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

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

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

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

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

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

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

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

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

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

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

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

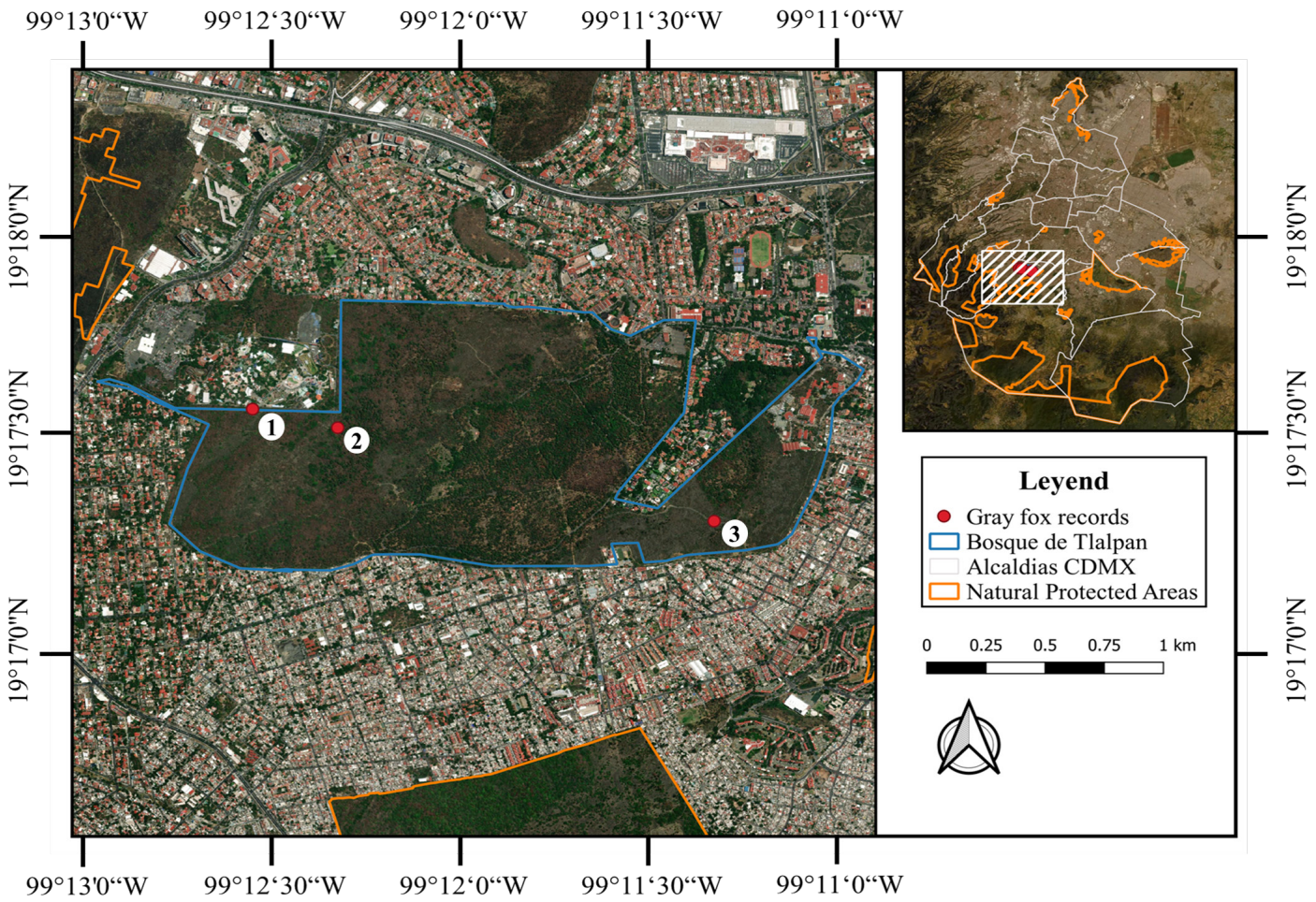

Figure 1. Area of Bosque de Tlalpan in southern México City where gray fox (*Urocyon cinereoargenteus)* was recorded (red dots) in 2021 and 2022. Numbers 1 and 2 mark the location of camera traps and number 3 shows the location of fox excreta on a footpath.

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

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

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

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

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

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

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