





New distribution records for three mesocarnivores in the state of Sinaloa, Mexico.

Nuevos registros de distribución de tres mesocarnívoros en el estado de Sinaloa, México.

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ABSTRACT

Here we report the photographic record of the spotted skunk (*Spilogale gracilis*) and two threatened species (NOM-059-SEMARNAT), the American badger (*Taxidea taxus*), and the Ringtail (*Bassariscus astutus*), as evidence of the expansion of their distributions. The photographs were obtained during a photo-trapping study in the protected area of Sierra de Navachiste, Sinaloa, in northwestern Mexico, over one year and seven months (2017-2018). The presence of these species in the Sierra de Navachiste highlights the importance of this protected area, which helps maintain multiple wildlife species that have become isolated in this habitat, particularly carnivorous mammals.

KEY WORDS : Sierra de Navachiste, Carnívoros, Natural Protected Area.

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RESUMEN

En la presente nota se reporta el registro fotográfico del zorrillo manchado (*Spilogale gracilis*) y dos especies en la categoría de “Amenazadas” de acuerdo con la NOM-059, el Tejón americano (*Taxidea taxus*) y el cacomixtle norteño (*Bassariscus astutus*) como evidencia de la ampliación de sus distribuciones, obtenidos durante el estudio de fototrampeo realizado en el área natural protegida sierra de Navachiste, Sinaloa, en el noroeste de México, en periodo de un año y siete meses (2017-2018). El registro de estas especies en la sierra Navachiste, hace referencia a la importancia de esta Área Natural Protegida, la cual permite mantener diferentes organismos de vida silvestre, particularmente los mamíferos carnívoros.

PALABRAS CLAVE: Sierra de Navachiste, Carnívoros, Área Natural Protegida.

Introduction

The Mammalia class includes more than 5,300 species grouped into 29 orders, which is a low species richness compared to other classes. However, mammals have a greater impact on ecosystem biodiversity since they often play a considerable ecological role concerning their numerical abundance (Wilson & Reeder, 2005). This group can be found in almost all habitats and occupy different niches due to their diverse morphology, size, and physiology. On the other hand, mammals exhibit different ecological relationships between two or more species that coexist and interact, so their function as population regulators can be direct or indirect (Cuarón, 2000). For example, carnivores provide structure and dynamism to the community, and regulate animal population densities at different trophic levels, supporting diversity in ecosystems (Weaver *et al.*, 1996). Many large carnivorous mammals are keystone species that significantly enhance ecosystem function through their activities. Their removal initiates a change in ecosystem structure and leads to biodiversity loss.

The Carnivora order consists of 254 terrestrial species, of which Mexico has 33 terrestrial species (González *et al.*, 2005; Pérez-Irineo & Santos-Moreno, 2013). This order is classified into hypercarnívoros, hypocarnívoros, and mesocarnívoros. The latter are small to medium-sized mammals (<15kg) with a diet composed of 30-70 % of vertebrates (Van Valkenburgh, 2007). Due to their characteristics and easy adaptability, they are often the most abundant group of mammals and play a crucial role in their habitat as competitors, seed dispersers, and predators (Aguilar-Romero *et al.*, 2022; Lot & Cano, 2009; Meza-González, 2019; Sánchez-Cordero *et al.*, 2014).

Due to a myriad of anthropogenic activities, worldwide about 26 % of the mammal species are under threat (IUCN, 2021). In Mexico, 525 mammal species are present, representing 11 % of the worldwide total (Sánchez-Cordero *et al.*, 2014), of these, around 35 % of mammal species in Mexico are threatened (SEMARNAT, 2010).

Despite this, many regions in Mexico have few studies on mammals, with knowledge gaps including species distribution (Gómez-Valenzuela *et al.*, 2017), since empirical observations of many species are lacking due to their cryptic behavior and low densities, among other reasons (Álvarez Castañeda & Patton, 2000; Karanth *et al.*, 2004; Wilson *et al.*, 1996). Therefore, in these regions, it is essential to utilize techniques and protocols that allow us to obtain sufficient information on mammal distribution, ecological niches, and habitat. However, sampling or monitoring animal populations with traditional methods based on direct visual detection or using methods that involve the capture, marking, and radio-tracking of individuals can be difficult since these approaches are usually expensive and challenging to implement (Chávez *et al.*, 2013).

Camera traps are a non-invasive technique that has allowed comprehensive studies to be carried out on a growing number of species through the individual identification of the photographed organisms through distinctive marks on their bodies (Delisle *et al.*, 2021). Similarly, it has been used to document the richness of large and medium-sized mammals in tropical forests (Tobler & Powell, 2013) generate quantitative information on the biology, ecology, and conservation of numerous species (Chávez *et al.*, 2013), particularly in the monitoring of carnivores and their preys (Karanth *et al.*, 2004; Smith *et al.*, 2020).

Material and Methods

The Sierra de Navachiste is located between Guasave and Ahome, Sinaloa municipalities, and has a total area of 17,055 ha (170,55 km²). It is bordered to the north by Bahía de Ohuira, to the south by Bahía de Navachiste, and to the west by the Gulf of California. The extreme geographic coordinates are 25° 27' 10" and 25° 36' 30" N and 108° 48' 05" and 109° 05' 00" W. The area is a Protected Area (PA) under state jurisdiction and is classified as a Zone Subject to Ecological Conservation (PROFEPA, 2022). The area presents various vegetation types: low thorny forest, xerophile scrub, sarcocaule and crasicaule, halophyte vegetation, and mangroves. Land use is limited to extensive livestock and fishing activities (Secretaría General de Gobierno del Estado de Sinaloa, 2004) (Figure 1).

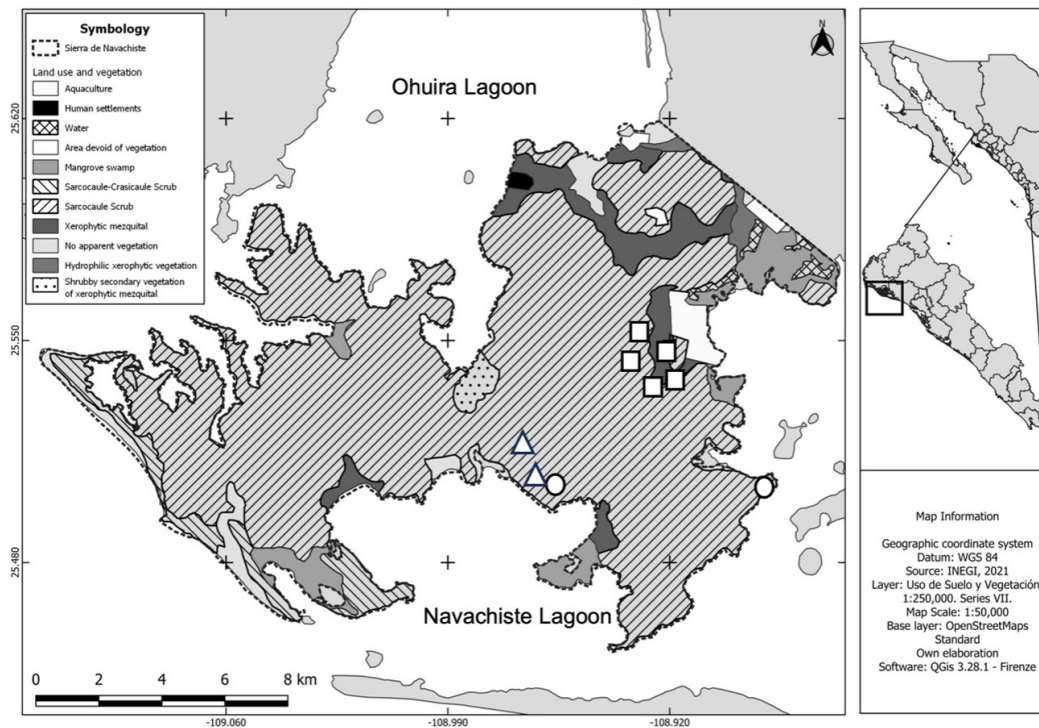


Figure 1. Protected Area Sierra de Navachiste, Sinaloa, Mexico. *Spilogale gracilis* records (Δ); *Taxidea taxus* records (\square); *Bassariscus astutus* records (\circ).

The Sierra de Navachiste is an ecosystem that maintains natural vegetation with few changes and is important for biodiversity conservation, so it is considered a relic of the forest because it is a remnant of another much wider (Secretaría General de Gobierno del Estado de Sinaloa 2004; Weigend *et al.*, 2005). The Sierra de Navachiste is an ecosystem surrounded by multiple anthropogenic activities, including agriculture, aquaculture, fishing, and livestock farming (Aguilar-Romero *et al.*, 2022). The latter compete with wildlife for land and resources, particularly water (Meza-González, 2019).

The camera trapping study in the Sierra de Navachiste, Sinaloa, in northwest Mexico, was conducted over one year and seven months (2017-2018). A total of 21 Stealth Cam[®] (models P12, P12X, PX14, RX24, and PX14) camera traps were used. The stations were placed in strategic locations facing north or south, where traces were previously observed on trails, clearings, water sources, riverbeds, streams, and dirt roads, among others. The methodology described by Chávez *et al.* (2013) was followed, which suggests that trails should be explored in the company of residents to become familiar with the study area and, at the same time, search for traces such as feces, footprints, and prey as indicators of possible camera trap sites.

Before installation, each camera trap was programmed with a one-minute delay between each photograph (Chávez *et al.*, 2013). Additionally, the option of a 5-second delay between photographs with five shots was enabled to capture as much information as possible.

Once each station was installed, objects that could accidentally trigger the sensor were removed from the detection line; these included grass, branches, and other wind-sensitive vegetation. The site was modified as minimally as possible to avoid signaling disturbance to the area's organisms. At each station, Calvin Klein's Obsession for Men perfume was used as an attractant (National Geographic, 2010), along with a homemade attractant containing cat urine and leftovers from commercial tuna cans.

On camera retrieval, the photographs were downloaded, and individuals of each species were identified using specialized guides and, in some cases, with the support of the experience and knowledge of local participants. Common names were defined according to Álvarez-Castañeda and González-Ruiz (2018). Subsequently, a database was created in Microsoft Excel using the obtained data.

Results and Discussions

Here we report the photographic record of the spotted skunk (*Spilogale gracilis*) and two threatened species according with the NOM-059 (SEMARNAT, 2010), the American badger (*Taxidea taxus*) and the Ringtail (*Bassariscus astutus*), as evidence of the expansion of their distributions (Figure 1, Table 1). The photographs were obtained during a photo-trapping study in the Sierra de Navachiste, Sinaloa, in northwestern Mexico, over one year and seven months (2017-2018).

Table 1. Recent records of three mesocarnivores in Mexico.

Species	Records	Vegetation	Capture location	Author
	Sonora	Sarcocaulle scrub	Not determined	(Álvarez-Castañeda & Patton 2000)
Spilogale gracilis	Sierra Seri, Sonora	Sarcocaulle scrub	29°12'42"N 112°09'16"O	(Barcéneas <i>et al.</i> , 2009)
	Sierra de Navachiste, Sinaloa	Low deciduous forest	25°31'60"N 108°58'1"O	This Study
	Elota, Sinaloa	Captured in crops	23°55'26" N 106°52'47"O	(Barcéneas <i>et al.</i> , 2009)
Taxidea taxus	Choix, Sinaloa	Mesquite (<i>Prosopis juliflora</i>)	Not determined	(Ceballos <i>et al.</i> , 2005)
	Durango	No Determinado	24°32'0"N 104°40'0"O	(Gómez-Valenzuela <i>et al.</i> , 2017)
	Sierra de Navachiste, Sinaloa	Mesquite (<i>Prosopis juliflora</i>)	25°31'60"N 108°58'1"O	This Study
Bassariscus astutus	Ahome, Sinaloa	Low deciduous forest	26°05'20.0"N 109°22'17.0"W	Naturalista 2022a
	Sierra de Navachiste, Sinaloa	Low deciduous forest	25°31'60"N 108°58'1"O	This Study

Spilogale gracilis

A member of the Mephitidae family, it is one of the four species of the *Spilogale* genus that are distributed in North America: *S. putorius*, *S. angustifrons*, *S. pygmaea* and *S. gracilis* (IUNC, 2023; Wozencraft, 2005). The latter is characterized as a small black nocturnal carnivore with a white spot on the forehead and on each ear, it has a pair of white stripes on the dorsolateral, lateral, and ventrolateral regions of its body and its tail is black on top with a white underside and white tip (Carraway & Kinlaw, 2001; Dragoo, 2010; IUNC, 2023).

One of the records obtained for *S. gracilis* was through direct observation, a sighting in a cave 10 km from the camera trapping station where the rest of the records occurred (Figure 2). Both areas are located on a hill that borders the Navachiste lagoon system. Cacti and Low deciduous forests characterize the vegetation in the area.

Currently, studies report that the species is distributed throughout the eastern region of Sinaloa, in the Sierra Madre Occidental (Barcénas *et al.*, 2009; IUNC, 2023; Naturalista, 2022c); however, no reports of *S. gracilis* exist on the Sinaloan coast. The only report of *S. gracilis* on the Mexican Pacific coast is from the Sierra Seri, Sonora (Barcénas *et al.*, 2009), which is 619 km from the Sierra de Navachiste. Therefore, our photographic records are the first record of this species in the coastal region of Sinaloa and the second record for the Mexican Pacific coast.

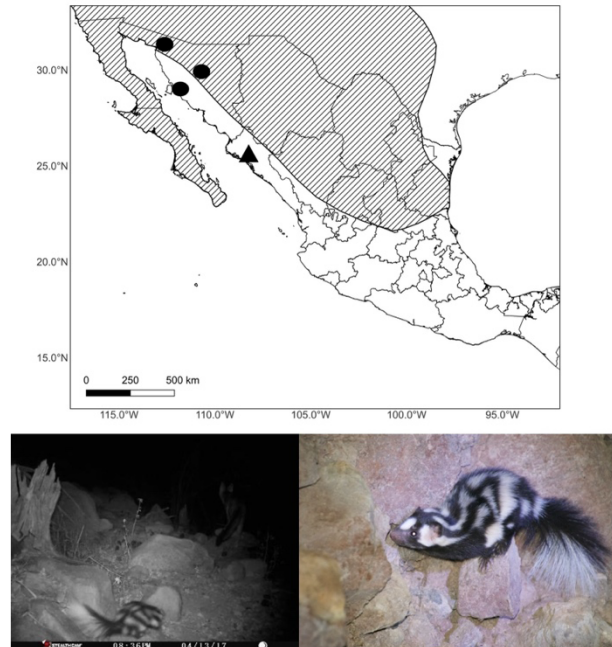


Figure 2. Photographic records of *Spilogale gracilis*. The location of the new record in Sierra de Navachiste, Sinaloa, Mexico (▲), previous records (●), and the shading area show known distribution according to IUNC (2023).

Taxidea taxus

The American badger is a medium-sized carnivore, a solitary nocturnal hunter, specialized for digging in search of its prey (Minta *et al.*, 1992). It is an elusive species, infrequently observed and with few records in Mexico, where it is currently categorized as “Threatened” (Ceballos *et al.*, 2005; SEMARNAT, 2010). According to the literature, this North American mustelid is distributed in Canada, the United States of America, and different states of Mexico (Gómez-Valenzuela *et al.*, 2017; IUNC, 2023). In Sinaloa, reports are scarce and were limited to the municipality of Choix

in the northeast, bordering Sonora (Jiménez & List, 2005). In this sense, Barcéñas *et al.* (2009) reported a range expansion to the municipality of Elota in southern Sinaloa (Figure 3).

However, the report from the Elota municipality was of a single organism captured in an area near agricultural fields (Barcéñas *et al.*, 2009). Although this species prefers undisturbed habitats such as grasslands and plains (Collins *et al.*, 2012; Vanek *et al.*, 2020). According to Duquette *et al.* (2014) and Doyle *et al.* (2019), this carnivore has adapted to highly fragmented agricultural areas, which expands its potential distribution since these areas offer further opportunities to forage and where home ranges can range between 3 to 30 km². The information provided is consistent with what has been observed in the Sierra de Navachiste, as the 11 photographic records reported here correspond to five organisms in different areas on the western side of the mountain range (Figure 1). These areas are all close to each other and characterized by flat terrain with vegetation mainly composed of Mesquite trees (*Prosopis juliflora*). They are located near agricultural fields and an artificial water body created for livestock (Figure 3).

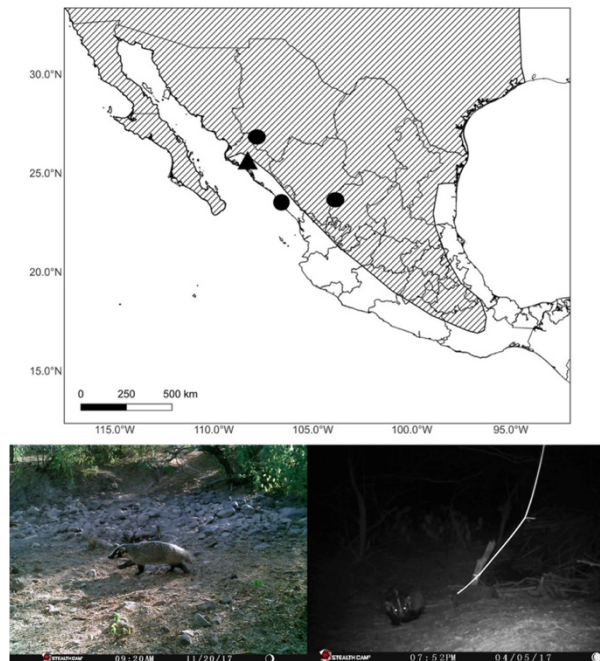


Figure 3. Photographic records of *Taxidea taxus*. The location of the new record in Sierra de Navachiste, Sinaloa, Mexico (▲), previous records (●), and the shading area show known distribution according to IUCN (2023).

The Sierra de Navachiste is located 191 km from the municipality of Choix and 347 km from Elota. In 2019 another organism was recorded in the town of Juan José Ríos, Ahome, 46.6 km from the Sierra de Navachiste (Naturalista, 2022b) consequently, these are the first records of *T. taxus* in the municipality of Ahome, northwestern Sinaloa, and the third record in the state, these records expand the known distribution of *T. taxus*.

Bassariscus astutus

The northern ringtail, *Bassariscus astutus*, presents a distribution from the southern United States to southern Mexico; it commonly inhabits arid and rocky areas and is characterized by its nocturnal and solitary habits (Aranda-Sánchez, 2012; Meza-González, 2019; Naturalista, 2022a). This species is included within the NOM-059 in a category of “Threatened”, principally due to habitat destruction and land use change, as well as anthropogenic activities that have impacted its populations (Lot & Cano, 2009).

While the IUCN (2023) reports the species’ distribution throughout the Sinaloa state in the distribution map for Mexico, this procyonid has been recorded 23 times, all towards the eastern part of the state adjacent to the Sierra Madre Occidental (SMO). The closest record to the Sierra de Navachiste is from the fishing community of Campo Nuevo Matacahui in Ahome, a coastal community bordering the SMO. This record was made 76 km from the Sierra de Navachiste (Naturalista, 2022a). During our study, three photographic records and three sightings of *B. astutus* were obtained (figure 4), representing the second record in the coastal zone of Sinaloa.

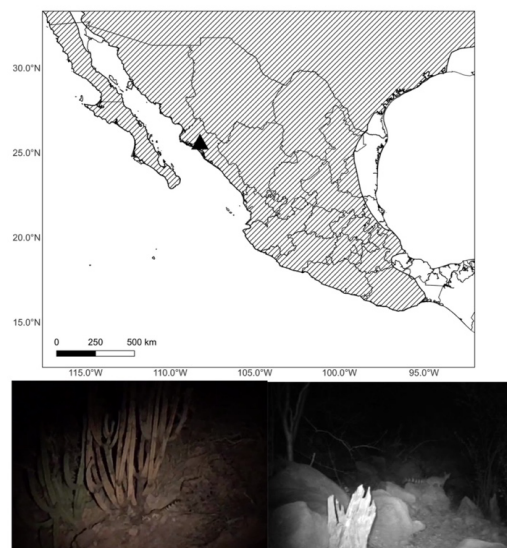


Figure 4. Photographic records of *Bassariscus astutus*. The location of the new record in Sierra de Navachiste, Sinaloa, Mexico (▲), and the shading area shows known distribution according to IUCN (2023).

This species was observed in the eastern zone of the Sierra de Navachiste at two stations. One station corresponds to the same location where the western spotted skunk was recorded, and the other station is at the base of hills in an area called “El Aparecido” adjacent to the Navachiste lagoon system. The vegetation in this area is primarily composed of cacti and thorn scrub (Figure 1).

Conclusions

Habitat destruction and fragmentation are considered the leading cause of biodiversity loss, resulting in reduced natural vegetation and a deterioration in the ecological processes of ecosystems (Lot & Cano, 2009). Therefore, maintaining natural areas for wildlife should be a priority in wildlife management and conservation planning, particularly when at-risk species are present.

The Sierra de Navachiste was declared a state Protected Area in 2005 and is one of the few sites in northwest Sinaloa that still maintains natural conditions and contains a significant portion of the native flora and fauna. It has also been part of the Navachiste RAMSAR sites since 2008 and Topolobampo since 2009. The Sierra de Navachiste does not have a connection with the Sierra Madre Occidental and faces strong anthropogenic pressure in its surroundings.

Mammals are considered excellent surrogate species to study an ecosystem's conservation status, allowing us to observe community attributes. These species can also serve as conservation umbrellas for other organisms and areas that require protection. However, carnivores can be elusive and challenging to observe directly. The use of camera trapping allows for the identification of present species. It provides insights into other community attributes, contributing to our understanding of the importance of specific areas for biodiversity conservation. Camera trapping has become a valuable tool for sampling and monitoring populations of cryptic species. It allows us to expand our observations of species over time and space without interfering with their behavior. This technique has proven useful in studying and monitoring elusive carnivores, providing valuable data for conservation efforts.

The presence of these mesocarnivores in the Sierra de Navachiste highlights the importance of this Protected Area as a refuge and habitat for multiple wildlife species. However, the high levels of anthropogenic activity in the surrounding areas pose a risk to the integrity of the Sierra de Navachiste. This underscores the significance of the Sierra de Navachiste as a protected area and wildlife sanctuary and the need to implement a management plan for its conservation. It is crucial to continue studying the biodiversity, ecology, and conservation status of the Sierra de Navachiste, including the anthropogenic activities that may influence its populations and threaten this natural wildlife refuge in the coastal region of northern Sinaloa.

Authors Contribution

“Work Conceptualization and development of methodology, CPLQ, EGM, AAZN; Development of methodology, analysis of results, data management, writing and manuscript preparation, CPLQ, EGM, AAZN; Editorial, revision and edition, CPLQ, CEH, AAZN; Project Manager and Funding Acquisition, CPLQ, AAZN.

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Conflicts of Interest

The authors declare no conflicts of interest.

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