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New record of interactions between spotted skunk (*Spilogale* sp.) and gray fox (*Urocyon cinereoargenteus*) in Nayarit, México

Nuevo registro de interacciones entre zorrillo manchado (*Spilogale* sp.) y zorra gris (*Urocyon cinereoargenteus*) en Nayarit, México

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To understand the dynamics of terrestrial ecosystems, it is essential to study the interactions between different species. These interactions (predation, mutualism, competition and parasitism) play a crucial role in regulating populations and distribution of species. Camera traps were used to record the biodiversity of the La Montaña Encantada Natural Park, Municipality of Xalisco, Nayarit. Three records of interaction were obtained between a spotted skunk (*Spilogale* sp.) and the gray fox (*Urocyon cinereoargenteus*). In the videos obtained, the skunk follows the fox very closely; in one of them the fox even comes back to look for him. These reports of interaction between skunks and foxes (the first recorded in the oak forest in western México), are added to those obtained for the arid ecosystems of the Tehuacán-Cuicatlán Biosphere Reserve, Puebla and in the tropical forest of the Península of Yucatán. Interactions between gray fox and skunks also occur in oak forests of Nayarit. It is necessary to carry out specific studies to understand the causes and consequences of these interactions.

Key words: Carnivores; commensalism; interspecific interactions; Nayarit.

Para entender la dinámica de los ecosistemas terrestres, es fundamental estudiar las interacciones entre diferentes especies. Estas interacciones (depredación, mutualismo, competencia y parasitismo), desempeñan un papel crucial en la regulación de las poblaciones y la distribución de las especies. Se utilizaron cámaras trampa para registrar la biodiversidad del parque natural La Montaña Encantada, Municipio de Xalisco, Nayarit. Se obtuvieron 3 registros de interacción entre un zorrillo manchado (*Spilogale* sp.) y la zorra gris (*Urocyon cinereoargenteus*). En los videos obtenidos, el zorrillo sigue a la zorra muy de cerca; en uno de ellos la zorra incluso regresa a buscarlo. Estos reportes de interacción entre zorrillos y zorras, los primeros registrados en bosque de encino en el occidente de México, se suman a los obtenidos para los ecosistemas áridos de la Reserva de la Biosfera Tehuacán-Cuicatlán, Puebla y en las selvas de la Península de Yucatán. Las interacciones entre zorra gris y zorrillos ocurren también en bosques de encino de Nayarit. Es necesario realizar estudios específicos para entender las causas y consecuencias de dichas interacciones.

Palabras clave: Carnívoros; comensalismo; interacciones interespecíficas; Nayarit.

Interspecific interactions among mammals constitute a vital component of terrestrial ecosystem ecology, influencing both its structure and function (Liesenjohann *et al.* 2011; Kelt *et al.* 2019). These interactions, ranging from predation and parasitism to mutualism and competition, are key to understanding population and community dynamics within an ecosystem (Liesenjohann *et al.* 2011). For example, predation relationships can regulate population sizes, thus affecting resource availability and species distribution in a given area. Similarly, mutualistic interactions, such as seed dispersal by mammals, can influence vegetation structure and, in turn, the diversity of habitats available for other species (Kelt *et al.* 2019).

These interactions not only have local implications but can also affect processes at regional and global levels. For instance, the presence or absence of herbivorous mammals can alter vegetation composition, which in turn can influence carbon storage and nutrient cycling at the ecosystem scale (Lacher *et al.* 2019).

Interactions between skunks of the genus *Spilogale* and foxes of the genus *Urocyon* have been studied, particularly on the islands of California, USA. In these ecosystems, various ecological aspects such as resource partitioning (Crooks and Van Vuren 1995), density-dependent population dynamics (Jones *et al.* 2008), the role of microhabitat and temporal activity in facilitating coexistence between these 2 carnivores (Bolas *et al.* 2022), as well as space use and den visits by both species (Gagorik *et al.* 2024), have been evaluated.

In non-insular contexts, casual observations of spotted skunks (*Spilogale* sp.) actively following gray foxes (*Urocyon cinereoargenteus*) have been reported in Mexi-

can ecosystems such as the Tehuacán-Cuicatlán Biosphere Reserve (Farías-González and Vega-Flores 2019; Pérez-Irineo *et al.* 2020) and the dry forests of the Yucatán Península (Mejenes-López *et al.* 2021). However, being casual records, the causes and consequences of such associations are unknown.

Understanding the nature and consequences of these interactions is essential for the effective conservation and management of biodiversity. For example, by understanding how the presence of predators influences the behavior and distribution of their prey, scientists and conservationists can design more effective strategies to protect endangered species and restore degraded ecosystems. Likewise, analyzing how interspecific interactions may change in response to human impacts, such as climate change and habitat fragmentation, is crucial for anticipating and mitigating negative effects on biodiversity and ecosystem services.

In this paper, we report 3 video-recorded events of interspecific interaction between a spotted skunk and a gray fox in an oak forest in Nayarit, México. So far, there are no meristic or genetic data on the skunks in the study area for specific identification. Given that they could be *S. leucoparia* or *S. angustifrons* based on their distribution area (McDonough *et al.* 2022), this paper refers only to the genus *Spilogale* sp.

To assess the diversity of terrestrial mammal species in La Montaña Encantada Natural Park, a property located south of Xalisco, Nayarit (21° 21' 12.83" N, 104° 48' 30.16" W, 1,030 m; Figure 1) biodiversity monitoring with camera traps began in January 2021. The park covers an area of 30 ha and is located in the complex of volcanoes and lagoons in the central region of the state (Luja and Zamudio 2019). The predominant native vegetation in the park is broadleaf forest, including oaks (*Quercus*), pines (*Pinus*), madrones (*Arbutus*), and acacias (*Acacia*). Some ravines are covered by medium subdeciduous forest (*Guazuma*, *Bursera*, *Brosimum*, *Lysiloma*, and *Quercus*), and secondary vegetation (SEMARNAT-CONAFOR 2015). The park is isolated in a matrix of sugar cane and agave crops. Four Browning camera traps were placed: one at the park entrance on a dirt road between oak forest and agave cultivation (21° 21' 21.25" N and 104° 48' 35.98" W, 1,026 m), another at an oak forest-low deciduous forest ecotone (21° 21' 18.89" N and 104° 48' 24.38" W, 1,037 m), another at an oak forest-low deciduous forest ecotone (21° 21' 8.77" N and 104° 48 '37.96" W, 1,000 m), and another in low deciduous forest (21° 20' 55.08" N and 104° 48' 25.84" W, 980 m). The average distance between the cameras was 526 m. These were placed perpendicular to trails with evidence of animal use

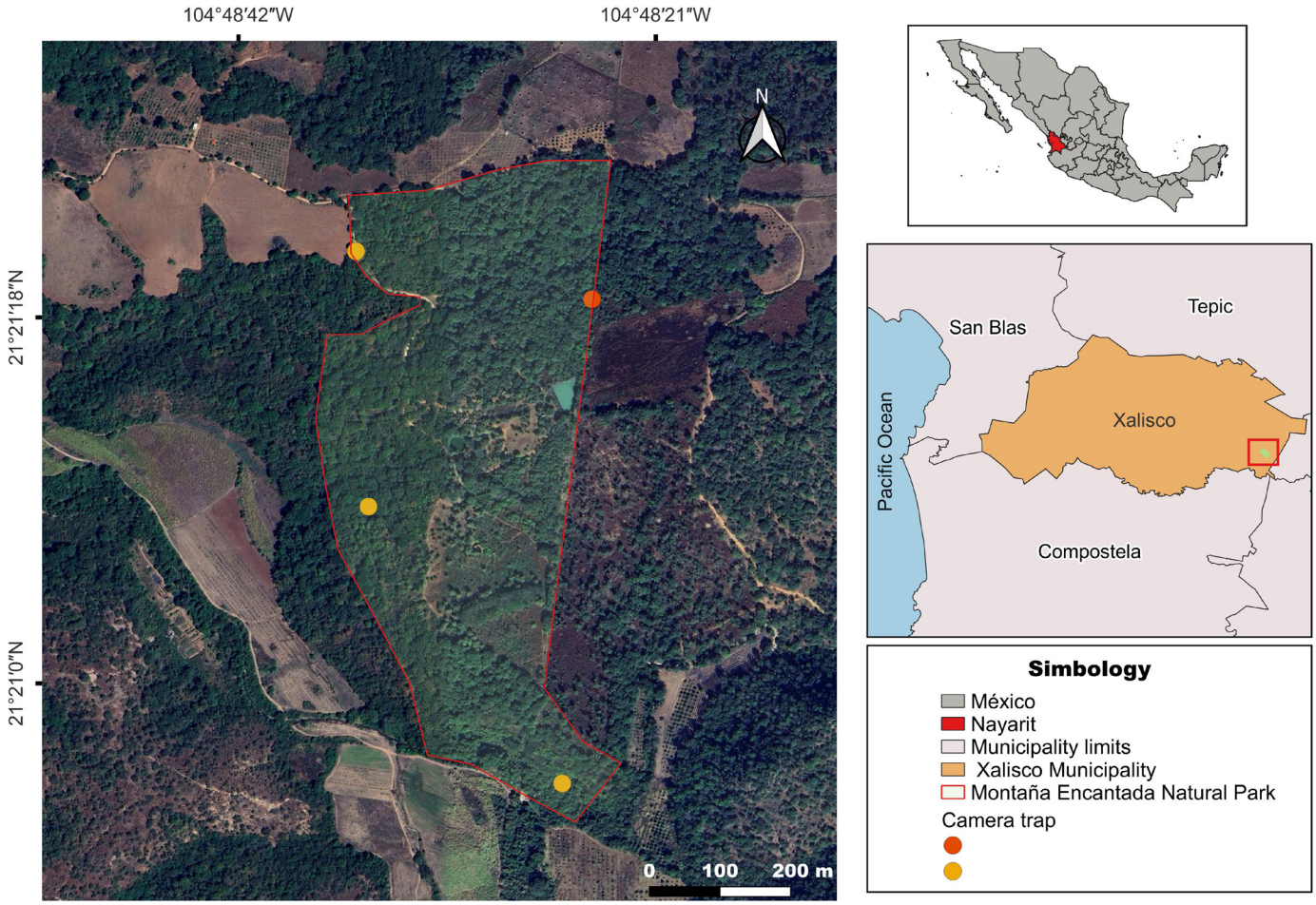

Figure 1. Geographic location of the "La Montaña Encantada" Natural Park, Municipality of Xalisco, Nayarit, México. Locations of camera stations (yellow dots), except where gray fox-skunk interaction events were recorded (red dot).

(tracks or droppings), attached to a tree 40 cm above the ground. They were programmed to record 20-sec videos and have remained active from January 15, 2021, to June 1, 2024. Memory cards, batteries, and general maintenance were done monthly.

Between January 2021 and June 2024, 3 records of a skunk and a fox in coexistence were obtained. All 3 events were recorded on a single camera (oak forest; Figure 1) and appear to involve the same pair of individuals. In the first video (May 17, 2021, 2:52 hr, 12 °C), the fox is seen in the foreground, quiet, with its tail raised and looking back down the path. It then returns along the path, and the skunk is seen circling a tree, 1 m high. The fox searches for it and, upon making visual contact, returns to the path. When the fox reaches the camera, it stops and returns to the tree for the second time. Only when the skunk follows does the fox pass quickly in front of the camera, followed by the skunk (Figure 2a). The same happens in the second (July 21, 2021, 22:04 hr, 20 °C; Figure 2b) and third videos (December 21, 2021, 3:37 hr, 10 °C; Figure 2c): both species appear in the footage, the fox first and the skunk following. The fox has its tail raised, moves relatively quickly, and the skunk follows, about 1.5 m behind. Link to videos is: https://drive.google.com/drive/folders/1jK96a2A8rvPci0jCIxMyTNU7ctohe94E?usp=sharing.

The observed interaction between the spotted skunk (*Spilogale* sp.) and the gray fox (*Urocyon cinereoargenteus*) in La Montaña Encantada Natural Park, Xalisco, Nayarit, provides a valuable addition to the types of interspecies interactions in oak forest ecosystems in western México.

The fact that the skunk was recorded following the fox, and the latter returning to search for it, suggests a relationship that may have components of mutualism or some form of social interaction not widely documented in these environments. Observing such behaviors in an oak forest is particularly interesting as it expands the geographical context of these interactions previously documented in arid and tropical forest ecosystems, such as the Tehuacán-Cuicatlán Biosphere Reserve and the Yucatán Península (Farías-González and Vega-Flores 2019; Pérez-Irineo *et al.* 2020; Mejenes-López *et al.* 2021). This raises additional questions about the adaptability and flexibility of these species in various habitats and the potential evolutionary advantages these interactions may confer.

It is relevant to consider that the recorded behavior could be influenced by specific environmental and ecological factors in La Montaña Encantada Natural Park, such as the density of both species, resource availability, predator pressure, and habitat structure, which have not yet been evaluated. These factors could facilitate or even promote interactions that would otherwise be rare or nonexistent in other environments. Additionally, the camera trap technology (in video mode) used in this study proves to be an effective tool for capturing and analyzing species interactions that are difficult to observe directly, offering new perspectives on animal behavior and ecology.

Figure 2. Frames (extracted from the videos) of the gray fox (*Urocyon cinereoargenteus*) followed by a spotted skunk (*Spilogale* sp.) in La Montaña Encantada Natural Park, municipality of Xalisco, Nayarit, México. In Figure 2a (event 1) the fox returns and looks for the skunk. In events 2b and 2c, only the fox passed first, followed by the skunk.

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