Therya Notes

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AMMAC
Asociación Mexicana de Mastozoología A.C.

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

En la Portada

El leucismo es la pérdida total o parcial de la pigmentación del pelaje o plumaje sin afectar el color de los ojos, la piel y las uñas. Durante uno de los recorridos diarios de vigilancia y protección que realiza la brigada comunitaria Teporingos 1 realizó el registro de un zacatuche juvenil leucístico en los terrenos de la Reserva Ecológica Comunal de San Miguel Topilejo de la Ciudad de México, México. En esta nota, reportamos este primer registro de leucismo en la especie y discutimos la relevancia de este hallazgo.
(Fotografía de Brigada comunitaria Teporingos 1)

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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Rediscovery of the Tamaulipas white-sided jackrabbit (*Lepus altamirae*) after a century from its description

Redescubrimiento de la liebre de flancos blancos de Tamaulipas (*Lepus altamirae*) después de un siglo de su descripción

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The Tamaulipas white-sided jackrabbit, *Lepus altamirae*, was originally described as a subspecies of *Lepus merriami* more than a century ago. Several decades later, it was reclassified as a subspecies of the black-tailed jackrabbit, *L. californicus altamirae*. Despite its ecological, social and economic importance of the jackrabbits, there is a gap in the knowledge of many species, such as *L. altamirae*, since historically few individuals have been sighted, collected and studied. On October 13, 2016 and September 22, 2021, 2 lagomorphs with straw-grayish fur as well as elongated limbs and ears was photographed *in situ* during the surveillance of wildlife in the lowlands of the Huasteca Potosina region, northeastern San Luis Potosí. Due to its coloration, morphological characteristics, and distribution, they were identified as *L. altamirae*. These are the first documented records of the species in the lowlands of the Huasteca Potosina, and the first records after a century of the species description. The closest known records are located *ca*. 98 km east in the state of Tamaulipas. The presence of the Tamaulipas white-sided jackrabbit in the region could be related to land use change. Systematic monitoring is necessary to improve knowledge about the distribution of this and other mammals in the lowlands of the Huasteca Potosina.

Key words: Coastal plain; Gulf of México; hare; lagomorph; Leporidae; San Luis Potosí.

La liebre de flancos blancos de Tamaulipas, *Lepus altamirae*, fue originalmente descrita como una subespecie de *Lepus merriami* hace más de un siglo. Varias décadas después fue reclasificada como una subespecie de la liebre de cola negra, *L. californicus altamirae*. A pesar de la importancia ecológica, social y económica de las liebres, existe un vacío en el conocimiento de muchas especies, tal es el caso de *L. altamirae*, ya que históricamente se han avistado, colectado y estudiado pocos individuos. El 13 de octubre de 2016 y el 22 de septiembre de 2021, 2 lagomorfos con pelaje pajizo-grisáceo, así como extremidades y orejas alargadas fueron fotografiados *in situ* durante el monitoreo de fauna silvestre en la región de la Huasteca Potosina, en el noreste de San Luis Potosí. Por su coloración, características morfológicas y distribución, se identificaron como *L. altamirae*. Estos son los primeros registros documentados de la especie en las tierras bajas de la Huasteca Potosina, así como los primeros registros después de un siglo de la descripción de la especie. Los registros conocidos más cercanos se encuentran *ca*. 98 km al este en el estado de Tamaulipas. La presencia de la liebre de flancos blancos de Tamaulipas en la región podría estar relacionada con el cambio de uso del suelo. Es necesario un monitoreo sistemático para mejorar el conocimiento sobre la distribución de éste y otros mamíferos en las tierras bajas de la Huasteca Potosina.

Palabras clave: Golfo de México; lagomorfo; Leporidae; liebre; planicie costera; San Luis Potosí.

México is one of the countries with the greatest diversity of lagomorphs (Fernández *et al.* 2015); totaling 13 species, 9 of which are rabbits (*Romerolagus* sp. and *Sylvilagus* spp.) and 4 are jackrabbits (*Lepus* spp.; Hoffmann and Smith 2005; Álvarez-Castañeda and Lorenzo 2016; Álvarez-Castañeda and Lorenzo 2017; Vargas *et al.* 2019). Lagomorphs play a key role in several ecological processes (Fernández *et al.* 2015; Brown *et al.* 2018a). They constitute the main prey for some predators (Moreno *et al.* 2004; Laundré *et al.* 2009; Brown *et al.* 2018a), regulate the diversity and structure of plant populations (Hernández *et al.* 2011), and are also an important game species (Leopold 2000; Moreno *et al.* 2004). In general, lagomorphs are conspicuous animals, and their populations are often abundant (Leopold 2000; Fernández *et al.* 2015; Brown *et al.* 2018a). However, their distribution records are scarce in some regions, as is information of their population status (Lorenzo and Jiménez 2013; Vargas *et al.* 2019; Schlater *et al.* 2021).

The Tamaulipas white-sided jackrabbit (*Lepus altamirae*) was originally described as a subspecies of *Lepus merriami* (Nelson 1904). This description was based on the fieldwork of E. W. Wilson and E. A. Goldman, who in 1898 collected 6 jackrabbits in the coastal plain of the Gulf of México, approximately 16 km north of Altamira, in southern Tamaulipas (Nelson 1904, 1909). After that, Nelson (1909) assigned *L. altamirae* to the white-sided group of jackrabbits. Several decades later, it was reclassified as a subspecies of the black-tailed jackrabbit (*Lepus californicus altamirae*; Hall 1951).

Nelson (1904) stated that this jackrabbit has "top of the head grizzled grayish buffy"; dorsal coloration "dull creamy buffy grizzled" and sides of body "slightly paler buffy grizzled with grayish". It has thighs and sides of rump "pale iron gray" and the top of fore feet and legs "dingy buffy". The Tamaulipas white-sided jackrabbit has a bicolored tail; the top of the tail has a black narrow line extending from the middle of rump to the tip of the tail and the underside is grayish white. It also has black nape patch extending back from the base of each ear, separated into two parallel black stripes by a well-defined median yellowish band. The front half of ears are dark buff with a posterior half white and no trace of black at tip (Nelson 1904, 1909). Ranges of average measurements (in mm) of the Tamaulipas white-sided jackrabbit are: total length, 587–605; length of tail vertebrae, 72–96; length of hind foot, 136–137; length of dried ear from notch, 110–112 (Nelson 1904, 1909).

According to Nelson (1909), the geographic distribution of the Tamaulipas white-sided jackrabbit only encompasses the coastal plains of southern Tamaulipas, with the extreme north Veracruz as the limit. This lagomorph inhabits environments between the sea level to an elevation of 150 m, within the "Arid Tropical" zonal range (Nelson 1904 Nelson 1904, 1909). Historically, the records of lagomorphs in the region are scarce. There are, however, few records of the black-tailed jackrabbit (*Lepus californicus*), a species with some shared physical characteristics, in the coastal plain of the Gulf of México (Hall 1951; Álvarez 1963; Vargas *et al.* 2019). Moreover, several authors have been dismissed the presence of jackrabbits in the easternmost portion of San Luis Potosí (Dalquest 1953; Leopold 2000; Ceballos *et al.* 2006; Cervantes and Hernández 2014; Cervantes *et al.* 2014; Farías *et al.* 2015a, 2015b; Martínez de la Vega *et al.* 2016; Brown *et al.* 2018b, 2018c; Brown and Smith 2019; Brown *et al.* 2019; Lavariega and Briones-Salas 2019). Consequently, the objective of our present note was to record the presence of *L. altamirae* in the lowlands of the Huasteca Potosina, in northeastern San Luis Potosí, based on photographic evidence.

The coastal plain of the Gulf of México occupies the eastern portion of the state of San Luis Potosí and part of the states of Nuevo León, Tamaulipas, Hidalgo and Veracruz. This physiographic province extends from the northern border of the country in Reynosa, Tamaulipas, to the area of Nautla, Veracruz (INEGI 2002). Within this coastal plain are the lowlands of the Huasteca Potosina, which encompass the municipalities of Tamuín, Ébano and San Vicente Tancuayalab in northeastern San Luis Potosí. This region is a broad plain with gentle slopes (5-15 %) and includes areas with small hills and scattered low mountains (elevation of 15–150 m); the predominant climate corresponds to a warm sub-humid with summer rainfall (Reyes *et al.* 2014). The main vegetation types in the lowlands of the Huasteca Potosina are tropical low thorn forest, tropical low dry deciduous forest and tropical medium semi-deciduous forest (Reyes *et al.* 2014).

We refer to several authors (Nelson 1904, 1909; Álvarez 1963; Hall 1981; Vargas *et al.* 2019) to assess the known distribution of the species. In addition, we searched for records, including direct observations, photographs, skulls, skins, and/or voucher specimens, in the scientific literature (*i. e*. search engines and scientific electronic libraries such as SciELO, Redalyc, and Google Scholar), and in institutional databases: Global Biodiversity Information Facility (https://www.gbif.org/); Division of Mammals Collections of the Smithsonian National Museum of Natural History (https://mczbase.mcz.harvard.edu/SpecimenSearch.cfm); Museum of Comparative Zoology-Harvard University (https://mczbase.mcz.harvard.edu); Sistema Nacional de Información sobre Biodiversidad de México (https://www.snib.mx/); and VertNet (http://vertnet.org/).

On October 13, 2016, at 14:29 hr, we sighted and photographed (Coolpix L120, 14.1 MP, Nikon Inc., Tokyo, Japan) an individual of Tamaulipas white-sided jackrabbit (Figure 1a) during a surveillance of wild felids (A. Silva-Caballero *pers. comm.*) in the 450 ha private ranch Toriles (Desarrollo Ganadero El Peñón S. P. R. de R. L.; Figure 1b), northern Tamuín, San Luis Potosí (22° 19' 53.26" N, 98° 53' 13.89" W, 88 m; Figure 2). The sighting took place while we were returning to the base camp, we were driving a vehicle through cattle pastures when the Tamaulipas white-sided jackrabbit jumped from the bush to the road approximately 50–60 m away from us. The surrounding vegetation type in the area is cultivated grasslands, since the main activity of the ranch is livestock production, as well as remnants of low tropical thorn forest and low tropical dry deciduous forest (Figure 1b).

Once more, on September 22, 2021, at 15:46 hr, we sighted and photographed (D3500, 24.2 MP, Nikon Inc., Tokyo, Japan) another individual of Tamaulipas white-sided jackrabbit (Figure 1c, 1d, 1e) during crocodilian capture activities (A. Silva-Caballero *pers. comm.*) in the vicinity of a thermoelectric plant (AES TEG Operation S de R. L. de C. V.; Figure 1f), eastern Tamuín, San Luis Potosí (22° 03' 38.01" N, 98° 50' 11.83" W, 45 m; Figure 2). The sighting took place on a paved road close to a railroad track, we were driving a vehicle through some farm plots when we sighted the jackrabbit on the side of the road in a little depression approximately 10–20 m away from us. The surrounding vegetation type in the area are cultivated grasslands, secondary vegetation and remnants of low tropical thorn forest (Figure 1f). This second sighting of the Tamaulipas white-sided jackrabbit ocurred approximately 30.5 km south of the 2016 sighting.

We corroborated the identification of the Tamaulipas white-sided jackrabbit individuals by its coloration,

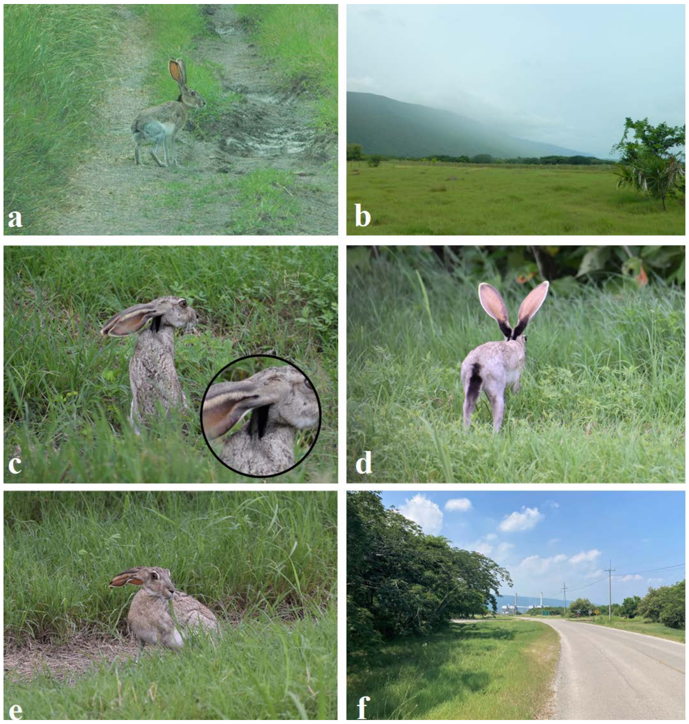

Figure 1. a) Photograph documenting the Tamaulipas white-sided jackrabbit (*Lepus altamirae*) in Tamuín, San Luis Potosí on October 13, 2016. b) Panoramic view of the sighting site in the lowlands of the Huasteca Potosina, México. c), d) and e) Photographs documenting the Tamaualipas white-sided jackrabbit (*Lepus altamirae*) in Tamuín, San Luis Potosí on October 22, 2021. f) Panoramic view of the sighting site in the vicinity of a thermoelectric plant in Tamuín, San Luis Potosí, México.

morphological characteristics, and the distribution of the species (Nelson 1904, 1909; Vargas *et al.* 2019). The photographed individuals of the Tamaulipas white-sided jackrabbit had a straw-grayish fur with conspicuous paler buffy flanks, two black stripes on the nape and a black tail. It also has elongated limbs and ears, the latter without black tips (Figure 1a, 1c, 1d, 1e). Our presence (the approach with the vehicles) probably favored the encounters, since in general, the jackrabbits rest during the day in a "shelter form" usually surrounded by dense clumps of tall grass (Best and Henry 1993; Leopold 2000; Reid 2006).

The only previous record of the species, and the type locality, is 98 km east at Altamira, Tamaulipas (USNM:92981; United States National Museum). Most reports of jackrabbit species in the state of San Luis Potosí are restricted to the Potosino-Zacatecano Plateau (Dalquest 1953; Martínez-Calderas *et al.* 2016; Martínez de la Vega *et al.* 2016; Brown *et al.* 2018b, 2018c). Moreover, recent mammal studies in northeastern San Luis Potosí did not record the presence of the Tamaulipas white-sided jackrabbit or any other jackrabbit species (Hernández-SaintMartín and Rosas-Rosas 2014; Martínez-Hernández *et al.* 2017; Del Río-García *et al.* 2020; Sahagún-Sánchez and De-Nova 2020).

We identified the Tamaulipas white-sided jackrabbit individual according to its coloration, morphological characteristics, and the distribution of the species, supported by the exhaustive review that we made in several sources. Even though the coloration could resemble the black-tailed jackrabbit (*L. californicus*), the sides of the latter tend to be brownish-gray and has black-tipped ears (Best 1996; Leopold 2000; Reid 2006; Cervantes and Hernández 2014). In contrast, the sides of the Tamaulipas white-sided jackrabbit are paler buffy and do not have black ear tips (Nelson 1904, 1909).

Furthermore, although the Tamaulipas white-sided jackrabbit was classified in the group of black-tailed jackrabbits (Hall 1951; Álvarez 1963), it was mentioned that in the state of Tamaulipas this taxon could present white flanks, and in some cases the lack of the black spot on the ears (Hall 1951, 1981; Best 1996), which could suggest an imprecise taxonomic classification (Vargas *et al.* 2019). Likewise, the distribution of the black-tailed jackrabbit within the state of San Luis Potosí is limited to the Potosino-Zacatecano Plateau (Ceballos *et al.* 2006; Cervantes and Hernández 2014; Farías *et al.* 2015b; Martínez-Calderas *et al.* 2016; Martínez de la Vega *et al.* 2016; Brown *et al.* 2019).

On the other hand, although the coat coloration of the individuals registered is also very similar to that of the white-sided jackrabbit (*Lepus callotis*), a reason for which several authors have placed *L. altamirae* in the white-sided group of jackrabbits (Nelson 1909; Vargas *et al.* 2019), the limbs of *L. callotis* tend to be whiter and the sides are pure white (Best and Henry 1993; Reid 2006; Cervantes *et al.* 2014; Brown *et al.* 2018b). Besides, the photographed individuals of the Tamaulipas white-sided jackrabbit had two black stripes on the nape, a characteristic that is not reported in the abovementioned jackrabbit species.

Our records are unique for the species in the state of San Luis Potosí, and they are the first records after a century of the species description (Nelson 1904). At the same time, our records support recent genetic findings (Vargas *et al.* 2019), which suggest the taxonomic restoration as a species of *L. altamirae* within the white-sided group of jackrabbits. Even more, Vargas *et al.* (2019) claim that from a biogeographic point of view, it seems more consistent to have a white-sided jackrabbit in tropical-subtropic Tamaulipas, an area that borders the Huasteca Potosina.

The Tamaulipas white-sided jackrabbit´s sighting sites are located in areas of cattle management and farm plots, which are adjacent to a Natural Protected Area (Reserva de la Biosfera Sierra del Abra Tanchipa). Additionally, these locations are nearby to several Wildlife Management Units (UMAs, from its name in Spanish), which together probably influences the presence of the Tamaulipas white-sided jackrabbit in the area. Despite the fact that mammal studies have been carried out in the area for more than 10 years (mainly in the Reserva de la Biosfera Sierra del Abra Tanchipa; Villordo-Galván *et al.* 2010; Hernández-SaintMartín and Rosas-Rosas 2014; Martínez-Hernández *et al.* 2017; Del Río-García *et al.* 2020), and although some included sites close to where we registered the Tamaulipas white-sided jackrabbit (Sahagún-Sánchez and De-Nova 2020), no one had reported any similar record.

The coastal plain of the Gulf of México is a physiographic province with high biodiversity (Caso *et al.* 2004) that still maintain areas with adequate habitats for medium and

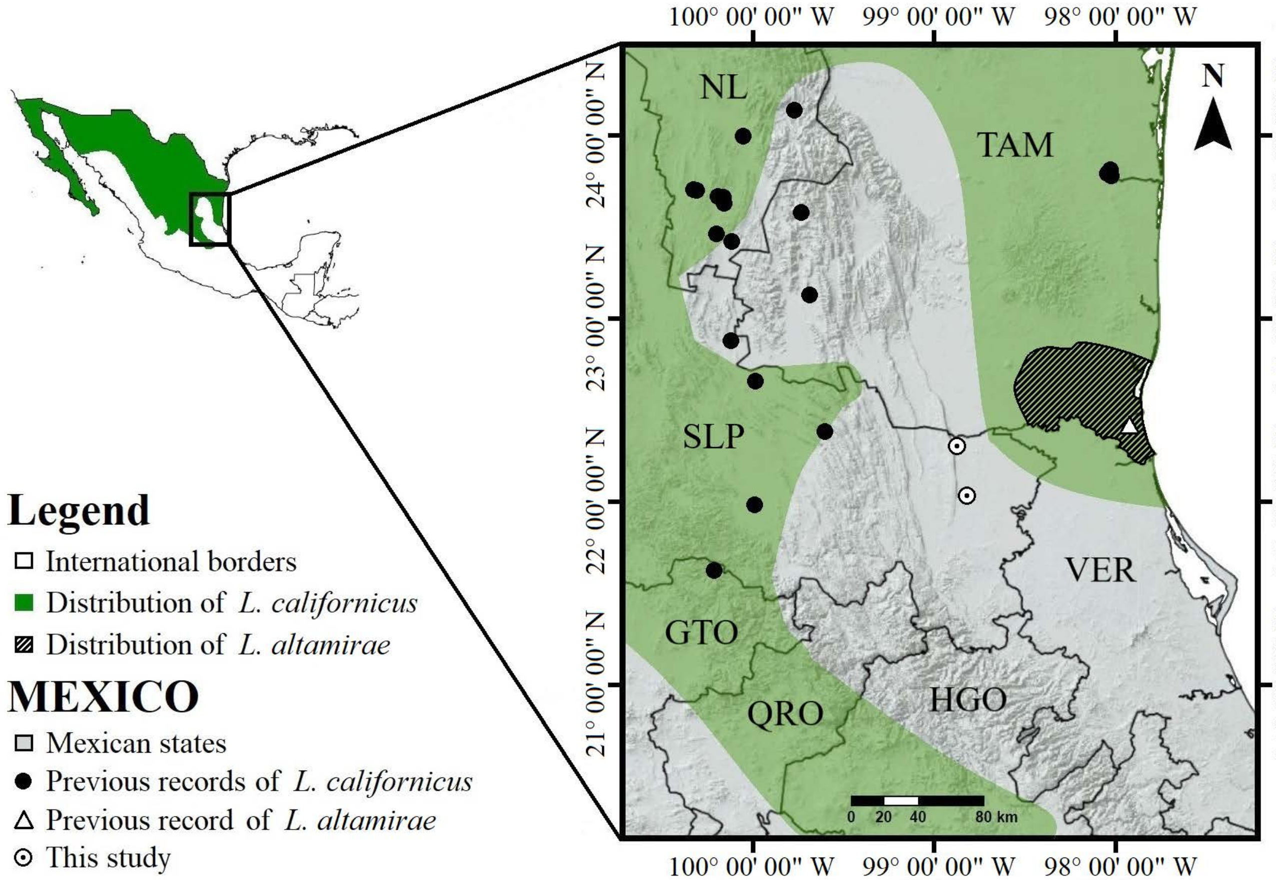

Figure 2. Firsts records of the Tamaualipas white-sided jackrabbit, *Lepus altamirae* (white dots) in the lowlands of the Huasteca Potosina, México, and literature record of the species (white triangle) and *Lepus californicus* in northeast México (black dots). Distribution of *L. altamirae* (black lines) according to Nelson (1909), and distribution of *L. californicus* (green) redrawn from Cervantes and Hernández (2014). Mexican states: GTO = Guanajuato; HGO = Hidalgo; NL = Nuevo León; QRO = Querétaro; SLP = San Luis Potosí; TAM = Tamaulipas; VER = Veracruz.

small mammals (Martínez de la Vega *et al.* 2016). Even though it is considered that the jackrabbits' populations have decreased elsewhere (Brown *et al*. 2018c; Brown and Smith 2019; Schlater *et al.* 2021) the presence of this species in the region could be related to cultivated grasslands and remnants of vegetation (Brown *et al.* 2018a). Nevertheless, due the high rate of land use change in the region (Reyes *et al.* 2014; E. Painter *pers. comm.*), it is necessary to establish systematic monitoring to improve the knowledge of the distribution of this and other mammal species in the lowlands of the Huasteca Potosina. Further studies should involve additional records and also molecular biology techniques to elucidate the population trend and ecology of the Tamaulipas white-sided jackrabbit in the area.

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Dispersal of *Hoffmannia excelsa* (Rubiaceae) by the Toltec fruit-eating bat (*Artibeus toltecus*) in central Veracruz, México

Dispersión de *Hoffmannia excelsa* (Rubiaceae) por el murciélago frugívoro Tolteca (*Artibeus toltecus*) en el centro de Veracruz, México

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In this note we report the fruit consumption and non-endozoochorous seed dispersal of a plant species that had not been mentioned in the diet of bats, and that does not present the typical characteristics of chiropterochory. This event was recorded while conducting night captures with mist nets in fragments of secondary vegetation in the metropolitan area of Xalapa de Enríquez, México. A female specimen of *Artibeus toltecus*, captured in June 2018 was carrying two fruits of *Hoffmannia excelsa* (Rubiaceae). Even though *H. excelsa* is a common shrub in central Veracruz, this is the first known record of dispersal in this species, carried out by bats. The consumption of this fruit, with ornithochorous characteristics, is possibly due to a situation of opportunism in the face of a temporarily abundant resource.

Key words: Bat; chiropterochory; diet; frugivory; neotropical; Rubiaceae.

En esta nota reportamos el consumo del fruto y dispersión no endozoócora de semillas de una especie vegetal que no había sido mencionada en la dieta de los murciélagos, y que no presenta las características típicas de quiropterocoria. Este evento fue registrado mientras realizábamos capturas nocturnas con redes de niebla, en fragmentos de vegetación secundaria en el área metropolitana de la ciudad de Xalapa de Enríquez, México. Un ejemplar hembra de *Artibeus toltecus*, capturada en junio de 2018, llevaba consigo dos frutos de *Hoffmannia excelsa* (Rubiaceae). Aunque *H. excelsa* es un arbusto común en el centro de Veracruz, éste es el primer registro conocido de dispersión en esta especie, llevada a cabo por murciélagos. El consumo de este fruto, con características ornitócoras, posiblemente obedece a una situación de oportunismo frente a un recurso temporalmente abundante.

Palabras clave: Dieta; Frugivoría; murciélago; neotropical; quiropterocoria; Rubiaceae.

The Toltec fruit-eating bat, *Artibeus toltecus*, is a small size species (38.7 ± 0.7 mm of forearm length,17.9 ± 2.1 gr in weight; *n* = 12). It is distributed from the north of México to the northwest of Ecuador and west of Colombia, in South America and lives mainly in wooded areas, in an altitudinal range that goes from 300 to 2,130 m (Webster and Jones 1982). This species is locally common in central Veracruz, México (Castro-Luna and Galindo-González 2012), and it is known that in Mesoamerica it feeds mainly of the Moraceae and Solanaceae families (Hernández-Conrique *et al.* 1997; García-Estrada *et al.* 2012; Hernández-Montero *et al.* 2015), although along its distribution range consumes fruits from plants of 13 taxonomic families: Actinidiaceae, Campanulaceae, Cannabaceae, Euphorbiaceae, Gesneriaceae, Hypericaceae, Lamiaceae, Melastomataceae, Muntingiaceae, Myrtaceae, Piperaceae, Rosaceae and Urticaceae (Lobova *et al.* 2009; Hernández-Montero *et al.* 2015; Castaño *et al.* 2018).

Phyllostomid frugivorous bats have developed remarkable plasticity in their use of food resources, but a few plant families make up the core of their diet throughout the year (Hernández-Montero *et al.* 2015; Sánchez and Giannini 2018). However, rare situations such as the supplementary consumption of insects during critical stages of nutrient demand (Orr *et al.* 2016), or the ingestion of pollen, leaves or fruits with ornitochorous characteristics (*e.g.*, red or purple color), may also occur (Galleti and Morellato 1994; Castro-Luna and Sosa 2009). In this study, we report a new plant species of the Rubiaceae family in the diet of the Toltec fruit-eating bat, which is rarely used as food by phyllostomid bats.

The study area is a fragmented landscape located in the metropolitan area of Xalapa de Enríquez, a city located in central Veracruz, México (19° 30′ N, 96° 58′ W to 19° 32′ N, 96° 56′ W: Figure 1); according to the political division, the capture site belongs to the neighboring municipality of Coatepec. The landscape is a mosaic of pastures, coffee and sugar cane plantations, urban areas, as well as riparian and secondary vegetation. The vegetation in the region was originally mountain cloud forest which, because of anthropogenic pressure, has been reduced to

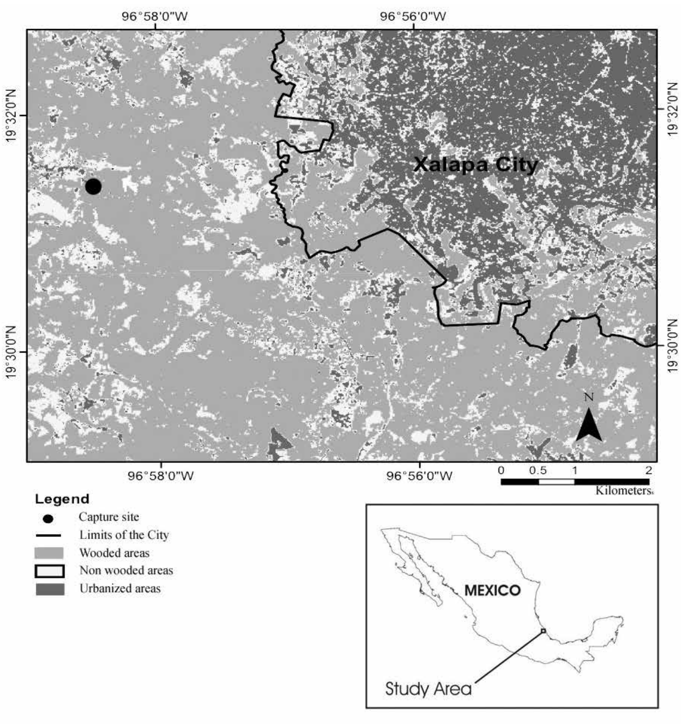

Figure 1. Geographical location of the capture site in the metropolitan area of the city of Xalapa de Enríquez in central Veracruz, México.

less than 10 % of its original area and now exists as isolated fragments with varying degrees of disturbance (Williams-Linera *et al.* 2002). The climate is cool to warm and humid with rain all year round and annual mean temperature ranges between 12 and 19 °C, with annual precipitation between 1,350 and 2,200 mm (García 1987).

The information we report here was generated while conducting a study on the diet of frugivorous bats in urbanized landscapes. We used six mist-nets (12 m long x 2.5 m height), disposed at the understory level, which remained active from dusk until completing six hours of sampling (Colorado-Durán 2020). When we captured a bat, it was kept in cloth bags for later taxonomically identification until the species level, using field keys (Medellín *et al.* 2008). To obtain excreta we used plastic sheets of 9 m long x 1.5 m wide, following the method proposed by Galindo-González *et al.* (2009).

Occasionally, we observed bats carrying fruits when captured in the net; this was the case that we present in this note. When this occurred, the fruit normally was in the bat's snout or next to it, in the net. No record was made if the fruit was on the ground or we were not sure the bat had carried it (*e.g.*, there were more bats in the net). For the taxonomic determination of the plant species, we collected voucher specimens of fruiting plants in the surroundings of the capture sites. We later determined them to the species level in the Herbarium of the Institute of Ecology, A. C.

On June 9, 2018, in a suburban site dominated by early stages of secondary vegetation, an adult female specimen of *A. toltecus* was captured, carrying two fruits of *Hoffmannia excelsa* (Rubiaceae). When detected in the mist net, the specimen had a fruit on its snout (the other fruit was attached, joined by a small stem fragment). However, before making the photographic record, the bat released the fruit, and the evidence was obtained as shown in Figure 2. The specimen did not show evidence of pregnancy or lactation and was released at the same capture site.

In the surroundings of the capture site, there were numerous shrubs of *H. excelsa* fructifying. The fruits obtained from the bat were cylindrical berries, reddish-pink, glabrous and shiny; one of them had the characteristic markings of the bat's bite (Figure 3). Inside, the fruits contained numerous tiny seeds (*ca*. 1 mm diameter).

According to the bibliographic review, this is the first report of *H. excelsa* seed dispersal by bats. Particularly striking is that the species of the Rubiaceae family are mainly dispersed by birds (Bremer and Erickson 1992) and not by frugivorous bats, at least in northern Mesoamerica. The dispersal syndrome hypothesis has been criticized as naive and overly adaptationist. However, studies from the past two decades strongly suggest that traits such as fruit or seed size, hardness, color, scent and chemical profile bear signatures that imply selection by animal mutualists (Valenta and Nevo 2020). The evidence suggests that

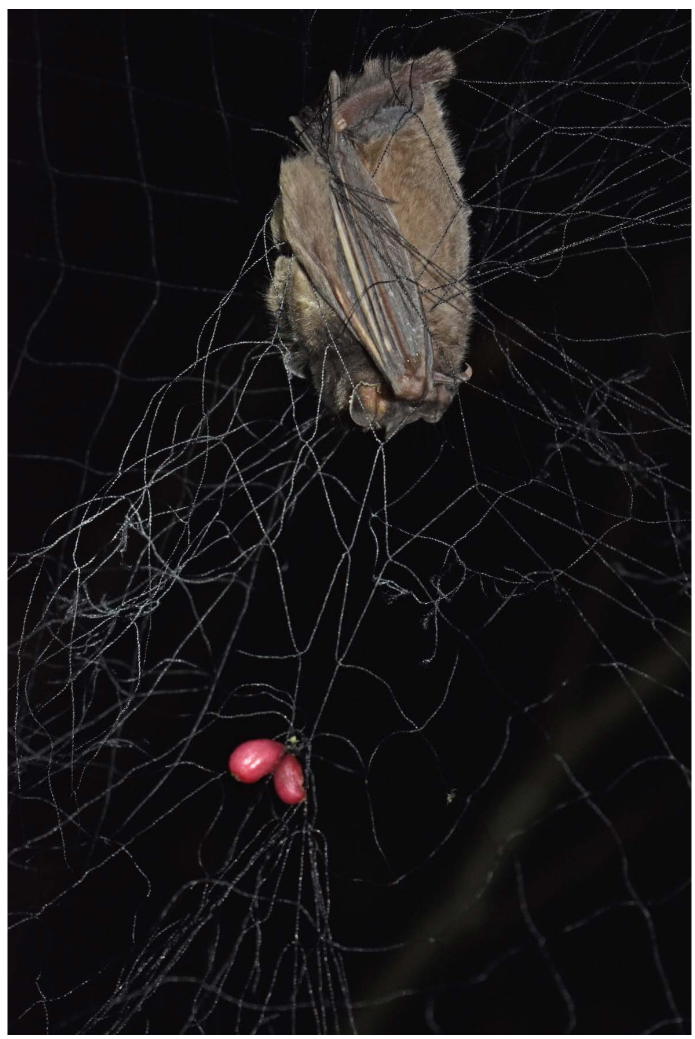

Figure 2. Toltec fruit bat (*Artibeus toltecus*) captured in Coatepec, Veracruz, México with a mist net while carrying two *Hoffmannia excelsa* fruits.

Figure 3. Fruit of *Hoffmannia excelsa* with bite marks from the bat *Artibeus toltecus* in Coatepec, Veracruz, México.

the interaction between bats and plants of the Rubiaceae family exists, but it is not frequent (Geiselman and Younger 2020). For example, the consumption of the pollen of this family by nectarivorous bats has been mentioned in Perú (Arias *et al.* 2009), and there are records of frugivory in South America (see Giannini 1999; Novaes *et al.* 2010; Preciado-Benítez *et al.* 2015; Castaño *et al.* 2018), as well as isolated events of consumption of the exotic *Coffea arabiga* (Gardner 1977). In all these cases, the fruits have characteristics of being dispersed by birds, which is not surprising since Rubiaceae is one of the most important families for tropical frugivorous birds (Snow 1981). In contrast, in Asia and the Pacific Islands, the reports of consumption of Rubiaceae by Pteropodid bats are frequent (*e.g.*, Aziz *et al.* 2017; Aung and Htay 2019; Geiselman and Younger 2020), being among the five families of plants most used as food by these bats (Muscarella and Fleming 2007).

It is interesting that although *H. excelsa* is a common shrub in the understory of the mountain cloud forest and riparian vegetation of the region (Hernández-Dávila *et al.* 2020), it does not seem to be frequently consumed by bats. We assume this, considering that there are no previous records of this interaction in the region (*e.g.*, Hernández-Montero *et al.* 2015; Colorado-Durán 2020). Some authors have mentioned that the consumption of some plant species occurs due to the large number of fruits available in the landscape (Zortéa 2007; Novaes *et al.* 2010), although it has also been reported the unusual consumption of plant species with ornitochorous characteristics (red or purple colors: Howe and Westley 1986), during emergency situations such as food shortage (Castro-Luna and Sosa 2009). In this sense, in the surroundings of the capture site, numerous shrubs of *H. excelsa* were fructifying at the moment we recorded this interaction. Therefore, the fruit consumption could have occurred by opportunism.

The observation of *A. toltecus* transporting *H. excelsa* fruits indicates that, like other phyllostomids, it can transport the fruits it eats to feeding roosts generally at some distance (20 - 250 m) from the tree where the fruit was picked (Galindo-González 1998). In this sense, it is important to recognize that we could not verify the consumption of the seeds by the bat, but only the fruit transportation and non-endozoochorous seed dispersal. We do not rule out that the ingestion of the seeds may occur due to their tiny size. However, this has to be experimentally verified in the future given the apparent rarity of this interaction. Non-endozoochorous seed dispersal has been poorly studied because of the difficulty to obtain information on these interaction events. This report contributes with a new species to the list of plants consumed and dispersed by bats and particularly *A. toltecus*.

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First record of leucism in the volcano rabbit (*Romerolagus diazi*), endemic to México

Primer registro de leucismo en el conejo zacatuche (*Romerolagus diazi*), endémico de México

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Leucism is the total or partial loss of the pigmentation of the fur or plumage without affecting the color of the eyes, skin, and nails. During one of the daily surveillance and protection tours carried out by the Teporingos 1 community brigade, a leucistic juvenile zacatuche was recorded within the San Miguel Topilejo Community Ecological Reserve of México City, México. This note reports the first record of leucism in *Romerolagus diazi* and discusses the relevance of this finding.

Key words: Citizen Science; coloration disorder; lagomorphs; San Miguel Topilejo.

El leucismo es la pérdida total o parcial de la pigmentación del pelaje o plumaje sin afectar el color de los ojos, la piel y las uñas. Durante uno de los recorridos diarios de vigilancia y protección que realiza la brigada comunitaria Teporingos 1 realizó el registro de un zacatuche juvenil leucístico en los terrenos de la Reserva Ecológica Comunal de San Miguel Topilejo de la Ciudad de México, México. En esta nota, reportamos este primer registro de leucismo en la especie y discutimos la relevancia de este hallazgo.

Palabras clave: Ciencia Ciudadana; desorden de coloración; lagomorfos; San Miguel Topilejo.

In nature, some organisms may have genetic disorders that affect the coloration patterns of the pelage or plumage (Bensch *et al.* 2000). One of these disorders is leucism, defined as the total or partial loss of the pigmentation of the pelage or plumage without affecting the color of the eyes, skin, and nails, as in the case of albinism (Miller 2005; Grouw 2006; Fleck *et al.* 2016; Zalapa *et al.* 2016). It has been reported that the gene MC1R is likely responsible for leucism, which encodes the melanocortin-1 receptor protein (MC1R), which regulates pigment production by encoding the melanocyte-stimulating hormone receptor (MSH; Peters *et al.* 2016). Constitutively active MC1R gene alleles are predominantly expressed and result in dark pigmentation, while dysfunctional inactive alleles are recessive and, when expressed, they produce slight or no pigmentation (Fontanesi *et al.* 2006; Peters *et al.* 2016).

Reports of mammalian leucism include the puma (Cronemberger *et al.* 2018), tapir (Tirira and Arbelaez 2020), coati (Silva-Caballero *et al.* 2014), dolphin (Hauser-Davis *et al.* 2020), bats (Zalapa *et al.* 2016; Aguilar-López *et al.* 2021; Salas *et al.* 2021), bear (Ritland *et al.* 2001), sea lion (Acevedo and Aguayo 2008), shrew (Chetnicki *et al.* 2007; Guevara *et al.* 2011), wild boar (Samson *et al.* 2021), and field mice (Brito and Valdivieso-Bermeo 2016). This note documents the first report of a leucistic individual of *Romerolagus diazi* (Ferrari Pérez *in* Diaz, 1893), commonly known as zacatuche or volcano rabbit, which is endemic to México, has a restricted distribution, and is listed as an endangered species (Velázquez and Guerrero 2019).

During one of the daily surveillance and protection tours carried out by the Teporingos 1 community brigade within the San Miguel Topilejo Community Ecological Reserve, mayoralty of Tlalpan, México City, a sighting of a volcano rabbit with atypical coloration was done at El Fraile area (Figure 1). The individual was surrounded by brigade members and captured manually by one of them; it was then photographed with a mobile phone. The dominant vegetation on the sighting site is pine forest with tufted grassland; the local climate is temperate subhumid with summer rains, with mean annual tem-

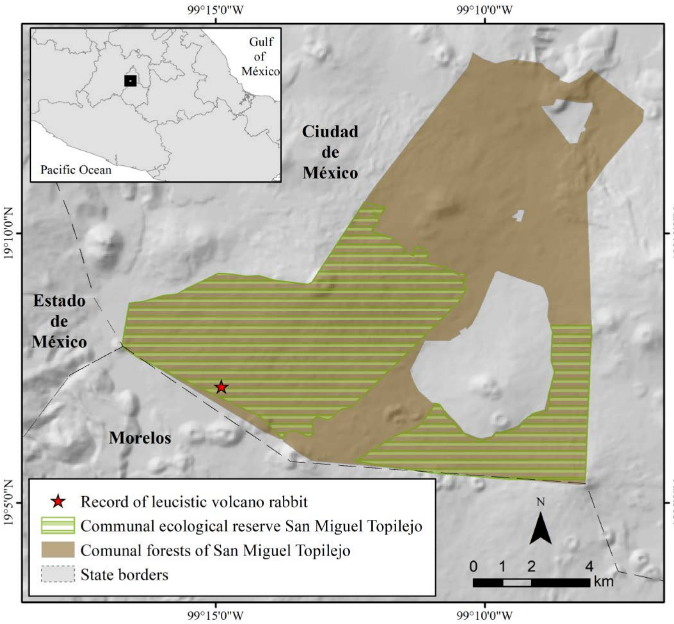

Figure 1. Study area where an individual of volcano rabbit (*Romerolagus diazi*) with leucism was registered in the El Fraile area of the San Miguel Topilejo Community Ecological Reserve, Tlalpan mayoralty, México City.

perature of 13 °C and mean annual precipitation of 950 mm (Velázquez 1996).

The individual was sighted on 23 August 2021 at around 14:00 hr at 19° 07′ 9.14″ N, 99° 14′ 53.74″ W. The specimen was found while it moved through a firebreak trench that crosses the grassland. The individual captured was a juvenile rabbit of approximately 150 mm in total length and apparently in a healthy condition, showing typical leucism traits such as the lack of pigmentation in the facial pelage (mouth, nose, and forehead near the base of the ears) and in a large part of the body, except for a portion of the right front leg, but with normally colored nails and eyes (Figure 2). The leucistic volcano rabbit was released at the site of capture.

The finding of coloration disorders is considered rare in wild populations because the white coloration may adversely affect camouflage and increase the vulnerability to predation (Sokos *et al.* 2018). It is known that the genetic disorder affecting pelage coloration may be associated with factors such as changes in the diet, follicle injuries, stress, inbreeding, or pollution (Hafner and Hafner 1987; Holt *et al.* 1995; Bensch *et al.* 2000; Moller and Mousseau 2001; González-Arrieta and Zuria 2015). The volcano rabbit is a habitat specialist that depends on the presence of sub-alpine bunchgrasses of the genera *Muhlenbergia*, *Stipa*, and *Festuca* (Velázquez and Heil 1996). In the Sierra Ajusco-Chichinautzin area, where the site of the sighting is located, the habitat of the volcano rabbit has been severely fragmented and degraded (Uriostegui-Velarde *et al.* 2018) as a result of anthropogenic activities such as agriculture, shepherding, land plundering, clandestine logging, and forest fires (Velázquez and Guerrero 2019). This poor habitat quality may have adversely affected the health of the species, as there is evidence that metabolic cortisol levels (one of the physiological stress indicators) measured in its feces were two times higher in heavily degraded areas compared with the levels recorded in areas with good habitat quality (Rizo-Aguilar *et al.* 2014). Besides, habitat loss in the study area has brought about a declining population density of volcano rabbit over the past ten years (Guerrero *et al.* 2020).

There is a report of gregarious or sedentary individuals with leucism, a phenomenon that could be associated with small and isolated populations, as reported for shrews and birds (Bensch *et al.* 2000; Chetnicki *et al.* 2007; Contreras-Balderas and Ruiz-Campos 2011), similar to the case of the volcano rabbit. The fragmentation of natural habitats reduces structural connectivity between patches, limiting the dispersal capabilities of individuals and restraining gene flow. This ultimately leads to changes in the distribution of genetic variability among populations due to inbreeding (Gurrutxaga and Lozano 2006), with negative effects on the fitness and fertility of individuals (Hedrick 2011). Although the fragmentation of the volcano rabbit habitat in the study area has not led to loss of genetic variability, it has caused a marked genetic structuring and a reduction of effective population sizes (Montes-Carreto *et al.* 2020). The presence of an individual with leucism is relevant as it corresponds to an endangered species; although leucism has not been reported to date in the population of the volcano rabbit living in the Chapultepec Zoo, attention should be paid to the sighting of

Figure 2. Juvenile individual of volcano rabbit (*Romerolagus diazi*) with leucism. Photographs taken by the Teporingos 1 community brigade.

this wild individual with leucism. We recommend conducting detailed genetic studies to explore the causes of these genetic aberrations in the populations of this endangered rabbit.

Finally, the importance of the surveillance and monitoring work of community brigades is worth highlighting since this activity made it possible to document the existence of a volcano rabbit individual with leucism. Besides the biological relevance of this finding, it reaffirms the commitment of these brigades to the generation of knowledge, as well as their importance in the management of the territory and the design of biodiversity conservation strategies in México.

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Albinism in a wild Caribbean night monkey (*Aotus griseimembra*) in a fragmented landscape in Colombia

Albinismo en un mono nocturno caribeño (*Aotus griseimembra*) silvestre en un paisaje fragmentado en Colombia

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Albinism results from the complete absence of melanin due to mutations in the OCA and TYR genes. This condition has been considered rare in primate species and could affect the survival and intraspecific interactions of individuals. The aim of this note is to report albinism in a wild individual of the Caribbean night monkey (*Aotus griseimembra*) in a fragmented landscape in Santander, Colombia. During 2020 and 2021 we visited the sleeping site of a Caribbean night monkey social group that inhabits a small fragment of forest surrounded by pastureland used for livestock and palm crops. Within the social group we recorded a juvenile individual of unknown sex with evident albinism, which shares its sleeping site with 3 other individuals with normal coloration. Unlike diurnal species, records of albino individuals in nocturnal primates are scarce and have been null for New World night monkeys (*Aotus* spp.). Therefore, it is likely that, in these nocturnal species, albinism imposes additional survival challenges. There is a need to obtain ecological and genetic data to understand the origins and implications of albinism in the Caribbean night monkey.

Key words: Abnormal coloration; habitat loss; melanin; New World primates; Santander; survival.

El albinismo es el resultado de la ausencia completa de melanina producto de mutaciones en los genes OCA y TYR. Esta condición ha sido considerada rara en especies de primates y podría afectar la sobrevivencia y las interacciones intraespecificas de los individuos. El objetivo de esta nota es reportar el albinismo de un individuo silvestre del mono nocturno caribeño (*Aotus griseimembra*) en un paisaje fragmentado en Santander, Colombia. Durante 2020 y 2021 visitamos el dormidero de un grupo social del mono nocturno caribeño que habita un pequeño fragmento de bosque rodeado por pastizales destinados a ganadería y cultivos de palma. Dentro del grupo social registramos a un individuo juvenil de sexo desconocido con evidente albinismo, el cual comparte su dormidero con 3 individuos más con coloración normal. A diferencia de especies diurnas, los registros de individuos albinos en primates nocturnos son escasos y han sido nulos para los monos nocturnos del Nuevo Mundo (*Aotus* spp.), por lo tanto, es probable que, en estas especies de hábitos nocturnos, el albinismo imponga retos adicionales de sobrevivencia. Es necesario obtener datos ecológicos y genéticos que permitan entender los orígenes e implicaciones del albinismo en el mono nocturno caribeño.

Palabras clave: Coloración anormal; melanina; pérdida de hábitat; primates del Nuevo Mundo; Santander; sobrevivencia.

Coloration patterns in primates result from a combination of factors such as hemoglobin, structural coloration and melanin pigmentation (Bradley and Mundy 2008). In the case of melanin pigmentation, there are different abnormal conditions produced by the absence of this pigment in specific parts or the whole body of the individuals. For example, the absence of melanin in small specific regions of the body is known as piebaldism, the partial absence of melanin in a large part of the body is known as leucism, and the complete absence of melanin is known as albinism (Fertl and Rosel 2002; Miller 2005; Acevedo and Aguayo 2008). Albinism has been associated with at least 18 mutations, mainly related to the TYR and OCA2 genes (Hutton and Spritz 2008; Grønskov *et al.* 2009; Summers 2009; Hu *et al.* 2011; Bridge *et al.* 2014; Montoliu and Kelsh 2014; Montoliu *et al.* 2014). The most common condition of albinism, is oculocutaneous albinism (OCA) which is an autosomal recessive inherited disorder characterized by reduced or absent melanin biosynthesis in melanocytes of the skin, coat and eyes (Spritz 1994; Oetting and King 1999). So far, four different types of OCA have been identified (OCA1, OCA2, OCA3 and OCA4) which are difficult to distinguish based on clinical diagnoses and are caused by mutations in different genes that can be identified from molecular analyses (Grønskov *et al.* 2007).

Albinism is a condition considered rare in primates (Mahabal *et al.* 2012; Abreu *et al.* 2013) as it may convey negative consequences (*e.g.*, reduced survival) due to their conspicuous appearance that might make them more susceptible to predation (Owen and Shimmings 1992; Caro 2005). Additionally, individuals with albinism exhibit reduced visual acuity and neurological changes

(Bridge *et al.* 2014). Individuals with albinism may also present problems such as ostracism (Slavík *et al.* 2015) infanticide (Leroux *et al.* 2021) and are usually not reproductively selected (Peles *et al.* 1995; Delibes *et al.* 2013). Despite this, in the wild, subadult and adult individuals with albinism have been recorded sharing with other individuals with normal colorations in several primate species from both the Old World (Mahabal *et al.* 2012; Le Pors *et al.* 2019) and New World (Duquette *et al.* 2015; López-Platas *et al.* 2021). There have even been reports of albino individuals that have successfully reproduced and whose offspring have normal coloration (Le Pors *et al.* 2019). There is also evidence of albinism in individuals of primates born in captivity or recovered from illegal trafficking as infants or juveniles (Prado-Martínez *et al.* 2013; Espinal *et al.* 2016; de Vasconcelos *et al.* 2017; Koga *et al.* 2020; Wu *et al.* 2020).

One of the most northern distributed night monkeys is the Caribbean night monkey, *Aotus griseimembra*, which inhabits the lowland tropical forests of northern South America, in Venezuela and Colombia. The distribution of the Caribbean night monkey in Colombia covers much of the lowland forests of the north of the country and the inter-Andean forests of the middle Magdalena valley, two of the regions most affected by deforestation and where the landscape is dominated mainly by pastures used for livestock and crops (Etter and van Wyngaarden 2000; Etter *et al.* 2008; Link *et al.* 2021). This primate is currently categorized as vulnerable to extinction mainly because of habitat loss due to the pervasive transformation of forests into agricultural fields and urban areas (Link *et al.* 2021). The risk of extant wild populations remains high as only approximately 17 % of the distribution of the Caribbean night monkey is within protected areas (Henao-Díaz *et al.* 2020).

The Caribbean night monkey is medium-sized (approximately 800 gr and 30 cm) and normally has a pelage on the dorsum brown and light yellow belly. The dorsal surface of the hands and feet is usually dark brown and the end of the limbs are darkly colored (Defler 2010). This note aims to report a wild individual of the Caribbean night monkey with albinism, which lives with its social group in a small forest fragment in Santander, Colombia.

Based on a personal communication from a resident suggesting the presence of a Caribbean night monkey with atypical coloration, we visited on three occasions (between August 2020 and August 2021) their habitual sleeping, a large tree of the genus *Ficus* sp. where a group of Caribbean night monkeys sleeps during daytime at about 15 m high. The group lives in a small forest fragment surrounded by guanabana, papaya and citrus tree, and immersed in a mosaic of pastures used for livestock and extensive palm oil crops. The study area is located in the vereda Patio Bonito in the municipality of Puerto Parra, Santander (6° 41′ 59″ N, 73° 58′ 29″ W; 135 m; Figure 1). We assigned an age category to each of the individuals observed based on their size and the presence of a spot at the ventral base of the tail, which is darker in adult individuals (Montilla *et al.* 2021).

The group of Caribbean night monkeys has an individual with albinism evidenced by a total absence of pigment in its entire body, including its skin, coat and red eyes (Figure 2). We observed this albino Caribbean night monkey always in the sleeping area together with 3 other individuals with normal coloration. The albino Caribbean night monkey is a large juvenile almost the size of a subadult of unknown sex and lives with 3 other individuals, 2 correspond to a heterosexual adult couple that are probably the parents of the albino. The other individual corresponds

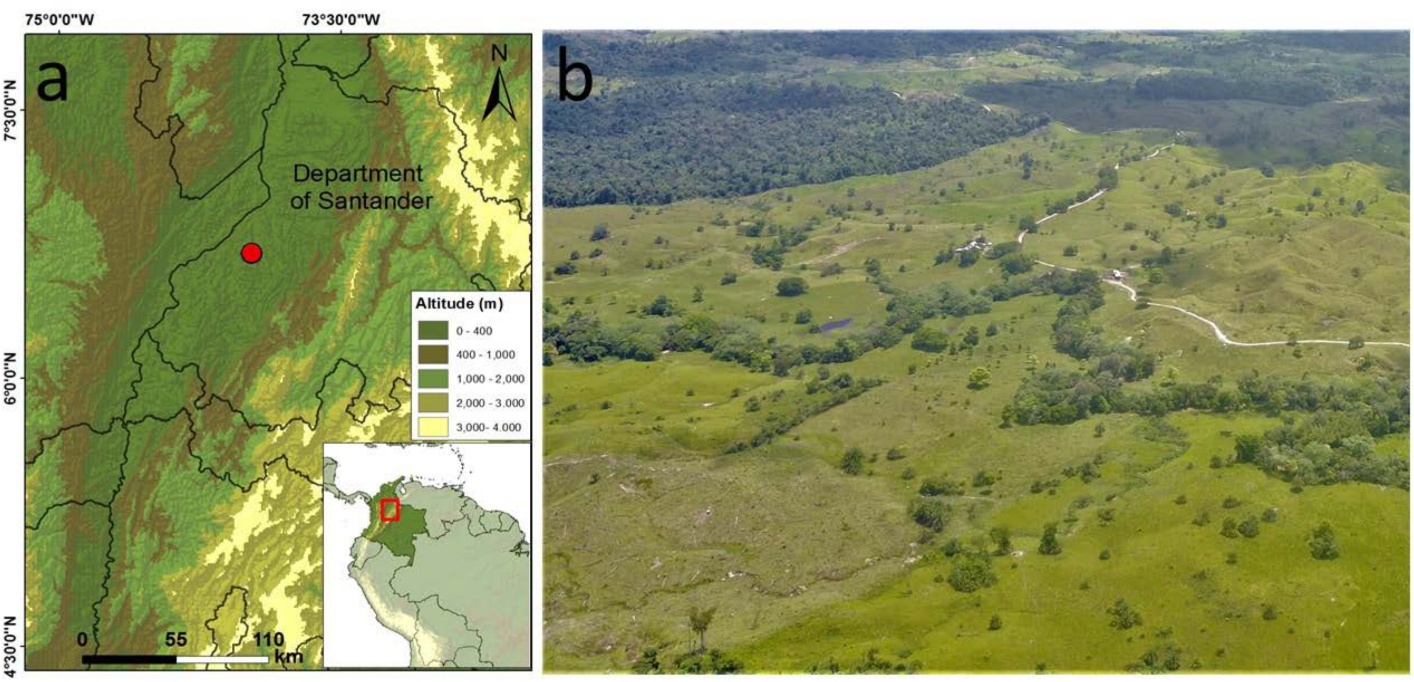

Figure 1. a) Geographical location of the albino Caribbean night monkey, *Aotus griseimembra*, and its social group in Santander, Colombia. b) Fragmented landscape where inhabits the albino Caribbean night monkey and its social group.

to a smaller juvenile of unknown sex that is most probably the younger brother of the albino. After detecting the presence of observers, all group members came out of the sleeping cavity and were alert. It was evident that the albino Caribbean night monkey has visual difficulties and tends to strain his eyes more than the rest of the individuals without pigmentation anomalies.

Given the complete absence of pigmentation in the Caribbean night monkey recorded in Santander, Colombia, we consider it most certainly has a condition of albinism and no other pigmentation disorders such as leucism or piebaldism (Fertl and Rosel 2002; Miller 2005; Acevedo and Aguayo 2008). Albinism has been associated with low genetic diversity, genetic inbreeding, loss of habitat quantity and quality, pollution and environmental stress (Bensch *et al.* 2000; Camargo *et al.* 2014). The albinism of the Caribbean night monkey is likely related to one or more of these factors as it inhabits a small fragment of a highly transformed forest. Local people indicate that this is not the first individual with this condition in the forest fragment and that they have observed at least 3 more albinos within the same social group.

Although the condition of albinism has been recorded in individuals of several primate species throughout the world (Prado-Martínez *et al.* 2013; Duquette *et al.* 2015; Espinal *et al.* 2016; Le Pors *et al.* 2019; Leroux *et al.* 2021; López-Platas *et al.* 2021), reports for nocturnal species have been scarce. In night monkeys (*Aotus* spp.), there are not published records of individuals with albinism. For other strepsirrhine or catarrhine nocturnal primates, there is only one report of albinism, in an individual of unknown sex of the cathemeral crowned lemur (*Eulemur coronatus*), which carries on its back an offspring of normal coloration (Le Pors *et al.* 2019). Like all night monkey species of the genus *Aotus*, Crowned lemur does not have trichromatic vision like most catarrhines (Jacobs 2009). Therefore, it is possible that albinism in these species where color vision is limited, does not have behavioral pressures and even individuals with this condition can reach adulthood and reproduce. This is contrary to what has happened with diurnal primates such as the eastern chimpanzee (*Pan troglodytes schweinfurthii*). A case of an infanticide of one individual with albinism was recently recorded (Leroux *et al.* 2021). However, it is also possible that albinism imposes additional challenges to nocturnal or catemeral primates. The few records of albinism in species with these activity patterns are related to low survival of albino individuals, which are more conspicuous at night to predators (Miller 2005).

A behavioral study of the albino Caribbean night monkey would offer a unique opportunity to better understand the challenges imposed by pigmentation anomalies in the ecology and social behavior of primates with nocturnal habits. Moreover, it is of great importance to conduct genetic studies to determine the origin of albinism in the Caribbean night monkey and its resemblance or not, with genetic mutations associated with albinism.

Figure 2. Albino individual of the Caribbean night monkey, *Aotus griseimembra*, together with individuals of its social group with normal coloration in Santander, Colombia.

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Use of abandoned buildings by mammals in tropical forest sites with no forest control

Uso de edificaciones abandonadas por mamíferos en sitios selváticos sin control forestal

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Mammal species can proliferate in abandoned buildings located in areas with medium evergreen tropical forest. This study assessed the wildlife that currently inhabits the abandoned buildings within the Parqueológico de la Flora y la Fauna Tropicales "Ingeniero José Narciso Rovirosa" (Tropical Wildlife Ecological Park; PFFT, in Spanish), located in the Emiliano Zapata municipality, Tabasco, México; this site has been abandoned for more than 3 decades. We placed rodent traps and bat nets within the PFFT facilities in 2019 and 2021. This site currently comprises areas of medium evergreen tropical forest, pastures, and *acahual* (a successional stage of medium evergreen tropical forest). Besides, we conducted sightings of mammal species in access roads and within abandoned buildings. Twenty-two species of terrestrial mammals were recorded in medium evergreen tropical forest, pastures, and *acahual* patches; bats attained the highest capture rate, followed by rodents. The individuals observed in the medium evergreen tropical forest belonged to the orders Didelphimorphia, Carnivora, Cingulata, Primates, and Lagomorpha. Two species are under a conservation status in national and international listings. Today, PFFT is an area where multiple mammal species coexist in a tropical habitat. The recorded mammal species are considered locally abundant and were observed in buildings surrounded by different types of plant cover. This work shows the establishment of a mammal community typical of medium evergreen tropical forest in sites with abandoned buildings undergoing a recolonization process by the local vegetation.

Key words: Abandoned buildings; biocultural heritage; biological heritage; colonization; conservation; ecological succession; management; México; Tabasco.

Las especies de mamíferos pueden proliferar en una serie de edificaciones abandonadas construidas en sitios de selva mediana perennifolia. Se evaluó la fauna silvestre que colonizó las edificaciones del Parqueológico de la Flora y la Fauna Tropicales "Ingeniero José Narciso Rovirosa" (PFFT) en el municipio Emiliano Zapata, Tabasco, México; sitio abandonado desde hace más de 3 décadas. Colocamos trampas para roedores y redes para murciélagos en 2019 y 2021 dentro de las instalaciones del PFFT. El sitio está actualmente embebido por el crecimiento de selva mediana perennifolia, pastizales y acahuales (estado sucesional de selva mediana perennifolia). Adicionalmente, se realizaron observaciones de especies de mamíferos en los caminos de acceso y dentro de las edificaciones abandonadas. Se registraron 22 especies de mamíferos terrestres, con la mayor tasa de captura de murciélagos, seguida de roedores, en selva mediana perennifolia, pastizales y acahuales. Se observaron ejemplares de los órdenes Didelphimorphia, Carnivora, Cingulata, Primates y Lagomorpha en selva mediana perennifolia. Dos especies están enlistadas en algún estado de conservación, en listados nacionales e internacionales. El PFFT es actualmente un área donde coexisten diversas especies de mamíferos en un ambiente tropical. Las especies de mamíferos registradas se consideran localmente abundantes y fueron registradas en edificaciones rodeadas de diferentes tipos de cobertura vegetal. En este trabajo se muestra el reclamo de una comunidad de mamíferos típicos de la selva mediana perennifolia en sitios con edificaciones abandonadas y en proceso de recolonización por flora nativa.

Palabras clave: Colonización; conservación; lugares abandonados; manejo; México; patrimonio biocultural; patrimonio biológico; sucesión ecológica; Tabasco.

Anthropocene is the geological epoch characterized by the presence of humans and the effects of deforestation, intensive agriculture, and urbanization on ecosystems (Lewis and Maslin 2015). The accelerated growth and needs of human populations, cultural and political changes, and disasters (both natural and anthropogenic) that characterize this epoch have frequently resulted in the abandonment of military facilities, household complexes, parks, and even entire cities. This is the case of the exclusion zone (30 km approximately) and areas adjacent to the Chernobyl power plant in Ukraine, which were severely polluted after a nuclear reactor collapsed in 1986 (Chesser and Baker 2006), or of the Rocky Mountain Arsenal chemical weapon factory, located in Denver, Colorado, U.S., which was abandoned in 1992 (Salcido 2014).

The successional process of the ecosystem started soon after these sites were abandoned, with no human influence thereafter. For instance, changes in the composition of tree species through time have been documented in Pripyat, a city located 3 km from the Chernobyl nuclear plant that was abandoned after the plant exploded. Initially, ornamental plants were more abundant than local species. After more than 40 years of abandonment, the most abundant plants are local species such as pine, oak, and maple trees (Laćan *et al.* 2015). As regards urban mammals, Baker *et al.* (1996) concluded that rodent populations have proliferated in the absence of predators. The same is true for larger wildlife, including wild pigs (*Sus scrofa*) and elks (*Cervus canadensis*; Chesser and Baker 2006).

These data correspond to abandoned sites in contexts of nuclear disasters, but buildings colonized by bats after abandonment or underuse have also been documented around the world (González 2007; Li and Wilkins 2015; Pérez-García *et al.* 2019). In México, there are several cases of abandoned sites, including infrastructure, that remain devoid of human activities. Sites currently abandoned were built over a period from pre-Columbian times (Ortega and Martínez-Rodríguez 2011; Pech-Canché *et al.* 2014) to recent years. Different studies have focused on sites with hundreds of years of abandonment, but places recently colonized by native wildlife are less known. Such is the case of the Parqueológico de la Flora y la Fauna Tropicales "Ingeniero José Narciso Rovirosa" (PFFT, in Spanish; a tropical ecological wildlife park) that stretches across 56 hectares, which was abandoned about three decades ago.

The Parqueológico de la Flora y la Fauna Tropicales "Ingeniero José Narciso Rovirosa" (PFFT) is located in the municipality of Emiliano Zapata, state of Tabasco, México. It was open to the public in December 1982 under the term of Leandro Rovirosa Wade (1977–1982) and was one of the largest family leisure centers in the Los Ríos productive sub-region. At the time, the PFFT included a small zoo that housed jaguars and other small mammal species representative of the region; a museum of the Maya-Olmec cultures; an orchid farm; an aviary with exotic birds; an exhibit of crocodiles, manatees, spider monkeys, and howler monkeys; an auditorium for various events; a swimming pool and a paddling pool with slides for kids; and a fishing lagoon (Nazur 2018); it even had a guest house, equipped with fireplace and jacuzzi.

The park facilities were abandoned definitively in 1988 and, as of the time of the present study, no maintenance works have been performed that would influence the natural plant succession and wildlife colonization process (Nazur 2018; Figure 1). Today, only a small area is preserved as a municipal plant nursery.

Wildlife succession processes in anthropized areas are hugely important for understanding the recovery capacity of altered areas. For this reason, this study was carried out to identify the mammalian species that can potentially recolonize a site that has remained abandoned for over 3 decades in a tropical region.

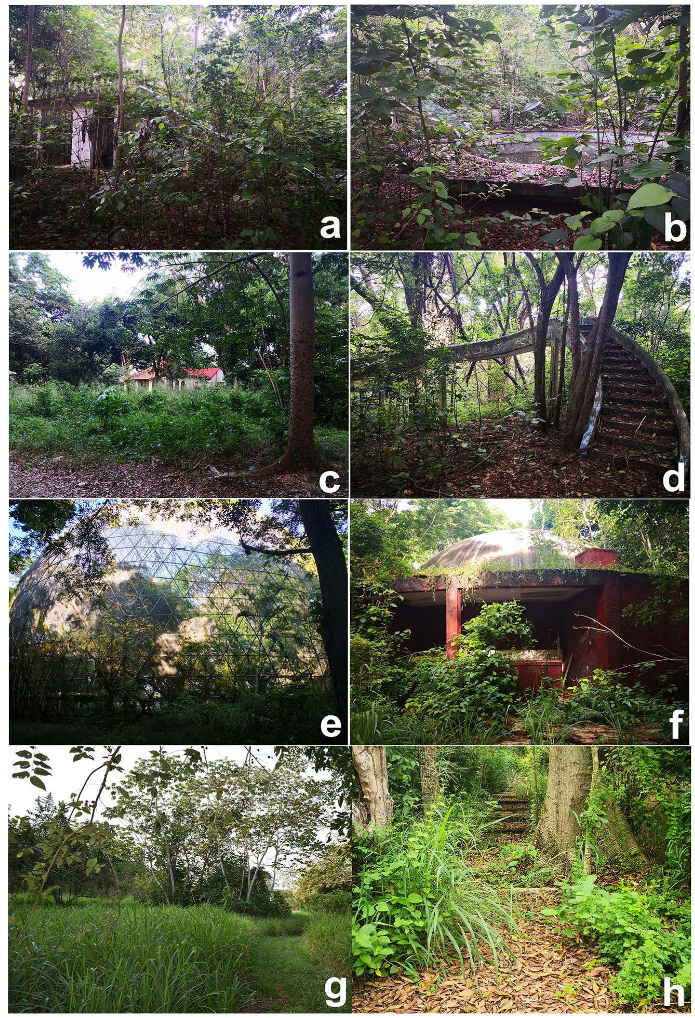

Figure 1. Views of the current (2021) infrastructure of the Parqueológico de la Flora y la Fauna Tropicales "Ingeniero José Narciso Rovirosa", Emiliano Zapata, Tabasco, México. a) Slide of the paddling pool and bathrooms; b) paddling pool; c) guest house; d) entrance to the pool slide; e) aviary; f) auditorium; g and h) trails. Photographs taken by C. Lorenzo (a-f, h), and J. E. Bolaños (g).

The park is located at coordinates 17° 43' 33.38" N, 91° 45' 3.95" W, at an altitude of 34 m in the municipality of Emiliano Zapata, Tabasco, México (Figure 2). Two field trips (18–20 February 2019; 29 September–1 October 2021) were conducted at the PFFT.

In 2019, for 2 consecutive nights, 180 Sherman traps were placed to capture rodents, in addition to 2 mist nets (12 m long x 3 m wide) at ground level and 1 harp trap to capture bats. In 2021, for 3 consecutive nights, 180 Sherman traps, 2 mist nets (12 m long x 3 m wide) at ground level, and 1 harp trap were placed. This yielded a total of 900 Sherman trap-nights and 756 m mist net-nights. Sherman traps were baited with a mixture of oats, vanilla, and sunflower seeds. Traps and nets were placed in the aviary, the paddling pool, the auditorium, the guest house, the museum, and the area where the annual livestock fair was held (Figure 2). These facilities are currently abandoned and surrounded, almost hidden, by medium evergreen tropical forest (SMP in Spanish; Figure 1). A brief description of these facilities is provided in Table 1.

Table 1. Characteristics of the facilities or sites where field work was carried out in Parqueológico de la Flora y la Fauna Tropicales "Ingeniero José Narciso Rovirosa" (PFFT), Emiliano Zapata, Tabasco, México.

Type of facility / site	Description / vegetation type
Auditorium	A circular building with a high vault. It still conserves the entrance doors. Surrounded by medium evergreen tropical forest (Figure 1f).
Guest house	The building is surrounded by lush trees and *acahual* areas. On the shore of San Marcos lagoon (Figure 1c).
Aviary	High-rise metal structure, approximately 50 m height (Figure 1e). Surrounded by medium evergreen tropical forest.
Trails	Running across medium evergreen tropical forest, with *acahual* and pasture patches (Figure 1g, 1h).
Edge of the PFFT	Transition zone between medium evergreen tropical forest and crops and pastureland.

The dominant vegetation comprises trees of the following species: guayacan (*Handroanthus guayacan*), trumpet tree (*Tabebuia rosea*), mahogany (*Swietenia macrophylla*), silk plant (*Albizia longipedata*), cedar (*Cedrela odorata*), teak (*Tectona grandis*), and turpentine tree (*Bursera simaruba*; Manzo Rodriguez pers. comm.). The PFFT nursery cultivates these species, as well as orange trees (*Citrus cinensis*) and mandarin orange trees (*Citrus reticulata*; Manzo Rodriguez pers. comm.).

Nets were left open from 18:00 to 22:00 hr. The specimens captured and their traces were identified using specialized keys (Aranda 2012; Álvarez-Castañeda *et al.* 2017); each individual captured was measured, weighed, and sexed before releasing it at the capture site. Additionally, some individuals were sighted and recorded, and photographs of their traces were captured along several trails in patches of SMP, *acahual*, and pastures.

A total of 22 terrestrial mammal species, corresponding to 7 orders, 13 families, and 20 genera, were recorded across 5 sites (Table 2). No mammals were recorded in the livestock-fair area. The sites with the highest number of mammalian records were the trails (10) and the auditorium (9; Table 2). The latter has turned into a humid and dark place where colonies of bats have been established (Table 2; see video in Appendix 1). Besides, the presence of the black howler monkey, *Alouatta villosa*, was observed in areas adjacent to the auditorium and the aviary. This species is listed as threatened according to the IUCN (Cortes-Ortíz *et al.* 2020) and as endangered of extinction in the Mexican Official Norm NOM-059-SEMARNAT-2010 (SEMARNAT 2010). On the other hand, the tropical porcupine, *Sphiggurus mexicanus*, listed as threatened in NOM-059-SEMARNAT-2010 (SEMARNAT 2010) was recorded in the guest house.

Table 2. Species of mammals recorded by type of facility at the Parqueológico de la Flora y la Fauna Tropicales "Ingeniero José Narciso Rovirosa" (PFFT), Emiliano Zapata, Tabasco, México. *Sighting. The species listed as threatened according to IUCN and NOM-059-SEMARNAT-2010 are marked in bold.

Order	Family	Species	Auditorium - Paddling pool	Guest house	Aviary - Museum	Trails	Edge of the PFFT
Didelphimorphia	Didelphidae	*Didelphis marsupialis**				X	
		*Philander opossum**	X				
Cingulata	Dasypodidae	*Dasypus novemcinctus**				X	
Chiroptera	Emballonuridae	*Saccopteryx bilineata*	X				
		Mormoops megalophylla	X				
	Mormoopidae	*Pteronotus davyi*	X				
		Pteronotus mesoamericanus	X			X	
		Desmodus rotundus	X				
		Glossophaga soricina	X	X		X	
	Phyllostomidae	*Artibeus lituratus*			X	X	
		Artibeus phaeotis		X			
		Sturnira parvidens	X	X			X
	Vespertilionidae	*Rhogeessa tumida*					X
Primates	Atelidae	***Alouatta villosa****	X		X		
Lagomorpha	Leporidae	*Sylvilagus floridanus**					X
Rodentia	Sciuridae	*Sciurus deppei**				X	
	Erethizontidae	***Sphiggurus mexicanus****		X			
		Reithrodontomys mexicanus		X			
	Cricetidae	*Oligoryzomys fulvescens*				X	
		Sigmodon toltecus				X	
Carnivora	Canidae	*Urocyon cinereoargenteus*				X	
	Procyonidae	*Procyon lotor**				X	

This study exemplifies the mammalian species that are able to colonize and thrive in abandoned sites with human facilities located in tropical environments. Today, the PFFT is a unique area where multiple mammal species coexist for being an environment that provides suitable habitats for them. A 2021 satellite image (refer to Figure 2) shows that the PFFT still includes a patch of tropical forest, which favors the presence of native fauna.

All the mammalian species recorded in the present study are considered locally abundant, living in more than one type of habitat, from sites covered by native forest to areas with secondary vegetation, and the conservation status of some of them has been established as per national and international listings. Besides, some species, mainly of bats, have successfully colonized the infrastructure that still persists in the PFFT; for example, the auditorium serves as shelter for several bat species, such as *Desmodus rotundus*, *Mormoops megalophyla*, *Pteronotus davyi*, *P. mesoamericanus*, and *Saccopteryx bilineata*, as well as for other mammals, such as the gray four-eyed opossum, *Philander opossum*, which was observed leaving the auditorium through the gate of the main entrance.

It is remarkable how the native rainforest vegetation has prospered in and around the man-made PFFT facilities and how these have deteriorated over time, since some have partly collapsed and the trails have been completely covered by overgrown vegetation. The presence of domestic species, such as cats and dogs, is also evident in the surroundings of the museum, as these areas are close to humans working in the park.

This study is the first to document the use by mammals of recreational buildings that have remained abandoned for decades in southern México. Other works conducted in northern México have recorded the use of abandoned mines by bats (Wilson *et al.* 1985; López-González and Torres-Morales 2004; López-González and García-Mendoza 2006).

Worldwide, several studies report buildings still inhabited by humans used by bats as shelters (Whitaker 1998; Siles *et al.* 2005; Debernardi and Patriarca 2007; González 2007; Mialhe 2013; de Paz *et al.* 2015; Li and Wilkins 2015; Alcalde *et al.* 2017; Pérez-García *et al.* 2019), unlike the PFFT infrastructure. This study describes abandoned buildings currently occupied by native fauna; some of these buildings are used as shelters for the bats that inhabit them, as is the case of the auditorium (see video in Appendix 1).

The findings of this study should be shared with the local and federal authorities to ensure that, if the park is reactivated

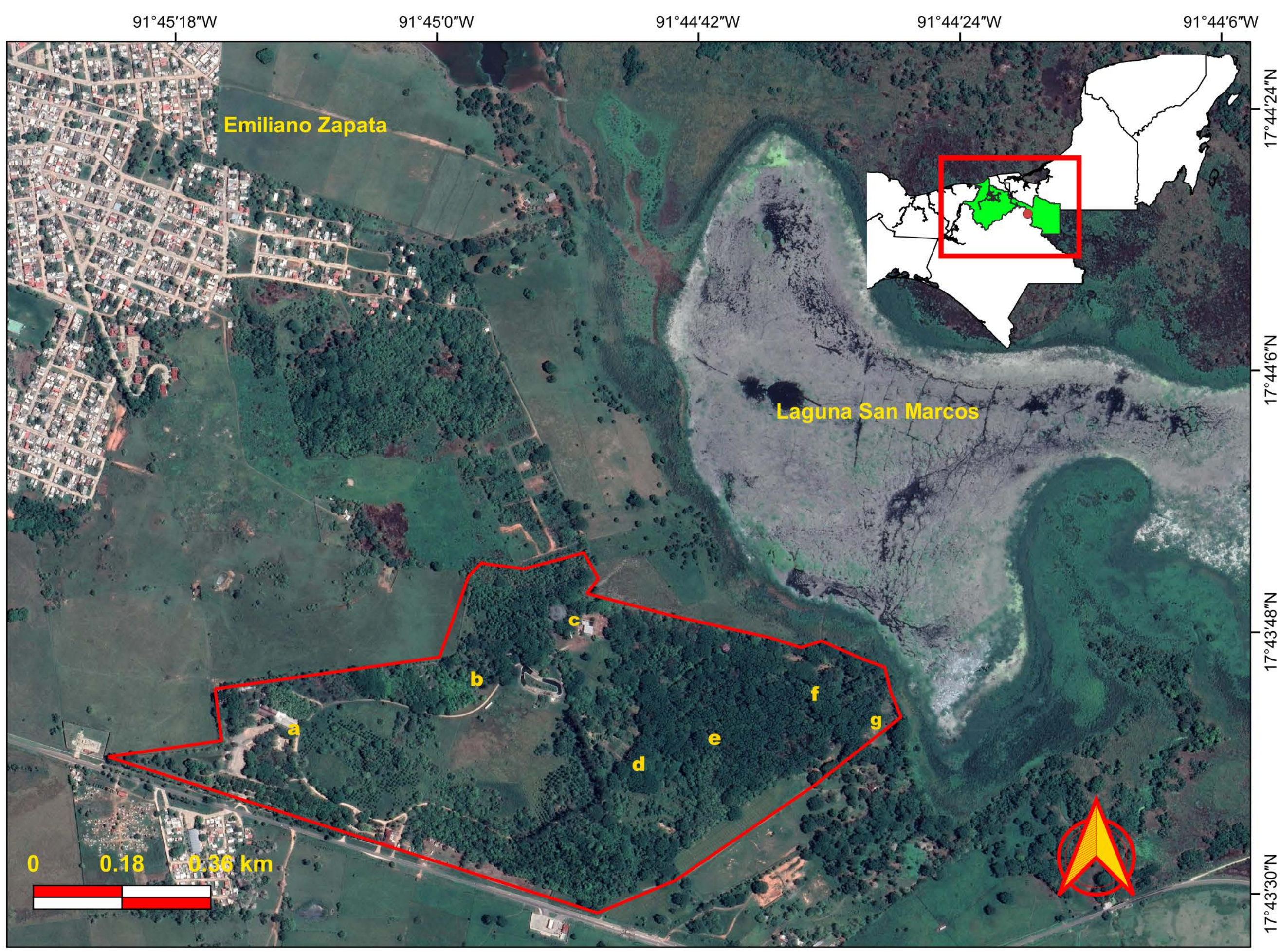

Figure 2. Collection and sighting sites (in yellow) of terrestrial mammals at the Parqueológico de la Flora y la Fauna Tropicales "Ingeniero José Narciso Rovirosa" (PFFT), Emiliano Zapata, Tabasco, México (red polygon). a) Site of the livestock fair, b) trail, c) aviary-museum, d) trail, e) auditorium-paddling pool, f) guest house, g) edge of the PFFT.

in the future, the mammals and wildlife living in it are managed properly to avoid their local extinction. In addition, the future conservation of this park is part of the plans approved by UNESCO (2017) for the protection of the world heritage, which seeks to identify, protect, conserve, restore, and pass to future generations the cultural and natural heritage.

Throughout history, mankind has transformed the environment for its own use and benefit, and in the worst case, this has led to the destruction and abandonment of natural habitats. The case of the PFFT is an example of the latter; however, the local wildlife has found suitable habitats in this abandoned environment. Although the creation of this natural and cultural site for recreational, cultural, and artistic purposes was a laudable project in its early days, no public policies have been issued to recreate the ancient splendor of this important biocultural heritage site of the state of Tabasco.

The PFFT of the municipality of Emiliano Zapata, Tabasco, built in the decade of the 1980s, sought not only to provide knowledge about the local flora and fauna to visitors, but also to rescue the cultural heritage of ancient Olmec and Mayan cultures in a regional museum. It is up to us to rethink the safeguarding of our biocultural heritage and the wild mammals inhabiting abandoned places. Last, the protection of PFFT as the natural and cultural heritage of the region is necessary to turn it into a sustainable model about the use of natural and cultural resources guided by ethical and professional principles.

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Appendix 1

Video of the interior of the auditorium, Parqueológico de la Flora y la Fauna Tropicales "Ingeniero José Narciso Rovirosa" (PFFT), Emiliano Zapata, Tabasco, México. Author: A. M. Romero-Lorenzo.

https://drive.google.com/file/d/1Ftc9NHiVb4740V6idGC5HiaNC_nWupsg/view?usp=sharing

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Predation on sea turtles by jaguars in the Mexican Caribbean

Depredación de tortugas marinas por jaguar en el Caribe Mexicano

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Jaguars are opportunistic carnivores whose diet mainly depends on prey availability. Jaguar predation on sea turtles has not been sufficiently documented in México. In this study, we recorded the predation of loggerhead (*Caretta caretta*) and green (*Chelonia mydas*) sea turtles by jaguar (*Panthera onca*) in Mahahual, Quintana Roo, México. From May to August 2021, 10 camera-trap stations were set on a nesting beach. Meanwhile, daytime and nighttime tours were conducted along the beach to detect turtles nesting on the site, as well as carcasses with evidence of predation. With a sampling effort of 600 camera trap nights, we obtained 10 independent jaguar predation events and 3 photo events confirming jaguar predation on sea turtles. Jaguar predation on sea turtles has been documented on Costa Rican beaches, but rarely in México. This report contributes to improving our understanding of the diet of the jaguar in coastal areas and the relationship between this feline species and sea turtles in México.

Key words: Camera-trapping; carnivores; Mexican Caribbean; Testudines; turtle nesting.

Los jaguares son carnívoros oportunistas, cuya dieta depende principalmente de la disponibilidad de sus presas. La depredación de tortugas marinas por parte de los jaguares ha sido raramente documentada en México. En este estudio registramos la depredación de tortugas caguamas (*Caretta caretta*) y verdes (*Chelonia mydas*) por parte de jaguares en la región de Mahahual, en el estado de Quintana Roo, México. De mayo a agosto de 2021, se establecieron 10 estaciones de fototrampeo en una playa de anidación. De forma paralela se realizaron recorridos nocturnos y diurnos a lo largo de las playas, con el fin de detectar tortugas que ovopositaran en el sitio, así como carcasas en el sitio que presentaran señales de depredación. Con un esfuerzo de muestreo de 600 noches / cámara se obtuvieron 10 eventos independientes de la presencia de jaguar en la zona, los cuales sucedieron en horarios diversos tanto diurnos como nocturnos, así como 3 eventos fotográficos en los que se confirmó la depredación del jaguar a tortugas marinas. La depredación de tortugas marinas por jaguares ha sido documentada en las playas de Costa Rica pero casi nunca en México, este reporte contribuye al escaso conocimiento de la dieta del jaguar en sitios costeros, así como a la relación que existe entre estos felinos y las tortugas marinas de México.

Palabras clave: Anidación de tortugas; cámaras trampa; Caribe mexicano; carnívoros; Testudines.

The jaguar (*Panthera onca*) is the largest feline in America and is among the most charismatic wildlife species (de la Torre *et al.* 2017). Historically, jaguars are distributed from the southern United States to northern Argentina (Brown and López-González 2000; McCain and Childs 2008). Due to various anthropic pressures such as poaching, deforestation, and changes in land use (Ceballos *et al.* 2016; de la Torre *et al.* 2017), the distribution of the jaguar has been significantly reduced in the Yucatán Peninsula and the rest of the country (Rodríguez-Soto *et al.* 2011). The importance of Jaguar Conservation Units (JCUs) as priority sites for the species has been highlighted in México; two examples of JCUs are the Sian Ka'an Biosphere Reserve and the biological corridor that connects the Calakmul Biosphere Reserve and the Balaan Kaáx Flora and Fauna Protection Area (Rabinowitz and Zeller 2010).

Jaguars are opportunistic carnivores whose diet mainly depends on prey availability, including at least 85 species of mammals, birds, reptiles, and fish (de Azevedo and Murray 2007; Reid 2009; Aranda 2012; Gallo-Reynoso 2021). In México, there are reports of jaguars feeding on different mammal species, including the white-tailed deer (*Odocoileus virginianus*), Central American tapir (*Tapirella bairdii*), brocket deer (*Mazama* sp.), peccary (*Dicotyles crassus*), coatimundi (*Nasua narica*), lowland paca (*Cuniculus paca*), agouti (*Dasyprocta* sp.) and nine-banded armadillo (*Dasypus novemcinctus*); bird species reported to be consumed as prey include the ocellated turkey (*Meleagris ocellata*) and the great curassow (*Crax rubra*); reptiles such as crocodiles, boas, iguanas, and land and sea turtles are also occasionally preyed upon (Aranda and Sánchez-Cordero 1996; Núñez *et al.* 2000;

Simá-Pantí *et al.* 2020). Predation of sea turtles by jaguars has been frequently documented in Costa Rica, where the species consumed most frequently are the hawksbill, olive ridley, and green turtles (*Eretmochelys imbricata*, *Lepidochelys kempii*, and *Chelonia mydas*, respectively; Herrera *et al.* 2016; Escobar-Lasso *et al.* 2017). However, predation on sea turtles in México remains poorly documented. The only reports available include outreach materials describing the predation of *E. imbricata* and *C. mydas* in nesting sites of the Mexican Caribbean north of Sian Ka´an (Cuevas *et al.* 2014), and some government reports on the Pacific coast recording predation on olive ridley turtles (*Lepidochelys olivacea*; CONANP 2019) in the *Marismas Nacionales* Biosphere Reserve, Nayarit. The effects of predators on adult sea turtles have remained unnoticed throughout their distribution range (Heithaus *et al.* 2008) because of the complexities in observing and quantifying them, and since many of the studies addressing the jaguar diet have not considered coastal areas.

This note reports 3 cases of predation on sea turtles by jaguar: 1 regarding loggerhead (*Caretta caretta*) and 2 on green (*Ch. mydas*) turtles, based on evidence recorded using camera traps in Mahahual, a locality on the southern coast of Quintana Roo. These photos show the predation behavior of jaguar described as common in Costa Rica (Cuevas *et al.* 2014; Arroyo-Arce and Salom-Pérez 2015) but that has been rarely recorded in México and provides relevant information to the current knowledge of the jaguar diet and the relationship between these felines and sea turtles in coastal areas of México. This study aims to establish strategies to improve the coexistence between jaguars and humans and determine the interaction of jaguars and sea turtles in the Mahahual coastal area.

From May to August 2021, 10 Browning digital camera traps (Strike force; Browning Trail Cameras) were placed at sea turtle nesting sites along Pulticup beach (19° 3′ 14.62″ N, 87° 34′ 14.74″ W, and 19° 10′ 9.00″ N and 87° 32′ 30.82″ W; Figure 1). Cameras were affixed to a tree or trunk 50 cm above the ground, always running parallel to the coast. The cameras were set to capture photos continuously over 24 hours and were reviewed every 20 days. In parallel, daytime and nighttime tours were conducted along the beach to detect turtles nesting on the beach and carcasses of turtles predated by jaguars.

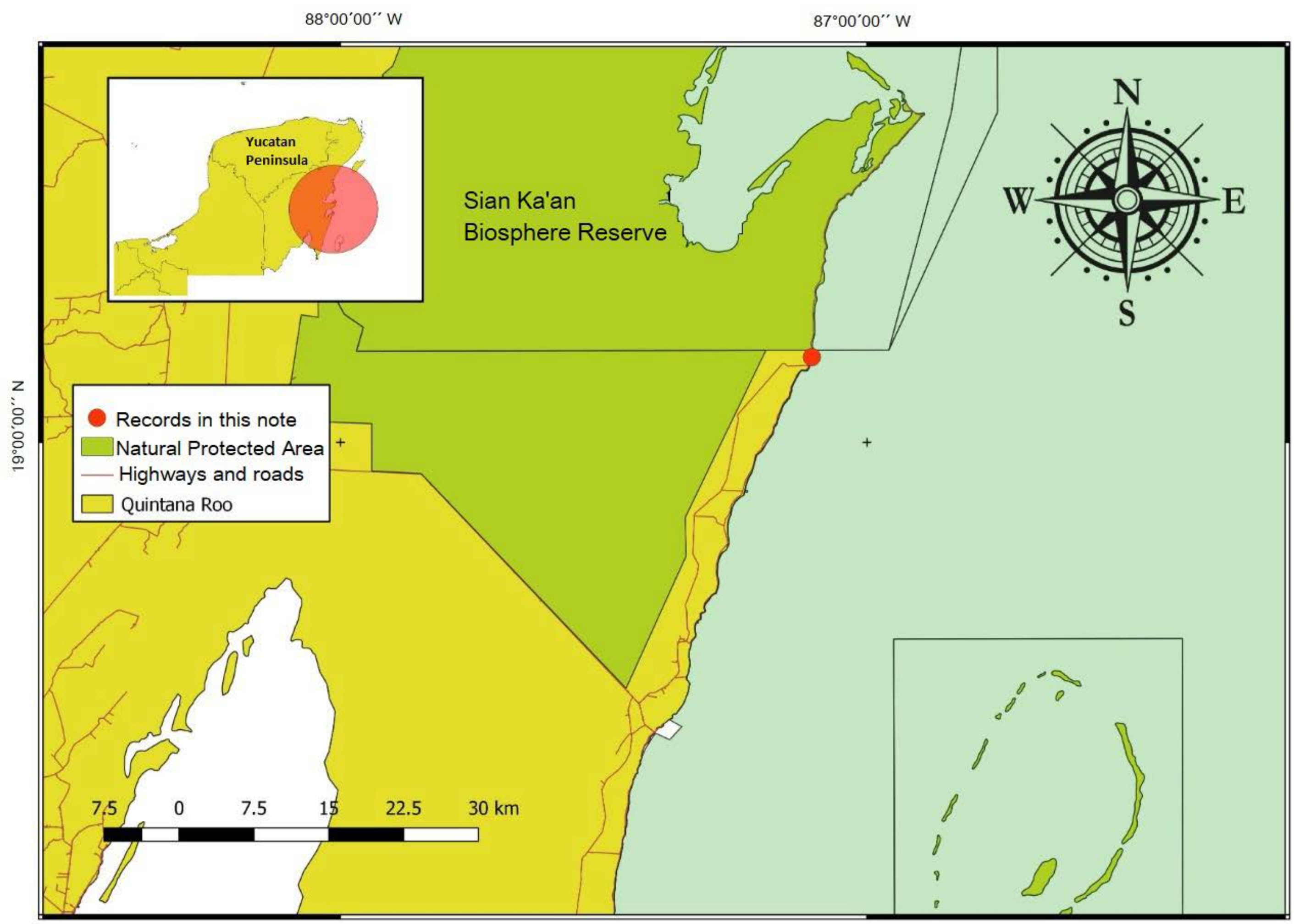

Figure 1. Location of the study site at coordinates 19° 4′ 51.91″ N, 87° 33′ 8.31″ W, in Mahahual, Quintana Roo, México, marking the exact site (red circle) where turtle carcasses were observed and the photographs of jaguars preying on sea turtles were recorded.

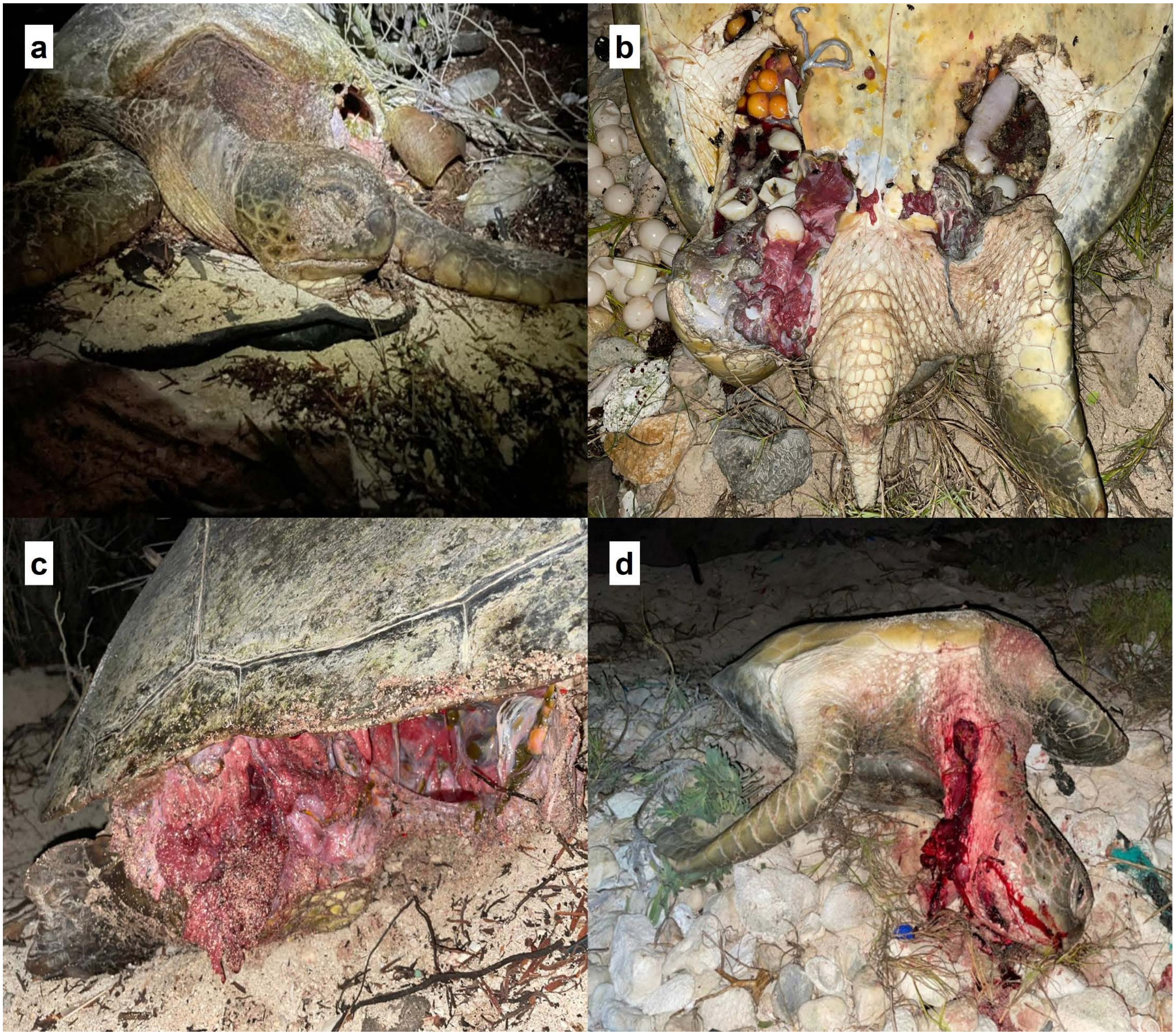

Figure 2. a-d) Turtle carcasses with evidence of jaguar predation. The records were collected on the beach in Mahahual, Quintana Roo, México.

With a sampling effort of 600 camera trap nights, we recorded 10 independent events of the presence of jaguar, which were captured at various times of the day and night, plus 3 photo events confirming jaguar predation on sea turtles. Multiple jaguar tracks (footprints and scats) were observed on the beach during the monitoring period, in addition to carcasses of jaguar-predated turtles (*C. mydas* and *C. caretta*) on 25, 28, and 29 July 2021.

A series of photographs were captured with a camera trap placed on the dunes of the beach at coordinates 19° 4′ 51.91″ N, 87° 33′ 8.31″ W (Figure 1), recording a jaguar walking in the same area where carcasses were found on 28 July (Figure 2a–2d), plus 2 photographs recorded on 29 July 2021 that captured 2 male jaguars feeding on sea turtles subsequently identified as *C. mydas* (Figure 3a) and *C. caretta* (Figure 3d) by direct observation. These carcasses showed bite marks on the legs and were partially eaten on the thighs; eggs were also consumed (Figure 3d). The characteristic spot-rosette pattern allowed identifying 2 solitary adult jaguar males that feed on turtles in the area. Dogs have also been observed at the site, occasionally scavenging on turtle carcasses left by jaguars. All predation events occurred at about 15–30 m from the coastline, between 0:00 and 5:00 hr. Jaguars were not recorded returning a second time to feed on the carcasses on subsequent nights.

Predation on sea turtles by jaguars in the Mexican Caribbean has not been sufficiently documented. Since nesting turtles are easy to capture, some jaguar individuals have likely learned to take advantage of these preys as sources of protein and energy, since preying upon them represents a low energy cost to meet the jaguar nutritional needs (Cuevas *et al.* 2014).

In the 2021 nesting season in Mahahual, we located 24 nests of *C. caretta* and 62 nests of *C. mydas* (Rosales-Hernández pers. comm. 2021). The number of nesting females of *C. mydas* has increased exponentially throughout the Gulf of México and the Caribbean Sea in recent years (Christianen *et al.* 2014), leading to higher abundance on the beach, even in places where it was rarely observed at least a decade ago (Lara-Dzul *et al.* 2014). This rise in the number of nests has been attributed to the outstanding implementation of protected beaches as habitats for sea turtles, mainly by the efforts of governments and conservation organizations (Shaver *et al.* 2020).

The use of camera traps has allowed documenting various aspects of the jaguar everyday life; however, they had rarely been used to evidence predation on sea turtles (Cuevas *et al.* 2014). The nighttime tours had no apparent effect on the presence of jaguars in turtle-nesting areas; in fact, the first author was able to directly take a photograph of a jaguar preying on a turtle (Figure 3d).

Dog predation by jaguars has been recorded in the study area (Carral-García *et al.* 2021). The particular spot–rosette patterns allowed identifying that the same jaguars were hunting both turtles and dogs, suggesting that they have diversified their diet to leverage on the local conditions and adapt their behavior to the environmental and anthropic factors around them. The current evidence indicates that in the Mexican Caribbean, the jaguar feeds on hawksbill, green, and loggerhead turtles; there is no evidence suggesting that it also consumes leatherback turtles (*Dermochelys coriacea;* de la Esperanza *et al.* 2017). Considering the low abundance of the leatherback turtle (*D. coriacea*), one might think that the jaguar is not discriminating between turtle species, but is feeding opportunistically since its dietary habits largely depend on prey availability (Seymour 1989; Núñez *et al.* 2000; Arroyo-Arce *et al.* 2014; Wolf and Ripple 2016). Sea turtles are consumed by a wide variety of natural predators during their early life stages *i.e.*, eggs and hatchlings (Engeman *et al.* 2005). However, they have few natural predators in their adult stage (Heithaus *et al.* 2008); therefore, these 2 new records of predation on sea turtles provide relevant information that will contribute to a better understanding of the feeding behavior of the jaguar, and document predation events on adult sea turtles. It also expands the current knowledge of the interactions of sea turtles with their natural predators on nesting beaches in countries where this same behavior has been previously reported, such as Costa Rica, Guyana, Suriname, and México (Fretey 1977; Autar 1994; Cuevas *et al.* 2014; Guilder *et al.* 2015). The relevance of this note is evident since the turtle species reported and the jaguar are classified as conservation priorities by the Mexican government, besides being considered flagship species in many countries.

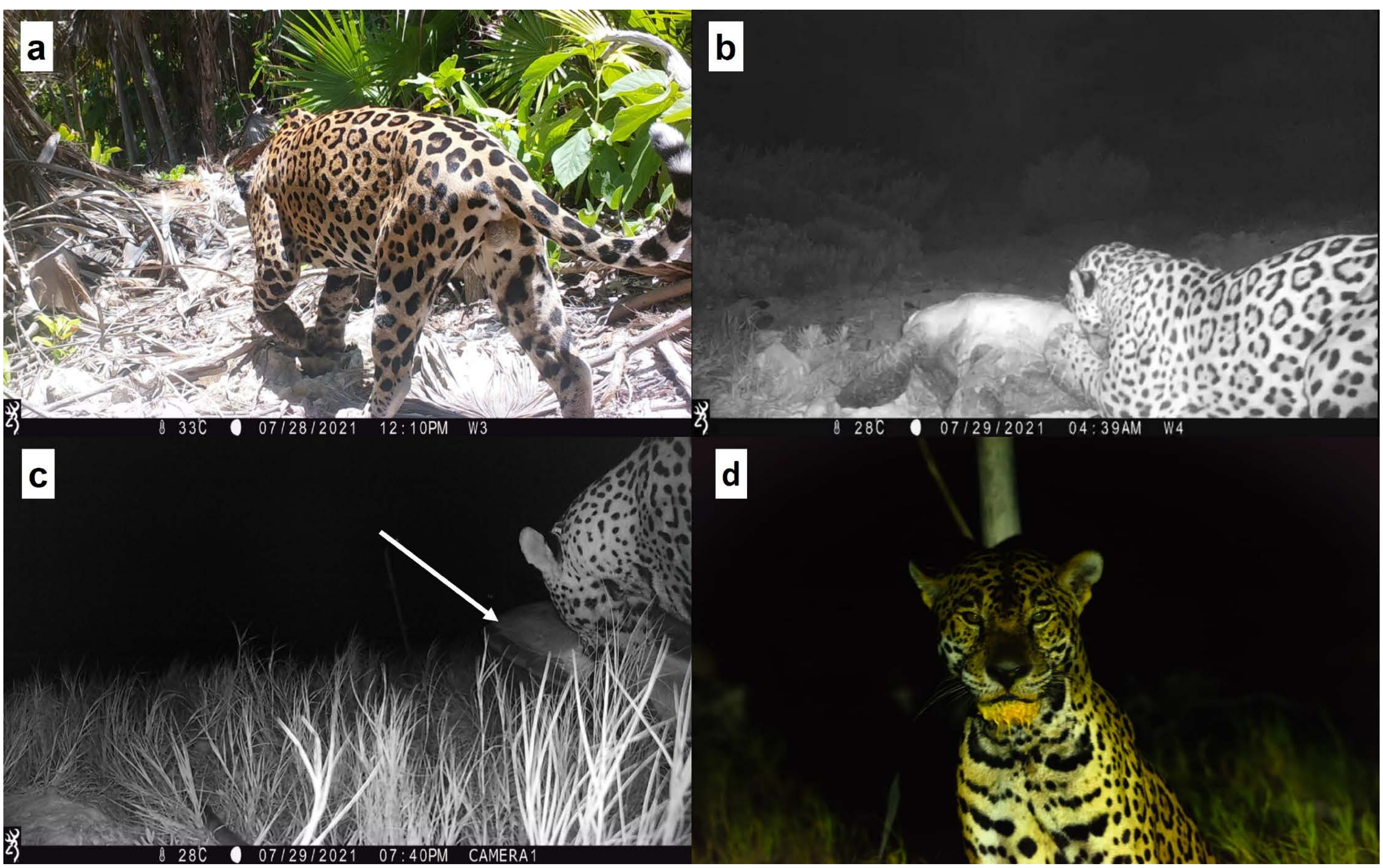

Figure 3. a-b) Jaguar wandering on the beach where preyed turtle carcasses were observed. c-d) Two jaguar predation events on sea turtles (*C. caretta*, c; *C. mydas*, d). The arrow in c marks the carcass of a turtle being eaten by a jaguar. The records were collected on the beach in Mahahual, Quintana Roo, México.

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Discovery of underground shelters occupied by the Chacoan Marsh Rat after massive wildfires in Pantanal, Brazil

Hallazgo de refugios subterráneos ocupados por la rata colorada chaqueña tras incendios forestales en Pantanal, Brasil

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The drought and wildfires that swept through Pantanal, the major South American wetland, in 2020 severely impacted the local biota. The resilience of native species to these types of extreme events remains largely unknown. During post-wildfire surveys at recently affected sites, we found three burrows containing the semi-aquatic Chacoan marsh rats (*Holochilus chacarius*). We also found a callichthyid catfish (*Hoplosternum* sp.) and a trichodactylid crab (*Dilocarcinus pagei*) alive and co-habiting one of the burrows with *H. chacarius*. We report for the first time the use of underground structures with a flooded chamber by the Chacoan marsh rat. We discussed the importance of these burrows for post-fire survivorship and whether they may serve as shelters for *H. chacarius* and other species against wildfires and drought, under the light of previous studies with other taxa.

Key words: Dry season; *Holochilus chacarius*; Oryzomyini; Sigmodontinae; survivorship; wetlands; wildfire.

Las sequías e incendios forestales que afectaron el Pantanal, la mayor llanura inundada de Sudamérica en 2020 impactaron fuertemente la biota, cuya resiliencia a estos tipos de eventos extremos todavía es desconocida. Durante muestreos posteriores a los incendios en sitios impactados, encontramos tres cuevas habitadas por la rata colorada chaqueña, *Holochilus chacarius*. Además, encontramos a un bagre calíctido (*Hoplosternum* sp.) y a un cangrejo tricodactílido (*Dilocarcinus pagei*) cohabitando una de las cuevas con *H. chacarius*. Reportamos, por primera vez, el uso de una cueva inundada por la rata colorada. Discutimos la importancia de dichas estructuras para la supervivencia posterior al incendio y si pueden servir como refugio para *H. chacarius* y otras especies a eventos extremos de incendios y sequía, a la luz de estudios previos con otros taxones.

Palabras clave: Estación seca; *Holochilus chacarius*; humedales; incendio forestal; Oryzomyini, Sigmodontinae; supervivencia.

In the Pantanal wetlands of central South America (Brazil, Bolivia, and Paraguay), wildfires in the dry season are part of the ecosystem dynamics (Alho and Silva 2012; Hardesty *et al.* 2005). Therefore, it is expected that such wildfires directly affect the local populations of small mammals, as in other fire-driven ecosystems (*e.g.*, Koprowski *et al.* 2006; Conner *et al.* 2011; Leahy *et al.* 2015; Pacheco *et al.* 2021). In some anomalous years, the fires in Pantanal may cover larger areas, influenced by natural events associated with anthropogenic factors such as the opening of pastures and agricultural areas (Alho and Silva 2012; Garcia *et al.* 2021; Marengo *et al.* 2021; Marques *et al.* 2021). This was the case in 2020, when wildfires burned approximately 26 % of the Brazilian Pantanal (Garcia *et al.* 2021; Libonati *et al.* 2021) and directly affected local flora and fauna (Garcia *et al.* 2021; Tomas *et al.* 2021).

Information on post-wildfire resilience of vertebrates in the Brazilian Pantanal remains obscure. Environmental factors affecting the survival of fauna during wildfires are many and have complex interrelationships, but it seems that burrows and other cavities may serve as immediate protection (Engstrom 2010; Bova *et al.* 2011; Robinson et al. 2013; van Mantgem et al. 2015). Additionally, previous studies in other ecosystems have indicated that small mammal individuals that survived after fires may play an important role in the recovery of populations in burned areas, when compared to immigrants from non-affected places (Banks *et al.* 2017; Hale *et al.* 2021).

During a survey to assess the first-order impact of wildfires on vertebrates in the Pantanal, we found flooded burrows occupied by individuals of the Chacoan marsh rat, *Holochilus chacarius* (Cricetidae, Sigmodontinae), alive immediately after a wildfire. *Holochilus chacarius* is a South American semi-aquatic rodent species which occurs in the Pantanal wetlands or Chaco areas in Paraguay, eastern Bolivia, northern Argentina, and western Brazil (Brandão and Nascimento 2015; Prado *et al.* 2021). Information on the behavior and biology of the species is largely restricted to anecdotal and natural history observations from Argentina (*e.g.*, Massoia 1971, 1976; Llanos 1944; Piantanida 1993; Díaz and Bárquez 2002) and Paraguay (Yahnke 2006). However, little is known about the species in the Brazilian Pantanal and most of such data are generalizations for the genus (see Oliveira and Bonvicino 2011).

Herein, we report on burrows occupied by individuals of *H. chacarius* in a recently burned area in Pantanal, Brazil. We describe these burrows in detail, assess the evidence of use presented in the structures and discuss, under the light of previous studies with other taxa, whether they may serve as shelters for *H. chacarius* and other species against droughts and wildfires in the Pantanal wetlands.

Data were collected during fieldwork related to the Mogu Matá Network, a survey carried out to assess the first-order impact of wildfires on vertebrates in Pantanal. From August to November 2020 (the local dry season), we surveyed burned areas along transect lines, searching carcasses, injured animals, and indirect signs of the presence of survivors (*e.g.*, burrows; nests). On September 15th, 2020, we visited an area that had been burned in the previous 24 hours. The study site, a seasonally flooded swamp (16° 57′ 8″ S, 56° 54′ 40″ W), with patches of water-saturated pre-turf or peat, is situated adjacent to the MT-060 road (Transpantaneira), located in the municipality of Poconé, Mato Grosso state (MT), Brazil (Figure 1a). The original vegetation is typical of local wetlands and dominated by *Thalia geniculata* (Marantaceae; Nunes da Cunha and Junk 2011).

Due to the ongoing wildfires in the region, the environmental temperature was high and the peaty soil was still scorching or burning underground (Figure 1b). During transect surveying, we found burrows in the ground with signs of recent use. After documenting the burrows, we carefully removed the top layer of soil with a machete. We measured only those burrows that were occupied by rodents. We then described the inner structure of each burrow and took measurements with a measuring tape (to the nearest 1.0 cm). Specimens were collected and preserved in ethanol and skulls were cleaned with dermestid beetles for taxonomic identification and further incorporated in the Coleção de Mamíferos da Universidade Federal de Mato Grosso (UFMT), Cuiabá, MT, Brazil. The collection permit was provided by the Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio), Brazil (permit number 76244–1). Handling and collection procedures followed the guidelines of the American Society of Mammalogists (Sikes *et al.* 2016).

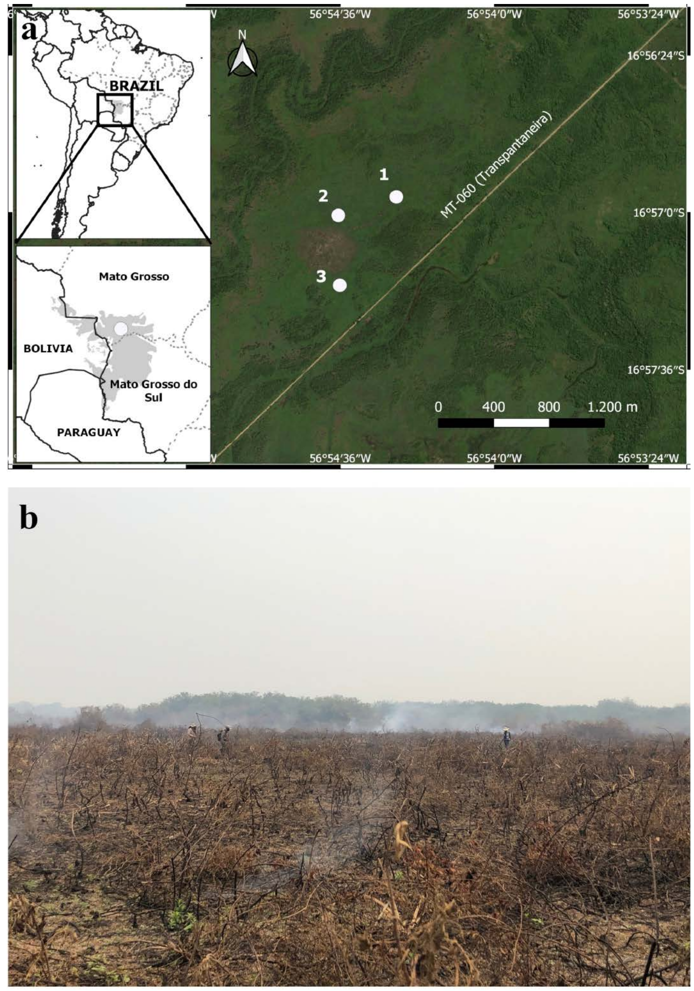

Figure 1. a) Map of the sampled area in the Pantanal, where the burrows of *Holochilus chacarius* were located in a seasonally flooded area. b) Sampled area where burrows of *H. chacarius* were recorded during a wildfire in the Brazilian Pantanal. Note in the background the researcher conducting transects and smoke from the active fire. Photo by M. Ardevino.

Three of the burrows examined were occupied each by a single individual of *H. chacarius*. Two of the 3 individuals were collected as vouchers (UFMT 4897-98). One female was pregnant (Figure 2); there were neither nestlings nor juveniles. All examined burrows had similar characteristics (Figure 3). The burrows were characterized externally by a hole in the ground with a round entrance, closed with a ball-like piece of loosely woven dry grass and litter, forming a stopper (Figure 3c, d). No soil monticule was present outside. The hole led to an oblique underground tunnel, with trampled shredded litter covering its surface (Figure 3a). The tunnel ended in a relatively wider vertical inner chamber, where the rodents were found. Each *H. chacarius* individual was partially submerged in the water (Figure 3b). A

Figure 2. Skull of *Holochilus chacarius* UFMT 4897, female, with a close view of its superior molar series. The white bars represent 1 mm scale of skull (upper left and bottom) and teeth (upper right).

callichthyid catfish (*Hoplosternum* sp.) and a trichodactylid crab (*Dilocarcinus pagei*) were found alive inside one of the flooded chambers, together with *H. chacarius*. A summary description of the burrows, including additional pictures (*e.g.*, entrance after cleaning; ball-like structure made of grass), are provided in Figure 3 and Table 1.

The use of nests, burrows, and galleries is widespread and well documented in rodents (Lacey *et al.* 2000; Begall *et al.* 2007; Wilson *et al.* 2016, 2017), including several genera of the subfamily Sigmodontinae (Formoso and Sánchez 2014; Patton *et al.* 2015; Bovendorp *et al.* 2017). *Holochilus* nests are usually above ground or water, from ground level up to 3 m high, and made with partially shredded grass or litter (Burmeister 1879; Moojen 1943; Yepes 1941; Llanos 1944; Moojen 1952; Twigg 1965; Barlow 1969; Massoia 1971, 1976; Barreto and García-Rangel 2005; Sauthier *et al.* 2010; Gonçalves *et al.* 2015).

Exceptionally, Massoia (1971) reported nests of *H. chacarius* found inside subterranean galleries, in Formosa province, Argentina. The galleries included up to 3 entrances and were used by several individuals (Massoia 1971). In contrast, the underground structures we found were hole-like with a single entrance, partially flooded, and only 1 individual was present per burrow. Although we found no clear evidence that burrows could be nesting places of *H. chacarius*, it is plausible, as one of the *H. chacarius* individuals was pregnant. Additionally, the woven grass rolls at the entrances (Figure 3c-d) could be used as nesting material.

Although the similarities among the burrows suggest the same species constructed them, the fact that we found both a crab and rodent cohabiting a hole, introduces a degree of uncertainty about which species initially dug the burrow. Literature data on nests among roots and aerial parts of plants imply that *Holochilus* is capable of digging and climbing, besides cursorial and natatorial locomotion (Tulli *et al.* 2016), but fossorial behavior has not been observed in the genus. However, Massoia (1971) considers *H. chacarius* had constructed the subterranean galleries reported in his study.

Anatomical features in the forelimbs of semiaquatic and fossorial sigmodontines were hypothesized as convergent traits associated with overcoming water and soil resistance (Tulli *et al.* 2016; Coutinho and Oliveira 2017). However, most of the propulsion efforts during swimming in *Holochilus* are generated by hindlimb pedaling (Torres *et al.* 2020), weakening this supposition. Thus, considering that the fossorial behavior of *Holochilus* has not been demonstrated, we refrain from asserting that the rodents constructed the burrows by themselves.

It is known that crabs construct small holes and that other animals use these as refugia from drought in Pantanal (Simioni *et al.* 2014). Therefore, it is possible that *H. chacarius* enlarged and maintained preexisting crab burrows. Both rodent and crab could have been using the burrows primarily as a refuge from the drought or other disturbances, and the protection against fire was a secondary benefit. This can also be the case for the catfish *Hoplosternum*, which can breathe air through gulping, travel small distances in land, and survive under hypoxic conditions (Nico *et al.* 1996; Jucá-Chagas 2004). Consequently, we consider the possibility that small

Table 1. . Descriptive characteristics of three burrows occupied by *Holochilus chacarius* in a Pantanal area that was hit by a wildfire, in Poconé, Mato Grosso, Brazil. All measures are in cm.

	Burrow 1	Burrow 2	Burrow 3
H. chacarius individuals	not collected (unknown sex and age)	UFMT 4897 (adult pregnant female)	UFMT 4898 (sub-adult male)
Tunnel length	–	30	28
Inner vertical chamber diameter	–	9	–
Inner vertical chamber height	–	52	58
Depth of water column	–	29	17
Observation	–	fish and crab also present (see text)	–
Coordinates	16° 56′ 57″ S, 56° 54′ 24″ W	16° 57′ 01″ S, 56° 54′ 36″ W	16° 57′ 17″ S, 56° 54′ 36″ W

burrowing animals, such as crabs or even rodents, could be micro-scale ecosystem engineers in the Pantanal (*i.e.*, species that modify the environment and can create suitable habitat for other species; Jones *et al.* 1994; Desbiez and Kluyber 2013).

Nevertheless, we interpret some signs at the burrows as indicatives of routine use by *H. chacarius*, such as the trampled vegetal pieces over the tunnel surface; the tunnel diameter, which was much larger than would be expected if crabs or fishes made the tunnel; the well excavated inner chamber several times larger than that reported for crab holes in Pantanal (Simioni *et al.* 2014); and the woven grass rolls which took some hours to be constructed (for observations in captivity, see Massoia 1971), blocking the entrances. Thus, regardless of which species firstly dug the holes, *H. chacarius* was certainly using the burrows, possibly as shelters from external factors before the wildfires.

Environmental factors affecting the survival of the fauna during wildfires are many and have complex interrelationships, but it seems that burrows and other cavities may serve as immediate protection (Engstrom 2010; Bova *et al.* 2011; Robinson *et al.* 2013; van Mantgem *et al.* 2015). The temperature and humidity inside burrows used by rodents are more stable compared to external conditions, although oxygen levels are influenced by soil type and water saturation (see Burda *et al.* 2007). As wildfires are relatively frequent in the Pantanal, the ability to seek refuge underground may benefit small mammals including *H. chacarius*, as observed in other taxa (Simioni *et al.* 2014). Some authors have shown that surviving individuals *in situ* may contribute to local population recovery, as well as those that immigrated from unaffected areas (Banks *et al.* 2017; Hale *et al.* 2021).

Massive wildfires (also called mega-fires) are a serious threat to mammals (Garcia *et al.* 2021; Pacheco *et al.* 2021). It has been estimated that wildfires, which burned around 2 million ha, directly killed more than 5.9 million mammals in Bolivia's Chiquitano dry forests in 2019, of which more than 60 % (> 3.6 million) were rodents (Pacheco *et al.* 2021). Recent studies showed that the 2020 extensive wildfires in the Brazilian Pantanal also had a severe impact, as the estimated burned area surpassed 4.5 million ha (Libonati *et al.* 2021), a land extension comparable to countries including Bhutan, Switzerland, Estonia, or Denmark. Also *ca.* 4.4 - 5.0 million mammals had died directly by these wildfires, *ca.* 3.6 - 3.8 were rodents (Tomas *et al.* 2021).

Factors that directly affect the small mammal populations after a wildfire strike, like food deprivation and increased predation (Sutherland and Dickman 1999; Conner *et al.* 2011; Leahy *et al.* 2015), would be aggravated after mega-fires, when resources and vegetation cover are less available. Thus, environmental traits could be key to enhance survivorship. The water-saturated holes may have helped to maintain the chamber with individuals of *H. chacarius* and other animals isolated from the fire and the heat, serving also as a hydration source in such hazardous conditions, a potentially rare resource in the dry season, especially during severe droughts (Marengo *et al.* 2021). Thus, by surviving locally, individuals would be able to improve population recovery, as reported for other species (Banks *et al.* 2017; Hale *et al.* 2021).

This contribution corroborates a single report of the use of underground structures by *H. chacarius* made half a century ago by Massoia (1971). We also add new data on the biology of this rodent, particularly regarding survivorship during wildfires in the threatened Pantanal wetland. Some questions remain unanswered, which could be subject of interest in future research: a) whether the burrows function as reproductive and / or nesting places; b) whether the use of burrows represents an adaptation to survive wildfires and drought; c) what the role of the surviving individuals in post-fire recovery of the population could be; and d) if *Holochilus* and / or trichodactylid crabs could be considered ecosystem engineers on a micro scale in the Pantanal, once the original constructor of the burrows and their occupancy processes are elucidated. We suggest that long-term monitoring of survivors and the population using genetic data, as well as other sampling techniques (*e.g.*, camera traps; borescope), will be fundamental in further studies concerning the relationship between the biology of *H. chacarius* and its relation to environmental disturbances, such as drought, wildfires and extreme temperatures.

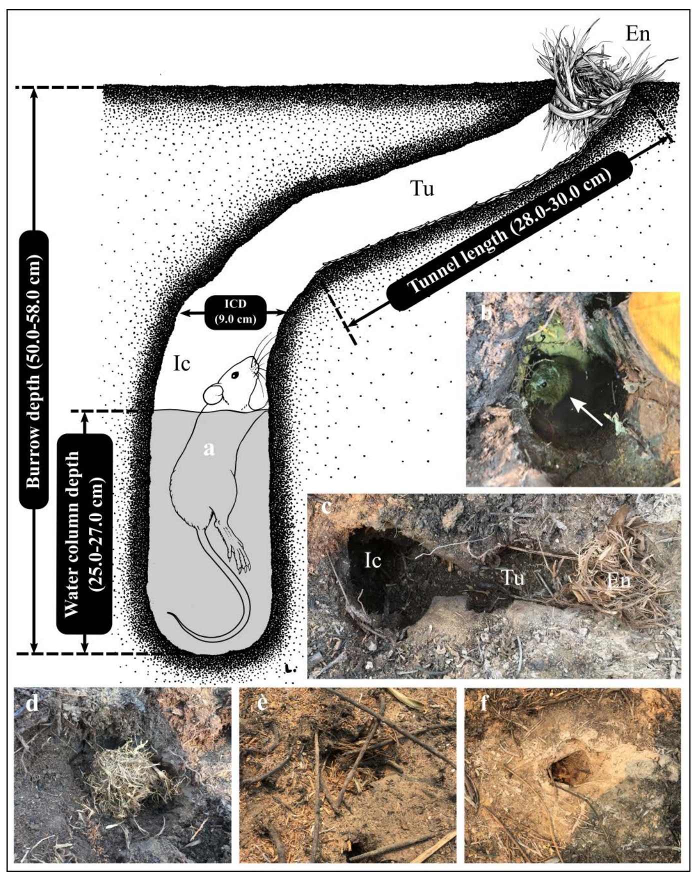

Figure 3. Schematic representation of the burrows where individuals of *Holochilus chacarius* were found in a recently burned area in the Pantanal (a). An individual is shown inside the inner chamber (b, white arrow) and top view (c) showing its inner structure: the entrance with the ball-like stopper (En); oblique tunnel (Tu); and flooded inner chamber (Ic), also note the inner chamber diameter (ICD); d) ball-like structure made of grass found in the entrance of burrows; e) an entrance with the ball-like stopper and f) entrance of the burrow after cleaning. Illustration by G. S. Libardi and photos by M. Ardevino.

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New records of *Leopardus guigna tigrillo* and *Lycalopex culpaeus* in Placilla de Peñuelas, Chile and threats to their conservation

Nuevos registros de *Leopardus guigna tigrillo* y *Lycalopex culpaeus* en Placilla de Peñuelas, Chile y amenazas a su conservación

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The kodkod (*Leopardus guigna*) is considered vulnerable by the International Union for Conservation of Nature. On the other hand, although the Andean fox (*Lycalopex culpaeus*) is considered as least concern in Chile, the protected areas it inhabits are not enough to maintain viable populations. Here, we contribute to the knowledge of the Chilean fauna and identify threats to its conservation through camera traps. Three camera traps were placed in the study area, which remained active for 2 months. Whenever activated, cameras recorded time / temperature and 30 s videos. The presence of the kodkod, subspecies tigrillo (*L. g. tigrillo*) was recorded in the study area through photographs and videos. Additionally, the presence of Andean fox (*L. culpaeus*) and evidence of anthropogenic activities were recorded. We highlight the presence of *L. g. tigrillo*, an endemic species recorded for first time in the study area, and that of *L. culpaeus*. We detected anthropogenic activities (illegal logging, cattle grazing, motocross) that may represent a threat to the survival of these carnivores. We propose specific conservation actions to protect these species and their habitat.

Key words: Camera trap; carnivore; conservation; record.

El gato güiña (*Leopardus guigna*) es considerado vulnerable por la Unión Internacional para la Conservación de la Naturaleza. Por otro lado, aunque el zorro culpeo (*Lycalopex culpaeus*) se considera especie de menor preocupación en Chile, las áreas protegidas donde se encuentra no son suficientes para mantener poblaciones viables. En este estudio, contribuimos al conocimiento de la fauna de Chile e identificamos amenazas a su conservación mediante fototrampeo. Se colocaron 3 cámaras trampa en la zona de estudio, éstas permanecieron activas durante 2 meses. Las cámaras tomaron fotografías y videos de 30 s, registrando hora y temperatura. Se registró la presencia del gato güiña, subespecie tigrillo (*L. g. tigrillo*) en la zona de estudio mediante fotografías y videos. Adicionalmente, se registró la presencia de zorro culpeo (*L. culpaeus*) y evidencia de actividades antropogénicas. Se destaca la presencia de *L. g. tigrillo*, una especie endémica que se registra por primera vez en la zona de estudio y la de *L. culpaeus*. Se detectaron actividades antropogénicas (tala ilegal, pastoreo de ganado, motociclismo) que pueden representar una amenaza a la supervivencia de estos carnívoros por lo que proponemos acciones de conservación específicas para proteger a estas especies y su hábitat.

Palabras clave: Cámaras trampa; carnívoro; conservación; registro.

The kodkod, *Leopardus guigna* Molina 1782, has an average weight of 1.4 to 2 kg (Iriarte *et al.* 2013) and is the smallest wild cat in the Americas (Nowell and Jackson 1996). It is one of the felids with the most restricted distribution in the world, it is distributed in south central Chile and Argentina (Nowell and Jackson 1996). There are two subspecies: *L. guigna tigrillo*, an endemic subspecies of Chile that is distributed between the Coquimbo and Biobío regions, and *L. guigna guigna* distributed from the Araucanía Region to Aysén and Argentina (Napolitano *et al.* 2013). In central Chile, the presence of this species has been confirmed by few records on the coastal edge of the Coquimbo and Valparaíso regions (Acuña 2019; Quiroz *et al.* 2019; Napolitano *et al.* 2014; Napolitano *et al.* 2020). This feline is found from sea level up to 2,500 m (Nowell and Jackson 1996), inhabiting sclerophyll forests, Mediterranean scrub, Valdivian and Patagonian temperate forest and near watercourses, where areas of dense vegetation act as a corridor for their dispersal (Sanderson *et al.* 2002).

Currently, *L. guigna* is listed as a vulnerable species internationally, due to its restricted distribution and ecological requirements that make it especially fragile in the face of growing habitat loss and fragmentation; this is attributed to causes such as the increase in the human population and deforestation in the humid temperate forest of Chile (Napolitano *et al.* 2015). The same category is valid for Argentina (Monteverde *et al.* 2019) and part of Chile, from the Coquimbo region to the Los Ríos region. On the other hand, from the Los Lagos region to the Aysén region, it is cataloged as near threatened by the Chilean Ministry of Environment (Ministerio del Medio Ambiente; MMA 2011). Because of this, obtaining up to date information on the ecology and distribution of this species is important for a correct risk categorization of the species in its restricted distribution. Additionally, *L. guigna* may contribute to rodent control, due to its diet composed mainly of small mammals (Dunstone *et al.* 2002; Sanderson *et al.* 2002; Correa and Roa 2005; Figueroa *et al.* 2018), such as the long-tailed pygmy rice rat (*Oligoryzomys longicaudatus*), which is an important reservoir host of pathogens causing the deadly Hantavirus Pulmonary Syndrome (Gálvez and Hernández 2009).

On the other hand, the culpeo or Andean fox, *Lycalopex culpaeus* (Molina 1782), is the largest canid found in Chile (MMA 2011). The species is distributed throughout the Andes mountain range, from Colombia in the north to Tierra del Fuego in the south (Jiménez and Novaro 2004). Throughout its range, it makes use of diverse habitats such as mountainous terrain, deep valleys and open deserts, scrub-covered pampas, sclerophyll scrub, and beech forest. In the Andes of Perú, Chile, Bolivia and Argentina, it reaches elevations of up to 4,800 m. Currently, it is listed as a species of least concern by the International Union for Conservation of Nature (IUCN), since its populations are considered stable throughout its distribution; nevertheless, in Chile, only 14 % of the protected areas where it is found are large enough to maintain viable populations of the species (Lucherini 2016). Despite of this, the Chilean Ministry of the Environment does not include the Andean fox in any risk category.

Given that both species coincide in certain habitats (*e.g.*, sclerophyll scrub) and conservation actions aimed at managing and protecting their distribution areas are recommended (Napolitano *et al.* 2015; Lucherini 2016), obtaining new records of these species can contribute to better planning and optimization of protected areas. In the present study, we aimed to contribute to the knowledge of the faunal richness of Chile, by carrying out a preliminary sampling of wild carnivores in the locality of Placilla de Peñuelas, commune of Valparaíso, Valparaíso Region, in central Chile.

The study area is located in the locality of Placilla de Peñuelas, 2 km west of the Lago Peñuelas National Reserve and south of the La Luz reservoir (33° 8′ 56.92″ S, 71° 34′ 37.52″ W; Figure 1). It is located in a ravine with coastal Mediterranean sclerophyllous vegetation and has an area of 11 ha, surrounded by plantations of introduced tree species (*Pinus radiata* and *Eucalyptus globulus*). In the area there are seeps of groundwater and evidence of illegal logging given the presence of tree stumps. It should be noted that the study area is classified by the Valparaíso communal regulatory plan (Ilustre Municipalidad de Valparaíso 2002) as a residential and habitat protection area.

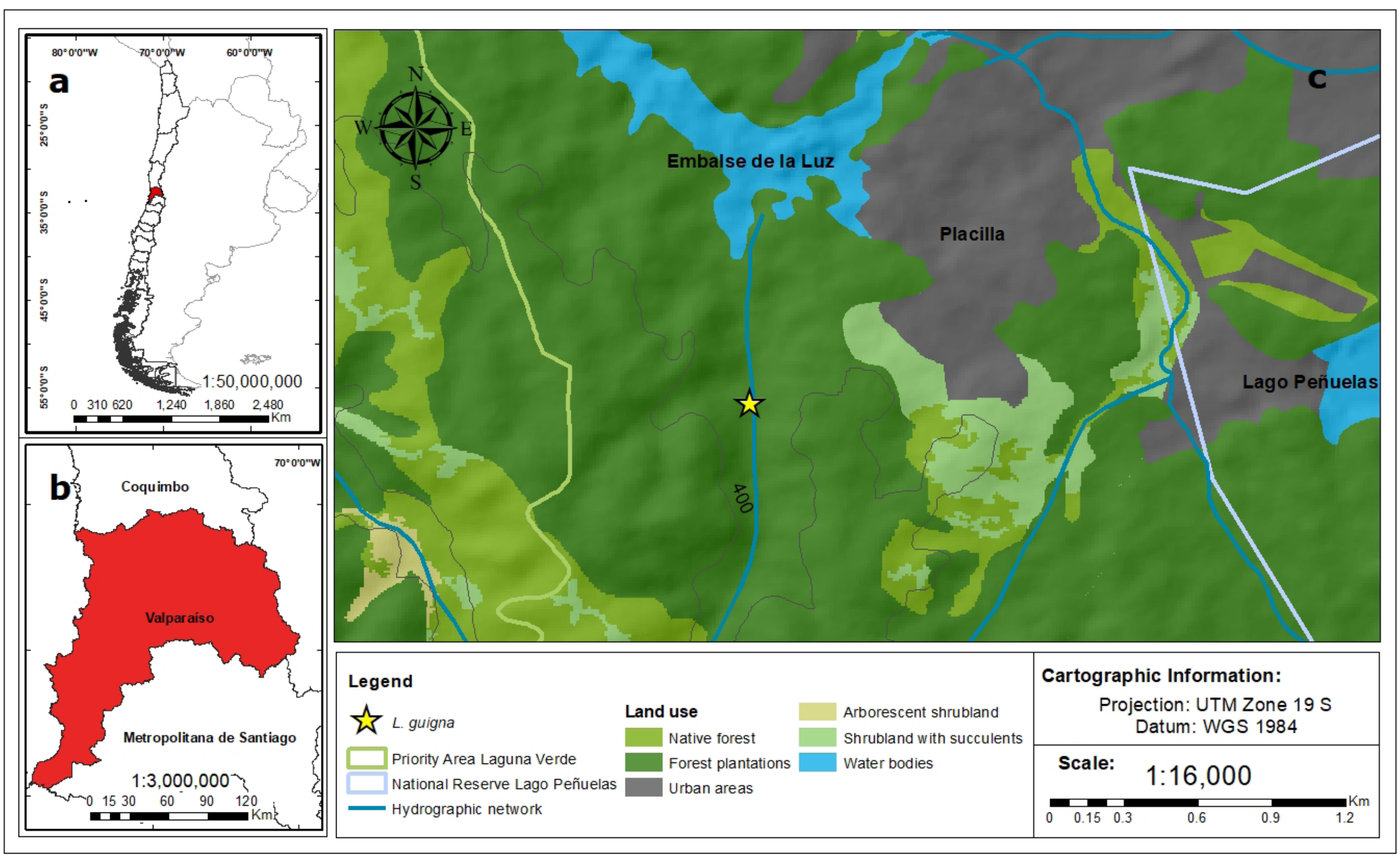

Figure 1. Location of the study area within the locality of Placilla de Peñuelas, Chile. a) Location at the national level indicated in red; b) record of *Leopardus guigna tigrillo* in the study area (Valparaíso); c) topographical characteristics around the study area.

We have monitored this area since 2016; however, it was at the end of July 2019 that we began using camera traps. Specifically, 3 camera traps were installed: a Bushnell (model Trophy Cam HD Aggressor) and 2 cameras HC801A model. To install the cameras, easily accessible sites were chosen where native vegetation did not interfere with visibility. The cameras were fixed on trees (50 cm from the ground), with a separation of 300 m between them, and were configured in hybrid mode to take 3 photos and 1 video of 30 s for each detection, with an interval of 1 s between detection events (with medium sensor sensitivity). Additionally, temperature logging was configured for detection events. The cameras remained active until the end of September 2019 (2 months in total), when the forest fire season began and they were removed from the field. During 2020 no cameras were set.

The first signs of the presence of the kodkod (*L. g. tigrillo*) were obtained on July 31, 2019 at 22:59 hr (33° 8′ 56.90″ S, 71° 34′ 37.49″ W). Subsequently, the camera traps recorded 15 photographs and 3 videos on August 4, 7 and 9, as well as on September 5 and 6 of the same year. Most of the records were at night (20:00 – 3:30 hr and there was only one at 13:37 hr), when relatively low temperatures were recorded (5 - 13 °C; Figure 2).

Another carnivore recorded by the camera traps was the Andean fox (*L. culpaeus*). Specifically, 4 photographs were obtained in 2019. In this case, we did not observe consistent patterns in terms of hours of greatest activity since both daytime and nighttime records were obtained and the recorded temperatures ranged between 10 - 32 °C. The records were made at elevations of up to 1,200 m, which confirms they were of Andean fox (*L. culpaeus*) and not of South American gray fox (*Lycalopex griseus*) since the South American gray foxes found mostly at altitudes below 500 m (Fuentes and Jaksic 19792). Finally, the camera traps also recorded the presence of cattle (*Bos taurus*) in the area.

Sampling with the photo-trapping method confirmed the presence of *L. g. tigrillo* in the town of Placilla de Peñuelas, commune of Valparaíso, this being the first record in the locality, corresponding to the endemic subspecies *L. g. tigrillo* given its distribution (Napolitano *et al.* 2013). Recently, Napolitano *et al.* (2020) extended the known distribution range of *L. g. tigrillo* to the Coquimbo Region and obtained new records for the Valparaíso Region, where the closest to our observations was obtained in the Puquén Biopark (100 km away in a straight line, eastbound). There have also been sightings in the commune of Olmue (~50 km east of Placilla de Peñuelas; Beltrami *et al.* 2015) and

Figure 2. a-b) Photographic records of the kodkod, *Leopardus guigna*; c-d) Andean fox, *Lycalopex culpaeus*, in Placilla de Peñuelas, Chile.

in the localities of San Antonio (~50 km to the south) and Viña del Mar (~15 km to the north; Acuña 2019). This last record would be the closest to those obtained in the present study. However, there is a highway (Route 68) that separates our study area from Viña del Mar and even from the Lago Peñuelas National Reserve, which could serve as a biological corridor between populations of kodkods in the communes of Valparaíso and Viña del Mar. In this regard, there is an urgent need to install wildlife crossings on Route 68 in order to maintain connectivity between kodkod habitat fragments and sympatric species.

Most of the kodkod records occurred at night, or when low temperatures were recorded, which coincides with previous observations (Delibes-Mateos *et al.* 2014). In the case of the Andean fox, the records were less restricted in terms of time and temperature and photographs were obtained up to 1,200 m. Although both species coincide (partially) in terms of hours of activity and were found in the same area, it is unlikely that competitive interactions will occur given that they have different habits. The Andean fox is strictly terrestrial, while the kodkod is partially arboreal. In a recent study, it was observed that coexistence between these carnivores was possible precisely due to ecological differences between both (Zúñiga *et al.* 2017).

We put forward forest fires as important threats to the habitat of these species, highlighting those of October and November 2019 that devastated more than 200 hectares in the Valparaíso Region (El Observador 2019), as well as the growing expansion of the real estate industry in the area, causing loss and fragmentation of the forest in Placilla de Peñuelas. In addition, during 2021 our cameras detected the presence of illegal logging and cross-country motorcycling in the study area. These activities, together with cattle grazing (detected by camera traps in 2019) could represent a threat to native fauna since they could modify the natural habitat and/or cause stress to wildlife. This could ultimately result in wildlife migrating to other areas.

It is suggested to establish a monitoring study in the locality and its surroundings in order to estimate the size of the local populations of kodkod and Andean fox, identify key sites for their conservation, and define the greatest threats to these species so we can start working on their mitigation. On the other hand, increasing photo-trapping effort could reveal the presence of other species in the area, thus strengthening the case for its protection. In addition to this, we propose to hold environmental education workshops in Placilla de Peñuelas, so that citizens value the biodiversity present in their environment and get involved in its conservation.

In conclusion, our study provides evidence of the presence of two carnivores with different conservation status, recorded for the first time in the locality of Placilla de Peñuelas. Given that we detected anthropogenic activities that could endanger the survival of these species, it will be necessary to continue monitoring the area and develop new avenues of research that can support the conservation of native fauna.

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New records of the kodkod (*Leopardus guigna tigrillo*) and the Pampas cat (*Leopardus colocola*) in Valparaíso region, Chile

Nuevos registros de la güiña (*Leopardus guigna tigrillo*) y el gato colocolo (*Leopardus colocola*) en la región de Valparaíso, Chile

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The kodkod, *Leopardus guigna tigrillo* and the Pampas cat, *Leopardus colocola* are two of the most elusive and cryptic species of wild cats in the Neotropical region. The few existing studies for both species suggested that their distribution is restricted almost entirely to large areas of native forest. Both species are classified within some category of extinction risk. As part of the citizen science projects, new records were obtained from the kodkod and the pampas cat in the central zone of Chile. In addition, to corroborate these records, previous records of both species were consulted in the available literature and databases. The site where the kodkod was sighted is an urban and beach area, with small strips of scrub, secondary native forest and forest plantations. The records of the Pampas cat were presented on roads, putting his integrity at risk. The records of both species were presented in sites with threats, where it is possible that due to the fragmentation of their habitats, they are forced to move to look for food resources where they did not before. Likewise, we highlight the importance of the vegetation fragments as biological corridors for these and other species that require large areas of continuous habitat, which is why it is necessary to prioritize the conservation of these sites in the region. It is essential to carry out more research in the region to know both species threats and population density.

Key words: Activity; Felidae; habitat quality; human landscape perturbation.

La güiña, *Leopardus guigna tigrillo* y el gato colocolo, *Leopardus colocola* son dos de las especies de felinos silvestres más escurridizas y crípticas de la región Neotropical. Los pocos estudios existentes para ambas especies sugieren que su distribución está restringida casi en su totalidad a grandes extensiones de bosque nativo. A ambas especies se les cataloga dentro de alguna categoría de riesgo de extinción. Como parte de los proyectos de ciencia ciudadana se obtuvieron nuevos registros de la güiña y del gato colocolo en la zona central de Chile. Además, para corroborar estos reportes se consultaron los registros previos de ambas especies en la literatura disponible y bases de datos. El sitio donde fue avistada la güiña es una zona urbana y de playa, con pequeñas franjas de matorral, bosque nativo secundario y plantaciones forestales. Los registros del gato colocolo se presentaron en carreteras, poniendo en riesgo su integridad. Los registros de ambas especies se presentaron en sitios con ciertas amenazas, en donde es posible que debido a la fragmentación de sus hábitats se vean obligados a desplazarse a buscar recursos alimenticios en donde antes no lo hacían. Asimismo, resaltamos la importancia de los fragmentos de vegetación como corredores biológicos para estas y otras especies en la región, que requieren de grandes áreas de hábitat continuo, por lo que es necesario priorizar la conservación de estos sitios en la región. Es indispensable realizar más investigaciones en la región con el fin de conocer las amenazas y la densidad poblacional de ambas especies.

Palabras clave: Actividad; calidad de hábitat; Felidae; perturbación del paisaje.

In Chile there are two genera of wild felids, distributed throughout the national territory (Iriarte *et al.* 2013). The genus *Leopardus* is the most diversified and includes 4 species (*L. colocola*, *L. geoffroyi*, *L. jacobita* and *L. guigna*; Johnson *et al.* 2005; Iriarte 2008). The kodkod *L. guigna* (Molina 1782) and the Pampas cat *L. colocola* (Molina 1782) are among the least know felids in South America.

The kodkod has the smallest distribution of all South American wild cats, restricted to central and southern Chile and marginally in adjacent border areas of south-west Argentina, from sea level up to 2,500 m (Lucherini *et al.* 2000; Sanderson *et al.* 2002; Napolitano *et al.* 2014). Two subspecies are recognized based on morphological and genetic data, *L. guigna tigrillo*, endemic to Chile, and *L. guigna guigna* (Napolitano *et al.* 2012). The Pampas cat has a wide geographical distribution in South America, ranging from Ecuador to the Argentinean Patagonia and from east to west from Brazil to Chile, from sea level up to 1,800 m (Nowell and Jackson 1996). Its taxonomy has been subject to conflicting classifications over the years. It has recently been proposed that *L. colocola* comprise 5 distinct species (Do Nascimento *et al.* 2020), which would place the records documented here as belonging to the species *L. colocola*, whose distribution covers central Chile, particularly in the western slope of the Andes. This classification has also been recognized in the updated list of living mammals of Chile (D'Elía *et al.* 2020).

Like most small cats, the kodkod and the Pampas cat are naturally cryptic species, rare and live in places where detection and tracking are difficult (Macdonald *et al.* 2010). The kodkod are closely associated with native Mediterranean forests and temperate rainforests, vegetation cover being a key ecological requirement for the species (Schüttler *et al.* 2017). The few studies published on the kodkod have suggested that the species is almost exclusively restricted to native *Nothofagus* forest (Acosta-Jamett and Simonetti 2004) and that it has been negatively affected by conversion of this forest to exotic pine plantations (Acosta-Jamett *et al.* 2003; Acosta-Jamett and Simonetti 2004). Regarding the Pampas cat, their preferred environment is open grassland and humid forest, but they are equally comfortable in the mountainous Andes (García-Perea 1994; Parera 2002; Iriarte 2008).

Currently, the kodkod is categorized as vulnerable by the International Union for Conservation of Nature (IUCN), due to its restricted distribution and ecological requirements that make it especially fragile in the face of growing habitat loss and fragmentation (Napolitano *et al*. 2015). On the other hand, the Pampas cat is considered near threatened as habitat conversion and destruction may cause the population to decline in the future (Lucherini *et al.* 2016).

Here, we present the first confirmed records of the Pampas cat and the second of the kodkod in the Puchuncaví commune, in the region of Valparaiso, Chile, which increases knowledge of their presence and distribution in the country.

As part of the citizen science projects "Yo cuido al gato güiña" and "Proyecto *Leopardus colocola*", we report a new record of the kodkod (*L. guigna tigrillo*) and two of the Pampas cat (*L. colocola*) in the Puchuncaví commune, Valparaíso province, Chile. The records were sent to the Foundation email address by citizens interested in sharing their records through both projects. In addition, to corroborate previous records of both species in the region, we consulted the available published literature and databases of the Global Biodiversity Information Facility (https://www.gbif.org), corresponding to available records dating from 1922 - 2021 (Figure 1). It is important to point out that the Valparaíso region is characterized by ecosystems that maintain a high level of biodiversity and endemism, which has led the region to be classified as a biodiversity hotspot (Arroyo *et al.* 1999; Myers *et al.* 2000).

The record of the kodkod was obtained on August 30, 2019 at 14:23 hr (32° 39′ 26.96″ S, 71° 26′ 36.01″ W). The felid was recorded by a local citizen while walking on the rocks on the beach, which when he realized that he was recorded did not show any reaction, slowly entering between the rocks.

The kodkod was identified based on the common morphological characteristics of the species: the coat is buff or gray-brown coat and is heavily marked with rounded, blackish spots on both the upper and lower parts, the tail has blackish rings (Nowak 1999; Figure 2A). The vegetation

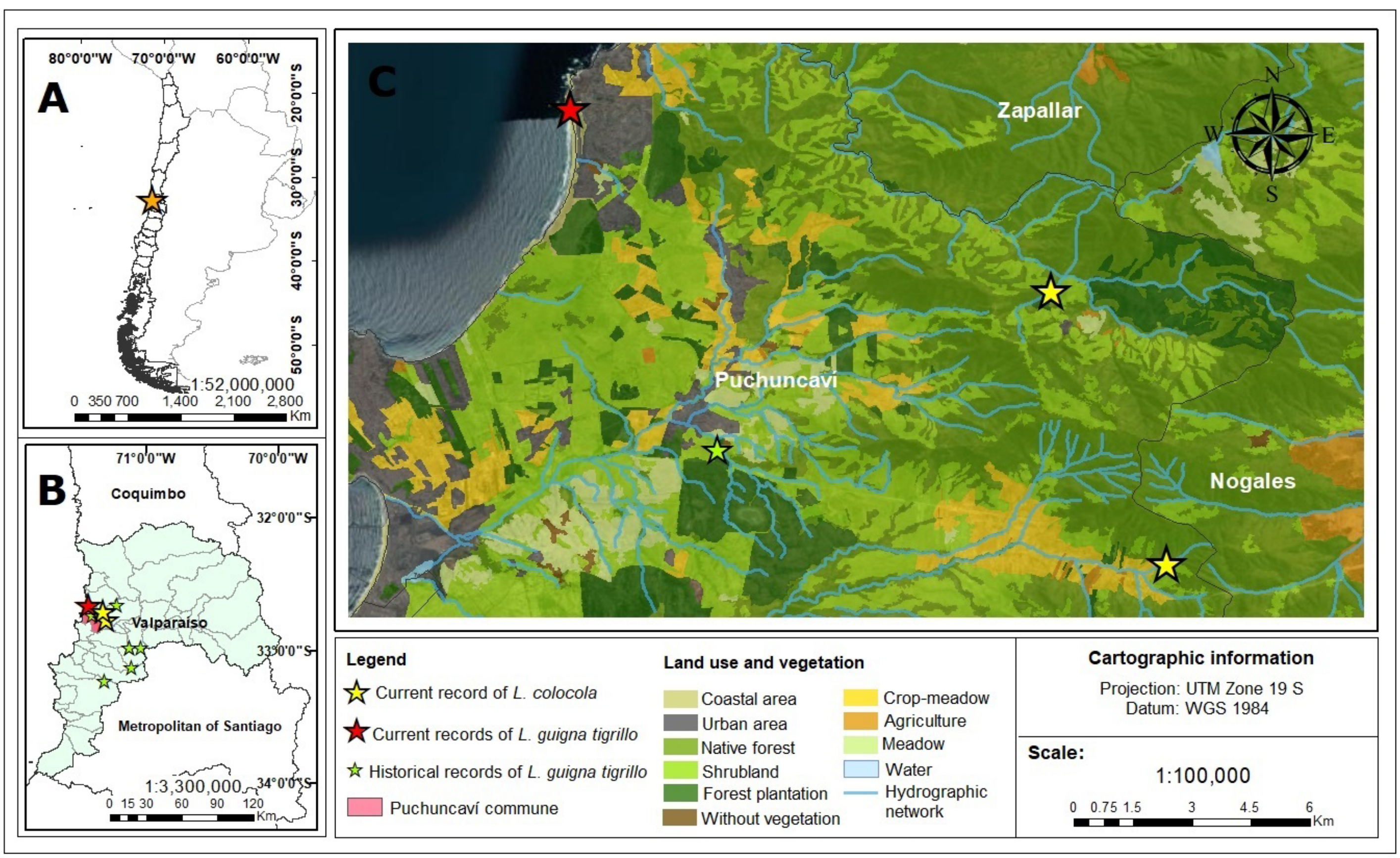

Figure 1. Geographic location of the records of *Leopardus guigna tigrillo* and *Leopardus colocola* in the Puchuncaví commune, Valparaíso region, Chile. A) Central Chile; B) historical records in the Valparaíso region.

of the site corresponds to coastal Mediterranean sclerophyllous forest composed of *Peumus boldus* and *Schinus latifolius*. However, the kodkod was sighted in an urban and beach area, with small strips of shrubland, secondary native forest and forest plantations, with a rocky-sandy substrate (Luebert and Pliscoff 2006).

The first record of the Pampas cat was obtained on August 15, 2019 at 7:45 hr (32° 45′ 41.1″ S, 71° 18′ 25.5″ W) on the F-20 Nogales-Puchuncaví route. The felid was photographed by a citizen who was on his way home with the help of his cell phone (Figure 2B). It should be noted that the felid was found lying by the side of the road and was not injured, although it is presumed that it could have been run over. Subsequently, the Agricultural and Livestock Service (SAG) was notified and went to the site to carry out the rescue; however, we were informed that he died two days later, with no further information on the felid. The surrounding vegetation of the recording site hosts a native forest with endemic species such as the northern tayú (*Archidasyphyllum excelsum*), northern acorn (*Beilschmiedia miersii*) and naranjillo (*Citronella mucronata*; Looser 1950; Armesto and Pickett 1985).

The second record was obtained on August 13, 2021 at 17:20 hr (32° 41′ 56.50″ S, 71° 20′ 0.20″ W). The felid was photographed by a citizen of the town of La Canela with the help of a camera when he was traveling in his vehicle on the F-126 route. The felid was moving along the road (Figure 2C), then moved towards the shore where it remained motionless among the vegetation (Figure 2D). Subsequently, he slowly retreated into the bushes.

The vegetation on the sighting site is open shrub-steppe landscape, associated with sclerophyllous shrubs such as litre (*Lithraea caustica*), molle (*Schinus latifolius*) and quillay (*Quillaja saponaria*; Flores *et al.* 2011). Both felids recorded had the common characteristics of the species: long hairs on the body, an erectile spinal crest slightly darker than ground colour, transverse dark stripes on the throat, markings on the flanks, legs with transverse dark stripes in the proximal portion, ears more pointed and tail relatively shorter than other South American felids (Eisenberg and Redford 1999; Sunquist and Sunquist 2002).

It has been mentioned that both the kodkod and the Pampas cat require an extensive home range, 2.5 - 2.88 km^2 and 11.5 - 55.3 km^2, respectively (Sunquist and Sunquist 2002; Iriarte and Jaksic 2012). In both species, their presence in different habitats has been related. In the case of the kodkod, its preference for native forests over exotic plantations has been demonstrated, indicating that this would be due to its predatory strategies and habitat use (Acosta-Jamett and Simonetti 2004). However, we document the first record of a kodkod on the beach, representing an unusual sighting of this species. It is possible that due to habitat fragmentation pressure, the kodkod is forced to look for food resources where it did not before. For example, in Guatemala, the first record of *Herpailurus*

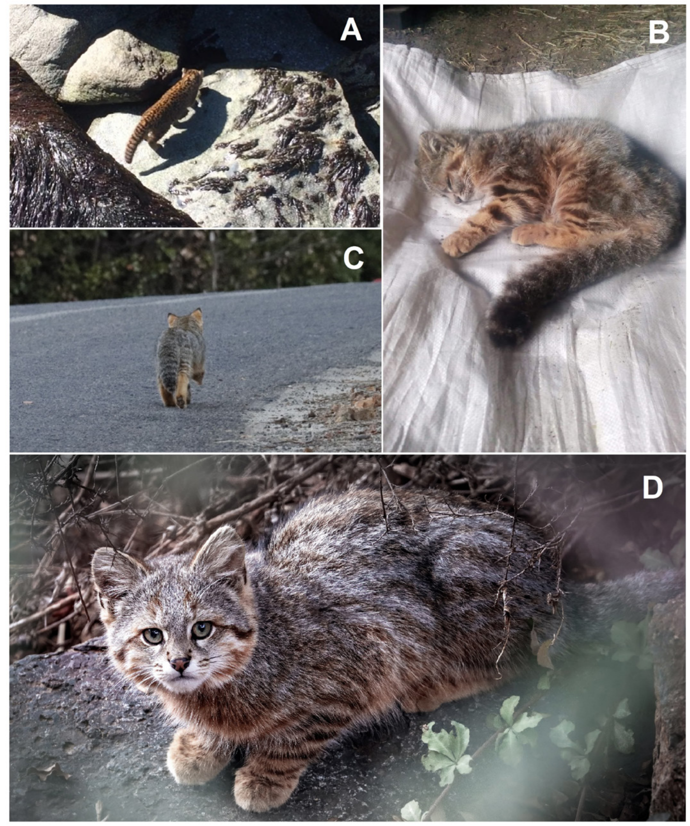

Figure 2. A) Record of the kodkod, *Leopardus guigna tigrillo*, on the southern beach of the town of Maitencillo; B) record of the Pampas cat, *Leopardus colocola*, on route F-20 Nogales-Puchuncaví; C) record of the Pampas cat, *L. colocola* moving along route F-126, north of the town La Canela; D) record of the Pampas cat, *Leopardus colocola* among the vegetation in the town La Canela.

yagouaroundi swimming was documented, attributed to foraging at the site of the record, which is particularly vulnerable due to its high rate of deforestation (Escobar-Anleu *et al.* 2020).

The current record of the kodkod is the second for the Puchuncaví commune, 10.5 km away in a straight line from the first record, which was obtained through camera-traps in Fundo El Pangue in 2017 (Quiroz *et al*. 2019; Figure 1). Regional findings of the kodkod are scarce, in addition, it presents empty areas in the north of its distribution (Acosta-Jammet *et al.* 2003), where it has been reported to inhabit isolated patches of vegetation (Quiroz *et al*. 2019), although it is not uncommon to observe it in meadows and near human settlements (Silva-Rodríguez *et al.* 2007), such as the present record.

The Pampas cat's presence has been documented in different habitats, such as forest plantations, vineyards, hydrophilic and deciduous forest, coastal desert and Andean steppe (Castro-Pastene *et al.* 2021). The present records are the first for the Puchuncaví commune, 17 km away in a straight line from the nearest record, obtained in 2020 by camera-trap on land belonging to the Pontificia Universidad Católica de Valparaíso, La Palma sector, Quillota commune (PUCV 2020).

It is worth noting that we reported an injured Pampas cat on the side of the road and another moving on the road, a situation that has led to the trampling of this and other species on the roads of Chile and that has been reported in various electronic media, where the most shared species and with the highest number of comments are the Pampas cat and the kodkod (Araya *et al.* 2021). In addition to habitat loss and degradation, there are a series of threats that affect the kodkod and the Pampas cat at the records sites, such as the introduction of domestic species, which can be reservoirs of vectors or disease-causing agents, as well as competition and attacks on both felids (Silva-Rodríguez *et al.* 2007; Napolitano *et al.* 2020). Likewise, both species are considered harmful for some people because they sometimes feed on poultry, which causes people to reject these felids (Sanderson *et al.* 2002; Espinosa *et al.* 2014).

However, it has also been mentioned that both species can adapt to fragmented landscapes dominated by humans, using small forest fragments and vegetation corridors within the agricultural matrix to move through the landscape (Gálvez *et al.* 2013). More information is needed to understand whether the records of both felids in disturbed areas are associated with movements between patches of native vegetation or regular use.

In conclusion, it is essential to have updated information on these species distribution to develop a conservation plan. It is also essential to carry out more research in the region in order to know the threats and their population density, so that they can form the basis for implementing monitoring and conservation strategies.

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Phoretic relationship between rodents and pseudoscorpions (Arachnida) in Chiapas, México

Relación forética entre roedores y pseudoescorpiones (Arachnida) en Chiapas, México

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Phoresy is defined as a non-parasitic association between an animal of small body size (phoront) and a large one (dispersal host), where the larger individual transports the smaller one. Rodents are frequently reported as dispersal hosts, of which 39 species are phoretic on 21 species of pseudoscorpion. The present note reports the incidental finding of the relationship between rodents and pseudoscorpions in 2 localities in Chiapas, México. Rodents were collected using Sherman live traps in an evergreen tropical forest at Ocuilapa de Juárez, municipality of Ocozocoautla, Chiapas, México. Pseudoscorpions were removed from the rodents using fine-tipped tweezers, stored in vials with 70 % alcohol, and processed for taxonomic identification. Five *Epichernes navarroi* pseudoscorpions were found associated with 2 species of rodents: *Peromyscus mexicanus* and *Heteromys desmarestianus*. Three pseudoscorpions were found with their chelae clamped to the hair near the base of the tail of *P. mexicanus* and 2 attached to the hair of the left hind leg of *H. desmarestianus*. All recorded arachnids were females; 3 had a newly formed brood sac containing 23 to 25 eggs each. There is an active phoretic relationship between *Epichernes* and the genera *Heteromys* and *Peromyscus*, probably due to their overlapping distribution ranges. This association is likely established in the nest of rodents. This work is the first to record the phoretic relationship between *P. mexicanus*, *H. desmarestianus*, and *E. navarroi*; besides, it is the first time that this pseudoscorpion species is reported for Chiapas, thus broadening its known distribution range in southeastern México.

Key words: *Epichernes*; *Heteromys*; new records; *Peromyscus*; phoresy.

La foresia se define como una asociación no parasítica entre un animal de pequeño tamaño corporal (foronte) y uno grande (hospedero dispersor), cuyo objetivo es el transporte del individuo pequeño por el grande. Los roedores han sido frecuentemente reportados como hospederos dispersores, de los cuales 39 especies están foréticamente asociadas a 21 especies de pseudoescorpiones. La presente nota, reporta el hallazgo casual de la relación entre roedores y pseudoescorpiones en 2 localidades en Chiapas, México. Los roedores fueron colectados usando trampas Sherman en selva alta perennifolia de Ocuilapa de Juárez, Municipio de Ocozocoautla en Chiapas, México. Posteriormente, los pseudoescorpiones fueron retirados de los roedores mediante pinzas de punta fina, almacenados en viales con alcohol al 70 % y procesados para su determinación taxonómica. Se encontraron 5 pseudoescorpiones de la especie *Epichernes navarroi*, asociados a 2 especies de roedores: *Peromyscus mexicanus* y *Heteromys desmarestianus*. En *P. mexicanus* se encontraron a 3 pseudoescorpiones sujetándose con sus quelas al pelo cerca de la base de la cola y en *H. desmarestianus* a 2 pseudoescorpiones sujetándose al pelo de la pata trasera izquierda. Todos los arácnidos encontrados fueron hembras, 3 de las cuales presentaban un saco de crianza de reciente formación, cada uno con 23 a 25 huevos. Existe una relación de foresis activa entre los géneros *Heteromys* y *Peromyscus* con *Epichernes*, la cual probablemente se deba al sobrelapamiento de sus distribuciones. Esta asociación posiblemente se establece en el nido del roedor. Se registra por primera vez a *P. mexicanus* y a *H. desmarestianus* asociados foréticamente con *E. navarroi*; asimismo, es la primera vez que se reporta esta especie de pseudoescorpión para Chiapas, por lo que se incrementa su distribución conocida al sureste de México.

Palabras clave: *Epichernes*; foresia; *Heteromys*; nuevos registros; *Peromyscus*.

In nature, species interact through a wide variety of symbiotic relationships, ranging from predation to mutualism (Goater *et al.* 2014). These include a non-permanent relationship known as phoresy or phoresis, defined as the association between a small animal (phoront) and a large one (dispersal host; Farish and Axtell 1971). The purpose of this interaction is the transportation or dispersal of the phoront to reach new habitats, establish new colonies, and reproduce (Vachon 1940; Farish and Axtell 1971). There are two types of phoresy: active, when the phoront clings or attaches to the body of the host through specialized structures such as chelicerae or claws, and passive, when the phoront places itself under or within a structure or cavity of the host (Vachon 1940; Athias-Binche 1994).

The most common dispersal hosts are arthropods, birds, and mammals (Bartlow and Agosta 2021). Among mammals, rodents have frequently been reported as dispersal hosts of mites, fleas, lice, beetles, moths, and pseudoscorpions (Bartlow and Agosta 2021). The order Pseudoscorpiones includes 4,026 species worldwide (WPC 2022); although the majority are free-living, members of the family Chernetidae are phoronts of rodents (Muchmore 1990b; Muchmore 1992; Villegas-Guzmán and Hernández-Betancourt 2006). In this interaction, rodents provide pseudoscorpions with a temporary habitat and a means of dispersal to reach sites with favorable conditions for their survival and reproduction (Farish and Axtell 1971), while the fur of the rodent serves as a thermoregulated environment for these arthropods (Walter and Proctor 2013).

Pseudoscorpions are small arachnids (0.3–12 mm; Villarreal et al. 2019) who, in free life, inhabit different microhabitats in caves, riverbanks, and coastal environments: under rocks, bark, soil, leaf litter, and fallen logs, as well as in nests of birds and social insects and burrows of small mammals (Muchmore 1990a; Beccaloni 2009). Some also spend part of their life cycle on their dispersal hosts (Beccaloni 2009). The size of these arachnids limits their natural displacement, so they have established a phoretic interaction with rodents and insects (Muchmore 1990a, 1990b). Although they represent a significant proportion of all known arachnid species, studies on their natural history, ecology, and behavior are still scarce (de Araujo-Lira and Tizo-Pedrozo 2017). Little is known about the mechanisms that lead to establishing this symbiotic relationship with a suitable host (Bartlow and Agosta 2021); apparently, pseudoscorpions feed on ectoparasites and other arthropods present in rodent fur (Durden 1991).

The cryptic habits of pseudoscorpions limit their study in natural environments (de Araujo-Lira and Tizo-Pedrozo 2017). Currently, 21 species belonging to 5 genera have been recorded worldwide: *Chiridiochernes, Megachernes, Lasiochernes, Nudochernes*, and *Epichernes*, associated with 39 species of rodents (Beier 1948; Muchmore 1972; Muchmore and Hentschel 1982; Harvey *et al.* 2012). In México, 2 species of the genus *Epichernes* have been reported, namely *E. aztecus* and *E. navarroi*. These are associated with 6 species of rodents (Muchmore and Hentschel 1982; Muchmore 1990b; Villegas-Guzmán and Hernández-Betancourt 2006) and have been found in the north, center, and south of the country (Figure 1a; Table 1). In this study, 2 rodent species are reported for the first time as dispersal hosts of a pseudoscorpion species in Ocuilapa de Juárez, Chiapas, México.

The phoretic interaction in this study was observed in the surroundings of Ocuilapa de Juárez, Ocozocoautla de Espinosa municipality, Chiapas, México, 34 km NW of the state capital, Tuxtla Gutiérrez. Rodents were collected in patches of evergreen tropical forest at 2 localities: 1) 4.7 km NNE of Ocuilapa (16° 53′ 46″ N, 93° 24′ 17″ W), and 2) 5.16 km SSE of Ocuilapa (16° 49′ 17″ N, 93° 22′ 39″ W; Figure 1b), on 7 December 2019, and 6 March 2021. Rodents were collected using Sherman live traps baited with a mixture of oat flakes, peanut butter, and sunflower seeds (Cruz *et al.* 2010). Pseudoscorpions were removed from the rodents with tweezers and stored in vials with 70 % alcohol at room temperature.

The pseudoscorpions were processed following the technique by Wirth and Marston (1968), which consisted of clearing the specimens with 10 % potassium hydroxide, dehydrating, and dissecting them to observe and measure the legs, pedipalp, chelae, and chelicerae. Afterward, permanent slide mounts were prepared using Canada balsam. The species were identified using the key by Muchmore (1992). Additionally, a literature survey was conducted on rodent records as dispersal hosts of pseudoscorpions

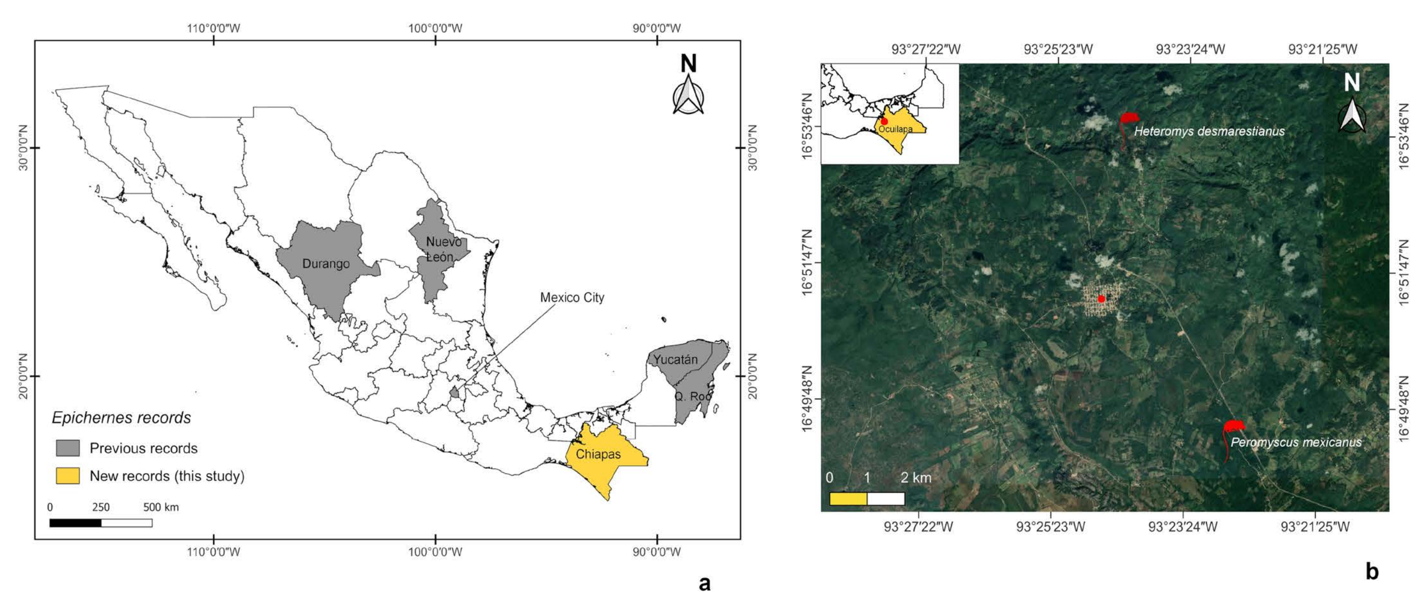

Figure 1. a) Previous records of phoretic interactions between rodents and pseudoscorpions of the genus *Epichernes* in México; b) sampling localities of rodents acting as dispersal hosts for pseudoscorpions in Ocuilapa (red dot), Chiapas, México.

of the genus *Epichernes* in México. Pseudoscorpions were deposited in the Acarology Collection of the Escuela Nacional de Ciencias Biológicas, Instituto Politécnico Nacional, in México City. The rodents were identified using specialized keys (Álvarez-Castañeda *et al.* 2017) and deposited in the Mammal Collection of El Colegio de la Frontera Sur, San Cristóbal de Las Casas, Chiapas.

Five pseudoscorpion specimens were found on two rodent species: *Peromyscus mexicanus* (ECO-SCM 9867) and *Heteromys desmarestianus* (ECO-SCM 9510; Figure 2a, 2b). In *P. mexicanus*, pseudoscorpions had their chelae clamped to the hair near the base of the tail (Figure 2a); in *H. desmarestianus*, they were attached to the middle part of the hair of the left hind leg (Figure 2b). Three pseudoscorpions were

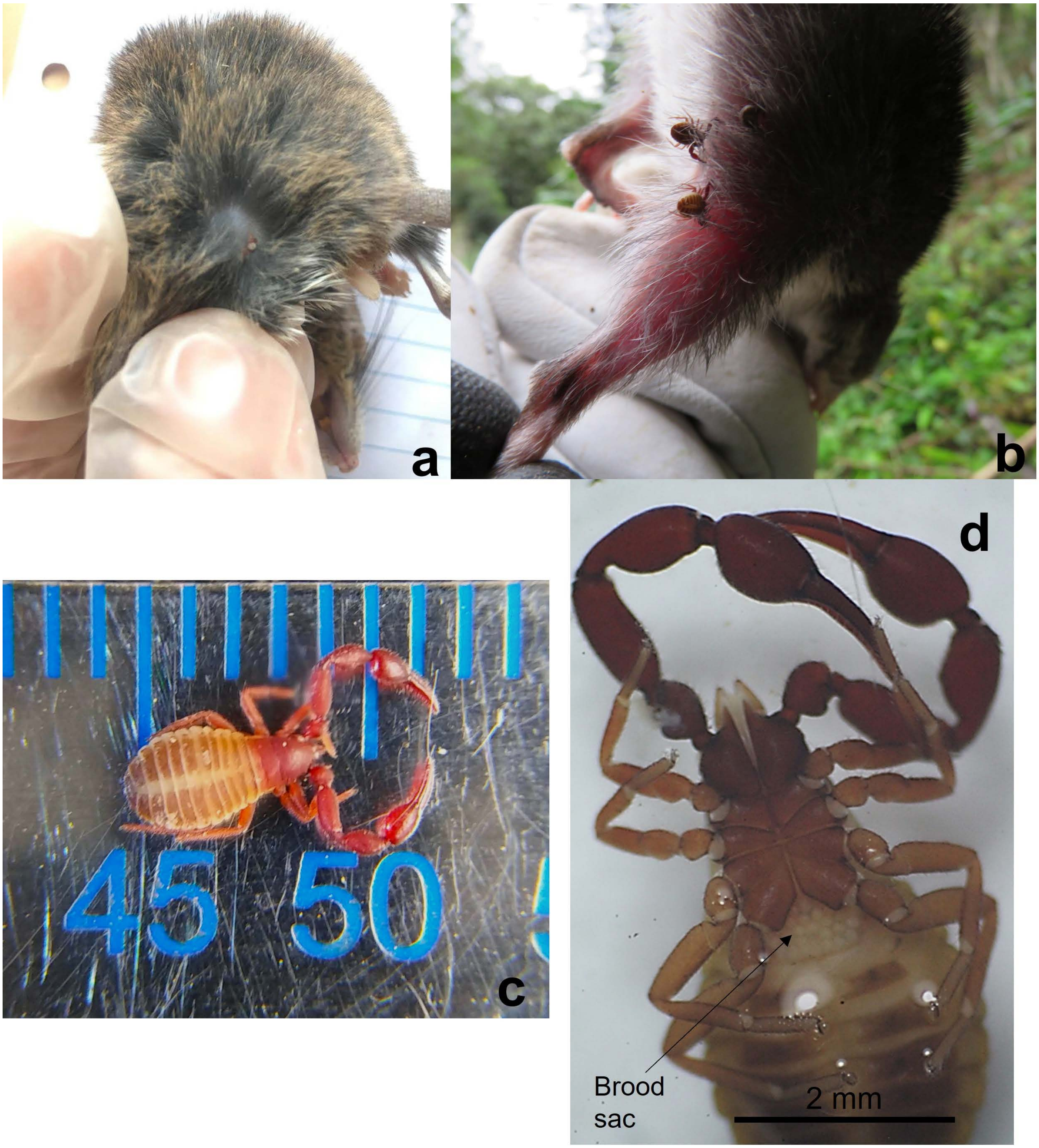

Figure 2. a) *Peromyscus mexicanus* transporting *Epichernes navarroi*; b) *Heteromys desmarestianus* transporting *E. navarroi*; c) female *E. navarroi* in dorsal view; d) female *E. navarroi* with the brood sac containing 25 eggs, collected in Ocuilapa, Chiapas, México. Photographs captured by G. Tapia-Ramírez (a), A. Hernández-Núñez (b, c), and G. Villegas-Guzmán (d).

Table 1. Rodent species recorded as dispersal hosts of pseudoscorpions of the genus *Epichernes* in México. The new records reported in this study are highlighted in *.

Rodent species	Pseudoscorpion species	Locality	References
*Heteromys desmarestianus**	*E. navarroi*	Ocuilapa, Chiapas*	This study*
H. gaumeri	*E. navarroi*	Felipe. Carrillo Puerto, Quintana Roo	Muchmore 1990b
	E. navarroi	Hobonil, Yucatán	Muchmore 1990b
H. irroratus	*E. aztecus*	San Josecito, Nuevo León	Villegas-Guzmán and Hernández-Betancourt 2006
H. pictus	*E. aztecus*	San Juan de Camarones, Durango	Villegas-Guzmán and Hernández-Betancourt 2006
	E. navarroi	San Juan de Camarones, Durango	Villegas-Guzmán and Hernández-Betancourt 2006
Neotomodon alstoni	*E. aztecus*	El Ajusco, México City	Muchmore and Henstchel 1982
*Peromyscus mexicanus**	*E. navarroi*	Ocuilapa, Chiapas*	This study*
P. yucatanicus	*E. navarroi*	Cancún, Quintana Roo	Muchmore 1990b

found on *P. mexicanus* (CAENCB-Psd 337-339) and two on *H. desmarestianus* (CAENCB-Psd 340-341). These arachnids belong to the species *Epichernes navarroi* (Chernetidae; Figure 2c), characterized by 6 to 7 setae on the cheliceral hand; galea with 5 to 6 rami, rallum with 4 denticulated blades; omega-shaped operculum; tubular spermathecae split in two in the anterior region, forming a "V"; tactile setae present on tarsus IV, with 7 to 16 external accessory teeth; length:width ratio of the palpal femur from 2.35 to 2.75 (Muchmore 1990b). All recorded specimens were females; 3 had newly formed brood sacs, each containing 23 to 25 eggs (Figure 2d).

Our results confirm the role of the genera *Peromyscus* and *Heteromys* as dispersal hosts of pseudoscorpions of the genus *Epichernes* in México. The rodent species most frequently reported as dispersal hosts are those of the genus *Heteromys*, with 4 species (Table 1). Therefore, a very close active phoretic relationship is suggested between *Peromyscus* and *Heteromys* with sympatric distributions (Muchmore 1990b, 1992; Villegas-Guzmán and Hernández-Betancourt 2006). Due to the wide distribution of *P. mexicanus* and *H. desmarestianus*, from México to Panamá, new records may be reported of *Epichernes* in Central America besides *Epichernes guanacastensis* whose dispersal host is *H. salvini* in Costa Rica (Muchmore 1992). Additional records of *P. mexicanus*, a common rodent in southern México, would be expected, even in anthropic ecosystems (Trujano-Álvarez and Álvarez-Castañeda 2010).

Although there is no data on when the pseudoscorpion-rodent phoresy is established, contact likely occurs in the burrows of rodents since it is there where the phoront and the dispersal host share the same habitat (Poinar *et al.* 1998). Additionally, the rodent nest provides the pseudoscorpion with food (mites, springtails, and fleas) and a suitable microhabitat to live in (Villegas-Guzmán and Pérez 2005). Thirty-two species of pseudoscorpions were found in the burrows of nine species of field mice of the genus *Neotoma* in the United States and México (Francke and Villegas-Guzmán 2006); these pseudoscorpions were not located on rats but in nests. In the literature, pseudoscorpions are considered nidiphilous, *i.e.*, organisms adapted to life in nests or burrows (Christophoryová *et al.* 2011).

Usually, it is females who perform phoresy. Pseudoscorpions reproduce in nests, and females leave the nest after forming the brood sac, where eggs develop until hatching. Females use the burrowing rodent as a dispersal host to seek better physical-environmental conditions for their offspring (Poinar *et al.* 1998).

Our results represent the first record of *P. mexicanus* and *H. desmarestianus* as dispersal hosts of *E. navarroi* in Chiapas. Also, the presence of this pseudoscorpion species is reported for the first time for the state, thus expanding its distribution range to southeastern México.

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