Therya Notes

Volumen 2 Número 2 Mayo 2021

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

El género *Peropteryx* contiene cinco especies distribuidas en la región Neotropical. Tres de estas especies se encuentran en Bolivia (*P. macrotis, P. kappleri* y *P. leucoptera*). *Peropteryx pallidoptera* fue recientemente descrita y se distribuye en los bosques de tierras bajas amazónicas de Ecuador, Perú, Brasil y Colombia. En esta nota, se reporta el primer registro de *P. pallidoptera* en Bolivia. En la imagen, se observa una vista lateral de esta especie.
(Fotografía de A. Amusquivar-Calustro)

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 2, fascículo 2, mayo - agosto 2021, 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 mayo de 2021.

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Nuevo registro del grisón mayor (*Galictis vittata*) en la Sierra Nororiental de Puebla, México

New record of the Greater grison (*Galictis vittata*) in the Northeast Sierra of Puebla, México

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A pesar de su amplia distribución en el Continente Americano, el grisón mayor (*Galictis vittata*) es uno de los mamíferos con menor número de estudios que reporten su presencia o describan aspectos de su ecología. En México, el grisón mayor es una especie en peligro de extinción y se encuentra protegida por el gobierno mexicano. Conocer la distribución de esta especie amenazada puede ayudar a diseñar estrategias de conservación. Nuestro objetivo fue describir un nuevo registro del grisón mayor en un paisaje heterogéneo de la Sierra Nororiental de Puebla, México. El 24 de Octubre de 2020 alrededor de las 12:00 horas, encontramos un individuo de la especie *Galictis vittata* en un cafetal bajo sombra, ubicado en un paisaje de bosque de niebla en Tuxtla, Puebla, México. Este registro del grisón mayor es el cuarto conocido para el estado de Puebla, México. Asimismo, amplía la distribución de la especie 11.2 km al suroeste de la localidad más cercana y ocurre fuera de su rango de distribución potencial. Resaltamos que este mamífero amenazado puede desplazarse en paisajes ribereños conformados por bosque de niebla, vegetación secundaria, cafetales y cultivos agrícolas manejados tradicionalmente por habitantes de una comunidad tutunakú.

Palabras clave: Bosque de niebla; cafetal bajo sombra; Mustelidae; rango de distribución; Zapotitlán de Méndez.

Despite its wide distribution throughout the American continent, the Greater grison (*Galictis vittata*) is one of the mammals with the fewest number of studies that report its presence or describe aspects of its ecology. In México, the Greater grison is an endangered species and is protected by the Mexican government. Knowing the distribution of this threatened species can help to design conservation strategies. Our aim was to describe a new record of the Greater grison in a heterogeneous landscape of the Northeast Sierra of Puebla, México. On October 24, 2020 around 12:00 hours, we found an individual of the *Galictis vittata* species in a shade-coffee plantation, located in a cloud forest landscape in Tuxtla, Puebla, México. This record of the Greater grison is the fourth known for the state of Puebla, México. Likewise, it broadens the distribution of the species 11.2 km southwest of the nearest locality, and occurs outside of their the range of potential distribution. We emphasize that this threatened species can move in riverside landscapes conformed by cloud forest, secondary vegetation, shade-coffee plantations, and agricultural crops traditionally managed by inhabitants of a tutunakú community.

Key words: Cloud forest; distribution range; Mustelidae; shade-coffee plantations; Zapotitlán de Méndez.

El grisón mayor *Galictis vittata* (Shreber 1776), es un mamífero carnívoro que pertenece a la familia Mustelidae (Kaufmann y Kaufmann 1965). Es principalmente terrestre y diurno. Su cuerpo alargado es de color grisáceo con una franja negra que va desde la cara hasta las extremidades y una franja blanca por encima de los ojos que va de oreja a oreja (Yensen y Tarifa 2003). Se distribuye desde el norte de México hasta el sur de Brasil y Bolivia, y desde el nivel de mar hasta los 1,790 m (Contreras-Díaz *et al.* 2020). Esta especie ha sido registrada en bosques de niebla, bosques riparios, selvas caducifolias, selvas lluviosas, manglares, pastizales y cafetales (Gallina *et al.* 1996; Yensen y Tarifa 2003; Ramírez-Pulido *et al.* 2005; De la Torre *et al.* 2009; Jiménez-Alvarado *et al.* 2016; Ramírez-Bravo y Hernández-Santin 2016; Hernández-Hernández *et al.* 2018). Para una hembra adulta de grisón mayor su ámbito hogareño se estimó en 4 km^2, con movimientos diarios de hasta 3 km dentro de esa área (Yensen y Tarifa 2003).

A pesar de su amplia distribución, el grisón mayor es considerado como una especie rara debido a su baja densidad poblacional (1–2.4 individuos/km^2; Eisenberg *et al.* 1979). Además, cuenta con escasos registros e información sobre diferentes aspectos de su ecología (Hernández-Hernández *et al.* 2018). En general, la información que existe sobre las especies del género *Galictis* es de las más escasas para la familia de los mustélidos (Bornholdt *et al.* 2013).

En México, el grisón mayor es una especie prioritaria para la conservación de la biodiversidad, debido a que se encuentra en peligro de extinción según la Norma Oficial

Mexicana, NOM-059-SEMARNAT-2010 de la Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT 2010). La distribución potencial del grisón en México abarca desde Tamaulipas hasta la Península de Yucatán, pasando por Veracruz, Puebla, Chiapas y Oaxaca (Contreras-Díaz *et al.* 2020). En Puebla, el grisón solo se ha registrado en los municipios de Zihuateutla (Ramírez-Pulido *et al.* 2005), Tuzamapan de Galeana (Ramírez-Bravo y Hernández-Santin 2016) y Cuetzalan (Hernández-Reyes *et al.* 2017). Conocer la distribución de esta especie amenazada puede ayudar a diseñar estrategias de conservación. En este trabajo presentamos un nuevo registro del grisón mayor (*Galictis vittata*) en una comunidad tutunakú de la Sierra Nororiental de Puebla.

El 24 de octubre de 2020 alrededor de las 12:00 horas, se capturó a una cría de la especie *Galictis vittata* en Tuxtla, municipio Zapotitlán de Méndez, en la Sierra Nororiental de Puebla (19° 59′ 49.49″ N, 97° 39′ 5.15″ O). El paisaje de esta localidad está formado principalmente por bosque de niebla, cultivos agrícolas y pastizales. El clima es templado húmedo con una temperatura media anual de 22 °C y una precipitación media anual igual a 2,750 mm (CIBCEC 2003). Tuxtla se encuentra ubicada en la Sierra Madre Oriental, en una zona con pendiente pronunciada que forma parte de la cuenca del río Tecolutla que tiene un área de ~7,400 km^2 (Basurto-Peña *et al.* 1998).

Durante una jornada de trabajo comunitario, el grisón fue encontrado junto a una madriguera en el suelo entre la vegetación herbácea de un cafetal bajo sombra a 500 m del río Tecolutla (Figura 1a, b). Se identificó al individuo basándose en las descripciones de Yensen y Tarifa (2003) y Álvarez-Castañeda *et al.* (2017). Posteriormente se liberó el individuo en el mismo sitio donde fue capturado. No se tomaron medidas morfométricas del individuo debido a que fue un encuentro fortuito y no se contaba con el equipo necesario.

Este registro es el cuarto conocido del grisón mayor para el estado de Puebla, México y amplía su distribución en el estado 11.2 km al suroeste de la localidad más cercana (Tuzamapan de Galeana; Figura 2). Asimismo, este registro ocurre ~10 km fuera del rango de distribución potencial estimado para la especie en México (Cuarón *et al.* 2016).

El individuo de grisón aquí reportado y los tres previamente registrados para el estado de Puebla (Ramírez-Pulido *et al.* 2005; Ramírez-Bravo y Hernández-Santin 2016; Hernández-Reyes *et al.* 2017), se han encontrado en comunidades tutunakú o nahuas ubicadas en la cuenca del río Tecolutla al norte del estado. Esta región cuenta con una alta biodiversidad (Pérez-Maqueo *et al.* 2011), pero en los últimos años ha sufrido una disminución en su cobertura vegetal (al menos 1.1 % anual; Osuna-Osuna *et al.* 2015). Particularmente, en la localidad tutunakú de Tuxtla, el bosque de niebla asociado a las zonas riparias del río Tecolutla ha sido transformado principalmente en pastizales y cultivos agrícolas como cafetales bajo sombra, chilar (*Capsicum annuum* y *C. a. glabriusculum*) y milpa (*Zea mays*, *Cucurbita* sp. y *Phaseolus* sp.; Basurto-Peña *et al.* 1998).

En los pueblos tutunakú del norte de Puebla la agricultura tradicional de cultivos como maíz, frijol, café y chile, se maneja principalmente como pluricultivos, manteniendo otras especies comestibles como árboles frutales o quelites (Basurto-Peña *et al.* 1998). Además, estos cultivos se distribuyen a lo largo de diferentes pisos altitudinales y aparecen en diferentes momentos del año, determinados por el uso de calendarios construidos a partir de observaciones solares y lunares (Basurto-Peña *et al.* 1998; Torres-Solís *et al.* 2020). En esta región, el manejo de los ecosistemas basado en el conocimiento tradicional ha permitido la presencia de especies amenazadas como el grisón mayor en al menos tres comunidades tutunakú: Zihuateula (Ramírez-Pulido *et al.* 2005),

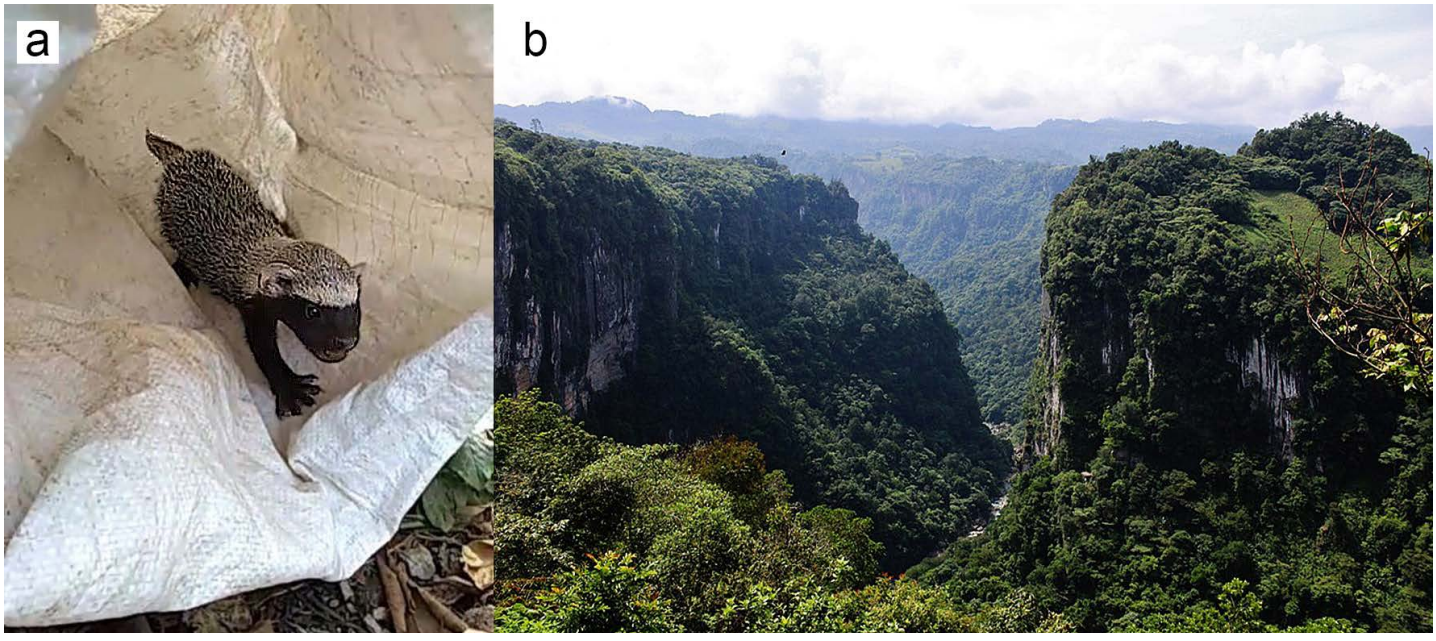

Figura 1. a) Individuo juvenil de grisón mayor *Galictis vittata* encontrado en un cafetal bajo sombra en Tuxtla, Zapotitlán de Méndez, Puebla. b) Paisaje sobre la cuenca del río Tecolutla donde ocurrió el registro del grisón mayor.

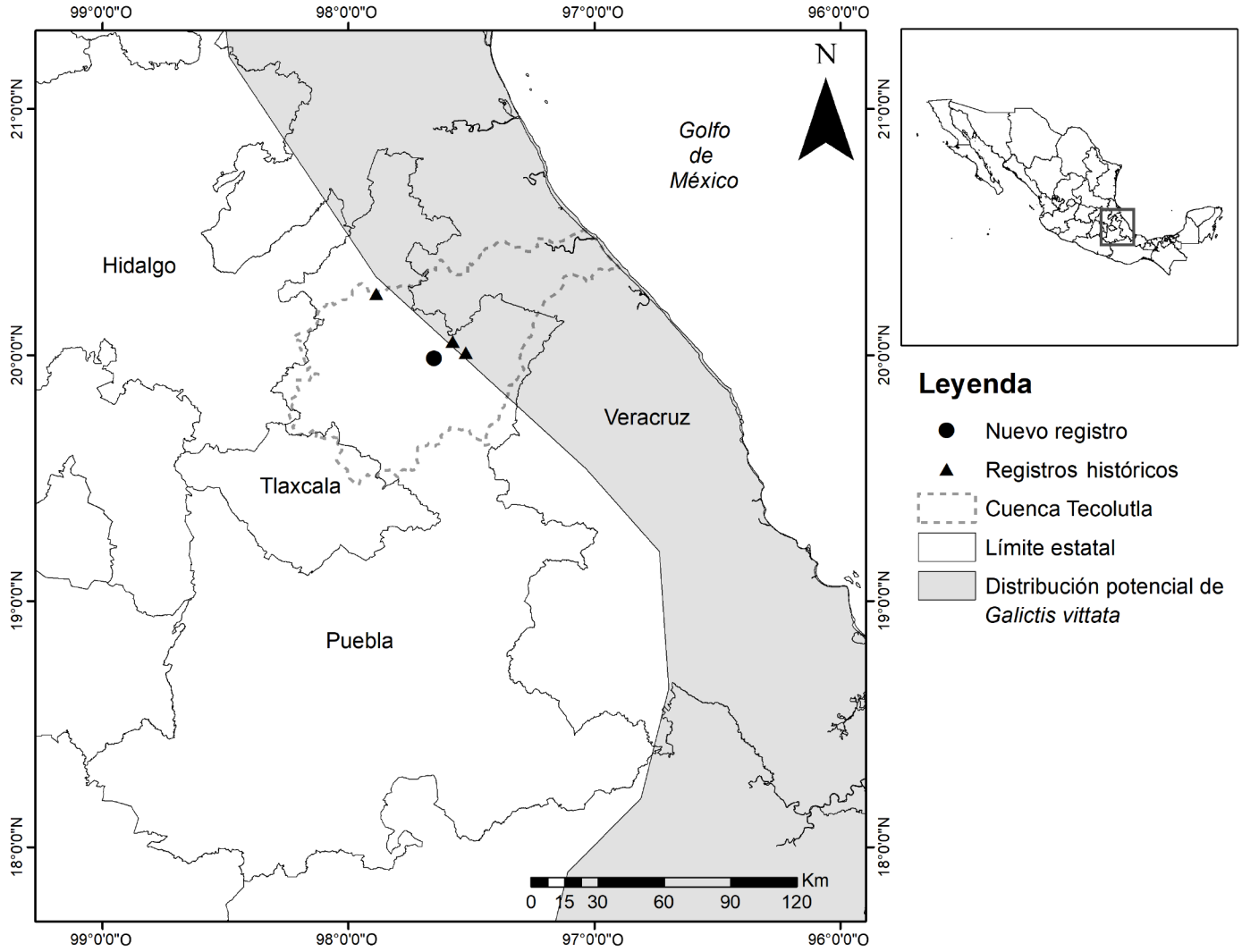

Figura 2. Ubicación del nuevo registro y registros históricos del grisón mayor *Galictis vittata* en el estado de Puebla, México.

Tuzamapan de Galeana (Ramírez-Bravo y Hernández-Santin 2016) y Tuxtla. Esto resalta el importante papel de las comunidades originarias de México en la conservación de la biodiversidad y en la implementación de prácticas de desarrollo sustentable (Boege 2008).

Se ha reportado la presencia del grisón mayor en zonas riparias con vegetación secundaria manejadas por comunidades mayas de la Selva Lacandona, Chiapas (De la Torre *et al.* 2009). Asimismo, el grisón ha sido reportado en cafetales bajo sombra cercano al río Tecolutla en el norte de Puebla (Ramírez-Bravo y Hernández-Santin 2016), tal como en este estudio. De esta manera, evidenciamos que *G. vittata* puede desplazarse en zonas ribereñas con parches de bosque primario, vegetación secundaria, pastizales y cultivos agrícolas. Sin embargo, se necesitan más estudios que ayuden a determinar si esta especie amenazada puede persistir en ambientes altamente antropizados.

Este nuevo registro de grisón mayor se trató de un individuo juvenil vivo a diferencia de los otros individuos registrados en Puebla, que se trataron de restos de individuos adultos cazados entre 1949 y 2017, y que fueron identificados por características morfológicas y morfométricas. En algunas comunidades originarias del norte de Puebla, el grisón mayor es cazado principalmente para autoconsumo y como elemento de utilería en la danza tradicional de "Los Huehues" que se baila en las celebraciones patronales (Ramírez-Pulido *et al.* 2005; Ramírez-Bravo y Hernández-Santin 2016; Hernández-Reyes *et al.* 2017).

En Tuxtla, el grisón mayor *G. vittata* es poco conocido por las personas locales, no forma parte de su dieta o danzas tradicionales, incluso existe un desconocimiento de su nombre en el idioma tutunakú. Por lo tanto, es necesario divulgar entre las personas de esta comunidad la importancia de este nuevo registro para contribuir al mantenimiento de esta especie amenazada. Se deben implementar estrategias de conservación y educación ambiental que informen a los y las habitantes la importancia del grisón mayor en términos ecológicos y de bienestar social, que eviten su caza, y que fomenten el seguimiento de prácticas agroecológicas que permitan conservar ecosistemas donde puedan habitar el grisón mayor y el resto de las especies animales que conforman la biodiversidad.

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Editor asociado: José F. Moreira-Ramírez
Sometido: Febrero 13, 2021; Revisado: Abril 5, 2021.
Aceptado: Abril 13, 2021; Publicado en línea: May 1, 2021.

THERYA NOTES 2021, Vol. 2 : 51-55 DOI: 10.12933/therya_notes-21-35 ISSN 2954-3614

First record of *Peropteryx pallidoptera* (Chiroptera: Emballonuridae) in Bolivia

Primer registro de *Peropteryx pallidoptera* (Chiroptera: Emballonuridae) en Bolivia

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The genus *Peropteryx* contains five species distributed in the Neotropical region. Three of these species occur in Bolivia (*P. macrotis*, *P. kappleri*, and *P. leucoptera*). The recently described *Peropteryx pallidoptera* is distributed in the Amazonian lowland forests of Ecuador, Perú, Brazil, and Colombia. We report the first record of *P. pallidoptera* in Bolivia. On November 22, 2016, we observed a bat colony in a ground cavity, in a forest patch located in the rural community of Isinuta in Chapare Province (Cochabamba Department). The area is classified as southwestern Amazonian forests ecoregion. We collected one specimen and confirmed the identification of the species with skull measurements. We observed all external and cranial diagnostic characters of *P. pallidoptera* in our specimen. Also, the external and cranial measurements are within the range reported for the species. Our specimen extends the known distribution of *P. pallidoptera* 1,420 km to the southeast from the nearest point in Perú, and it is the southernmost locality for the species. The habitat type and roost where we collected *P. pallidoptera* is consistent with the descriptions in the literature. Our new record in Bolivia is within the potential wide distribution in the Amazon region predicted in the species description. However, it creates a large gap in northern Bolivia, northwestern Brazil, and southeastern Perú where more records should be expected in the future.

Key words: Amazonian region; Cochabamba; pale-winged doglike bat; range extension; southernmost record.

El género *Peropteryx* contiene cinco especies distribuidas en la región Neotropical. Tres de estas especies se encuentran en Bolivia (*P. macrotis*, *P. kappleri* y *P. leucoptera*). *Peropteryx pallidoptera* fue recientemente descrita y se distribuye en los bosques de tierras bajas amazónicas de Ecuador, Perú, Brasil y Colombia. En esta nota, se reporta el primer registro de *P. pallidoptera* en Bolivia. El 22 de noviembre de 2016, se observó una colonia de murciélagos en una cavidad en el suelo, en un parche de bosque ubicado en la comunidad rural de Isinuta en la Provincia Chapare (Departamento de Cochabamba). El área está clasificada como ecorregión de bosques del sudoeste de la Amazonía. Se colectó uno de los murciélagos y confirmamos la identificación de la especie con medidas del cráneo. Se observaron todos los caracteres diagnósticos externos y craneales de *P. pallidoptera* en el ejemplar. Además, las medidas externas y craneales están dentro del rango reportado para la especie. Este ejemplar extiende la distribución conocida de *P. pallidoptera* 1,420 km al sureste desde el punto más cercano en Perú, y es la localidad más austral de la especie. El hábitat y refugio donde se colectó *P. pallidoptera* concuerda con lo descrito en la literatura. El nuevo registro en Bolivia se encuentra dentro de la amplia distribución potencial en la región amazónica predicha en la descripción de la especie. Sin embargo, crea una gran brecha en el norte de Bolivia, el noroeste de Brasil y el sureste de Perú, donde se espera tener más registros en el futuro.

Palabras clave: Cochabamba; extensión de rango; murciélago cara de perro de alas pálidas; región Amazónica; registro más austral.

The genus *Peropteryx* Peters, 1867 (Emballonuridae) contains five species (Simmons and Cirranello 2020) distributed in the Neotropical region. Three of these species have been reported in Bolivia: *P. macrotis*, *P. kappleri,* and *P. leucoptera* (Aguirre *et al.* 2019; Poma-Urey *et al.* 2021). *Peropteryx pallidoptera* is a recently described species (Lim *et al.* 2010) that is distributed in the Amazonian lowland forests below 400 m of Ecuador, Perú, Brazil, and Colombia (Solari 2016). This distribution is known from 34 specimens collected in 10 localities (Lim *et al.* 2010; McDonough *et al.* 2010; Díaz 2011; Castro *et al.* 2012; Suarez-Castro *et al.* 2012; Guerra and Albuja 2012; Morales-Martínez 2013; Medina *et al.* 2015; Wilson and Mittermeier 2019). *Peropteryx pallidoptera* is included in the IUCN red list of threatened species as Data Deficient due to the few known collecting localities, apparently all restricted to one unique ecoregion (Solari 2016). We report the first individual of *P. pallidoptera* collected in Bolivia, which now represents the southernmost locality of the species.

We collected our specimen in the rural community of Isinuta Nueva América (16° 42′ 50.94″ S, 65° 40′ 4.98″ W, 260 m), Chapare Province, Cochabamba Department, Bolivia. The area is located between the rivers Isinuta to the south, and Isiboro to the north. The site is near the southern border of the indigenous protected area Territorio Indígena y Parque Nacional Isiboro-Sécure (TIPNIS, by its initials in Spanish). Also, it is 0.5 km west from the secondary road under construction that will connect the departments of

Cochabamba and Beni. According to Ibisch *et al.* (2003), the area is classified as southwestern Amazonian forests ecoregion, and Isinuta is in the limit between Subandean and Preandean forests subecoregions, which are the transition from the montane forests of the Andes (Yungas ecoregion) to the Amazon lowland forests. The average annual temperature in the Preandean forest subecoregion is 24 – 28 °C, the average annual precipitation is 1,300 - > 7,000 mm, with a maximum of 2 dry months, the landscape is dominated by moderate hills, and the vegetation is mostly evergreen rainforest disturbed by agricultural use (Ibisch *et al.* 2003).

The collecting locality is in a patch of forest where the terrain is hilly (4 - 8 m high) and, under the trees, we found small cavities supported by plant roots where the soil was clayey and reddish yellow. The cavities were usually 1 m tall; some were very deep, and others were shallow. On November 22, 2016, we observed a colony of bats in a root cavity (Figure 1a) and we manually captured two females with translucent wings. We collected one of the bats (subadult) following the guidelines by Sikes *et al.* (2016), and we measured and released the other bat (pregnant female). External measurements recorded in the field were: total length (TL), tail length (T), hind foot length (HF), ear length (E), and forearm length (FA) in millimeters, and weight (W) in grams. We stored the specimen in alcohol and deposited it at the Museo de Historia Natural Alcide d'Orbigny (Cochabamba, Bolivia; MHNC-M 555). To confirm identification, we extracted and cleaned the skull, and measured it with a digital caliper to the nearest 0.01 mm. Cranial measurements taken were: greatest length of skull (GLS), condyloin-

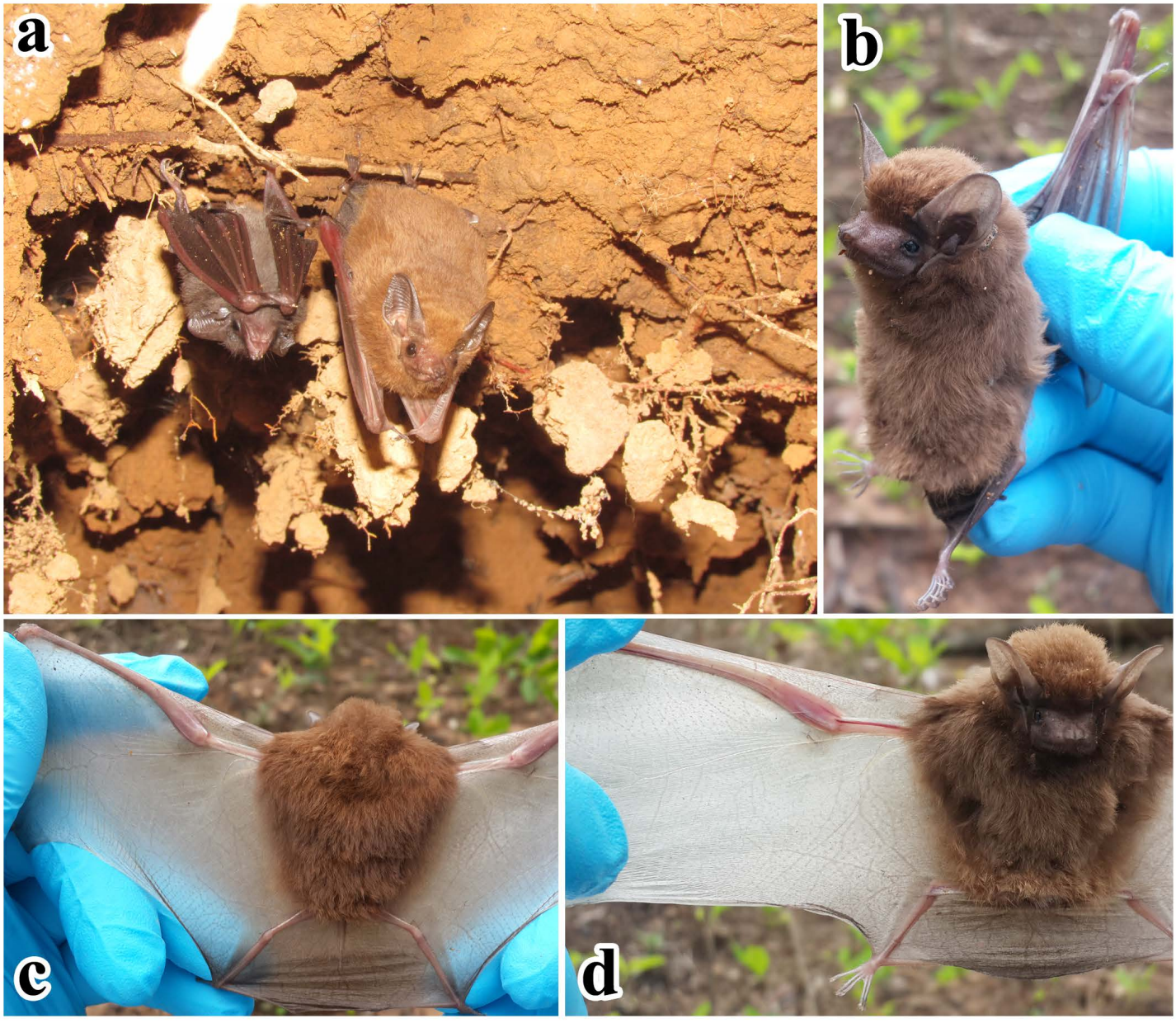

Figure 1. Photographs of live specimens of *Peropteryx pallidoptera* in Bolivia: a) roost where the bats were captured (bats photographed do not represent the specimen collected); b) lateral view of the specimen collected (MHNC-M 555); c) dorsal view showing translucent wings, pale brown arms, and brown interfemoral membrane; d) ventral view showing ears not connected by a band of skin and poorly developed wing sac on the leading edge of the propatagium. Photographs: roost (a) by T. Camacho, and live bat (b - d) by A. Amusquivar-Calustro.

cisive length (CIL), zygomatic breadth (ZB), mastoid breadth (MB), breadth of braincase (BBC), postorbital constriction (POC), maxillary toothrow length (CM3), and breadth across molars (M3M3) in millimeters. Measurements reported by other authors were compiled and differentiated by sex and country in Table 1: Peruvian specimens were obtained from Lim *et al.* (2010) and Díaz (2011), Ecuadorian specimens from Lim *et al.* (2010), McDonough *et al.* (2010) and Guerra and Albuja (2012), Brazilian specimen from Castro *et al.* (2012), and Colombian specimens from Suarez-Castro *et al.* (2012) and Morales-Martínez (2013). It is noteworthy that in some cases the authors reported the condylobasal length and not the condyloincisive length, and thus these measurements were not included.

We observed all external diagnostic characters of *P. pallidoptera* described by Lim *et al.* (2010) in our specimen (Figure 1b - 1d): translucent wings from the tip to the elbow and evenly colored with a tinge of brown, pale brown arms and digits, and ears not connected by a band of skin. Our specimen also presented all cranial diagnostic characters: the rostrum is not broad (Figure 2a), the lateral pterygoid pits are narrow and shallow, and separated by the mesopterygoid extension (Figure 2b), and the upper anterior premolar is tiny and peglike (Figure 2c).

Other morphological characters we observed in the specimen also coincide with the description: long dorsal brown fur with pale hair bases, pale ventral hair, brown ears, brown interfemoral membrane, a poorly developed wing sac on the leading edge of the propatagium (Figure 1b - 1d), slender postorbital processes, and a rostrum not dorsally inflated. The only difference we observed was that our specimen had translucent wings that included the propatagium and plagiopatagium, on the sides of the body, when the bat was alive, which is similar to the report by Castro *et al.* (2012). It is noteworthy that the digits and feet turned white in the alcohol preserved specimen.

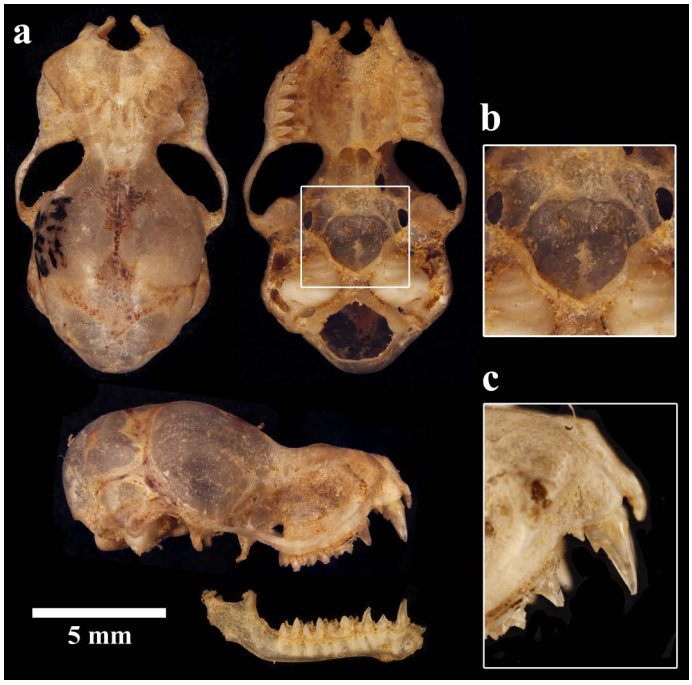

Figure 2. Cranial photographs of the voucher specimen of *Peropteryx pallidoptera* (MHNC-M 555) in Bolivia: a) dorsal, ventral, and lateral views of the skull of the specimen; b) detail of the narrow and shallow lateral pterygoid pits separated by the mesopterygoid extension anteriorly and the basisphenoid pit; c) detail of the upper anterior premolar, which is tiny and peglike. Photographs: G. Callapa.

The external and cranial measurements are within the range reported in the description and for other individuals (females) collected in Perú, Ecuador, Brazil, and Colombia (Table 1). Our specimen extends the known distribution of *P. pallidoptera* 1,420 km to the southeast from the nearest point in Perú reported by Medina *et al.* (2015). It is currently the southernmost locality for the species (Figure 3).

Table 1. External and cranial measurements of the new record of *Peropteryx pallidoptera* in Bolivia (MHNC-M 555) compared to specimens from Perú, Ecuador, Brazil, and Colombia reported in the literature. The range is followed by number of individuals in parenthesis. The abbreviations and sources are specified in the text.

	Bolivia	Perú		Ecuador		Brazil	Colombia	
Sex	♀	♀	♂	♀	♂	♀	♀	♂
TL	55	58 - 67 (18)	62	43.8 - 55 (2)	44.6 - 57 (4)	55	52 - 53.5 (2)	54
T	10	11 - 14 (18)	11	12 - 13 (2)	8.6 - 15 (4)	12	9.6 - 12 (2)	12
HF	8	8 - 10 (18)	9	6.5 - 7 (2)	6.6 - 9 (4)	9	7.4 - 10 (2)	8
E	16	14 - 17 (18)	15	11.5 - 14.5 (2)	9 - 15 (4)	15	13.4 - 14 (2)	13
FA	41.28	40.21 - 43 (14)	39	39.5 - 42 (2)	37.5 - 41.2 (4)	42.96	37 - 37.1 (2)	40
W	6	4.5 - 6 (15)	4.3	3 - 4.7 (2)	4 - 6 (4)	5	-	-
GLS	13.73	13.46 - 14.10 (8)	-	13.50	13.50 - 14.10 (3)	14.16	13.70 - 13.74 (2)	13.60
CIL	12.38	12.20 - 12.86 (8)	-	-	12.5	12.36	12.40	12.00
ZB	8.43	8.00 - 8.70 (9)	8.10	7.90	7.90 - 8.20 (3)	8.54	7.90 - 8.39 (2)	-
MB	7.27	6.90 - 7.45 (9)	7.20	6.90	6.80 - 7.30 (3)	7.10	6.90 - 7.40 (2)	7.10
BBC	6.66	6.30 - 6.76 (9)	6.50	6.50	6.40 - 6.80 (3)	6.58	6.20 - 6.36 (2)	6.30
POC	2.60	2.60 - 2.91 (9)	2.60 - 2.90 (2)	2.40	2.60 - 2.80 (3)	2.86	2.40 - 3.00 (2)	2.20
CM3	5.41	5.00 - 5.50 (9)	5.00 - 5.20 (2)	5.20	5.10 - 5.30 (3)	5.56	5.33 - 5.4 (2)	5.40
M3M3	5.97	5.70 - 6.59 (9)	5.80 - 5.90 (2)	5.70	5.90 - 6.10 (3)	6.34	6.00	5.90

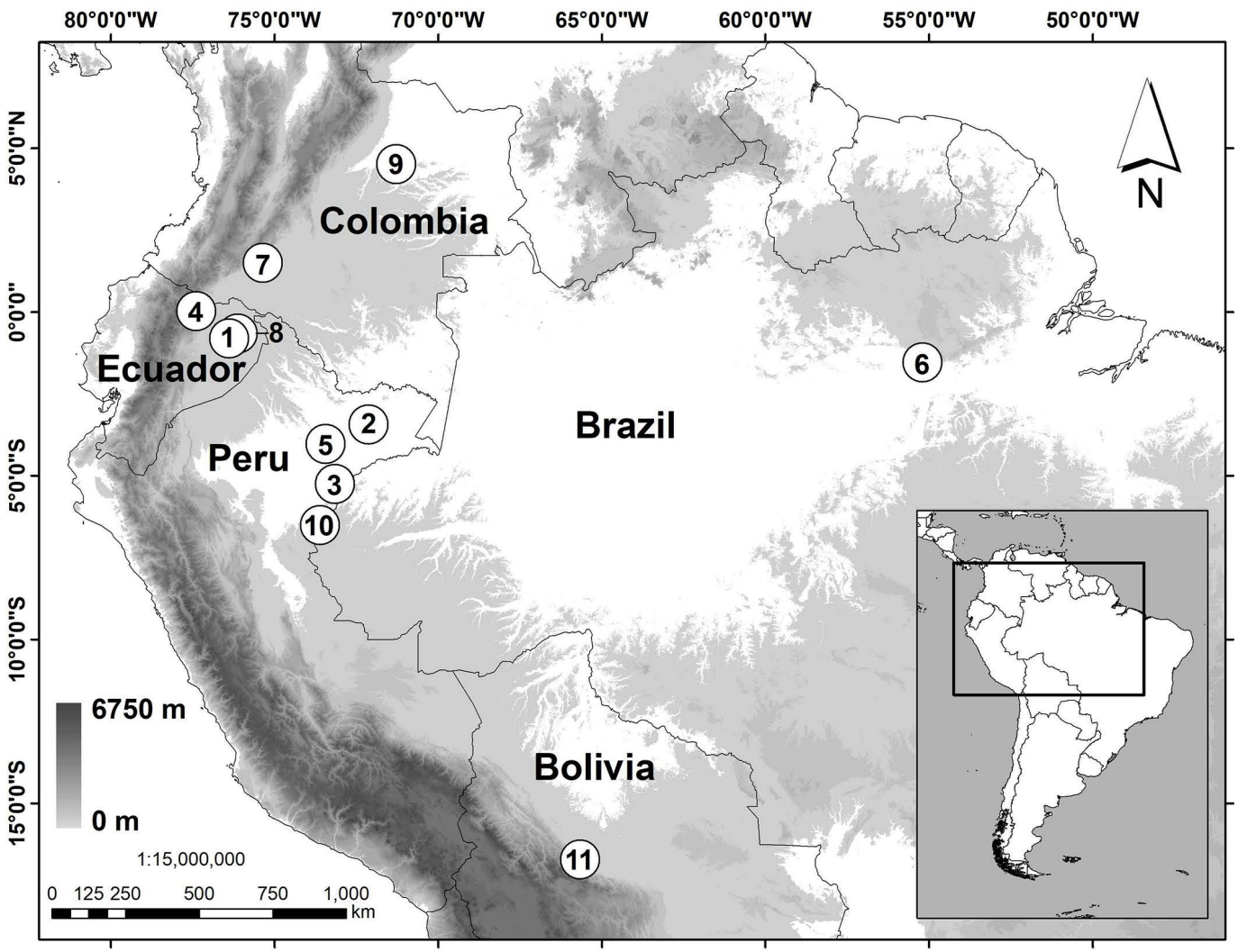

Figure 3. Map of the collecting localities of *Peropteryx pallidoptera* reported to date: 1) Ecuador, Orellana, 66 km S of Pompeya Sur 00° 48′ S, 76° 24′ W; 2) Perú, Loreto, Amazon River, Orosa 03° 26′ S, 72° 08′ W; 3) Perú, Loreto, Rio Galvez, Nuevo San Juan 05° 14′ 50″ S, 73° 09′ 50″ W (19 specimens, Lim *et al.* 2010); 4) Ecuador, Bosque del Aguarico, 20 km from Lumbaqui 00° 2′ 4.17″ N, 71° 24′ 13.93″ W (1 specimen, McDonough *et al.* 2010); 5) Perú, Loreto, San Juan, Camino a El Paujil, 1.8 km al W del km 35 de la carretera Iquitos-Nauta 4° 01.217′ S, 73° 26.787′ W (5 specimens, Díaz 2011); 6) Brazil, Pará, Curuá, Mamiá Village, farm Mangal 1° 32′ 14.7″ S, 55° 12′ 30.1″ W (1 specimen, Castro *et al.* 2012); 7) Colombia, Caquetá, Montañita, vereda Las Juntas, hacienda Las Delicias, quebrada El Oso, cueva La Virgen 01° 30′ 9.6″ N, 75° 22′ 5.9″ W (2 specimens Suarez-Castro *et al.* 2012); 8) Ecuador, Cueva Yasuní 1, a 1 km de la margen derecha del Río Tiputini, Parque Nacional Yasuní 00° 39′ 07″ S, 76° 08′ 25″ W (4 specimens, Guerra and Albuja 2012); 9) Colombia, Meta, Puerto López, Carimagua 4° 31′ 36″ N, 71° 17′ 43″ W (1 specimen, Morales-Martínez 2013); 10) Perú, Loreto, Cabeceras de Qda. Lobo, Zona Reservada Sierra del Divisor, Distrito Tapiche, Provincia Requena 6° 30′ 27.6″ S, 73° 37′ 26.1″ W (1 specimen, Medina *et al.* 2015); 11) Bolivia, Cochabamba, Isinuta Nueva America, Provincia Chapare 16° 42′ 50.94″ S, 65° 40′ 4.98″ W (1 specimen, this study). Gray scale indicates range of elevation from 0 m (white) to 6,750 m (dark gray). Design: M. Ocampo.

Peropteryx pallidoptera is known to occupy a variety of roosts: in animal burrows or holes, cavities in fallen trees, foliage, under fallen trees, and cavities roofed by roots and soil along the margins of water bodies (Lim *et al.* 2010; Voss *et al.* 2016). The type of roost we observed in the locality of Isinuta is consistent with the description of a hole in the ground supported by roots (Figure 1a). Similarly, the habitat type where we caught our specimen shares the same characteristics where most specimens have been previously reported, *i.e.* lowland rainforest, below 400 m, that receives more than 2,800 mm of annual precipitation (Lim *et al.* 2010). Consequently, our new record in Bolivia is not surprising and supports the potential wide distribution in the Amazon region proposed by Lim *et al.* (2010). Our record in Bolivia constitutes a remarkable distribution extension of *P. pallidoptera*, by 1,420 km southeast from the nearest collecting locality in Perú. It is the southernmost collecting locality to date, and it creates a large gap in the Amazonian region of Bolivia, northwestern Brazil, and southeastern Perú where more records should be expected in the future.

Acknowledgements

The Rufford Foundation financed the fieldwork for the project "Andean Forest Conservation and Small Mammals in Bolivia" lead by MH-C. We thank the community of Isinuta Nueva América, especially A. García Tenorio, his wife Romualda, and his family for all the support in the study site. We also thank M. Ocampo for the map design, and G. Callapa for the skull photographs. The Plurinational State of Bolivia provided research and collecting permissions CAR/MMAyA/VMABCCGDF/UVSAPN°1080/2015.

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Associated editor: Cristian Kraker-Castañeda
Submitted: January 27, 2021; Reviewed: April 6, 2021.
Accepted: April 14, 2021; Published on line: May 1, 2021.

THERYA NOTES 2021, Vol. 2 : 56-64 DOI: 10.12933/therya_notes-21-36 ISSN 2954-3614

Evaluation of the potential highest altitudinal record of *Micronycteris hirsuta*

Evaluación del registro potencial de mayor altitud para *Micronycteris hirsuta*

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Micronycteris hirsuta is a species widely distributed in Central and South America at altitudes no higher than 1,500 m, and it is associated with conserved forests. We found a dead individual in Bogotá city at 2,600 m. Considering that previous records for this species come from lower altitudes and that this species is mostly found in undisturbed ecosystems, we question the presence of *M. hirsuta* in the city. To assess the possibility that this species inhabits areas close to the city, we developed an Ecological Niche Model (ENM), reviewed its distribution in Colombia, and the reported bat species from the city of Bogotá. We report the highest altitudinal record of *M. hirsuta* at 2,600 m. The specimen found exhibits all the diagnostic characters recognized for this species. However, we did not find evidence that supports the likelihood that *M. hirsuta* inhabits areas near Bogotá. According to our results and the species' ecological attributes, we do not support that *M. hirsuta* inhabits areas near Bogotá and other high-altitude ecosystems. We discuss other hypotheses that could explain this record's presence, including a possible migration or an accidental transport from lowlands. We highlight the importance of evaluating unusual distributional records of species using ENMs and discuss these below the light of species' ecological attributes.

Key words: Biological collections; ecological niche model; Micronycterinae; urban bats.

Micronycteris hirsuta es una especie ampliamente distribuida en el Centro y Sur de América en altitudes no mayores a los 1,500 m y asociada con bosques conservados. Se registró un individuo muerto de esta especie en la ciudad de Bogotá, a 2,600 m. Considerando que los registros previos provienen de altitudes más bajas y que esta especie no es frecuente en ecosistemas perturbados, se cuestiona la presencia de *M. hirsuta* en la ciudad. Para evaluar si es probable que esta especie habite en áreas cercanas a Bogotá, se desarrolló un modelo de nicho ecológico (ENM, por sus iniciales en inglés), se revisó la distribución de esta especie en Colombia y las especies reportadas para la ciudad de Bogotá. Se reporta el registro de mayor altitud de *Micronycteris hirsuta*, a 2,600 m. El espécimen encontrado exhibe todos los caracteres diagnósticos conocidos para esta especie. Sin embargo, no se encontró evidencia que respalde la presencia de *M. hirsuta* en áreas cerca de Bogotá. De acuerdo con los resultados y los atributos ecológicos de esta especie, no se respalda que *M. hirsuta* habite áreas cercanas a Bogotá y otros ecosistemas de altitud alta. Se discuten otras hipótesis que pueden explicar este registro, incluyendo una posible migración o un transporte accidental desde las zonas bajas. Se resalta la importancia de evaluar los registros inusuales en la distribución de las especies usando ENMs y analizándolos bajo la luz de los atributos ecológicos de cada especie.

Palabras clave: Colecciones biológicas; Micronycterinae; modelo de nicho ecológico; murciélagos urbanos.

Micronycteris hirsuta (W. Peters, 1869) has a wide distribution range. However, it is considered a rare species due to its low abundance from few and scattered localities (Arita 1993; Reid 2009). This species inhabits primary forests (Sampaio *et al.* 2016), deciduous lowland forests, and forest edges (Reid 2009), but also occurs in cleared areas and secondary vegetation (Handley 1978; Simmons and Voss 1998), always near to conserved forests (Sampaio *et al.* 2016). This species feeds on insects gleaned from vegetation and fruits depending on the season (Reid 2009) and, like other *Micronycteris* bats, can be considered as an indicator of undisturbed forests (Fenton *et al.* 1992; Medellín *et al.* 2000; Schulze *et al.* 2000).

Micronycteris hirsuta is distributed from the border between Honduras and Nicaragua to the south through Central America and northern South America. To the west of the Andes, it is present in Ecuador, and to the east through Colombia, Venezuela, Trinidad and Tobago, and the Guianas to the lowlands from Perú, the north of Bolivia, and the Brazilian Amazons; additionally, there is an isolated population in south-eastern Brazil (Williams and Genoways 2008; Sampaio *et al.* 2016). This species

is known on an altitudinal range from 0 to 1,500 m (Reid 2009). In Colombia, *M. hirsuta* is present in the lowlands of the Amazon, Andean, Caribbean, and Pacific regions in localities with elevations between 20 and 1,100 m (Mantilla-Meluk *et al.* 2009; Solari *et al.* 2013).

Recently, we found a dead individual of *M. hirsuta* in a street of Bogotá city that could correspond to the highest record for the species, at 2,600 m. However, because the species is known from lowlands and is infrequent in highly disturbed areas, we assess the likelihood of *M. hirsuta* inhabiting Bogotá through an Ecological Niche Model (ENM) and a review of its distribution. Additionally, we included a revision of the bat species recorded in Bogotá.

The record we report here corresponds to a carcass found in a sidewalk under a *Cecropia* sp. tree in the Chapinero neighborhood (Calle 53#3-27 Bogotá D. C. 4° 38′ 17″ N, 74° 03′ 36″ W) at 2,600 m on February 29, 2020. We preserved the specimen and tissue samples (foot) in 96 % ethanol and deposited it in the mammal collection "Colección de mamíferos Alberto Cadena García" at the Instituto de Ciencias Naturales, Universidad Nacional de Colombia (ICN), under the catalogue number ICN 24849.

We revised all known records of *M. hirsuta* for Colombia to describe its distribution and built a points distribution map, including the biogeographic provinces proposed by Hernández-Camacho *et al.* (1992). To do this, we examined all specimens of *M. hirsuta* deposited in six scientific collections, and verified the identification of each of them based on Simmons (1996): Instituto Alexander von Humboldt, Villa de Leyva, Colombia (IAvH); Colección de mamíferos "Alberto Cadena García", Instituto de Ciencias Naturales, Universidad Nacional de Colombia, Bogotá, Colombia (ICN); Museo de Historia Natural Universidad del Cauca, Popayán, Colombia (MHNUC); Colección de mamíferos, Universidad del Valle, Cali, Colombia (UV); Colección Teriológica Universidad de Antioquia (CTUA); and the American Museum of Natural History, New York (AMNH). Additionally, we include Colombian specimens reviewed by Simmons (1996) and Castaño *et al.* (2003; Table 1).

We observed diagnostic characters and took morphological measurements of the voucher specimen (Figure 1). We took the external measurements from specimen tags. We measured the forearm and skull with digital calipers to the nearest 0.01 mm, following Simmons and Voss (1998). We registered a total of 5 external measurements and 8 skull measurements (Table 2). However, for ICN 24849 reported here, we were unable to take all measurements due to the specimen's condition. For ICN 24849, we measured the following (Table 2): length of the tail (TV), length of the hind foot (HF), length of the ear (EAR), and length of the forearm (FA).

To assess if the species is likely to occur in Bogotá and effectively finds suitable habitats around the city, first, we reviewed the bat species recorded in the urban area of Bogotá. We searched for *M. hirsuta* or closely related species that inhabit the vicinity of Bogotá through a Boolean Search of articles through Google Scholar, Scopus, and Web of Science. We conducted the search using the following keywords, in Spanish and English: Bats, Chiroptera, Bogotá, using the conjunction "AND". Additionally, we revised the ICN's online specimens' database (https://www.biovirtual.unal.edu.co/es/colecciones/search/mammals/) visited on April 20, 2020.

We used ENMs to explore the likelihood that suitable habitat for *M. hirsuta* exists near Bogotá. We based our analysis in all specimens with confirmed taxonomical identification through morphology (revised by us or included in Simmons 1996) or molecular information (Porter *et al.* 2007; Table 1) considering the high misidentification rates in other species of the genus (Morales-Martínez *et al.* 2018) that could have an impact in the modeling. We do not include records from southeastern Brazilian distribution because cytogenetic evidence supports cryptic diversity in eastern Brazilian populations (Ribas *et al.* 2013). We used these 42 records representing 32 localities of 6 countries and our record from Bogotá to construct our ENMs (Appendix 1). We spatially thinned our original data to reduce sampling biases, ensuring that the distance between all localities pairs exceeds 10 km, using the R package spThin (Aiello-Lammens *et al.* 2015).

We used the World Clim v2.1 data set (Fick and Hijmans 2017) as potential predictors of the species, all of them with a spatial resolution of 30 arc seconds (approximately 1 km^2 resolution at the equator). To exclude highly correlated variables (> 0.80), we calculated Pearson's correlation coefficients for every pairwise comparison of variables and chose 4 variables: Isothermality (Bio 3), Temperature Seasonality (Bio 4), Annual Precipitation (Bio 12), and Precipitation Seasonality (Bio 15). These variables are important in the distribution of different species of Neotropical bats due to their effect on primary productivity, the availability of food resources, and physiological requirements (McCain 2006; Ferreira *et al.* 2017). We delimited the study area to a buffer of two degrees around each locality and included 100,000 background points within the study area using the R packages sp and rgeos (Pebesma *et al.* 2005; Bivand *et al.* 2017) implemented in the package Wallace (Kass *et al.* 2018). To evaluate our models' accuracy, we used a *k*-fold cross-validation approach, with a random block spatial partition of $k = 4$, separating the Amazon, the central, north, and the eastern Andes.

We constructed two frameworks of niche models with maximum entropy (Maxent; Phillips *et al.* 2006) approach using Maxent (Phillips *et al.* 2017) and the r package dismo (Hijmans *et al.* 2017) in Wallace. The first framework omitted the record of Bogotá, and the second included the record of Bogotá in the selected localities. For each model, we tested five different feature class combinations: L, LQ, H, LQH, and LQHP (L = linear, Q = quadratic, H = hinge, P = product) and regularization multipliers from 0.5 to 5 (with a multiplier step value of 0.5) to construct a total of 100 models. We evaluated our models using ENMeval (Muscarella *et al.* 2014) and used the AUC scores and a

Figure 1. Morphological characters of *Micronycteris hirsuta* (ICN 24849): A) lower incisors: bifid, high crowned, and wedged between canines (see white arrow); B) dermal pads arranged in "V" (see white arrow); C) calcar greater than the foot (see white arrow).

second-order Akaike Information Criterion (AIC, Akaike 1973; 1998) correcting for small sample sizes (AICc; Anderson and Burnham 2004; Burnham and Anderson 2004) to compare the fit of the models to our data statistically. We selected the models with the highest AUC and the lowest Akaike scores.

Finally, we used the average presence suitability to assess this species' potential distribution, with the 10th percentile training presence used to create a presence-absence threshold (Hijmans *et al.* 2017). This procedure allowed us a stricter evaluation than a minimum training presence threshold (Waltari *et al.* 2007). We compare the two frameworks to test if the inclusion of the record of Bogotá influences the predicted model, increasing its distribution suitability near the city, and assess if the climate of the area is suitable for the species.

We report an unusual record of *Micronycteris hirsuta*, at 2,600 m (Figure 2C). Specimen ICN 24849 has all the diagnostic characters recognized for *M. hirsuta* (Simmons 1996; Simmons and Voss 1998; Williams and Genoways 2008). In terms of dental characters, the lower incisors are bifid, high crowned, and wedged tightly between the canines (Figure 1A). The specimen exhibits uniform brown coloration with bicolored long fur, ventral and dorsal fur not contrasting to each other, ears not completely rounded and connected by an interauricular band of skin, chin with a pair of dermal pads arranged in a "V" shape with no central papilla (Figure 1B), and a calcaneus greater than the foot (Figure 1C). The external measurements of the ICN 24849 are within the known range of the species. The averages of the examined specimens' measurements are higher in females than in males (see Table 2); this could be attributed to sexual dimorphism in size, although our sample size did not allow us to test it statistically.

In Colombia, we know *M. hirsuta* from 21 localities (Table 1) spanning over 6 of the 9 biogeographic provinces of the country (Hernández-Camacho *et al.* 1992): the Caribbean dry belt province, the Choco-Magdalena province, the Orinoquia province, the Guyana province, the Amazon province, and the Northern Andes province (Figure 2A). The altitude ranges from 0 to 500 m (71 % of the records), 500 to 1,000 m (14 %), and 1,000 to 1,500 m (10 %). The ICN 24849 is the only record above 1,500 m (Figure 2B).

We did not find evidence of records of *M. hirsuta* near Bogotá. Near the city, we documented 12 species according to 9 articles published between 1927 and 2015. Shamel (1927) described *Sturnira bogotensis* based on a series of specimens captured in the "La Uribe" train station. Tamsitt *et al.* (1964) reported 8 species for the urban area of Bogotá: *Carollia perspicillata, Sturnira ludovici, Myotis nigricans, Eptesicus fuscus, Histiotus colombiae, Aeorestes cinereus, Tadarida brasiliensis*, and *Eumops glaucinus.* After these early records, other species have been reported: *Sphaeronycteris toxophylum* (Rodríguez-Posada and Cárdenas-González 2012), *Lasiurus blossevillii* (Morales-Martínez and Ramírez-Chaves 2015), and *Choeroniscus godmani* (Morales-Martínez and Henao-Cárdenas 2015). Andersen (1906) reported a specimen of *Micronycteris megalotis* from Bogotá. However, Tamsitt *et al.* (1964) discarded this finding and attributed the specimen to an accidental introduction. Other specimens in the ICN collection online database correspond to *Anoura geoffroyi* (ICN 3425, 12971), *Promops* sp. (ICN 4719), *Artibeus* sp. (ICN 12964), and *Nyctinomops laticaudatus* (ICN 19199).

In Figure 2C, we include the map of the distribution of *M. hirsuta* following Rojas *et al.* (2018). In Figure 3A and 3B, we include the logistic suitability with and without Bogotá, respectively. In both frameworks, we selected the models with the highest AUC and the lowest AIC. Both models used a linear feature and a regularization value of 0.5 and predicted the presence of *M. hirsuta* in Bogotá when applying the 10th percentile training presence threshold (Figure 3C and 3D). However, the suitability of the climatic characteristics for this species in Bogotá is low (without Bogotá 0.321, with Bogotá 0.335; Figure 3A and 3B). Our highest supported model without Bogotá shows lower suitability of distribution (0.331, AUC = 0.654) compared with the model including Bogotá, which has slightly higher suitability (0.389, AUC = 0.617).

According to our results and the species' ecological attributes, we do not support that *M. hirsuta* inhabits areas near

Table 1. Number ID, source (we indicate uncatalogued numbers with the letter T in bold), locality, geographic coordinates, and altitude of the revised specimens of *Micronycteris hirsuta* in Colombia. ICN: Instituto de Ciencias Naturales, Universidad Nacional de Colombia; CTUA: Colección Teriológica Universidad de Antioquia; IAvH: Instituto Alexander von Humboldt, Villa de Leyva, Colombia; MHNUC: Museo de Historia Natural Universidad del Cauca, Popayán, Colombia; UV: Universidad del Valle, Cali, Colombia.

Number ID	Source	Locality	Geographic coordinates		Altitude (m)
			Latitude	Longitude	
1	ICN-**T**-ATG 161	Amazonas: La Pedrera	1° 19' 40.87" S	69° 33' 47.1" W	95
2	Simmons *et al.* (2002)	Antioquia: La Frijolera	7° 7' 0.12" N	75° 25' 0.12" W	1,500
3	CTUA 2405	Antioquia: Remedios	7° 3' 7.68" N	74° 18' 17.6" W	296
4	IAvH 9312	Arauca: Tame	6° 24' 6.5" N	71° 56' 35.9" W	792
5	CTUA 750	Atlántico: Santa Catalina	10° 35' 49.1" N	75° 17' 10.3" W	103
6	**ICN 24849**	***Bogotá D.C: Carrera 3 calle 45**	4° 38' 17" N	74° 3' 36" W	2,600
7	IAvH 7155	Caquetá: río Mesay	0° 4' 27" N	72° 27' 4.99" W	250
8	Simmons *et al.* (2002)	Cauca, río Saijá	2° 55' 36.52" N	77° 33' 52.9" W	38
9	MHNUC 814	Cauca: El Tambo	2° 43´ 2.99" N	76° 56´ 52.0"W	1,407
10	ICN 24461	Cesar: La Gloria	8° 35' 24.55" N	73° 34' 19.8" W	471
11	CTUA 750	Chocó: Quibdó	5° 47' 34.69" N	76° 37' 37.7" W	35
12	ICN 17236	Córdoba: Pueblo Nuevo	8° 24' 5" N	75° 22' 50" W	52
13	ICN 19413	Guajira: Maicao	11° 15' 24.1" N	72° 21' 39.0" W	105
14	ICN 23867	Guaviare: San José del Guaviare	2° 31' 31.87" N	72° 48' 26.8" W	224
15	Simmons *et al.* (2002)	Magdalena: Bonda	11° 14' 1.32" N	74° 7' 29.63" W	65
16	Simmons *et al.* (2002)	Magdalena: río Don Diego	11° 13' 59.8" N	74° 7' 59.88" W	53
17	ICN 24463	Meta: Mapiripan	2° 58' 43.06" N	71° 55' 0.11" W	208
18	ICN 14393	Meta: Cubarral	3° 48' 28.30" N	73° 52' 51.9" W	941
19	ICN-**T**-D3M541	Santander: Puerto Parra	6° 36' 36.82" N	74° 5' 4.52" W	104
20	UV 11497	Valle: Buenaventura	3° 14' 3.72" N	77° 32' 14.2" W	14
21	ICN 22829	Valle del Cauca: Yotoco	3° 52' 40.44" N	76° 25' 56.9" W	1,480

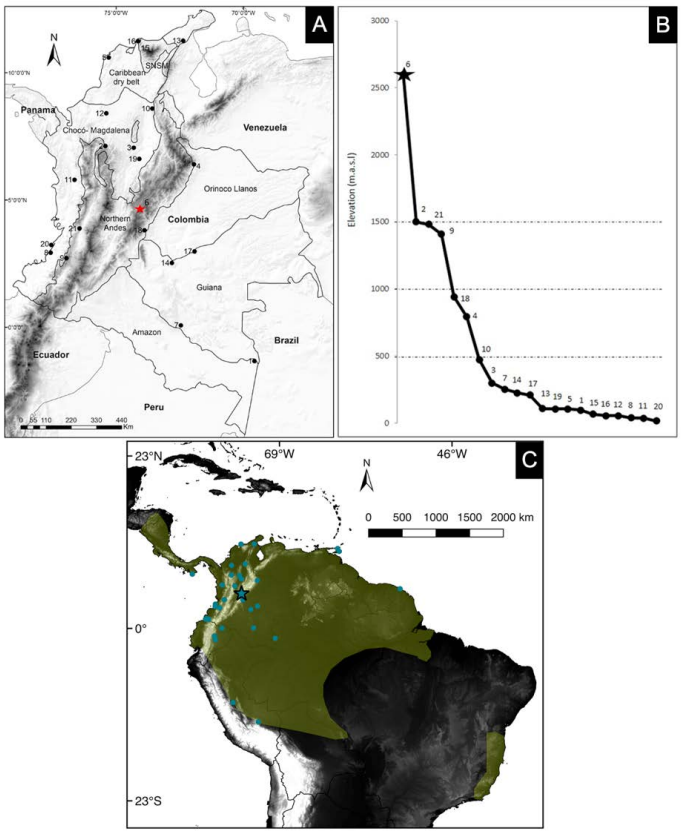

Figure 2. Distribution of *Micronycteris hirsuta* in Colombia: A) records of confirmed localities (circles), where the star corresponds to ICN 24849; B) elevation profile of *M. hirsuta* in Colombia; C) map of the distribution of *Micronycteris hirsuta* following Rojas *et al*. (2018). The dots refer to the localities used to make the Ecological Niche Model (see Appendix 1). The blue star corresponds to ICN 24849.

Bogotá and other high-altitude ecosystems. We found that, despite ENMs predicting areas with adequate climatic characteristics for *M. hirsuta* in high altitudes near Bogotá, it is unlikely to occur due to low suitability of presence in ENMs, previous information of Bogotá bat fauna, and ecological attributes of *M. hirsuta*.

In our search on bat records from the area of Bogotá, we include surrounding forests from the city above 2,500 m (*e. g*., Pérez-Torres and Ahumada 2004), and we did not find evidence of the presence of any species of *Micronycteris*. Our specimen revision and literature records show that *M. hirsuta* is mainly recorded below 500 m (Patterson *et al.*1996; Figure 3B). Even this species is still rare in scientific collections, and researchers do not usually capture it (Solari *et al.* 2019; Costa *et al.* 2020; Silva *et al.* 2020a, 2020b), *M. hirsuta* shows an extensive distribution in a variety of biogeographic areas and ecosystems below the 1,500 m corroborated by our ENMs results.

Our ENMs support the presence of a few amounts of suitable dispersed habitat for this species in the high altitudes of Bogotá, predicting that principally the lowlands surrounding the Bogotá savanna provide the continuous, suitable conditions for the presence of *M. hirsuta.* Some ecological attributes of the species cast doubt on ENMs predictions. For instance, the bat species that inhabit lowlands can occasionally reach high elevations have some characteristics such as high independence of continuous forest, often use underground roost, and their geographical ranges comprise high southern latitudes (de Carvalho *et al.* 2019). Contrary, *M. hirsuta* does not exhibit these characteristics because it shows a high dependence on continuous forest (Williams and Genoways 2008), and the most meridional record of the species is in the Atlantic forest in southeastern Brazil (Esbérard 2004). However, these populations probably correspond to an undescribed species (Ribas *et al.* 2013).

Additionally, *M. hirsuta* prefers undisturbed forests with no evidence of generalist habits (Williams and Genoways 2008; Medellín *et al.* 2000). The impact that urbanization has on bats has been defined as species-specific (Russo and Ancillotto 2015), showing that some are better adapted to city conditions while others avoid cities entirely. Highways have strong barrier effects on maneuverable, slow-flying bats that forage by gleaning (Kerth and Melber 2009) as *M. hirsuta* being unlikely that the species tolerate urban conditions.

Alternative hypotheses to explain this record include a possible migration of the species from lower altitudes. In tropical regions, there is evidence of altitudinal migrations in several bat species (McGuire and Boyle 2013). For Colombia, some species of the Phyllostomidae family might migrate attitudinally (Naranjo and Amaya 2009). Other species, like the vespertilionid (Vespertilionidae) *Aeorestes cinereus*, make altitudinal migrations on the Andes' western slopes (Sanborn and Crespo 1957). Although there is still an important lack of information on this behavior, there is

Table 2. External and skull measurements (mm), including the mean, the observed range (in parentheses), and the sample size of specimens per sex of *Micronycteris hirsuta* previously recorded in Colombia and external measurements (mm) of the specimen reported in the present study. Abbreviations: total body length (TL), tail length (TV), hind foot length (HF), ear length (EAR), forearm length (FA), greatest length of the skull (GLS), condyloincisive length (CIL), postorbital breadth (PB), braincase breadth (BB), zygomatic breadth (ZB), mastoid breadth (MB), maxillary toothrow length (MTRL), breadth across molars (BAM). ICN: Instituto de Ciencias Naturales, Bogotá, Colombia.

Measurements	Reviewed material		ICN 24849
	Males	Females	
TL	61.3 (48-75)7	78.3 (78-79)3	-
TV	13.3 (6-20)7	14.7 (14-15) 3	13.0
HF	12.6 (11-17)7	13.3 (11-15)3	11.0
EAR	23.2 (19-33)7	24.3 (22-26)3	20.0
FA	43.4 (40.7-46.2)10	44.2 (41.9-47)3	44.0
GLS	23.8 (22.5-25.0)10	24.0 (23.2-24.9)5	-
CIL	20.9 (20.2-21.6)9	21.1 (20.7-21.6)5	-
PB	5.0 (4.8-5.4)10	5.1 (4.9-5.5)5	-
BB	8.6(8.2-8.9)10	8.7 (8.5-8.9)5	-
ZB	11.4 (10.7-11.8)7	11.7(11.5-12)4	-
MB	10.3 (9.6-10.6)8	10.5(10.1-10.9)5	-
MTRL	9.3 (8.9-9.6)9	9.3 (9.0-9.8)5	-
BAM	4.5(4.3-4.6)10	4.5 (4.3-4.7)5	-

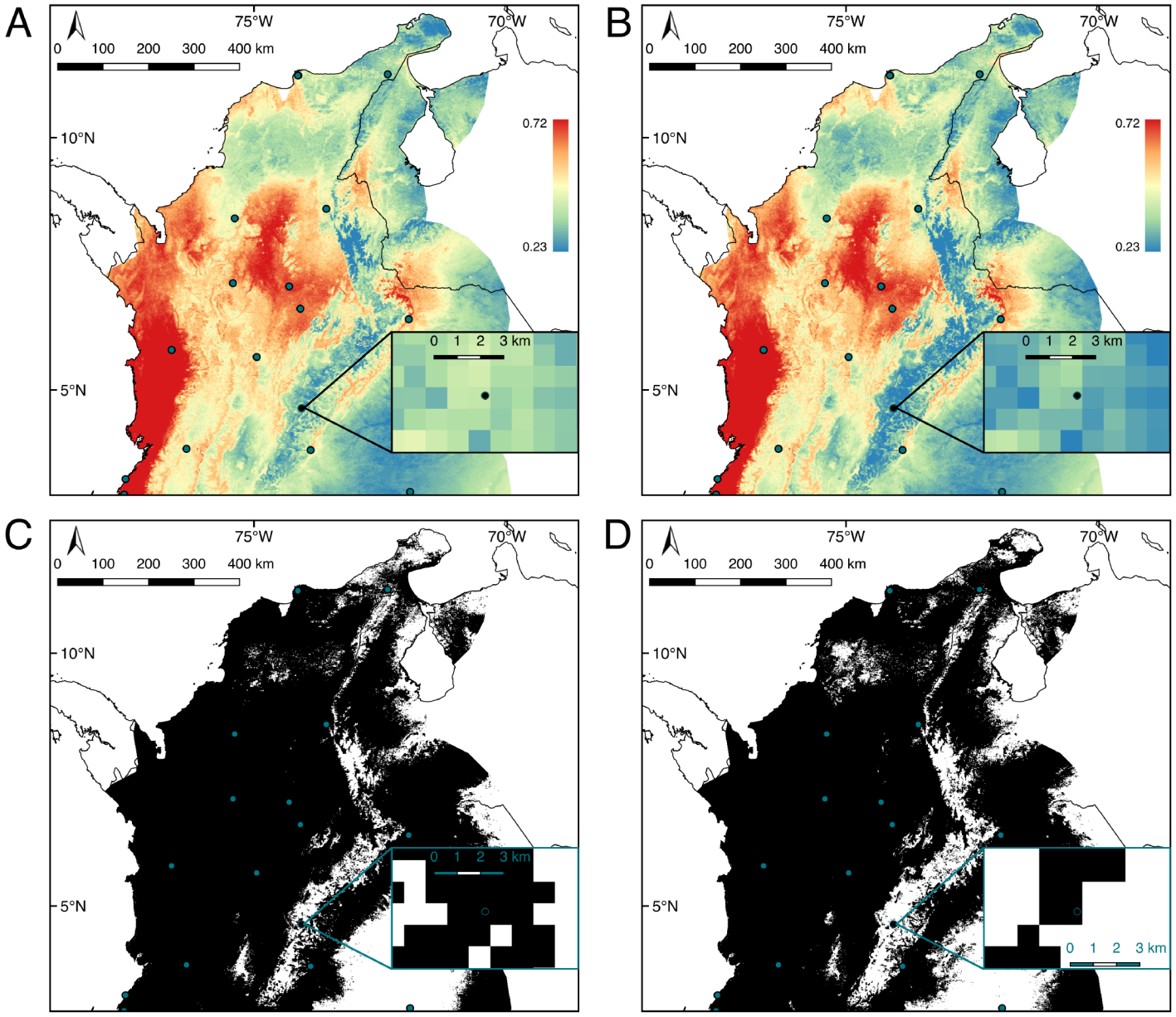

Figure 3. Selected Ecological Niche Model of *Micronycteris hirsuta* based on AICc support. A and B represent the logistic suitability with and without Bogotá, respectively. The suitability of *M. hirsuta* is low in both models for the collecting locality of ICN 24849. C and D show the presence-absence distribution map based on the 10th percentile training presence threshold with and without Bogotá, respectively.

no indication or consistent evidence of altitudinal migrations in *M. hirsuta,* or any other species of *Micronycteris*. Probably because some species in this genus have been attributed to having small home ranges (*e. g.*, *Micronycteris microtis* home range of 1 to 5 ha) and tend to remain in forest patches before venturing across open areas (Fleming *et al.* 1972; Albrecht *et al.* 2007; Geipel *et al.* 2013).

Another hypothesis is accidental transportation by a vehicle. Other authors have proposed this possibility for bat species' unexpected findings in other localities in the Neotropics (Tamsitt *et al. 1964*; Jarrin 2003; Morales-Martínez and Henao-Cárdenas 2015); this hypothesis might be possible if we consider the high vehicular traffic from the lowlands towards the city.

Our results suggest that the specimen ICN 24849 was accidentally transported from the lowlands to Bogotá. We strongly recommend the revision of verified identification records and the use of ENMs as a valuable tool to test the suitability of the presence of suspect records, especially of species that are threatened and poorly known. Since the specimen was found and delivered to us by a citizen, it reflects the importance of participatory science to gather species information, mainly in understudied places.

Acknowledgements

We want to thank P. Kamila Guerrero García and L. Pinillos Collazos, who rescued the specimen from the street, informed about it, and delivered it to DM-M. We thank all the scientific collections that DMM-M visited and J. Betancur for the photographic equipment loan. We thank the reviewers for their valuable comments that helped to improve the final version.

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Associated editor: Cristian Kraker-Castañeda
Submitted: November 9, 2020; Reviewed: April 13, 2021.
Accepted: April 21, 2021; Published on line: May 11, 2021.

Appendix 1

List of localities used to make the Ecological Niche Model. Country, locality, geographic coordinates, and source of information; the data with an asterisk correspond to the specimens reviewed in this paper, and we indicate uncatalogued numbers with the letter T (in bold). CTUA: Colección Teriológica Universidad de Antioquia; ICN: Instituto de Ciencias Naturales, Universidad Nacional de Colombia; IAvH: Instituto Alexander von Humboldt; MHNUC: Museo de Historia Natural del Cauca; UV: Universidad del Valle; QCAZ: Museo de Zoología Pontificia Universidad Católica del Ecuador.

Country	Locality	Latitude	Longitude	Source
Colombia	Antioquia: La Frijolera	7° 7' 0.12" N	75° 25' 0.12" W	Simmons *et al.* (2002)
Colombia	Antioquia: Remedios, Vda. Ojos Claros	7° 3' 7.68" N	74° 18' 17.65" W	CTUA 2405*
Colombia	Amazonas: La Pedrera	1° 19' 40.87" S	69° 33' 47.16" W	ICN-**T**-ATG 161*
Colombia	Arauca: Tame, Reserva Forestal protectora del río Tame	6° 24' 6.5" N	71° 56' 35.99" W	IAvH 9312*
Colombia	Caldas: Municipio Samana, corregimiento San Diego, vda Risaralda	5° 39' 12.41" N	74° 56' 50.16" W	Simmons *et al.* (2002)
Colombia	Caquetá: Río Mesay, PNN Chiribiquete, Puerto Abeja	0° 4' 27" N	72° 27' 5" W	IAvH 7155*
Colombia	Cauca: El Tambo, PNN Munchique, Sector El Cóndor	2° 43' 2.99" N	76° 56' 52.01" W	MHNUC 814*
Colombia	Cauca: Río Saijá	2° 55' 36.52" N	77° 33' 52.97" W	Simmons *et al.* (2002)
Colombia	Cesar: La Gloria	8° 35' 24.55" N	73° 34' 19.83" W	ICN 24461
Colombia	Chocó: Quibdó, Icho	5° 47' 34.69" N	76° 37' 37.72" W	CTUA 734*
Colombia	Córdoba: Pueblo Nuevo, Had. La Vaqueta	8° 24' 5" N	75° 22' 50" W	ICN 17236*
Colombia	Guajira: Maicao, Serranía del Perijá Carraipía, Pozo San Jonás	11° 15' 24.12" N	72° 21' 39.01" W	ICN 19413*
Colombia	Guaviare: San José del Guaviare	2° 31' 31.87" N	72° 48' 26.89" W	ICN 23867*
Colombia	Magdalena: Bonda	11° 14' 1.32" N	74° 7' 29.63" W	Simmons *et al.* (2002)
Colombia	Meta: Cubarral, Vda. El Vergel Alto	3° 48' 28.30" N	73° 52' 51.97" W	ICN 14393*
Colombia	Meta: Mapiripan	2° 58' 43.06" N	71° 55' 0.11" W	ICN 24463*
Colombia	Santander: Puerto Parra	6° 36' 36.82" N	74° 5' 4.52" W	ICN-**T**-D3M541*
Colombia	Valle del Cauca: Buenaventura, Punta Ají, Río Naya	3° 14' 3.72" N	77° 32' 14.21" W	UV 11497*
Colombia	Valle del Cauca: Yotoco,Reserva Natural Bosque de Yotoco	3° 49' 60" N	76° 19' 59.99" W	ICN 22829*
Ecuador	Esmeraldas: E San Lorenzo (toward Lita), Finca San José	1° 15' 54.50" N	78° 47' 5.31" W	Porter *et al.* (2007)
Ecuador	Esmeraldas: San Lorenzo, La Chiquita Experimental Station	1° 14' 35.19" N	78° 50' 59.1" W	Porter *et al.* (2007)
Ecuador	Esmeraldas: Mataje, Navy Base.	1° 20' 45.6" N	78° 43' 0.09" W	Porter *et al.* (2007)
Ecuador	Pastaza: Arajuno, Villano A	1° 29' 50.80" S	77° 32' 13.71" W	QCAZ 15478*
Ecuador	Sucumbíos: Hotería Montetour	0° 1' 39.33" N	76° 40' 11.81" W	QCAZ 6943*
Ecuador	Napo: Tena, Jatunsacha Reserva	1° 1' 59.71" S	77° 39' 37.10" W	QCAZ 210*
Ecuador	Esmeraldas: San Lorenzo, Estación La Chiquita	1° 13' 59.99" N	78° 45' 36" W	QCAZ 9125*
Ecuador	Esmeraldas: San Lorenzo, Mataje, Base Naval	1° 12' 43.70" N	78° 25' 57.82" W	QCAZ 9124*
Guyana Francesa	Paracou: near Sinnamary	5° 16' 31.08" N	52° 55' 24.96" W	Simmons and Voss (1998)
Panamá	Veraguas: Cerro Hoya, Rio Portobelo	7° 14' 28.38" N	80° 36' 43.13" W	Porter *et al.* (2007)
Perú	Perú: Pasco, Oxapampa, San Juan	9° 53' 3.76" S	75° 10' 38.40" W	Simmons (2002)
Perú	Perú: Madre de Dios, left bank Rıo Palotoa	12° 28' 36.17" S	71° 47' 47.62" W	Simmons (2002)
Trinidad y Tobago	Trinidad: County St. George	10° 38' 49.2" N	61° 15' 13.47" W	Porter *et al.* (2007)
Trinidad y Tobago	Trinidad: County Mayaro	10° 16' 49.22" N	61° 1' 46.81" W	Porter *et al.* (2007)

THERYA NOTES 2021, Vol. 2 : 65-72 DOI: 10.12933/therya_notes-21-37 ISSN 2954-3614

Current distribution of the Mexican hairy dwarf porcupine, *Sphiggurus mexicanus*, in Guerrero, México

Distribución actual del puercoespín enano peludo mexicano, *Sphiggurus mexicanus* en Guerrero, México

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The Mexican hairy dwarf porcupine, *Sphiggurus mexicanus*, is listed as threatened in the Mexican regulations. It has previously been recorded in three terrestrial ecoregions of the State of Guerrero. However, there are still several regions with no information on this species. The objective of this note is to provide a detailed account of the current distribution of *S. mexicanus* in the State of Guerrero and fill the information gaps on its occurrence information for the poorly studied regions. We searched for reports of *S. mexicanus* in electronic repositories such as Enciclovida, Naturalista, and Global Biodiversity Information Facility, as well as in scientific literature for the State of Guerrero. In addition, we created an updated database that includes recent and unpublished observations, both direct and indirect (skin, bone remains, excreta, barrows, run-over, and hunted specimens). We found a total of 59 records of *S. mexicanus*, of which 24 % are accounts from the literature and electronic repositories collected over the past 60 years. Within our database, 45 records correspond to 16 municipalities in Guerrero that comprise three ecoregions, of which Sierra Madre del Sur has the largest number ($n = 26$) of records. All sightings occurred between 7 and 2,400 m, and 58 % ($n = 26$) of records were either direct sightings or evidence of indirect observations over the past two decades (years 2000–2020). Our new records provide the most comprehensive data set on the distribution of *S. mexicanus* in 11 municipalities with no previous records. We confirmed its presence in a total of 19 municipalities in the State of Guerrero. Most of our records come from temperate forests and dry tropical forests; however, there were occasional sightings on farmland. Our observations mostly corroborated that *S. mexicanus* depends on high plant coverage as it was commonly found in forest habitats. Moreover, based on the results obtained from indirect observations of deceased individuals or their remains, the two major threats to populations of *S. mexicanus* in Guerrero appear to be hunting and running-over (resulting in road death).

Key words: Habitat; mammal; observations; rodent; southwestern México; use of tree species.

El puercoespín enano peludo mexicano *Sphiggurus mexicanus* está catalogado como amenazado por la ley mexicana y ha sido registrado previamente en el estado de Guerrero en tres ecorregiones terrestres. Sin embargo, todavía hay varias regiones sin información sobre esta especie. El objetivo de esta nota es proporcionar una descripción detallada de la distribución actual de *S. mexicanus* en el estado de Guerrero y llenar los vacíos de información de ocurrencia para las regiones poco estudiadas. Buscamos ocurrencias de *S. mexicanus* en repositorios electrónicos como Enciclovida, Naturalista y Global Biodiversity Information Facility, y en la literatura científica publicada para el estado de Guerrero. Adicionalmente, creamos una base de datos actualizada que incluye observaciones recientes e inéditas, tanto directas como indirectas (piel, restos óseos, excretas, púas, atropellados y cazados). Recolectamos un total de 59 registros de *S. mexicanus*, de los cuales el 24 % son ocurrencias extraídas de la literatura y los repositorios electrónicos recogidos en los últimos 60 años. Dentro de nuestra base de datos, 45 registros corresponden a 16 municipios de Guerrero; distribuidos en tres ecorregiones, la Sierra Madre del Sur tiene el mayor número ($n = 26$) de registros. Todos los avistamientos ocurrieron entre altitudes de 7 y 2,400 m y el 58 % ($n = 26$) de los registros corresponden a observaciones directas y evidencias de observaciones indirectas de las últimas dos décadas (2000 – 2020). Nuestros nuevos registros proporcionan el conjunto de datos más completo de la distribución de *S. mexicanus* en 11 municipios sin registros previos. Confirmamos su presencia en un total de 19 municipios del estado de Guerrero. La mayoría de nuestros registros provienen de bosques templados y selvas tropicales secas; sin embargo, hubo avistamientos ocasionales en tierras de cultivo. Nuestras observaciones corroboraron en su mayoría la dependencia de la especie de una alta cobertura vegetal, ya que fue encontrada comúnmente en hábitats arbóreos. Además, con base en los resultados obtenidos de las observaciones indirectas de individuos fallecidos y/o sus restos, las dos mayores amenazas para las poblaciones de *S. mexicanus* en Guerrero parecen ser la cacería y los atropellamientos (que resultan en muerte en carretera).

Palabras clave: Hábitat; mamífero; observaciones; roedor; suroeste de México; uso de especies arbóreas.

The tropical porcupine *Sphiggurus mexicanus* is a medium-sized rodent with a robust body covered mostly by spines and a long tail and prehensile (Juárez-G. 2005; Aranda 2012). It is an arboreal, solitary, and nocturnal species (Aranda 2012) that can have a home range of approximately 10 hectares (Wainwright 2002). In particular, *S. mexicanus* is classified as threatened based on the Mexican legislation (SEMARNAT 2010) and as a minor concern at the international level (Vázquez *et al.* 2016).

In México, *Sphiggurus mexicanus* is distributed along the two coastal (Gulf and Pacific) slopes, from San Luis Potosí to the Yucatán peninsula and from Michoacán to Chiapas (Juárez-G. 2005), and along the Sierra Madre Oriental (Ramírez-Bravo 2012; Lira-Torres *et al.* 2014). It has been recorded in various types of vegetation, including coastal dunes (Briones-Salas and Sánchez-Cordero 2004), evergreen and sub-evergreen (Juárez-G. 2005; Lira-Torres *et al.* 2005; Mejenes-López *et al.* 2010; Lira-Torres *et al.* 2014), subtropical and deciduous tropical forests (Briones-Salas and Sánchez-Cordero 2004; Juárez-G. 2005; Lira-Torres *et al.* 2005; Ramírez-Bravo 2012; Lira-Torres *et al.* 2014; Lorenzo *et al.* 2014), temperate forests (Monterrubio-Rico *et al.* 2010; Lira-Torres *et al.* 2014), and mountain cloud forests (Juárez-G. 2005; Lira-Torres *et al.* 2014; Cisneros-Palacios *et al.* 2015). In addition, it thrives in areas with a certain degree of disturbance (Riechers-Pérez 2004; Faller-Menéndez *et al.* 2005; Lira-Torres *et al.* 2005; Lira-Torres 2006; Barragán *et al.* 2010; Cisneros-Palacios *et al.* 2015; Galindo-Aguilar and Lavariega 2019), in an altitudinal range from sea level to 3,200 m (Juárez-G. 2005).

In Guerrero, there are historical records of the presence of *S. mexicanus* in the municipalities of Acapulco de Juárez, Atoyac de Álvarez, Chilpancingo de los Bravo, Juan R. Escudero, Leonardo Bravo, Ometepec, Petatlán, and Zirándaro, located in the terrestrial ecoregions (TE; INEGI-CONABIO-INE 2008): Balsas Depression (BD); Sierra Madre del Sur (SMS); and Planicie Costera y Lomeríos del Pacífico Sur (South Pacific Coastal Plains and Hills; SPCPH), which span across an altitudinal range between 11 and 2,216 m (Leopold 1959; Hall 1981; Lozano-Guzmán 1983; Sánchez-Hernández and Gaviño de la Torre 1988; León-Paniagua and Romo-Vázquez 1991; Jiménez-Almaraz *et al.* 1993; Almazán-Núñez *et al.* 2011; Marín *et al.* 2016; Espinosa-Martínez *et al.* 2017; Almazán-Núñez *et al.* 2018; Zavala- Sánchez *et al.* 2018; Ruiz-Gutiérrez *et al.* 2020). In Guerrero, the records correspond to low deciduous forest, oak, pine-oak and mountain cloud forests (Leopold 1959; Lozano-Guzmán 1983; Sánchez-Hernández and Gaviño de la Torre 1988; León-Paniagua and Romo-Vázquez 1991; Jiménez-Almaraz *et al.* 1993; Almazán-Núñez *et al.* 2011; Marín *et al.* 2016; Almazán-Núñez *et al.* 2018; Zavala- Sánchez *et al.* 2018).

Although there are records of *S. mexicanus* in Guerrero, the information on its distribution is incomplete since there are large areas considered within its potential distribution range, but where its presence has not been reported. As a result, its distribution area may be either over- or underestimated. The main objective of this study is to collect and expand the knowledge of the current distribution of *S. mexicanus* in the State of Guerrero, generating new information for the regions lacking data and determining its current distribution more accurately.

Study Area. The State of Guerrero is located in southwest México between coordinates 16° 42′ 16.21″, 18° 46′ 56.73″ N and 98° 00′ 40.59″, 102° 10′ 40.20″ W. Its territory is part of four terrestrial ecoregions (TE): Trans-Mexican Volcanic Belt (TMVB), Balsas Depression (BD), Sierra Madre del Sur (SMS), and *Planicie Costera y Lomeríos del Pacífico Sur* (South Pacific Coastal Plains and Hills; SPCPH; INEGI-CONABIO-INE 2008). The State of Guerrero has an elevation range from sea level to 3,550 m. The vegetation types include mountain cloud forest, pine, pine-oak and oak-pine forests, low deciduous tropical forest, medium subdeciduous tropical forest, mangrove forest, and thorny scrubland, as well as secondary vegetation, induced pastures, and crop areas (INEGI 2010).

For the collection of records, reports of *S. mexicanus* occurrence were searched in electronic repositories that included Enciclovida (CONABIO 2019), Naturalista (Naturalista 2019), and Global Biodiversity Information Facility (GBIF 2019). From the reports obtained, those lacking coordinates, poorly georeferenced, or not matching the study area were excluded. Likewise, we conducted a comprehensive scholar Google search of published scientific literature for the State of Guerrero using the keywords: *mamíferos de Guerrero*, mammals of Guerrero, *puerco espín tropical* (tropical porcupine), *puerco espín* (porcupine), porcupine, *Coendou mexicanus*, *Sphiggurus mexicanus*.

In addition, new records of secondary sightings were obtained while carrying out activities related to several research projects on terrestrial vertebrates by the authors. These data were collected through direct sightings of live individuals and indirect observations of specimen signs (skin, bone remains, excreta, spines) and specimens killed by different factors (*e.g.*, run over or hunted by humans and domestic dogs; Figure 1). All historical and recent records were entered in a georeferenced database.

We obtained a total of 59 records of *S. mexicanus*, of which 19 % (n = 11) proceeded from the scientific literature published between 1959 and 2020; 5 % (n = 3) are data from electronic repositories collected between 1904 and 2019, and 76 % (n = 45) corresponds to field sampling over the past two decades (Figure 2; Table 1).

The highest percentage (58 %) of records (n = 26) of *S. mexicanus* corresponded to live organisms observed in the field and 42 % (n = 19) to dead organisms, of which 24 % (n = 11) pertained to run-over and hunted animals (Table 1). The reports of the presence of this species were expanded to 19 municipalities, 3 ecoregions, and 6 vegetation types (Table 1; Figure 2). Among the records of live organisms, the highest percentage (31 %) occurred in low deciduous forests (Table 1). Observations of live organisms were associated with trees of the genera *Annona, Cecropia, Curatella, Enterolobium, Ficus, Gliricidia, Inga, Mangifera*,

Figure 1. Photographic evidence of direct and indirect observations of *Sphiggurus mexicanus* in 10 municipalities of Guerrero, México. a) to g) correspond to live organisms, h) to o) correspond to remains of organisms. Individuals with daytime activity observed in tree habitats, associated with humid and tropical forests (a–e). Individuals with nocturnal activity observed below the canopy in a pine forest (f) and associated with human buildings (g). Remains *of S. mexicanus*, spines in the snout of a domestic dog when attacking a porcupine (h); spines, hairs, and skulls of specimens apparently killed by a wild predator (i–k). Specimen as a hunting trophy (l). Specimens ran over in a highway (m) and dirt roads (n–o). © Copyright: b) Concepción Ojeda; e) Contreras Javier; h) Salmerón-Barrera; l) Poblete López.

and *Pithecellobium*, of which *Ficus* and *Mangifera* were most common. Porcupines were recorded in daytime (08:00–18:00 hr), twilight (06:00– 8:00 hr; 18:00–0:00 hr), and nighttime (20:00–06:00 hr) hours, being more common nighttime hours (20:30, 21:00, 22:00, 22:40, 23:00 hr).

There is a lack of studies on wild mammals for the State of Guerrero, particularly for areas that are difficult to access due to topographic, political, and social issues, resulting in poor knowledge of the species and large information gaps about the actual distribution of the species (Almazán-Cata-

Table 1. Database of the new records of *Sphiggurus mexicanus* in Guerrero, México. The numeral corresponds to the record in Figure 2. Ecoregion: BD = Balsas Depression; SMS = Sierra Madre del Sur; SPCPH = *Planicie Costera y Lomeríos del Pacífico Sur* (South Pacific Coastal Plain and Hills). Vegetation: LDTF = Low deciduous tropical forest; C = crops; MSETF = Medium sub-evergreen tropical forest; PF = Pine forest; MCF = Mountain Cloud Forest; OPF = Oak-Pine forest; OF = Oak forest. Type of record: a = sighting; b = hunted; c = bone remains, skin, spines, excreta; d = run over.

No.	Latitude	Longitude	Municipality	Altitude (m)	Ecoregion	Vegetation	Record type	Activity (hr)	General observations
1	18°02′56.23″N	99°45′25.86″W	Cocula	538	BD	C	Direct [a]	07:00	Individual crossing a crop heading toward natural vegetation (LDTF).
2	18°03′20.57″N	101°44′14.69″W	La Unión	137	BD	LDTF	Direct [a]	23:00	Individual climbing the middle part of a *parota* tree (*Enterolobium cyclocarpum*).
3	17°44′33.60″N	99°17′54.50″W	Mártir de Cuilapan	1,261	SMS	LDTF	Direct [a]	15:30	Sheltered inside a crack immersed in the ravine.
4	17°40′10.30″N	99°18′33.10″W	Mártir de Cuilapan	1,492	SMS	LDTF	Direct [a]	08:17	Feeding on a *Ficus* tree.
5	17°40′17.33″N	99°52′10.09″W	Leonardo Bravo	2,400	SMS	OPF	Indirect [d]	------	----------
6	17°40′04.70″N	99°56′37.50″W	Leonardo Bravo	1,384	SMS	C	Indirect [c]	------	----------
7	17°33′56.55″N	99°23′13.91″W	Tixtla de Guerrero	1,344	BD	C	Direct [a]	------	During hurricanes Ingrid and Manuel, the porcupine seek shelter in a villagers' house; it was released afterward.
8	17°33′27.64″N	99°23′00.37″W	Tixtla de Guerrero	1,362	SMS	LDTF	Indirect [c]	------	----------
9	17°33′58.20″N	99°34′03.96″W	Chilpancingo de los Bravo	1,525	SMS	C	Direct [a]	------	Climbing a shrub; it possibly used it as shelter upon feeling threatened by the presence of people.
10	17°31′46.25″N	99°27′48.84″W	Chilpancingo de los Bravo	1,497	BD	OF	Indirect [c]	------	----------
11	17°29′16.26″N	99°27′14.92″W	Chilpancingo de los Bravo	1,177	BD	LDTF	Direct [a]	13:00	On a tree of the genus *Pithecellobium*; the porcupine was attacked by children from the community.
12	17°29′07.98″N	99°27′56.25″W	Chilpancingo de los Bravo	1,151	BD	C	Indirect [b]	------	Porcupine attacked by dogs; it died from the severity of the injuries.
13	17°29′01.53″N	99°25′23.58″W	Chilpancingo de los Bravo	1,050	SMS	LDTF	Indirect [d]	------	Local inhabitants comment that porcupines are misidentified for tlacuaches by their naked tail.
14	17°28′37.40″N	99°26′26.30″W	Chilpancingo de los Bravo	1,365	SMS	LDTF	Indirect [c]	------	----------
15	17°31′30.36″N	100°40′27.48″W	Técpan de Galeana	849	SMS	OF	Direct [a]	22:00	Inside the forest, two individuals were observed on the canopy.
16	17°30′29.00″N	100°41′46.00″W	Técpan de Galeana	681	SMS	OPF	Direct [a]	20:30	Inside the forest, an individual was observed sniffing the soil.
17	17°30′17.64″N	100°42′32.16″W	Técpan de Galeana	736	SMS	OPF	Direct [a]	22:00	Two organisms were observed on the canopy.
18	17°28′33.33″N	100°45′44.78″W	Técpan de Galeana	1,270	SMS	MCF	Direct [a]	------	An individual was observed in a mountain cloud forest.
19	17°28′30.00″N	100°45′04.45″W	Técpan de Galeana	1,336	SMS	MCF	Direct [a]	------	On a *Cecropia obtusifolia* tree.
20	17°26′53.24″N	100°13′01.34″W	Atoyac de Álvarez	1,443	SMS	MCF	Direct [a]	21:00	On a *Ficus* tree.
21	17°25′27.36″N	100°10′55.62″W	Atoyac de Álvarez	1,670	SMS	MCF	Direct [a]	08:00	On an *Inga vera* tree.
22	17°21′37.14″N	99°28′03.22″W	Chilpancingo de los Bravo	829	SMS	C	Indirect [d]	------	----------
23	17°21′09.48″N	99°27′03.11″W	Mochitlán	745	SMS	OF	Direct [a]	20:00	Climbing a large (unidentified) tree in a ravine.
24	17°19′33.55″N	99°34′12.98″W	Chilpancingo de los Bravo	651	SMS	PF	Direct [a]	22:40	Feeding on a *Mangifera* tree.
25	17°16′54.93″N	99°28′30.08″W	Chilpancingo de los Bravo	927	SMS	OPF	Direct [a]	20:30	Climbing a rock wall covered by *Ficus petiolaris* roots.
26	17°13′24.14″N	98°38′01.68″W	Malinaltepec	2,216	SMS	OPF	Direct [a]	------	Individual captured in a sawmill, then released into natural vegetation near the locality.
27	17°17′42.34″N	100°13′27.40″W	Atoyac de Álvarez	1,178	SMS	MCF	Indirect [c]	------	----------
28	17°16′15.75″N	99°57′41.74″W	Chilpancingo de los Bravo	1,070	SMS	OPF	Indirect [c]	------	----------
29	17°15′06.63″N	100°19′28.13″W	Atoyac de Álvarez	742	SPCPH	OPF	Direct [a]	10:00	On the branches of an unidentified tree.

Table 1. Continuation...

No.	Latitude	Longitude	Municipality	Altitude (m)	Ecoregion	Vegetation	Record type	Activity (hr)	General observations
30	17°07'05.88"N	99°44'12.48"W	Acapulco de Juárez	643	SPCPH	PF	Direct [a]	------	On a *Curatella americana* tree.
31	17°06'11.52"N	99°19'50.90"W	Juan R. Escudero	542	SMS	OF	Indirect [c]	------	----------
32	17°04'26.21"N	99°41'39.76"W	Acapulco de Juárez	664	SPCPH	PF	Direct [a]	13:00	On an *Annona squamosa* tree.
33	17°04'22.51"N	99°41'35.68"W	Acapulco de Juárez	644	SPCPH	PF	Indirect [b]	------	Porcupine sighted on the top of a tree and shot after being misidentified for a badger.
34	17°03'43.63"N	98°52'58.34"W	San Luis Acatlán	1,320	SMS	PF	Indirect [b]	------	----------
35	17°02'46.72"N	99°19'36.60"W	Tecoanapa	739	SMS	LDTF	Direct [a]	13:00	Resting on an oak tree.
36	17°02'56.54"N	98°50'53.74"W	San Luis Acatlán	1,280	SMS	OPF	Indirect [b]	------	----------
37	17°02'57.29"N	98°49'34.95"W	San Luis Acatlán	1,100	SMS	C	Indirect [b]	------	----------
38	17°01'43.06"N	98°51'06.14"W	San Luis Acatlán	1,005	SMS	PF	Indirect [b]	------	----------
39	17°00'47.32"N	98°40'13.44"W	Malinaltepec	971	SMS	OPF	Indirect [c]	------	----------
40	17°00'10.14"N	100°11'43.93"W	Coyuca de Benítez	15	SPCPH	C	Indirect [d]	------	----------
41	16°57'48.61"N	99°53'10.05"W	Acapulco de Juárez	225	SPCPH	LDTF	Direct [a]	------	Porcupine climbing a *Gliricidia sepium* tree; the villagers saw dogs injured by porcupine spines.
42	16°54'09.00"N	99°56'21.65"W	Acapulco de Juárez	279	SPCPH	LDTF	Direct [a]	------	Porcupine crossing a patch with scarce vegetation, heading into denser vegetation (LDTF).
43	16°53'32.21"N	99°53'49.33"W	Acapulco de Juárez	361	SPCPH	MSETF	Direct [a]	07:00	Porcupine sniffing the understory.
44	16°42'04.58"N	99°38'34.56"W	Acapulco de Juárez	7	SPCPH	C	Indirect [b]	------	----------
45	16°39'06.97"N	98°52'42.34"W	Copala	80	SPCPH	LDTF	Direct [a]	18:40	Individual sheltered in a *Mangifera* tree.

lán *et al.* 2005; Espinosa-Martínez *et al.* 2017). Mammals have been studied in the State of Guerrero for almost 148 years (Espinosa-Martínez *et al.* 2017) and only 10 papers have been published that provide indirect information on *S. mexicanus,* which underlines the scarcity of information for some species (Leopold 1959; Lozano-Guzmán 1983; Sánchez-Hernández and Gaviño de la Torre 1988; León-Paniagua and Romo-Vázquez 1991; Jiménez-Almaraz *et al.* 1993; Almazán-Núñez *et al.* 2011; Marín *et al.* 2016; Almazán-Núñez *et al.* 2018; Zavala- Sánchez *et al.* 2018; Ruiz-Gutiérrez *et al.* 2020). This analysis gathers and expands for the first time the knowledge of the current distribution of *S. mexicanus* in the State of Guerrero.

Forty-six percent (n = 21) of our records add 11 municipalities to the distribution of *S. mexicanus*, where no previous records had been documented (Cocula, Copala, Coyuca de Benítez, La Unión, Malinaltepec, Mártir de Cuilapan, Mochitlán, San Luis Acatlán, Tecoanapa, Técpan de Galeana, and Tixtla de Guerrero). The updated database generated in this paper confirms the presence of the species in 19 municipalities in the State of Guerrero. In addition, the knowledge of the distribution of the species for the Balsas Depression is enriched with six additional records; to note, only a single record for this ecoregion had been reported 37 years ago, between the borders of Guerrero and Michoacán (Lozano-Guzmán 1983).

In the past 15 years, two proposals have been generated that predict the potential distribution of *S. mexicanus* in México and Central America (Ceballos *et al.* 2006; Lavariega and Briones-Salas 2019); however, 27 % (n = 12) of the records reported here do not match the distribution projections referred, as they are outside the proposed areas. The spatial distribution of living organisms is known to be dynamic and experiences contractions and expansions over time (Maciel-Mata *et al.* 2015), so we can expect to find records outside the known or potential distribution of the species. It is necessary to incorporate all records from this study to improve predictive distribution models; also, more georeferenced records are needed to assess habitat suitability and frequency of records in different regions.

Recent studies describe the distribution of *S. mexicanus* at state and national levels (*e.g.*, Monterrubio-Rico *et al.* 2010; Ramírez-Bravo 2012; Lira-Torres *et al.* 2014; Lorenzo *et al.* 2014; Cisneros-Palacios *et al.* 2015). However, there are still several states that lack an accurate diagnosis indicating the relationship between distribution and environmental parameters. The proportion of records of live organisms reported here ranges between 43 % and 72 %; this can be considered an indirect measure of the status of possibly stable populations. We recorded a total of nine genera of tree species (*Annona, Cecropia, Curatella, Enterolobium, Ficus, Gliricidia, Inga, Mangifera, Pithecellobium*) used by porcupines, which is consistent with the literature (Monterrubio-Rico *et al.* 2010; Lorenzo *et al.* 2014), except for the genera *Curatella* and *Gliricidia*, which had not been reported.

The records of direct observations of *S. mexicanus* in this work are located at an average distance of 37 km from records of observations reported historically (Figure 2),

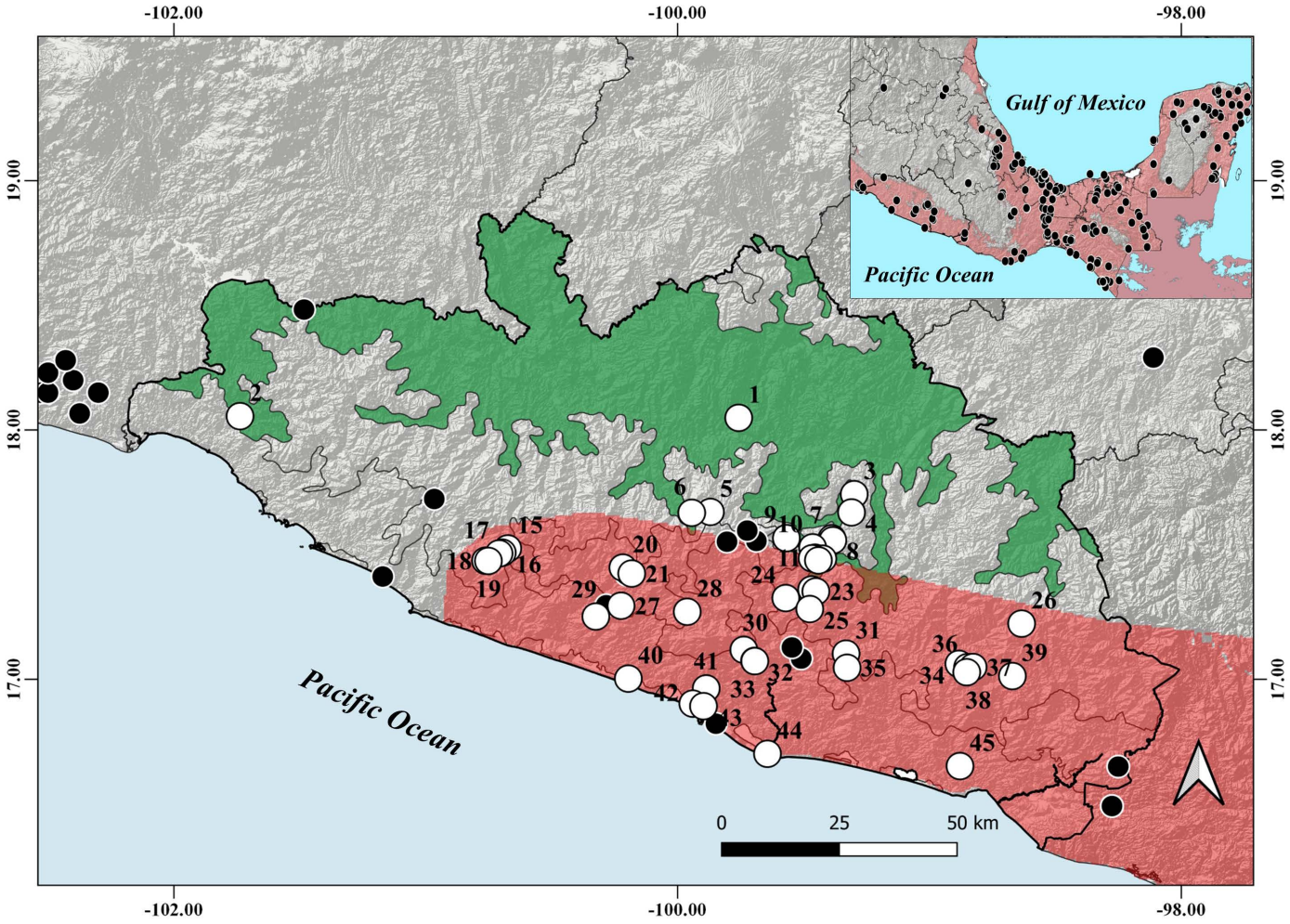

Figure 2. Map of the distribution of records of *Sphiggurus mexicanus* in Guerrero, México. The area marked in red is the potential distribution proposed by Ceballos *et al.* (2006) and Lavariega and Briones-Salas (2019). The area marked in green corresponds to the Balsas Depression terrestrial ecoregion. White circles mark the records in this study; black circles are historical records from the scientific literature and electronic repositories.

indicating the expansion of the distribution of the species to the Balsas Depression terrestrial ecoregion in Guerrero. This information can be used in the development of new research aiming to provide information on its biology and ecology for management and conservation purposes. Our results show hunting and roadkills as causes of mortality of *S. mexicanus* in Guerrero; on 11 occasions, the records corresponded to affected individuals.

Sixty-seven percent (n = 30) of the records obtained are located in temperate forests (n = 19) and dry forests (n = 11). As *Sphiggurus mexicanus* is a species of arboreal habits (Juárez-G. 2005; Monterrubio-Rico *et al.* 2010), it depends on forests (Lorenzo *et al.* 2014), which is confirmed by most of our observations of porcupines performing activities on the canopy. The nine records located in crops support the assumption that porcupines can take advantage of crops when seeds, fruits, and buds are available, and these may be occasional records, as stated by Lorenzo *et al.* (2014).

This paper highlights the importance of continuing conducting scientific surveys in the state, particularly in areas that have been poorly explored. In addition, local communities should be encouraged to develop a responsible coexistence with nature, protecting forests through the certification by the National Commission on Natural Protected Areas (CONANP), which decrees Areas Purposely Dedicated to Conservation.

Acknowledgements

We thank all the people who provided assistance in data collection, especially the members of Bio-Explora Guerrero. The first author thanks E. A. Alvarez-Alvarez, P. Sierra-Morales, and M. Brito-Millan for their valuable comments that improved the manuscript. We also thank the reviewers for their comments and recommendations that helped improve this work. M. E. Sánchez-Salazar translated the manuscript into English.

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Associated editor: Romeo A. Saldaña-Vázquez
Submitted: February 17, 2020; Reviewed: February 13, 2021.
Accepted: May 2, 2021; Published on line: May 31, 2021.

THERYA NOTES 2021, Vol. 2 : 73-78 DOI: 10.12933/therya_notes-21-38 ISSN 2954-3614

First record of collared peccary (*Pecari tajacu*) in the southern part of the Mexican Altiplano

Primer registro de pecarí de collar (*Pecari tajacu*) en el sur del Altiplano Mexicano

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The collared peccary (*Pecari tajacu*) is found from northern Argentina to the southern United States. In México it is widely distributed in different habitats, mainly in tropical areas. In the southern portion of the Mexican Altiplano its historic distribution is unclear, and it has been considered extirpated due to the overexploitation of its populations and the development of agriculture. We report the first record of collared peccary for the Llanos de Ojuelos, obtained with a trail camera placed in xeroriparian habitat. This finding confirms the reports of inhabitants about the presence of peccary in the region, approximately 20 km north of the record reported here. There are two recent records of the species in the municipalities of Pinos, Zacatecas and Corral de Palmas, San Luis Potosí, about 60 km from ours, and based on that, the three records and verbal information from peasants appear to refer to different herds. The site of the record reported here is a wash with dense cover by trees and shrubs, surrounded by grassland and xeric scrubland with abundant nopales that provide the peccaries with food and water. The presence of the peccary and other mammals, like puma and deer, in Los Llanos de Ojuelos can be used to implement awareness campaigns among the inhabitants to promote the conservation of the natural resources of the region.

Key words: Conservation; Llanos de Ojuelos; puma; xerophilous scrub; xeroriparian habitat.

El pecarí de collar (*Pecari tajacu*) se encuentra desde el norte de Argentina hasta el sur de Estados Unidos. En México se distribuye ampliamente en diferentes hábitats, principalmente en zonas tropicales. En la porción sur del Altiplano Mexicano su distribución histórica es poco clara y se le ha llegado a considerar extirpado por la sobreexplotación de sus poblaciones y el desarrollo de agricultura. Reportamos el primer registro de pecarí de collar para los Llanos de Ojuelos, obtenido mediante una cámara trampa colocada en hábitat xeroribereño. Este hallazgo confirma los informes de campesinos sobre la presencia de pecarí en la región, unos 20 km al norte del registro aquí reportado. Dos registros recientes de la especie en los municipios de Pinos, Zacatecas y Corral de Palmas, San Luis Potosí, distan aproximadamente 60 km del nuestro, por lo que serían de manadas diferentes. El sitio de donde proviene el registro aquí presentado es el cauce de un arroyo con cobertura densa de árboles y arbustos, rodeado de pastizal y matorral xerófilo con abundantes nopales que proveen alimento y agua a los pecaríes. La presencia del pecarí y otros mamíferos grandes, como el puma y el venado, en Los Llanos de Ojuelos puede aprovecharse para realizar campañas de sensibilización entre los habitantes para conservar los recursos naturales de la región.

Palabras clave: Conservación; hábitat xeroribereño; Llanos de Ojuelos; matorral xerófilo; puma.

The collared peccary, *Pecari tajacu*, is found from northern Argentina to the southern United States (Sowls 2013). In México, it is widely distributed, and has its most numerous populations in the tropical areas of the Gulf and Pacific slopes (Hall 1981). The tropical deciduous forest is one of the best habitats for the species, but it is found also in rain forests, pine-oak forests, and temperate forests in southern México and in the Highlands (Leopold 1959). In arid and semiarid ecosystems, it has been reported in xerophytic thorn forest, grassland, and xerophytic scrub vegetation (March and Mandujano 2005; Sowls 2013) where plants of the genus *Opuntia* are abundant (Schmidly 2004), and in riparian habitats (Albert *et al.* 2004).

The presence of the collared peccary in the southern part of the Mexican Altiplano, specifically in the Llanos de Ojuelos region, has historically been unclear and discordant among authors. It has been said that the species is distributed throughout the state of San Luis Potosí and northern Zacatecas, but not in northeastern Jalisco and northern Aguascalientes and Zacatecas (Hall 1981; March and Mandujano 2005; Reyna-Hurtado *et al.* 2019). In contrast, Leopold (1959) included the region omitted by the above-cited authors in the distribution of the species but excluded most of western San Luis Potosí. On the other hand, the International Union for the Conservation of Nature excludes the entire Mexican Altiplano from the

distribution of the species (Góngora *et al.* 2011). The potential distribution of the collared peccary in México, modeled through a GARP algorithm, includes almost the entire Mexican Altiplano (Ceballos *et al.* 2006). Although this must be considered carefully because this map includes also as potential habitat large areas of the Baja California peninsula, where it is firmly established that the species has never occurred naturally. Recent studies (Riojas-López and Mellink 2019; Riojas-López *et al.* 2019) stressed that in the region of Los Llanos de Ojuelos in the Mexican Altiplano, there is little information on most of the biological groups. This gap in the knowledge of biodiversity in general, and of the mammalian fauna in particular, contributes to the ambiguity about the distribution of the collared peccary, and obscures knowledge of the historical presence of the species in the region covered here.

In México, the collared peccary was overhunted in the mid-20th Century, leading to its extirpation from the center of the country (Leopold 1959). In the San Luis Potosí part of the Mexican Altiplano, collared peccary meat was not of great esteem and was consumed less than in the tropical areas of the same state, but they were hunted because of the fine quality and high price of their hides (Dalquest 1953). In the 1980s, hides from collared peccary were still considered of superior quality for the making of gloves (R. García-Maldonado, pers. comm.). In some areas of the southern Mexican Altiplano, including San Bartolo de Berrio, Guanajuato and Pinos, Zacatecas, the species was extirpated, or almost extirpated, during the 20th Century as a result of its hunting, in the first place, and by hunting combined with the expansion of agriculture, in the second (Matson and Baker 1986; Mellink *et al.* 1986).

Since 2016, as part of different research projects, the authors performed a monitoring program to document the presence of mammalian carnivores in xeroriparian systems in the Llanos de Ojuelos region. One of the techniques used to this end was the deployment of trail cameras. With these, we detected a herd of collared peccaries.

The record that we present here confirms the current presence of collared peccary in the Llanos de Ojuelos, for which there were no previous reports, and where there was disagreement between the distribution maps for the species in the country. It has been said that its presence in the southern Mexican Altiplano would be rather rare (Dalquest 1953; Leopold 1959; Hall 1981; Matson and Baker 1986), and the species was even considered as extirpated since the first half of the last century (Leopold 1959; Matson and Baker 1986; Mellink *et al.* 1986).

The region of the Llanos de Ojuelos is located in the southern part of the Mexican Altiplano, at the convergence of the states of Aguascalientes, Guanajuato, Jalisco, San Luis Potosí, and Zacatecas (Figure 1) between 1,800 and 2,500 m. It has a semi-arid climate with an annual rainfall between 400 and 700 mm, 80 % of which falls between June and September. The average annual temperature is 16-18 °C, with the minimum in January (-2 °C) and the maximum in May (32 °C). The dominant types of natural vegetation are semi-arid grassland, dominated by grasses of the genera *Bouteloua*, *Muhlenbergia*, and *Eragrostis,* xerophytic scrub of varied composition (*Vachellia* spp., *Mimosa* spp., *Opuntia streptacantha*, *O. lasiacantha*, *O. hyptiacantha*, and *O. leucotricha*) and dwarf oak forests (*Quercus* spp.; Riojas-López and Mellink 2005; Rzedowski 2006; Harker *et al.* 2008).

The grasslands and shrubs are embedded in a diffuse agricultural matrix (Riojas-López *et al.* 2011) and all of these habitats are used to a greater or lesser extent to graze sheep, cattle, and goats. Regional agriculture is dominated by rain-fed crops (beans, chili, wheat, and barley). The riparian systems of the region are temporary streams with surface water running during rainy season, but thanks to year-round underground currents they support a more or less exuberant tree layer composed of willows (*Salix* sp.), Peruvian pepper trees (*Schinus molle*), mesquite (*Prosopis* sp.) and, to a lesser extent, cottonwoods (*Populus* sp.). This physiognomy clearly differentiates riparian systems from adjacent habitats, composed of open xerophytic scrubs (*Opuntia* spp., *Vachellia* spp., *Mimosa* spp., among the most abundant shrubs) and / or short grasslands (the most abundant species belonging to the genera *Bouteloua*, *Muhlenbergia*, *Eragrostis,* and *Aristida*). In this diffuse matrix with patches of natural vegetation that characterizes the regional landscape, riparian systems could function as corridors between the different habitats that are most suited to larger mammals.

As part of a monitoring program of carnivorous mammals in xeroriparian systems of the Llanos de Ojuelos, since 2016 we installed trail cameras (Bushnell Trophy Cam HD Essential E2 12M) in a cattle ranch in Salitrillo de Chinampas, municipality of Ojuelos de Jalisco, in the state of Jalisco. The monitoring included three cameras separated from each other approximately 400 m, covering the entire length of the stream (1.3 km), placed in sections where vegetation is dense and has superficial water for at least 6 months of the year. These cameras have been working uninterrupted ever since. The vegetation along the stream is made up of an arboreal layer dominated by willows and Peruvian pepper trees, and a dense community of tall shrubs (2 m tall on average), of the genera *Ageratina*, *Montanoa*, *Baccharis* and *Senecio*. In the dry season, the creek bed remains humid due to the shadowing by dense canopy and the presence of a spring, while in the rainy season small pools of 10 to 20 cm deep are formed along it. The adjacent habitat on the west side of the xeroriparian system is a rangeland where a community of grasses (*Bouteloua* spp., *Aristida* spp. and *Eragrostis* spp.) intermingles with huizaches (*Vachellia* spp.). The east side of the creek is covered by a xerophytic shrubland, which includes a dense strip of arborescent nopales (*Opuntia* spp.). The xeroriparian system and adjacent habitats are used for the raising of fighting-bull cattle.

To document the historical and current distribution of the collared peccary in the southern Mexican Altiplano

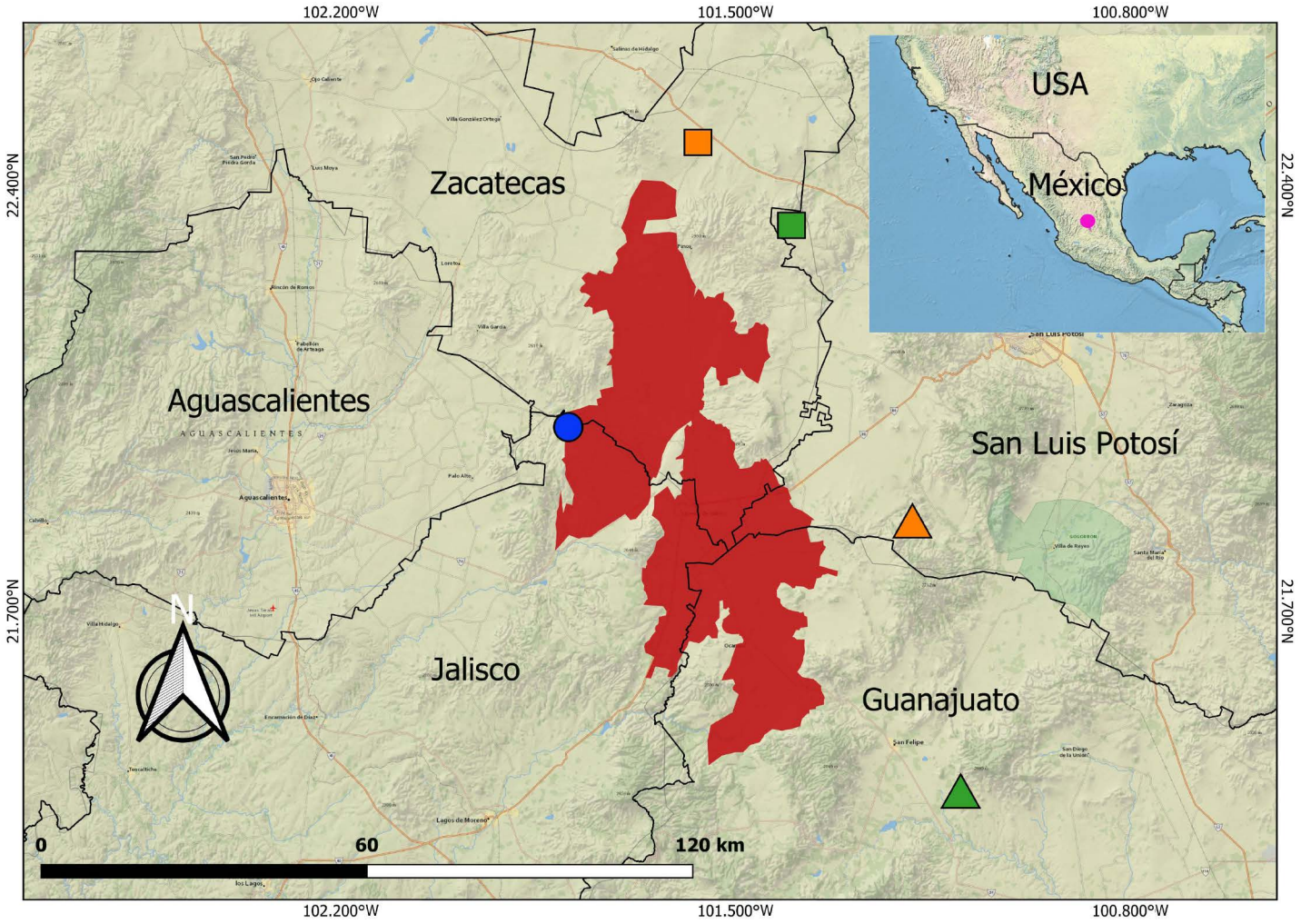

Figure 1. The Llanos de Ojuelos (red polygon) and location of the record of collared peccary (*Pecari tajacu*) in Salitrillo de Chinampas, Ojuelos de Jalisco, Jalisco (blue circle). Recent records from Naturalista (2018a; Pinos, Zacatecas, orange square) and Naturalista (2018b; Corral de Palmas, San Luis Potosí, green square). Historical records from Dalquest (1953; Bledos, San Luis Potosí, orange triangle) and Leopold (1947; San Bartolo de Berrios, green triangle).

and in México, we reviewed the published literature and searched for records in the databases of the Global Biodiversity Information Facility (GBIF 2020) and the Naturalista (2020) digital platform of citizen science. In addition, during our field trips to the region, for four years we have been given verbal reports of collared peccary sightings from the inhabitants.

Our record of collared peccary is the first to confirm the current presence of this species in the Llanos de Ojuelos region. For approximately four years, we had been informed by different peasants of the presence of "peccaries", in the northern part of the sierra that runs between La Montesa and La Laborcilla, Zacatecas. However, we were uncertain that they were collared peccaries, as they could have been feral pigs or European wild boars (*sensu* Secretaría General de Gobierno del estado de Aguascalientes, SEGGOB 2020). On September 12, 2020 at 03:20 a.m. we recorded four adult individuals of collared peccary (Figure 2) through a trail camera, 3.8 km west of Salitrillo de Chinampas, municipality of Ojuelos de Jalisco (21° 55' 00.71" N; 101° 47' 32.37" W; 2,215 m), 20 km south of the above-indicated verbal reports. The camera was installed in the floodplain of a xeroriparian habitat fed by runoff from a 2-m long spring that has water year-round. The vegetation around the trail camera location was of Peruvian pepper trees, willows and shrubs of the genera noted in the description of the study area.

The most recent and nearest peccary records to Los Llanos de Ojuelos are two reported in Naturalista (2018a, 2018b), both 40 km northeast of La Laborcilla. The first of them is from the municipality of Pinos, Zacatecas (Naturalista 2018a) and the second from the municipality of Corral de Palmas, San Luis Potosí (Naturalista 2018b). The two are separated from each other by approximately 17 km, and both are 60 km from our sighting.

Different authors indicate that the collared peccary is found throughout the state of San Luis Potosí and northern Zacatecas, but not in northeastern Jalisco or southeastern Zacatecas, nor from the states of Aguascalientes and Guanajuato (Hall 1981; March and Mandujano 2005; Reyna-Hurtado *et al.* 2019). In contrast, Leopold (1959) included the Llanos de Ojuelos in the distribution of the collared peccary but did not include most of western San Luis Potosí. The two recent and nearest records consigned

in Naturalista (2018a, 2018b) are not included in our study area and are physically separated from it by the Sierra de Pinos in Zacatecas. Of the nearby historical records, one is in Bledos, San Luis Potosí, 90 km east of ours (Dalquest 1953) and dates from 1950. The second, consigned in Hall (1981), is from San Bartolo de Berrios, Guanajuato, 100 km southeast of our current report, supported by a map by Leopold (1947).

Although it has been stated that the collared peccary does not inhabit the desert plains of San Luis Potosí (Dalquest 1953), local populations were later documented in the Sierra de La Mojonera (Luévano *et al.* 1991) and in different nopalera sites in the mid-20th Century (R. García-Maldonado, pers. comm.). It has been speculated that the collared peccary would have inhabited the tunales (communities of arboreal nopales) of the southern Mexican Altiplano, from where it disappeared along with the almost total disappearance of this habitat (Mellink *et al.* 2018).

In arid and semi-arid areas, the presence of collared peccaries is related to the abundance of cacti, especially nopales, and dense plant cover. Cacti are their main source of both food (Dalquest 1953; Leopold 1959; Luévano *et al.* 1991; Schmidly 2004; Sowls 2013) and water (Bissonette 1982; Day 1985; Sowls 2013). In these habitats, peccaries reduce water loss by spending much of their time in the shade of vegetation (Sowls 2013), which is why, in these regions, dense scrub is essential for their survival (Dalquest 1953; Leopold 1959; Schmidly 2004). Likewise, the activity of peccaries is linked to temperature, so that in arid habitats they tend to be more active during the night to avoid excessive day-time heat (Bissonette 1982). The site of the herd herein reported has dense plant cover and thick canopy, and, on the west side of the xeroriparian system, abundant *Opuntia* spp. plants. The nocturnal behavior of the herd matches that which occurs in arid environments or in warm climates.

The main predators of collared peccaries are pumas (*Puma concolor*), and, mainly of young peccaries, coyotes (*Canis latrans*) and bobcats (*Lynx rufus*; Sowls 2013). The first species was recently documented in the same locality where we obtained the record of collared peccary (Riojas-López *et al.* 2019), while the two other species are common in the region. Peccaries could contribute to the maintenance of these carnivores, especially of puma as they are

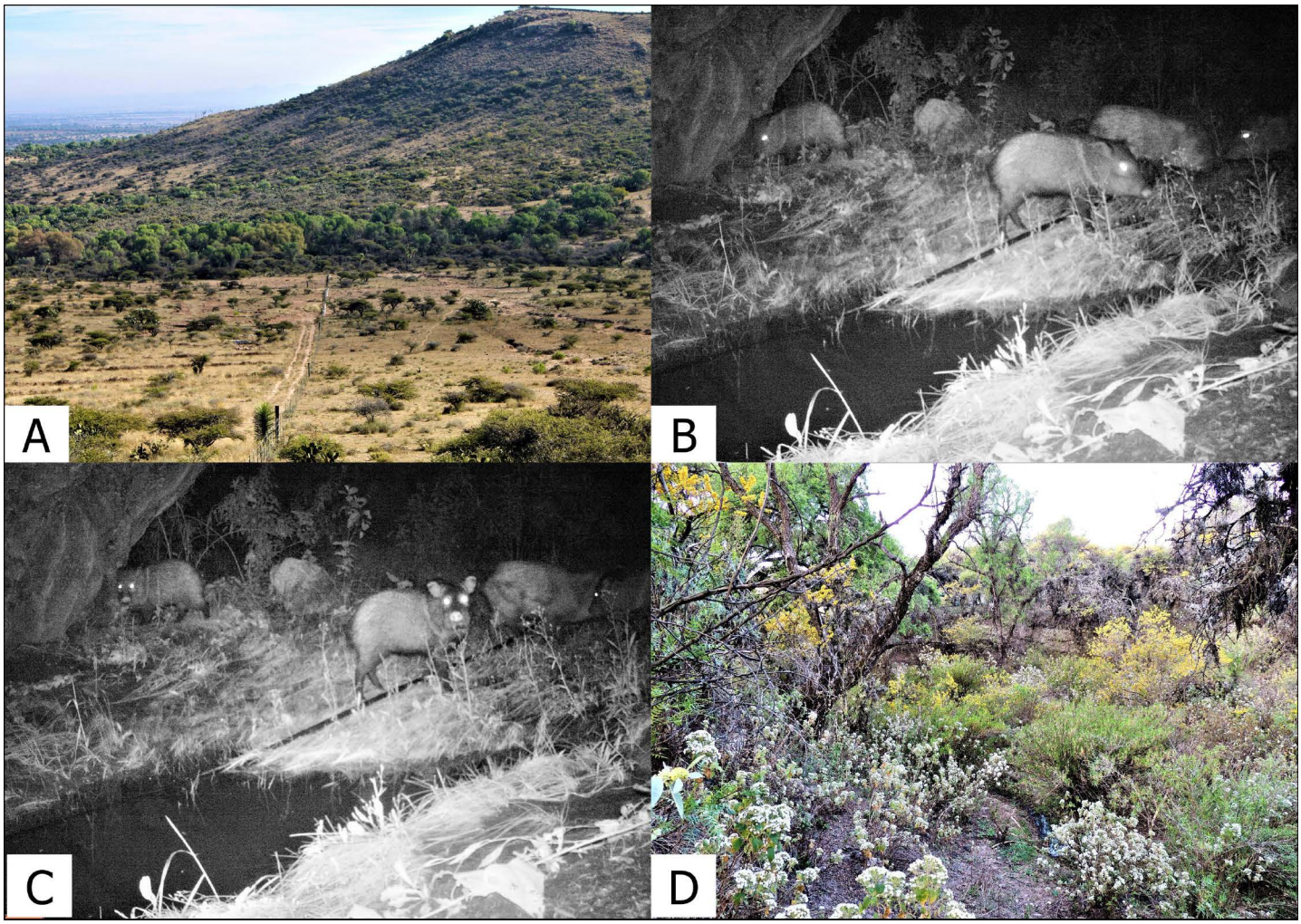

Figure 2. A: Panoramic view of the xeroriparian habitat in which collared peccaries were recorded in the Llanos de Ojuelos, México. B and C: The recorded collared peccaries. D: Vegetation at the trail camera placing. Photographs A and D were taken by the authors.

one of its preferred prey items (Currier 1983). In addition, an increase in the prey species of large mammalian carnivores could prevent them to depredate livestock.

Our record, complemented by the other two reports northeast of Pinos, suggest that the verbal reports on the presence of peccaries in the mountain range near La Laborcilla are most likely also collared peccary. The species usually restrict its movements to a few kilometers, although individuals have been found up to 11 km from the point where they were released (Ellisor and Harwell 1969; Schweinsburg 1971), but these were suggested to be dispersing individuals. Based on this, our own, the verbal reports (20 km north of our record), and the recent records in Naturalista (2018a, 2018b), would correspond to different herds. This indicates that currently the collared peccary is distributed in a wider area of the southern Mexican Altiplano than previously considered, and possibly represents a recent population increase and distribution expansion. A possible explanation for this is a decrease in poaching as an unanticipated result of the increase in police and, especially, military presence in the region in recent years. The group we report here may have been dispersing in search of suitable habitat. The origin of the individuals we recorded cannot be determined. In the region there are no game ranches in which individuals of this species have been introduced; and the Sierra Fría, which has natural populations of peccaries, is more than 70 km away from our study area.

The current record of collared peccary in Llanos de Ojuelos region, and an increase in the presence of white-tailed deer and puma (Riojas-López *et al.* 2019; M. Riojas and E. Mellink, pers. obs.), can be used to promote regional awareness campaigns, regarding the conservation of biodiversity and contribute to the revaluation of the natural habitats of the region by its inhabitants.

Acknowledgements

To family Santoyo who allowed us access to their property. To D. Almanzor and G. Volpi, E. Martínez and M. Chávez for logistic support during field work. We also acknowledge the commentaries and suggestions of two anonymous reviewers who contributed to improve this note. This record was obtained under the financing by the Universidad de Guadalajara and the Centro de Investigación Científica y de Educación Superior de Ensenada.

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Associated editor: Beatriz Bolívar-Cimé
Submitted: February 10, 2021; Reviewed: April 13, 2021.
Accepted: May 11, 2021; Published on line: June 18, 2021.

THERYA NOTES 2021, Vol. 2 : 79-84 DOI: 10.12933/therya_notes-21-39 ISSN 2954-3614

First record of the coexistence of two mesocarnivores in the Yucatán Peninsula, México

Primer registro de coexistencia de dos mesocarnívoros en la Península de Yucatán, México

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The simultaneous occurrence of two or more species in space and time (coexistence) is the initial condition for interspecific interactions. One example is the little known binomial of *Urocyon cinereoargenteus* and *Spilogale angustifrons*. Our objective is to contribute information on the coexistence of these mesocarnivores in Komchén de los Pájaros, in the north of Yucatán, an area covered by low deciduous tropical forest. We placed eight camera traps from 23 December 2019 to 20 June 2020 in eight sampling stations. We depicted the daily activity patterns using an hourly circular diagram based on the frequency of camera-trap records. We obtained 68 camera-trap records with a sampling effort of 4,320 trap-hours over 180 days, with three corresponding to the coexistence of *U. cinereoargenteus* and *S. angustifrons*. The activity of *U. cinereoargenteus* occurred all day during the dry season. The relative abundance index of the coexistence of *S. angustifrons* and *U. cinereoargenteus* was 0.7 and for *U. cinereoargenteus* alone was 15.74. We recorded the synchronized activity of *U. cinereoargenteus* and *S. angustifrons* on three occasions. These events occurred at night, early morning hours, and dawn, which confirmed the coexistence of both species in space (low deciduous tropical forest) and time (dry season). The photographic records showed no antagonistic events and the fact that one species followed the other suggests mutualism. We confirmed the coexistence based on the follow-up behavior of *U. cinereoargenteus* by *S. angustifrons*, and believe that these two species are mutualist in the dry season and in the low deciduous tropical forest.

Key words: Deciduous tropical forest; Dzemul; gray fox; Komchén de los Pájaros; mammals; private natural reserve; spotted skunk.

La ocurrencia de dos o más especies en espacio y tiempo (coexistencia) es la condición inicial para las interacciones interespecíficas. Por ejemplo, el binomio *Urocyon cinereoargenteus* y *Spilogale angustifrons* es poco conocido. Nuestro objetivo es contribuir con información sobre la coexistencia de estos mesocarnívoros en Komchén de los Pájaros, en el norte de Yucatán, dominada por selva baja caducifolia. Colocamos ocho cámaras-trampas del 23 de diciembre de 2019 al 20 de junio de 2020 distribuidas en ocho estaciones de muestreo. Representamos los patrones de actividad diaria mediante un diagrama circular por horas con base en la frecuencia de los registros fotográficos. Obtuvimos 68 foto-registros con un esfuerzo de muestreo de 4,320 hr-trampa en 180 días, tres corresponden a la coexistencia de *U. cinereoargenteus* y *S. angustifrons*. La actividad de *U. cinereoargenteus* ocurrió todo el día durante la temporada seca. El índice de abundancia relativa de la coexistencia de *S. angustifrons-U. cinereoargenteus* fue de 0.7 y solo para *U. cinereoargenteus* fue de 15.74. En tres momentos registramos la sincronización de la actividad de *U. cinereoargenteus* y *S. angustifrons*. Estos eventos ocurrieron en la noche, madrugada y al amanecer, lo que confirmó la coexistencia de ambas especies en espacio (selva baja caducifolia) y tiempo (temporada de seca). Los registros fotográficos no mostraron eventos antagónicos y el seguimiento de una especie por la otra sugiere un mutualismo. Confirmamos la coexistencia basada en el comportamiento de seguimiento de *U. cinereoargenteus* por *S. angustifrons* y planteamos que son especies mutualistas en temporada seca y en la selva baja caducifolia.

Palabras clave: Bosque tropical caducifolio; Dzemul; Komchén de los Pájaros; mamíferos; reserva natural privada; zorra gris; zorrillo manchado.

In the ecology of communities, interspecific interactions stand out, either between not taxonomic-related species (*e.g.*, plant-animal) or taxonomically related, as beween species in the order Carnivora (Donadio and Buskirk 2006). In theory, populations or individuals of two species interact in three basic ways: 1) neutral interactions, when any of the two species is affected by the other; 2) positive interactions, when both species benefit from the interaction; and 3) negative interactions, when both populations are inhibited or at least one is negatively affected (Odum and Barret 2006). In particular, carnivores can exploit a resource, such as space or food, in a similar way, forming guilds (Root 1967); these are classified according to their diet in hypercarnivores (diet > 70 % meat), mesocarnivores (diet between 50 % and 70 % meat, balanced by invertebrate consumption), and hypocarnivores (diet > 70 % invertebrates; Van Valkenburgh 2007). Accordingly, *Urocyon cinereoargenteus* Schreeber 1775 and *Spilogale angustifrons* Howell 1902 are species referred to as mesocarnivores.

At least 123 species of terrestrial mammals inhabit the Yucatán peninsula, of which 17 belong to the order Carnivora (Sosa-Escalante *et al.* 2013; Sosa-Escalante *et al.* 2014); these include the gray fox (*Urocyon cinereoargenteus*) and the southern spotted skunk (*Spilogale angustifrons*). *Spilogale angustifrons* is distributed from central México to northern Costa Rica (Helgen *et al.* 2016). In México, it can be found in south and southeast regions through the Yucatán peninsula and the State of Chiapas (Reid 2009; Hidalgo-Mihart *et al.* 2014). It feeds mainly on insects, small vertebrates, and occasionally fruits; therefore, it is considered a generalist and omnivorous species (Cantú-Salazar *et al.* 2005). *Urocyon cinereoargenteus* is distributed from southern Canadá through the United States of America, excluding the northwestern mountainous areas, to northern Venezuela and Colombia, as well as to eastern Central America. It is a species in the order Carnivora that feeds mainly on meat, supplementing its diet with fruits and insects, so it is considered omnivorous (Fritzell and Haroldson 1982; Reid 2009). In México, it has a potential distribution spanning virtually the whole national territory (Ceballos *et al.* 2006), including practically all vegetation types in the country (Fritzell and Haroldson 1982). Both *U. cinereoargenteus* and *S. angustifrons* have been reported based on isolated camera-trap records in the north of the Yucatán peninsula (Vu 2011; Hernández-Pérez *et al.* 2015).

The coexistence between *S. angustifrons* and *U. cinereoargenteus* was reported for the first time for México based on camera-trap records by Farías-González and Vega-Flores (2019) in a locality within the Tehuacán Cuicatlán biosphere reserve in the municipality of San José Miahuatlán, southeast State of Puebla, characterized by deciduous tropical forest at an altitude of 900 to 1,400 m. The objective of this note is to contribute to the record of coexistence between *U. cinereoargenteus* and *S. angustifrons* in the northern region of the State of Yucatán.

This work was carried out in Komchén de los Pájaros, a private protected area voluntarily dedicated to conservation, comprising deciduous tropical forest across 300 ha (21° 12′ 42.36″ N, 89° 19′ 16.36″ W; Figure 1), with registration pending with SEMARNAT. It is located at kilometer 1.5 of the Dzemul-Xtampú beltway, to the south of the munici-

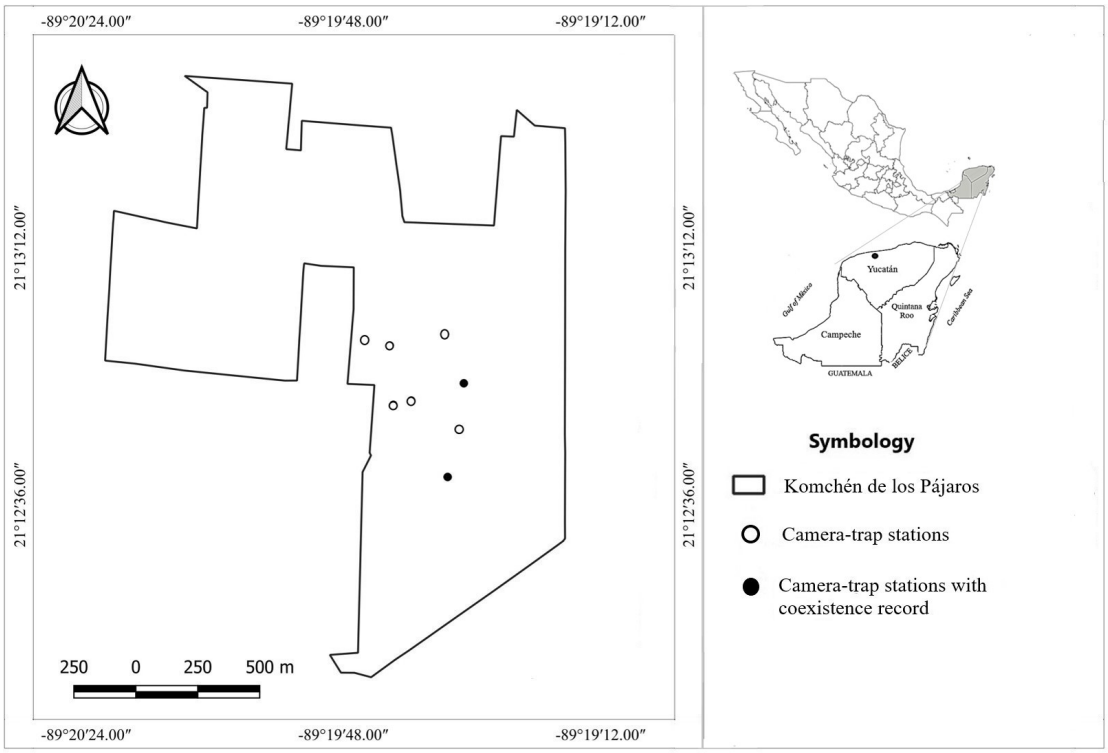

Figure 1. Location of camera traps across the private protected area voluntarily dedicated to the conservation named Komchén de los Pájaros, municipality of Dzemul, Yucatán, México.

pality of Dzemul and to the north of the State of Yucatán. The protected area has an altitude of zero meters (INEGI 2005). The climate is warm subhumid with summer rains; the drought in this area is quite severe, can last from seven to eight months (November to June) and is only slightly attenuated by "Norte" rains or winter storms. The soil type is Leptosol and the area includes two cenotes (wells) that contain water for most of the year (INEGI 2009).

As part of a monitoring study of medium-sized and large mammals in the private reserve, we placed eight camera traps (seven Bushnell camera traps, three of model 119636c and four of model 119447, plus one Cuddleback trap model H-1453) from 23 December 2019 to 20 June 2020. The camera traps were affixed to trunks of living trees, at a height of of approximately 50 cm from the ground, along paths created for both humans and wildlife; animals were attracted by water contained in drinkers made of concrete. Each camera was set to run 24 hr a day with three shots per second, operating for the duration of batteries, and camera cards were checked weekly. We determined the species captured by camera traps using field guides, based on the distinctive characteristics of *S. angustifrons, i.e.*, its white lateral and dorsal strips (Figure 2a), and on the physiognomy of *U. cinereoargenteus*, considering the shape of ears, body, and tail (Reid 2009; Aranda-Sánchez 2012). In addition, we use the term "following" when in the same camera station, *S. angustifrons* was recorded behind *U. cinereoargenteus* in the same image (Farías-González and Vega-Flores 2019). To identify the daily activity patterns of both species, we built a circular diagram based on the hourly photographic records with the software Oriana ver. 4 (Kovach 2011). We did not capture any photographic records of *S. angustifrons* alone, so neither comparative nor statistical analyses were conducted.

The total sampling effort (MS) was 4,320 trap-hours over 180 days, which was used to calculate the relative abundance index for each species (IAR; Maffei *et al.* 2002). The equation used for this purpose was: IAR = (C/EM)*1000 trap-days, where C is the number of camera-trap events and 1,000 camera-trap-days is the standard correction factor.

We obtained a total of 68 camera trap records in two of eight stations, including three observations of *S. angustifrons* in physical proximity of *U. cinereoargenteus*. The first observation was obtained on 21 January 2020 at 05:09:11 hr, recording a distance of 6 m between both species; the second, on 28 march 2020 with three photographs (two at 21:18:03 hr and one at 21:18:04 hr) with a separation of 2 m between the individuals of both species; the third record, on 30 march 2020 with three photographs (01:08:53, 01:08:54, 01:08:55 hr) where an individual of one species is virtually facing an individual of the other species at a distance of approximately 2 m between them (Figure 2a). The evidence of coexistence was recorded in the dry season.

We estimated the IAR of *S. angustifrons* from the three records along with *U. cinereoargenteus* (IAR = 0.7) and the records of *U. cinereoargenteus* alone including 68 photographs (IAR = 15.74), suggesting that *U. cinereoargenteus* is a dominant species for displaying greater activity in the study area (Figure 3).

Figure 2. Sequence of three photographs showing the gray fox (*Urocyon cinereoargenteus*) observing an individual of southern spotted skunk (*Spilogale angustifrons*); a) on 30 March 2020 at 01:08:53-55 hr (21°12"46' N, 89°19'32" W), which is moving around; b-c) 21 January 2020 and 28 March 2020, respectively, in Komchén de los Pájaros, municipality of Dzemul, Yucatán, México. The white arrow indicates the position of the southern spotted skunk (*S. angustifrons*).

Based on the 68 record captured, *U. cinereoargenteus* was active practically all day, mostly from 21:00 to 22:00 hr and from 03:00 to 04:00 hr. Besides, two additional activity periods were observed, namely from 00:00 to 02:00 hr and from 08:00 to 09:00 hr (Figure 3). Only on three occasions (21 January 2020, 28 March 2020, and 30 March 2020), we recorded the simultaneous activity of *U. cinereoargenteus* and *S. angustifrons* (Figures 2 and 3).

The synchronous activity of *U. cinereoargenteus* and *S. angustifrons* was recorded during the night, the early morning hours and at dawn, confirming the simultaneous spatial-temporal presence of both species. This note shows that both species coexist, where the individual of *U. cinereoargenteus* is observed sitting, waiting, in addition to being in front of *S. angustifrons*, which is moving (Figure 2a).

Urocyon cinereoargenteus is mainly a twilight and nocturnal species, and during the day it searches for resting places in the dense understory (Fritzell and Haroldson 1982; Fritzell 1987). Our data inform that *U. cinereoargenteus* is very active in morning hours in the deciduous tropical forest of northern Yucatán (Figure 3). By contrast, *S. angustifrons* is a nocturnal species; during the day, it rests on underground burrows and dens that may or may not share with other conspecifics (Verts *et al.* 2001; Lesmeister *et al.* 2008; Dragoo 2009). The activity of both species coincides at night, which we recorded on three occasions in this study (Figure 3).

Urocyon cinereoargenteus and *S. angustifrons* are mesocarnivorous and omnivorous mammals, respectively, that share predators, means of locomotion and habitat use (Fritzell 1987; Hunter and Caro 2008; Dragoo 2009). However, several factors related to the social structure and behavior of *U. cinereoargenteus* and *S. angustifrons* remain unclear due to the lack of information on their coexistence (Fritzell and Haroldson 1982; Dragoo 2009).

In carnivorous mammals, body size is considered to be the primary driver of the coexistence of species (Simberloff and Dayan 1991). For the above, we consider that *U. cinereoargenteus* may be a stronger competitor given its larger body size relative to *S. angustifrons*. However, the photo-

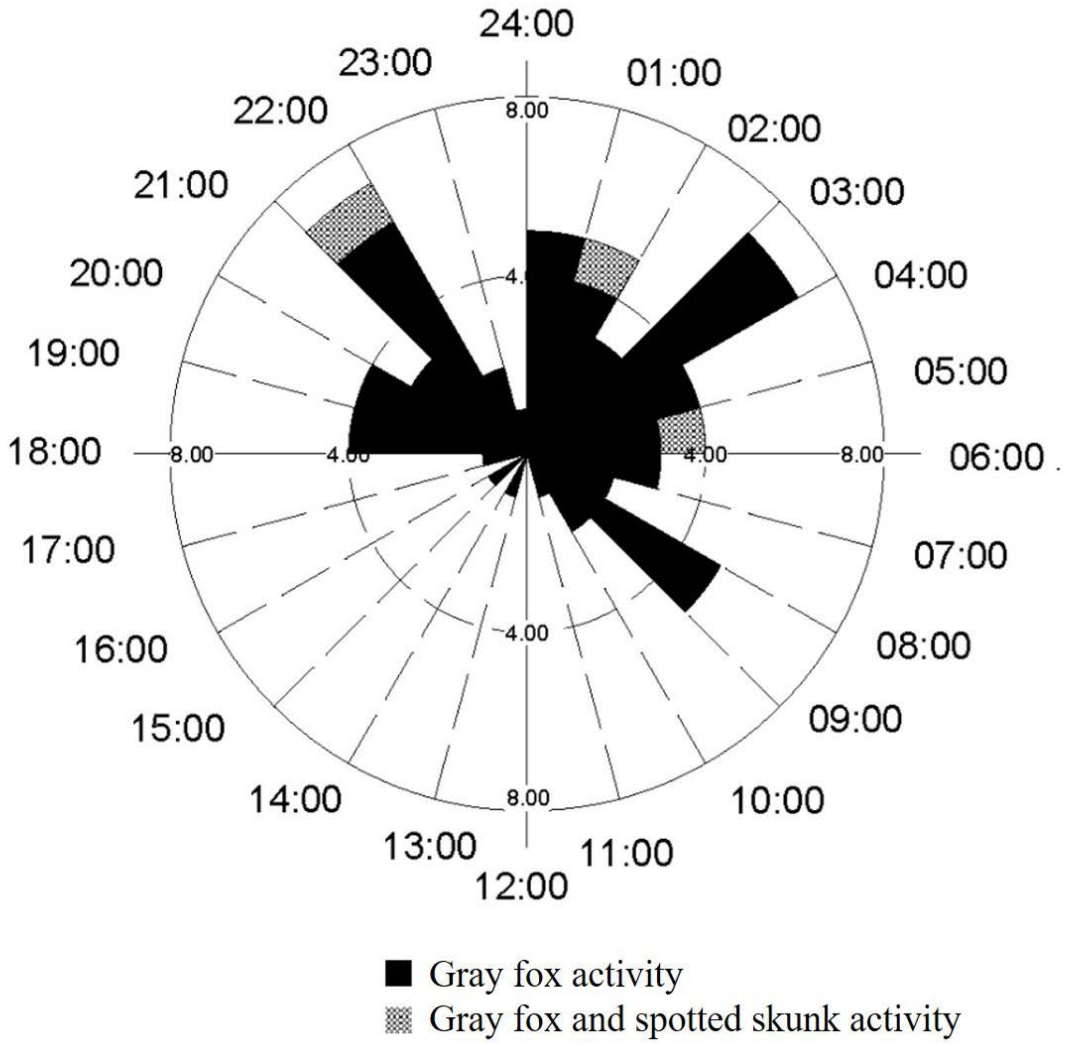

Figure 3. Daily activity based on 68 records, where 65 record only *Urocyon cinereoargenteus* (in black) and three record its coexistence with *Spilogale angustifrons* (in gray). The inner values 4 and 8 refer to the frequency of coexistence.

graphic records showed no evidence of antagonistic events. Thus, camera-trap records can be interpreted as illustrating two potential interactions: mutualistic, where both species benefit, or neutral, where one does not affect the other (Odum and Barrett 2006). *Spilogale angustifrons* has been found to walk behind *U. cinereoargenteus*, with camera-trap records during the dry season and in the deciduous tropical forest (Figure 2b, 2c; Farías-González and Vega-Flores 2019), as evidenced in this study. The fact that one species follows the other precludes the possibility of a neutral interaction. Therefore, it has been suggested that the behavior of *S. angustifrons* following *U. cinereoargenteus* aims to reduce the risk of predation and improve foraging (Farías-González and Vega-Flores 2019). From the closeness observed in the sequence of photographs in Figure 2 and the additional camera-trap records captured on 21 January and 28 March 2020, we consider the existence of a mutualistic relationship between these two species. We confirmed the coexistence based on the behavior of *S. angustifrons* following *U. cinereoargenteus* in the dry season, so this note contributes to the knowledge of the natural history of these mesocarnivores in México; therefore, long-term studies should be performed to broaden the knowledge of this interaction.

Acknowledgements

Thanks to D. Chí Aké, G. Valencia Aké and M. Sosa Escalante for their support in field work in the reserve. To the National System of Researchers for the economic support through grant 21467 for the fourth author. The valuable feedback from two anonymous reviewers helped improve the manuscript. M. E. Sánchez-Salazar translated the manuscript into English.

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Associated editor: Beatriz Bolívar-Cimé
Submitted: January 13, 2021; Reviewed: April 27, 2021.
Accepted: May 17, 2021; Published on line: June 18, 2021.

THERYA NOTES 2021, Vol. 2 : 85-88 DOI: 10.12933/therya_notes-21-40 ISSN 2954-3614

Noteworthy record of the kit fox, *Vulpes macrotis*, in the southcentral limit of its historical distribution

Registro notable de la zorrita del desierto, *Vulpes macrotis*, en el límite centro-sur de su distribución histórica

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Kit fox, *Vulpes macrotris*, is a nocturnal carnivore uncommon to rare that inhabits desert and semiarid regions of western North America. Unlike the northern populations, there is less information about this species in the southcentral part of its distribution. In this work, we report a noteworthy record of the kit fox from northwestern San Luis Potosí, México. On 12 August 2017, one road-killed male kit fox was recorded from the municipality of Charcas, San Luis Potosí, México. The specimen was photographed and external somatic measurements were taken. Additionally, geographic coordinates were taken and the characteristics of the habitat type were determined. Our record represents the first reliable evidence of the kit fox in the state of San Luis Potosí, México, and it is also possibly the second southernmost record for this species in the southcentral part of its historical range. The individual was found 107 km northwest the previous record from 11.26 km S at Real de Los Pinos, Zacatecas, México. The presence of the kit fox is confirmed in northwest San Luis Potosí, México, after 65 years of its last record in the closest locality in the state of Zacatecas. The biological implications of this record, as well as the need to carry out effective long-term monitoring in order to know the distribution of kit foxes' populations and their ecological parameters are discussed.

Key words: Canid; carnivores; highway fatalities; roads; run over; San Luis Potosí.

La zorrita del desierto, *Vulpes macrotris*, es un carnívoro nocturno poco común a raro que habita las regiones desérticas y semiáridas del oeste de Norteamérica. A diferencia de las poblaciones más norteñas, en el centro-sur de su distribución geográfica existe menos información sobre esta especie. En esta nota, reportamos un registro notable de la zorrita del desierto en el noroeste de San Luis Potosí, México. El 12 de agosto de 2017, se realizó el registro de un ejemplar macho atropellado en una carretera del municipio de Charcas San Luis Potosí, México. Esta zorrita del desierto fue fotografiada y se le tomaron medidas somáticas externas. Adicionalmente, se tomaron las coordenadas geográficas y se determinaron las características del tipo de hábitat. Nuestro registro representa la primera evidencia confiable de la zorrita del desierto en el estado de San Luis Potosí, México y posiblemente también es el segundo registro más sureño de la especie en el centro-sur de su distribución histórica. El ejemplar fue registrado a 107 km al noroeste del registro anterior en 11.26 km al S de Real de Los Pinos, Zacatecas, México. Se confirma la presencia de la zorrita del desierto para el noroeste de San Luis Potosí, México, después de 65 años de su último registro en la localidad más cercana en el estado de Zacatecas. Se discuten las implicaciones biológicas de este registro, así como la necesidad de realizar un seguimiento efectivo a largo plazo para conocer la distribución y determinar los parámetros ecológicos de las poblaciones de la zorrita del desierto en la zona.

Palabras clave: Atropellamientos; cánido; carnívoros; carreteras; distribución; San Luis Potosí.

The kit fox, *Vulpes macrotis* Merriam, 1888, is the smallest North American canid, weighing between 1.4 to 3 kg (Arjo *et al.* 2003). This species is closely associated with desert climates and it is inhabiting desert scrub, chaparral, saltbush, creosote bush, and natural grassland habitats with sandy and deep soils (McGrew 1979; O'Farrell 1987). It is a semi fossorial and primarily nocturnal carnivore that is uncommon to rare, and their population densities fluctuates in relation to annual environmental conditions (Cypher and List 2014). Their trophic spectrum includes a wide variety of species of rodents, lagomorphs, birds, reptiles, and insects (McGrew 1979; White *et al.* 1996; List *et al.* 2003). They can also occasionally feed on seeds and some fruits of Cactaceae (Morrell 1972).

Kit foxes are historically distributed in desert and semiarid regions of western North America (McGrew 1979). Its current distribution probably includes from southeastern United States (southern California to western Colorado and western Texas towards North into southern Oregon and Idaho), and to North and Central México from Baja

California Peninsula, Sonora, and Chihuahua to western Nuevo León, Zacatecas, and San Luis Potosí (McGrew 1979; Hall 1981; Dragoo *et al.* 1990; Álvarez-Castañeda 2000; Álvarez-Castañeda 2002).

In México, kit fox is listed as threatened (SEMARNAT 2010). However, globally it is conservation status is considered as Least Concern (Cypher and List 2014). Unlike kit foxes' populations from the United States of America, in Central México their distribution and ecology are poorly known. Due to the lack of information on the size and population trends, it is not possible to determine their conservation status (Cypher and List 2014). The main threats for kit fox conservation include the habitat loss by changes in land use, the use of poisoned grains to control rodents, and possibly hunting (Cypher and List 2014; Martínez de la Vega *et al.* 2016). Besides that, because this canid is unwary, highway fatalities are a significant source of mortality (Clevenger *et al.* 2010).

The state of San Luis Potosí, México, represents its southernmost distribution limit, and there are not documented records for *V. macrotis* in the state (Dalquest 1951; Martínez de la Vega *et al.* 2016). The records for this canid in the nearest locality from the state of Zacatecas dates back 65 years (Sydney and Hadary 1965). In this context, it is fundamental to know the kit fox's current distribution and ecology requirements to implement measures that contribute to its conservation in southcentral México. In this work, we report a noteworthy record of the kit fox from northwestern San Luis Potosí, México.

On 12 August 2017, we recorded a run over kit fox male in a federal highway from the municipality of Charcas, San Luis Potosí, México. Geographic location of the kit fox record was projected on a map of the region and in relation to its historical range according to the IUCN (Cypher and List 2014). The specimen was photographed and its external somatic measurements were taken, along with the habitat's characteristics. Unfortunately, the specimen could not be collected because we did not have a scientific collection permit at this time. The confirmation of the taxonomic identity of this species was confirmed by experts. The main types of vegetation in the area correspond to desert microphilous scrub, desert rosetophilous scrub, and crassicaule scrub, where the physiognomically dominant species are *Larrea tridentata*, *Flourensia cernua*, *Yucca carnerosana*, *Agave lechuguilla*, and *Opuntia* sp. (Reyes-Agüero *et al.* 1996).

In order to know the distribution of *V. macrotis* in San Luis Potosí and other nearby localities in adjacent states, we conducted a search of scientific literature using the Web of Science, Scopus and Google Academic platforms. This information was supplemented with records and observations gathered from Global Biodiversity Information Facility (GBIF 2021), and Naturalista (Naturalista, CONABIO 2021).

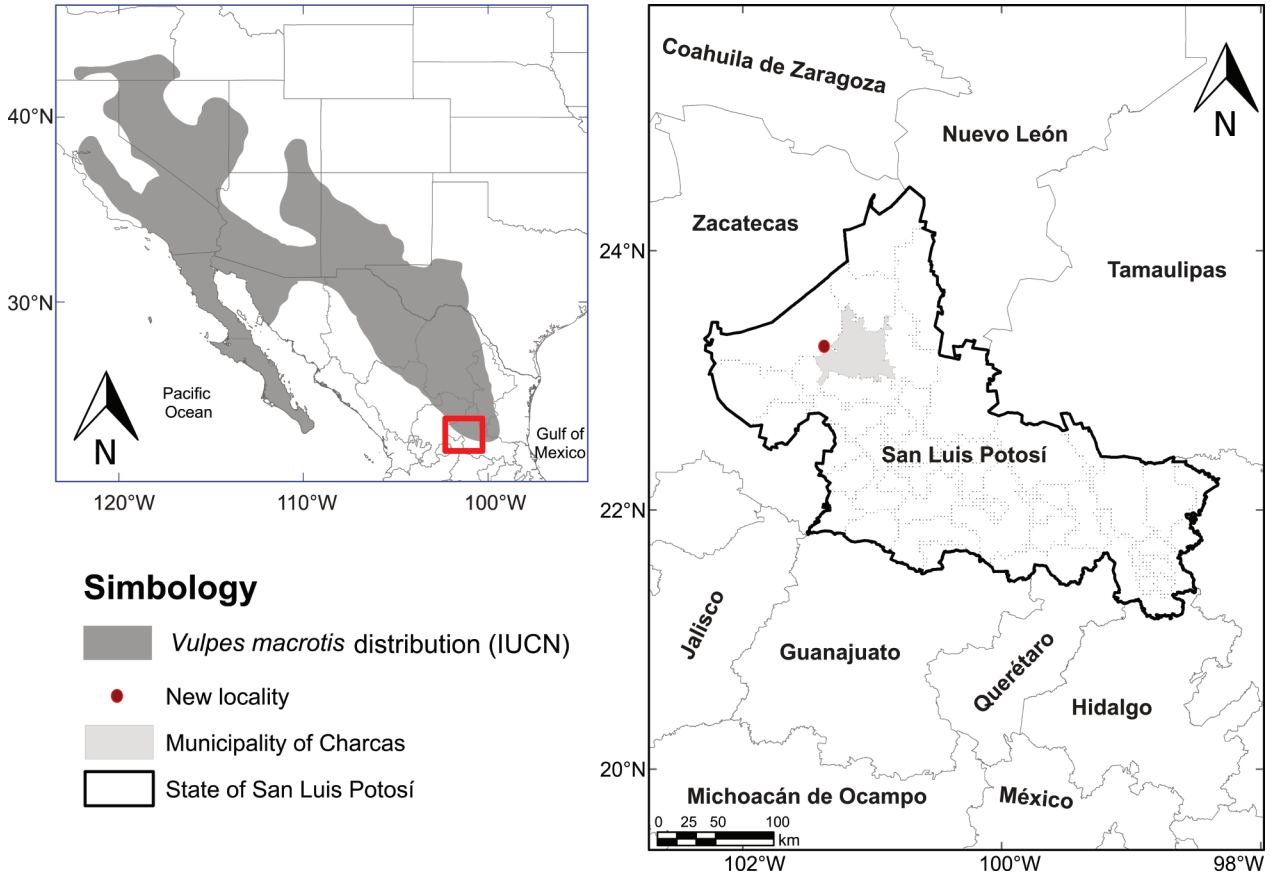

Figure 1. Geographic location of the male kit fox, *Vulpes macrotis*, recorded in the state of San Luis Potosí: 107 km northwest from 7 mi S at Real de Los Pinos, Zacatecas, México. The historical distribution of the kit fox by the IUCN is indicated (Cypher and List 2014).

Our record of the kit fox is located at northwestern San Luis Potosí, México (23° 15′ 48.6″ N, 101° 21′ 18.36″ W at 2,240 m; Figure 1). This location is approximately 107 km northwest of the previous record from 11.26 km S at Real de Los Pinos, Zacatecas, México (Sydney and Hadary 1965). The external somatic measures (in mm) of this specimen were as follows: total length, 732; tail length, 280; hind foot length, 110; ear length, 85, and the weight was 2,750 gr (Figure 2a). The type of vegetation where the road-killed kit fox specimen was found corresponds to crassicaule scrub (Figure 2b).

According to our literature and database search, this record represents the first reliable evidence of the kit fox in the state of San Luis Potosí, México. Furthermore, it is possibly the second southernmost record of the species after six decades of not being recorded in the area (Sydney and Hadary 1965; Martínez de la Vega *et al.* 2016). It should be noted that the external somatic measurements for the specimen are within the range of those reported for the species (McGrew 1979; Álvarez-Castañeda *et al.* 2017). One road-killed kit fox, plus a single rock squirrel (*Otospermophilus variegatus*), and three domestic dogs larger than a coyote were observed in autumn 2005 along the road from northwestern San Luis Potosí (Dean *et al.* 2006). However, the locality, specific coordinates as well as date and measurements of the specimen are not provided.

The effect of road developments on kit fox mortality rates are apparently different through its geographical distribution. For example, highway kills, shooting, and eagle predation were the main mortality factors in Tooele County, Utah (Egoscue 1962). By contrast, the effects of two-lane roads did not appear to impact on kit fox demographic and ecological attributes in western Kern County, California (Cypher *et al.* 2009). However, it's possible that road effects could be more pronounced under low prey availability or other adverse environmental conditions because kit foxes would have to travel greater distances for foraging (Cypher *et al.* 2009).

The most recent records of kit fox in México correspond to localities in the states of Coahuila (Contreras-Balderas *et al.* 2007), Sonora (Verona-Trejo *et al.* 2012), and the Baja California Peninsula (Álvarez-Castañeda 2002; Escobar-Flores *et al.* 2017). As well as to other citizen-based observations in Baja California Sur, Baja California, Sonora, Chihuahua, Coahuila and Nuevo León (Naturalista, CONABIO 2021). While in the southern limit of the distribution of *V. macrotis* there is less data on the distribution of its populations. In order to correct this lack of knowledge about this elusive and cryptic canid, it is necessary to implement long-term monitoring efforts with the use of more efficcient methods (*e.g.*, camera-traps), in addition to determining geographic location of its dens, use of habitat, and prey availability, among other important factors.

In desert communities, *V. macrotis* is an ecologically very relevant predator since it regulates the abundance of many prey species, mainly rodents (Ostfeld and Hold 2004). Therefore, the absence of kit fox populations can alter the behavioral ecology of preys, causing negative changes in the habitat by impoverishing it and favoring the desertification of the environment (Roemer *et al.* 2009). In this context, it is necessary to identify kit fox populations in southcentral México and implement effective conservation actions to ensure its long-term presence and conservation in the area.

Acknowledgements

We thank M. Aguilar-López for her help in making the map. M. Aranda, J. E. Maldonado, A. E. Rojas-Martínez, and D. J. Long helped us with the taxonomic identification of the specimen; A. Palma-Ramírez and I. A. Sologuren contributed with valuable comments and suggestions to the manuscript. We also want to express our deep gratitude to two anonymous reviewers for their valuable comments that allowed us to substantially improve the quality of this note.

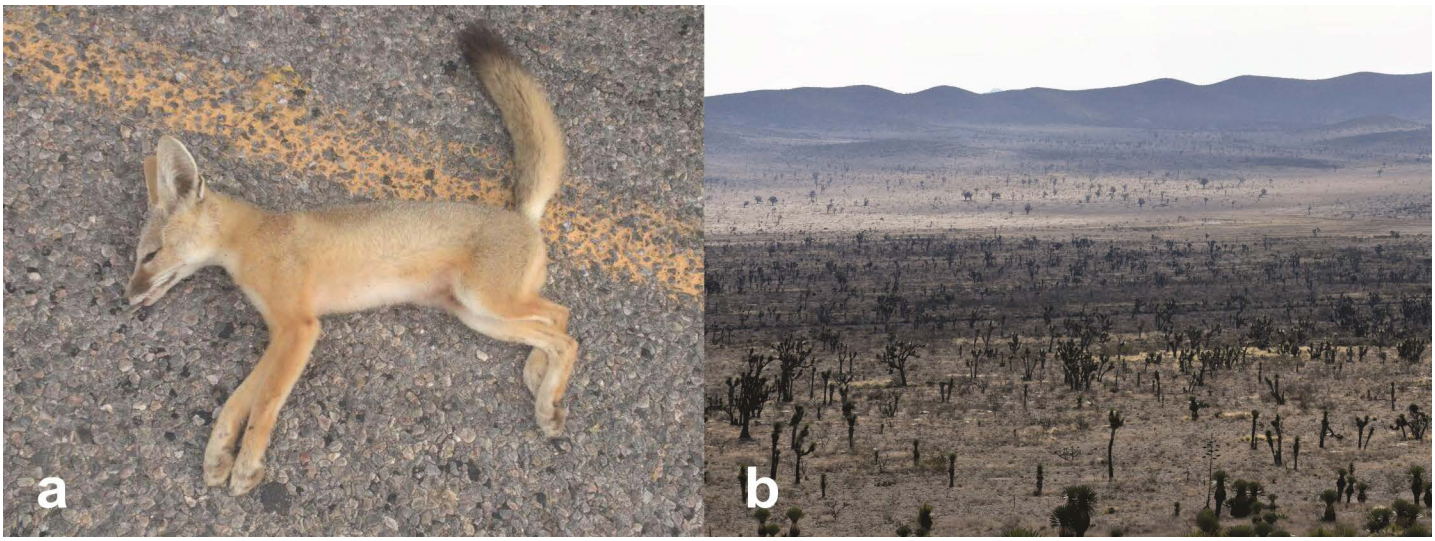

Figure 2. a) A male kit fox, *Vulpes macrotis,* killed in a road from the Municipality of Charcas, San Luis Potosí, México; b) type of vegetation near to the area where the road-killed kit fox was found.

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Associated editor: José F. Moreira-Ramírez
Submitted: February 18, 2021; Reviewed: May 26, 2021.
Accepted: June 1, 2021; Published on line: June 18, 2021.

THERYA NOTES 2021, Vol. 2 : 89-93 DOI: 10.12933/therya_notes-21-41 ISSN 2954-3614

Vertebrates visiting natural waterholes in a tropical seasonal habitat in central México

Vertebrados que visitan pozos de agua naturales en un hábitat estacional tropical en el centro de México

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The spatial and temporal distribution of water availability impacts the behavior of species. Particularly in arid habitats, waterholes are sources of water for many species. Herein, records of vertebrates are describing visiting natural waterholes by camera traps during the dry season in a dry tropical forest of central México. During the dry season (December 2015, May 2016, and April-May 2019), we placed seven camera traps during 135 days in seven waterholes. This method was used as part of monitoring and conservation activities, implemented within an extensive wildlife management unit in central Mexico. We recorded a total of 20 vertebrates visiting the waterholes: 15 mammals, four birds, and one reptile. The coexistence between species without negative interactions, and some recorded conduct included: playful behavior, grooming and rubbing against stones; we observed some species waiting for their turn to drink. At least four individuals of *Mephitis macroura* were identified. Our study also emphasizes a basic aspect, but perhaps underestimated in recent years resulting from the use of camera traps: the qualitative observation of animals through photos. These observations can reveal basic and interesting aspects of the natural history of species that allow us to improve the knowledge about coexistence in the same place.

Key words: Camera traps; *Mephitis macroura*; non-lethal interactions; *Urocyon cinereoargenteus*.

La distribución espacial y temporal de la disponibilidad de agua impacta el comportamiento de las especies. Particularmente en hábitats áridos, los pozos de agua son fuentes de agua para muchas especies. Presentamos registros interesantes de vertebrados que visitaron pozos de agua naturales mediante cámaras-trampa durante la estación seca en un bosque tropical seco del centro de México. Durante la estación seca (diciembre de 2015, mayo de 2016 y abril-mayo de 2019), colocamos siete cámaras-trampa durante 135 días en siete pozos de agua. Este método utilizado fue parte de las actividades de monitoreo y conservación, implementadas dentro de una amplia unidad de manejo de vida silvestre en el centro de México. Registramos 20 especies de vertebrados visitando los pozos de agua: 15 mamíferos, cuatro aves, y un reptil. La co-ocurrencia entre especies sin interacciones negativas, y algunos registros de conducta incluyeron: eventos de juego, acicalamiento y frotamiento contra piedras; se observó a algunas especies esperando su turno para beber. Pudimos identificar al menos cuatro individuos de *Mephitis macroura*. Nuestro estudio también enfatiza un aspecto básico, pero quizás subestimado en los últimos años producto del uso de cámaras-trampa: la observación cualitativa de animales a través de fotografías. Estas observaciones pueden revelar aspectos básicos e interesantes de la historia natural de las especies que permiten mejorar el conocimiento sobre la coexistencia en un mismo lugar.

Palabras clave: Cámaras trampas; interacciones no letales; *Mephitis macroura*; *Urocyon cinereoargenteus*.

The spatial and temporal distribution of water availability impacts foraging behavior, activity times, and microhabitat use of species (Rosenstock *et al.* 1999; Tanner *et al.* 2015). Particularly in arid habitats, water is a resource limited in time and space (Krausman *et al.* 2006). Waterholes are sources of water for many species of different taxa, such as reptiles, birds, and mammals (Martínez-Kú *et al.* 2008; Delgado-Martínez *et al.* 2018), and several of these species also use waterholes as refuge and resting areas (Martínez-Kú *et al.* 2008). However, species can also be negatively affected when visiting waterholes due to the increased risk of predation or competitive interactions (Rosenstock *et al.* 1999; Krausman *et al.* 2006; Hall *et al.* 2013; Perera-Romero *et al.* 2021).

Herein, records of species visiting natural waterholes by camera traps during the dry season in a dry tropical forest of central México are documented. We obtained these records as part of monitoring and conservation activities, implemented within an extensive wildlife management unit (UMA in Spanish). The site is located

in the Ejido Rancho El Salado, municipality of Jolalpan, in the southeast of the state of Puebla, in central México (18° 20´ N, 98° 57´ W). The region is highly seasonal, with the occurrence of pronounced wet (from June to November) and dry (from December to May) seasons (INEGI 2009). The climate is warm sub-humid, with rainfall in the summer, temperatures range between 22-28 °C, and an annual precipitation of 800 to 1,000 mm. The study area is located between 700 and 1,700 m (INEGI 2009). The predominant vegetation type is tropical dry forest, and the dominant species are trees of the Fabaceae and Anacardiaceae families (Martínez-Moreno *et al.* 2016). The main economic activities practiced in the area are seasonal agriculture and livestock production (INAFED 2019).

During the dry season (December 2015, May 2016, and April-May 2019), we placed 7 camera traps in 7 waterholes (also known as *aguaje;* Table 1) during 135 days, which contain water during the dry season. Cameras were programmed (models Primos Truth Cam 35® y Moultrie Game Spy D-55IR®) to take three pictures every ten seconds and to remain active for 24 hours. We used field guides and specialized bibliography for species identification (Hall 1981; Reid 1997; Ceballos and Oliva 2005).

We recorded a total of 20 species of vertebrates from different taxonomical groups visiting the waterholes: four birds, one reptile, and 15 mammals including a species of goat (Table 1). The mammal species with the highest number of records were (decreasingly): *Urocyon cinereoargenteus* (grey fox, 95 records), *Mephitis macroura* (hooded skunk, 39 records), *Odocoileus virginianus* (white-tailed deer, 25 records), and *Nasua narica* (white-nosed coati, 22 records). All mammal species has been reported in the studied location (Ramírez-Carmona 2018) and in other waterholes in nearby areas (Mandujano and Hernández-Gómez 2019a; Mandujano and Hernández-Gómez 2019b).

Within the birds, there were four species recorded, been *Zenaida* sp. with the highest number of records (36 records; Table 1). Only on reptile species, *Ctenosaura pectinata* (guerreran spiny-tailed iguana) was recorded (Table 1).

We recorded co-occurrence (*i.e.*, species found in the same region because a multitude of processes acting at different scales) between two species on several occasions: *M. macroura – U. cinereoargenteus* on two occasions, *N. narica – U. cinereoargenteus* on one occasion, *M. macroura – Bassariscus astutus* (ringtail) on one occasion, two individuals of *M. macroura* on one occasion, and two individuals of *U. cinereoargenteus* on two occasions (Figure 1). Although we obtained few observations of this co-occurrence (7 of 271 records), these observations have been rarely documented for these species. We also recorded behaviors such as playful behavior, grooming, and rubbing against stones, and some species were observed waiting for a turn to drink (Figure 1). Non-lethal interactions between species have been previously recorded between *Taxidea taxus* (American

Table 1. Vertebrate species and records detected by camera traps in seven waterholes in the Ejido Rancho El Salado in central México, during the dry season of 2015 - 2016. Waterholes: LS = Las Salinas; EP = El Pípilo; AP = Agua de la Peña; LJ = La Jícara; A = Alseseca; ER = El Rincón; EA = El Azumiate. Common names of mammals taken from Álvarez-Castañeda and González-Ruiz (2018).

Class	Species	Common Name	LS	EP	AP	LJ	A	ER	EA
Aves	*Ortalis poliocephala*	West Mexican chachalaca	7				6		3
	Zenaida sp.	White-winged dove	20						16
	Bubo virginianus	Great horned owl	1						
	Coragyps atratus	American black vulture	3				2		
Mammalia	*Didelphis virginiana*	Virginia opossum	3					3	1
	Dasypus novemcinctus	Nine-banded armadillo	1						
	Canis latrans	Coyote	1				1	1	
	Urocyon cinereoargenteus	Gray fox	4			4		3	84
	Leopardus pardalis	Ocelot	1					1	
	Conepatus leuconotus	American hog-nosed skunk						1	1
	Mephitis macroura	Hooded skunk							39
	Spilogale angustifrons	Southern spotted skunk						1	
	Bassariscus astutus	Ringtail						1	4
	Nasua narica	White-nosed coati	3			1	3		15
	Procyon lotor	Raccoon			2				1
	Odocoileus virginianus	White-tailed deer	6	6	4		2	4	3
	Dicotyles crassus	Eastern collared peccary				1			
	Sylvilagus floridanus	Eastern cottontail					1		
Reptilia	*Ctenosaura pectinata*	Guerreran spiny-tailed iguana	5						
Domestic species	*Capra* sp.	Goat							1
Camera days			15	15	15	15	15	15	45

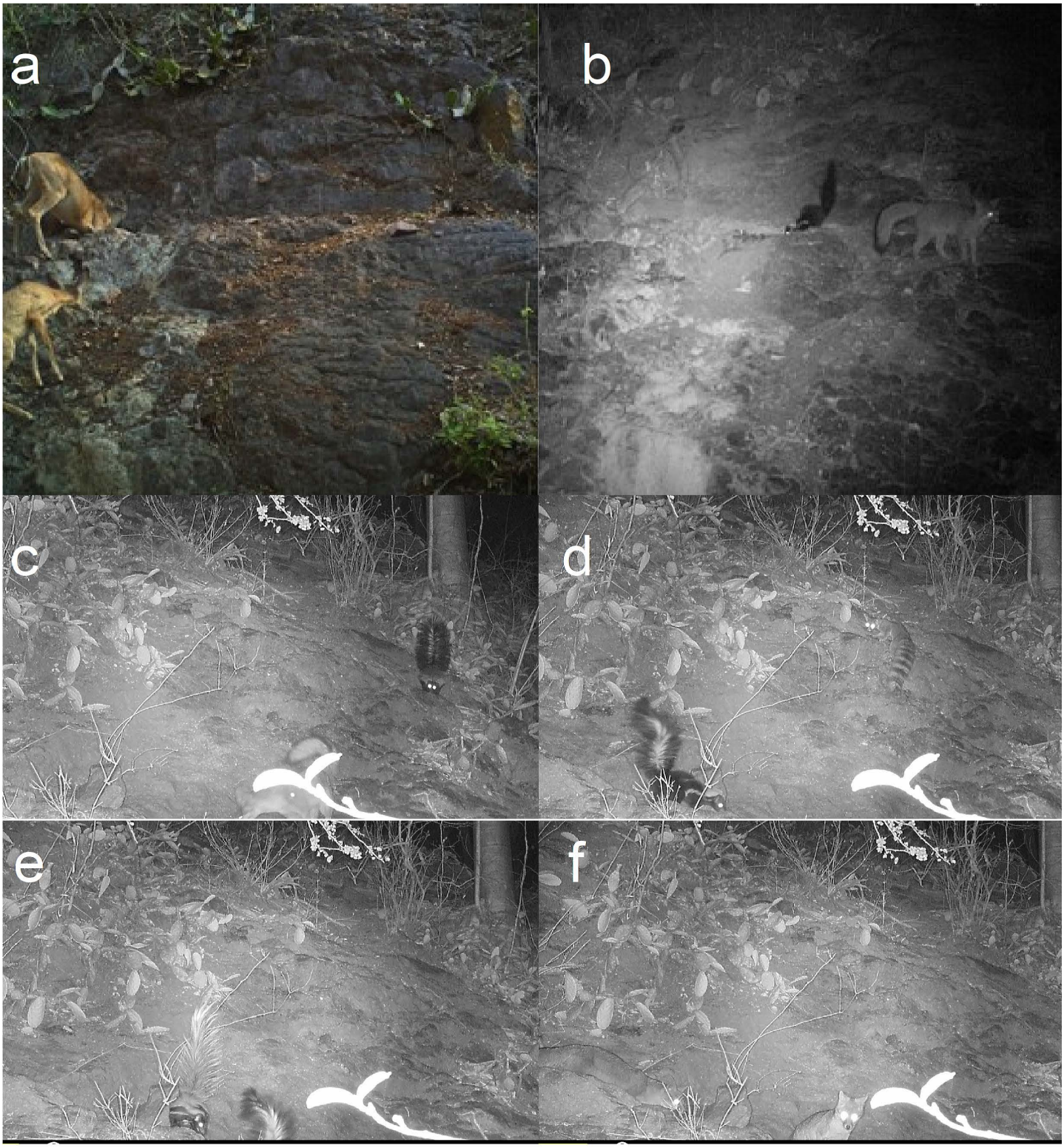

Figure 1. Co-occurrence in the waterhole between: a) two individuals of *Odocoileus virginianus*; b and c) *Mephitis macroura* and *Urocyon cinereoargenteus* individuals; d) *Mephitis macroura* and *Bassariscus astutus* individuals; e) two individuals of *M. mephitis*, and f) individuals of *U. cinereoargenteus* in the Ejido Rancho El Salado, in the southeast of the state of Puebla, in central México.

badger) and canids (Lehner 1981; Minta *et al.* 1992; Clark *et al.* 2015) and between *U. cinereoargenteus* and *Spilogale angustifrons* (southern spotted skunk; Farías-González and Vega-Flores 2019; Pérez-Irineo *et al.* 2020; Mejenes-López *et al.* 2021), as well as a co-occurrence between *C. cinereoargenteus* and *M. macroura* (Pérez-Irineo *et al.* 2020).

Water availability varies with the rainfall regime, nearby rivers have water only during the rainy season, and other deposits are small and temporary runoffs. There is, therefore, a severe water shortage for several months of the year. Thus, it is possible that the need to meet their water requirements outweighs the negative interactions among

the species in our study site. In previous studies it has been recorded that the probability of negative interactions between species might increase especially when there are limited resources such as water (Rosenstock *et al.* 1999; Krausman *et al.* 2006; Perera-Romero *et al.* 2021). However, negative interactions, such as kicking, pushing, or chasing among species, when using waterholes were not recorded in our study site as in other studies (Rosenstock *et al.* 2004).

We recorded a high frequency of visits to the waterhole by *Mephitis macroura*. We also observed that it was possible to identify individuals through the coloration pattern of the back and tail, and at least four individuals were identified during the sampling period (Figure 2). Our records raise the possibility of carrying out population and ecological studies. These could include estimation of population size using capture-recapture models, and activity, residence and reproduction patterns, in order to establish conservation strategies for these species (Cuarón *et al.* 2016). The use of this variation in skunk coloration for the identification of individuals has been previously mentioned for striped skunks, *Mephitis mephitis* (Theimer *et al.* 2017), although it has not been applied for either of the two species thus far.

Waterholes contribute to the survival of several species and they serve as sites for resting and refuge against predators (Rosenstock *et al.* 1999; Martínez-Kú *et al.* 2008; Delgado-Martínez *et al.* 2018; Rich *et al.* 2019). Our records showed that they may also function as play and grooming areas and for interactions among species, then its conservation should be considered a priority in our study site.

Our study also emphasizes a basic aspect, but perhaps underestimated in recent years for the sake of quantitative analysis of a large amount of data resulting from the use of camera traps: the qualitative observation of animals through photos. These observations can reveal basic and interesting aspects of the natural history of species that allow us to improve the knowledge we have about them and infer hypotheses in this case about coexistence in the same place. Observation of wildlife was an essential part of the development of modern science through "natural historians" such as Aldo Leopold (Piccolo 2020). This knowledge is also important for conservation actions. The camera traps offer us the opportunity to observe the animals in activities that are not easy to record. Recent works where these "curious observations" are reported, such as those by López-Tello and Mandujano (2016), Farías-González and Vega-Flores (2019), Pérez-Irineo *et al.* (2020), Mejenes-López *et al.* (2021) are examples of what is discussed here.

Acknowledgements

We received logistic support from the Facultad de Ciencias Biológicas, Benemérita Universidad Autónoma de Puebla, and Red de Biología y Conservación de Vertebrados of the Instituto de Ecología, A. C. We appreciate the field help by local people of the Ejido Rancho El Salado. The authors thank the anonymous reviewers as well as the people who collaborated during field work. This research was funded by Consejo Nacional de Ciencia y Tecnología (CONACyT) by the project CB-2015-01-256549.

Figure 2. Observation of different individuals of *Mephitis macroura* in the waterhole in the Ejido Rancho El Salado, Puebla, in central México. The coloration pattern varied from almost white (a, b) to almost black (c, d).

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Associated editor: Nicté Ordoñez-Garza
Submitted: February 18, 2021; Reviewed: June 1, 2021.
Accepted: June 11, 2021; Published on line: July 2, 2021.

THERYA NOTES 2021, Vol. 2 : 94-98 DOI: 10.12933/therya_notes-21-42 ISSN 2954-3614

A new locality record and distribution of *Caluromys derbianus* in México

Nuevo registro y distribución de *Caluromys derbianus* en México

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The Derby's wooly opossum, *Caluromys derbianus*, is regarded in México as a rare, threatened mammal species that inhabits tropical forests. It has been recorded in only 14 localities over the past 10 years and, thus, any new locality record helps to better elucidate its geographic distribution. This study aimed at describing the roadkill of a *C. derbianus* individual and mapping the geographic range of *C. derbianus* in México based on current and historical records. An adult *C. derbianus* female was roadkilled on 27 August 2019 in the Peñuela town, municipality of Amatlán de Los Reyes, state of Veracruz, México. Peñuela is a semi-urban area characterized by the presence of secondary vegetation and a tributary of the Río Blanco river. This unusual record, given the low population density of this species, confirms its presence in a previously unrecorded locality within its potential distribution range and helps to understand the effects of disturbance and fragmentation of the sub-evergreen tropical forest on the habitat of this species.

Key words: Derby's wooly opossum; Didelphidae; roadkill; sub-evergreen tropical forest.

En México, el tlacuachillo dorado (*Caluromys derbianus*) se considera un mamífero raro y amenazado que habita bosques tropicales. En los últimos 10 años, su presencia se ha registrado en 14 localidades, por lo que un nuevo registro contribuye a describir aspectos de su distribución geográfica. El objetivo del estudio fue registrar las características del atropellamiento de un ejemplar de *C. derbianus* y describir su área de distribución geográfica en México con base en registros históricos y actuales. El día 27 de agosto de 2019 se registró una hembra adulta de *C. derbianus* atropellada en la localidad de Peñuela, municipio de Amatlán de Los Reyes, Veracruz, México, localidad que se caracteriza por ser un área semiurbana, con presencia de vegetación secundaria y un arroyo tributario del Río Blanco. Este registro, poco habitual por la baja densidad poblacional de la especie, confirma su presencia en una localidad no conocida dentro de su área de distribución potencial y ayuda a entender el efecto de la perturbación y fragmentación del bosque tropical subperennifolio sobre el hábitat de esta especie.

Palabras clave: Bosque tropical subperennifolio; colisión; Didelphidae; tlacuachillo dorado.

Mammals exhibit dynamic geographic ranges that vary spatially and temporally. Records of the occurrence of a species in previously unreported localities within its potential distribution range help to better understand the processes of colonization of new habitats and advance the knowledge on the geographic distribution and biogeographic history of the taxon (Zunino and Zulini 2003). Some individuals of a population frequently move to new geographic areas in search of habitats suitable for their survival, thus increasing the probability of their being recorded in previously unreported localities within their potential distribution range. Documenting these events is essential for enhancing the knowledge of the geographic range of the species (Galindo-Aguilar *et al.* 2019).

The family Didelphidae (Order Didelphimorphia) is represented in México by 8 species (Sánchez-Cordero *et al.* 2014; Arcangeli *et al.* 2018), some of which typically present a structure known as marsupium (Ramírez-Pulido *et al.* 2014). Most species in this family face serious threats to their demography and genetic structure due to habitat loss (Medina-Romero *et al.* 2012), so that strategies for their conservation are urgently required. *Caluromys derbianus* (Waterhouse 1841) is a threatened (SEMARNAT 2019), low-abundance (Sánchez-Cordero *et al.* 2014) species. Although its potential distribution range is well documented (Gómez-Nísino 2006), any new record from a previously unreported locality within its potential distribution range confirms its presence and has implications for the biogeographic history of the taxon and its conservation (Ortega *et al.* 2021).

Caluromys derbianus, commonly known as tlacuachillo dorado, Derby's wooly opossum, or Central American woolly opossum (Bassa-Hernández *et al.* 2016), is a nocturnal, arboreal, solitary, medium-sized mammal. It is characterized by a coat bearing a greyish-whitish, long-haired, woolly section on the sides of the body, three orange-golden patches on the neck and shoulders, and large pink ears (Gómez-Nísino 2006). Bucher and Hoffmann (1980) concluded that *C. derbianus* comprises seven distinct subspecies; however, Fonseca and Astúa (2015) failed to find geographic differences in cranial traits to support the existence of subspecies. The geographic distribution of *C. derbianus* ranges from south-central Veracruz (México) to eastern Colombia and northern Ecuador (Bucher and

Hoffmann 1980); its potential distribution ranges from central México to South America (Emmons and Feer 1997) including Belize, Guatemala, Honduras, Nicaragua, Panamá, Colombia, Costa Rica, and Ecuador (Solari and Lew 2015). The potential distribution of *C. derbianus* in México comprises the north of Veracruz, eastern Puebla, Tlaxcala, southeast Oaxaca, and parts of the states of Campeche, Chiapas, Tabasco, and Quintana Roo (Solari and Lew 2015). This species has been usually recorded in protected areas in the states of Chiapas: Selva Lacandona (Medellín 1994), Laguna Bélgica (Riechers-Pérez 2004), and La Sepultura (Espinoza-Medinilla *et al.* 2004); Oaxaca: Selva Zoque and Los Chimalapas (Lira-Torres and Briones-Salas 2012); and Veracruz: Sierra de Los Tuxtlas (González-Christen 2008; González-Christen and Coates 2019).

Globally, *C. derbianus* is regarded as a species of least concern since there is no evidence of decreasing population size across its geographic range, although their populations are known to be declining (Solari and Lew 2015). Anthropogenic activities have caused major ecological changes and impacts on ecosystems in recent decades. The major driving force has been land-use change caused by urbanization for human settlements and industry, development of transport infrastructure, and agricultural activities, all of which have impacted the habitats and populations of numerous mammal species (Briones-Salas *et al.* 2016). Fragmentation and disturbance reduce habitat suitability, which might alter the migration and demographic patterns of mammal populations, as individuals are forced to move away from disturbed habitats where competition for resources and space is intense, towards habitats with more conducive environment (Cruz-Bazán *et al.* 2017). This also increases the number of wildlife that cross highways, freeways, and main or secondary streets, increasing their risk of dying by vehicular collision (González-Gallina and Benítez-Badillo 2013; González-Gallina *et al.* 2013). This study aimed at describing the roadkill of a *C. derbianus* individual and mapping the known geographic distribution of this species in México, based on occurrence records obtained from electronic databases.

Record of the roadkill of a *C. derbianus* individual. On 27 August 2019 at approximately 15:20 hr, a *C. derbianus* specimen (Figure 1a) was found dead at coordinates 18° 51′48″N, 96° 54′00″W. The corpse was on the ground next to the pavement of a secondary road that connects the semi-urban area of the Peñuela town (where agriculture is the main land use, including various crops such as banana, coffee, tropical fruit trees, and sugar cane; Figure 1b) with the main highway to the municipal capital Amatlán de Los Reyes, state of Veracruz, some 500 m north from the facilities of the Facultad de Ciencias Biológicas y Agropecuarias (Faculty of Biological and Farming Sciences) at Universidad Veracruzana. The corpse was rigid, had whitish eyes, and had been colonized by ants, fly larvae, and flies. The specimen was identified as an adult female in lactating condition, as it had hairless dugs. Standard body measurements of the specimen were taken in triplicate and averaged (Ceballos and Oliva 2005; Romero-Almaráz *et al.* 2010), with the following results: 549 mm total length, 343 mm length of vertebral tail, and 262 mm length of rear right leg. Features such as salmon-pink colored ears and nose, golden coloration on the sides with a whitish belly, and hairy tail, dark brown at the base that faded into white-bone coloration at the tip (Figure 1a), coincided with those described by Aranda (2012) and Gómez-Nísino (2006).

The skin, skull, and axial skeleton of the specimen were preserved and deposited under accession number IIB-UV 4322 in the Veracruz Mammal Collection (registry number VER.-MAM-191-10-06 SEMARNAT) of the Instituto de Investigaciones Biológicas (Institute of Biological Research) at Universidad Veracruzana.

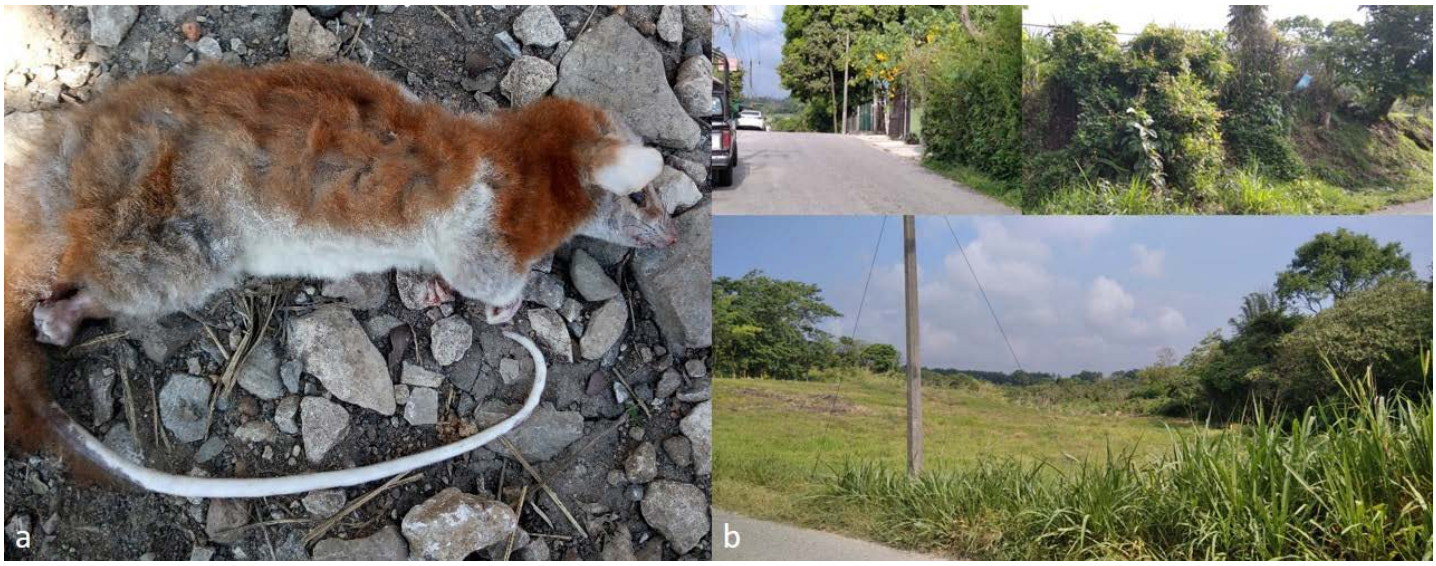

Figure 1. a) Female specimen of the Derby's wooly opossum, *Caluromys derbianus*, roadkilled in Peñuela town, Amatlán de los Reyes, Veracruz, México; b) habitat in the locality where the roadkill of *C. derbianus* occurred.

Known distribution of *C. derbianus* in México. Current (15 records dating from 1989 to 2019, GBIF 2019a) and historical (70 records dating from 1900 to 1988; GBIF 2019b) occurrence records, retrieved from the Global Biodiversity Information Facility database (GBIF 2019c), were used to map the known distribution of *C. derbianus* in México. Records providing geographic coordinates were included in the map, as they helped to understand how the species distribution has been affected spatially and temporally, either reducing its distribution range or by causing displacements to new sites leading to the expansion of its range (Zunino and Zulini 2003). Only 47 (67 %) of the 70 historical records (visual observations and records retrieved from the GBIF database) of *C. derbianus* in México provided geographic coordinates of collection localities; 34 % (16) of those correspond to the state of Veracruz, 23 % (11) to Chiapas, 19 % (9) to Tabasco, 11 % (5) to Quintana Roo, 8.5 % (4) to Campeche, 4.3 % (2) to Oaxaca, and one to San Luis Potosí. The oldest record retrieved dates back to the year 1961 and was made in the Sarabia town, state of Oaxaca, México; this can be regarded as the locality where this species was first recorded in México.

Bucher and Hoffman (1980) reported that the distribution limit of *C. derbianus* in México is the south-central part of the state of Veracruz. However, we recorded this species in the central-western part of the state of Veracruz, thus expanding its known distribution range by approximately 20 km to the west, where the mountain cloud forest, tropical evergreen forest, and tropical sub-evergreen forests converge (Gómez-Nísino 2006). The records retrieved reported elevations ranging from 0 to 3,600 m; this can be regarded as the altitudinal range encompassed by this species in México. In other countries such as Colombia, this species has been reported to occur from coastal areas up to 2,600 m (Alberico *et al.* 2000).

Of the 15 records of *C. derbianus* deposited in the GBIF database for the 1989-2019 period, 14 (93 %) came from different locations. Nine (65 %) of these records were made in the state of Chiapas at elevations ranging from 36 to 300 m; 6 (42 %) were made in the state of Veracruz, and 2 (14 %) in the state of Tabasco, but these did not include information on vegetation type or elevation. The distribution map of *C. derbianus* shows that the northernmost record is located in the state of San Luis Potosí, México, and that the records are concentrated along the Sierra Madre Oriental mountain range (Figure 2). The new record of this species falls amid a set of historical records. Thus, future studies should further investigate demographic aspects and characterize the

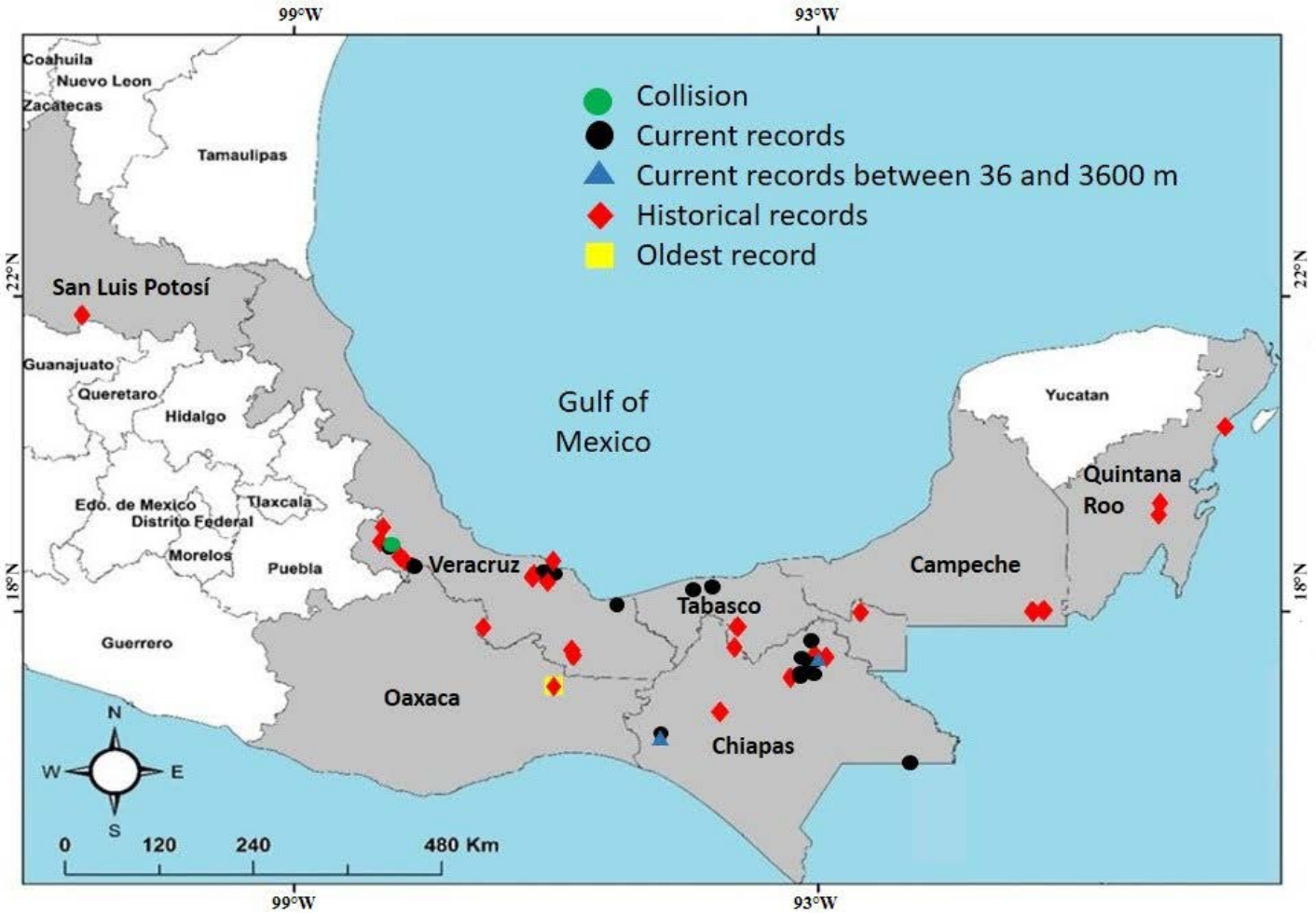

Figure 2. Geographic location of historical (scientific collections) and recent (GBIF database) records of the Derby's wooly opossum, *Caluromys derbianus*, in México. Mexican states shown in gray are those where this species has been recorded.

habitat of this species to help formulate and implement specific actions for conservation. The presence of *C. derbianus* is usually associated with coffee, banana, and cocoa plantations (Marineros-Sánchez *et al.* 2016), as confirmed in the field in the area surrounding the locality where the roadkill occurred. Most recent records of these marsupials have been made near human settlements, as this species rapidly adapts to disturbed places, making encounters with them to be frequent (Hillman and Thompson 2016).

Acknowledgements

The authors thank the three reviewers whose suggestions greatly improved and enriched our manuscript. M. E. Sánchez-Salazar translated the manuscript into English.

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Associated editor: Romeo A. Saldaña-Vázquez
Submitted: November 14, 2020; Reviewed: May 21, 2021.
Accepted: June 16, 2021; Published on line: July 2, 2021.

THERYA NOTES 2021, Vol. 2 : 99-104 DOI: 10.12933/therya_notes-21-43 ISSN 2954-3614

Outstanding records of mammals from two protected areas of central Guerrero, México

Registros notables de mamíferos en dos áreas protegidas del centro de Guerrero, México

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This work describes outstanding records of 8 threatened mammal species (as per the Official Mexican Norm NOM-059), which are also new records for two protected areas of the central region of the state of Guerrero, México. These species are difficult to observe, have been scarcely studied, and had not been previously recorded in the study area. The study was carried out from July 2018 to July 2019 using 22 camera traps separated from each other by 170 m to 1,300 m in stands of pine-oak forest, oak-pine forest, and low-stature tropical deciduous forest. Photographic records were compared with previous records by entering their coordinates into a geographic information system. *Herpailurus yagouaroundi*, *Leopardus pardalis*, *Leopardus wiedii*, *Lontra longicaudis*, *Panthera onca*, *Coendou mexicanus*, *Spilogale pygmaea*, and *Tamandua mexicana* were recorded both by photo-trapping and direct observations. These mammal species are listed in the Official Mexican Norm NOM-059-SEMARNAT-2020. Our results significantly contribute to expand the knowledge of mammals of the state of Guerrero, México. No information on the presence of these species in the study area or nearby locations was available prior to our study. The confirmed presence of these species in the study area is an indicator of its conservation status.

Key words: Carnivores; conservation; photo-trapping; voluntary conservation areas; wildlife.

Se describen registros notables de 8 especies de mamíferos en categorías de riesgo de acuerdo con la Norma Oficial Mexicana NOM-059, los cuales son nuevos para 2 áreas naturales protegidas de la región centro de Guerrero, México. Estas especies son difíciles de observar y hay pocos estudios, por lo que no se cuenta con registros previos en la zona de estudio. El estudio se realizó entre julio 2018 y julio 2019 con 22 cámaras trampa distribuidas en bosque de pino-encino, bosque de encino-pino, y selva baja caducifolia con un rango de separación entre las mismas de 170 m a 1,300 m. Se compararon los registros fotográficos con registros previos mediante el ingreso de coordenadas a un sistema de información geográfica. Se registró mediante foto-trampeo y observación directa a *Herpailurus yagouaroundi, Leopardus pardalis, Leopardus wiedii, Lontra longicaudis, Panthera onca, Coendou mexicanus, Spilogale pygmaea* y *Tamandua mexicana*; estos mamíferos están incluidos como especies en categoría de riesgo de acuerdo con la Norma Oficial Mexicana NOM-059-SEMARNAT-2020. Nuestros resultados son de relevancia para el conocimiento mastozoológico en el estado de Guerrero; antes del presente trabajo no se contaba con información sobre la presencia de estas especies en el área de estudio ni en localidades cercanas. El registro de estas especies sugiere un indicador del buen estado de conservación de la zona estudiada.

Palabras clave: Áreas de conservación voluntaria; carnívoros; conservación; fauna silvestre; foto-trampeo.

In México, mammals have been affected by land-use change, poaching, and illegal trafficking (Lira-Torres *et al.* 2014). In response, Protected Areas (PAs) have been created as a major conservation strategy (Bello and Estrada-Lugo 2012). This study was conducted in 2 PAs in the municipality of Chilpancingo de los Bravo, state of Guerrero, México: the El Borbollón, La Pandura y La Yerbabuena Voluntary Conservation Area (VCA), owned by the Azinyahualco ejido, and the Los Olivos State Reserve, in ejido La Esperanza.

The 2011 decree of Los Olivos PA (Gobierno del Estado de Guerrero 2010) mentioned the presence of 4 mammal species listed in NOM-059-SEMARNAT-2020 (SEMARNAT 2020): jaguarundi (*Herpailurus yagouaroundi*), ocelot (*Leopardus pardalis*), margay (*L. wiedii*), and the Northern tamandua (*Tamandua mexicana*). However, the decree neither state the type of observations that support this claim nor whether historical sightings by inhabitants of the La Esperanza town were reviewed. Thus, it was not entirely certain whether the above-mentioned species were indeed present in Los Olivos. No published information on mammal species occurring in El Borbollón, La Pandura y La Yerbabuena VCA is available. Both PAs are managed by their respective local communities. The lack of biological data for these PAs reflects the overall scarcity of information on the mammals of the state of Guerrero. Our study aimed at identifying mammal species listed

in NOM-059-SEMARNAT-2020 that have been recorded in these PAs. This is an effort to assess the conservation status and envision action plans to preserve the integrity and complexity of the habitats therein.

Los Olivos PA (1,243 ha) and El Borbollón, La Pandura y La Yerbabuena VCA (817 ha) are located contiguous to each other, 80 km southwest of Chilpancingo City, in the state of Guerrero, on the Sierra Madre del Sur mountain range. The predominant vegetation types are low-stature tropical deciduous forest, pine-oak forest, and oak-pine forest (Miranda and Hernández-Xolocotzi 1963). A semi-warm humid climate prevails at the lower elevations of both PAs, and a temperate humid climate in the higher parts (INEGI 2008). Elevation ranges from 950 to 2,000 m and soils are of volcanic and sedimentary origin (INEGI 2007).

Twenty-two photo-trapping stations fitted with Cuddeback E3 cameras were placed in the study area, separated from each other by 170-1,300 m. The motion-activated cameras were placed approximately 50 cm above the ground (Chávez et al. 2013) and set to shoot a 20-megapixel picture followed by a 20-second 720p video and then a 30-second pause for the sensor to reactivate, during the day and nighttime; no attractant was used. Sites for trap placement were chosen *a priori* aiming to sample the three vegetation types, proportionally to the extent of the PAs, along trails located away from commonly used paths to prevent camera traps from being vandalized or stolen (Figure 1; Table 1). Camera traps experienced occasional malfunctioning; each camera trap was operational for 232 ± 15 days on average over the 12-month study period (July 2018 to July 2019), for a total sampling effort of 5,103 trap-days, as per the analysis conducted with the program CAMERASWEET of the Small Wild Cat Conservation Foundation (SWCCF 2020).

The species recorded were identified using specialized literature (Reid 2009; Ceballos and Oliva 2005); the nomenclature follows Ramírez-Pulido *et al.* (2014). We searched the Unidad de Informática para la Biodiversidad (Information Unit for Biodiversity; UNIBIO 2020) and the Global Biodiversity Information Facility (GBIF 2021) digital databases for records of mammal species listed in NOM-059-SEMARNAT-2020 for the study area. Records that included geographic coordinates of collection localities were entered into a geographic information system using the software QGis version 3.14 (2020) to compare them with previous records from the study area (Figure 2).

Wild mammals were recorded in all sampling sites. The following species were recorded in sites No. 13 to No. 22 (Table 1): ringtail (*Bassariscus astutus*), American hog-nosed skunk (*Conepatus leuconotus*), nine-banded armadillo (*Dasypus novemcinctus*), Virginia opossum (*Didelphis virginiana*), white-nosed coati (*Nasua narica*), white-tailed deer (*Odocoileus virginianus*), Eastern collared peccary (*Dicotyles crassus*), raccoon (*Procyon lotor*), Mexican gray squirrel (*Sciurus aureogaster*), and gray fox (*Urocyon cinereoargenteus*). Since we focused on records of mammal species listed in NOM-059-SEMARNAT-2020, Table 2 shows the species recorded in sites No.1 to No.12 where such species occurred. Our photo trap records documented (Figure 3) the presence of the following species in the study area: jaguarundi (*H. yagouaroundi*), ocelot (*L. pardalis*), margay (*L. wiedii*), jaguar (*Panthera onca*), Mexican hairy dwarf porcupine (*Coendou mexicanus*), pygmy spotted skunk (*Spilogale pygmaea*), and Northern tamandua (*T. mexicana*). Additionally, the presence of the neotropical otter, *Lontra longicaudis*, in the Los Olivos state reserve was documented both by direct observation and through excreta (Figure 3h). The four felid species were recorded in both PAs in the three vegetation types, with varying frequency and time of occurrence (Table 2). *Herpailurus yagouaroundi* was recorded between April and June 2019 (Figure 3b); *L. wiedii*, between October 2018 and June 2019 (Figure 3c); *P. onca*, between March and May 2019 (Figure 3d); and *L. pardalis*, from August 2018 to June 2019 (Figure 3a). The latter was recorded with cubs on five occasions (Figure 3a).

Spilogale pygmaea was recorded in both PAs, but only in pine-oak and oak-pine forests, in May, July, and August 2019 (Figure 3e). *Coendou mexicanus* was observed only once in

Table 1. Geographic coordinates of the photo-trapping stations deployed in the Los Olivos State Reserve and the El Borbollón, La Pandura y La Yerbabuena Voluntary Conservation Area (BYP), state of Guerrero, México. Stations shown in boldface recorded mammal species listed in the Official Mexican Norm NOM-059-SEMARNAT-2020. ANP = Protected Area. Vegetation types: BEP = oak-pine forest, BPE = pine-oak forest, SBC = low-stature deciduous tropical forest.

Photo-trapping stations	Longitude (W)	Latitude (N)	ANP	Vegetation types
1	**99° 35' 22.99"**	**17° 24' 43.87"**	**Los Olivos**	**BEP**
2	**99° 35' 04.60"**	**17° 24' 34.69"**	**Los Olivos**	**SBC**
3	**99° 35' 21.50"**	**17° 23' 55.87"**	**Los Olivos**	**BPE**
4	**99° 35' 01.56"**	**17° 23' 34.36"**	**Los Olivos**	**BPE**
5	**99° 34' 29.77"**	**17° 23' 16.41"**	**Los Olivos**	**SBC**
6	**99° 34' 42.46"**	**17° 22' 10.25"**	**Los Olivos**	**BPE**
7	**99° 34' 12.87"**	**17° 24' 14.93"**	**BYP**	**BEP**
8	**99° 34' 07.53"**	**17° 24' 14.43"**	**BYP**	**BPE**
9	**99° 34' 07.95"**	**17° 23' 44.22"**	**BYP**	**BEP**
10	**99° 34' 08.65"**	**17° 23' 21.46"**	**BYP**	**BEP**
11	**99° 34' 01.19"**	**17° 23' 17.72"**	**BYP**	**SBC**
12	**99° 33' 56.52"**	**17° 23' 05.99"**	**BYP**	**SBC**
13	99° 34' 57.99"	17° 24' 3.23"	Los Olivos	SBC
14	99° 35' 4.17"	17° 24' 13.26"	Los Olivos	SBC
15	99° 35' 21.48"	17° 24' 10.41"	Los Olivos	BPE
16	99° 35' 19.37"	17° 23' 34.57"	Los Olivos	BPE
17	99° 34' 36.86"	17° 23' 14.61"	Los Olivos	BEP
18	99° 33' 48.87"	17° 24' 7.90"	BYP	BPE
19	99° 34' 15.23"	17° 24' 6.43"	BYP	SBC
20	99° 33' 54.35"	17° 23' 22.78"	BYP	SBC
21	99° 33' 36.73"	17° 22' 27.96"	BYP	SBC
22	99° 34' 0.26"	17° 22' 24.92"	BYP	SBC

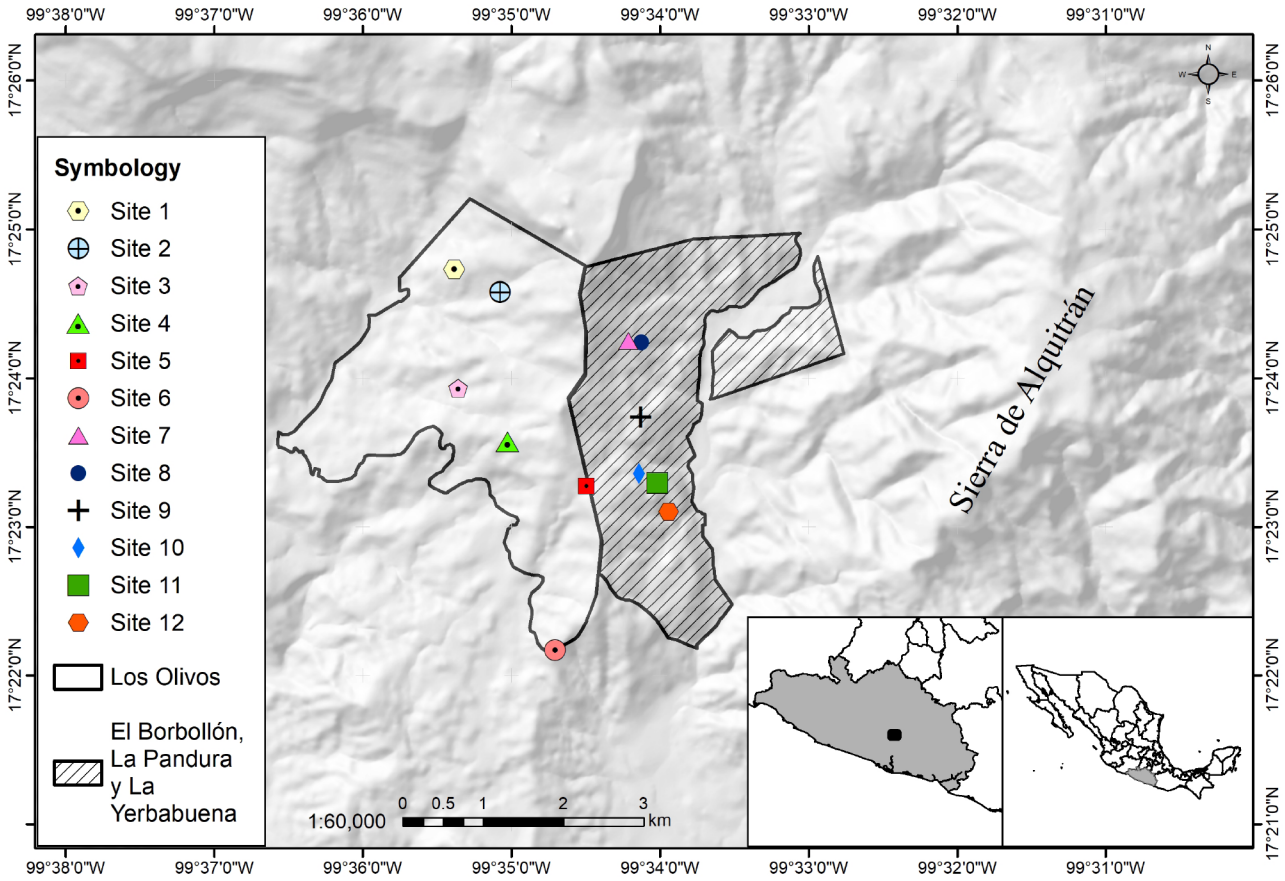

Figure 1. Map showing the location of Los Olivos and El Borbollón, La Pandura y La Yerbabuena protected areas in the municipality of Chilpancingo de Los Bravo, state of Guerrero, México, and photo-trapping stations where records were made.

the low-stature tropical deciduous forest in May (Figure 3f). Similarly, *T. mexicana* was recorded only in the low-stature tropical deciduous forest (Figure 3g), once in September 2018 and then in May 2019 (Table 2). *Lontra longicaudis* was directly observed during a camera-trap maintenance visit to Los Olivos State Reserve; excreta from *L. longicaudis* were also found some 4 m from the direct observation location (Figure 3h) on the margin of La Esperanza river (coordinates 17° 24′ 46.91″ N, 99° 35′ 40.06″ W).

Assessing the presence of predators and species sensitive to habitat degradation in the study area contributes to broadening the knowledge of mammals of the state of Guerrero; few studies addressing this group have been conducted in this part of the country in recent years. The nearest previous record of *S. pygmaea* is from a location 4 km east of the Xochipala locality, some 45 km north of our study sites; this skunk prefers low-elevation areas mainly covered by low-stature tropical deciduous

Table 2. Mammal species listed in the Official Mexican Norm NOM-059-SEMARNAT-2020 recorded in photo-trapping stations in the Los Olivos State Reserve and the El Borbollón, La Pandura y La Yerbabuena Voluntary Conservation Area (BYP), number of records, and vegetation types where they were recorded. ANP = Protected Area. Conservation status: A = threatened, P = endangered, Pr = subject to special protection. Vegetation types: SBC = low-stature deciduous tropical forest, BEP = oak-pine forest, BPE = pine-oak forest.

Species	ANP	Photo-trapping stations	Vegetation types	Number of records	Conservation status
Herpailurus yagouaround	Los Olivos, BPY	5, 4, 7, 8	SBC, BEP, BPE	5	A
Leopardus pardalis	Los Olivos, BPY	4, 7, 8, 9, 10, 11, 12	SBC, BEP, BPE	18	Pr
Leopardus wiedii	Los Olivos, BPY	1, 2, 3, 5, 6, 7	SBC, BEP, BPE	10	Pr
Panthera onca	Los Olivos, BPY	5, 6, 9	SBC, BEP, BPE	6	P
Coendou mexicanus	BPY	11	SBC	1	A
Spilogale pygmaea	Los Olivos, BPY	1, 8, 9	BEP, BPE	9	A
Tamandua mexicana	BPY	12	SBC	2	P
Lontra longicaudis	Los Olivos	No station	SBC	1	A

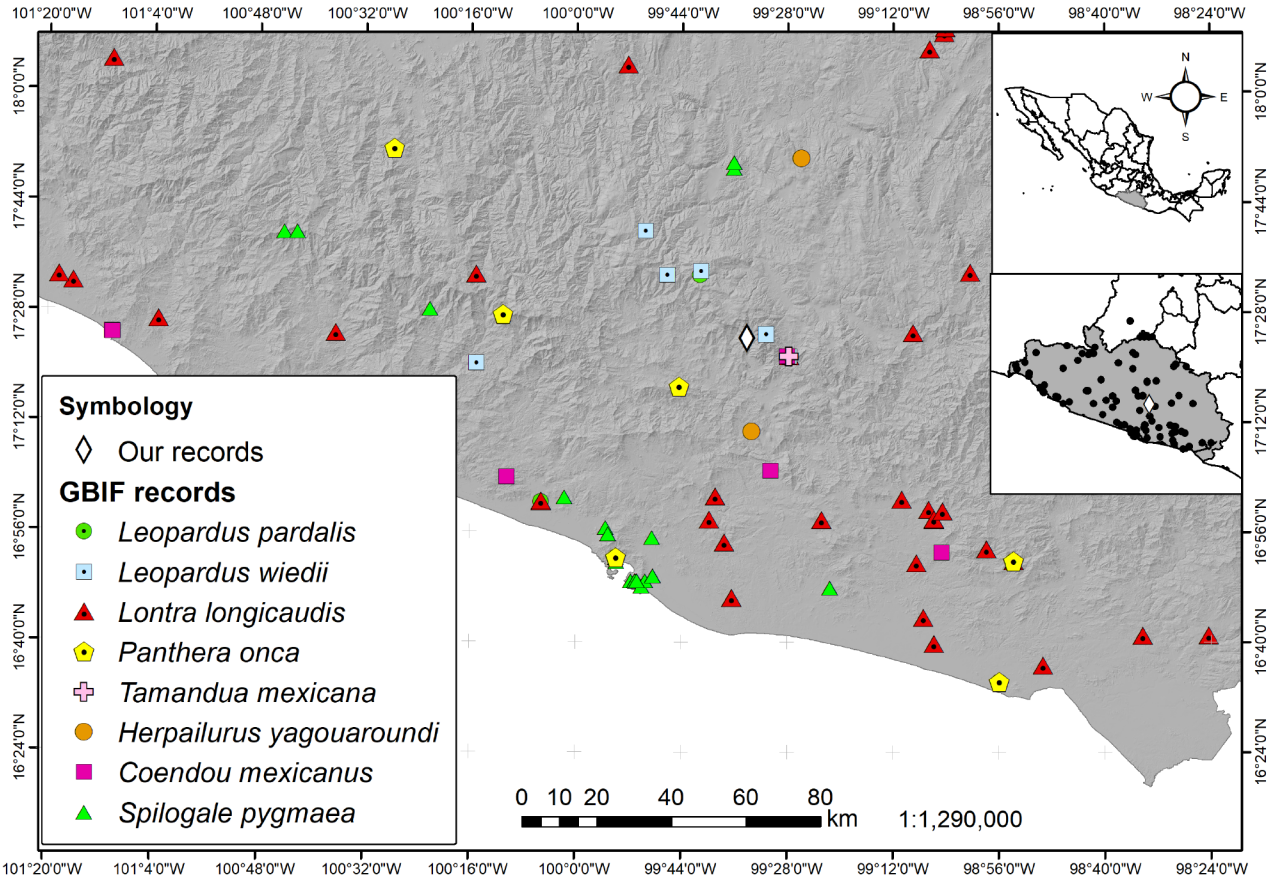

Figure 2. Map showing the location of previous records of mammal species located within or near the study area in the state of Guerrero, México, as retrieved from online databases and the literature. The white symbol shows the location of the study area.

forest (Medellín *et al.* 1998; Ceballos and Miranda-Sánchez 2000). However, we recorded *S. pygmaea* more frequently in oak-pine forests in both PAs at elevations from 1,374 to 1,580 m. This is the first record of this species in high elevation areas of the state of Guerrero, outside its known distribution range (Lavariega and Briones-Salas 2019).

As per the GBIF database (2021), the nearest previous record of *P. onca* is a footprint found near the Carrizal town, some 20 km south of our study area, which was reported to the iNaturalist platform in 2018. The home range of *P. onca* males can reach up to 90 km^2, depending on the abundance of prey (Chávez *et al.* 2005); thus, the ranges of the two jaguars that we recorded are unlikely to overlap the range of this previous record. In addition, this was the only species for which we were able to differentiate individuals based on their spot patterns (Figure 3d); we were also able to determine that one of these individuals was a male, but the sex of the other is unknown.

A record of *H. yagouaroundi* 22 km south of our study area on the México-Acapulco highway, 3 km northwest of the Tierra Colorada town, in low-stature tropical deciduous forest and maize crop fields is reported by Almazán-Catalán *et al.* (2013). This felid is widely distributed in different habitat types, but most records are from elevations below 1,000 m (Oliveira-Gomes 1998; Aranda-Sánchez 2005a). We made a few records of *H. yagouaroundi* in oak-pine forest and low-stature tropical deciduous forest at elevations ranging between 1,519 and 1,628 m. One *L. wiedii* specimen was captured using a Tomahawk trap 6 km east of our study area at an elevation of 2,560 m (Almazán-Catalán *et al.* 2013). The home range of an adult *L. wiedii* can reach up to 11 km^2 (Aranda-Sánchez 2005b); thus, the ranges of the jaguarundis recorded in our study area are also unlikely to overlap the range of this previous record. Although the distance between the previous record and ours is relatively short, confirming the continued presence of this endangered species in the study area is a key finding.

Coendou mexicanus had been previously recorded some 12 km east of our study area, in the Acahuizotla town at 860 m (GBIF 2021). This locality is separated from our study sites by the Sierra de Alquitrán mountain range. The arboreal habits of this rodent make its recording by camera traps set near the ground unlikely, while its nocturnal habits make direct observations difficult (Juárez-G. 2005). One record of *L. pardalis* was retrieved from the GBIF database; the record was obtained 21 km to the northwest of our study area in the Omiltemi town but does not include any other information. Ocelots can inhabit a wide range of habitats and are generally found at elevations below 1,200 m (Murray and Gardner 1997). Our 18 records were made at elevations from 1,400 to 1,580 m; one shows a cub with its mother (Figure 3a). *Tamandua mexicana* had been previously recorded

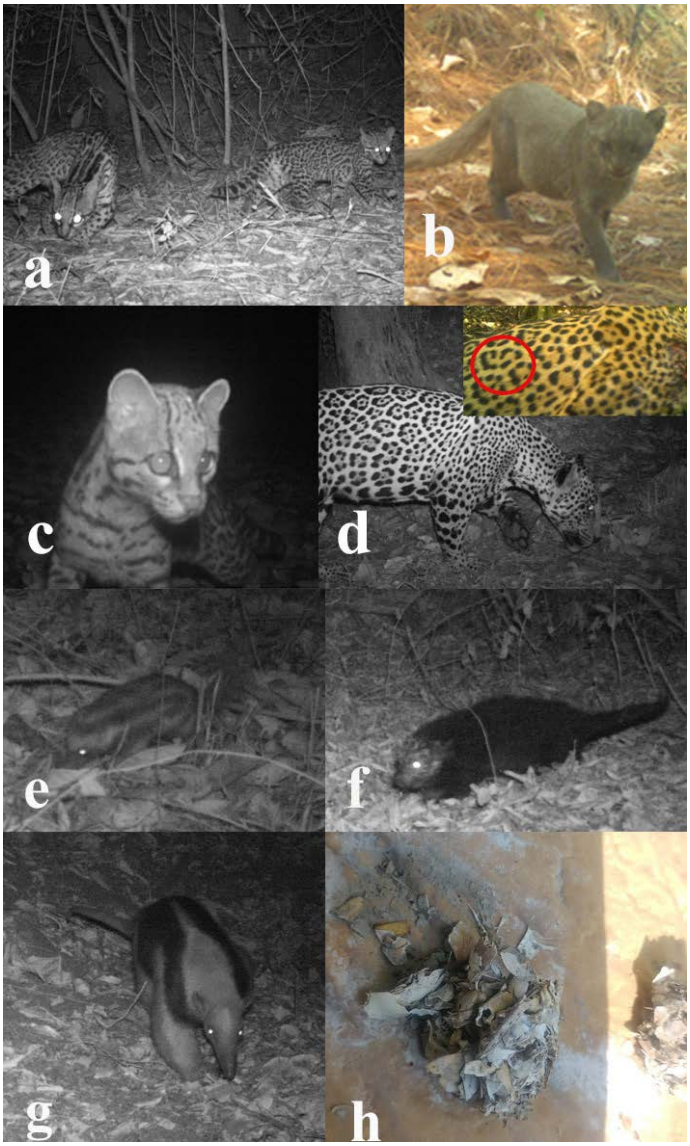

Figure 3. Photographic records of wild mammals in El Borbollón, La Pandura y La Yerbabuena and Los Olivos protected areas in the state of Guerrero, México. a) *Leopardus pardalis*, b) *Herpailurus yagouaroundi*, c) *Leopardus wiedii*, d) *Panthera onca*, e) *Spilogale pygmaea*, f) *Coendou mexicanus*, g) *Tamandua mexicana*, h) excreta of *Lontra longicaudis*.

13 km east of our camera site No. 12 (Table 1) at an elevation of 860 m; our record was made at 1,300 m, while most records reported in the literature were made below 1,000 m (Navarrete and Ortega 2011).

Lontra longicaudis was the only species that we were able to record by both direct observation and through signs found on the riverbank. The nearest previous record was made 14 km east of La Esperanza river, separated from our study area by the foothills of the Sierra de Alquitrán mountain range. Since river otters generally stay close to water bodies (Larivière 1999), it is likely that separate populations exist on both sides of Sierra de Alquitrán. This record is important as it documents the conservation of this threatened species (Gallo-Reynoso 1997) in the PA.

The UNIBIO (2020) and GBIF (2021) databases contain few records of mammal species from the state of Guerrero and these do not include additional observations such as those recorded in our study. Thus, in addition to this publication, our records will be uploaded to the iNaturalist platform. Since iNaturalist is linked to the GBIF database, this will help to continue the systematization and publication of records to enhance the knowledge on mammals of the state of Guerrero.

Acknowledgements

We thank the inhabitants of ejidos Azinyahualco and La Esperanza for kindly granting access to their land and their hospitality. The first author was the recipient of scholarship No. 702287 granted by CONACyT. We also thank the NGO Bosque Nuboso A. C. for their support in the field during the setting up of camera traps. We thank the reviewers whose comments and recommendations greatly improved our manuscript. M. E. Sánchez-Salazar translated the manuscript into English.

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Associated editor: Jesús R. Hernández-Montero
Submitted: February 9, 2021; Reviewed: May 24, 2021.
Accepted: June 17, 2021; Published on line: July 2, 2021.

THERYA NOTES 2021, Vol. 2 : 105-108 DOI: 10.12933/therya_notes-21-44 ISSN 2954-3614

Predation of the hooded skunk, *Mephitis macroura*, by the great horned owl, *Bubo virginianus*, in the Barranca de Metztitlán Biosphere Reserve, Hidalgo, México

Depredación del búho cornudo (*Bubo virginianus*) sobre el zorrillo listado (*Mephitis macroura*) en la Reserva de la Biosfera Barranca de Metztitlán, Hidalgo, México

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Documenting and describing natural history events such as predation contribute to better understand the ecological responses of species. This note describes the predation of a hooded skunk individual, *Mephitis macroura*, by the great horned owl, *Bubo virginianus*, based on video recording and photographs. Audiovisual materials were obtained as part of the camera-trap sampling of carnivorous mammals in the Barranca de Metztitlán Reserve during August–December 2016. Camera traps record the time and date of events, thus allowing an accurate recording of the interactions between the owl and the skunk individuals. Three photographs and two 10-second videos were examined. One of the videos recorded the skunk vocalization upon being attacked by the owl. The entire second video shows the inert skunk. The two species could be accurately identified on the photographs. Skunks display an aposematic coloration that is usually a highly effective camouflage to hide from terrestrial predators. However, this seems to be ineffective against nocturnal birds of prey. Owls are probably the main regulators of skunk populations. This record shows that such interaction is maintained even at the southernmost end of the distribution range of the two species.

Key words: Camera traps; monitoring; natural history; photo interpretation; predation.

Documentar y describir los eventos de historia natural como la depredación son de gran ayuda para entender las respuestas ecológicas de las especies. En esta nota se describe la depredación del búho cornudo (*Bubo virginianus*) sobre un zorrillo listado (*Mephitis macroura*) mediante la descripción de un video y una serie de fotografías. El material audiovisual se obtuvo durante un muestreo enfocado en mamíferos carnívoros usando trampas cámara durante los meses de agosto a diciembre de 2016, en la Reserva Barranca de Metztitlán. El material registra la hora y el día de los eventos por lo que se pudo registrar la interacción entre el búho y el zorrillo. Se obtuvieron tres fotografías y dos videos de 10 segundos, en uno de ellos se registró la vocalización del zorrillo cuando es atacado por el búho. El segundo video se mantiene con la misma imagen del zorrillo abatido. En las fotografías es posible distinguir sin duda la identidad de ambas especies. Los zorrillos son una especie con una coloración aposemática que suele ser muy efectiva para camuflajearse de depredadores terrestres. Sin embargo, en el caso de las rapaces nocturnas, ésta parece ser inefectiva y probablemente los búhos sean los principales reguladores de las poblaciones de zorrillos. Este registro implica que esta interacción se mantiene aún en las regiones más sureñas de la distribución de ambas especies.

Palabras clave: Depredación; fotointerpretación; historia natural; monitoreo; trampas cámara.

Interactions between vertebrate species in the wild cannot always be observed or recorded directly. The increasing use of camera traps has contributed to significantly expand the monitoring and study of terrestrial mammals in recent years (Mandujano 2019). As a result, numerous observations on the natural history of mammals and other species have been made possible. Photographs recorded during camera-trapping studies often allow observing the behavior of and interactions between species and, in addition to confirming their occurrence, these document their temporality as data on the date, time, and some environmental aspects are also recorded (Jenkins *et al.* 2011; Norouzzadeh *et al.* 2018).

Predation is one of the interactions that has been recorded in camera-trap materials as videos or photographs often allow clearly identifying the interacting species. For example, a jaguar directly predating on a crocodile (Simá-Pantí *et al.* 2020), or the likely association between species to reduce the risk of predation, as documented for the southern spotted skunk, *Spilogale angustifrons*, which subordinates its movements to those of the gray fox, *Urocyon cinereoargenteus*, in arid (Farías-González and Vega-Flores 2019) and warm subhumid (Mejenes-López *et al.* 2021) environments. Photographic records are often the only evidence available on rare events, such as the predation by a carnivore.

This note describes a predation event of a hooded skunk individual, *Mephitis macroura*, by the great horned owl, *Bubo virginianus*, based on the examination of a video recording and photographs captured during a study of carnivorous mammals in the Barranca de Metztitlán Biosphere Reserve, state of Hidalgo, in 2016.

The event was documented during a field study using camera traps to record carnivorous mammals. The monitoring was carried out from August to December 2016 within the boundaries of the Barranca de Metztitlán Biosphere Reserve. The reserve was decreed by the Mexican government in March 2000 and registered by UNESCO in October 2006. The reserve is in the state of Hidalgo, México (20° 14′ 15″ – 20° 45′ 26″ N, 98° 23′ 00″– 98° 57′ 08″ W) and comprises a total area of 96,042.94 ha (CONANP 2003).

The reserve is characterized by a rugged topography with steep slopes; the elevation ranges from 1,000 to 2,000 m. The local climate is dry, semi-warm with a summer rainy season (García 1973); the mean annual temperature varies between 18 and 22 ºC, and the mean annual precipitation is less than 600 mm. The reserve harbors eleven vegetation and six land-use types. Crassicaulescent shrubland is the most extensive vegetation type (19.18 % of the total area of the reserve), followed by pine forest (15.83 %), submontane shrubland (10.53 %), oak forest (10.43 %), and other vegetation types (11.93 %); the rest of the reserve (32.1 %) is covered by irrigated and rain-fed agriculture, urban zones, induced or cultivated pastures, and areas with no vegetation (INEGI 2016).

A total of 30 photo-trapping stations were set for the sampling; in each station, a Cuddeback E2 long range IR, 20 MP-resolution camera was fitted. Stations were located within the reserve following two criteria: vegetation type and easy of access along existing trails, aiming to sample the full extent of the reserve and keeping a minimum distance of 1.5 km between adjacent camera traps.

The sampling was carried out for 150 days for a total sampling effort of 4,500 camera-days. In this period, hooded skunk individuals were recorded in 13 capture events, while the great horned owl was only recorded in another locality. The predation event took place on 17 December 2016 and was recorded by a camera trap located in the El Palmar town, municipality of Metztitlán (20° 30′ 33″ N, 98° 48′ 54″ W); four photographs and two 10-second videos were recorded. The video recordings can be viewed at the following links: https://youtu.be/LMoj-S-uQRQ and https://youtu.be/DWGxDUdjTLk.

Figure 1 shows the chronological sequence of the recorded predation event of a hooded skunk by a great horned owl. a) A photograph captured at 7:43 pm shows, to the lower right, the wing of a horned owl and the tail of a hooded skunk. b) A frame from a video shows the head of the owl, which confirms its identity. c) A photograph captured seven minutes later (7:50 pm) shows the owl fly-

Figure 1. Photographic chrono-sequence of the predation of a hooded skunk (*Mephitis macroura*) individual by the great horned owl (*Bubo virginianus*) in the Barranca de Metztitlán Biosphere Reserve, State of Hidalgo, México. The chrono-sequence is described in the text. All the material was entered into the photo-trapping archive of the laboratory of biological conservation of the Área Académica de Biología, Instituto de Ciencia Básica e Ingeniería, Universidad Autónoma del Estado de Hidalgo.

ing and carrying the hooded skunk in its claws; the tail and the back of the owl and the tail of the skunk under the owl are clearly seen, which confirms the identity of the two species. d) This photograph shows the hooded skunk lying some 6 meters away from the camera trap; its bright eyes stand out, and it can be assumed that it was already dead. A video was recorded immediately after the latter photograph; this shows the same image for the entire 10-second length. This camera was reviewed again 10 days after the event, but no trace of the skunk could be found around, and no further events were recorded. All the audiovisual materials recorded were entered into the photo-trapping archive of the Laboratory of Biological Conservation of the Department of Biology of the Institute of Basic Science and Engineering (Área Académica de Biología, Instituto de Ciencia Básica e Ingeniería) at Universidad Autónoma del Estado de Hidalgo.

Hooded skunks are nocturnal carnivores whose anal glands produce toxic chemical secretions that they can spray out when faced with a potential predator threat. All skunks have black-and-white colored coats; this is the aposematic color signal most commonly found in mammals and acts as a warning for predators. These defense mechanisms are likely successful for evading terrestrial predators in the open environments where skunks are more susceptible to being attacked (Stankowich *et al.* 2014). However, they do not seem to be highly effective against nocturnal aerial predators such as owls; in fact, predation by owls has been identified as the main cause of mortality for some skunk species of the genera *Spilogale* (Lesmeister *et al.* 2010), *Conepatus* (Anza and Zilio 2015), and *Mephitis* (Fisher and Stankowich 2018).

It is also likely that owls feed on skunks more frequently than what has been reported in feeding studies. Such studies are usually based on the analysis of pellets in which regularly eaten, small and medium-sized prey, mainly lagomorphs and rodents, are more easily observed (Zimmerman *et al.* 1996; Tomazzoni *et al.* 2004; Kopij 2016). Remains of carnivores such as weasels (*Mustela frenata*; Kremer and Belk 2003) are hardly detected in pellets. Thus, the role that the great horned owl plays in the regulation of populations of this type of carnivores might be underestimated (Tomazzoni *et al.* 2004; Lesmeister *et al.* 2010; Anza and Zilio 2015).

Recording this type of events is important, as these may document the role of the great horned owl in regulating hooded skunk populations. Our record may also be related to unconventional interactions such as the one observed between the gray fox and the spotted skunk (Farías-González and Vega-Flores 2019; Mejenes-López *et al.* 2021). Camera-trapping is a valuable tool for documenting natural history events, such as interactions between vertebrates in protected areas.

Acknowledgements

We thank the staff of the Barranca de Metztitlán Biosphere Reserve and CONANP for the financial support provided through the PROCER/CCER/DRCEN/04/2016 "Conservación de carnívoros silvestres en Barranca de Metztitlán" (Conservation of wild carnivores inhabiting the Barranca de Metztitlan) project. Particularly, we thank the director of the reserve, Mr. E. H. Olvera Delgadillo. We also thank the staff of the NGO Soluciones Ambientales Itzeni A. C. for their support, and Mr. G. Sánchez Martínez for his support in the field. The authors thank the two reviewers whose suggestions greatly improved and enriched our manuscript. M. E. Sánchez-Salazar translated the manuscript into English.

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Associated editor: José F. Moreira-Ramírez
Submitted: October 14, 2020; Reviewed: June 3, 2021.
Accepted: June 21, 2021; Published on line: July 9, 2021.

THERYA NOTES 2021, Vol. 2 : 109-111 DOI: 10.12933/therya_notes-21-45 ISSN 2954-3614

Albino wild boar (*Sus scrofa*) in Tamil Nadu, Southern India

Jabalí albino (*Sus scrofa*) en Tamil Nadu, sur de la India

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Albinism is a hypo-pigmentary disorder with a total lack of melanins in hairs, eyes, and skin due to the heritable absence of functional tyrosinase enzyme in pigment cells affecting all skin and hairs, resulting in a total white fur with red eyes. On 10th August 2019, 11:30 am during a fieldwork we recorded an albino male wild boar in Sathyamangalam Tiger Reserve, Eastern Ghats, Tamil Nadu, Southern India. Unfortunately, numerous records of this kind of colour aberrations were not reported properly. In this note we highlight the importance of photographs as an important tool for documentation about natural history. This observation is limelight into the scientific community to better recognizing this phenomenon and the insights into the ecological and physiological implications of this situation, which has a major influence on animal survival.

Key words: Albinism; Eastern Ghats; Tiger Reserve; wild boar.

El albinismo es un trastorno hipopigmentario con una falta total de melanina en el pelo, los ojos y la piel debido a la ausencia hereditaria de la enzima funcional tirosinasa en las células pigmentarias que afectan a toda la piel y el pelo, lo que da como resultado un pelaje blanco total con ojos rojos. El 10 de agosto de 2019 a las 11:30 am durante un trabajo de campo, registramos un jabalí macho albino en la Reserva de Tigres de Sathyamangalam, Eastern Ghats, Tamil Nadu, sur de la India. Desafortunadamente, numerosos registros de este tipo de aberraciones de color no se informaron adecuadamente. En esta nota destacamos la importancia de las fotografías como una herramienta importante para la documentación sobre la historia natural. Esta observación centra la atención de la comunidad científica por reconocer mejor este fenómeno y comprender las implicaciones ecológicas y fisiológicas de esta situación, que tiene una gran influencia en la supervivencia animal.

Palabras clave: Albinismo; Ghats orientales; jabalí; Reserva de tigres.

Mammalian color is almost entirely dependent on the presence (or absence) of the pigment melanin in the skin, hair, and eyes. Melanin is produced through a stepwise biochemical pathway in which the amino acid tyrosine is converted to melanin. The enzyme tyrosinase plays a critical role in this pathway, and alterations or mutations in the tyrosinase gene can result in a defective enzyme that is unable to produce melanin or does so at a reduced rate. Albinism is a hypo-pigmentary disorder with a total lack of melanins in hairs, eyes, and skin due to the heritable absence of functional tyrosinase enzyme in pigment cells affecting all skin and hairs, resulting in a total white plumage / fur with red eyes (Smielowski 1987). Albinism is controlled via inheritance by an autosomal recessive gene in all animal species (Hale *et al.* 2005; van Grouw 2006; van Grouw 2013). This note has portrayed the albinism in wild boar (*Sus scrofa*) in Sathyamangalam Tiger Reserve, Eastern Ghats, Tamil Nadu, Southern India.

Sathyamangalam Tiger Reserve (11° 30′ 17.1936″ N ,77° 14′ 18.2256″ E) is situated in the south-west corner of the Eastern Ghats, and covering 1,408.40 km^2. This protected area is an important wildlife corridor connecting the Western Ghats and the Eastern Ghats (Figure 1). A wide variety of habitats can be seen from eastern to the western part of the sanctuary. The eastern part of this sanctuary is located in the rain shadow region of Western Ghats. The average minimum and maximum temperature of the study area are 21.5 ºC and 32.8 ºC, respectively. The average annual rainfall is 824 mm. The Sathyamangalam Tiger Reserve is represented by several forest types such as tropical and dry deciduous, tropical scrub, tropical moist deciduous, and tropical semi-evergreen forests (Champion and Seth 1968). The study area is very rich in wildlife harboring populations of Asian elephants (*Elephas maximus*), tiger (*Panthera tigris*), and numerous other wild fauna and flora species.

On 10th August 2019 at 11:30 am during a fieldwork, we recorded a male wild boar that was digging the soil surface for feeding. The male was completely white with pinkish snout, ears and hoofs, and reddish eyes (11° 38′ 32.30″ N, 77° 10′ 8.22″ E; Figure 2). We photographed the animal for further references, and finally we conclude that it was an albino wild boar.

In India 34 mammalian species has been recorded with albinism condition. Regarding wild boars, there are only two official records in the Indian region (Mahabal *et*

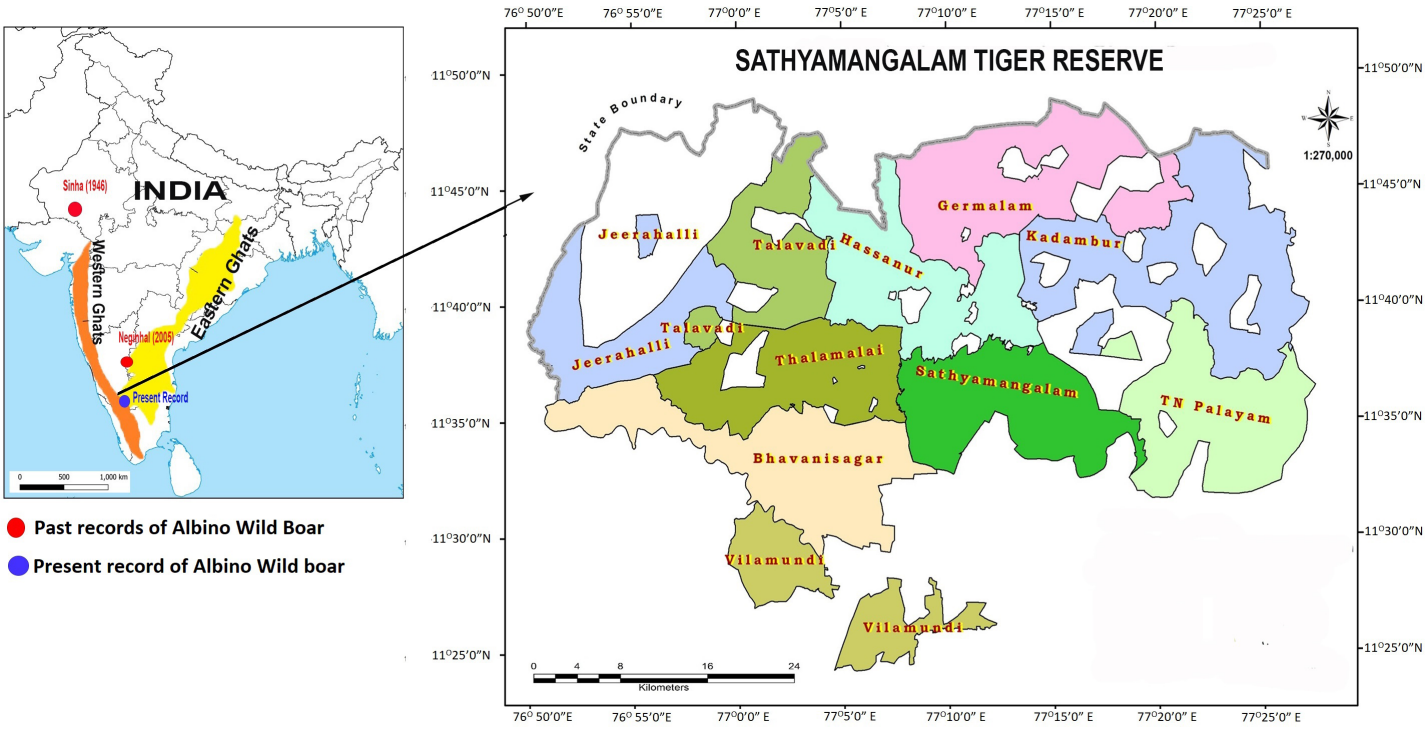

Figure 1. Map showing the study area Sathyamangalam Tiger reserve, Tamil Nadu, India.

al. 2019). Sinha (1946) recorded an albino wild boar on 27 May 1946, 45 miles from Udaipur (24° 50′ 26.98″ N, 73° 35′ 11.72″ E). Neginhal (2005) observed an albino wild boar in November 2004 in Daroji Sloth Bear Sanctuary (15° 23′ 34.14″ N, 76° 48′ 45.06″ E), Hospet, Bellary District, Karnataka (Figure 1). Both records were adult males. Albino individuals are more conspicuous as compared to normal individuals. Additionally, anomalous coloration tends to strongly reduce the survival of these organisms, as these deficiencies make them visible to predators (Samson *et al.* 2017). Similarly, visual problems are associated with albinism, as reduced amount of melanin can cause eye problems. This

Figure 2. Albino wild boar in Satyamangalam Tiger Reserve, Eastern Ghats, Tamil Nadu. Photograph of Nagarajan Krishna Kumar.

is because melanin is involved in the development of the retina (Pérez-Carpinell *et al.* 1992; Grant *et al.* 2001; Garipis and Hoffmann 2003). In prey species, there is a definite disadvantage in the struggle for existence and very few albinos manage to escape their natural enemies and survive to attain sexual maturity (Mahabal *et al.* 2019). For this reason, albino individuals are only sporadically reported. Unfortunately, numerous of these were not on the record, maybe due to the lack of knowledge by the collectors and / or collection managers about the significance of this phenomenon (Samson *et al.* 2017; Samson *et al.* 2021).

We highlight the importance of photographs as valuable tool for documentation of natural history of species. In conclusion, further studies must be encouraged to report the records of colour aberration in wildlife. This is necessary for a better understanding of this phenomenon and its insights into the ecological and physiological implications of this condition considerably affecting the animal survival (Samson *et al.* 2017).

Acknowledgements

We want to acknowledge the anonymous reviewers that improve the manuscript.

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Associated editor: Nicté Ordóñez-Garza
Submitted: September 7, 2020; Reviewed: June 7, 2021.
Accepted: August 2, 2021; Published on line: August 13, 2021.