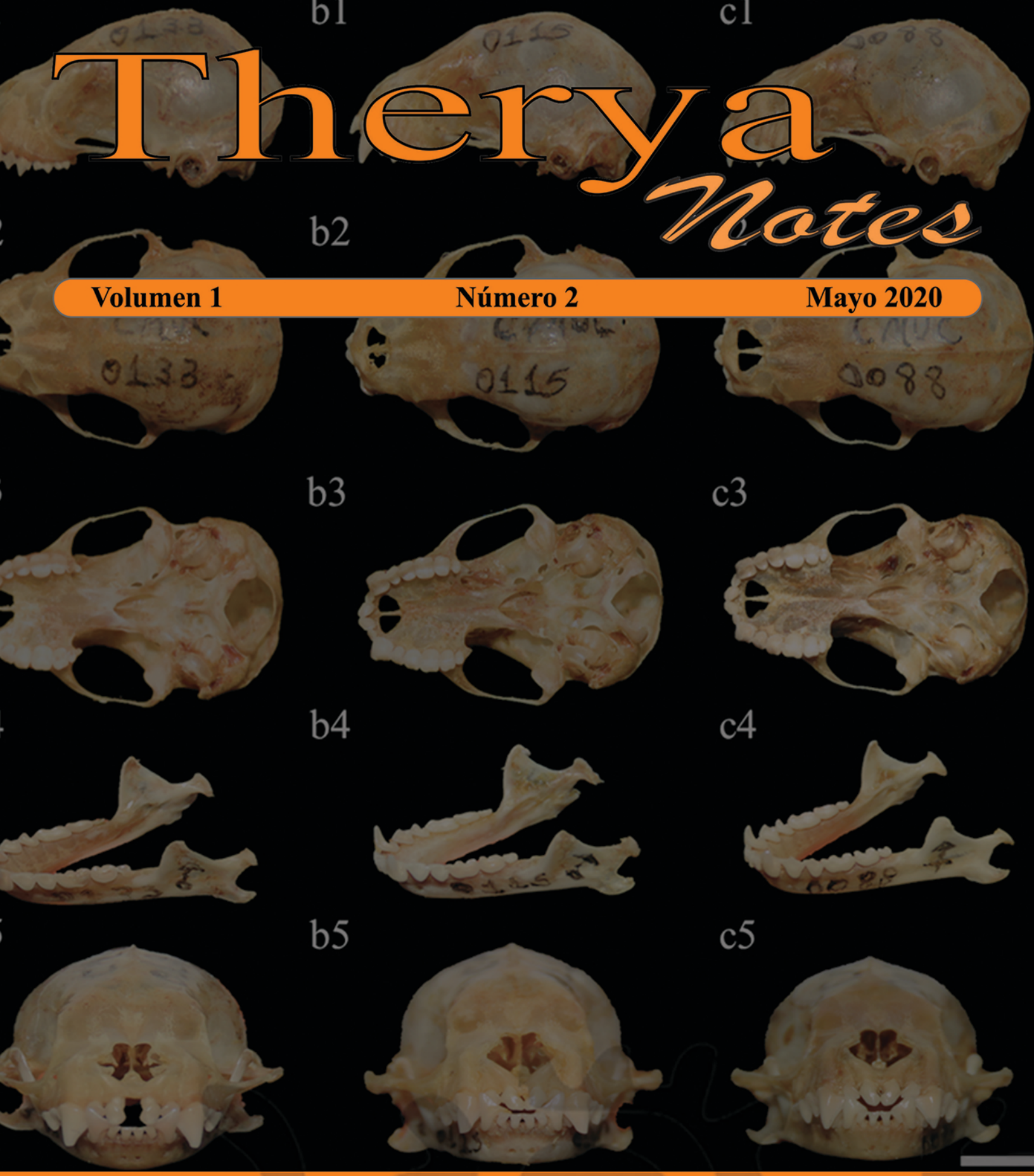

Therya Notes

Volumen 1 Número 2 Mayo 2020

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 continua 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

Las fórmulas dentales anormales se presentan con frecuencia en poblaciones naturales. Se han reportado numerosos casos de anomalías dentales para muchos grupos de mamíferos, y los murciélagos son el grupo con la mayoría de las anomalías dentales entre los mamíferos. Aquí se describe la aparición de un diastema en la posición de los incisivos superiores en un individuo de *Sturnira lilium* recolectado en el sur de Brasil. Este es el primer registro de un diastema para la especie.
(Imagen de Liposki-Biassi et al. 2020)

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."

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CONTENIDO

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Noteworthy records of Jaguar *Panthera onca* in Guatemala

Registros notables de jaguar *Panthera onca* en Guatemala

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The jaguar is the largest terrestrial carnivore in America. According to the International Union for the Conservation of Nature, its conservation status is "Near Threatened" in its distribution range. In Guatemala, the jaguar is mainly distributed in the Maya Biosphere Reserve (MBR). In the years 2016 and 2018, camera-trapping studies were conducted in the San Miguel La Palotada-El Zotz Protected Biotopo (BPSMPZ) and in Yaxhá Nakum Naranjo National Park (PNYNN), respectively; both core zones of the MBR. Eight camera-trap stations were installed in BPSMPZ and 5 in PNYNN during the dry season, with at least 90 trap-days/nights in each site. In BPSMPZ, one adult jaguar of undetermined sex was recorded in one of the eight sampling stations installed; in PNYNN, there were 22 records (independent events) of at least 6 adult individuals (1 female, 3 males, 2 of undetermined sex) in three of the five sampling stations installed. This work reports important records on the presence of jaguars in core zones currently under pressure from human activities conducted within the southern limits of the MBR. Maintaining the integrity of these two areas is imperative to preserve this species in the MBR.

Key words: Camera-traps; core zones; habitat loss; Selva Maya; threatened species.

El jaguar es el carnívoro terrestre de mayor talla en América. Según la Unión Internacional para la Conservación de la Naturaleza, su estado de conservación es "Casi Amenazado" en su área de distribución. En Guatemala, el jaguar se distribuye principalmente en la Reserva de la Biosfera Maya (RBM). En los años 2016 y 2018, respectivamente, se realizaron estudios de fototrampeo en el Biotopo Protegido San Miguel La Palotada-El Zotz (BPSMPZ) y el Parque Nacional Yaxhá Nakum Naranjo (PNYNN), zonas núcleo de la RBM. Se emplearon 8 estaciones de trampas-cámara en el BPSMPZ y 5 en el PNYNN durante la época seca con al menos 90 noches-trampa en cada estación. Se obtuvo el registro de 1 individuo de jaguar adulto de sexo indeterminado para el BPSMPZ en una de las ocho estaciones de muestreo instaladas y 22 registros (eventos independientes) en el PNYNN de al menos 6 individuos adultos (1 hembra, 3 machos y 2 de sexo indeterminado) en tres de las cinco estaciones de muestreo. Se muestran registros importantes sobre la presencia actual de jaguares en zonas núcleo que están bajo presión de actividades humanas presentes dentro de los límites del sur de la RBM. Mantener la integridad de estas dos áreas es urgente, para garantizar el cumplimiento de conservación para esta especie en la RBM.

Palabras clave: Especies amenazadas; pérdida de hábitat; Selva Maya; trampas-cámara; zonas núcleo.

The jaguar, *Panthera onca,* is the largest terrestrial mammal predator in continental America (Nowell and Jackson 1996; Sollman 2010). Currently, the conservation status of the jaguar throughout its range (from northern Mexico to northern Argentina) is "Near Threatened" (Quigley *et al.* 2017). According to Sanderson *et al.* (2002), the current global area of distribution of this species is only 46 % of its historic range due to the loss of forest cover over the past century. In Guatemala, despite the still uncertain conservation status of the species, García-Anleu *et al.* (2016) estimated that the jaguar is distributed approximately across 58 % of the national territory. Currently, the main distribution area of the jaguar in Guatemala is the Maya Biosphere Reserve (MBR), home for viable populations, and where major efforts have been made to the study of this species (García-Anleu *et al.* 2016; De la Torre *et al.* 2017).

The MBR includes 2,090,667 ha of the more than 4,000,000 hectares of the so-called Selva Maya (SM), a territory shared with Mexico and Belize (CONAP 2015). The SM represents the largest remnant of tropical forest in Mesoamerica and the second largest in America, after the Amazon rainforest in South America (Sanderson *et al.* 2002). The MBR includes zones in three categories: a Buffer Zone (BZ), a Multiple-use Zone (MUZ), and many Core Zones (CZ). The latter comprises a total of 817,206 ha and consist of five National Parks (PN): PN Tikal (PANAT), PN Yaxhá Nakum Naranjo or PN Yaxhá (PNYNN), PN Sierra del Lacandón (PNSL), PN Mirador-Río Azul (PNMRA), and PN Laguna del Tigre (PNLT); and four Protected Biotopos (BP): BP San Miguel La Palotada-El Zotz or BP El Zotz (BPSMPZ), BP Dos Lagunas (BPDL), BP Laguna del Tigre-Río Escon-

dido (BPLT), and BP Cerro Cahuí (CONAP 2015). The MUZ comprises mainly industrial and community forestry concessions, and the BZ is a 15 km-wide strip in the southern border of the reserve, where productive activities compatible with conservation are allowed.

As regards their spatial arrangement, the CZ are distributed to the periphery of the MBR. As a result, BPSMPZ, PANAT, and PNYNN are vulnerable areas that are vulnerable due to the edge effect, for being located in the southern limit of the forest cover in the MBR, adjacent to communities and farms in the BZ (CONAP 2015; Figure 1).

Various camera-trapping studies have confirmed the presence of jaguar in CZ of the MBR such as PANAT (García *et al.* 2005; Ruano *et al.* 2010), BP and PN Laguna del Tigre (García and Radachowsky 2004; Márquez 2009; Moreira *et al.* 2009b), PN Sierra del Lacandón (Soto 2003; Márquez 2009), PN Mirador-Río Azul (Moreira *et al.* 2008a; Moreira *et al.* 2011; González-Castillo *et al.* 2018), and in BP Dos Lagunas (Moreira *et al.* 2008a; González-Castillo *et al.* 2018). The presence of the jaguar has also been confirmed in the MUZ, specifically in the forestry concessions of Melchor de Mencos (Moreira *et al.* 2009a), Carmelita (Moreira *et al.* 2008b), La Gloria-El Lechugal (Moreira *et al.* 2007), and in other areas to the south of the MBR, such as the Montañas Mayas-Chiquibul Biosphere Reserve (García 2013). This study reports important photographic records of jaguar for BPSMPZ and PNYNN, both core zones of the MBR where no camera-trapping studies had been conducted previously.

The BPSMPZ is located in northern Guatemala, west of PANAT, in the Department of Petén (Figure 1). Its territorial extension is 34.934 ha and is currently one of the CZ facing higher risks and threats due to the advance of the agricultural frontier, extraction of precious woods, poaching, and forest fires (CECON 1996; CONAP 2015). It is located in the Neotropical Biogeographic Province in the upper part of the San Pedro River basin, which in turn belongs to the Usumacinta River basin draining into the Gulf of Mexico (CECON 1996). The mean temperature ranges between 20

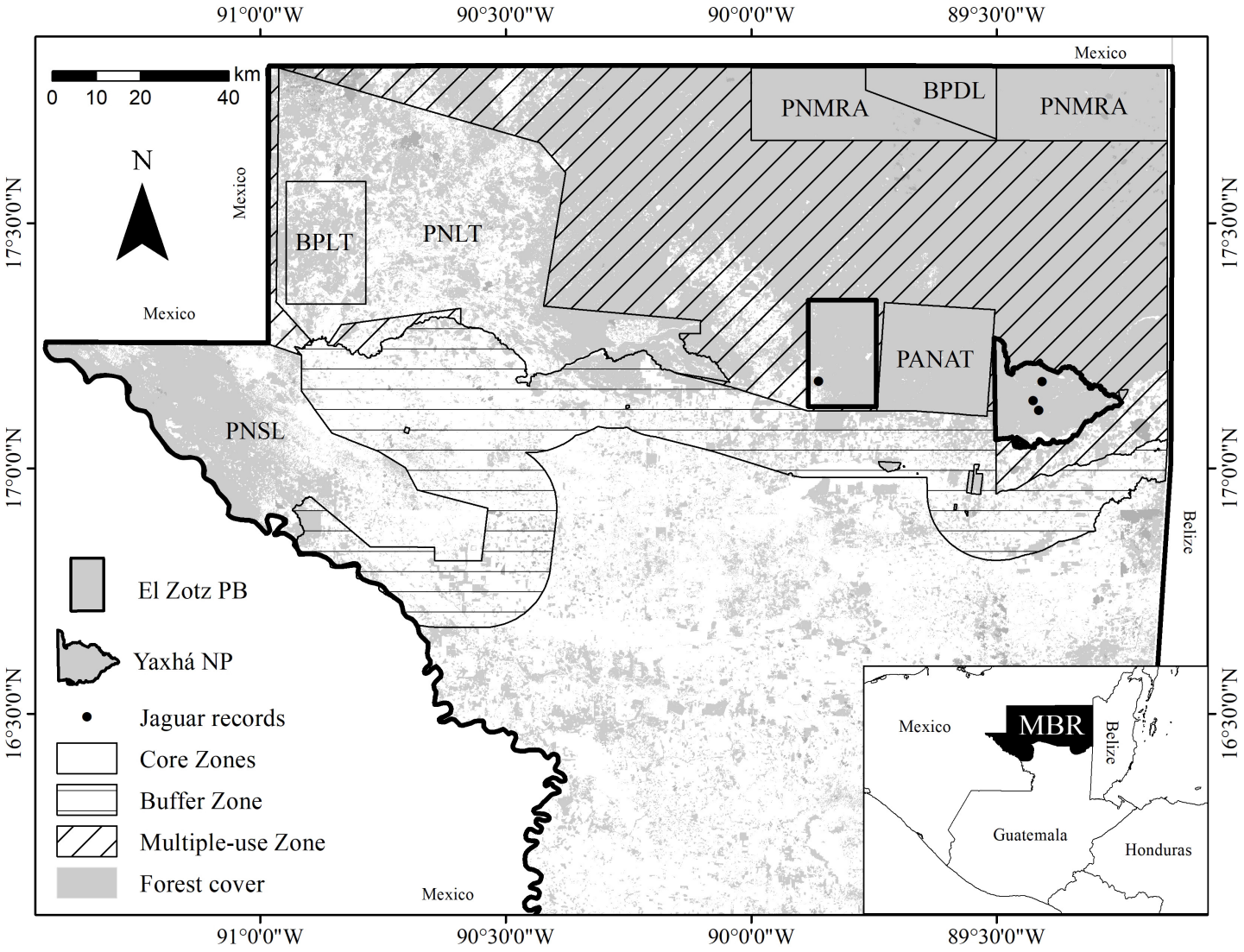

Figure 1. Location and administrative boundaries of San Miguel La Palotada-El Zotz Protected Biotopo and Yaxhá Nakum Naranjo National Park in the Maya Biosphere Reserve (MBR), Guatemala. PNSL: Sierra del Lacandón National Park; BPLT: Laguna del Tigre-Rio Escondido Protected Biotopo; PNLT: Laguna del Tigre National Park; PNMRA: Mirador-Río Azul National Park; BPDL: Dos Lagunas Protected Biotopo; PANAT: Tikal National Park.

°C and 32 °C, with an average of 26 °C; the mean annual precipitation ranges from 1,200 to 1,400 mm, and elevation ranges from 50 to 300 m. Soils are calcareous, clayey, shallow, and of low fertility (CECON 1996). BPSMPZ is home to at least 160 plant species, 223 species of vertebrates (not including fish), fungi, and invertebrates (Ixcot *et al.* 2005).

PNYNN is located in northeastern Guatemala, to the southeast of PANAT and west of the city of Melchor de Mencos (Figure 1). It stretches across 37,160 ha and is currently one of the CZ most at risk of threats within the MBR (CONAP 2015). It encompasses two physiographic provinces, the Lacandón Fold Belt and the Yucatan Platform (CECON 1996). The physiography is typical of low lands, also including a number of hills, which makes water to accumulate in lower areas. The topsoil is shallow and mainly made of organic matter, with a clayey subsoil on limestone rock; the susceptibility to erosion is 30 % (CECON 1996; CONAP 2015). Hydrologically, PNYNN is a priority area for conservation, as it includes important water bodies such as the Holmul and Naranjo rivers, the Yaxhá, Sacnab, and Lancajá lagoons, along with numerous ponds and temporary water bodies, locally known as *aguadas* (CECON 1996). The mean annual temperature ranges between 11 and 39.7 °C, averaging 25.3 °C; the mean annual precipitation is 1,800 mm, and the altitude varies between 50 and 400 m asl (CECON 1996; CONAP 2006). This area has reported at least 62 tree species and 22 species of fish, 14 of amphibians, 45 of reptiles, 99 of birds, and 42 of mammals (CONAP 2015).

As a result of the promotion by the "Guatemala Baird's Tapir Conservation Program" of the Centro de Estudios Conservacionistas (CECON) of the Faculty of Chemical Sciences and Pharmacy at Universidad de San Carlos, Guatemala, and the Fundación Defensores de la Naturaleza (FDN), several research projects and initiatives for the monitoring and conservation of fauna have been launched in various CZ of the MBR. For BPSMPZ and PNYNN, these projects started in 2016 and 2018, respectively. Annual sampling campaigns were conducted in the dry season and early rainy season (March to August), using camera-trapping stations according to the methodology proposed by the CECON and FDN (2016) for the monitoring of the Central-American tapir, *Tapirella bairdii*. For the above, priority was given in both areas to locating the sampling stations in sites with a greater probability of tapir detection, mainly on the banks of water bodies such as *aguadas* and rivers; camera-traps were placed at approximately 40 cm above ground, affixed to trees (García *et al.* 2017; García *et al.* 2019). In BPSMPZ, in each of eight stations, we installed a Bushnell® Trophy Cam automatic camera-trap with 8 MP resolution, set to take three images per capture event, with a 15-second interval between capture events. In PNYNN, camera-traps were installed in 5 sampling stations; we used Bushnell® Trophy Cam AGRESSOR No-Glow automatic camera-traps with 14 MP resolution, taking one image per capture event, and with 1-second intervals between capture events. All cameras were set to be activated by a motion sensor 24 hours a day. All cameras were operating for at least 90 trap-days/nights at each site.

One jaguar individual (adult, undetermined sex) was recorded in 1 of the 8 sampling stations at BPSMPZ during the 2016 dry season (10:26 h of 7 August 7; Figure 2a). Twenty-two individual records or events were also recorded (involving at least six adults: 1 female, 3 males, and 2 individuals of undetermined sex) in three of the five sampling stations in PNYNN during the 2018 dry season (February to August; Figure 2b).

In BPSMPZ, the sampling station where the jaguar individual was captured is located in a secondary forest near the southwestern border of the Biotopo, at approximately 8 km from the nearest town (Cruce Dos Aguadas town), and 22 km from the nearest jaguar camera-trapping record in PANAT (García *et al.* 2005; Ruano *et al.* 2010; García-Anleu *et al.* 2015). In PNYNN, the sampling stations where jaguar individuals were captured are located in two *aguadas* (ponds) and a river, recording more than one event per site, 11 km away from the nearest town (Yaxhá) and 15 km from the nearest jaguar records reported for PANAT (García *et al.* 2005; Ruano *et al.* 2010; García-Anleu *et al.* 2015).

These photographic records of jaguars in BPSMPZ and PNYNN represent a relevant event for both CZ, since this species, along with the puma *Puma concolor*, the tapir *Tapirella bairdii*, the white turtle *Dermatemys mawii*, the white-lipped peccary *Tayassu peccari*, and the scarlet macaw *Ara macao*, are conservation elements at the species level and, therefore, they are conservation and management priorities across the MBR according to its Master Plan (CONAP 2015).

The presence of jaguar in the MBR is well-documented, and previous studies (García *et al.* 2005; Ruano *et al.* 2010; García-Anleu *et al.* 2015) had reported the presence of jaguar in PANAT (Figure 1). The recent photographic records of adults of both sexes reported herein suggest that jaguars may reproduce in the southern portions of the MBR. These new records are relevant given their proximity to human settlements and the edge of the forest cover in the south of the MBR. Also, these records confirm the presence of jaguars in areas subjected to a high degree of anthropic pressure in southern MBR.

Both BPSMPZ and PNYNN are currently under pressure from illegal logging, poaching, and livestock raising (CECON 1996; CONAP 2015). In addition, along with PANAT and Montañas Mayas-Chiquibul Biosphere Reserve, these are protected areas bordering areas with a high incidence of livestock-related conflicts within the BZ (CONAP 2015). Therefore, the presence of jaguars in zones near the southern border of BPSMPZ and PNYNN may trigger potential conflicts between humans and jaguars in relation to human settlements and farms (CONAP 2015; García-Anleu *et al.* 2016). This possibility highlights the importance of implementing programs aiming to reduce potential human-carnivore conflicts in these areas. The photographs captured during the sampling in this study evidenced the presence of poachers in sampling stations, which represent an additional threat related to the proximity to populated areas (CONAP 2015).

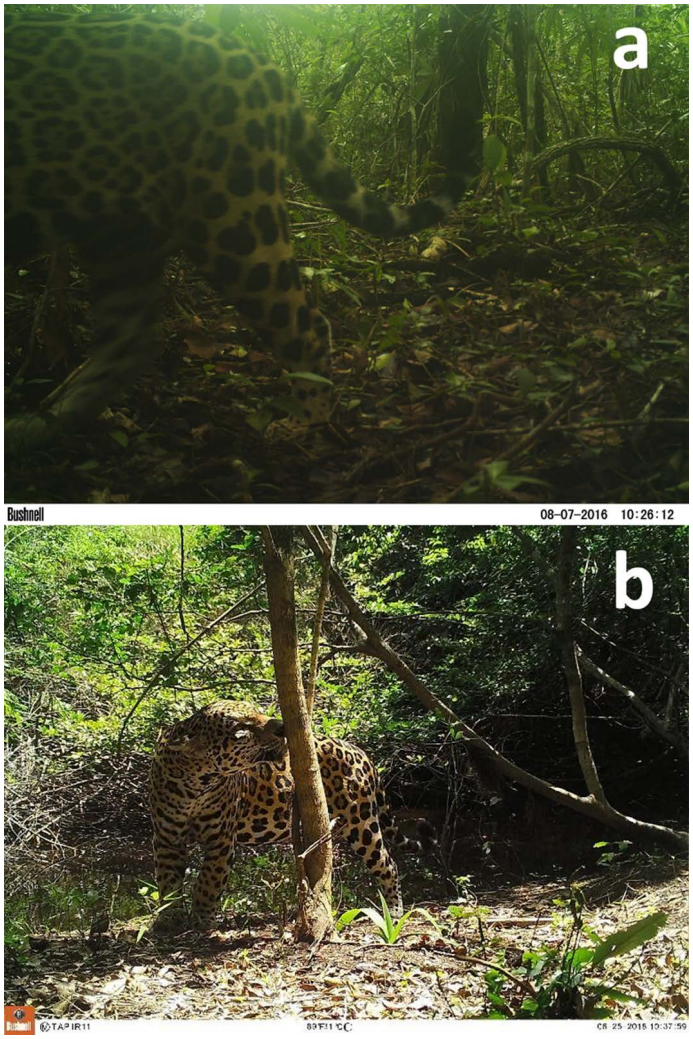

Figure 2. Photographic records of jaguar, *Panthera onca*, in a) San Miguel La Palotada-El Zotz Protected Biotopo, "Saulito", and b) the Yaxhá Nakum Naranjo National Park, "Leonel," Maya Biosphere Reserve, Guatemala.

In spite of a lower sampling effort in PNYNN, we obtained 95 % more independent records of jaguars relative to those captured in BPSMPZ. In 2019, we completed the fourth year of regular sampling in BPSMPZ; however, only one jaguar individual has been captured in a single sampling event, namely the one described herein. This suggests that the probability of recording jaguars in BPSMPZ is very low, despite its primary forest cover (Figure 1). In this sense, it can be assumed that the conservation of forest cover does not warrant the sustainability of large mammal species such as the jaguar and its main prey, nor the ecological integrity of the protected areas, giving rise to negative phenomena such as the empty forest syndrome or defaunation (Wilkie *et al*. 2011; Young *et al*. 2014; García *et al*. 2019).

There are currently no studies for the evaluation of jaguar populations in BPSMPZ and PNYNN; however, there are several studies in other areas of the MBR, including those by García *et al*. (2005), Moreira *et al*. (2009b), Ruano *et al*. (2010), García-Anleu *et al*. (2015), and Tobler *et al*. (2018). The records reported herein highlight the need to conduct sampling with an appropriate design and determine the conservation status of the jaguar in southern areas of the MBR under high risk of defaunation or with low ecological integrity (García *et al*. 201). We also recommended conducting studies on activity patterns, prey availability, population density, and occupancy for the jaguar as a conservation element of the MBR. This work highlights the importance of preserving the ecological integrity of the BPSMPZ-PANAT-PNYNN complex, together with the Bio Itzá Indigenous Community Reserve, through the strengthening of its administration and the development of integrated management programs, taking local communities into account.

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Primer registro de nado de *Herpailurus yagouaroundi* en Guatemala

First swim record of *Herpailurus yagouaroundi* in Guatemala

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El jaguarundi (*Herpailurus yagouaroundi*) es una especie de félido neotropical con hábitos alimenticios diversos y presencia en distintos tipos de hábitat. El 6 de febrero de 2018 observamos y grabamos a un individuo de esta especie nadando en una zona con pastos marinos, en Bahía la Graciosa, en el Refugio de Vida Silvestre Punta de Manabique, Izabal, Guatemala. En esta nota reportamos el primer registro de comportamiento de nado en esta especie, el cual consideramos que puede ser atribuido a búsqueda de alimento en el área. A pesar de que el jaguarundi se considera una especie generalista, el conocimiento sobre su comportamiento y poblaciones en general, es escaso. Es por esto que consideramos que este primer reporte es una valiosa contribución al conocimiento y comprensión de este félido neotropical.

Palabras clave: Carnivora; comportamiento animal; Felidae; Izabal; Refugio de Vida Silvestre Punta de Manabique.

The jaguarundi (*Herpailurus yagouaroundi*) is a species of neotropical felid with diverse eating habits and it is present in different types of habitat. On February 6, 2018, we observed and recorded an individual of this species swimming in an area with seagrass, in Bahia la Graciosa, in the Punta de Manabique Wildlife Refuge, Izabal, Guatemala. In this note, we report the first record of swimming behavior for this species, which we believe can be attributed to the individual searching for food in the area. Although the jaguarundi is considered a generalist species, knowledge about its behavior and populations, in general, is scarce. This is why we consider this first report to be a valuable contribution to the knowledge of this neotropical felid.

Key words: Animal behavior; Carnivora; Felidae; Izabal; Punta de Manabique Wildlife Refuge.

El jaguarundi (*Herpailurus yagouaroundi*) es un félido neotropical de características distintivas como cabeza pequeña, cuerpo delgado y cola muy larga, lo cual le da una apariencia única (Sunquist y Sunquist 2002) con relación a otras especies de felinos. Su pelaje es corto, uniforme y los individuos tienen tres variantes de coloración: café-negro, gris y amarillo-rojo (Cat Specialist Group 2019). Es la única especie del género *Herpailurus* y está más emparentada filogenéticamente con el puma (*Puma concolor*) y la chita (*Acinonyx jubatus*) que con otros felinos neotropicales, compartiendo con estas dos especies algunas características como el no retraer completamente las garras de sus patas traseras (Cat Specialist Group 2019).

Los jaguarundis se consideran generalistas, ya que se alimentan de múltiples presas (Bianchi *et al.* 2011; Silva-Pereira *et al.* 2011) y viven en variedad de hábitats (Nowell y Jackson 1996). Sin embargo, buscan cobertura vegetal densa y sitios con cierta protección en áreas abiertas (de Oliveira 1994). A pesar de su amplia distribución geográfica (desde el sur de Texas y Arizona en Estados Unidos, hasta las provincias de Buenos Aires y Río Negro en Argentina) es probablemente, la especie de felino neotropical menos estudiada (Grassman y Tewes 2004; Maffei *et al.* 2007; Tófoli *et al.* 2009; Monterrubio-Rico *et al.* 2012).

La Unión Internacional para la Conservación de la Naturaleza (UICN) considera al jaguarundi en la categoría de Preocupación Menor (Caso *et al.* 2015), mientras que en Guatemala se encuentra en el Índice 2 del Listado de Especies Amenazadas (LEA; este índice incluye especies en peligro de extinción por pérdida de hábitat, comercio o con poblaciones muy pequeñas) y en el Apéndice I de la Convención sobre el Comercio Internacional de Especies Amenazadas de Fauna y Flora Silvestres (CITES 2019; CONAP 2009). Sin embargo, es importante considerar que no hay suficientes datos e información que permitan respaldar el estado de las poblaciones de la especie en Guatemala.

Por otro lado, existe poca información publicada sobre la importancia de las fuentes de agua y su uso por parte de los félidos. Algunos autores lo atribuyen a que la mayoría de félidos no disfrutan esta actividad (Pitsko 2003). Sin embargo, los jaguares tienen la capacidad de llevar una presa grande mientras nadan, por lo que su emboscada puede incluir saltar al agua y cazar en ella (Neto *et al.* 2011). Algunos estudios en cautiverio también han documen-

tado cómo algunas especies, especialmente tigres y jaguares, disfrutan del agua y de nadar (Shoemaker *et al.* 1997; Bush *et al.* 2002), incluso se recomienda la disponibilidad de piscinas dentro de los lineamientos para la recreación de félidos en cautiverio (Bush *et al.* 2002). El propósito de esta nota es presentar el primer registro de comportamiento de nado para una especie poco conocida como el jaguarundi (*Herpailurus yagouaroundi*).

El Refugio de Vida Silvestre Punta de Manabique (RVSPM) se ubica en el municipio de Puerto Barrios, departamento de Izabal, Guatemala (15° 50′ N, 88° 28′ O) y tiene un área total de 1,519 km^2, de los cuales 492.96 km^2 son terrestres y 1,026.04 km^2 son zonas marítimas y aguas interiores (FUNDARY *et al.* 2006). El RVSPM constituye la única área marino-costera protegida del país, con un importante humedal que forma una península que separa la Bahía de Amatique del Golfo de Honduras (CONAP 2013). En el área también se conservan zonas de arrecife, pastos marinos, bosques inundables, manglares, pantanos y otros cuerpos de agua dulce y salobre, haciendo de éstos un refugio importante para mamíferos amenazados como el manatí (*Trichechus manatus*), el tapir (*Tapirus bairdii*) y el jaguar (*Panthera onca*; FUNDARY *et al.* 2006; CONAP 2013).

El RVSPM también es considerado como uno de los 7 humedales de importancia mundial en Guatemala, según la Convención Internacional de Sitios RAMSAR (CONAP 2013; The Ramsar Convention Secretariat 2014). El RVSPM también forma parte de un área clave para la conservación a nivel regional, considerada un *hot spot* de biodiversidad, conocida como Sistema Arrecifal Mesoamericano (SAM), que comprende la segunda barrera de coral más larga del mundo y brinda sustento a más de 12 millones de personas en México, Belice, Guatemala y Honduras, los cuatro países que la conforman (HRI 2015; WWF 2017).

Entre las mayores amenazas para el RVSPM están el avance de la frontera ganadera, la extracción de madera, el manejo inadecuado de la Cuenca del Río Motagua y la extracción de fauna, actividades que constituyen un grave riesgo para las poblaciones de fauna silvestre (FUNDARY *et al.* 2006; GIMBOT 2014). Actualmente, en el RVSPM quedan 132.16 km^2 de cobertura forestal terrestre (MARN *et al.* 2020). El área tiene una tasa de deforestación anual del 1.54%, valor que corresponde a la mayor pérdida de cobertura boscosa en áreas protegidas de la región norte-oriente de Guatemala. De seguir así el área podría haber perdido toda la cobertura boscosa para el 2041 (CONAP 2013).

Personal del RVSPM que se transportaba en una embarcación de fibra de vidrio de 15 pies, con un motor de 15 HP, realizó una observación que fue documentada a través de un video de ocho segundos, resolución 1920x1080 y 30 fps con un teléfono SAMSUNG GALAXY A3.

Durante un recorrido en lancha, el 6 de febrero de 2018 a las 14:01 horas, con el acompañamiento del guardaparques del RVSPM, se realizó la observación casual de un individuo de *H. yagouaroundi* que se encontraba dentro del agua en la Bahía la Graciosa, en la RVSPM, municipio de Puerto Barrios, Izabal, Guatemala (15º 51′ 34″ N, -88º 33′ 48″ O; Figura 1; Figura 2; Apéndice 1). El área donde se avistó al individuo, tenía cobertura de pasto marino, donde suelen encontrarse peces. Por el sitio donde se encontró el individuo, así como la dirección que llevaba, consideramos que es muy probable que se dirigiera hacia la parte boscosa en el sur de la Comunidad La Graciosa.

Este reporte representa un avistamiento inusual en el comportamiento del jaguarundi. Es posible que dicho comportamiento sea frecuente en la especie, pero que no haya sido documentado anteriormente. El jaguarundi es una especie principalmente diurna (Reid 2009), por lo cual tiende a ser observada más fácilmente que otras especies de félidos, llevando a la falsa suposición de que es común (Caso *et al.* 2015; Reid 2009). Es principalmente terrestre, pero también considerado buen escalador (Reid 2009).

Otra explicación de nuestra observación, podría ser que la especie está realizando comportamientos atípicos debido a la presión por la fragmentación de su hábitat, que lo obliga a buscar algunos recursos en donde antes no lo hacía. Está documentado para el área de Izabal, que las áreas con mayor cobertura de vegetación acuática presentan mayor biomasa de peces (Barrientos y Allen 2008). Por lo que cabe la posibilidad de que el individuo avistado se encontrara en búsqueda de alimento. Tófoli *et al.* (2009) hicieron un estudio de los hábitos alimenticios de esta especie, en el cual consideraron nueve estudios realizados en 4 países (Belice, Brasil, México y Venezuela). Aunque determinaron que esta especie se alimenta principalmente de pequeños vertebrados como mamíferos, aves y reptiles, también hay algunos registros de presencia de peces en su dieta (Manzani y Monteiro-Filho 1989; Olmos 1993; Guerrero *et al.* 2002). El horario del avistamiento coincide con el patrón de actividad de *H. yagouaroundi*, pero el comportamiento de nado no estaba reportado para esta especie.

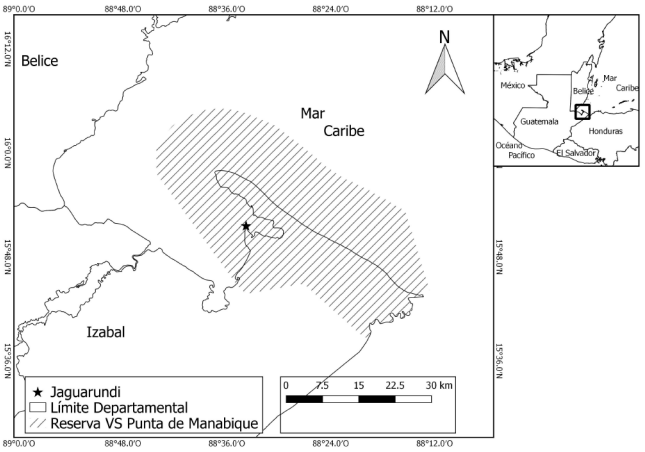

Figura 1. Ubicación geográfica del avistamiento de un jaguarundi (*Hepailurus yagouaroundi*) nadando en Bahía la Graciosa, Refugio de Vida Silvestre Punta de Manabique, Puerto Barrios, Izabal, Guatemala.

Figura 2. Individuo de *Herpailurus yagouaroundi* observado en Bahía la Graciosa, Refugio de Vida Silvestre Punta de Manabique, Puerto Barrios, Izabal, Guatemala. Créditos del video: Sergio Hernández (Analista Marino costero RVSPM).

Esta nota es una contribución importante al conocimiento del poco estudiado félido neotropical *Herpailurus yagouaroundi* y a su comportamiento. Nuestra observación permite que se generen preguntas como ¿qué tan común es este comportamiento? ¿este evento se relaciona con uso de peces u otro recurso acuático? ¿podría ser respuesta a alguna perturbación del hábitat? A pesar de ser un área importante por la interconectividad con otras áreas protegidas de Izabal, Guatemala (Reserva Protectora de Manantiales Cerro San Gil, Parque Nacional Río Dulce, Reserva de Usos Múltiples Río Sarstún), el Refugio de Vida Silvestre Punta de Manabique es un área particularmente vulnerable por su alta tasa de deforestación, el manejo inadecuado de la Cuenca del Río Motagua y la extracción de fauna (FUNDARY *et al.* 2006; IARNA-URL 2012; CONAP 2013).

Además, considerando que las tasas de deforestación en Guatemala y Honduras son las más altas de Centroamérica (Redo *et al.* 2012), la ubicación geográfica del RVSPM también es importante para la conectividad con otras áreas colindantes con Honduras, como la Reserva Hídrica Forestal Sierra Caral y el Parque Nacional Cuyamel-Omoa. Por esto es necesario promover más investigación en campo en Guatemala (Escobar-Anleu *et al.* 2018), así como documentar este tipo de observaciones, ya que consideramos que el poco conocimiento sobre la biodiversidad puede agravar las amenazas ya existentes en el área, al impedirnos tomar medidas de manejo y conservación adecuadas.

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Apéndice 1

Video de un individuo de *Herpailurus yagouaroundi* nadando en Bahía la Graciosa, Refugio de Vida Silvestre Punta de Manabique, Puerto Barrios, Izabal, Guatemala. Créditos del video: Sergio Hernández (Analista Marino costero RVSPM).
https://drive.google.com/file/d/1jZcNZIhL72zLa-9-224uu96aD2DVYQYu/view?usp=sharing

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Broadening the distribution of the microendemic shrew *Cryptotis phillipsii* (Eulipotyphla, Soricidae)

Ampliación de la distribución de la musaraña microendémica *Cryptotis phillipsii* (Eulipotyphla, Soricidae)

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The Phillips´ small-eared shrew, *Cryptotis phillipsii* (Schaldach, 1966), is geographically restricted to a small patches of montane cloud forests from southern Oaxaca, México. Distributional records and specimens of *C. phillipsii* are relatively scarce, so it still remains as poorly-known species. Here, we provide 2 new localities based on the analyses of specimens that remained unidentified in a museum. We analyzed 5 specimens from the Sierra Madre del Sur biogeographic province, southwestern Oaxaca, which were collected in 1-liter pitfall traps. We determined the taxonomic identity of the specimens using specialized literature and by comparison with other shrew species potentially inhabiting the region. The external and cranial morphology allowed us to determine that these 2 specimens belong to the species *Cryptotis phillipsii*. These records extend the known distribution of *C. phillipsii* by about *ca.* 60 km west and provide additional information about their habitat preferences. The records presented here extend the range of *C. phillipsii* and corroborate predictions maps of current potential distributions suggesting the existence of suitable conditions for the species in the region. We urge continuing support and funding for fieldwork and the updating of scientific collections in order to accomplish the urgent task of completing the inventory of species and overcome the lack of their distributional information.

Key words: Cloud forests; inventories; México; museum specimens; taxonomy.

La musaraña de orejas pequeñas de Phillips, *Cryptotis phillipsii* (Schaldach, 1966), está geográficamente restringida a pequeños parches de bosques de niebla en el sur de Oaxaca, México. Los registros de distribución y los especímenes de *C. phillipsii* son relativamente escasos, por lo que sigue siendo una especie poco conocida. Proporcionamos 2 nuevas localidades basadas en el análisis de especímenes que permanecieron sin identificar en un museo. Analizamos 5 especímenes de la provincia biogeográfica de Sierra Madre del Sur, en el suroeste de Oaxaca, que fueron recolectados en trampas de caída de 1 litro de capacidad. Determinamos la identidad taxonómica de los especímenes usando literatura especializada y con la comparación con especímenes de otras especies de musarañas que potencialmente habitan la región. La morfología externa y craneal permitió determinar que estos 5 especímenes pertenecen a la especie *Cryptotis phillipsii*. Estos registros extienden la distribución geográfica conocida de *C. phillipsii* unos *ca.* 60 km al oeste y brindan más información sobre sus preferencias de hábitat. Los registros presentados aquí amplían la distribución de *C. phillipsii* y corroboran las predicciones de mapas de distribuciones potenciales actuales que sugieren la existencia de condiciones adecuadas para la especie en la región. Instamos a continuar el trabajo de campo y la actualización de las colecciones científicas para realizar la tarea urgente de completar el inventario de especies y superar la falta de información de su distribución geográfica.

Palabras clave: Bosques de niebla; especímenes de museos; inventarios; México; taxonomía.

The lack of geographic information on species distributions (*i.e.*, the Wallacean shortfall; Whittaker *et al.* 2005) hinders our ability to adequately manage and conserve the natural resources of the planet. Although the scientific interest in the study of mammals has grown over the time, baseline data on the diversity and distribution of some taxonomic groups are far from well known, because biological explorations are insufficient, especially in tropical mountain regions (Guevara and Sánchez-Cordero 2018; Mayén-Zaragoza *et al.* 2019). On the other hand, it has been observed that specimens representing new records (or even new species) have already been obtained but remain unidentified or misidentified in natural history collections (Kemp 2015). Thus, it is necessary to work from several fronts to achieve a minimal knowledge on the geographical distribution of species, particularly those secretive, elusive or rare species, for which the use of inappropriate collecting methods, poor sampling effort, and problems in taxonomic identification prevent the completeness of inventories (Carraway 2007; Lobo *et al.* 2018).

One of these groups are the shrews (Eulipotyphla, Soricidae), which comprise small-sized mammals that occupy various ecological niches and modes of life (Berman *et al.* 2007). In México and the United States of America, where

Figure 1. Specimen of the Phillips´ small-eared shrew, *Cryptotis phillipsii*, collected in San Miguel Panixtlahuaca, Oaxaca (OAX.MA 4263). Bar indicates 5 mm.

the greatest diversity of shrews in the Americas occurs, the discovery and description of new species, rediscoveries, and range extensions within this family are yet common (Cervantes *et al.* 2008; Lorenzo *et al.* 2019). Of the 5 extant genera of shrews in the Americas, small-eared shrews of the genus *Cryptotis* have the widest distribution extending from eastern North America to the north of South America (Woodman 2019). The genus attains its greatest diversity in the northern tropics of southern México, particularly in the State of Oaxaca, including the presence of sympatric and syntopic species (Guevara and Cervantes 2017). Most of the species of *Cryptotis* in Oaxaca are relatively homogeneous in external and cranial morphology (Choate 1970; Guevara and Cervantes 2017). It is therefore not unusual to find species to be morphologically almost indistinguishable, and for which some specimens could remain unidentified or misidentified in museums (Woodman and Timm 2000; Guevara and Sánchez-Cordero 2018).

Long-term field inventories of small mammals in the Sierra Madre del Sur biogeographic province, southwestern Oaxaca, have yielded various specimens of the genus *Cryptotis* collected in 1-liter capacity pitfall traps (collecting permit FAUT-0037, SEMARNAT). However, some specimens have remained unidentified. Therefore, we revised five specimens from two localities to clarify their taxonomic status using specialized literature (Carraway 2007; Woodman and Timm 2000) and by comparison with specimens of *C. goldmani machetes*, *C. phillipsii*, and *C. pueblensis*, which correspond to shrew species potentially inhabiting the same region (see Appendix I). The five specimens examined have a broad zygomatic plate and a well-developed lower third molar compared to *C. pueblensis*; they are also relatively smaller in head-and-body length and exhibit narrower foreclaws compared to *C. goldmani machetes*. The external and cranial morphology of the specimens examined allowed us to determine that these belong to the species *Cryptotis phillipsii* (Figure 1).

Two specimens (Mammal Collection of the CIIDIR-Oaxaca, OAX.MA 4268, 4269) were collected along a stream surrounding by montane cloud forest and coffee plantations at 914 m in the municipality of San Agustín Chayuco, whereas other 3 specimens (OAX.MA 4262, 4263, and 4264) were collected in a very wet slope of cloud forests with arborescent ferns at 1,654 m in the municipality of San Miguel Panixtlahuaca (Figure 2). In the same area where *C. phillipsii* was collected in San Agustín Chayuco, some specimens of *Peromyscus aztecus* were also obtained. In San Miguel Panixtlahuaca, also *P. aztecus*, plus *P. melanurus*, *P. mexicanus*, *Oryzomys fulgens*, and *Heteromys pictus* were collected and deposited at the OAX.MA.

The Phillips´ small-eared shrew, *Cryptotis phillipsii* (Schaldach, 1966), is one of the less-known species in México. Initially described as *Notiosorex phillipsii*, was later included as a population of *C. mexicana peregrina* (or most recently as *C. peregrinus*); however, a morphological and molecular revision supports its status as species separated from *C. peregrinus*, a similar but not closely related species (Woodman and Timm 2000). The revised specimens of southwestern Oaxaca increase the number of specimens known of *C. phillipsii* available in natural history museums, from 55 to 60 specimens, of which just over half (51.6 %) are housed in Mexi-

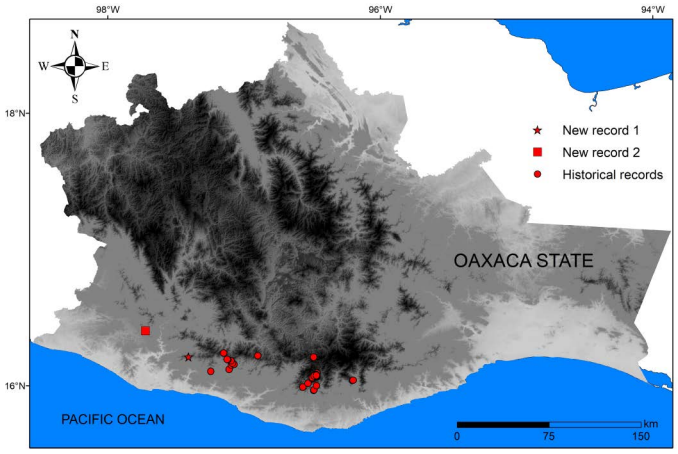

Figure 2. Map showing historical (dots) and new records (star, San Miguel Panixtlahuaca; square, San Agustín Chayuco) of the Phillips´ small-eared shrew, *Cryptotis phillipsii*, in Oaxaca, southern México. New records extend its geographic range *ca.* 60 km to the west.

Table 1. Records of the Phillips´ small-eared shrew, *Cryptotis phillipsii*, in Oaxaca, México, indicating the month and year of collecting. American Museum of Natural History, New York, New York (AMNH); California Academy of Sciences, San Francisco, California (CAS); Colección Nacional de Mamíferos, México City (CNMA); Escuela Nacional de Ciencias Biológicas, México City, (ENCB); The University of Kansas Natural History Museum, Lawrence, Kansas (KU); Louisiana State University, Baton Rouge, Louisiana (LSUMZ); University of Michigan, Museum of Zoology, Ann Arbor, Michigan (UMMZ); Colección Mastozoológica del CIIDIR-Oaxaca, IPN (OAXMA).

Records	Month	Year	Locality
AMNH 178739	August	1957	San Andres Lovene, San Juan Ozolotepec
UMMZ 112572	July	1963	Near Campamento Río Molino (Hwy 175), 7300 ft
CNMA 8444-8446, 8447; AMNH 213758-213759; 214152, 214803-214805; KU 114226	December	1964	Río Molino
KU 121661	December	1969	Río Molino
KU 124298-124299	April	1970	Río Molino
LSUMZ 11915	July	1969	Río Molino
KU 98728	July	1964	20 mi S, 5 mi E Sola De Vega
CAS 14940-14941	March	1965	Sinai, 10 km E Nopala
AMNH 214806, 214808	October	1967	San Miguel Suchixtepec
CAS 14069, 14071-14072 CNMA 26552	April	1968	Km 178, Rio Jalatengo, Puerto Angel Rd.
CAS 15475	January	1970	Rio Jalatengo, Puerto Angel Rd.
ENCB 3413-3414	January	1968	16 km SW San Miguel Suchixtepec
CAS 14068	April	1968	Km 153, Rio Molino, Puerto Angel Rd.
KU 124295-124296	November	1969	27.8 Km (By Road) N of San Gabriel Mixtepec
CNMA 27517-27518	June	1970	Puerto Ángel Road, Km 158
CNMA 26551	January	1970	Km 195 Oaxaca-Puerto Ángel Rd.
CAS 15478	January	1970	Lumber Camp, Km 158, Puerto Angel Rd.
CAS 15476	January	1970	Km 195 Puerto Escondido Rd.
CAS 15474	January	1970	Km 193 Puerto Escondido Rd.
CAS 15473	January	1970	La Cima, Km 184-1/2 Puerto Escondido Rd.
KU 124294	May	1970	36 Km (By Road) N San Gabriel Mixtepec
CNMA 44682, 44724-44736	October	2006	Campamento Río Molino, 2 km SSW San Miguel Suchixtepec
CNMA 44723	October	2006	3.25 Km NE San Juan Lachao
CNMA 44699	October	2006	Santa Rosa, 1.5 km NE San Juan Lachao
OAXMA 4262-4264	March	2009	5.08 km S, 3.32 km W San Miguel Panixtlahuaca
OAXMA 4268-4269	February	2009	9 km E San Agustín Chayuco

can museums (Table 1). *Cryptotis phillipsii* inhabits tropical montane cloud forests over an altitudinal range of 900 to 2,500 m, being geographically restricted to only 6,000 km^2 in the Sierra Madre del Sur biogeographic province, within the state of Oaxaca (Álvarez-Castañeda *et al.* 2018). The records presented here fall in this habitat and elevational range. Further research is necessary to assess how coffee plantations affect their populations, in particular in San Agustín Chayuco. A search in databases and literature indicates that this species has been collected throughout the year (Table 1; Sánchez-Cordero and Guevara 2016; Woodman and Timm 2000).

The two new localities presented here extend the distribution by *ca.* 60 km to the west of the nearest localities in the Sierra de Miahuatlán (Figure 2; Woodman and Timm 2000). In particular, the records of San Agustín Chayuco are notables because they are located crossing Río Verde, a large watercourse running in northern-southern direction that break the continuity of the mountains in the Sierra Madre del Sur. Maps of current potential distributions have suggested the existence of suitable conditions for cloud forest shrews in that region, but so far there were no records that corroborate its presence (Guevara *et al.* 2015; Guevara and Sánchez-Cordero 2018). Therefore, the records analyzed here contribute to the value of these studies by corroborating their predictions. Due to its estimated area of occupancy and environmental threats within its distribution area, it is cataloged as vulnerable according to the International Union for Conservation of Nature (Álvarez-Castañeda *et al.* 2018); however, it has not been considered of priority protection by the Mexican government (SEMARNAT 2010, 2019).

It is feasible that the lack of more records of *C. phillipsii* in other predicted regions, such as southern Guerrero, is due to insufficient fieldwork. We then invite the scientific community to continue long-term surveys in under-sampled regions using proper methods for small mammals. In the case of shrews from northern Neotropics, pitfall traps have proven be highly efficient (Umetsu *et al.* 2006). On the other hand, it is also possible that, as shown in this work, specimens have already been collected but remain forgotten or ignored in the drawers of the collections (Kemp 2015). Therefore, we urge the constant updating of scientific col-

lections, as well as the databases associated with voucher specimens. Collaborative work between curators and specialist taxonomists should be the norm in order to accomplish the task of completing the inventory of species and overcome the lack of distributional information (Johnson 2012). This accumulated knowledge will provide crucial information for a better understanding of the evolutionary history and conservation status of poorly-known species.

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Appendix I

Specimens examined

Cryptotis pueblensis (17). México: Oaxaca; 1.5 km NE Santa Rosa, Santiago Jamiltepec (CNMA 44691, 44693, 44694, 44698, 44701); km 193 Oaxaca-Puerto Escondido Road, 2.25 km NE San Gabriel Mixtepec (CNMA 44704, 44705, 44707–44709, 44711, 44713, 44715–44717); 20 mi S, 5 mi E Sola de Vega (KU 99547); 27 km (by road) S Juchatengo, 1850 m (KU 121662).

Cryptotis goldmani machetes (14). México: Oaxaca; Campamento Río Molino, 2 km SSW San Miguel Suchixtepec (CNMA 44675-44681, 44683-44689).

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Fecal nitrogen of the white-tailed deer (*Odocoileus virginianus*) in southern México

Nitrógeno fecal del venado cola blanca (*Odocoileus virginianus*) en el sureste de México

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The seasonal changes of the plant species consumed by the white-tailed deer in wildlife influence the availability and quality of their diet and is directly proportional to fecal nitrogen (FN). The objective is to evaluate the content of FN and the use of the fragmented habitat of the white-tailed deer in the dry season when food is scarce. We installed 300 quadrants of 100 m^2 in different habitat types: agricultural, secondary vegetation, and tropical forest in the drought season of 2011. Twenty-seven samples of fresh feces were selected and the FN was quantified to relate it to the quality of food in the habitat fragments. The use of habitat fragments was determined by the distribution of tracks and feces recorded in the quadrants. The levels of FN were of 2.495 ± 0.580 mg/ml without significant differences between habitat fragments ($P > 0.05$). In the use of habitat fragment there was no significant difference ($P > 0.05$). Deer ingest foods that contain a relatively high amount of protein, regardless of habitat type, and they use habitat fragments to consume quality foods based on seasonal availability.

Key words: Feeding; foraging; habitat; quality; seasonality.

Los cambios estacionales de las especies vegetales consumidas por el venado cola blanca (*Odocoileus virginianus*) en vida silvestre influyen en la disponibilidad y calidad de su dieta y son proporcionales al nitrógeno fecal (NF). El objetivo del presente trabajo fue evaluar el contenido de NF y el uso del hábitat del venado cola blanca en la estación seca cuando el alimento es escaso. Se establecieron 300 cuadrantes de 100 m^2, en fragmentos de habitat agrícola, vegetación secundaria y selva en la estación seca de 2011. Se seleccionaron 27 excretas frescas y se cuantificó el NF, para relacionarlo con la calidad de la alimentación en los fragmentos del hábitat. El uso del hábitat se determinó por la distribución de huellas y excretas registradas en los cuadrantes. Los niveles de FN fueron de 2.495 ± 0.580 mg/ml sin diferencias significativas entre los fragmentos de hábitat ($P > 0.05$). En el uso de hábitat no hubo diferencias significativas ($P > 0.05$). Los venados ingieren alimentos que contienen una cantidad relativamente alta de proteínas, independientemente del tipo de hábitat, y también usan los fragmentos de hábitat para consumir alimentos de calidad de acuerdo con la disponibilidad estacional.

Palabras clave: Alimentación; calidad; forrajeo; hábitat; temporalidad.

The behavior of herbivory, habitat use and reproductive success in wildlife of the white-tailed deer (WTD), *Odocoileus virginianus* is usually linked to the quality and quantity of food ingested. An indirect method to measure this quality is the fecal nitrogen index (FN). This method is relatively inexpensive and it is not necessary to capture specimens from the study population, the samples that are collected are feces, therefore this type of sample, also, it serves to carry out population studies (Mandujano 2014; Monteith *et al.* 2014; Gallina *et al.* 2015).

Several studies have shown a strong correlation between FN and diet quality attributes, including intake, digestibility, changes in weight and phosphorus in the diet of several of cervids such as *Cervus elaphus, O. hemionus* and *C. nippon* (Holechek *et al.* 1982; Leslie and Starkey 1985; Howery 1987; Osborn and Ginnet 2001; Ueno *et al.* 2007). In WTD, relationships between FN and organic nitrogen have been established in the plants it consumes (Howery and Pfister 1990), reproductive status (Monteith *et al.* 2014) and sexual segregation (Gallina *et al.* 2015).

The FN is usually influenced by the quality of the diet, regardless of the physiological state of the animal. In addition, the seasonal changes in the plant species consumed by the WTD, and which are available in the habitats, influence the availability and digestibility of the forage (Leslie and Starkey 1985; Duncan and Gordon 1999). Brown *et al.* (1995) demonstrated that low levels of FN were associated with low levels of protein and energy in the diet of the deer. Other studies have linked high levels of FN with high levels of tannins rather than high levels of nitrogen in the diet or high digestibility rates, finding that the FN is frequently high and variable in herbivores that consume shrubs and herbaceous species (Howery 1987; Thompson 1987; Osborn and Ginnet 2001). However, the saliva

in members of the genus *Odocoileus*, like other deer of the concentrate selector type, contains substances that bind to tannins, neutralizing them for the most part, thereby managing to digest the proteins in the food more efficiently (Austin *et al.* 1989; Hofmann 1999).

The type of vegetation, its distribution and abundance are proportionally linked to rainfall (Granados *et al.* 2014). The sub-humid warm climate of Yucatán is characterized by two seasons determined mainly by rainfall: rainy season (from June to November) and dry season (from December to May), so in the dry season there is little availability of plants consumed by the WTD (Mardero *et al.* 2012). Our hypothesis is that, due to the lower rainfall during the dry season in Yucatán, the quality and abundance of vegetation are affected negatively, and therefore expecting in low FN levels. The habitat also influences the consumption behavior of WTD, using areas with greater food availability, such as agriculture fields and secondary vegetation. This study aims to evaluate the content of FN and the use of habitat fragments of the WTD during the dry season, in Yucatán state, México.

The study was conducted in Tzucacab, municipality of Yucatán, México, located between 19° 38" and 20° 09" N and 88° 59" and 89° 14" W, and with 1,289 km^2 of which 302.16 km^2 corresponding of native vegetation (Wyman *et al.* 2007). The climate is Aw1 (i ') g, corresponding to the warm sub-humid with mostly summer rains, which has little thermal oscillation (Duch 1988). The soil can be Lithosol or Luvisol types, having mainly bare rocks, with an average depth of 10 cm, although in some parts they can reach 60 cm. The vegetation cover or natural habitat corresponds to the type of tropical medium subdeciduous forest, the habitat is fragmented, especially for secondary vegetation with different successional stages, agricultural and livestock systems (Wyman *et al.* 2007). From March to May (dry season) six transects of 5,000 m long and 2 m wide, were installed randomly located in the municipality of Tzucacab (Figure 1).

Three hundred square plots of 100 m^2 (10 x 10 m) were installed, along these six transects, and the type of habitat was identified in each plot. The number of tracks and feces was recorded in each type of fragment. The chi-square test (Byers *et al.* 1984) was used to test the use of each fragment or habitat type according to them disponibility. The expected number of observations in each habitat type was computed by multiplying the relative area of the habitat type by the total number of tracks registered. With these data the chi-square goodness-of-fit test ($\chi^2 = \sum(O_i - E_i)^2/E_i$) was realized.

A single deposition of 10 or more pellets was considered as a fecal group, with equal characteristics of coloration, size, and humidity (Elbroch 2003). Fecal groups that showed to be fresh were selected, because of its brightness and humidity; the dried ones, with fungi or insect larvae were discarded. The pellets were collected in the apical part of the fecal cluster to avoid contamination by soil and litter remains; they were placed in paper bags and transferred to the laboratory. The samples were dried at 60 °C for 48 h and then ground, as finely as possible, with a conventional

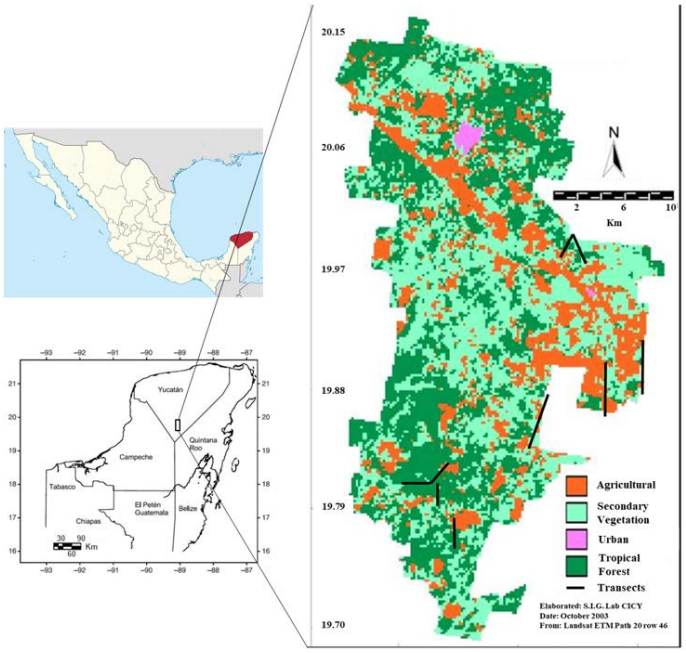

Figure 1. Study area in the municipality of Tzucacab, Yucatán, México.

blender (Moulinex, model 4090). The fecal groups were separated according to the habitat type where they were collected: secondary vegetation (SV), agricultural (AG), and tropical forest (T).

To contrast the food quality with that of animals in captivity, six samples were obtained in the Wildlife Management Unit (WMU) "Xmatkuil" of the Campus of Biological and Agricultural Sciences of the Autonomous University of Yucatán, located in Mérida, Yucatán. These animals have *ad libitum* diet based on fruits (papaya, cucumber and pumpkin), tree fodder (*Brosimum alicastrum* and *Leucaena leucocephala*), and supplemented with commercial feed for pigs, with crude protein contents of 9 %.

The FN content of each sample was quantified in duplicate by the Kjeldahl method (AOAC 1999) and expressed as a percentage of dry matter using a micro-Kjeldahl device, (VELP Scientifics brand, model DK-6). To find differences in the contents of FN, the non-parametric Kruskal-Wallis test was performed because it did not meet the normality requirements.

The plots in each habitat were distributed as follows: SV: 46, AG: 103 and T: 151. In these we found 6, 24 and 58 tracks in SV, AG and T, respectively (Table 1). No significant differences ($P > 0.05$, $\chi^2 = 5.616$, df = 2) were found in the use of habitat type by the WTD. One hundred fifty-three total tracks were obtained and 65 samples of fecal groups of white-tailed deer, 27 of which were taken as suitable for measuring FN. The fecal samples for the NF analysis were classified as follows: SV: 4, AG: 2, T: 21. The FN in each type of habitat (average ± standard deviation) was: SV = 2.198 ± 0.577 mg/ml, AG = 2.574 ± 0.436 mg/ml and T = 2.543 ± 0.597 mg/ml and globally of 2,495 ± 0.580 mg/ml. The concentrations of FN did not have significant differences according to habitat type ($P > 0.05$). For the samples obtained in the WMU, the FN was 2,535 ± 0.695. There were no significant differences between wild habitats and the WMU ($P > 0.05$).

Table 1. Data used for each fecal plots by habitat type in Tzucacab, Yucatán, México.

Habitat	Number plots	Relative plots	Expected usage (Ei)	Observed usage (Oi)
Tropical forest (T)	151	0.50	44.3	58
Secondary vegetation (SV)	46	0.15	13.5	6
Agricultural (AG)	103	0.34	30.2	24

The wild NF values obtained show a high-quality diet since they are similar to those recorded in captive animals in the WMU with diets supplemented with 9 % protein already found by Howery and Pfister (1990) when they are provided with high levels of protein (foods with 16.5 % crude protein, with a value of 2.26 mg/ml of FN) to females of WTD. Massey *et al.* (1994) reported low FN values (1.92 mg/ml) in black-tailed deer (*O. hemionus columbianus*) in the dry season when nutritious foods are scarce.

However, the highest levels of FN (2.495 mg/ml) obtained from the WTD in wildlife in this research confirm that due to the type of foraging, the deer is selective, ingesting foods that provide the nutrients it needs (Berteux *et al.* 1998; Silva-Villalobos *et al.* 1999; Dostaler *et al.* 2011).

This food selection was also demonstrated by Granados *et al.* (2014) in a study of the WTD in the Yucatán Peninsula where they found that the plant species consumed in the dry season decreased (12 species against 29 in the rainy season) and that the most consumed species in the dry season was *L. leucocephala*, which has a crude protein content of 24.63 % dry matter (DM), a high digestibility rate (81 % DM) and a low tannin content (2.09 % DM; López-Cobá *et al.* 2007). This behavior of maximizing the consumption of high-quality foods and minimizing that of secondary metabolites has been mentioned by Duncan and Gordon (1999).

Although they have been reported that agricultural areas in the dry season can serve as feeding areas to the WTD, due to the availability of sprouts (Mandujano and Rico-Gray 1991; Greenberg 1992; Meek *et al.* 2008), which are more palatable and 20-30 % richer in organic nitrogen (Robbins *et al.* 1975). However, the use for some type of habitat can also be explained by the WTD's foraging strategy, typical of an opportunistic concentrate selector to feed in addition to woody material (Granados *et al.* 2014), such as those found in shrubs, stems and tropical leaves and secondary vegetation. These last sites can also provide them with shade and rest sites, an important factor in hot weather, since it has been observed that herbivores at this time increase their body temperature, heart rate, and respiration rate, affecting their voluntary consumption by reducing their foraging time while remaining in the shade and increasing inactivity (Morillo 1994). These foraging strategies, applied by these herbivores, allow them to ingest high-quality food, even if it is to a lesser extent, given the limited availability (Duncan and Gordon 1999).

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New records of red brocket deer (*Mazama temama*) in cloud forests in northeastern Hidalgo, México

Nuevos registros del venado temazate (*Mazama temama*) en bosques mesófilos del noreste de Hidalgo, México

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The red brocket deer (*Mazama temama*) is one of the least studied species of deer in Latin America. In México, little information is available on this species in mountainous regions, particularly in mountain cloud forests (MCF) in the state of Hidalgo. Since red brocket deer and MCF are threatened, mainly by anthropogenic activities, it is essential to carry out monitoring to corroborate the presence of this species in the MCF of Hidalgo. Here we report new records of this species in MCF of northeastern Hidalgo, in a forest management unit. The study was carried out in the 1302 Zacualtipán-Molango Forest Management Unit (UMAFOR) as part of the Strengthening of Social Organizations in the Forestry Sector project of the 2016 National Forestry Program. Monthly walks were carried out in different locations (sites) within the area between January 2016 and February 2019. The presence of red brocket deer was inferred from evidence of scats, tracks, direct sightings, and photographic records. For the latter, trap cameras were placed at sites identified as likely wildlife passes. We obtained 20 records (1 track, 2 scats, 1 sighting, 16 photographs) of red brocket deer. The sighting consisted of an adult individual being chased by seemingly feral dogs. These records provide up-to-date information on the distribution of red brocket deer in MCF in northeastern Hidalgo. To note, records were obtained in an area subjected to forest use under sustained anthropogenic impact. However, owners dedicate their premises to conservation, specifically those including MCF. Since red brocket deer thrives in conserved forests, the records reported here suggest positive effects of forest management on this UMAFOR. Biological monitoring in the area should be continued and extended, also covering areas subject to forest exploitation, as feral dogs may undermine red brocket deer populations. Finally, we recommend the development of research projects in the area, to contribute to management plans aiming to preserve red brocket deer populations.

Key words: Anthropogenic impact; cervid species; feral dogs; forest management.

El venado temazate (*Mazama temama*) es una de las especies de cérvidos menos estudiados en América Latina. En México, se tiene poca información de esta especie en regiones montañosas, particularmente en bosques mesófilos de montaña (BMM) del estado de Hidalgo. Dado que el venado temazate y los BMM se encuentran amenazados, principalmente por las actividades antropogénicas, es importante realizar monitoreos para corroborar la presencia de esta especie en los BMM de la entidad. Presentamos nuevos registros de esta especie en bosques mesófilos del noreste de Hidalgo, en una unidad de manejo forestal. El estudio se realizó en la Unidad de Manejo Forestal (UMAFOR) 1302 Zacualtipán-Molango, como parte del proyecto Fortalecimiento de las Organizaciones Sociales del Sector Forestal, del Programa Nacional Forestal 2016. Se llevaron a cabo recorridos mensuales en diferentes localidades (predios) de la zona, entre enero de 2016 a febrero de 2019. La presencia de venado temazate se verificó mediante el hallazgo de excretas, huellas, avistamientos directos y registros fotográficos. Para esto último, se colocaron cámaras trampa en sitios identificados como posibles pasos de fauna. Obtuvimos 20 registros (1 huella, 2 excretas, 1 avistamiento, 16 fotografías) de venado temazate. El avistamiento consistió en un individuo adulto que era perseguido por perros, aparentemente ferales. Estos registros aportan información actualizada acerca de la distribución del venado temazate en BMM del noreste de Hidalgo. Destacamos que los registros se obtuvieron en una zona de aprovechamiento forestal donde existe impacto antropogénico constante. Sin embargo, las personas destinan en sus predios áreas para conservación, específicamente los BMM. Dado que esta especie es considerada especialista de bosque conservado, los registros podrían indicar impactos positivos del manejo forestal en esta UMAFOR. Se deben continuar y extender los monitoreos biológicos en el área, abarcando también las zonas sujetas a aprovechamiento forestal ya que se observaron perros ferales que pueden vulnerar las poblaciones de venado temazate. Finalmente, exhortamos el desarrollo de proyectos de investigación en el área, para contribuir a los planes de manejo con el objetivo de la persistencia de las poblaciones de venado temazate.

Palabras clave: Especies de cérvidos; impacto antropogénico; manejo forestal; perros ferales.

The red brocket deer, *Mazama temama* (Kerr 1792), is one of the least studied species of deer in Latin America in terms of biology, ecology, distribution, and other aspects (Weber and González 2003; Mandujano 2004; Gallina 2005; Gallina and Mandujano 2009; Mandujano 2011). As a result, the International Union for the Conservation of Nature (IUCN) lists this species as Data Deficient, indicating that it cannot be included in the red list of threatened species until its distribution range and other ecological aspects are better defined (Bello *et al.* 2016). Similarly, the limited information available for the species in México, particularly about its distribution, explains why it is currently not listed in any risk category (SEMARNAT 2010) despite being considered a conservation priority (SEMARNAT 2014). Its historical distribution includes southern México, Belize, Guatemala, El Salvador, Costa Rica, Nicaragua, Honduras, Panama, and western Colombia (Bello *et al.* 2010, 2016); in México, it is reported in the states of Tamaulipas, San Luis Potosi, Veracruz, Hidalgo, Oaxaca, Chiapas, Tabasco, Campeche, and Quintana Roo (Jones *et al.* 1983; Gallina 2005; Bello *et al.* 2016).

The red brocket deer inhabits mainly high evergreen and medium subdeciduous tropical forests, and mountain cloud forests (MCF); it has also been reported in temperate pine-oak forests (Bello *et al.* 2010). It commonly thrives in areas with dense vegetation coverage, high water availability, and low anthropogenic pressure (Weber 2008). Its presence has also been reported in patches of secondary vegetation near to more conserved MCF fragments (Lira-Torres and Naranjo 2003; Pérez-Solano *et al.* 2012, 2016).

MCF are recognized worldwide for their high biodiversity levels and the hydrological services provided. In México, these forests are considered one of the most threatened terrestrial ecosystems due to the small area covered (less than 1 %), and the constant anthropogenic impact associated with changes in land use (Challenger and Soberón 2008; CONABIO 2010; Ponce-Reyes *et al.* 2012; López-Arce *et al.* 2019).

Particularly, mountain cloud forests located in the state of Hidalgo are considered to be of high priority for conservation due to pressures related to extensive livestock, agriculture, and selective logging (CONABIO 2010). Of the two MCF subregions in the entity (CONABIO 2010), research work on red brocket deer has been carried out and published for the San Bartolo Tutotepec-Cuetzalan Cloud Forest subregion (Muñoz and Gallina 2014; Muñoz-Vazquez and Gallina-Tessaro 2016). In contrast, there are scarce research projects and little knowledge about biodiversity for MCFs in the other subregion, named Northeastern Hidalgo-Huayacocotla Cloud Forests (SERFORH 2017).

Since little is known about the current distribution of red brocket deer in mountainous regions of México (Ortíz-Garcia *et al.* 2012; Pérez-Solano *et al.* 2012; Ramírez-Bravo and Hernández-Santín 2012; Pérez-Solano and Mandujano 2013; Pérez-Solano *et al.* 2016), particularly in the state of Hidalgo (Muñoz and Gallina 2014; Muñoz-Vazquez and Gallina-Tessaro 2016), medium - and long - term monitoring in MCF of this state is deemed essential. In this note, we report new records of red brocket deer in Northeastern Hidalgo-Huayacocotla Cloud Forests, which supplement records reported for the San Bartolo Tutotepec MCF (Muñoz and Gallina 2014; Muñoz-Vazquez and Gallina-Tessaro 2016) and contribute with additional information on the current distribution of this species. Particularly relevant are the photographic records obtained in an area subjected to forest exploitation, which is poorly researched despite it represents an important site for biodiversity conservation.

The study was carried out in the 1302 Zacualtipán-Molango Forest Management Unit (UMAFOR), an area comprising 228,341.94 ha (SERFORH 2011; Figure 1). It is located to the northeast of the state of Hidalgo (20º 58′ 34″-20º 23′ 15″ N, 98º 57′ 56″-98º 25′ 12″W) and encompasses 8 municipalities: Calnali, Juárez Hidalgo, Metztitlán, Molango de Escamilla, San Agustín Metzquititlán, Tianguistengo, Xochicoatlán, and Zacualtipán de Ángeles.

MCF is the most widely distributed vegetation type in this UMAFOR, stretching across an area of 62,177.51 ha (SERFORH 2011; Figure 1). On the other hand, the dominant vegetation types in the localities studied within the UMAFOR (sites) are pine-oak and oak-pine forests subjected to forestry management (SERFORH 2011). It is worth mentioning that the sites studied have been under this forest management scheme since the 1980s, and their forest zoning programs consider MCFs as conservation and non-use zones (SERFORH 2011). The mammal species recorded in MCFs include lion mountain (*Puma concolor*), margay (*Leopardus wiedii*), tayra (*Eira barbara*), white-tailed deer (*Odocoileus virginianus*), and collared peccary (*Pecari tajacu*; SERFORH 2017). Some sites are currently managed under the pay-for-environmental-services scheme, involving monitoring brigades to prevent poaching; however, subsistence hunting is practiced in forestry areas (SERFORH 2011, 2017).

As part of the field work of the Strengthening of Social Organizations in the Forestry Sector project, 2016 National

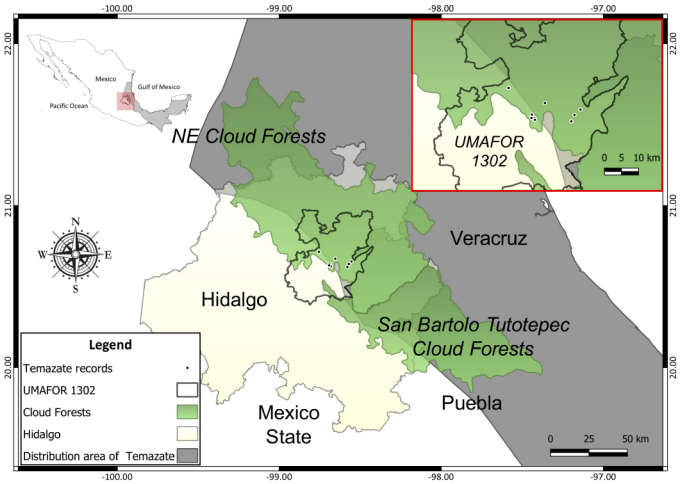

Figure 1. Study area and location of records of red brocket deer (*Mazama temama*) in mountain cloud forests in northeastern Hidalgo, México. Known distribution of *Mazama temama* (IUCN 2016), the two mountain cloud forest regions of Hidalgo: Northeastern (NE)-Huayacocotla Cloud Forest and San Bartolo Tutotepec-Cuetzalan Cloud Forest (CONABIO 2010), as well as the 1302 Zacualtipán-Molango Forest Management Unit (UMAFOR) polygon are shown.

Forestry Program, monthly walks across different sites were conducted for 3 years (January 2016 to February 2019). The distance covered in each walk was 1 km minimum, depending on the orography of the site studied, with 2 walks per month. Walks were carried out in the morning (8 am to 3 pm); the presence of red brocket deer was inferred from indirect evidence, mainly scats and tracks, using illustrated field guides to support each determination (Aranda-Sánchez 2012). The accuracy of records was further confirmed by placing 7 camera traps model Bushnell® Trophy® Cam HD (Bushnell©) at sites previously identified as wildlife passes. Camera traps were spaced about 500 m to 1 km apart, and were set to capture 3 images per detection event; traps operated 24 hours a day for 30 days in each location. The camera-trap sampling period covered the dry and rainy seasons of the year, with a total of 90 days trap per year. Finally, the sampling effort was calculated by multiplying the total number of camera traps by the total number of sampling days (trap nights), as reported for medium- and large - sized mammals (Hernández-Pérez *et al.* 2015).

Camera traps were placed in forest trails, firewall gaps, adjacent to streams, forestry areas, and conservation areas (Table 1). From the photographic records obtained, red brocket deers were identified based on the physical characters described for the species and applying quality filters to photographs (Reid 1997; Gallina 2005; Lara-Díaz *et al.* 2011; Aranda-Sánchez 2012).

We obtained 20 records of red brocket deer over the 3 years of sampling (2016: $n = 5$, 2017: $n = 3$, 2018: $n = 7$, 2019: $n = 5$), which correspond to scats ($n = 2$), tracks ($n = 1$), sightings ($n = 1$), and photographic records ($n = 16$; Table 1). The total sampling effort over the 3 years was at least 48 linear kilometers (walks) and 1,890 trap-nights (camera traps).

One of the scats records was found in a trail within the area dedicated to conservation in Ejido Olotla, municipality of Metztitlán. The second scat was found in a forest trail along the protection strip within the Apaxtitla site, which is under forest management. The record corresponding to the track was found in a trail within the Tetenatipa site, which is under forest management, located 2 km from the

Table 1. Location of records of red brocket deer (*Mazama temama*) in mountain cloud forests located in the 1302 Zacualtipán-Molango Forest Management Unit, Hidalgo, México. *n*: number of records.

Record	Location	Municipality	Latitude	Longitude	n	Age	Observations	Month, year
Scat	Predio Apaxtitla	Zacualtipán de Ángeles	20 °38′ 21.52″	98° 34′ 17.57″	1	Undefined	In a forest trail within a conservation area, Apaxtitla private premises.	February, 2016
Scat	Ejido Olotla	Metztitlán	20° 37′ 48.40″	98° 40′ 59.04″	1	Undefined	In a trail by a stream, within the conservation area 5 km from Olotla.	March, 2016
Sighting	Predio Cruxtitla	Zacualtipán de Ángeles	20° 39′ 15.87″	98° 33′ 17.45″	1	Adult	Cruxtitla, land under forest use. Specimen chased by feral dogs observed during a transect review.	August, 2016
Photo-record-4	Ejido Olotla	Metztitlán	20° 37′ 32.8″	98° 40′ 54.5″	2	Adults (female and male)	10 m from a stream, within the conservation area.	August, 2016
Photo-record-3	Ejido Olotla	Metztitlán	20° 38′ 25.88″	98° 41′ 25.95″	2	Fawn and yearling	On a firewall gap, within the areas under forest management, delimiting the area under recovery.	January and February, 2017
Photo-record-6	Ejido Santo Domingo	Zacualtipán de Ángeles	20° 37′ 17.03″	98° 34′ 48.36″	1	Adult (male)	On a forest gap, within the areas under forest management.	August, 2017
Photo-record-5	Ejido Olotla	Metztitlán	20° 37′ 34.5″	98° 40′ 57.5″	3	Adult (females)	10 m from a stream running across the conservation area.	March, 2018
Photo-record-7	Ejido San Agustín	Eloxochitlán	20° 42′ 53.46″	98° 45′ 20.96″	1	Adult (male)	In a gap adjacent to the stream in San Agustín Eloxochitlán, within the conservation area.	August, 2018
Photo-record-1	Bienes Comunales Olotla	Metztitlán	20° 37′ 58.83″	98° 41′ 34.11″	3	Adults (1 female and 2 males)	On a firewall gap delimiting Olotla and Bienes Comunales Olotla.	November, 2018
Photo-record-2	Bienes Comunales Olotla	Metztitlán	20° 37′ 51.0″	98° 41.3′ 30.0″	4	Adults (3 females and 1 male)	On a firewall gap, within the areas under forest management.	February, 2019
Track	Predio Tetenatipa	Zacualtipán de Ángeles	20° 40′ 20.37″	98° 39′ 14.80″	1	Undefined	On a gap, in the Tetenatipa private premises subjected to forest management, 2 km from Zacualtipán de Ángeles.	July, 2019

urban area in the municipality of Zacualtipán de Angeles. The sighting occurred within the Cruxtitla site, also under forest management. During a survey walk of transects across this site, an adult red brocket deer was observed being chased by a pack of dogs (apparently unguarded by people), which were after it until leaving the area.

The rest of records were photographic evidence. Two adult individuals were recorded in August 2016, 1 female and 1 male. In 2017, 3 specimens were recorded, corresponding to one fawn, one yearling, and one adult, in January, February and August, respectively (Figure 2). In 2018, 7 records were obtained: 3 adult females in March, one adult male in August, and 2 adult males plus one adult female in November. Finally, 4 records were obtained in February 2019, corresponding to 3 adult females and 1 adult male. Of the photographic records, 11 were captured during the night (between 6:45 pm and 1 am) and 5 during the day (between 8 am and 3 pm).

The records of red brocket deer reported in this note provide relevant information about its current distribution in the state of Hidalgo, México, and contribute to the information available on the conservation status of this cervid species (SEMARNAT 2010; Bello *et al.* 2016). Our work is a contribution to the few studies carried out on this species in the MCF of Hidalgo (Muñoz and Gallina 2014; Muñoz-Vazquez and Gallina-Tessaro 2016), being among the early works covering Northeastern Hidalgo-Huayacocotla Cloud Forest subregion.

The records were obtained in the UMAFOR's MCF, a managed forest where the main anthropogenic impact is the land use change for forest activities, including selective logging (CONABIO 2010; SERFORH 2011). Regarding this, habitat fragmentation and human presence have been reported to adversely impact red brocket deer populations; hence, this species is considered to be an inner-forest specialist in different regions of México (Reyna-Hurtado and Tanner 2005; Ortiz-Garcia *et al.* 2012; Ramírez-Bravo and Hernández-Santín 2012; García-Marmolejo *et al.* 2015; Contreras-Moreno *et al.* 2016; Pérez-Irineo and Santos-Moreno 2016), particularly in San Bartolo Tutotepec Mountain Cloud Forest, Hidalgo (Muñoz and Gallina 2014; Muñoz-Vazquez and Gallina-Tessaro 2016). In our study, carried out on some MCF sites in the Northeastern Hidalgo-Huayacocotla subregion, community companies classify these forests as conservation areas exempted from any sort of forest use (SERFORH 2011), resulting in areas of dense vegetation cover surrounding disturbed sites. Thus, the presence of

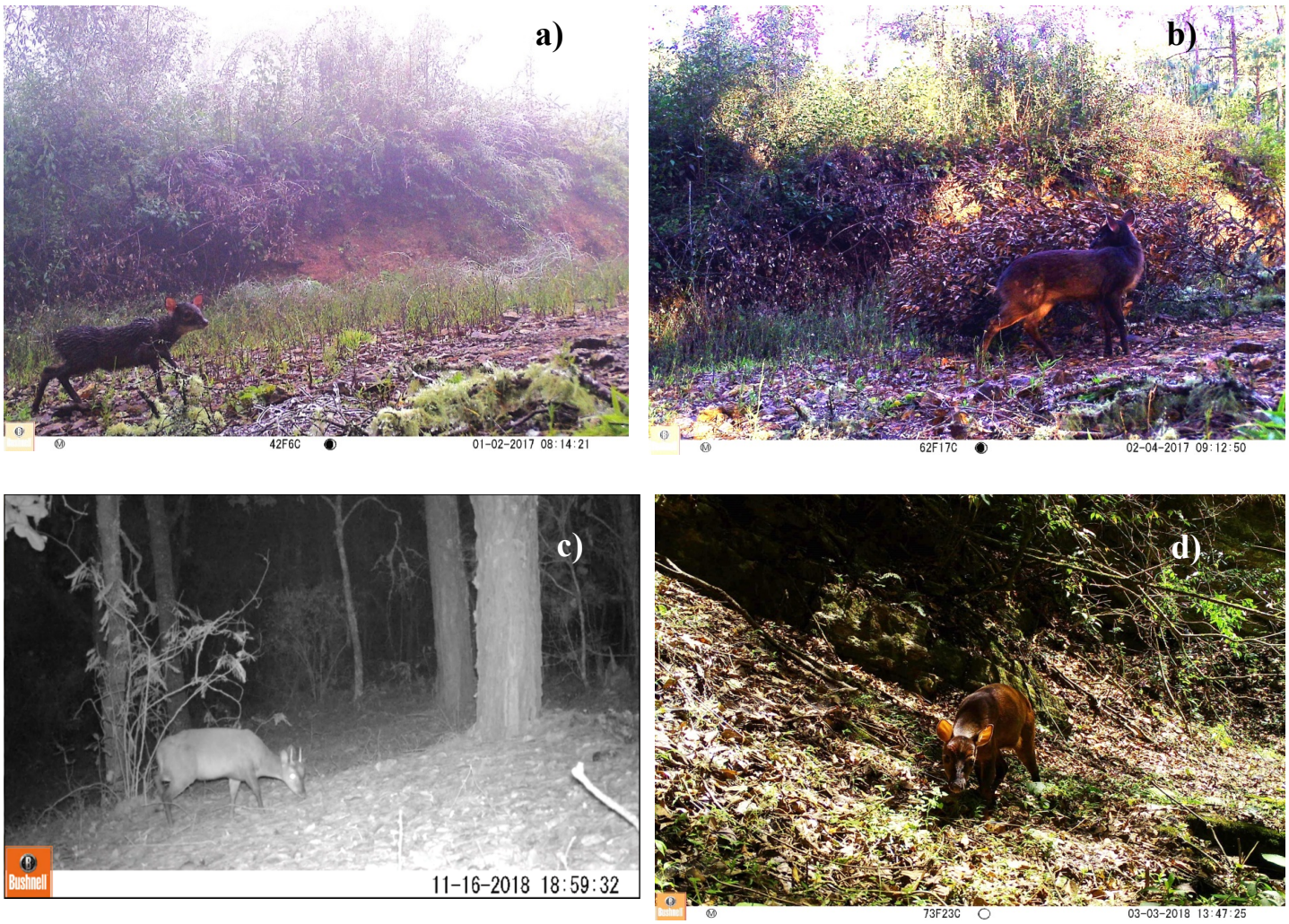

Figure 2. Photographic records of red brocket deer (*Mazama temama*) in the 1302 Zacualtipán-Molango Forest Management Unit, Hidalgo, México: a) fawn (small size, presence of white spots along the back), b) yearling or adult female, c) male (small, unbranched antlers), d) yearling or adult female.

red brocket deer in this UMAFOR could be associated with the existence of MCF, as reported elsewhere (Lira-Torres and Naranjo 2003; Reyna-Hurtado and Tanner 2007). Given the above, MCFs in northeastern Hidalgo may represent the northernmost shelters for red brocket deer populations, which could be connected with San Bartolo Tutotepec MCFs (Muñoz-Vazquez and Gallina-Tessaro 2016).

In this regard, community forests in México have been documented as high species richness sites because owners set limits on deforestation and degradation of the forest cover, hence promoting biodiversity conservation (Bray *et al.* 2007; CONAFOR 2016). Similarly, the adoption of a socio-ecological approach where the use of natural resources considers the interactions between the social and natural environments, has been proposed as a successful management approach for the conservation of wildlife species in fragmented environments, particularly the red brocket deer (García-Marmolejo *et al.* 2015). Therefore, our results suggest positive impacts of forest management on this UMAFOR. This finding may be further confirmed through additional monitoring in areas under forest exploitation, using specific methods to estimate population abundance and density (see Lara-Díaz *et al.* 2011), coupled with more accurate assessments of the impact of forest management on red brocket deer populations (Muñoz-Vazquez and Gallina-Tessaro 2016). It is worth stressing that this forest management scheme has contributed to reducing the negative impacts on mammalian diversity (Hernández-Rodríguez *et al.* 2019); therefore, this UMAFOR may be considered a management scheme that is compatible with the conservation of priority species.

On the other hand, the presence of seemingly feral dogs in the study area demonstrates the importance of continuing the monitoring efforts in this and other management units, since red brocket deer are preyed upon by them (Weber and González 2003; Mandujano 2011). UMAFOR units are areas with little published information about the species they harbor, especially mammals (SERFORH 2017). Additionally, our photographic records suggest that red brocket deer is particularly active at night in the MCF located at this UMAFOR, which could be interpreted as a strategy to evade humans and its activities, including poaching (Reyna-Hurtado and Tanner 2005).

Our results suggest that UMAFORs may supplement the protection provided by natural areas of high conservation priority, including MCFs (Challenger and Soberón 2008; CONABIO 2010), which harbor priority species such as red brocket deer (SEMARNAT 2014). Finally, we encourage the development of research projects at this UMAFOR specifically addressing the red brocket deer. These will contribute to a better understanding on its ecology, ethnoecology, ethology, and genetics (Weber and González 2003; Mandujano 2004; Reyna-Hurtado and Tanner 2005; Gallina and Mandujano 2009; Escobedo-Morales *et al.* 2016), and will set the groundwork for the development of management and conservation plans for this species populations.

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To the Association of Forest Managers of the Zacualtipán-Molango Region, who kindly granted permission to carry out monitoring within areas under forest management, and for their constant company during field trips. To F. Martínez-Pérez and H. A. González-Moreno for the assistance and financial support provided during the monitoring. To our coworkers, J. C. Badillo-Rojas and D. Lucio-Bautista. M. E. Sánchez-Salazar translated the manuscript into English.

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Use of mitochondrial DNA from feces to evaluate the range of secretive species: the case of volcano rabbit

Uso de ADN mitocondrial de heces fecales para evaluar la distribución de especies secretivas: el caso del conejo zacatuche

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The volcano rabbit, *Romerolagus diazi*, is endemic to a small region along the Trans-Mexican Volcanic Belt in central México. Although its distribution in the volcanic fields of the Sierras Nevada and Chichinautzin is not debated, its occurrence in the Nevado de Toluca volcano has been controversial. In this study, we used a species identification tool using DNA isolated from fecal pellets in order to corroborate the occurrence of volcano rabbit in the Nevado de Toluca. Both PCR assays and phylogenetic analysis of fragments of cytochrome b and D-Loop mitochondrial genes provide evidence that although the morphology of collected pellets resemble those of *R. diazi,* they instead correspond to a *Sylvilagus* species. These results support the hypothesis that *R. diazi* is not currently distributed in the Nevado de Toluca.

Key words: DNA; Nevado de Toluca; species identification; volcano rabbit.

El conejo zacatuche es endémico de una pequeña región de la Faja Volcánica Transmexicana en el centro de México. Aunque su distribución en las Sierras Nevada y Chichinautzin no se debate, su presencia en el volcán Nevado de Toluca ha sido controvertida. En este estudio, utilizamos una herramienta de identificación de especies que utiliza fragmentos de los genes mitocondriales citocromo b y D-Loop amplificados de muestras de excretas para corroborar la ocurrencia del conejo zacatuche en el Nevado de Toluca. Tanto los ensayos de PCR como el análisis filogenético de ADN mitocondrial proporcionaron evidencia de que, aunque la morfología de las excretas recolectadas se asemeja a la de las excretas de *R. diazi*, en realidad corresponden a una especie de *Sylvilagus*. Estos resultados soportan la hipótesis de que el Nevado de Toluca no forma parte de la distribución actual de *R. diazi*.

Palabras clave: ADN; conejo zacatuche; identificación de especies; Nevado de Toluca.

The volcano rabbit, *Romerolagus diazi* (Ferrari-Pérez, 1893), known locally as *zacatuche*, is endemic to a small region along the Trans-Mexican Volcanic Belt in central México where it occupies a specialized habitat, in altitudes ranging between 2,900 and 4,250 m (Rizo-Aguilar *et al.* 2016; Velázquez and Guerrero 2019). This range is becoming increasingly fragmented and the area of suitable habitat is decreasing gradually for agriculture, ranching and logging and by forest fires (Uriostegui-Velarde *et al.* 2018). Populations of the volcano rabbit are now at risk and this species is categorized as Endangered, both by the Mexican government (SEMARNAT 2010) and on the IUCN Red List of Threatened Species (Velázquez and Guerrero 2019). The distribution of *R. diazi* in Tláloc, Pelado, Chichinautzin, Monte Tláloc, Iztaccíhuatl and Popocatépetl volcanoes has been documented by collecting, sightings, camera trapping and indirect traces such as fecal pellets identified morphologically (Hoth *et al.* 1987; Velázquez *et al.* 1996; Hunter and Cresswell 2015; Rizo-Aguilar *et al.* 2015, 2016; Uriostegui-Velarde *et al.* 2018). However, its occurrence in the Nevado de Toluca volcano has been controversial (Hoth *et al.* 1987; Cervantes *et al.* 1990; Ceballos *et al.* 1998; Velázquez and Guerrero 2019).

On the basis of such controversy, a recent study attempted to confirm the presence of the volcano rabbit in the Nevado de Toluca both by searching its fecal pellets in 1,807 sites with habitat suitable for the species and by camera trapping (Monroy-Vilchis *et al.* 2020). The authors found fecal pellets attributable to *R. diazi* in only 41 sites but failed to obtain a photographic record of the species. Consequently, they suggest continuing with camera trapping in order to verify the species occurrence in the zone.

Although camera trapping is highly reliable, this direct method is not efficient because it is time consuming and costly, making cameras difficult to deploy. In this study, we used a species identification tool using DNA isolated from pellet samples in order to corroborate the occurrence of the volcano rabbit in the Nevado de Toluca. This non-invasive method has been accomplished for several mammalian species, including rabbits (Waits and Paetkau 2005; Adams *et al.* 2011).

During June to October 2018, we conducted an exhaustive search for pellets of *R. diazi* in 120 sites in the Nevado de Toluca where we had previously identified the presence of bunchgrasses through the analysis of Sentinel 2 satellite images (Figure 1). It was possible to collect 77 pellet samples with similar characteristics to those of the volcano rabbit in only 15 sites. The pellets were put in plastic bags, transported on ice to the laboratory, and stored at -20 °C prior to DNA extraction.

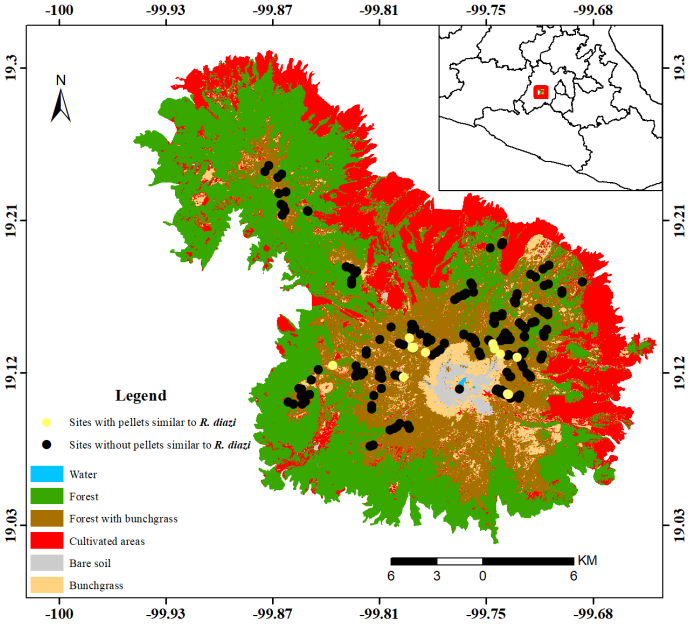

Figure 1. Map depicting the polygon of the Nevado de Toluca and sites surveyed for volcano rabbit pellets.

We attempted to isolate total genomic DNA for all 77 samples with the "ZR Fecal DNA MiniPrep" kit (Zymo research, Irvine, CA, U.S.A.), following manufacturer's instructions, however 17 samples failed to yield quantifiable DNA. Two approaches were then implemented to assess the species identity of the 60 samples that yielded DNA. In the first one, we used the PCR technique as an identification tool of DNA isolated from putative volcano rabbit pellets using a combination of primers that only amplify a 467 base pair fragment of the cytochrome b gene for *R. diazi* (see Osuna *et al.* 2020 for details of primers used). Each PCR reaction contained 1 µl of each 10 µM primer, 12.5 µl of PCR master mix 2X (Promega), 4 µl of DNA extract and 6.5 µl of bidistilled water. PCR amplification was performed in an Eppendorf thermocycler using the following program: a first step of 5 min at 94 °C followed by 34 cycles of 1min at 94 °C, 35 sec at 50 °C, and 40 sec at 72 °C, and a final extension of 10 min at 72 °C. We included two positive controls in all PCR amplification tests. One was obtained from extracted DNA from liver tissue of a road-killed volcano rabbit collected in National Park Iztaccíhuatl-Popocatépetl and the second one was from DNA extracted from a fecal sample of *R. diazi* collected in the locality of Coajomulco, Morelos. These controls had similar conditions (DNA quality and quantity) with respect to the rest of the DNA samples. Negative controls (no template added) were also included to monitor for contamination. All PCR products (25 µl each sample) were checked on 2.0 % agarose gel electrophoresis to confirm the amplification of the desired product.

In the second approach, we amplified and sequenced a 418 base pairs fragment of the control region (D-Loop) in 17 samples that yielded DNA of adequate quality using the primers Pro1 5´-CCACCATCAGCACCCAAAGCT-3 (Mougle 1997) y NC4 5´-AAGAATGGAGTCCCGGTA-3 (Ramírez 2009). PCR and sequencing conditions were described in detail by Osuna *et al.* (2020). Bidirectional sequence reactions were read with a 3500xl genetic analyzer (Life Technology) at the Laboratory of Genomic Sequencing of Biodiversity and Health at the Instituto de Biología, UNAM. The sequences were inspected to correct reading mistakes or ambiguities and aligned with the software Bioedit 7.2.1 (Hall 1999). From the 17 sequenced samples, we obtained only four different haplotypes, which were included in a data matrix containing 31 D-Loop sequences of volcano rabbit obtained from Osuna *et al.* (2020). In addition, we downloaded homologous D-Loop sequences from GeneBank of *Sylvilagus floridanus* (accession number KC923350) and one of *Lepus californicus* (accession number KJ397614) as outgroup. With this matrix, we performed a phylogenetic analysis with the Bayesian inference method using the program MrBayes 3.2.6 (Ronquist *et al.* 2011). The program was run for 1 x 10^7 generations sampling every 10,000 generations and applying a burn-in of 10 %. The molecular evolution model was selected in the program JModelTest 2.1.7 (Posada 2008) using the Akaike information criterion.

PCR profiles of cytochrome b gene showed that none of the 60 putative volcano rabbit samples tested yielded PCR products. Moreover, all positive controls always yielded PCR products of the expected fragment size (Figure 2). Because this reaction is designed to only amplify a 467 bp fragment of cytochrome b if the DNA came from a volcano rabbit, these results suggest that pellets collected in the Nevado de Toluca do not correspond to *R. diazi*. It has been documented that failures in PCR amplifications may occur due to the amount of time the sample is exposed to the environment (Brinkman *et al.* 2010). However, we are certain that DNA degradation is not the reason for the lack of success in obtaining amplicons from pellets collected in the Nevado de Toluca, as the fecal positive control used in all the assays always yielded PCR products of the appropriate size (Figure 2). In addition,

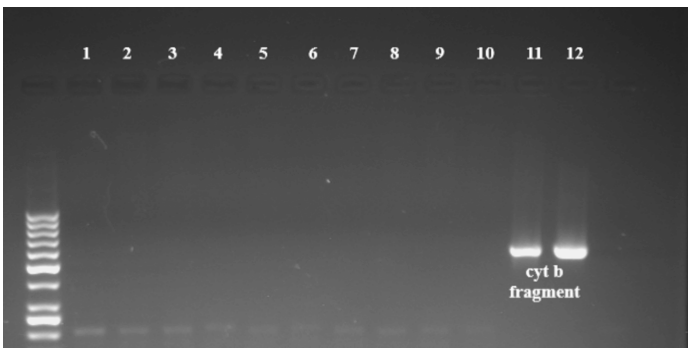

Figure 2. Image of an agarose gel showing resulting PCR assay to identify amplicons of *Romerolagus diazi*. 1-10 correspond to putative volcano rabbit pellet samples, 11-12 are *R. diazi* positive controls.

all the amplifications performed with the D-Loop primers for 17 of the same samples also resulted in amplicons, thus corroborating that the failed cytochrome b PCR amplifications were not due to DNA degradation or a PCR artifact.

The resulting phylogenetic tree showed that the four D-Loop haplotypes of samples attributable to *R. diazi* from the Nevado de Toluca volcano were grouped with the GenBank *S. floridanus* haplotype instead of grouping with any of the 31 previously published haplotypes of *R. diazi* (Figure 3). The haplogroups recovered were strongly supported with posterior probabilities of 1. This result indicates that the pellets are not from *R. diazi*, but from a *Sylvilagus* species. However, we could not definitively assign the identity of the pellets to a particular species of *Sylvilagus* because both *S. floridanus* and *S. cunicularius* are known to occur in the area and there are no available cytochrome b sequences for *S. cunicularius* in GenBank.

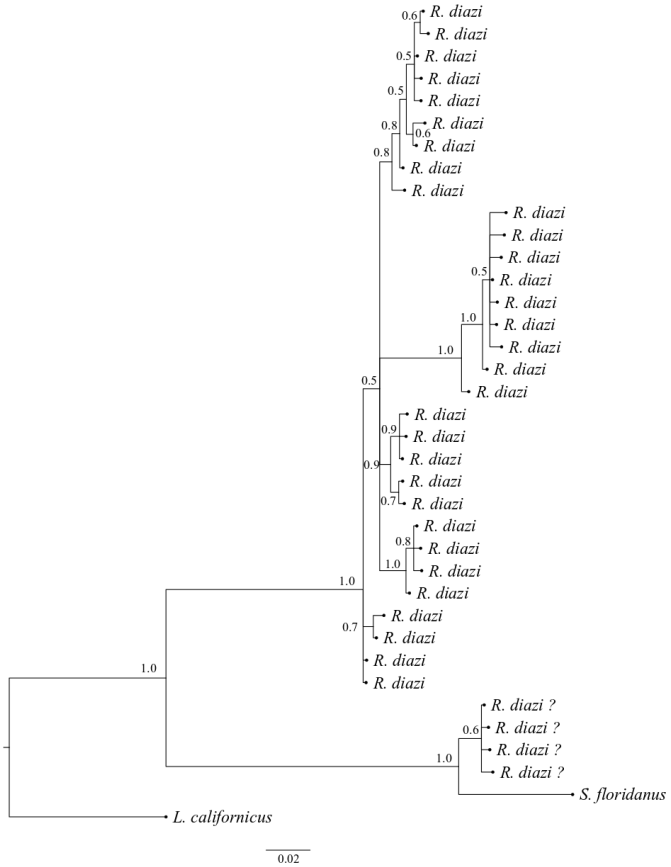

Figure. 3. Bayesian phylogenetic tree of haplotypes of *Romerolagus diazi* and haplotypes obtained from putative samples of *R. diazi*? Numbers in branches represent posterior probabilities.

PCR assays and the phylogenetic analysis based on a fragment of mitochondrial DNA of fecal pellets provide evidence that *R. diazi* does not occur in the Nevado de Toluca. According to Velázquez and Guerrero (2019), native populations of this species have never existed in the Nevado de Toluca. However, at the beginning of the 1970s, a group of volcano rabbits that was confiscated by the General Direction of Flora and Fauna was released in a locality situated at the foothills of the volcano, called "Raíces" (A. Velázquez, personal communication). A few years later, an individual was collected in the same locality and deposited in the mammalian collection of the Instituto Politécnico Nacional (Cervantes *et al.* 1990; Ceballos *et al.* 1998). Since then, there is only indirect evidence where similar pellets to those of the volcano rabbit were adjudicated to the species (Ceballos *et al.* 1998; Monroy-Vilchis *et al.* 2020). Our molecular analysis suggests that fecal pellets that resemble those of *R. diazi* (Cervantes *et al.* 1990) correspond indeed to a *Sylvilagus* species. Consequently, our results support the hypothesis that *R. diazi* is not currently distributed in the Nevado de Toluca (Velázquez and Guerrero 2019). However, more studies are needed in order to confirm our results. Specially because several studies have shown that the use of fecal pellets has been a reliable tool for monitoring the volcano rabbit.

The fact that pellets collected in the Nevado de Toluca were previously misidentified as *R. diazi* pellets is notable, given that in other areas where the species is distributed, the use of pellets has been a reliable tool for monitoring volcano rabbit, as well as to document aspects of habitat use (Velázquez and Heil 1996; Hunter and Cresswell 2015; Rizo-Aguilar *et al.* 2015), diet (Cervantes and Martínez 1992; Martínez-García *et al.* 2012) and physiological stress (Rizo-Aguilar *et al.* 2014), even though *S. cunicularius* and *S. floridanus* are present. Further studies are needed to understand why pellets of *Sylvilagus* converged to the morphology of pellets of *R. diazi* in the Nevado de Toluca.

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Confirmation of the presence of *Dasyprocta azarae* in the Paraguayan Chaco

Confirmación de la presencia de *Dasyprocta azarae* en el Chaco paraguayo

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Azara's Agouti (*Dasyprocta azarae*) was included within the mastofauna of Paraguay's Chaco until 2016. Later literature exclude it from the region, since no published records include a concrete evidence like museum specimens, DNA sequences or photos. The objective of this note is to provide evidence of the distribution of *D. azarae* in the Paraguayan Chaco to help understand its distribution in Paraguay. The distribution of *D. azarae* was re-evaluated by a review of literature, museum specimens, and photograph analysis from the Zoological Collection of the Faculty of Exact and Natural Sciences (ZCENS) to update the species' geographic range. The photographs were captured via camera trapping methods. We provide new records of Azara's Agouti at three locations, two of them located in the transition zone between the Dry Chaco and Pantanal ecoregions, and one in the Dry Chaco ecoregion of the Paraguayan Chaco. Recent literature also confirms the presence of the species in the Humid Chaco ecoregion. Along with other recently published records, we confirm the presence of the species in three ecoregions of the Paraguayan Chaco. With these documented records, its distribution is expanded to more than 270 km west into the region.

Key words: Azara's Agouti; camera trapping; distribution; geographic range; monitoring fauna.

Dasyprocta azarae fue considerada dentro de la mastofauna de la región occidental del Paraguay hasta el año 2016. Literatura posterior excluye a la especie de la región ya que no existe ningún registro publicado que incluya evidencia concreta como ejemplares de museo, secuencias de ADN, o fotografías. El objetivo de esta nota es demostrar evidencia de la distribución de *D. azarae* en el Chaco Paraguayo para aportar al conocimiento de su distribución en Paraguay. La distribución actual de la especie fue re-evaluada mediante una revisión de literatura, ejemplares de museo, y fotografías de la fototeca de la Colección Zoológica de la Facultad de Ciencias Exactas y Naturales (CZCEN) para actualizar la misma. Las fotografías provienen de métodos de foto trampeo. Demostramos registros de Agouti de Azara en tres localidades, dos de ellos en la zona de transición entre las ecorregiones Chaco Seco y Pantanal y uno en el Chaco Seco del Chaco Paraguayo. Literatura reciente también confirma la presencia de la especie en el Chaco Húmedo. En conjunto con otros registros que fueron recientemente publicados, confirmamos la presencia de la especie en tres ecorregiones del Chaco Paraguayo. Con estos registros, su distribución se amplía más de 270 km al oeste dentro de la región.

Palabras clave: Agouti; distribución; fototrampeo; monitoreo de fauna; rango geográfico.

Azara's Agouti, *Dasyprocta azarae,* is a member of the family Dasyproctidae which includes two genera and 13 species (Wilson and Reeder 2005). It is a frugivorous rodent that stores uneaten fruits and nuts by burying them in the ground. In doing so, it plays an important role as a seed disperser for fruit bearing trees (Redford and Eisenberg 1992). It is also preyed upon by carnivorous mammals such as *Leopardus wiedii* which is currently listed as Near Threatened by the IUCN (de Oliveira *et al.* 2015), making *D. azarae* an important prey species.

According to IUCN's Red List, it is present in southwestern and south-central Brazil, from Mato Grosso and Goias states to the coast in Rio Grande do Sul and Sao Paul States, in Bolivia south of the Rio Beni, eastern Paraguay and northeastern Argentina (Catzeflis *et al.* 2016). Myers *et al.* (2002) describes the distribution of the species extending to the Oriental and Occidental regions of Paraguay. Rumbo (2010) also places the species in the Occidental region, but this was based mostly on a previous list (Gamarra de Fox and Martin 1996) and not on concrete evidence. Most recently, Patton and Emmons (2015) and de La Sancha and Ortiz (2017) only place the species in the oriental region due to the lack of evidence supporting its presence in Paraguay's occidental region.

The species has been recently confirmed in Corrientes, Argentina (Chatellenaz *et al.* 2015), which is evidence that its distribution is still poorly known. This supports its categorization as a Data deficient species in IUCN´s Red List (Catzeflis *et al.* 2016), even though it is considered a Least concern species at the national level (Asociación

Paraguaya de Mastozoología and Secretaría del Ambiente 2017). The objective of this note is to provide evidence of the distribution of *D. azarae* in the Paraguayan Chaco to help understand its distribution in Paraguay.

The current distribution of *D. azarae* was re-evaluated and updated via a review of literature, museum specimens, and photographs from the Zoological Collection of the Faculty of Exact and Natural Sciences (ZCENS) at Universidad Nacional de Asunción that had not previously been considered. These photographs were obtained through camera trapping methods developed in a series of projects that monitor biodiversity at cattle ranches in all three departments of the Paraguayan Chaco. The projects began in 2017 and are still underway. In all projects, photographs were considered to be independent records if they were captured at least one hour apart. All photographs obtained were considered, but only those from camera traps at Estancia San Juan (21° 08′ 13.27″ S, 60° 27′ 47.91″ W), Estancia Cerro Corá (20° 16′ 29.2″ S, 58° 15′ 54.6″ W) and Estancia Santa Teresita (20° 24′ 12.5″ S, 58° 26′ 09.4″ W) provided data on *D. azarae*. Camera traps were active for 720, 124, and 234 days respectively. The first ranch lies in the Dry Chaco ecoregion and the last two are located in the transition zone between the Pantanal and Dry Chaco ecoregions (Mereles *et al.* 2013). Museum specimens were searched for through literature and museums with *D. azarae* specimens collected in eastern Paraguay were contacted to request further information.

Through our studies, we have obtained a total of 38 independent photographs and one video of the species via camera traps between 2017 and 2019 at the three cattle ranches; San Juan (one record) in the Dry Chaco ecoregion, and Cerro Corá (27 records) and Santa Teresa (ten records) in the transition zone between the Dry Chaco and Pantanal ecoregions.

One existing museum specimen (FMNH 64200) was located in the zoological collection of the Field Museum of Natural History in Chicago. It was collected in Orloff (22° 18′ 59.4″ S, 59° 54′ 17.64″ W), in the Boquerón Department in 1946 by J. Unger (Londoño-Gaviria *et al.* 2018). Although it was collected in Paraguay's occidental region, this specimen was not considered by de La Sancha and Ortiz (2017) or Patton and Emmons (2015), possibly due to its age.

Additionally, Gonzáles *et al.* (2019) provides new photographic records of the species captured via camera traps at Estación Los Tres Gigantes (20° 4′ 42.44″ S, 58° 9′ 39.06″ W), which is located in the Pantanal ecoregion. Finally, Caballero-Gini *et al.* (2020) provides records of the species at cattle ranch Estancia Playada (24° 57′ 59.88″ S, 57° 21′ 56.12″ W), located in the Humid Chaco ecoregion.

Figure 1. Photographs of *Dasyprocta azarae* from the Zoological Collection of the Faculty of Exact and Natural Sciences captured at three new locations in the Dry Chaco and Dry Chacho/Pantanal transition zone: a) Estancia San Juan, b) Estancia Santa Teresa, c) Estancia Cerro Corá, d) Estancia Cerro Corá.

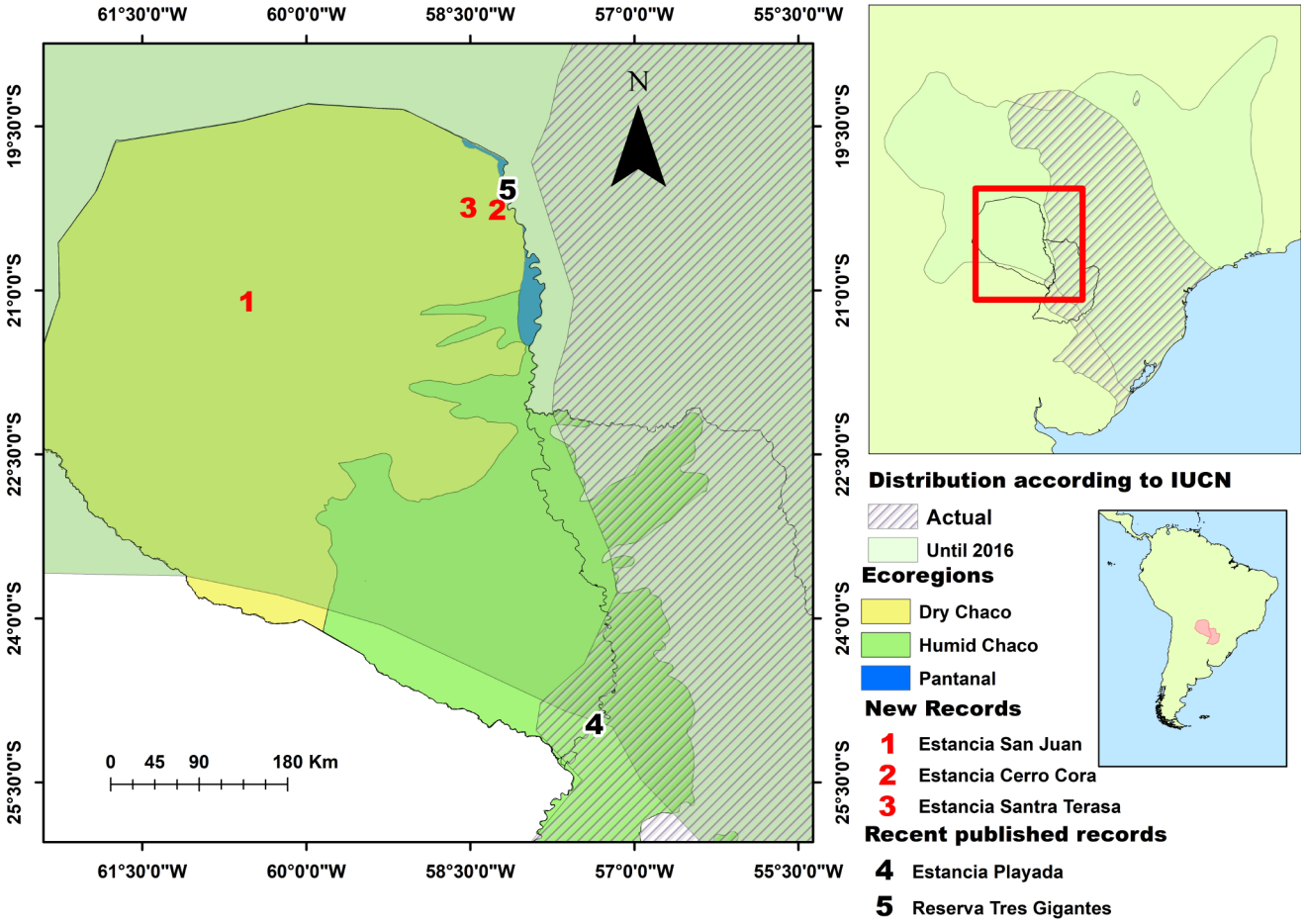

Figure 2. A comparison of the IUCN distribution maps of *Dasyprocta azarae* before and after 2016 along with newly considered records of the species in Paraguay's occidental region.

Together, these records confirm the presence of the species in all three ecoregions in the occidental region and serve as evidence that its distribution expands west of the Paraguay River as was thought until 2016 (Figure 2). Twenty-seven individuals were photographed at Estancia Cerro Corá and 10 were photographed at Estancia Santa Teresa. These locations are close to each other and are in the northeastern area of the Dry Chaco in transition to the Pantanal. Caballero-Gini *et al.* (2020) reports a total of 15 records at Estancia Playada, which is ~532 km southeast of Estancias Cerro Corá and Santa Teresa and is next to the Paraguay River. Only one individual was photographed at Estancia San Juan, which lies to the west of the other three and is further away from the Paraguay River and its adjacent humid environments. This suggests that Estancia San Juan lies on the range margin of the species, possibly due to the low availability of water in the region as compared to Estancias Santa Teresa, Cerro Corá and Playada.

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Dental anomaly in the yellow-shouldered bat, *Sturnira lilium*

Anomalía dental en el murciélago de hombros amarillos, *Sturnira lilium*

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Abnormal dental formulas occur frequently in natural populations. Numerous cases of dental anomalies have been reported for many groups of mammals, and bats are the group with most dental anomalies among mammals. Here we describe the occurrence of a diastema in the position of the upper incisors in an individual of *Sturnira lilium* collected in southern Brazil. This is the first record of a diastema for the species. The dental anomaly reported here may be an isolated case present in this one individual, and without a permanent presence in the population since no other specimens with this type of anomaly were found in the region.

Keywords: Anomaly; Brazil; Chiroptera; Neotropical mammals; skull of bats.

Las fórmulas dentales anormales ocurren con frecuencia en poblaciones naturales. Se han reportado numerosos casos de anomalías dentales para muchos grupos de mamíferos, y los murciélagos son el grupo con la mayoría de las anomalías dentales entre los mamíferos. Aquí describimos la aparición de un diastema en la posición de los incisivos superiores en un individuo de *Sturnira lilium* recolectado en el sur de Brasil. Este es el primer registro de un diastema para la especie. La anomalía dental reportada aquí puede ser un caso aislado presente en este individuo, y sin una presencia permanente en la población ya que no se encontraron otros especímenes con este tipo de anomalía en la región.

Palabras clave: Anomalía; Brasil; Chiroptera; cráneo de murciélago; mamíferos neotropicales.

Mammalian teeth are similar in basic components, they exhibit great diversity in number, size, and shape, and they have much to contribute to the study of ecology, paleontology, functional morphology, and systematics. Dental formulas are widely used in taxonomy studies for the diagnosis of mammalian genera and species (Bergqvist 2003). However, abnormal dental formulas occur frequently in natural populations. Numerous cases of dental anomalies have been reported for many groups of mammals (Azorit *et al.* 2002; Martin 2007; Loch *et al.* 2010; Libardi and Percequillo 2014), and bats are the group with most dental anomalies among mammals (López-Aguirre 2014; Esquivel-Melo *et al.* 2017). In bats, different types of cranial anomalies involving dental formulas may occur. These anomalies are usually related to numerical, morphological, positional, occlusion, or eruption of teeth (Hoff and Hoff 1996). At the Neotropic, the frugivorous bat *Artibeus lituratus* (Phyllostomidae) is the bat species with the highest number of records of dental anomalies. According to López-Aguirre (2014), after deep bibliographical research, compiled data from the last 50 years, the list of bat species with cases of dental anomalies rise to 64 species.

Among frugivorous phyllostomids, bats of the genus *Sturnira* have the largest number of known species. The genus includes at least 23 monophyletic clades of frugivorous bats that are all endemic to the Neotropics (Velazco and Patterson 2013). The diversity of *Sturnira* has grown substantially from recent revision studies (Velazco and Patterson 2013). It has a broad distribution and occurs from México to northern Argentina, including the Lesser Antilles (Simmons 2005; Velazco and Patterson 2013).

The yellow-shouldered bat, *Sturnira lilium* (Chiroptera, Phyllostomidae) is a widespread species and often represents one of the most abundant frugivorous bat in neotropical communities (Simmons 2005; Velazco and Patterson 2013). The yellow-shouldered bat is an intermediate-sized species, with an average weight of 21 g and forearm length measuring about 41 mm (Gannon *et al.* 1989; Gardner 2008; Reis *et al.* 2017). Like most species of *Sturnira*, *S. lilium* has a dental formula of I2/2, C1/1, P2/2, M3/3 = 32 teeth. The internal upper incisors are sickle-shaped, the upper molars have a longitudinal notch and poorly developed cusps, and the second lower molar has prominent parallel and prominent longitudinal notch (Gardner 2008). Here we describe the occurrence of a diastema in the position of the upper incisors in an individual of *S. lilium* collected in southern Brazil.

The specimen was collected in a fragment of mixed ombrophilous forest (MOF) of about 20 ha located in Chapecó, Santa Catarina, southern Brazil (27º 05'S, 52º 39'W; Figure 1). It was captured using mist nets (9 x 3 m), disposed at 0.5 meters from the ground and preserved as dry skin and skull in the Coleção de Mamíferos da Universidade Comunitária da Região de Chapecó, Chapecó, Brazil (CMUC0133). All handling procedures and field activity were approved by the Animal Use Ethics Committee of the Universidade Comunitária da Região de Chapecó (CEUA-Unochapecó, protocol 006/17). The study area is situated in a transition between MOF and seasonal deciduous forest (SDF). MOF has a complex structure and several types of plant communities within its distribution, with *Araucaria angustifolia* (Bertol.) Kuntze as dominant species. SDF comprises forests characterized by the predominance of deciduous trees, with more than 50 % of plant species shedding all their leaves during unfavorable seasons (Gasper *et al.* 2013).

The specimen with a diastema is an adult male (weight 23 g, 43.62 mm, body length 50.63 mm, ear 12.84 mm, and leaf height of 8.18 mm), collected by Fernanda W. Oliveira and Denyelle H. Corá on 5 January 2018 (Figure 2). Fifteen skull measurements were taken from the specimen (for more details see Moratelli *et al.* 2011). All measurements were taken using a digital caliper (0.01 millimeters). Selected cranial measurements (in millimeters) of CMUC0133 were: greatest length of skull (GLS) = 23.7; condylo-canine length (CCL) = 18.12; condylo-incisive length (CIL) = 18.66; basal length (BL) = 19.80; zygomatic breadth (ZB) = 14.03; mastoid breadth (MAB) = 12.70; braincase breadth (BCB) = 10.92; inter-orbital breadth (IOB) = 6.70; postorbital breadth (POB) = 6.41; breadth across canines (BAC) = 6.08; breadth across molars (BAM) = 8.10; maxillary tooth row length (MTL) = 6.96; molariform tooth row length (M3) = 3.27; mandibular length (MAL) = 15.02; mandibular toothrow length (MAN) = 7.70. We compared the skin and dentition of this specimen (CMUC0133) with other 63 individuals of the same species collected in the same fragment and nearby populations. From all analyzed specimens, CMUC0133 matches the description of *S. lilium* and fits the morphological pattern, except for the anomaly here described (Figure 2). The identification of morphological diagnostics characters was based on Giannini and Barquez (2003) and Reis *et al.* (2017).

Although it is relatively easy to distinguish among some species of *Sturnira*, there is considerable intraspecific variation in color, size, and skull shape. Additionally, multilocus molecular analyses of the genus showed *S. lilium* to be a paraphyletic complex of species, including new species (Velazco and Patterson 2013). However, most authors (Davis 1980; Iudica 2000) agree that the dentition provides some of the most consistent characters for the primary bases for

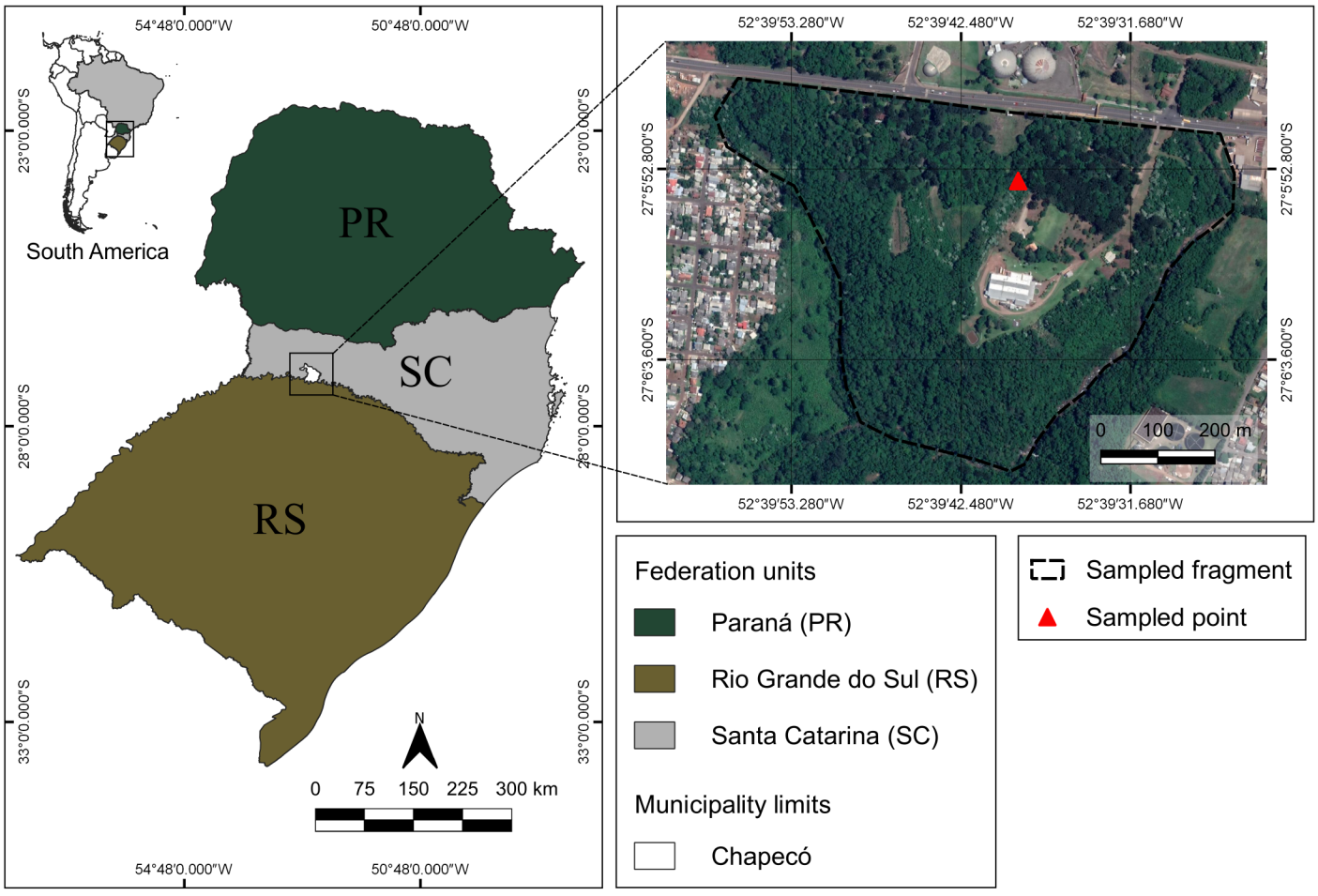

Figure 1. Location of the study area in Chapecó, Santa Catarina, southern Brazil.

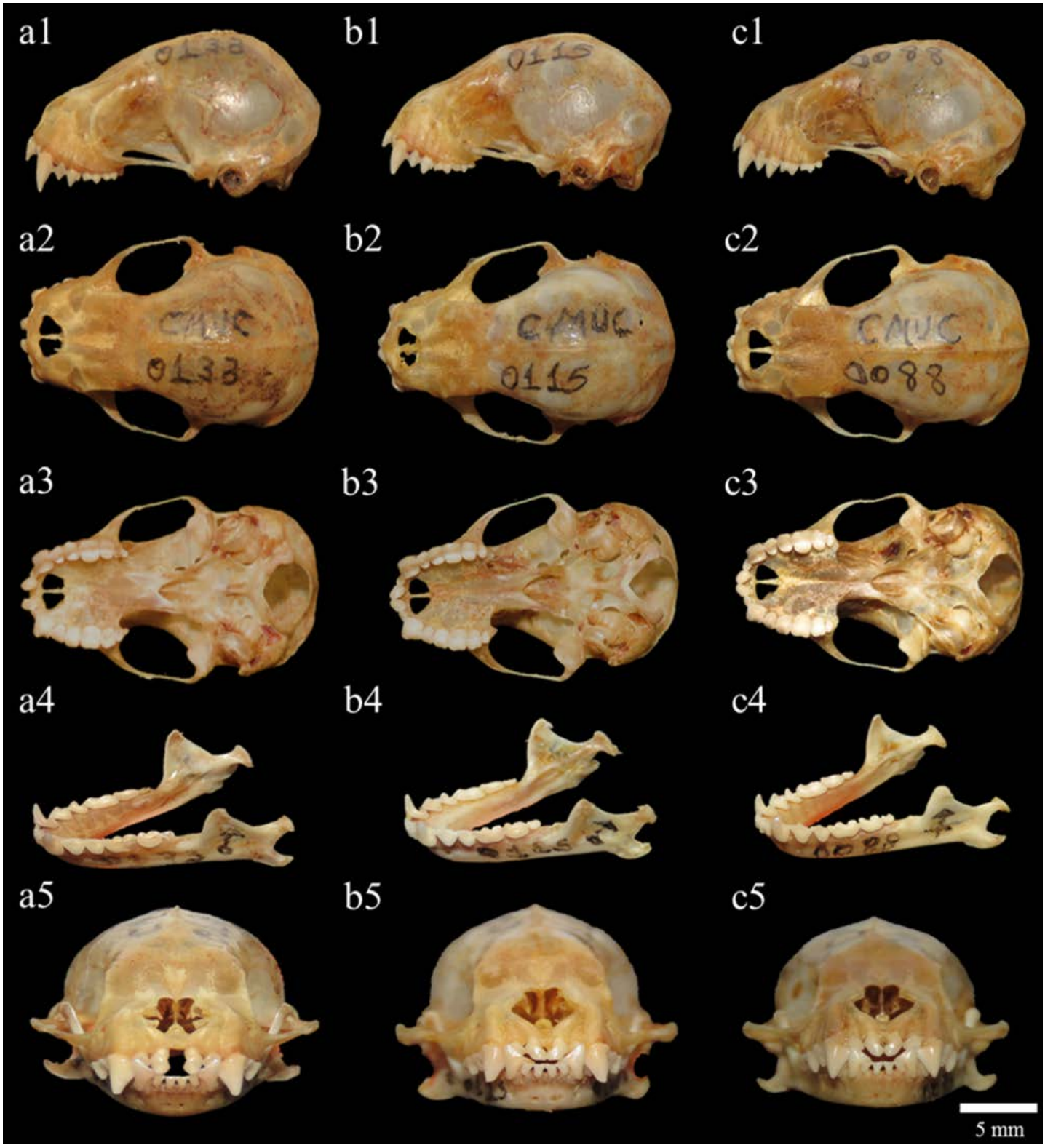

Figure 2. Lateral (a1-c1), dorsal (a2-c2) and ventral (a3-c3) views of the skulls; lateral view of the mandibles (a4-c4); and frontal view of the skulls (a5-c5) from individuals of *Sturnira lilium* collected in Chapecó, Santa Catarina state, southern Brazil. a1-a5: *Sturnira lilium* adult male CMUC0133 with the presence of the diastema. Skulls from other two individuals of *S. lilium* are also displayed (CMUC0115: adult male – b1-b5; and CMUC0088: adult female – c1-c5, respectively). The scale bar (in white) represents 5 mm.

separation of species (Davis 1980; Giannini and Barquez 2003). To our knowledge, from all recognized species of *Sturnira*, there is no record in the literature of a diastema between the upper incisors to the moment, although diastemas might occur naturally in some species of insectivorous, frugivorous and nectarivorous bats (Reis *et al.* 2017).

The causes of dental anomalies reported in bats have been attributed to multiple causes, including genetic, nutritional, pathogenic, or developmental disorders (Hoff and Hoff 1996). Cranial anomalies in bats are mainly recorded for variation in the number of teeth (Rui and Drehmer 2004; López-Aguirre 2014; Esquivel-Melo *et al.* 2017), and pheno-

typic plasticity regarding the abnormal variation in teeth spacing of the upper incisors is little known. The dental anomaly reported here may be an isolated case present in this one individual, and without a permanent presence in the population since no other specimens with this type of anomaly were found in the region. The collection and preparation of specimens with similar characteristics are essential to help understand the possible processes involved in such anomalies.

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First records of leucism in small rodents for Argentina

Primeros registros de leucismo en pequeños roedores para Argentina

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Leucism appears in various groups of vertebrates, although it is rare in mammals. For Argentina, we do not know of any documented registry for small rodents. The objective of our work is to report the first cases of leucism in cricetid rodents in the Puna Desert of Argentina. Field work was carried out in the Multiple Use Provincial Reserve Don Carmelo (San Juan, Argentina), located in the Puna Desert. The animals were captured in 9 grids formed by 36 Sherman-type traps, established in plots located between 3.100 and 3.300 m, in the years 2013-2014. We recorded 6 cases of leucism in 3 species of cricetids: *Eligmodontia* sp. ($n = 3$), *Abrothrix andina* ($n = 2$), and *Phyllotis xanthopygus* ($n = 1$). This work represents the first report of cases of leucism in small mammals from Argentina. The cases in the studied population could be due to the low gene flow imposed by the high environmental severity of an extreme desert, probably related to genetic causes derived from climatic and ecological factors, as these are non-anthropized environments.

Key words: Cricetids; leucism; pigment disorder; Puna Desert; rodents.

El leucismo aparece en varios grupos de vertebrados, aunque es menos frecuente en mamíferos. Para Argentina no conocemos ningún registro documentado para roedores pequeños. El objetivo de nuestro trabajo es informar los primeros casos de leucismo en roedores cricétidos en la Puna Desértica de Argentina. El trabajo de campo se llevó a cabo en la Reserva Provincial de Uso Múltiple Don Carmelo (San Juan, Argentina), ubicada en la Puna Desértica. Los animales fueron capturados en 9 cuadrículas formadas por 36 trampas tipo Sherman, establecidas en parcelas situadas entre los 3,100 y 3,300 m, en los años 2013-2014. Registramos 6 casos de leucismo en 3 especies de cricétidos: *Eligmodontia* sp. ($n = 3$), *Abrothrix andina* ($n = 2$) y *Phyllotis xanthopygus* ($n = 1$). Este trabajo representa el primer reporte de casos de leucismo en mamíferos pequeños para Argentina. Los casos en la población estudiada podrían deberse al bajo flujo génico impuesto por la alta rigurosidad ambiental de un desierto extremo, probablemente relacionándose con causas genéticas derivadas de factores climáticos y ecológicos, al tratarse de ambientes no antropizados.

Palabras clave: Cricétidos; desorden pigmentario; leucismo; Puna Desértica; roedores.

Genetic abnormalities that affect color expression are known as albinism, leucism, and melanism. Albinism is the condition defined by the total absence of melanin pigment in the eyes, skin and hair (Lamoreux *et al.* 2010). In leucism, animals have a lighter color or are stained, with pigmented eyes (Miller 2005; García-Morales *et al.* 2012; Liu *et al.* 2019). In melanism, animals are overproduced with melanin, resulting in completely black fur (Jimbow *et al.* 1976; Silvers 2012).

In natural populations, these pigmentation abnormalities often occur in isolated and small populations, reflecting low levels of genetic diversity (Holyoak 1978; Bensch *et al.* 2000; Brito and Valdivieso-Bermeo 2016; Rubio and Simonetti 2018). They have also been related to contamination in urban areas (Il'enko 1960) and radioactive contamination, as in the case of areas near Chernobyl (Møller and Mousseasu 2001).

Pigmentation abnormalities associated with albinism, such as leucism, appear in various vertebrate groups although they are less frequent in mammals (Dunlop *et al.* 2019). Cases were reported in fish (Mena-Valenzuela and Valdiviezo-Riveira 2016; Nugra *et al.* 2018; Liu *et al.* 2019); amphibians and reptiles (Krecsák 2008; López and Ghirardi 2011; Escoriza 2012), and birds (Comisso 2012; Chiale and Gerardo 2014; Atauchi 2015; Cadena-Ortíz *et al.* 2015).

In mammals, the leucism was found in various species such as bats (*Artibeus fraterculus*; Fernández de Córdova *et al.* 2017), agouti (*Dasyprocta azarae* and *D. fuliginosa*; Vilges de Olivera 2009; Mejía-Valenzuela 2019), two-furred fur sea wolf (*Arctocephalus australis*; Abreu *et al.* 2013), opossum (*Didelphis albiventris*; Abreu *et al.* 2013), squirrel (*Funambulus palmarum*; Samson *et al.* 2017), guanaco (*Lama guanicoe*; Puig *et al.* 2017), among other.

Likewise, in several genera of small rodents such as *Reithrodontomys* (Egoscue 1958), *Otomys* (Pirlot 1958), *Mus musculus* (Winston and Lindzey 1964), *Perognathus* (Egoscue and Lewis 1968), *Microtus* (Brewer *et al.* 1993; Peles *et al.* 1995), *Myodes* (Steen and Sonerud 2012), *Peromyscus* (Camargo *et al.* 2014), *Akodon*, *Nephelomys*, *Transandinomys*, *Thomasomys* and *Mesomys* (Brito and Valdivieso-Bermeo 2016), *Akodon* (Montoya- Bustamante *et al.* 2017), and *Abrothrix* (Rubio and Simonetti 2018). Currently for Argentina, we do not know of any documented record for small rodents. Thus, the objective of this work is to report the first cases of leucism in small rodents in the Argentine Puna Desert.

The study site is located in the Multiple Use Provincial Reserve Don Carmelo, at the southernmost tip of the Argentina Puna Desert. The protected area is located in the west center of Ullum department, in the province of San Juan-Argentina (31° 10′ S, 69° 46′ W; Figure 1), with an altitude that ranges from 3,000 to 3,800 m. It has an average annual temperature of 8.15 °C, an absolute maximum temperature of 26 °C, and an absolute minimum temperature of -22 °C (Andino and Borghi 2017). The vegetation consists of low xerophilous shrubs and grasses, with immature, stony or sandy soils (Martínez-Carretero 1995; Beninato *et al.* 2019).

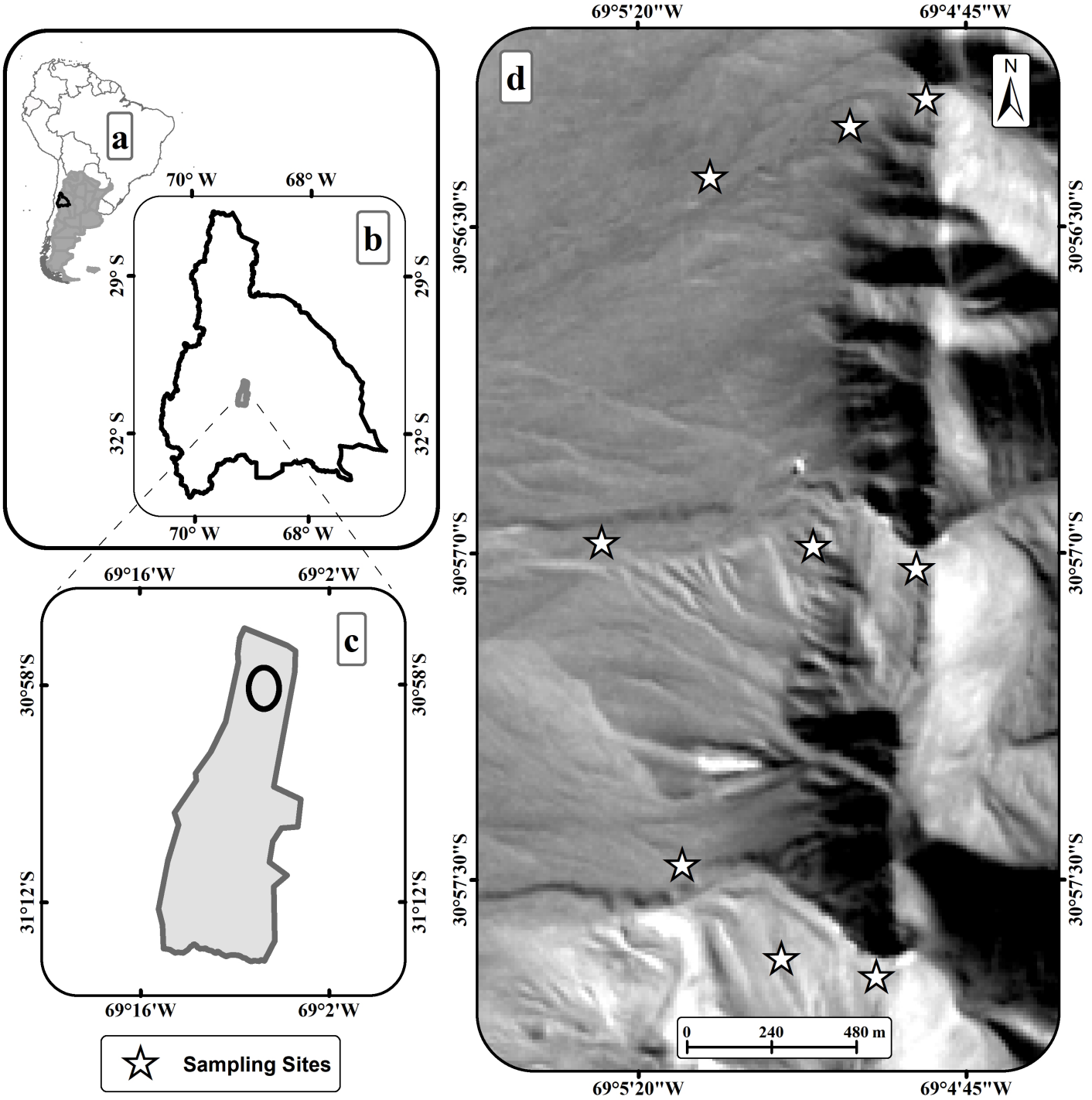

Figure 1. Location of the study area located in the Argentina Puna Desert, province of San Juan, Argentina. a) South America (in gray Argentina); b) San Juan; c) Don Carmelo Multiple Use Reserve, d) Study sites.

The work was carried out in the 3 dominant environments of this sector of the Puna: rocky outcrop, hillside and plain, in plots located between 3,100 and 3,300 m, between the years 2013-2014. Sampling was carried out on 9 fixed grids, separated by a minimum of 500 m, made up of 36 Sherman-type traps 15 m apart (more details in Beninato *et al.* 2019). The captures were carried out during the 4 stations. The sampling effort was 2,592 traps nights.

From a total of 309 captured individuals, 6 individuals with leucism were registered, belonging to 3 species of cricetid rodents, thus representing 2 % of the total captured animals. There were 3 adult individuals of *Eligmodontia* sp. (15 %; *n* = 20), 1 juvenile and 1 adult individual of *Abrothrix andina* (2.1 %; *n* = 93) and 1 adult individual of *Phyllotis xanthopygus* (0.51 %; *n* = 196; Figure 2a-f; Table 1). The individuals presented small spots of white coloration on the back and / or lateral parts, with the pigmentation of the retinas and normal eyelids. The individuals of *Eligmodontia* sp. had spots on the back, head and sides; that of *P. xanthopygus* spots on the head; and that of *A. andina* spots on one of the ears and one of the flanks (Figure 2a-f).

Coloring patterns in wildlife are fundamental ecological adaptations for species survival because they facilitate camouflage, mimicry, sexual selection, and thermoregulation (Caro 2005; Mullen and Hoekstra 2008; Protas and Patel 2008; Hubbard *et al.* 2010). In individuals with pigmentation abnormalities, such as leucism, the condition is considered a disadvantage because they are more likely to be detected by predators than individuals with normal coloration (Owen and Shimmings 1992; Vignieri *et al.* 2010).

In South America, so far there are few records of leucism in small rodents and all have been associated with anthropogenic effects. In Ecuador, leucism was recorded in an anthropized environment of the Cordillera in the genera *Akodon*, *Nephelomys*, *Transandinomys*, *Thomasomys* and *Mesomys* (Brito and Valdivieso-Bermeo 2016) and in a valley near Quito (*Reithrodontomys mexicanus*; Ramírez-Jaramillo *et al.* 2019). In Colombia, leucism was found in specimens of *Akodon affinis* (Montoya- Bustamante *et al.* 2017) which was associated with possible inbreeding effects due to discontinuous distribution and habitat fragmentation in the Andes. In Chile, the presence of specimens with leucism in *Abrothrix hirta* and *A. olivacea* was associated with a possible decrease in genetic diversity due to the effect of human disturbances

Figure 2. Leucism in 3 species of small rodents in the Argentina Puna Desert, province of San Juan Argentina. *Eligmodontia* sp. (a, b, c), *Phyllotis xanthopygus* (d) and *Abrothrix andina* (e, f). Photography: V. A. Beninato.

(Rubio and Simonetti 2018). For the genus *Eligmodontia* so far there is no documentation of any pigment disorder, while for *Phyllotis andium* there is a record of albinism in the coastal desert of Perú (Ramírez and Arana 2005). With respect to Argentina, total melanism, another pigmentary disorder, had previously only been registered in two species of small mammals (*Scapteromys tumidus* and *Oligoryzomys flavescens*) from the Paraná Delta (Massoia 1978).

The cases of leucism reported in this work for *P. xanthopygus*, *A. andina* and *Eligmodontia* sp. in the Argentina Puna Desert, could have an origin in low genetic variability, as has been suggested for other vertebrates (Owen and Shimmings 1992; Bensch *et al.* 2000), and other small mammals (Brito and Valdivieso-Bermeo 2016; Rubio and Simonetti 2018). The Argentina Puna Desert presents extreme climatic conditions, with scarce vegetation cover, except in the rocky outcrops, which appear as patchy and scarce environments (Beninato *et al.* 2019), in addition to the presence of air and land predators. Beninato *et al.* (2019) found

Table 1. Cases of leucism in 3 species of small rodents in the Argentina Puna Desert, province of San Juan Argentina.

Species	Latitude	Longitude	Altitude	Environment	Sex	Season	Photography
Eligmodontia sp.	30°57'26.8"	69°5'15.8"	3.115	Plain	Female	Spring	a
Eligmodontia sp.	30°56'26.2"	69°5'12.7"	3.096	Plain	Male	Winter	b
Eligmodontia sp.	30°56'26.3"	69°5'12.1"	3.120	Hillside	Male	Winter	c
Phyllotis xanthopygus	30°57'2.4"	69°4'50.04"	3.096	Rock	Male	Autumn	d
Abrothrix andina	30°57'0.0"	69°4'50.7"	3.165	Rock	-	Summer	e
Abrothrix andina	30°56'56.8"	69°4'48.2"	3.175	Rock	-	Summer	f

that *P. xanthopygus* and *A. andina*, restricted their distribution almost exclusively to the rocky areas and *Eligmodontia* sp. to the plains. The cases of leucism in the studied population could be due to the low gene flow imposed by the high environmental rigor.

This work represents the first report of cases of leucism in small rodents for Argentina. In this case, the presence of leucism is probably related to the effect of natural ecological factors in these extreme non-anthropic environments. However, genetic studies are required to advance the causality that this type of condition is generating in the wild fauna of the small mammal of the arid end of the Argentina Puna Desert.

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New record of *Nyctinomops aurispinosus* with an update of its known distribution

Nuevo registro de *Nyctinomops aurispinosus* con una actualización de su distribución conocida

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Nyctinomops aurispinosus is one of four species of the genus *Nyctinomops* (Molossidae) and is considered monotypic. This insectivorous species has a wide but poorly known neotropical distribution. This study documents the first record of the species for the Sama Valley, Tacna department, Perú. In addition, a current distribution map of the species is presented together with facts concerning its dietary composition. The specimen was collected using mist nets during a local bat study and compared with *N. aurispinosus* individuals in the scientific collection of the Museo de Historia Natural Javier Prado, Universidad Nacional Mayor de San Marcos. The distribution map was made of published records and the diet of the specimen was analyzed by stereoscopy of the contents of its digestive tract. The collected specimen was identified as an adult male *N. aurispinosus* in reproductive condition. Analysis of the digestive tract contents showed that its diet was composed of lepidopterans. The current distribution map of the species consisted of a total of 78 published records. This new record for Tacna department expands the distribution of *N. aurispinosus* ca. 270 km to the south of Camaná, Arequipa department, becoming the southernmost record for the Pacific coast. The lepidopteran remains in the digestive tract show that its diet is similar to those reported for other molossids. This finding extends the known distribution of this species to the southwest of South America and increases to ten the number of bat species known from Tacna department. The proximity of this Peruvian record to Chilean territory and regional habitat continuity suggests the probable presence of *N. aurispinosus* in that country.

Keys words: Desert; diet; molossids; range; Tacna; valley.

Nyctinomops aurispinosus es una de las cuatro especies del género *Nyctinomops* (Molossidae), monotípica e insectívora de amplia distribución Neotropical, pero muy poco conocida. El presente estudio documenta el primer registro de la especie para el valle de Sama, departamento de Tacna, Perú, además se elabora el mapa de distribución actual de la especie y brinda aportes sobre la composición de su dieta. El ejemplar fue colectado en un estudio de quiropterofauna local utilizando redes niebla y comparado con individuos de *N. aurispinosus* de la colección científica del Museo de Historia Natural de la Universidad Nacional Mayor de San Marcos. El mapa de distribución se realizó mediante registros publicados y la dieta del ejemplar se analizó por estereoscopia del contenido de su tracto digestivo. El ejemplar colectado fue identificado como un individuo de *N. aurispinosus*, macho, adulto y en etapa reproductiva. El análisis del contenido del tracto digestivo reveló que su dieta estuvo compuesta de lepidópteros. La elaboración del mapa de distribución actual de la especie comprendió un total de 78 registros publicados. Este nuevo registro para el departamento de Tacna expande la distribución de *N. aurispinosus* en aproximadamente 270 km al sur de Camaná, departamento de Arequipa, convirtiéndose en el más austral para la costa del Pacífico. Las estructuras de lepidópteros en el contenido del tracto digestivo del ejemplar revelan que la dieta de la especie es similar a la reportada en otros molósidos. Este hallazgo incrementa la distribución conocida de esta especie hacia el suroeste de Sudamérica, además de elevar a diez el número de especies de murciélagos conocidas para el departamento de Tacna. Debido a la proximidad del registro y similitud de hábitats entre el sur del Perú y el norte de Chile se sugiere la presencia de *N. aurispinosus* en este último país.

Palabras clave: Desierto; dieta; molósidos; rango; Tacna; valle.

The insectivorous bat family Molossidae has a pantropical distribution (Simmons 2005; Peracchi *et al.* 2011) and is represented by 11 genera and 50 species in the Neotropics (Solari and Martinez-Arias 2014; Medina *et al.* 2014; Loureiro *et al.* 2018; Moras *et al.* 2018), being 29 the species that have been reported for Perú (Pacheco *et al.* 2009; Gregorin and Chiquito 2010; Díaz 2011; Medina *et al.* 2012, 2014). In this family, the genus *Nyctinomops* Miller 1902 is distributed widely in the Western Hemisphere: from Canadá, United States, México, Belize, El Salvador, Cuba, Jamaica, Haití, Honduras, Nicaragua, Guatemala, Dominican Republic, Panamá, Guyana, French Guyana, Surinam, Colombia, Venezuela, Ecuador, Trinidad and Tobago, Brazil, Perú, Bolivia, Paraguay, to Argentina, and Uruguay (Silva-Taboada and Koopman 1964; McCarthy *et al.* 1987; McCarthy *et al.* 1993; Nowak 1994; Simmons 2005; Eger 2008; Owen and

Girón 2012; Medina-Fitoria *et al.* 2015; Kraker-Castañeda *et al.* 2016; Soto-Centeno *et al.* 2017). The individuals documented in Canadá (British Columbia) and the United States (states of Iowa and Kansas) are considered as vagrants or extralimital records (Milner *et al.* 1990). There are four species of *Nyctinomops*: *N. laticaudatus* (É. Geoffroy St.-Hilaire 1805), *N. macrotis* (Gray 1839), *N. aurispinosus* (T.R. Peale 1848), and *N. femorosaccus* (Merriam 1889).

Peale's free-tailed bat, *N. aurispinosus* was described as *Dysopes aurispinosus,* with a type locality south of Cape St. Roque, Estado do Río Grande do Norte, Brazil (Peale 1848). Later, Cassin (1858) used the name *Molossus aurispinosus* for the specimen described by Peale because of its similarity to *M. rugosus* d'Orbigny, 1837 (a synonym of *Tadarida brasiliensis brasiliensis* I. Geoffroy St. Hilaire 1824) but differing in the color of the fur. Moreover, this author questioned the use of the specific epithet "*aurispinosus*", which translated from the Latin means "thorny ear" (an external characteristic of *N. aurispinosus*) because of its resemblance to the translation "golden ear".

Afterwards, Miller (1902) described the genus *Nyctinomops* conformed by eight species, designating *N. femorosaccus* as type species. This author also argued that *Nyctinomops* members were intermediate in body size between the genera *Promops* and *Tadarida*, distinguished from *Promops* by narrowly separated premaxillaries anteriorly and from *Tadarida* by its possession of parallel upper incisors that are sometimes in contact with each other.

Shamel (1931) synonymized *Nyctinomops* with the genus *Tadarida*, but recognized two groups; the first with nine smallish species (the *brasiliensis* group) and the second with six larger species (the *macrotis* group), including *Tadarida aurispinosa*, *T. europs, T. femorosacca, T. laticaudata, T. macrotis*, and *T. yucatanica.* Later, *T. europs* and *T. yucatanica* were recognized as *T. laticaudata europs* (Jones and Álvarez 1962) and *T. l. yucatanica* (Silva-Taboada and Koopman 1964), respectively, leaving the *macrotis* group conformed by four species. Through a phenetic analysis of the family Molossidae, Freeman (1981) found similarities among these four species of the *macrotis* group, grouping them in the genus *Nyctinomops* with the names of their original descriptions (*N. aurispinosus, N. femorosaccus*, *N. laticaudatus* and *N. macrotis*).

Nyctinomops aurispinosus is distributed in México, Honduras, Colombia, Venezuela, Brazil, Bolivia, and Perú from sea level to 3,115 m (Peale 1848; Sanborn 1941; Ortiz de la Puente 1951; Carter and Davis 1961; Ochoa 1984; Ibáñez and Ochoa 1989; Espinal *et al.* 2016), being most frequently reported below 1,000 m (Jones and Arroyo-Cabrales 1990). In México, it is found in tropical deciduous forest and trees of the genus *Cupresus*, around rivers and thorny deciduous riparian forests (Gardner 1963; Jones and Álvarez 1964; Baker and Jones 1972; Wang *et al.* 2003), as well as in tropical vegetation, thorny bushes, cacti, oak, grasslands, and mesquites (Baker *et al.* 1967; Wilson 1985; López-González and García-Mendoza 2006). In Honduras, it was reported in pine-oak forests with pastures converted for livestock (Espinal *et al.* 2016); in Venezuela, in very humid pre-montane forest (Ochoa 1984); in Bolivia, it was reported in spiny trees along the edges of fresh water sources (Ibáñez and Ochoa 1989); in Brazil, it has been recorded in the Cerrado, Caatinga, and Atlantic Forest biomes (Taddei and Garutti 1981; Bredt 2003; Eger 2008; Bianconi *et al.* 2009; Tavares *et al.* 2010; Aguiar *et al.* 2012; Garbino 2016; Oliveira *et al.* 2019); whereas in Perú, *N. aurispinosus* is distributed in the Dry equatorial forest (characterized by flora of the families Capparaceae, Cassuarinaceae, Fabaceae, and Loranthaceae), Pacific coastal desert, and Subtropical puna (Ortiz de la Puente 1951; Sanborn 1951; Eger 2008; Velazco *et al.* 2013; Pari *et al.* 2015).

The holotype of *N. aurispinosus* is deposited in the Smithsonian National Museum of Natural History (USNM 3726, collected by Peale on November 18th, 1848) and is an adult male preserved in alcohol with removed skull that was subsequently misplaced (Shamel 1931). From the registration of the holotype to today, the wide distribution of *N. aurispinosus* stands in contrast to the few specimens in scientific collections around the world; this relates to the fact that molossids represent about 11.7 % of the bat specimens in museums, because their flight characteristics and echolocation make them difficult to capture by conventional methods (Ammerman *et al.* 2012).

Ortiz de la Puente (1951) reported the first Peruvian record of *N. aurispinosus* from Lima department (Museo de Historia Natural de la Universidad Nacional Mayor de San Marcos – MUSM 235, 6051). Sanborn (1941) and Carter and Davis (1961) referred a specimen (Field Museum of Natural History - FMNH 68561) collected in Marcapata, Huajyumbe in Cuzco department to this species. Later, Eger (2008) and Dolman and Ammerman (2015) reported *N. aurispinosus* (Louisiana State University Museum of Zoology, Baton Rouge, Louisiana, USA - LSUMZ 25011, 25012, 25013, 25014, 25021, 25022, 25029) 12 km from Olmos in Lambayeque department. Velazco *et al.* (2013) reported two specimens (American Museum of Natural History - AMNH 278527 and Colección de Mastozoología, Centro de Ecología y Biodiversidad, Lima, Perú - CEBIOMAS 228) from La Brea, Talara in Piura department, and Pari *et al.* (2015) reported a specimen (without catalogue information) collected in Camaná, Arequipa department. Recent research has documented an important diversity of insectivorous bats in the south of Perú (molossids and vespertilionids; Medina *et al.* 2014; Flores-Quispe *et al.* 2015; Málaga *et al.* 2020); however, the difficulty of catching individuals has hampered learning about their natural history.

In this study, we present the first record of *N. aurispinosus* for Tacna department in the extreme south of Perú, which extends its known geographical distribution, and consider this in the context of the currently known distribution of the species. Additionally, we offer the first contributions about the diet of these bats through microscopic examination of its digestive tract contents.

The capture location (-17° 49′ 58.23″ S, -70° 30′ 41.07″ W; 464 m) of the *N. aurispinosus* specimen was 1 km to the north of the locality of Tomasiri, Inclán district, Tacna province in Tacna department, Perú on August 1st, 2015, during the wet season in a study about the diversity of bats in the Sama valley. The research involved a total of six sampling stations, each with seven mist-nets open 11 hours (from 18:00 to 5:00 hours) during four nights per station and season of evaluation (wet and dry), with a cumulative sampling effort of 3,696 hours/net/night. The research was authorized through permit R.D. N°246-2017-SERFOR/DGGSPFFS and authorization code with purposes of scientific research AUT-IFS-2017-057.

The specimen was an adult male in reproductive condition captured in a mist-net placed perpendicular to the main course of Sama river, which was found drowned due to the low flight of *Anas georgica* at the moment of the collection. The sampling station was close to a hillside of semi-consolidated gravel with coarse river sand and clay that reaches 50 m of height with regard to the ground. The riparian forest to the riversides is narrow and for the right presents a wide extension of agricultural crops.

The specimen was identified preliminarily as *N. aurispinosus* because of its external characteristics and measurement of the forearm using the taxonomic key of Díaz *et al.* (2016), being later preserved in alcohol with the skull removed. Following Freeman (1981) and Velazco and Solari (2003), the following external and cranio-dental measurements were taken with a digital vernier (± 0.01 mm) for the accurate identification of the species: total body length, TL; tail length, T; length of hind foot, HF; ear length, E; total weight, Wt (in grams); greatest length of skull, GLS; condyloincisive length, CIL; postorbital breadth, POB; maxillary toothrow length, CM; upper molar breadth, MM; upper canine breadth, CC; zygomatic breadth, ZB; mastoid breadth, MAB; braincase breadth, BCB; greatest length of mandible, GLM; lower toothrow length, Cm; length of forearm, FA; length of third metacarpal, III MET; total length of fourth metacarpal, IV MET; total length of fifth metacarpal, V MET. These morphological characteristics were compared with other specimens of *N. aurispinosus* (MUSM 235 and MUSM 6051) deposited in the Museo de Historia Natural de la Universidad Nacional Mayor de San Marcos (Table 1).

In order to elaborate the current distribution of the species, we reviewed 78 records covered in other studies (Peale 1848; Sanborn 1941; Ortiz de la Puente 1951; Carter and Davis 1961; Gardner 1962a, 1962b; Álvarez 1963; Gardner 1963; Álvarez and Aviña 1964; Jones and Álvarez 1964; Baker *et al.* 1967; Linares 1969; Baker and Jones 1972; Taddei and Garutti 1981; Ochoa 1984; Ibáñez and Ochoa 1989; Silva *et al.* 1996; Anderson 1997; Pedro *et al.* 2001; Bredt 2003; López-González and García-Mendoza 2006; Eger 2008; Bianconi *et al.* 2009; Tavares *et al.* 2010; Velazco *et al.* 2013; Dolman and Ammerman 2015; Pari *et al.* 2015; Espinal *et al.* 2016; Garbino 2016; Oliveira *et al.* 2019), which reported specimens deposited in the following scientific collections: American Museum of Natural History (AMNH), Colección de Mastozoología, Centro de Ecología y Biodiversidad, Lima, Perú (CEBIOMAS), Colecão de Chiroptera do Departamento de Zoologia da Universidade Estadual Paulista, São José do Rio Preto (DZSJRP), Colecão de Mamíferos, Universidade Federal de Lavras (UFLA), Colecão de Mamíferos, Universidade Federal de Minas Gerais (UFMG), Colección Privada de Omar Linares (OL), Collection of Recent Mammals, Museum of Texas Tech University (TTU), Estación Biológica de Doñana (EBD_MAM), Field Museum of Natural History (FMNH), Instituto de Biología de la Universidad Autónoma de México (IB), Instituto Politécnico Nacional, Colección Regional de Durango (CRD), Louisiana State University Museum of Zoology, Baton Rouge, Louisiana, USA (LSUMZ), Mammal Collection, University of Arizona Museum of Natural History (UAZ), Museo de Biología de la Universidad Central de Venezuela (MBUCV), Museo de Historia Natural de la Universidad Nacional Mayor de San Marcos (MUSM), Museo de la Estación Biológica de Rancho Grande (EBRG), Museum of Zoology of the University of São Paulo / Museu de Zoologia da Universidade de São Paulo (MZUSP), University of Kansas, Natural History Museum and Biodiversity Research Center (KU), United States National Museum of Natural History (USNM), Texas A&M University, Texas Cooperative Wildlife Collections (TCWC), The Field Museum of Natural History (FMNH), and Michigan State University (MSU; Appendix I).

In addition, to characterize the digestive tract contents, a ventral incision was made to open the digestive tube and separate it in small portions. Its contents were placed over Petri plates and scattered in distilled water with help of stilettos, the samples of interest were preserved in alcohol of 96º (Shiel *et al.* 1997; Vidal-Martínez *et al.* 2002; Caspeta-Mandujano *et al.* 2007). Finally, the keys of Whitaker *et al.* (2009) and Whitaker and Castor (2010) were used for identification under a stereomicroscope at 40 and 100X magnifications in the Laboratory of Genetics of the Universidad Nacional Jorge Basadre Grohmann.

The study area of the new record of *N. aurispinosus* located in the Sama valley is surrounded by great desertic areas, cracks, and riverbeds of scarce flow with xeric vegetation (families Anacardiaceae, Asteraceae, Cupressaceae, Fabaceae, and Poaceae). It is geographically located where the Coastal Desert of Perú finishes, and the Atacama Desert begins in Chile. This valley is one of the most important of Tacna department, principally dedicated to agricultural (crops of alfalfa, peppers, onion, corn, and olive) and livestock activities (caprine, equine, porcine, ovine, and bovine cattle).

After external and cranial comparisons with MUSM 235 and MUSM 6051 and based on the original description of *N. aurispinosus* (Peale 1848) and its subsequent re-description (Casssin 1858), our specimen (GPZ 001) presented the diagnostic characters for the species, which are described as follows: at external level, the dorsal and ventral fur is short, dense, fine and of chestnut brown color lighter in the base of the hair with tips that give it a silver appearance under the light, wing membranes are brown-violet, ears are big

Table 1. Measurements (and intervals) of the new record from Perú of *Nyctinomops aurispinosus* (MUSM 48232), specimens reviewed in this study, and specimens from Perú, México, Colombia, Venezuela, Brazil, and Bolivia. The abbreviations are specified in the text.

Measurement	MUSM 48232	MUSM 6051	Perú[A,B]		México[B, C, D, E, F, G, H, I]		Colombia[J]	Venezuela[K]		Brazil[L, M, N]			Bolivia[O]	
Sex	M		M	F	M	F	M	M	F	M	M	M	M	F
GLS	19.45	19.38	20	20.8	20.4 (18.7 - 21.6) 17	20.02 (17.9 - 20.8) 12	20.7	21.7	21.6 (21.7 - 21.4) 2					
CIL	18.43		18.8	19.1	18.47 (17.6 - 20) 14	17.7 (16.9 - 19.1) 11	18.8			19.9			18.9 (18.7 - 19.2) 4	19.6 (19 - 20.5) 4
POB	3.72	3.64	3.7	3.6	3.73 (3.5 - 4) 16	3.67 (3.4 - 3.8) 11	3.9	4.7	4.4 (4.5 - 4.2) 2	3.6			3.8 (3.7 - 3.9) 4	3.9 (3.9 - 4) 4
CM	7.40	7.30	7.8	7.8	7.65 (6.8 - 8.2) 17	7.46 (6.9 - 7.8) 13	7.8	8.5	8.4 (8.4 - 8.3) 2	8.1	8.1	7.9	7.9 (7.8 - 8) 4	8 (7.9 - 8.1) 4
MM	7.83	7.96	8.06	8.4	8.17 (7.3 - 8.5) 17	8.2 (7.2 -8.6) 11		9.4	9.1 (9.1 - 9) 2	8.2	8.3		8.4 (8.3 - 8.6) 4	8.7 (8.6 - 8.7) 4
CC	4.71	4.58	4.58	4.8	4.47 (4.1 - 4.8) 6	4.55 (4.2 - 4.9) 4	4.7	5.3	5.1 (5.1 - 5) 2	4.7	4.7			
ZB	11.16	11.2	11.2	11.7	11.59 (11.1 - 12) 14	11.43 (11 - 11.8) 12	11.6	12.7	12.1 (12.1 - 12) 2	11.9			11.7 (11.5 - 11.8) 4	12 (11.7 - 12.1) 4
MAB	9.60	9.59		10.9	10.85 (10.2 - 11.3) 6	11.05 (11 - 11.1) 2	10.4	11.7	11.1 (11.1 - 11) 2	11.1				
BCB	9.52		9	9.5	9.37 (9.1 - 9.7) 13	9.22 (8.9 - 9.5) 11	9.3	10.4	9.6 (9.6 - 9.5) 2	9.3				
GLM	14.15	13.79	13.6							15	15.5	14.1		
Cm	8.1	8.22	8.5	8.9	8.33 (7.7 - 9.4) 11	8.1 (7.5 - 9) 10	8.5			8.7	8.6	8.6		
FA	50		48	51.4	48.23 (47.1 - 50.4) 16	47.67 (42.4 - 49.8) 13	49.5	55.3	54.9 (55.7 - 54.2) 2	51.5	53.4	51.6	49.7 (48.7 - 50.3) 4	51 (50.3 - 52.8) 4
III MET	50		48	48.4	48.76 (47.9 - 49.9) 9	47.6 (46.2 - 48.6) 10	49	56.5	54.3 (54.6 - 54) 2	51	51.6	49.4		
IV MET	49		46.3	46.8	47.32 (46.7 - 48.5) 9	46.16 (44.9 - 47.7) 9	46.2	54.2	53.3 (53 - 52.6) 2	50.6	50.7	47.8		
V MET	28.5		26	26.9	27.88 (26.6 - 29.2) 9	27.32 (26 - 28.5) 9	27.5	31.7	29.8 (30.4 - 29.1) 2	31	28.9	27.3		

A: Ortiz de la Puente (1951), B: Carter and Davis (1961), C: Gardner (1962a, 1962b), D: Gardner (1963), E: Álvarez and Aviña (1964), F: Baker *et al.* (1967), G: Baker and Jones (1972), H: Anderson (1997), I: López-González and García-Mendoza (2006), J: Sanborn (1941), K: Ochoa (1984), L: Taddei and Garutti (1981), M: Bianconi *et al* (2009), N: Oliveira *et al.* (2019), O: Ibáñez and Ochoa (1989). M = Male, F = Female.

and united to the front with presence of small thorn-shape protuberances (from 6 to 8) in their anterior margin, the upper lips wrinkled, the nostrils rounded of lengthened edges with small stiff bristles and the feet with large vibrissa (Figure 1a-f). The skull is large and narrow with a rounded dorsal contour and bulky frontal region, upper incisors are parallel and divided by a narrow emargination of the palate, the posterior margin of which is at the level of the posterior border of the third molars (Shamel 1931; Gardner 1963). The basisphenoid pits are moderately deep (Eger 2008; Gregorin and Ciranello 2015) and the sagittal crest is slightly developed (Jones and Arroyo-Cabrales 1990; Figure 2).

The specimen has the following external measurements: TL = 106 mm, T = 48 mm, HF = 8 mm, E = 21 mm, and Wt = 14.5 g. Moreover, the forearm has a length of 50 mm and a total length of the skull of 19.45 mm and other measurements that were compared with the reported for the records of *N. aurispinosus* of Ortiz de la Puente (1951) and Carter and Davis (1961) for Perú; Carter and Davis (1961), Gardner (1962a, 1962b), Gardner (1963), Álvarez and Aviña (1964), Baker *et al.* (1967), Baker and Jones (1972), Anderson (1997), and López-Gonzáles and García-Mendoza (2006) for México; Sanborn (1941) for Colombia; Ochoa (1984) for Venezuela; Taddei and Garutti (1981), Bianconi *et al.* (2009), and Oliveira *et al.* (2019) for Bolivia, evidencing that is inside the range of size of the species. Our specimen was deposited as MUSM 48232 in the scientific collection of the Mammalogy department of the Museo de Historia Natural de la Universidad Nacional Mayor de San Marcos.

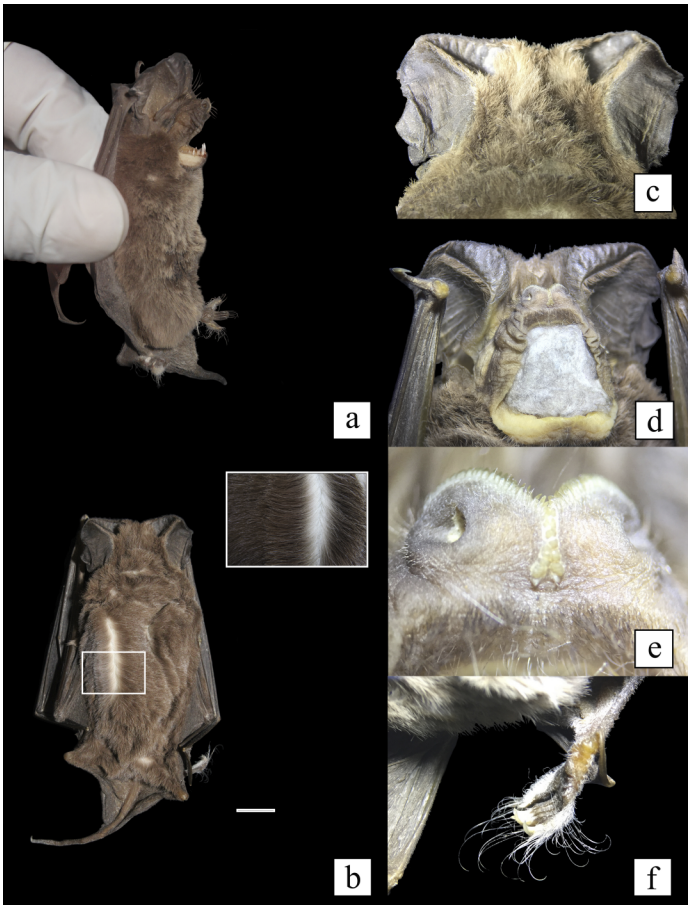

Figure 1. Male adult specimen of *N. aurispinosus* (MUSM 48232), fur characteristics are observed. a) Lateral view of the specimen. b) Dorsal view of the specimen. c) Presence of spine-shaped bumps on the anterior margin of the ears. d) Presence of big ears joined to the front. e) Presence of small stiff bristles at the edge of the nostrils. f) Presence of vibrissa in the hind legs. Scale bar: 5 mm.

Figure 2. Ventral, dorsal, and lateral views of the skull of *Nyctinomops aurispinosus* (MUSM 48232). Scale bar: 5 mm.

The current distribution map of *N. aurispinosus* in the Neotropics was elaborated from 78 records referred in scientific publications (Figure 3). On the other hand, the digestive tract content analysis uncovered remains of insects corresponding to 100 % lepidopterans, consisting of antennas, scales, legs, and proboscis (galeas that compounds the proboscis; Figure 4 a-f).

Nyctinomops aurispinosus is considered a rare species due to the relatively few specimens in scientific collections (Bianconi *et al.* 2009) and infrequent captures related to its sophisticated system of echolocation and flight at high altitudes; these characteristics of most molossids make their capture difficult with mist-nets (Norberg and Rayner 1987; Kalko *et al.* 1996; Voss and Emmons 1996).

In this study, we present the current distribution and the first record of *N. aurispinosus* for Tacna department, Perú. This finding represents the southernmost report for the Pacific coast, extending the geographical distribution of *N. aurispinosus ca*. 270 km to the south, from the previous record of the species in Arequipa department (Pari *et al.* 2015). The presence of *N. aurispinosus* in the extreme south of Perú is consistent with other records of the species along the American tropics and sub-tropics (Eger 2008; Bianconi *et al.* 2009; Espinal *et al.* 2016).

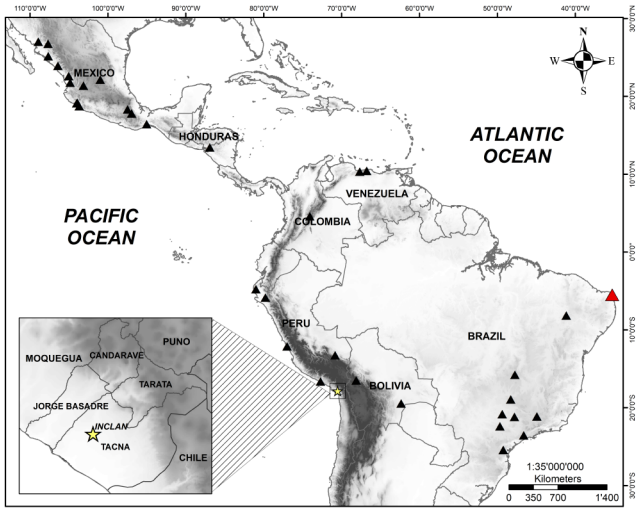

Figure 3. Geographic distribution of *Nyctinomops aurispinosus* in México, Honduras, Colombia, Venezuela, Brazil, Bolivia, and Perú (▲); type locality (▲); including the new southernmost record from Perú (☆) (MUSM 48232).

The record of *N. aurispinosus* over the course of Sama river is consistent with reports of the species near freshwater bodies, such as streams, puddles, and rivers in México and Bolivia (Gardner 1962a, 1962b, 1963 ; Baker *et al.* 1967; Baker *et al.* 1972; Wilson 1985; Ibáñez and Ochoa 1989); these may relate to the foraging behavior of molossids at great height, but they are also captured with mist-nets over fresh water sources when descending to drink (Voss and Emmons 1996). The majority of the records of the species are associated to coastal places at low altitude (Álvarez and Aviña 1964; Wilson 1985), suggesting that it prefers low and warm zones, again in agreement with the zone of the new record.

The roosts that *N. aurispinosus* probably uses in the Sama valley are rock cracks in steep slopes, as has been observed for *Mormopterus kalinowskii*, *Promops davisoni*, and *Tadarida brasiliensis* in nearby valleys (Aragón and Aguirre 2014; Flores-Quispe *et al.* 2019). Previous reports referred to its occupation of cracks and caves with other molossids (Ortiz de la Puente 1951; Sanborn 1951; Carter and Davis 1961; Álvarez 1963), as well as high-rise human constructions (Taddei and Garutti 1981; Ochoa 1984; Bianconi *et al.* 2009).

The specimen (MUSM 48232), as shown in Table 1, has external and cranial measurements slightly smaller than reported by other studies. Additional studies are needed to determine whether size variation in the species is significant.

The analysis of the digestive tract contents showed the remains of lepidopterans, as occurs for *N. macrotis* and *N. femorosaccus* in studies about their diets (Ross 1967; Easterla and Whitaker 1972; Sparks and Valdez 2003; Debelica *et al.* 2006; Matthews *et al.* 2010). Molossids with long thin teeth, which are characteristic of the genus *Nyctinomops*, have a wide gape and can feed on large flying insects, provided that they have a soft consistency (Freeman 1979).

Previously, nine bat species were reported for Tacna department (*Amorphochilus schnablii, Desmodus rotundus, Histiotus macrotus, H. montanus, Mormopterus kalinowskii, Myotis atacamensis, Platalina genovensium, Promops davisoni* and *Tadarida brasiliensis*; Aragón and Aguirre 2014; Flores-Quispe *et al.* 2015). The new record of *N. aurispinosus* (MUSM 48232) brings to ten the number of species recorded in the department. In the same way, the proximity of the record and the similarity among the habitats of the Peruvian south and the Chilean north suggests that *N. aurispinosus* may also occur in Chile, similarly to the proposal by Flores-Quispe *et al.* (2015) for *Promops davisoni*, which was recently confirmed by Ossa *et al.* (2018).

Figure 4. Remains of lepidoptera found in the digestive tract of the specimen MUSM 48232. a) Scales and leg. b) and c) Tibia. d) Section of the flagellum of an antenna and portion of proboscis. e) Proboscis: galeas that compound the proboscis. f) Scale.

The new record and range extension presented in this work fill information gaps about the distribution and ecology of *N. aurispinosus*. Therefore, we recommend the development of more studies in order to obtain a better approximation about the diversity of bats in the extreme south of Perú.

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Appendix I

Records of *Nyctinomops aurispinosus* used in the map of the update of its distribution (Figure 3). Las letters in parenthesis indicate the records of the specimens used in the table of measurements (Table 1). Names of the corresponding collections to the abbreviations are described in Materials and Methods.

Nyctinomops aurispinosus

Perú: (A) Lima, Cerro Agustino, 12° 06′ S, 77° 00′ W (MUSM 235, 6051); **(B)** Cusco, Huajyumbe, 13° 15′ S, 70° 30′ W (FMNH 68561); Lambayeque, 12 Km al N de Olmos, 5° 50´ S, 79° 47´ W (LSUMZ 25010, 25011, 25012, 25013, 25014, 25015, 26016, 25017, 25018, 25021, 25022, 25025, 25029); Piura, Talara, 4° 46′ S, 80° 59′ W (AMNH 278527, CEBIOMAS 228); Arequipa, Camaná, 16° 37′ S, 72° 43′ W; Tacna, Inclán, 17° 49′ S, 70° 30′ W (MUSM 48232). **México: (C)** Tamaulipas, Cueva de Abra, 22° 36′ N - 99° 01′ W (TCWC 6573, 6474, IB 4838, 4839, 4841) (KU KUM 90542, 90543, 90544, 90545); **(D)** Colima, Pueblo Juárez, 19° 10′ N - 103° 55′ W (UAZ 7943); Colima, Las Juntas, 5 Km al SE de Pueblo Juárez, 19° 08′ N, 103° 54′ W (UAZ 8553, 8554, 8555, 8556, 8583); Colima, Cuastecomatán, 19° 7′ N, 103° 54′ W (UAZ 8894, 8895, 8896, 8897, 8898, 8899, 8900, 8901, 8943); **(E)** Nayarit, 21° 44′ N, 104° 51′ W ; San Luis Potosí, Cueva en El Salto, 22° 09´ E, 100° 59´ W (KUM 91774); **(F)** Michoacán, Coahuayana, 18° 45′ N, 103° 38′ W (IB 6241, 6269); Oaxaca, Juchitlán, 16° 26′ N, 95° 01′ W (IB 4592, 1547); **(G)** Zacatecas, Juchipila, 21° 25′ N, 103° 07′ W (MSU 10273); **(H)** Sonora, rio Cuchahaqui, 26° 52′ N, 108° 55′ W (TTU 62969, 62970); **(I)** Sonora, Comanito, 25° 10′ N, 107° 40′ W (AMNH 244353); **(J)** Chihuahua, Morelos, 26° 47′ N, 107° 41′ W, (CRD 4550). **Honduras:** San Marcos de Colón, 53 Km al NE de Choluteca, 13° 27´ N, 86° 55´ W. **Colombia: (K)** Bogotá, 04° 36′ N, 74° 05′ W (FNMH 48560). **Venezuela: (L)** Aragua, Estación Biológica de Rancho Grande, 10° 21´ N, 67° 40´ W (MBUCV 1067, EBRG 1856, 2691, 2693); Miranda, Cueva de los Carraos, 10° 26´ N, 66° 47´ W (OL 1065 SVE). **Brazil: (M)** São Paulo, São José do Rio Preto, 20° 49´ N, 49° 23´ W (DZSJRP 4786); São Paulo, Ribeirão Preto, 21° 10´ S, 47° 49´ W (MZUSP 15463); São Paulo, Estación Ecológica Caetetus, 22° 25′ S, 49° 42′ W; São Paulo, São Paulo, 23° 32′ S, 46° 37′ W; **(N)** Paraná, Curitiba, 25° 25′ S, 49° 15′ W (RA 24116); Rio Grande do Norte, 160 Km al S de Cabo San Roque, 5° 29′ S, 35° 26´ W (USNM 3726); Minas Gerais, Lavras, 21° 07′ S, 45° 56′ W (UFLA 4049); Minas Gerais, Uberlândia, 18° 55´ S, 48° 16´ W (UFMG 6940); Distrito Federal, Brasília, 15° 45´ S, 47° 45´ W; Piauí, Paulistana, 08° 09´ S, 41° 09´ W; **Bolivia: (O)** Santa Cruz, Haciendo Cerro Colorado, 19° 27′ S, 56° 21′ W (EBD_MAM 14047, 14280, 14281, 14282, 14283, 14284, 14285, 14286, 14378); La Paz, La Reserva, 15° 44′ S, 67° 31′ W.

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New record and natural history notes of the Colombian endemic brown hairy dwarf porcupine, *Coendou vestitus*

Nuevo registro y notas sobre historia natural del puercoespín enano pardo y peludo endémico de Colombia, *Coendou vestitus*

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The brown hairy dwarf porcupine *Coendou vestitus* is an endemic species to Colombia. Is one of the least studied mammals at the national level, is only known from a small area in the Eastern Cordillera, and is considered data deficient globally by the International Union for Conservation of Nature (IUCN) and threatened at the national level (Vulnerable, VU). During a bird inventory, three records of *C. vestitus* were occasionally found on the branch of a gaque and roble tree in a fragment of a secondary growth forest in the municipality of Santa Sofia, Department of Boyacá, Colombia. The new records for the species represent the seventh locality from where it is known to occur, and contribute to a better understanding of its distribution and natural history, information that ultimately is indispensable for further conservation actions.

Key words: Eastern Cordillera; geographic distribution; mammals; rodents.

El puercoespín enano pardo y peludo *Coendou vestitus* es una especie endémica de Colombia. Es uno de los mamíferos menos estudiados a nivel nacional, solo se conoce de una pequeña área en la Cordillera Oriental, y es considerada con datos deficientes a nivel mundial según la Union Internacional para la Conservación de la Naturaleza (UICN) y amenazada a nivel nacional (Vulnerable, VU). Durante un inventario de aves, se encontraron ocasionalmente tres registros de *C. vestitus*, en la rama de un árbol de gaque y roble en un fragmento de un bosque secundario en el municipio de Santa Sofía, departamento de Boyacá, Colombia. Los nuevos registros de la especie representan la séptima localidad desde donde se conoce su presencia y contribuyen a una mejor comprensión de su distribución e historia natural, información que en última instancia es indispensable para futuras acciones de conservación.

Palabras clave: Cordillera Oriental; distribución geográfica; mamíferos; roedores.

The genus *Coendou* comprises 15 species (Barthelmess 2016), that range from México to Uruguay and northern Argentina. Fourteen species occur in South America, except for *Coendou mexicanus*. These species inhabit tropical and subtropical moist and dry forests from 0-3,500 m (Voss 2015). In Colombia, the genus *Coendou* its distributed along the three Andean Cordilleras and trans-Andean valleys, as well as in mountains, foothills, and adjacent lowlands from 0-3,100 m (Solari *et al.* 2013). According to Ramírez-Chaves *et al.* (2016), six species have been recognized for Colombia: *C. ichillus*, *C. prehensilis, C. pruinosus, C. quichua, C. rufescens*, and *C. vestitus*.

The brown hairy dwarf porcupine, *C. vestitus* (Thomas 1899) is a rare mammal, which is restricted to a small area of montane ecosystem from the Eastern Cordillera on Andes of central Colombia, in an elevation range from 1,250 to 2,890 m (Ramírez-Chaves *et al.* 2019). The species is found in Andean and sub-Andean forests which is characterized by lower montane moist forest vegetation (Emmons and Feer 1997; Voss and Da Silva 2001; Alberico and Moreno 2006; Barthelmess 2016). The International Union for Conservation of Nature (IUCN) has listed this species as "Data Deficient" (DD) given the absence of recent information on its status and ecological requirements (Weksler *et al.* 2016). In Colombia, the species has been categorized as "Vulnerable" (VU) due the reduced geographical range and habitat destruction (Alberico and Moreno 2006; Ministerio del Ambiente y Desarrollo Sostenible 2017). According to Ramírez-Chaves *et al.* (2019), *C. vestitus* is one of the least studied porcupines, and it has the most restricted distribution in America, which makes it the rarest species within the genus. Research is urgent to understand different aspects of its natural history, ecology, conservation, and distribution. To contribute to filling the lack of information for this rare species, herein, I report a new record for the species in Colombia as well as natural history observations.

On April and June 2020 during a bird inventory, three records of *C. vestitus* were occasionally found in the same place and photographed between 9:35 and 10:01 hours, in the Lower Montane Moist Forest life zone (Corpoboyacá 2015) in a farm called El Rocio located in the Vereda Sorocota, municipality of Santa Sofía, department of Boyacá (5° 45' 32.42" N, -73° 36' 17.97" W, 2,300 m; Figure 1). This area is located in the Magdalena Valley montane forests Ecoregion which is part of the Tropical and Subtropical Moist Broadleaf Forests Biome (Olson *et al.* 2001; Dinerstein *et al.* 2017). The specimens were recorded in a temperature transition zone in the middle of a warm and cool-season

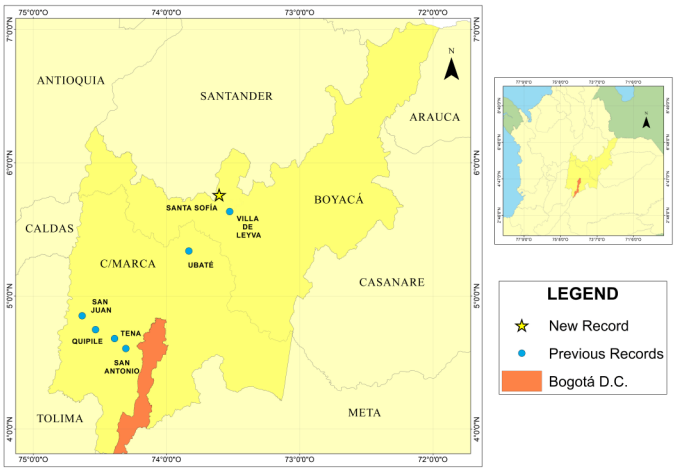

Figure 1. *Coendou vestitus* known distribution (blue dots) in the Eastern Cordillera of the Andes and new record (yellow star) in Boyacá department in Colombia.

(April-June), with an average between April (10 °C-20 °C) and June (11 °C-19 °C; WeatherSpark 2020). Observations were also recorded during a precipitation wet season with rainfall increased in April (150-188 mm) and decrease in June (104-98 mm; WeatherSpark 2020).

The specimens were not captured, the reason why it was not possible to know if the three records were only one or the same individual, and were simply identified through their external morphology following Voss (2015) and Ramírez-Chaves *et al.* (2019); small size (average); very short tail (about 50 % of head and body length); dorsal pelage with long blackish fur that partially conceals defensive quills; bristle- quills -bicolored (whitish and dark brown or blackish distally; Figure 3a, b, c, d, e, f).

The three subadults/adults records of unknown sex were found resting in trees of secondary growth forest fragment next to an area recently affected by a fire caused in 2019, and that is currently in a process of ecological succession (Figure 2a). The first record was found at 1.70 m above the ground on a branch of a gaque or cucharo (*Clusia multiflora*: Clusiaceae; April 8, 2020; Figure 3e, f.), and the second and third record at about 4 m above the ground on a branch of a roble (*Quercus humboldtii*: Fagaceae; June 7, 2020 and June 8, 2020; Figure 3a, b, c, d). The roble tree is situated about 10 meters inside the forest from the edge outside the farm, a lotic body of water locally known as Quebrada de Piedras (Figure 2b). This section of the forest fragment is surrounded by human activities such as livestock and agriculture (Figure 2c, d).

Figure 2. *Coendou vestitus* habitat and anthropic activities around. a) Habitat characteristics of the first record. b) Habitat characteristics of the second and third records. c) Livestock next to the Quebrada de Piedras. d) Agriculture activities.

Figure 3. Photographic records from Santa Sofia, Boyacá, Colombia (first record e, f; second record c, d; third record a, b), showing dorsal pelage with long blackish fur that partially conceals defensive quills and relative tail size concerning head and body length (b, c, e). Details of whitish basally and dark brown distally bristle quills in the face (a, c, f).

This is the first record of *C. vestitus* for the municipality of Santa Sofia in Boyacá and extends the distribution of the species 16.5 km in a straight line from the closest known locality at the municipality of Villa de Leyva in Boyacá (Ramírez-Chaves *et al.* 2019).

Coendou vestitus was recorded between a temperature transition zone (warm to cool season) during the rainy season (WeatherSpark 2020). In this life zone, the climatic conditions may be associated to exceptional topographic characteristics that facilitate the natural regeneration of forest native species due to moisture in the soil (Holdridge 1987; Kessler and Kluge 2008), as well as the occurrence of endemic species with specific habitat requirements (Kessler and Kluge 2008), such as *C. vestitus.* Although, its occurrence may be also related to a possible edge effect (López-Barrera 2004), concerning its association to disturbed ecosystems such as the secondary growth forest fragment, and the probability for the species to move through other suitable habitats nearby, like biological corridors such as the Quebrada de Piedras (Concejo Municipal de Santa Sofia 2019), that allows the species to reach these or other forest fragments as climatic conditions changes and favors the availability of resources (Kessler and Kluge 2008).

According to Weksler *et al.* (2016), agriculture and livestock activities might be considered as possible threats for *C. vestitus* habitat, although this might also indicate some kind of ability for the species to adapt to disturbed Andean ecosystems; consider as the most impacted areas of Colombia due to deforestation and agriculture (Harden 2006; Rodríguez *et al.* 2013). The Andean Region contains more than 60 % of the mammal endemic species of Colombia, but some species such as *C. vestitus*, are only known from a few localities over 1,500 m of elevation (Solari *et al*. 2013), which suggests further monitoring activities along the Eastern Cordillera of the Andes, in order to fill these information gaps and define other conservation actions for the species.

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