interspecific variations of the bats' ultrasonic vocalizations, improving the sound collection performed in the country.

The present work is one of the first contributions to the acoustic ecology of the Mormoopidae family in Colombia, identifying acoustic variations for the 3 species of *Pteronotus* to what has been reported up to date for Central and South America. Although these variations could be the product of inter and intraspecific factors such as sex, age, body condition, reproductive stage (Jones 1997; Jacobs *et al.* 2007; Jones and Holderied 2007), or a consequence of environmental factors like the increased absorption of the high frequencies in echolocation calls recorded in humid environments, the amount of vegetative clutter in foraging spaces and noisy conditions (Lawrence and Simmons 1982; Arlettaz *et al.* 2001; Kalko *et al.* 2008; Tressler and Smotherman 2009). We urge the scientific community to record reference calls accompanied by the collection of voucher specimens as the only way to ensure that each acoustic record will provide full information for species discrimination as would be the case of the *P. parnellii* complex, given the taxonomic transitions these species have been through in recent years.

Acknowledgements

We want to thank the Wildlife Conservation Society (WCS), The Nature Conservancy (TNC), the South Pole Foundation, and the Cuántico Global Eco Services SAS for allowing us to use the acoustic recordings taken in the different projects they have executed in the department of Vichada. To Elekon AG for granting us the BatExplorer software license to perform the acoustic analysis. Finally, we would like to thank Miguel E. Rodriguez-Posada for his recommendations and advice in this note, and two anonymous reviewers who enriched this manuscript with their comments.

Literature cited

Alberico, M., *et al.* 2000. Mamíferos (Synapsida:Theria) de Colombia. Biota Colombiana 1:43-75.

Arias-Aguilar, A., *et al.* 2018. Who's calling? Acoustic identification of Brazilian bats. Mammal Research 63.

Arias-Aguilar, A., and M. J. Ramos-Pereira. 2022. Acoustic clue: bringing echolocation call data into the distribution dilem-

ma of *Pteronotus* (Chiroptera: Mormoopidae) complexes in Central America. Biological Journal of the Linnean Society 135:586–598.

Arlettaz, R., G. Jones, and P. A. Racey. 2001. Effect of acoustic clutter on prey detection by bats. Nature 414:742–745.

Bader, E., *et al*. 2015. Mobility explains the response of aerial insectivorous bats to anthropogenic habitat change in the Neotropics. Biological Conservation 186:97–106.

Bateman, G. C., and T. A. Vaughan. 1974. Nightly Activities of Mormoopid Bats. Journal of Mammalogy 55:45-65.

Bejarano-Bonilla, D. A., A. Yate-Rivas, and M. H. Bernal-Bautista. 2007. Diversidad y distribución de la fauna quiroptera en un transecto altitudinal en el departamento del Tolima, Colombia. Caldasia 29:297-308.

Briones-Salas, M., M. Peralta-Pérez, and M. García. 2013. Acoustic characterization of new species of bats for the State of Oaxaca, Mexico. Therya 4:15-32.

Chacón-Pacheco, J., J. Ballesteros-Correa, and J. Racero-Casarrubia. 2018. Nuevos registros de *Pteronotus parnellii* (Chiroptera, Mormoopidae) en el departamento de Córdoba, Colombia. Boletín Científico Centro de Museos Museo de Historia Natural 22:121–127.

Clare, E. L., *et al*. 2013. Diversification and reproductive isolation: cryptic species in the only New World high-duty cycle bat, *Pteronotus parnellii*. BMC Evolutionary Biology 13:26.

Cuervo-Díaz, A., J. Hernández, and A. Cadena. 1986. Lista actualizada de los mamíferos de Colombia: Anotaciones sobre su distribución. Caldasia 15:71-75.

de Oliveira, L.Q., *et al*. 2015. Activity of the insectivorous bat *Pteronotus parnellii* relative to insect resources and vegetation structure. Journal of Mammalogy 96:1036-1044.

de la Torre, J.A., and R. A. Medellín. 2010. *Pteronotus personatus*. Mammalian Species 42:244–250.

Díaz, M., *et al*. 2021. Clave de identificación de los murciélagos neotropicales. Publicación Especial N°4 Programa de Conservación de los Murciélagos de Argentina. Tucumán, Argentina.

Ferrer-Pérez, A., *et al*. 2009a. Lista de los mamíferos de la cuenca del río Orinoco. Biota Colombiana 10:179-207.

Ferrer-Pérez, A., M. Beltrán, and C. A. Lasso. 2009b. Mamíferos de la estrella fluvial de Inírida: ríos Inírida, Guaviare, Atabapo y Orinoco (Colombia). Biota Colombiana 10:209-218.

Gardner, A. L. 2007. Mammals of South America. The University of Chicago Press. Chicago, U.S.A.

GBIF.org. 2021. Occurrence Download. https://www.gbif.org/occurrence/download/0233508-200613084148143. Accessed on March 26, 2021.

Guillén-Servent, A. 2005. Diversity of echolocation and foraging behavior of mormoopid bats in an evolutionary context. Bat Research News 46:1801–1817.

Jacobs, D. S., R. M. R. Barclay, and M. H. Walker. 2007. The allometry of echolocation call frequencies of insectivorous bats: Why do some species deviate from the pattern? Oecologia 152:583–594.

Jones, G. 1997. Acoustic Signals and Speciation: The Roles of Natural and Sexual Selection in the Evolution of Cryptic Species. Advances in the Study of Behavior 26:317–354.

Jones, G., and M. W. Holderied. 2007. Bat echolocation calls: adaptation and convergent evolution. Proceedings of the Royal Society B: Biological Sciences 274:905–912.

Kalko, E. K., *et al*. 2008. Flying high-Assessing the use of the aerosphere by bats. Integrative and Comparative Biology 48:60–73.

Kober, R., and H. U. Schnitzler. 1990. Information in sonar echoes of fluttering insects available for echolocating bats. The Journal of the Acoustical Society of America 87:882–896.

Lawrence, B. D., and J. A. Simmons. 1982. Measurements of atmospheric attenuation at ultrasonic frequencies and the significance for echolocation by bats. The Journal of the Acoustical Society of America 71:585–590.

Macías, S., E. C. Mora, and A. García. 2006. Acoustic identification of mormoopid bats: A survey during the evening exodus. Journal of Mammalogy 87:324–330.

MacSwiney, M. C., F. M. Clarke, and P. A. Racey. 2008. What you see is not what you get: The role of ultrasonic detectors in increasing inventory completeness in Neotropical bat assemblages. Journal of Applied Ecology 45:1364–1371.

Mancina, C. A., L. García-Rivera, and B. W. Miller. 2012. Wing morphology, echolocation, and resource partitioning in syntopic Cuban mormoopid bats. Journal of Mammalogy 93:1308–1317.

Martínez-Medina, D., *et al*. 2021a. Estándares para registrar señales de ecolocalización y construir bibliotecas de referencia de murciélagos en Colombia. Biota Colombiana 22:1–17.

Martínez-Medina, D., *et al*. 2021b. Estado, desarrollo y tendencias de los estudios en acústica de la fauna en Colombia. Biota Colombiana 22:7–25.

Montes, G., *et al*. 2012. Nuevos datos sobre la distribución de *Pteronotus personatus* (Wagner, 1843) (Chiroptera: Mormoopidae) en Colombia. Revista Colombiana de Ciencia Animal 4:435–440.

Muñoz-Arango, J. 2001. Los murciélagos de Colombia. Sistemática, Distribución, Descripción, Historia natural y Ecología. Editorial Universidad de Antioquia, Medellín.

Neuweiler, G. 1989. Foraging ecology and audition in echolocating bats. Trends in Ecology and Evolution 4:160–166.

O'Farrell, M., and B. W Miller. 1997. A new examination of echolocation calls of some Neotropical bats (Emballonuridae and Mormoopidae). Journal of Mammalogy 78:954-963.

Orozco-Lugo, L., *et al*. 2013. Descripción de los pulsos de ecolocalización de once especies de murciélagos insectívoros aéreos de una selva baja caducifolia en Morelos, México. Therya 4:33–46.

Páez-Vásquez, M., *et al*. 2020. Murciélagos de la Reserva Natural Bojonawi (Escudo Guayanés), Orinoquia, Vichada, Colombia. Pp. 323-343 *in* VIII Biodiversidad de la Reserva Natural Bojonawi, Vichada, Colombia: río Orinoco y planicie de inundación (Lasso, C., F. Trujillo, and M. Morales-Betancourt, eds.). Serie Editorial Fauna Silvestre Neotropical. Instituto de Investigación de Recursos Biológicos Alexander von Humboldt. Bogotá D. C., Colombia.

Pavan, A. C., and G. Marroig. 2016. Integrating multiple evidences in taxonomy: species diversity and phylogeny of mustached bats (Mormoopidae: *Pteronotus*). Molecular Phylogenetics and Evolution 103:184–198.

Pavan, A. C., and V. C. Tavares. 2020. *Pteronotus gymnonotus*. Mammalian Species 52:40–48.

Pio, D. V., *et al*. 2010. Echolocation calls of the bats of Trinidad, West Indies: Is guild membership reflected in echolocation signal design? Acta Chiropterologica 12:217–229.

Ramírez-Chaves, H. E., *et al*. 2021. Mamíferos de Colombia. v1.12. Sociedad Colombiana de Mastozoología. Dataset/Checklist. https://doi.org/10.15472/kl1whs

Schnitzler, H. U., and A. Denzinger. 2011. Auditory fovea and Doppler shift compensation: adaptations for flutter detection in echolocating bats using CF-FM signals. Journal of Comparative Physiology A 197:541–559.

Schnitzler, H. U., C. F. Moss, and A. Denzinger. 2003. From spatial orientation to food acquisition in echolocating bats. Trends in Ecology and Evolution 18:386–394.

SIB Colombia. 2021. Biodiversidad en Cifras, Sistema de Información sobre Biodiversidad de Colombia 2016:1–5.

Smotherman, M., and A. Guillén-Servent. 2008. Doppler-shift compensation behavior by Wagner's mustached bat, *Pteronotus personatus*. The Journal of the Acoustical Society of America 123:4331–4339.

Solari, S., *et al*. 2013. Riqueza, endemismo y conservación de los mamíferos de Colombia. Mastozoologia Neotropical 20:301–365.

Tressler, J., and M. S. Smotherman. 2009. Context-dependent effects of noise on echolocation pulse characteristics in free-tailed bats. Journal of Comparative Physiology A: Neuroethology, Sensory, Neural, and Behavioral Physiology 195:923–934.

Walters, C. L., *et al*. 2013. Challenges of Using Bioacoustics to Globally Monitor Bats. Pp. 479-499 *in* Bat Evolution, Ecology, and Conservation (Adams, R., and S. Pedersen, eds.). Springer. New York, U.S.A.

Von Der Emde, G., and H. U. Schnitzler. 1990. Classification of insects by echolocating greater horseshoe bats. Journal of Comparative Physiology A 167:423–430.

Zamora-Gutierrez, V., *et al*. 2016. Acoustic identification of Mexican bats based on taxonomic and ecological constraints on call design. Methods in Ecology and Evolution 7:1082–1091.

Zárate-Martínez, D. G., *et al*. 2018. Intraspecific Evolutionary Relationships and Diversification Patterns of the Wagner's Mustached Bat, *Pteronotus personatus* (Chiroptera: Mormoopidae). Acta Chiropterologica 20:51–58.

Associated editor: Jorge Ayala Berdón.

Submitted: November 7, 2022; Reviewed: February 9, 2023.

Accepted: February 22, 2023; Published on line: March 13, 2023.

Appendix 1

Spectral and temporal parameters of the echolocation calls obtained from the search phase of *Pteronotus personatus, Pteronotus gymnonotus, Pteronotus* cf. *rubiginosus*, and *Pteronotus parnellii* recorded in this study and other Neotropical regions. We also added spectral and temporal parameters of the echolocation calls of the approach phase of *P. personatus* and *P.* cf. *rubiginosus*. Mean ± Standard Deviation (X ± *SD*), ms = milliseconds, kHz = kilohertz, IP = Interpulse Interval, SF = Start frequency, EF = End frequency, PF = Peak frequency, MaxF = Maximum frequency, and MinF = Minimum frequency, n = number echolocation pulses and N= number sequences. [1]Vichada, Colombia. [2]Belize. [3]Yucatan Península, México. [4]Oaxaca, México. [5]México. [6]Morelos, México. [7]Brazil. [8]Cuba. [9]Trinidad.

Species	Phase type	Length [ms] (*X* ± *SD*)	IP [ms] (*X* ± *SD*)	SF [kHz] (*X* ± *SD*)	EF [kHz] (*X* ± *SD*)	PF [kHz] (*X* ± *SD*)	MaxF [kHz] (*X* ± *SD*)	MinF [kHz] (*X* ± *SD*)	n/N	References
P. personatus	Search	6.8 ± 1.3	78.9 ± 26.5	77.2 ± 2.0	66.2 ± 2.0	68.0 ± 4.0	78.5 ± 2.0	65.3 ± 1.7	132/22	This study[1]
	Approach	6.5 ± 1.5	56.8 ± 10.9	78.4 ± 2.3	66.6 ± 2.0	68.6 ± 3.3	79.4 ± 2.2	65.8 ± 22	117/16	This study[1]
	Search	5.7	48.3				83	68	25	O'Farrell and Miller 1997[2]
	Search	7.1 ± 0.5	53.9 ± 10.0			80.1 ± 1.5	80.9 ± 1.5	74.1 ± 4.2	8	MacSwiney *et al.* 2008[3]
	Search	4.40 ± 0.57					83.72 ± 1.44	66.75 ± 1.61	12	Briones-Salas *et al.* 2013[4]
	Search	5.71 ± 1.18		82.83 ± 2.68	64.12 ± 2.84	70.53 ± 5.25	82.88 ± 2.66	64.12 ± 2.84	10	Zamora et al. 2016[5]
	Search	5.7 ± 0.02	55.1	82.2 ± 0.05	67.6 ± 0.02	81.4 ± 0.05			-	Orozco-Lugo *et al.* 2013[6]
P. gymnonotus	Search	7.5 ± 0.9	68.0 ± 3.5	57.5 ± 3.2	49.8 ± 3.1	57.2 ± 3.9	58.8 ± 3.6	48.5 ± 3.4	34/3	This study[1]
	Search	5.33 ± 0.82		54.99 ± 3.14	45.81 ± 2.85	51.34 ± 4.87	55.51 ± 3.19	45.81 ± 2.84	-	Zamora *et al.* 2016[5]
	Search	5.3 ± 0.6	84.9 ± 53.0			53.1 ± 2.7	60.6 ± 1.0	48.4 ± 1.5	-	Arias-Aguilar *et al.* 2018[7]
P. cf. *rubiginosus*	Search	28.5 ± 0.5	187.6 ± 60.9	58.3 ± 0.7	53.8 ± 0.8	60.5 ± 0.1	60.8 ± 0.3	53.4 ± 0.6	5/1	This study[1]
	Approach	25.0 ± 5.2	79.4 ± 14.1	59.2 ± 1.1	56.0 ± 3.2	60.2 ± 0.6	60.6 ± 0.8	54.2 ± 3.1	49/4	This study[1]
P. parnellii species complex	Search	30.4	61.9				63.5	54.5	30	O'Farrell and Miller 1997[2]
	Search	21.23 ± 0.87		60.6 ± 0.08	48.05 ± 0.61	60 ± 0.17	60 ± 0.17	59.61 ± 0.16	67	Macías et al. 2006[8]
	Search	25.8 ± 3.1	48.0 ± 21.1			64.5 ± 1.0	64.6 ± 1.0	64.2 ± 1.1	25	MacSwiney *et al.* 2008[3]
	Search	15.8 ± 4.8	47.4 ± 37.7			53.9 ± 3.4	57.2 ± 0.5	46.7 ± 2.3	-	Arias-Aguilar *et al.* 2018[7]
	Search	21 ± 5.5	25 ± 15.6			58.2 ± 0.7	60.2 ± 0.8	46.3 ± 1.9	5	Pio et al. 2010[9]
	Search	27.8 ± 3.1	64.8	61.3 ± 1.8	55.7 ± 2.8	63.1 ± 1.1			-	Orozco-Lugo *et al.* 2013[6]
	Search	24.42 ± 3.7					64.73 ± 1.42	54.93 ± 1.61	388	Briones-Salas *et al.* 2013[4]
	Search	21.21 ± 4.97		61.93 ± 2.04	52.87 ± 2.20	63.61 ± 3.19	64.97 ± 1.27	52.86 ± 2.20	50	Zamora *et al.* 2016[5]

Appendix 2

Records of *Pteronotus* species in Colombia were obtained from the Biodiversity Information System of Colombia (SIB), Global Biodiversity Information Facility (GBIF), and biological collections. USNM: National Museum of Natural History, ICN: Instituto de Ciencias Naturales, FMNH: Field Museum of Natural History, ROM: Royal Ontario Museum, MHNG: Muséum d'histoire naturelle de la Ville de Genève, MUJ: Museo Javeriano de Historia Natural, CZUC-M: Colección Zoológica de la Universidad de Córdoba - Mamíferos, MHNLS: Museo de Historia Natural La Salle, MHNUCa: Museo de Historia Natural de la Universidad de Caldas, MHNU: Museo de Historia Natural Unillanos. *Specimen deposited in the Laboratory of Biology I – Universidad de Sucre.

Species	Department	Locality	Latitude	Longitude	Source	References
Pteronotus gymnonotus	Vichada	Santa Teresita			USNM 431554	GBIF 2021
	Córdoba	Corregimiento El Diluvio			ICN 2481	ICN online database
	Bolívar	Bocachica, Ruinas de San Angel (Cerro de La Popa). Salón en una galería.			ICN 1668	ICN online database
	Bolívar	Bahía de Cartagena, Isla de Tierra Bomba, Bocachica. Fuerte de San Fernando. En las galerías bajas laterales atravesando las bóvedas			ICN 2255	ICN online database
	Bolívar	Bocachica, Cartagena	10° 19' 60.0" N	75° 29' 40.9" W	FMNH 122063 - 122064	Chacón-Pacheco *et al.* 2018
	Bolívar	Cartagena	10° 23' 59.0" N	75° 30' 52.0" W	ROM 43984, 45303, 52542, 53999,	Chacón-Pacheco *et al.* 2018
	Bolívar	Isla Barú	10° 14' 23.8" N	75° 35' 46.4" W	MHNG 1922.023 - 1922.064	Chacón-Pacheco *et al.* 2018
	Cesar	Los Besotes, Valledupar	10° 34' 13.7" N	73° 16' 15.3" W	MUJ 1661	Chacón-Pacheco *et al.* 2018
	Guainía	Inírida	03° 50' N	67° 55' W	Ferrer-Pérez *et al.* 2009b	Chacón-Pacheco *et al.* 2018
	Huila	Baraya, Las Delicias	03° 09' 05.6" N	75° 01' 19.5" W	ICN 13589 - 13590	Chacón-Pacheco *et al.* 2018
	Huila	Tamarindo, Neiva	03° 03' 36.0" N	75° 22' 12.0" W	MUJ 655, 1003	Chacón-Pacheco *et al.* 2018
	Magdalena	PNN Tayrona	11° 18' 59.5" N	73° 56' 59.4" W	ICN 7822	Chacón-Pacheco *et al.* 2018
	Sucre	La Florida, San Marco	08° 35' 49.9" N	75° 08' 31.2" W	ICN 17441, 17442, 17443, 17444, 17445, 17446	Chacón-Pacheco *et al.* 2018
	Sucre	Estación Meteorológica Primates, Coloso	09° 31' 50" N	75° 21' 01" W	Montes *et al.* 2012	Chacón-Pacheco *et al.* 2018
	Sucre	Las Campanas, Coloso	09° 30' 00.0" N	75° 21' 00.0" W	FMNH 69367 - 69396	Chacón-Pacheco *et al.* 2018
	Tolima	Gualanday	04° 15' N	74° 59' W	Bejarano-Bonilla *et al.* 2007	Chacón-Pacheco *et al.* 2018
	Tolima	Pastales, Ibagué	04° 30' N	75° 18' W	Bejarano-Bonilla *et al.* 2007	Chacón-Pacheco *et al.* 2018
	Tolima	Boquerón, Ibagué	04° 24' 13.4" N	75° 11' 49.9" W	ROM 77274	Chacón-Pacheco *et al.* 2018
	Vichada	PNN El Tuparro, Administrative Center	05° 21' 07.8" N	67° 51' 15.1" W	ICN 12688	Chacón-Pacheco *et al.* 2018
	Córdoba	La Oscurana, Tierralta	08° 00' N	76° 05' W	ICN 19907, 19912	Chacón-Pacheco *et al.* 2018
Pteronotus parnellii	Córdoba	PNN Paramillo, Llanos del Tigre	07° 36' 49.5" N	76° 00' 44" W	MUJ 1520	Chacón-Pacheco *et al.* 2018
	Córdoba	PNN Paramillo, Zancó	07° 40' 02.5" N	076 °05' 50.5" W	MUJ 1523	Chacón-Pacheco *et al.* 2018
	Córdoba	Tuis Tuis, Tierralta	08° 02' 46.8" N	076° 05' 43.5" W	CZUC-M 0131, 0239	Chacón-Pacheco *et al.* 2018
	Córdoba	Cajón del Diablo, Tierralta	08° 17' 24.2" N	075° 59' 49.8" W	CZUC-M 0240, 0241	Chacón-Pacheco *et al.* 2018
	Guainía	Inírida			MHNLS	Ferrer-Pérez *et al.* 2009b
	Vichada	Puerto Carreño, Reserva Natural Privada Bojonawi	6° 5' 52.789" N	67° 28' 59.581" W	MHNUCa 1108	GBIF 2021
	Vichada	Puerto Carreño, Reserva Natural Privada Bojonawi	6° 5' 52.789" N	67° 28' 59.581" W	MHNUCa 1113	GBIF 2021
	Bolívar	Bahía de Cartagena, Isla de Tierra Bomba, Bocachica, Ruinas de San Angel, Cerro de La Popa, salón en galerías			ICN 2628-2677	ICN online database
	Cesar	San Martin	07º 53' 19,5" N	73º 39' 17,4" W	ICN 18892	ICN online database
	Cesar	El Paso			ICN 18893	ICN online database
	Bogotá	Ciudad de Bogotá			ICN 1533	ICN online database
	Huila	Baraya, Sitio El Cruce, finca Las Delicias	3° 9' 5.608" N	75° 1' 19.501" W	ICN 13589 - 13590	ICN online database
	La Guajira	Guajira, Albania, Valle del Cerrejón, Arroyo Bruno			ICN 19486	ICN online database
	Magdalena	Parque Nacional Natural Tayrona, Arrecifes	11° 19' 4.080" N	73° 56' 52.584" W	ICN 7822	ICN online database
	Magdalena	Parque Nacional Natural Tayrona, Gairaca	11° 19' 39.828" N	74° 6' 38.412" W	ICN 7823	ICN online database
	Magdalena	Colonia Agrícola de Caracolito			ICN 875	ICN online database
	Sucre	San Marcos, Vereda La Florida, ciénaga Gamboa, Granja Cocodrilia	8° 35' 49.901" N	75° 8' 31.194" W	ICN 17441-17446	ICN online database
	Vichada	Parque Nacional El Tuparro, alrededores del Centro Administrativo	5° 21' 7.751" N	-67° 51' 15.120" W	ICN 12688, ICN 13944	ICN online database

Appendix 2

Continuation

Species	Department	Locality	Latitude	Longitude	Source	References
	Antioquia	Turbo			Gardner 2007	Montes *et al.* 2012
	Antioquia	Boca Chica			Muñoz-Arango 2001	Montes *et al.* 2012
	Bolívar	Tierra Bomba			Muñoz-Arango 2001	Montes *et al.* 2012
	Bolívar	Cartagena			Muñoz-Arango 2001	Montes *et al.* 2012
	Cauca	El Bordo			USNM 595072	Montes *et al.* 2012
	Cundinamarca	Santa Fe de Bogotá			Muñoz-Arango 2001	Montes *et al.* 2012
	La Guajira	Nazaret			Gardner 2007	Montes *et al.* 2012
	Sucre	Tolúviejo			USNM 431459-431464	Montes *et al.* 2012
	Sucre	Colosó			*ADNO 0007	Montes *et al.* 2012
	Valle del Cauca	El Pital			USNM 595073	Montes *et al.* 2012
Pteronotus personatus	Vichada	Santa Teresita			USNM 431484-431488	Montes *et al.* 2012
	Meta	Restrepo	4° 15' 0.000" N	73° 34' 0.001" W	ROM 50142	GBIF 2021
	Vichada	Puerto Carreño, Vda Caño Negro			MHNU 406	GBIF 2021
	Vichada	Santa Teresita			USNM 431484-431486	GBIF 2021
	Bolívar	Bahía de Cartagena, Isla de Tierra Bomba, Bocachica, Fuerte de San Fernando, en las galerías laterales de la parte alta			ICN 2573-2627	ICN online database
	Bolívar	Castillo de San Fernando			ICN 3873-3902	ICN online database
	Bolívar	Bahía de Cartagena, Isla de Tierra Bomba, Bocachica, Ruinas de San Angel, Cerro de La Popa, salón en galerías			ICN 2676-2681	ICN online database
	Córdoba	Montería, Corregimiento El Diluvio			ICN 2686	ICN online database
	La Guajira	Hatonuevo			ICN 14950	ICN online database
	La Guajira	Albania			ICN 19487	ICN online database
	Nariño	Km 98 vía Tumaco. Río Nambí, cuenca río Telembí, Quebrada. Babosa, cuenca del río Patía			ICN 2722	ICN online database

THERYA NOTES 2023, Vol. 4 : 21-26 DOI: 10.12933/therya_notes-23-100 ISSN 2954-3614

New records of grison (*Galictis vittata*) in Campeche, México

Nuevos registros del grisón (*Galictis vittata*) en Campeche, México

Fernando M. Contreras-Moreno[1]*, Daniel Jesús-Espinosa[2], Lizardo Cruz-Romo[1], Gabriela Méndez-Saint Martin[2], Luis A. Tamay Yah[3], Khiavett G. Sánchez-Pinzón[3], Carlos M. Delgado-Martínez[4,5], Eduardo Mendoza[5], Klaus Dræby[6], and Evelio Uc-Monrrero[7]

[1]World Wildlife Fund Inc. Av. Insurgentes Sur 1216, C. P. 03100, Benito Juárez. Ciudad de México, México. E-mail: fernandom28@hotmail.com (FMC-M); lcruz@wwfmex.org (LC-R).

[2]Grupo de Monitoreo Socioambiental. 27 de Febrero 127, Col. San Joaquín, C. P. 86930, Balancán. Tabasco, México. E-mail: danieljesus_esp@outlook.com (DJ-E); mendez.blue93@hotmail.com (GM-SM).

[3]Reserva de la Biosfera de Calakmul, Comisión Nacional de Áreas Naturales Protegidas. Puerto Rico s/n, Col. Fundadores, C. P. 24640, Calakmul. Campeche, México. E-mail: ltamay@hotmail.com (LATY); khiavettsanchez@hotmail.com (KGS-P).

[4]Posgrado en Ciencias Biológicas, Universidad Nacional Autónoma de México, C. P. 04510. Ciudad de México, México. E-mail: pistache06@ciencias.unam.mx (CMD-M).

[5]Instituto de Investigaciones sobre los Recursos Naturales, Universidad Michoacana de San Nicolás de Hidalgo. C. P. 58337, Morelia. Michoacán, México. E-mail: eduardo.mendoza@umich.mx (EM).

[6]Monkeyfingers Wildlife Reserve. C. P. 24640, Calakmul. Campeche, México. E-mail: draeby@gmail.com (KD).

[7]Reservas Estatales Balam-Kin y Balam-Kú, Secretaría de Medio Ambiente, Biodiversidad y Cambio Climático y Energía. C. P. 24095, San Francisco de Campeche. Campeche, México. E-mail: evelioUC@hotmail.com (EU-M).

*Corresponding author

The grison is a carnivorous mammal of the family Mustelidae listed as threatened in México. There are few records and information on different aspects of its ecology. The objective of this note was to report new records of grison in Campeche. From January 2017 to June 2022, 30 camera-trap stations were installed in natural and artificial water bodies within the Calakmul Biosphere Reserve to capture and identify wildlife. Additionally, roadkilled individuals were recorded by vehicle tours along the Campeche roads. Records were also searched in international databases, books, and published articles. With a sampling effort of 15,000 camera trap nights, we captured 2 separate grison photographs in the Calakmul Biosphere Reserve and 6 records of roadkilled animals in Campeche. This note documents the presence of grison in several habitats of Campeche. The lack of information on the species might be due to multiple reasons. The sampling methods target large animals and the greatest sampling efforts are performed in protected natural areas with a high conservation level. We found that most records correspond to disturbed sites with secondary vegetation. The fact that many records were of roadkilled animals suggests that this species is susceptible to the impact of roads in Campeche.

Key words: Calakmul; camera-trap; carnivores; mammals; Mustelidae.

El grisón es un mamífero carnívoro perteneciente a la familia Mustelidae, que en México está clasificado como amenazado. Existen pocos registros e información sobre diferentes aspectos de su ecología. El objetivo de esta nota es reportar nuevos registros de grisón en el estado de Campeche. De enero de 2017 a junio de 2022 se instalaron 30 estaciones de fototrampeo en cuerpos de agua naturales y artificiales dentro de la Reserva de la Biosfera Calakmul para identificar fauna silvestre que los utiliza. Adicionalmente, se obtuvieron registros de individuos atropellados derivado de recorridos realizados en carreteras de Campeche. Se buscaron registros en bases de datos internacionales, en libros y artículos publicados. Con un esfuerzo de muestreo de 15,000 noches/cámara, se obtuvieron 2 registros independientes de grisón por fototrampeo en la Reserva de la Biosfera Calakmul, y 6 registros de animales atropellados en carreteras del estado de Campeche. Los registros en esta nota indican la presencia del grisón en diversos lugares de Campeche con hábitats variables. La falta de información previa sobre la especie puede deberse a diversas razones, los métodos de muestreo son dirigidos a animales grandes, los mayores esfuerzos de muestreo se realizan en áreas naturales protegidas en hábitats con mayor grado de conservación. Encontramos que la mayoría de los registros se dieron en sitios perturbados con vegetación secundaria. El que varios registros hayan sido animales atropellados, sugiere que esta especie es susceptible de los efectos de las carreteras en el estado de Campeche.

Palabras clave: Calakmul; cámara-trampa; carnívoros; mamíferos; Mustelidae.

The grison (*Galictis vittata*) is a medium-sized carnivorous mammal of the family Mustelidae. This species has a small head, elongated body, and short legs and tail (Kaufmann and Kaufmann 1965; Álvarez-Castañeda *et al.* 2015). The body is coated by gray dorsal fur and a mixture of light hairs that extends to the flanks, legs, and tail. This species has a white stripe that crosses the forehead, continues below the ears, and ends diagonally towards the beginning of the neck and forelimbs. The eyes, face, neck, chest, limbs, and belly are blackish (Yensen and Tarifa 2003). The grison is a solitary animal with terrestrial habits and diurnal activity (Kaufmann and Kaufmann 1965), although it can also

be active at night (Sunquist *et al.* 1989). It feeds on small mammals, birds, amphibians, reptiles, fish, invertebrates, and fruit (Leopold 1959; Bisbal 1986; Sunquist *et al.* 1989; Vaccaro and Canevari 2007; Hidalgo-Mihart *et al.* 2018); in captivity, it can also consume plants (Dalquest and Roberts 1951; Ewer 1973).

The species has been recorded at altitudes from sea level to 2,200 m, but is more common below 500 m in some localities (Bornholdt *et al.* 2013; Escobar-Lasso and Guzmán-Hernández 2014). The distribution ranges from central-southern México through Central America to northern South America, inhabiting areas of tropical and subtropical forests such as the Amazon basin. It has not been found in adjacent biomes, such as savannas, deserts, mountain grasslands, and most of the forest in eastern South America (Bornholdt *et al.* 2013; Cuarón *et al.* 2016). In México, there are records of this species in southern Tamaulipas, eastern San Luis Potosí (Chávez 2005; Contreras-Díaz *et al.* 2020), Sierra Norte de Puebla (Lucas-Juárez *et al.* 2021), Oaxaca, Chiapas, and Tabasco (García-Morales and De Bonilla-Cervantes 2021); it has also been reported in the Yucatán Peninsula, where Campeche has the lowest number of records (Contreras-Díaz *et al.* 2020). This mustelid inhabits a wide range of habitats, such as tropical forests, grasslands, arid regions, tropical dry forests, secondary vegetation, crops, and suburban areas (Estrada *et al.* 1993; Gallina *et al.* 1996; De la Torre *et al.* 2009; Pérez-Solano *et al.* 2018). It also lives in sites adjacent to permanent water bodies such as rivers, streams, and wetlands (Cuarón *et al.* 2016). Recently, grison records have been obtained in open and disturbed environments and fruit crops (García-Morales and De Bonilla-Cervantes 2021; Soto and Brito 2022). The grison is one of the least studied mammals in México. It is listed as Threatened in NOM-059-SEMARNAT-2010 (SEMARNAT 2010), while the IUCN has listed it as Least Concern (Cuarón *et al.* 2016).

There are few records and information on the ecology of this species (Hernández-Hernández *et al.* 2018), which is one of the least studied mustelids (Bornholdt *et al.* 2013). Since it was first recorded in Campeche (Escalona-Segura *et al.* 2002), there has been scarce information produced in the state, particularly in the west (Guzmán-Soriano *et al.* 2013; Vargas-Contreras *et al.* 2016). For this reason, the objective of this note is to report new records of grison for the state of Campeche, Yucatán Peninsula.

The records reported herein are located in Campeche, Yucatán Peninsula, between coordinates 17° 49' – 20° 51' N and 89° 06 '– 92° 27' W (INEGI 2020). The state of Campeche comprises 57,507 km^2, where the major vegetation types are evergreen tropical forest, tropical deciduous and subdeciduous forests, savannas, mangroves, coastal dunes, *petén*, and secondary vegetation (Flores-Guido and Sánchez-González 2010; Noriega-Trejo and Arteaga 2010). Regarding the physiography, it is classified into 3 areas: lowlands (north), plateaus and hills (center and south), and the southwest plains comprising a wetlands zone (Bautista-Zúñiga *et al.* 2005). The prevailing climate is warm, with summer rains. The annual mean temperature is 26.2 °C, and the annual mean precipitation is 1,272.8 mm (Mendoza-Vega and Ku-Quej 2010).

As part of the project "Monitoring of water bodies in the Calakmul region", from January 2017 to June 2022, 30 camera-trap stations were placed adjacent to natural and artificial water bodies within the Calakmul Biosphere Reserve (southern Campeche) to capture and identify the local wildlife using them (Contreras-Moreno *et al.* 2019, 2020; Borges-Zapata *et al.* 2020; Simá-Pantí *et al.* 2020; Delgado-Martínez *et al.* 2021; Contreras-Moreno *et al.* 2022). At each station, a digital camera trap of one of the following models was installed: Bushnell (TropyCam; Outdoor Operations LLC.), Browning (Strike force; Browning Trail Cameras), or Cuddeback (Cuddeback IR; Non-Typical Inc.). Cameras were affixed 50 cm above the ground on tree trunks adjacent to the water bodies, and were set to capture photographs 24 hr a day, with 5 sec between each. The sex of the organisms was determined by the presence/absence of visible sexual organs (testes).

Additionally, incidental records of the grison, *G. vittata* were noted through non-systematic tours on the roads of Campeche from January 2017 to July 2022. Previous records were also gathered from international biodiversity databases, such as the Global Biodiversity Information Network (REMIB, in Spanish; http://www.conabio.gob.mx/remib/) and the Global Biodiversity Information Facility (GBIF; http://www.gbif.org). This information was completed through a literature survey (including capture and release, direct observations, camera trapping, and tracking data) conducted in Google Scholar (http://www.scholar.google.com/) and the Mammal Networked Information System (MaN; http://www. manisnet.org/).

With a sampling effort of 15,000 camera trap nights, we captured 2 records of *G. vittata*. Furthermore, 6 roadkilled individuals of the species were recorded during road surveys (Table 1; Figures 1 and 2). The first photograph was captured on 22 February 2017 at 11:49 hr in the Ejido Conhuas (km 7), municipality of Calakmul (18° 27' 38.52" N, 89° 52' 39.94" W). The presence of testicles allowed the identification of an adult male walking in a tropical subdeciduous forest near crops and grasslands. The second photograph, captured on 21 January 2019 within the buffer zone of the Calakmul Biosphere Reserve (km 40; 18° 14' 32.81" N, 89° 52' 3.06" W), belongs to an adult of indeterminate sex. The dominant vegetation in the site is tropical subdeciduous forest.

Six roadkilled grison individuals were recorded along the 5,000 km traveled on Campeche roads between the years 2017 and 2022 (Table 1). All individuals were adult males crossing roads surrounded by secondary vegetation (*acahuales*).

The records reported herein show the presence of grison in multiple sites of Campeche with different habitats. However, records of the species for this state are scarce. The lack of information on the species might be due to several reasons, *e.g.*, sampling methods do not target medium-

Table 1. New records of grison (*Galictis vittata*) in Campeche, México.

Municipality	Study site	Coordinates	Year of record	No. of records	Record type
Calakmul	Conhuas (km 7)	18° 27' 38.52" N 89° 52' 39.94" W	2017	1	Photographs
Palizada	Ejido Tumbo de la Montaña	18° 10' 12.55" N 91° 46' 39.22" W	2017	1	Roadkilled
Palizada	Carretera Santa Adelaida-Palizada	18° 03' 31.11" N 91° 57' 48.70" W	2018	1	Roadkilled
Escárcega	División del Norte	18° 29' 23.25" N 90° 46' 27.40" W	2019	1	Roadkilled
Calakmul	Reserva de la Biosfera de Calakmul (km 40)	18° 14' 32.81" N 89° 52' 03.06" W	2019	1	Photographs
Candelaria	El Desengaño	17° 52' 09.34" N 90° 26' 16.25" W	2021	1	Roadkilled
Champotón	Carretera Escárcega-Champotón	19° 16' 27.15" N 90° 43' 57.16" W	2021	1	Roadkilled
Calakmul	Carretera Xpujil-Zoh Laguna	18° 34' 50.62" N 89° 24' 40.31" W	2022	1	Roadkilled

sized mammals (such as the grison). Although camera trapping is extensively used in México, it has only gained increasing importance in Campeche in recent years (Contreras-Moreno *et al.* 2019; Borges-Zapata *et al.* 2020; Contreras-Moreno *et al.* 2020; Delgado-Martínez and Mendoza 2020; Simá-Pantí *et al.* 2020). However, this method has targeted mainly large-sized mammals (Contreras-Moreno *et al.* 2022), and the height, direction, and position of the camera are usually not intended to capture medium-sized species (Delgado-Martínez *et al.* 2022).

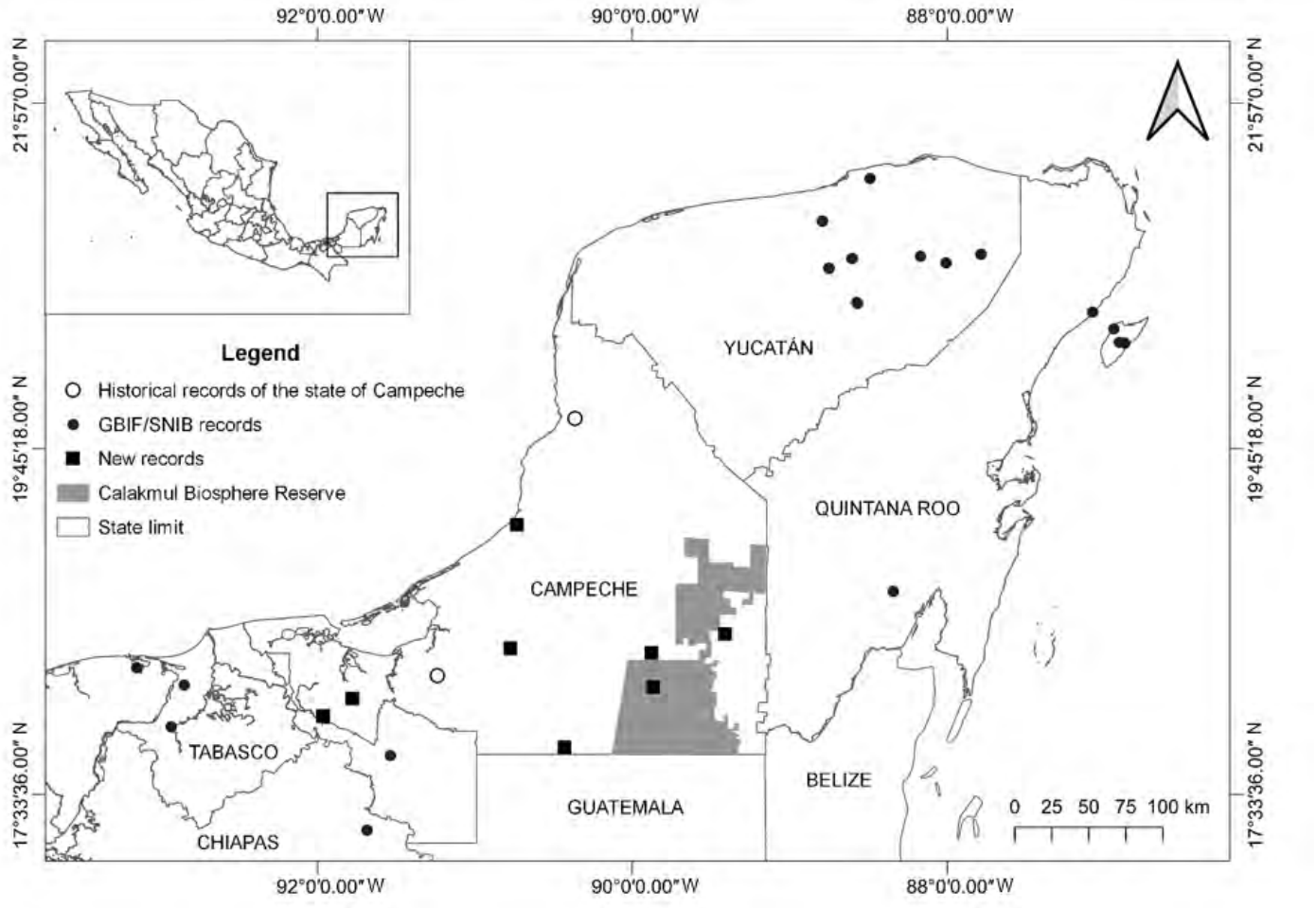


Figure 1. Location of the new grison records (*Galictis vittata*) in Campeche, México (black squares). Historical records are marked by circles (Escalona-Segura *et al.* 2002).

Figure 2. a) and b) Grison specimens (*Galictis vittata*) recorded in Campeche, México, by camera traps; c) to e) roadkilled individuals.

The lack of grison records for Campeche might also be due to the fact that studies have been conducted mainly in protected natural areas (ANP, in Spanish) where the habitat has a high conservation level. Most records reported in this note were obtained in disturbed sites with secondary vegetation, as in other regions of México (García-Morales and De Bonilla-Cervantes 2021; Soto and Brito 2022).

The fact that several of the recorded grisons were roadkilled suggests that the roads of Campeche impact the species mortality when these animals attempt to cross these roads. The disturbance exerted by roads on grison populations in México is currently unknown. However, in species with low densities and small population sizes, road collisions with motor vehicles, although being rare events, may become a major mortality factor that reduces the survival of local populations (Maehr *et al.* 1991). This is worrying because Mexican environmental regulations recognize the grison as a threatened species (SEMARNAT 2010). Specialized studies on the effects of road characteristics on medium-sized mammals such as the grison are needed in Campeche and throughout México.

The records reported in this note are evidence of the presence of grison in Campeche, southeastern México. However, information on this species remains scarce, so further research on wild mammals should consider medium-sized carnivores such as the grison within their sampling design.

Acknowledgements

To the 00092169 project: "Strengthening of the management of the Protected Area System to improve the conservation of species at risk and their habitats", by the United Nations Development Program (UNDP), implemented by the Comisión Nacional de Áreas Naturales Protegidas (National Commission on Natural Protected Areas; CONANP, in Spanish) and funded by the Global Environment Facility (GEF). To the colleagues at the Calakmul Biosphere Reserve, who were always willing to support the monitoring project. To the World Wildife Fund, Inc. (WWF-México) for the financing granted through the Monitoring Water Bodies in the Calakmul Biosphere Reserve program, within the framework of the project "Saving the jaguar: ambassador of America". To the park rangers of the Calakmul Biosphere Reserve. CMD-M and EM were supported by the Rufford Foundation (grant 24083-1), the National Geographic Society (grant EC-196R-18) and IDEA WILD. To the two anonymous reviewers

for their valuable comments to improve this note. M. E. Sánchez-Salazar translated the manuscript into English.

Literature cited

Álvarez-Castañeda, S. T., T. Álvarez, and N. González-Ruiz. 2015. Keys for identifying Mexican mammals. Impresiones Pandora S. A. de C. V. Jalisco, México.

Bautista-Zúñiga, F., *et al*. 2005. Integración del conocimiento actual sobre los paisajes geomorfológicos de la península de Yucatán. Pp. 33–58 *in* Caracterización y manejo de suelos en la Península de Yucatán: Implicaciones agropecuarias, forestales y ambientales (Bautista, F., and G. Oliva, eds.). Universidad Autónoma de Campeche, Universidad Autónoma de Yucatán, Instituto Nacional de Ecología. México City, México.

Bisbal, E. F. J. 1986. Food habits of some Neotropical carnivores in Venezuela (Mammalia, Carnivora). Mammalia 50:329–340.

Borges-Zapata, J. Y., *et al*. 2020. Uso de bebederos artificiales por el sereque centroamericano (*Dasyprocta punctata*) en la Reserva de la Biosfera Calakmul, México. Agroproductividad 13:51–58.

Bornholdt, R., *et al*. 2013. Taxonomic revision of the genus *Galictis* (Carnivora: Mustelidae): species delimitation, morphological diagnosis, and refined mapping of geographical distribution. Zoological Journal of the Linnean Society 167:449–472.

Chávez, C. 2005. *Galictis vittata*. Pp. 378–380 *in* Los Mamíferos de México (Ceballos, G., and G. Oliva, eds.). Comisión Nacional para Conocimiento de la Biodiversidad-Fondo de Cultura Económica. México City, México.

Contreras-Díaz, C., *et al*. 2020. Expansion of distribution range of the greater grison (*Galictis vittata*) in México. Therya Notes 1:1–4.

Contreras-Moreno, F. M., *et al*. 2019. Registro fotográfico de un murciélago capturado por *Leopardus pardalis* (Carnivora: Felidae) en la Reserva de la Biosfera de Calakmul, México. Mammalogy Notes 5:6–9.

Contreras-Moreno, F. M., *et al*. 2020. Registro del coyote (Carnivora: Canidae) en la Reserva la Biosfera de Calakmul, México. UNED Research Journal 12:e2890.

Contreras-Moreno, F., *et al*. 2022. Registros destacados de *Spilogale angustifrons* en la Reserva de la Biosfera Calakmul. Revista Colombiana de Ciencia Animal-RECIA 14:e913-e913.

Cuarón, A. D., *et al*. 2016. *Galictis vittata*. The IUCN Red List of Threatened Species 2016:e.T41640A45211961. https://dx.doi.org/10.2305/IUCN.UK.2016-1.RLTS.T41640A45211961.en. Accessed on January 2, 2023.

Dalquest, W. W., and J. H. Roberts. 1951. Behavior of young grisons in captivity. American Midland Naturalist 46:359–366.

De la Torre, J. A., C. Muench, and M. Arteaga. 2009. Nuevos registros de grisón *Galictis vittata* para la Selva Lacandona, Chiapas, México. Revista Mexicana de Mastozoología 13:109–114.

Delgado-Martínez, C., *et al*. 2021. Spider monkeys use small terrestrial water sources to drink water in Calakmul, Mexico. Behaviour 158:161–175.

Delgado-Martínez, C. M., and E. Mendoza. 2020. La importancia de las sartenejas como fuente de agua para la fauna silvestre en la región de Calakmul, Campeche. Biodiversitas 151:2–6.

Delgado-Martínez, C. M., S. Cudney-Valenzuela, and E. Mendoza. 2022. Camera trapping reveals multispecies use of water-filled tree holes by birds and mammals in a neotropical forest. Biotropica 54:262–267.

Escalona-Segura, G., J. A. Vargas-Contreras, and L. Interián-Sosa. 2002. Registros importantes de mamíferos para Campeche, México. Revista Mexicana de Mastozoología (nueva época) 6:166–170.

Escobar-Lasso, S., and C. F. Guzmán-Hernández. 2014. El registro de mayor altitud del Hurón Mayor *Galictis vittata*, con notas sobre su presencia y conservación dentro del departamento de Caldas, en la región andina de Colombia. Therya 5:567–574.

Estrada, A., R., *et al*. 1993. Patterns of Frugivore Species Richness and Abundance in Forest Islands and in Agricultural Habitats at Los Tuxtlas, Mexico. Vegetation 107:245–257.

Ewer, R. F. 1973. The carnivores. Ithaca, New York, U.S.A.

Flores-Guido, J. S., and M. C. Sánchez-González. 2010. Diversidad florística. Pp. 210-213 *in* La Biodiversidad en Campeche: Estudio de Estado (Villalobos-Zapata, G., and J. Mendoza, coord.). Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (CONABIO), Gobierno de Estado de Campeche, El Colegio de la Frontera Sur. Campeche, México.

Gallina, S., S. Mandujano, and A. González-Romero. 1996. Conservation of mammalian biodiversity in coffee plantations of Central Veracruz, México. Agroforestry Systems 33:13–27.

García-Morales, R. G., and B. B. De Bonilla-Cervantes. 2021. Registro de *Galictis vittata* (Carnivora: Mustelidae) en un área suburbana en el estado de Tabasco, México. Mammalogy Notes 7:215.

Guzmán-Soriano, D., *et al*. 2013. Registros notables de mamíferos para Campeche, México. Acta Zoológica Mexicana 29:269–286.

Hernández-Hernández, J. C., *et al*. 2018. Registros del grisón (*Galictis vittata*), nutria de río neotropical (*Lontra longicaudis*) y conejo (*Sylvilagus* sp.) en la Reserva de la Biosfera La Encrucijada, Chiapas, México. Revista Mexicana de Mastozoología (nueva época) 8:8–12.

Hidalgo-Mihart, M. G., *et al*. 2018. Greater grison (*Galictis vittatta*) hunts a Central American indigo snake (*Drymarchon melanurus*) in southeastern Mexico. The Southwestern Naturalist 63:197–199.

Instituto Nacional de Estadística y Geografía (INEGI). 2020. Perspectiva Estadística: Campeche. Instituto Nacional de Estadística y Geografía. Aguascalientes, Aguascalientes.

Kaufmann, J. H., and A. Kaufmann. 1965. Observations of the behavior of tayras and grisons. Zeitschrift für Säugetierkunde 30:146–155.

Leopold, A. S. 1959. Wildlife of Mexico: The game birds & mammals. Berkeley, California, U.S.A.

Lucas-Juárez, G., J. D. Lucas-Juárez, and J. M. Díaz-García. 2021. Nuevo registro del grisón mayor (*Galictis vittata*) en la Sierra Nororiental de Puebla, México. Therya Notes 2:47–50.

Maehr, D. S., E. Land, and M. Roelke. 1991. Mortality Patterns of Panthers in Southwest Florida. Proceedings of the annual conference / Southeastern Association of Fish and Wildlife Agencies 45:201–207.

Mendoza-Vega, J., and V. M. Kú-Quej. 2010. Clima. Pp. 16-19 *in* La Biodiversidad en Campeche: Estudio de Estado (Villalobos-Zapata, G., and J. Mendoza, coord.). La Biodiversidad en Campeche: Estudio de Estado. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (CONABIO), Gobierno de Estado de Campeche, El Colegio de la Frontera Sur. Campeche, México.

Noriega-Trejo, R., and M. A. Arteaga-Aguilar. 2010. Síntesis de los tipos de vegetación terrestre. Pp. 148-155 *in* La Biodiversidad en Campeche: Estudio de Estado (Villalobos-Zapata, G., and J. Mendoza, coord.). Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (CONABIO), Gobierno de Estado de Campeche, El Colegio de la Frontera Sur. Campeche, México.

Pérez-Solano, L. A., *et al*. 2018. Mamíferos medianos y grandes asociados al bosque tropical seco del centro de México. Revista de Biología Tropical 66:1232–1243.

Secretaría del Medio Ambiente y Recursos Naturales (SEMARNAT). 2010. Norma Oficial Mexicana NOM-059-SEMARNAT-2010, Protección ambiental-Especies nativas de México de flora y fauna silvestres-Categorías de riesgo y especificaciones para su inclusión, exclusión o cambio-Lista de especies en riesgo. Accessed on November 10, 2022.

Simá-Pantí, D. E., *et al*. 2020. Predation of morelet's crocodile by jaguar in the Calakmul Biosphere Reserve in southeastern México. Therya Notes 1:8-10.

Soto, S. S., and E. Brito. 2022. Registros del grisón grande *Galictis vittata* (Carnivora: Mustelidae) en el oeste de Tabasco, México. Notas sobre mamíferos sudamericanos 4.

Sunquist, M. E., F. Sunquist, and D. E. Daneke. 1989. Ecological separation in a Venezuelan llanos carnivore community. Pp. 197-232 *in* Advances in Neotropical Mammalogy (Redford, K., and J. Eisenberg, eds.). Sandhill Crane Press. Gainesville, Florida, U.S.A.

Vaccaro, O., and M. Canevari. 2007. Guía de mamíferos del sur de América del sur. Editorial L.O.L.A. Buenos Aires, Argentina.

Vargas-Contreras, J., *et al*. 2016. Mamíferos de Campeche, México. Pp. 129-152 *in* Riqueza y Conservación de los Mamíferos en México a Nivel Estatal (Briones-Salas, M., *et al*., eds.). Instituto de Biología, Universidad Nacional Autónoma de México, Asociación Mexicana de Mastozoología A. C. and Universidad de Guanajuato. México City, México.

Yensen, E., and T. Tarifa. 2003. *Galictis vitatta*. Mammalian Species 727:1-8.

Associated editor: Beatríz Bolívar Cimé.
Submitted: September 29, 2022; Reviewed: January 24, 2023.
Accepted: March 7, 2023; Published on line: March 14, 2023.

THERYA NOTES 2023, Vol. 4 : 27-33 DOI: 10.12933/therya_notes-23-101 ISSN 2954-3614

Mamíferos medianos y grandes en un fragmento de bosque subandino en Colombia

Medium and large mammals in a sub-Andean forest fragment in Colombia

Alex Mauricio Mopán-Chilito[1]*, J. Alejandro Camacho[2], Estefanía Franco-Pérez[3], O. Eduardo Grajales-Hernández[4], Andrés Link[5,6], y Sebastián O. Montilla[5,6]

[1]Centro Tlaxcala de Biología de la Conducta, Universidad Autónoma de Tlaxcala. La Loma Xicohtencatl, C. P. 90070, Tlaxcala de Xicohténcatl. Tlaxcala, México. E-mail: alexmauriciomopan@gmail.com (AMM-Ch).
[2]Programa de Antropología, Universidad de Caldas. Cl. 65 No. 26-10, C. P. 170002, Manizales. Caldas, Colombia. E-mail: jagiraldocamacho@gmail.com (JAG).
[3]Programa de Biología, Universidad de Caldas. Cl. 65 No. 26-10, C. P. 170002, Manizales. Caldas, Colombia. E-mail: estefaniafranco413@gmail.com (EF-P).
[4]Asociación de Biólogos de la Universidad del Quindío (ASOBIOUQ). Cra. 15 No. 12N, C. P. 630004, Armenia. Quindío, Colombia. E-mail: oscargrajales13@gmail.com (OEG-H).
[5]Departamento de Ciencias Biológicas, Universidad de Los Andes. Cra. 1 No. 18A – 12, C. P. 110311. Bogotá D. C., Colombia. E-mail: juansomontilla94@gmail.com (SOM).
[6]Fundación Proyecto Primates. Cra. 11a No 91-55, C. P. 110211. Bogotá D. C., Colombia. E-mail: a.link74@uniandes.edu.co (AL).
*Autor de correspondencia

Los fragmentos de bosques que aún persisten dentro de los ambientes antropizados, juegan un papel fundamental en la conservación de diferentes especies de animales. Diferentes organismos, usan los fragmentos de bosque como hábitats permanentes o como corredores de paso dentro de los agropaisajes. El objetivo de este estudio es reportar los mamíferos medianos y grandes en un fragmento de bosque del centro de Colombia. Este estudio se realizó en un fragmento de bosque de 6 ha ubicado en la finca El Billar, en el municipio de Pijao, Quindío, Colombia. Para la detección de los mamíferos se utilizó la metodología de fototrampeo, observaciones directas a partir de recorridos (nocturnos y diurnos) y encuestas realizadas a los habitantes locales sobre la mastofauna local percibida. El periodo de muestreo comprendió entre agosto de 2018 hasta junio de 2021. Registramos 15 especies de mamíferos medianos y grandes, agrupadas en 12 familias pertenecientes a 6 órdenes, siendo Carnivora y Didelphimorphia los mejor representados, con 6 y 3 especies, respectivamente. Especies de particular interés por su estado de amenaza y rasgos ecológicos como *Aotus lemurinus* y *Leopardus tigrinus,* persisten en este fragmento de bosque a pesar de su reducido tamaño. Estos registros resaltan el papel que cumplen los pequeños remanentes de bosque en la conservación de las especies y la importancia de generar estrategias de conectividad entre ecosistemas altamente antropizados.

Palabras clave: Agropaisaje; Andes centrales; conservación; fragmentación; inventario de mamíferos.

Forest fragments that still persist within anthropized environments play a fundamental role in the conservation of different animal species. Different organisms use forest fragments as permanent habitats or as passage corridors within agro-landscapes. The objective of this study is to report medium and large mammals in a forest fragment in central Colombia. This study was conducted in a forest fragment of 6 ha located in the farm El Billar, in the municipality of Pijao, Quindío, Colombia. For the detection of mammals were used the methodology of photo-trapping, direct observations from walks (nocturnal and diurnal) and surveys conducted to local inhabitants about the perceived local mastofauna. The sampling period was from August 2018 to June 2021. We recorded 15 species of medium and large mammals, grouped into 12 families belonging to 6 orders, being Carnivora and Didelphimorphia the best represented ones, with 6 and 3 species, respectively. Species of particular interest due to their threat status and ecological traits such as *Aotus lemurinus* and *Leopardus tigrinus*, persist in this forest fragment despite their small size. These records highlight the role of small forest remnants in the conservation of species and the importance of generating connectivity strategies between highly anthropized ecosystems.

Key words: Agro-landscapes; Central Andes; conservation; fragmentation; mammal inventory.

La región de los Andes centrales de Colombia (500 – 5,000 m; Etter y van Wyngaarden 2000) presenta diversos ecosistemas, los cuales albergan hasta el 10 % de la biodiversidad nacional (Rangel-Ch 2015). Sin embargo, es en esta región donde se concentran los principales asentamientos humanos del país, los cuales están ligados con uno de los mayores índices de deforestación entre las principales regiones biogeográficas de Colombia (Kattan 1992; Etter *et al.* 2006; IDEAM 2015). Tanto la deforestación como otras actividades humanas han conducido a la fragmentación (transformación de grandes áreas boscosas en pequeños fragmentos de bosque) y la desaparición de ecosistemas, acelerando la pérdida de la biodiversidad (Etter y van Wyngaarden 2000; Santos y Telleria 2006; WWF 2020).

Los fragmentos de bosque (FB) juegan un papel fundamental como unidades de conservación, teniendo el potencial de servir como hábitats permanentes o como corredores de paso que facilitan el movimiento de diferentes especies de animales (*e. g.*, mamíferos) a través del agropaisaje (Harvey *et al.* 2008). Sin embargo, los efectos de la fragmentación y pérdida de hábitat son diferentes entre especies y dependen directamente de sus historias de vida (Arroyo-Rodríguez y Mandujano 2009). Mamíferos, como los primates y carnívoros, enfrentan numerosas amenazas, ya que dependen directamente de las coberturas boscosas para ejercer sus funciones vitales, que son de gran importancia en las dinámicas ecológicas de los ecosistemas (Santos y Tellería 2006; Escribano-Ávila *et al.* 2015; García-T *et al.* 2020).

Para el departamento del Quindío, la Corporación Autónoma Regional (CRQ) hasta la fecha, ha reportado un total de 21 especies de mamíferos medianos y grandes en 11 de las 12 áreas de conservación presentes en el departamento (Vásquez *et al.* 2019), número que es bajo en comparación al número de especies esperadas (Torres-Trujillo y Mantilla-Meluk 2017). Por ende, resulta relevante y urgente el levantamiento de inventarios de la mastofauna persistente en FB como pequeñas unidades del paisaje que no figuran como áreas de conservación, dando puntos de partida para el establecimiento de estrategias de estudio, monitoreo y conservación. Por tal razón, el objetivo de este estudio es reportar los mamíferos medianos (entre 150 y 5,000 gr) y grandes (mayor a 5,000 gr; Stuart y Stuart 2006) presentes en un FB subandino del municipio de Pijao, Quindío (Andes centrales de Colombia).

Este estudio se realizó en un FB de 6 ha denominado Bosque de Las Martejas ubicado en la finca agrícola El Billar, en el municipio de Pijao, Quindío, Colombia (4° 19' 58" N, 75° 42' 39" O, 1,750-1,800 m; Figura 1). Este FB se encuentra clasificado dentro de la categoría de Bosque Húmedo Premontano (Bh-PM) según la clasificación de Holdridge (IDEAM *et al.* 1997). El FB comprende una única unidad de bosque sin conexión directa con otros fragmentos y está inmerso en un mosaico de pequeños fragmentos de bosque y cultivos principalmente de banano (*Musa paradisiaca*), plátano (*M. balbisiana*), café (*Coffea arabica*) y aguacate (*Persea americana*). El dosel del FB tiene una altura de aproximadamente 25 m y conserva las características típicas de un bosque andino con árboles de gran tamaño de especies como *Poulsenia armata* y *Cecropia telealba* y varias especies de *Ficus*. Dentro del FB también hay varias agrupaciones de bambú (*Guadua angustifolia*) que cubren

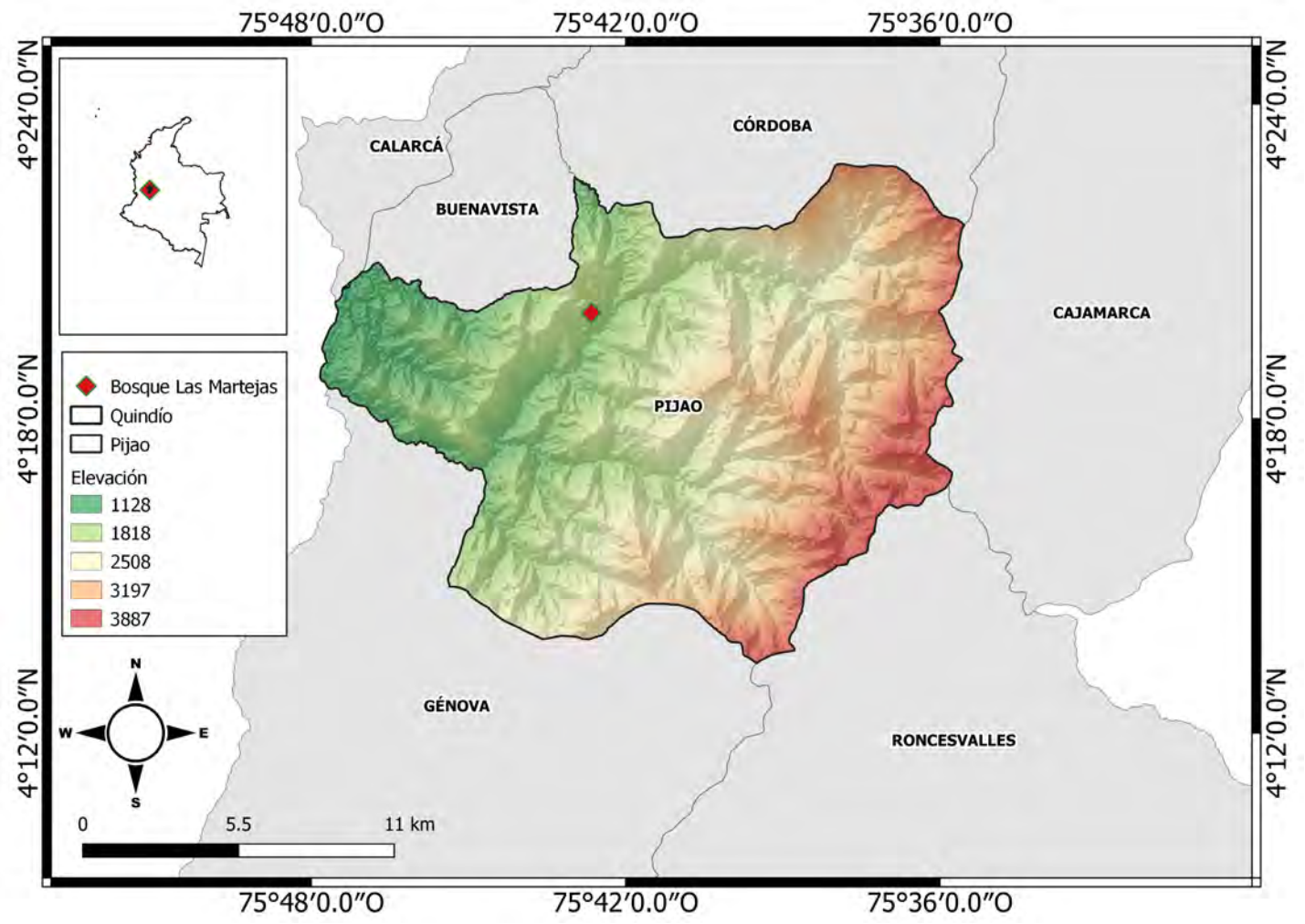


Figura 1. Ubicación del área de estudio: Bosque de las Martejas (1,750 –1,800 m), en el municipio de Pijao, Quindío, Colombia.

aproximadamente el 10 % de todo el fragmento y están principalmente asociadas a 2 nacimientos de agua que presentan un ancho de aproximadamente 50 cm. Por decisión de los propietarios, el FB de estudio no presenta presiones humanas directas de tala y caza. Sin embargo, en la actualidad tampoco se cuenta con procesos de restauración o reforestación que permitan la conectividad con otros fragmentos de bosque cercanos.

Para la detección de los mamíferos instalamos 2 cámaras trampa (Browning Btc COMMAND OPS PRO) separadas entre sí (a distancias de ~ 200 m) en árboles asociados a sitios estratégicos de paso (caminos con rastros), osaderos y madrigueras dentro del FB. Cada cámara trampa fue programada para tomar fotos (series de 3 fotos consecutivas separadas por intervalos de 1 s) y videos (15 s) activados por movimiento, y sus baterías fueron reemplazadas cada 20 días. Las cámaras fueron reubicadas, en promedio, cada 2 meses, utilizando el mismo criterio para selección de sitios, cubriendo un total de 16 puntos de muestreo que atraviesan la totalidad del FB. Estas cámaras permanecieron instaladas entre septiembre de 2018 y junio de 2019 (esfuerzo de muestreo acumulado de 300 días/trampa). Complementariamente, realizamos recorridos nocturnos (entre las 18:00 y las 6:00 hr durante 5 noches por semana) y diurnos (entre las 8:00 y las 17:00 hr cada 15 días) por 5 transectos (~ 800 m), desde agosto de 2018 hasta junio de 2021. Los recorridos se realizaron como parte de un estudio a largo plazo sobre monos nocturnos (*Aotus lemurinus*) que incluyó un monitoreo nocturno de los primates y una evaluación quincenal de transectos fenológicos (Montilla *et al.* 2021). Los recorridos nocturnos siempre fueron realizados por 2 personas, las cuales fueron sustituidas cada 6 meses para un total de 10 personas a lo largo del proyecto. Todas las personas que realizaron los recorridos fueron entrenadas por los coordinadores del proyecto en la toma de datos y siguieron los mismos métodos establecidos, realizando recorridos a velocidades constantes y registrando en cada observación la especie avistada, la hora, el número de individuos y la actividad que se encontrarán realizando (alimentación, movimiento, descanso). Cuando las condiciones climáticas fueron adversas por elevadas precipitaciones, los recorridos nocturnos fueron detenidos. Como métodos de detección indirecta, realizamos entrevistas informales sobre los mamíferos que han observado dentro y en los alrededores del FB al personal que laboró en la finca durante los últimos 3 años ($n = 4$ personas desde 2017 hasta el 2020, año en el que se realizaron las entrevistas), utilizando como referencias ilustraciones de mamíferos neotropicales. Para las entrevistas tuvimos en cuenta información como la presencia/ausencia de la especie, la posible ubicación dentro del FB y la hora y fecha estimada de los avistamientos. Para la identificación de las especies de mamíferos medianos y grandes se siguió a Emmons y Feer (1997), Suárez-Castro y Ramírez-Chaves (2015), Flórez-Oliveros y Vivas-Serna (2020) y Ramírez-Chaves *et al.* (2021). La validez y el estado nomenclatural de los taxones se constataron con la lista de verificación de los mamíferos de Colombia (Ramírez-Chaves *et al.* 2021). Por último, consultamos las categorías de amenaza a nivel global para cada especie en la Lista roja de la Unión Internacional para la Conservación de la Naturaleza (IUCN 2021).

Se registraron 10 especies de mamíferos medianos y 5 especies de mamíferos grandes (por cámara trampa $n = 10$, por observación directa $n = 11$ y por entrevistas $n = 10$) agrupados en 6 órdenes y 12 familias, siendo Carnivora y Didelphimorphia los órdenes mejor representados, con 6 y 3 especies, respectivamente (Tabla 1; Figura 2). Adicionalmente, durante los recorridos nocturnos de mayo de 2021, se avistó presuntamente un individuo de la especie *Procyon cancrivorus* cruzando por la carretera aledaña al FB. Sin embargo, no se obtuvo evidencia fotográfica, por lo que no se incluyó este registro en el listado, a falta de evidencia corroborable y documentación científica previa sobre la presencia de esta especie para esta localidad.

Los mamíferos medianos y grandes encontrados en el FB de la finca El Billar representan el 71.4 % del total de especies reportadas en 11 áreas de conservación de la Corporación Autónoma Regional del Quindío (CRQ; 15 de 21 especies.; Vásquez *et al.* 2019), y al 15.3 % de las especies de mamíferos esperadas para el departamento del Quindío (~ 98 especies; Torres-Trujillo y Mantilla-Meluk 2017). Haciendo una comparación basada únicamente con los registros de las cámaras trampa, las técnicas adicionales empleadas en este estudio (observación directa a partir de los recorridos y entrevistas) nos permitieron registrar 5 especies de mamíferos adicionales (4 medianos y 1 grande) que no fueron detectadas por la técnica de cámaras trampa, posiblemente debido a sus hábitos arborícolas (*Caluromys derbianus, Choloepus hoffmanni, Aotus lemurinus* y *Potos flavus*; Ramírez-Chaves *et al.* 2021). Estos resultados resaltan la importancia de implementar diferentes métodos de muestreos, los cuales permiten obtener información de manera eficiente, precisa y complementaria (Farías 2019).

Entre las especies registradas, 2 son consideradas globalmente vulnerables (VU): *Aotus lemurinus* (Link *et al.* 2021) y *Leopardus tigrinus* (Payán y de Oliveira 2016). Ambos registros, revisten de particular interés: por un lado, *A. lemurinus* es un primate nocturno estrictamente arborícola y altamente frugívoro que depende de las coberturas boscosas (Montilla *et al.* 2021) y, por otro lado, *L. tigrinus*, es un felino de pequeño tamaño, que requiere de vegetación cerrada y una buena oferta de presas para su permanencia en los hábitats (CAR 2019). Aunque las demás especies a nivel global se hallan en la categoría de preocupación menor (LC), a nivel local experimentan un declive poblacional como consecuencia de la deforestación (Gaviria-Santa 2015). Respecto al avistamiento de *P. cancrivorus*, la CRQ confirmó la presencia de esta especie en un área de conservación del municipio de Buenavista, Quindío (a ~ 15 km lineales del área de estudio) a través de cámaras trampa, siendo este el primer registro para el departamento del Quindío (CRQ 2022).

Tabla 1. Mamíferos medianos y grandes registrados en el FB Bosque de Las Martejas, municipio de Pijao, Quindío, Colombia. Tamaño: M: mediano, G: grande. Tipo de registro: CT: cámara trampa, OBS: observación directa, ENT: entrevista. Categoría de amenaza (CA): LC: preocupación menor, VU: vulnerable, según la IUCN (2021).

Taxón	Nombre común	Tamaño	Tipo de registro	CA	Figura
Orden Didelphimorphia					
Didelphidae					
Caluromys derbianus	Chucha lanuda	M	OBS	LC	
Didelphis marsupialis	Chucha, Zarigüeya	M	CT, OBS, ENT	LC	2l
Marmosa demerarae	Chucha mantequera	M	CT, OBS	LC	2m
Orden Cingulata					
Dasypodidae					
Dasypus novemcinctus	Gurre, Armadillo	G	CT, OBS, ENT	LC	
Orden Pilosa					
Choloepidae					
Choloepus hoffmanni	Perezoso	G	OBS, ENT	LC	2k
Orden Carnivora					
Canidae					
Cerdocyon thous	Zorro perro	G	CT	LC	2d
Felidae					
Leopardus tigrinus	Tigrillo	M	CT, OBS, ENT	VU	2f-g
Puma yagouaroundi	Jaguarundi	G	CT	LC	2e
Mustelidae					
Eira barbara	Tayra	M	CT, OBS	LC	2h
Neogale frenata	Comadreja	M	ENT	LC	
Procyonidae					
Potos flavus	Marteja, Perro de monte	M	OBS, ENT	LC	2i
Rodentia					
Dasyproctidae					
Dasyprocta punctata	Guatín	M	CT, ENT	LC	2c
Cuniculidae					
Cuniculus paca	Guagua	G	CT, OBS, ENT	LC	2b
Sciuridae					
Syntheosciurus granatensis	Ardilla	M	CT, OBS, ENT	LC	2a
Orden Primates					
Aotidae					
Aotus lemurinus	Marteja, Mono nocturno	M	OBS, ENT	VU	2j

Es importante destacar que el orden Carnivora, el mejor representado en este estudio, está conformado por especies que difieren en tamaño, hábitos, dietas, comportamientos e historias de vida, y, por tanto, aprovechan diferencialmente todos los estratos de la vegetación (Suárez-Castro y Ramírez-Chaves 2015). Especies como *Potos flavus* y *Eira barbara* son principalmente arborícolas, mientras que otras, como *L. tigrinus, Cerdocyon thous, Neogale frenata* y *Puma yagouaroundi* se desplazan principalmente por el suelo. Estas características del uso del estrato del bosque permiten que estos mamíferos jueguen un papel crucial moldeando la estructura ecológica de las comunidades (Terborgh *et al.* 2001), ya que, al ocupar los niveles más altos de las redes tróficas, las especies de mayor tamaño influyen en la composición y abundancia de las poblaciones de algunas especies de niveles intermedios o inferiores, manteniendo el equilibrio ecológico por los llamados "efectos en cascada" (Berger 1999; Schmitz 2008). Sin embargo, en los FB, la coexistencia de estas especies de carnívoros con humanos, sumada a la escasez de presas y a la abundancia de especies domésticas como perros, gatos y aves de corral principalmente, da lugar a conflictos de confrontación, competencia y transmisión de enfermedades que ponen en riesgo su supervivencia a nivel local.

A pesar de que los mamíferos registrados en el FB de la finca El Billar, son categorizados como medianos y grandes debido a su peso, no son tan grandes como otros mamíferos registrados en zonas cercanas y que potencialmente podrían habitar la zona de estudio como *Puma concolor* o *Leopardus pardalis* (Vásquez *et al.* 2019). Es probable que mamíferos de mayor peso a los registrados, tengan mayores requerimientos de hábitats y de desplazamiento y no

Figura 2. Mamíferos medianos y grandes registrados en las cámaras trampa y a partir de observaciones directas en el fragmento de bosque, Bosque de Las Martejas, municipio de Pijao, Quindío, Colombia. a) *Syntheosciurus granatensis*, b) *Cuniculus paca*, c) *Dasyprocta punctata*, d) *Cerdocyon thous*, e) *Puma yagouaroundi*, f-g) *Leopardus tigrinus*, h) *Eira barbara*, i) *Potos flavus*, j) *Aotus lemurinus*, k) *Choloepus hoffmanni*, l) *Didelphis marsupialis*, m) *Marmosa demerarae*. En la esquina inferior derecha de cada imagen individual se muestra la categoría de amenaza global para cada especie; LC: preocupación menor, VU: vulnerable (IUCN 2021).

encuentren en el FB estudiado características óptimas para habitarlo o para llegar a él a través de la matriz transformada (Harestad y Bunnel 1979; Fisher *et al.* 2011). Adicionalmente, las especies de mayor tamaño, mantienen densidades poblaciones pequeñas y pueden ser más difíciles de registrar en los bosques (Damuth 1981).

En entornos degradados, como los Andes de Colombia, las áreas naturales remanentes están distribuidas en diversos fragmentos de bosque, principalmente pequeños (Armenteras *et al.* 2003). Tales fragmentos, frecuentemente no figuran como áreas de conservación reales, ya que no son reconocidos por las entidades territoriales bajo ninguna categoría de protección. Dada la importancia de los FB como reservorios de biodiversidad, en los últimos años han aumentado los esfuerzos por conocer la conformación de las comunidades de mamíferos que habitan en ellos (*e. g.*, Aya-Cuero et al. 2020; Henao-Isaza *et al.* 2020) y su relevancia en la conservación de la mastofauna nacional (*e. g.*, López-Arévalo *et al.* 2021). No obstante, las dinámicas ecológicas, los efectos del confinamiento poblacional de las especies, el alcance de los potenciales efectos del cambio climático y la naturaleza y grado de los tensores antrópicos que afectan a los FB, parecen rasgos pobremente estudiados en el ámbito nacional e internacional (Torres *et al.* 2012; Falcão *et al.* 2012; Mercado-Gómez *et al.* 2018; Ballesteros-Correa *et al.* 2019; Melo 2019). A esto se suma la continua expansión de las actividades antrópicas, que ponen en riesgo su permanencia a largo plazo. Por tal motivo, es necesario un efectivo despliegue de estrategias de conservación a través de las entidades territoriales y organizaciones civiles, en donde las comunidades locales, por su cercanía e influencia, sean los principales actores involucrados en la conservación de los FB.

Finalmente, se resalta la importancia de los FB en la conservación y preservación no solo de los mamíferos sino de la fauna en general, ya que les permite a las especies tener la capacidad de tolerar las presiones que ejerce la fragmentación de los ecosistemas como es el caso de los mamíferos medianos y grandes registrados en el FB de la finca El Billar.

Agradecimientos

Los autores agradecen a la Fundación Proyecto Primates por el préstamo de las cámaras trampa, a todos los pasantes que hicieron parte del proyecto de monos nocturnos, a R. Orozco y a la familia Montilla por permitirnos realizar el inventario de mamíferos en su propiedad y brindarnos apoyo logístico. A los 2 revisores anónimos por sus observaciones que ayudaron a mejorar esta nota.

Literatura citada

Armenteras, D., F. Gast, y H. Villareal. 2003. Andean forest fragmentation and the representativeness of protected natural areas in the eastern Andes, Colombia. Biological Conservation 113:245-256.

Arroyo-Rodríguez, v., y S. Mandujano. 2009. Conceptualization and measurement of habitat fragmentation from the primates' perspective. International Journal of Primatology 30:497-514.

Aya-Cuero, C. A., C. A. Díaz-B, y D. A. Esquivel. 2020. Mamíferos medianos y grandes del Espacio Territorial de Capacitación y Reincorporación (ETCR) Playa Rica, La Macarena, Meta, Colombia. Mammalogy Notes 6:mn0188.

Ballesteros-Correa, J., *et al.* 2019. Composición y estructura vegetal de fragmentos de bosque seco tropical en paisajes de ganadería extensiva bajo manejo silvopastoril y convencional en Córdoba, Colombia. Caldasia 41:224-234.

Berger, J. 1999. Anthropogenic extinction of top carnivores and interspecific animal behaviour: implications of the rapid decoupling of a web involving wolves, bears, moose and ravens. Proceedings of the Royal Society of London 266:2261-2267.

CAR (Corporación Autónoma Regional de Cundinamarca). 2019. Plan de Manejo y Conservación de la Oncilla (*Leopardus tigrinus*) para la Jurisdicción de la Corporación Autónoma Regional de Cundinamarca CAR. Corporación Autónoma Regional de Cundinamarca. Bogotá, D. C., Colombia.

CRQ (Corporación Autónoma Regional del Quindío). 2022. Primer registro de Mapache (*Procyon cancrivorus*) en el Quindío. https://crq.gov.co/2022/03/31/atencion-primer-registro-de-mapache-procyon-cancrivorus-en-el-quindio/. Consultado el 28 de septiembre de 2022.

Damuth, J. 1981. Population density and body size in mammals. Nature 290:699-700.

Emmons, L., y F. Feer. 1997. Neotropical Rainforest Mammals: A Field Guide (2nd edition). The University of Chicago Press. Chicago, EE.UU.

Etter, A., *et al.* 2006. Regional patterns of agricultural land use and deforestation in Colombia. Agriculture, Ecosystems & Environment 114:369-386.

Etter, A., y W. van Wyngaarden. 2000. Patterns of landscape transformation in Colombia, with emphasis in the Andean region. Journal of the Human Environment 29:432-439.

Escribano-Ávila, G., *et al.* 2015. Importancia ecológica de los mamíferos frugívoros en la dinámica de regeneración de tierras abandonadas en ambientes mediterráneos. Ecosistemas 24:35-42.

Falcão, F., D. Guanaes, y A. Paglia. 2012. Medium and large-sized mammals of RPPN Estação Veracel, southernmost Bahia, Brazil. CheckList 8:929-935.

Farías, A. 2019. Cap. 15. Captura y manejo de mamíferos medianos y grandes en el campo. Pp. 155–169 *in* Experimentación con animales no tradicionales en Uruguay (Teixeira de Mello, F., ed.). Comisión Honoraria de Experimentación Animal. Montevideo, Uruguay.

Flórez-Oliveros, F. J., y C. Vivas-Serna. 2020. Zarigüeyas (chuchas comunes), marmosas y colicortos en Colombia. Fundación Zarigüeya-FUNDZAR. Medellín, Colombia.

Fisher, J. T., B. Anholt, y J. P. Volpe. 2011. Body mass explains characteristic scales of habitat selection in terrestrial mammals. Ecology and Evolution 1:517-528.

Gaviria-Santa, A. M. 2015. Plantaciones forestales: una amenaza para los bosques del trópico. Revista Grafias Disciplinares de la UCPR 29:7-13.

García-T, L. C., R. Guillen, y A. Savage. 2020. Inventario de mamíferos medianos y grandes en la reserva los Titíes de San Juan, Montes de María, Bolívar, Colombia. Mammalogy Notes 6:mn0154.

Harestad, A. S., y F. K. Bunnel. 1979. Home range and body weight-A reevaluation. Ecology 60:389-402.

Harvey, C. A., *et al.* 2008. Importancia de los fragmentos de bosque, los árboles dispersos y las cortinas rompevientos para la biodiversidad local y regional: el caso de Monteverde, Costa

Rica. Pp. 289-325 *in* Evaluación y Conservación de Biodiversidad en Paisajes Fragmentados de Mesoamérica (Harvey, C. A., y J. C. Sáenz, eds.). INBio Editorial. San Jose, Costa Rica.

Henao-Isaza, J. R., *et al*. 2020. Inventario de mamíferos no voladores en remanentes de bosque seco tropical en el valle del río Cauca, Cartago, Colombia. Mammalogy Notes 6:mn0144.

IDEAM (Instituto de Hidrología, Meteorología y Estudios Ambientales), A. Guhl, y P. Leyva. 1997. Zonificación Ecológica de Colombia usando las Zonas de Vida de Holdridge. C. D. IDEAM. Bogotá, Colombia.

IDEAM (Instituto de Hidrología, Meteorología y Estudios Ambientales). 2015. Deforestación y afectación de los ecosistemas por ocupación del territorio y actividades económicas (Tomo II). IDEAM. Bogotá D. C., Colombia.

IUCN (International Union for Conservation of Nature). 2021. The IUCN Red List of Threatened Species. IUCN.

Kattan, G. H. 1992. Rarity and vulnerability: the birds of the Cordillera Central of Colombia. Conservation Biology 6:64-70.

Link, A., S. de la Torre, y P. Moscoso. 2021. *Aotus lemurinus*. The IUCN Red List of Threatened Species 2021:e.T1808A17922601. IUCN. Gland, Switzerland.

López-Arévalo, H. F., L. F. Liévano-Latorre, y O. L. Montenegro. 2021. El papel de las pequeñas reservas en la conservación de mamíferos en Colombia. Caldasia 43:354-365.

Melo, O. 2019. Estructura de fragmentos de bosque seco tropical en el sur del departamento del Tolima, Colombia. Boletín Científico. Centro de Museos. Museo de Historia Natural 23:31-51.

Mercado-Gómez, *et al*. 2018. Mariposas en un fragmento de bosque seco tropical en Montes de María (Colombia). Ciencia en desarrollo 9:35-45.

Montilla, S. O., *et al*. 2021. Activity patterns, diet and home range of night monkeys (*Aotus griseimembra* and *Aotus lemurinus*) in tropical lowland and mountain forests of central Colombia. International Journal of Primatology 42:130-153.

Payán, E., y T. de Oliveira. 2016. *Leopardus tigrinus*. The IUCN Red List of Threatened Species 2016: e.T54012637A50653881. IUCN. Gland, Switzerland.

Ramírez-Chaves, H. E., *et al*. 2021. Mamíferos de Colombia. Versión 1.12. Sociedad Colombiana de Mastozoología. Checklist dataset. https://www.gbif.org/es/dataset/e8b9ed9b-f715-4eac-ae24-772fbf40d7ae. Consultado el 22 de noviembre de 2022.

Rangel-Ch, J. O. 2015. La biodiversidad de Colombia: significado y distribución regional. Revista de la Academia Colombiana de Ciencias Exactas, Físicas y Naturales 39:176-200.

Santos, T., y J. L. Telleira. 2006. Pérdida y fragmentación del hábitat: efecto sobre la conservación de las especies. Ecosistemas 2:3–12.

Suárez-Castro, A. F., y H. E. Ramírez-Chaves. 2015. Los carnívoros terrestres y semiacuáticos continentales de Colombia. Guía de Campo. Editorial Universidad Nacional de Colombia. Bogotá, Colombia.

Schmitz, O. J. 2008. Herbivory from individuals to ecosystems. Annual Review of Ecology, Evolution, and Systematics 39:133-152.

Stuart, C.T., y M. D. Stuart. 2006. Field Guide to the Larger Mammals of Africa. Struik Publishers, Cape Town.

Terborgh, J., *et al*. 2001. Ecological meltdown in predator-free forest fragments. Science 294:1923–1925.

Torres, A. M., *et al*. 2012. Dinámica sucesional de un fragmento de bosque seco tropical del Valle del Cauca, Colombia. Biota Colombiana 13:12-29.

Torres-Trujillo, N. T., y H. Mantilla-Meluk. 2017. Común e ignorado: ausencia de documentación científica del guatín *Dasyprocta punctata* (Rodentia: Dasyproctidae) en el departamento del Quindío, Colombia. Biodiversidad Neotropical 7:30-38.

Vásquez, S., *et al*. 2019. Mamíferos en áreas de conservación de la Corporación Autónoma Regional del Quindío, Colombia. Biota Colombiana 20:93-104.

WWF (World Wildlife Fund). 2020. Living Planet Report 2020 - Bending the curve of biodiversity loss (Almond, R. E. A., M. Grooten, y T. Petersen, eds.). World Wildlife Fund. Gland, Switzerland.

Editor asociado: José R. Soto-Shoender.

Enviada: Abril 5, 2022; Revisada: Marzo 20, 2023.

Aceptada: Marzo 29, 2023; Publicada en línea: Abril 20, 2023.