

Vertebrates visiting natural waterholes in a tropical seasonal habitat in central México

Vertebrados que visitan pozos de agua naturales en un hábitat estacional tropical en el centro de México

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The spatial and temporal distribution of water availability impacts the behavior of species. Particularly in arid habitats, waterholes are sources of water for many species. Herein, records of vertebrates are describing visiting natural waterholes by camera traps during the dry season in a dry tropical forest of central México. During the dry season (December 2015, May 2016, and April-May 2019), we placed seven camera traps during 135 days in seven waterholes. This method was used as part of monitoring and conservation activities, implemented within an extensive wildlife management unit in central Mexico. We recorded a total of 20 vertebrates visiting the waterholes: 15 mammals, four birds, and one reptile. The coexistence between species without negative interactions, and some recorded conduct included: playful behavior, grooming and rubbing against stones; we observed some species waiting for their turn to drink. At least four individuals of *Mephitis macroura* were identified. Our study also emphasizes a basic aspect, but perhaps underestimated in recent years resulting from the use of camera traps: the qualitative observation of animals through photos. These observations can reveal basic and interesting aspects of the natural history of species that allow us to improve the knowledge about coexistence in the same place.

Key words: Camera traps; *Mephitis macroura*; non-lethal interactions; *Urocyon cinereoargenteus*.

La distribución espacial y temporal de la disponibilidad de agua impacta el comportamiento de las especies. Particularmente en hábitats áridos, los pozos de agua son fuentes de agua para muchas especies. Presentamos registros interesantes de vertebrados que visitaron pozos de agua naturales mediante cámaras-trampa durante la estación seca en un bosque tropical seco del centro de México. Durante la estación seca (diciembre de 2015, mayo de 2016 y abril-mayo de 2019), colocamos siete cámaras-trampa durante 135 días en siete pozos de agua. Este método utilizado fue parte de las actividades de monitoreo y conservación, implementadas dentro de una amplia unidad de manejo de vida silvestre en el centro de México. Registramos 20 especies de vertebrados visitando los pozos de agua: 15 mamíferos, cuatro aves, y un reptil. La co-ocurrencia entre especies sin interacciones negativas, y algunos registros de conducta incluyeron: eventos de juego, acicalamiento y frotamiento contra piedras; se observó a algunas especies esperando su turno para beber. Pudimos identificar al menos cuatro individuos de *Mephitis macroura*. Nuestro estudio también enfatiza un aspecto básico, pero quizás subestimado en los últimos años producto del uso de cámaras-trampa: la observación cualitativa de animales a través de fotografías. Estas observaciones pueden revelar aspectos básicos e interesantes de la historia natural de las especies que permiten mejorar el conocimiento sobre la coexistencia en un mismo lugar.

Palabras clave: Cámaras trampa; interacciones no letales; *Mephitis macroura*; *Urocyon cinereoargenteus*.

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The spatial and temporal distribution of water availability impacts foraging behavior, activity times, and microhabitat use of species ([Rosenstock et al. 1999](#); [Tanner et al. 2015](#)). Particularly in arid habitats, water is a resource limited in time and space ([Krausman et al. 2006](#)). Waterholes are sources of water for many species of different taxa, such as reptiles, birds, and mammals ([Martínez-Kú et al. 2008](#); [Delgado-Martínez et al. 2018](#)), and several of these species also use waterholes as refuge and resting areas ([Martínez-Kú et al. 2008](#)). However, species can also be negatively

affected when visiting waterholes due to the increased risk of predation or competitive interactions ([Rosenstock et al. 1999](#); [Krausman et al. 2006](#); [Hall et al. 2013](#); [Perera-Romero et al. 2021](#)).

Herein, records of species visiting natural waterholes by camera traps during the dry season in a dry tropical forest of central México are documented. We obtained these records as part of monitoring and conservation activities, implemented within an extensive wildlife management unit (UMA in Spanish). The site is located

in the Ejido Rancho El Salado, municipality of Jolalpan, in the southeast of the state of Puebla, in central México (18° 20' N, 98° 57' W). The region is highly seasonal, with the occurrence of pronounced wet (from June to November) and dry (from December to May) seasons (INEGI 2009). The climate is warm sub-humid, with rainfall in the summer, temperatures range between 22-28 °C, and an annual precipitation of 800 to 1,000 mm. The study area is located between 700 and 1,700 m (INEGI 2009). The predominant vegetation type is tropical dry forest, and the dominant species are trees of the Fabaceae and Anacardiaceae families (Martínez-Moreno *et al.* 2016). The main economic activities practiced in the area are seasonal agriculture and livestock production (INAFED 2019).

During the dry season (December 2015, May 2016, and April-May 2019), we placed 7 camera traps in 7 waterholes (also known as *aguaje*; Table 1) during 135 days, which contain water during the dry season. Cameras were programmed (models Primos Truth Cam 35® y Moultrie Game Spy D-55IR®) to take three pictures every ten seconds and to remain active for 24 hours. We used field guides and specialized bibliography for species identification (Hall 1981; Reid 1997; Ceballos and Oliva 2005).

We recorded a total of 20 species of vertebrates from different taxonomical groups visiting the waterholes: four birds, one reptile, and 15 mammals including a species of goat (Table 1). The mammal species with the highest

number of records were (decreasingly): *Urocyon cinereoargenteus* (grey fox, 95 records), *Mephitis macroura* (hooded skunk, 39 records), *Odocoileus virginianus* (white-tailed deer, 25 records), and *Nasua narica* (white-nosed coati, 22 records). All mammal species has been reported in the studied location (Ramírez-Carmona 2018) and in other waterholes in nearby areas (Mandujano and Hernández-Gómez 2019a; Mandujano and Hernández-Gómez 2019b).

Within the birds, there were four species recorded, been *Zenaida* sp. with the highest number of records (36 records; Table 1). Only on reptile species, *Ctenosaura pectinata* (guerreran spiny-tailed iguana) was recorded (Table 1).

We recorded co-occurrence (*i.e.*, species found in the same region because a multitude of processes acting at different scales) between two species on several occasions: *M. macroura* – *U. cinereoargenteus* on two occasions, *N. narica* – *U. cinereoargenteus* on one occasion, *M. macroura* – *Bassariscus astutus* (ringtail) on one occasion, two individuals of *M. macroura* on one occasion, and two individuals of *U. cinereoargenteus* on two occasions (Figure 1). Although we obtained few observations of this co-occurrence (7 of 271 records), these observations have been rarely documented for these species. We also recorded behaviors such as playful behavior, grooming, and rubbing against stones, and some species were observed waiting for a turn to drink (Figure 1). Non-lethal interactions between species have been previously recorded between *Taxidea taxus* (American

Table 1. Vertebrate species and records detected by camera traps in seven waterholes in the Ejido Rancho El Salado in central México, during the dry season of 2015 - 2016. Waterholes: LS = Las Salinas; EP = El Pipilo; AP = Agua de la Peña; LJ = La Jícara; A = Alseseca; ER = El Rincón; EA = El Azumiate. Common names of mammals taken from Álvarez-Castañeda and González-Ruiz (2018).

Class	Species	Common Name	LS	EP	AP	LJ	A	ER	EA
Aves	<i>Ortalis poliocephala</i>	West Mexican chachalaca	7				6		3
	<i>Zenaida</i> sp.	White-winged dove	20						16
	<i>Bubo virginianus</i>	Great horned owl	1						
	<i>Coragyps atratus</i>	American black vulture	3				2		
Mammalia	<i>Didelphis virginiana</i>	Virginia opossum	3					3	1
	<i>Dasyurus novemcinctus</i>	Nine-banded armadillo	1						
	<i>Canis latrans</i>	Coyote	1				1	1	
	<i>Urocyon cinereoargenteus</i>	Gray fox	4			4		3	84
	<i>Leopardus pardalis</i>	Ocelot	1					1	
	<i>Conepatus leuconotus</i>	American hog-nosed skunk						1	1
	<i>Mephitis macroura</i>	Hooded skunk							39
	<i>Spilogale angustifrons</i>	Southern spotted skunk						1	
	<i>Bassariscus astutus</i>	Ringtail						1	4
	<i>Nasua narica</i>	White-nosed coati	3			1	3		15
	<i>Procyon lotor</i>	Raccoon			2				1
	<i>Odocoileus virginianus</i>	White-tailed deer	6	6	4		2	4	3
	<i>Dicotyles crassus</i>	Eastern collared peccary				1			
<i>Sylvilagus floridanus</i>	Eastern cottontail					1			
Reptilia	<i>Ctenosaura pectinata</i>	Guerreran spiny-tailed iguana	5						
Domestic species	<i>Capra</i> sp.	Goat							1
Camera days			15	15	15	15	15	15	45

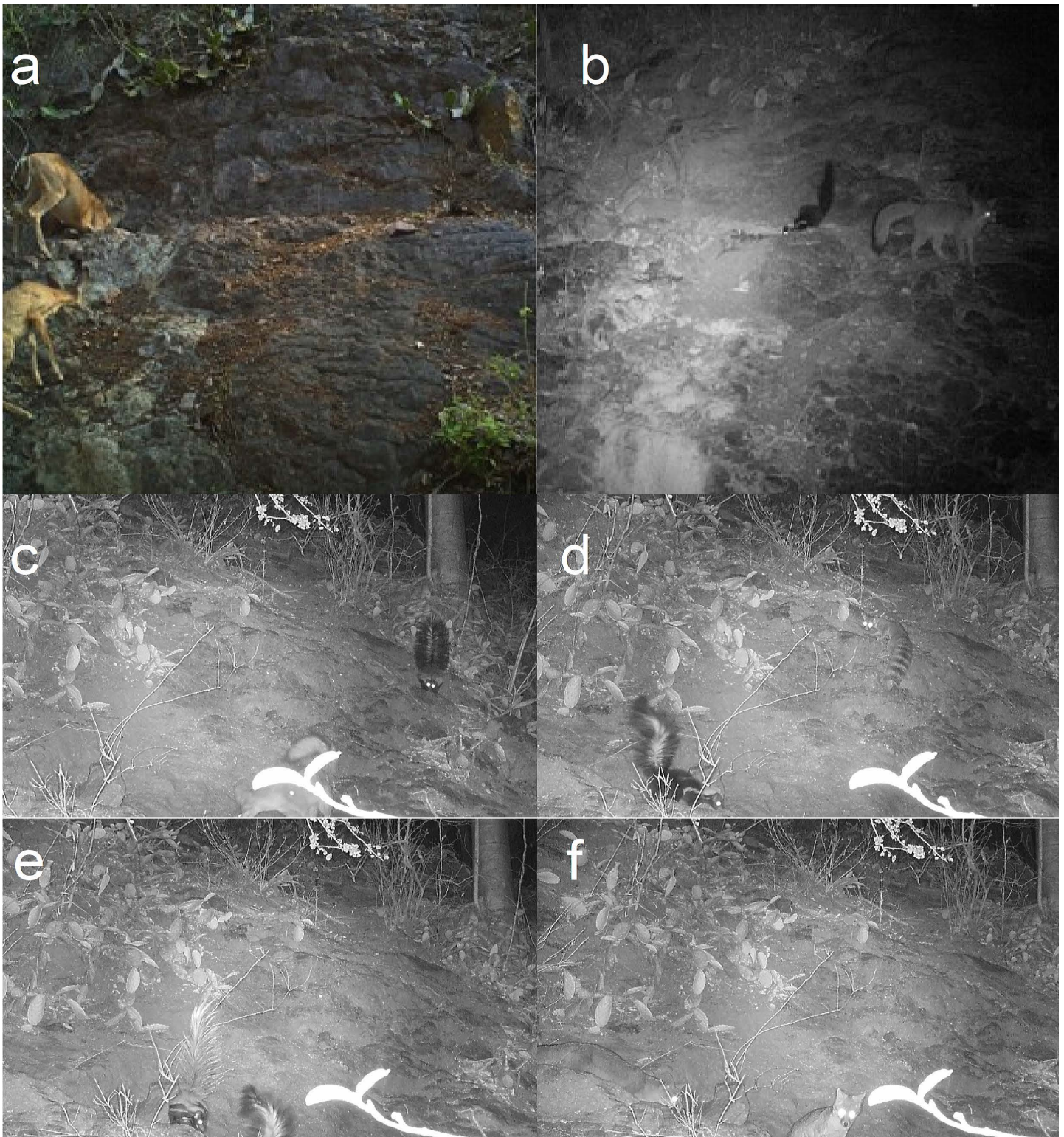


Figure 1. Co-occurrence in the waterhole between: a) two individuals of *Odocoileus virginianus*; b and c) *Mephitis macroura* and *Urocyon cinereoargenteus* individuals; d) *Mephitis macroura* and *Bassariscus astutus* individuals; e) two individuals of *M. mephitis*, and f) individuals of *U. cinereoargenteus* in the Ejido Rancho El Salado, in the southeast of the state of Puebla, in central México.

badger) and canids (Lehner 1981; Minta et al. 1992; Clark et al. 2015) and between *U. cinereoargenteus* and *Spilogale angustifrons* (southern spotted skunk; Farías-González and Vega-Flores 2019; Pérez-Irineo et al. 2020; Mejenes-López et al. 2021), as well as a co-occurrence between *C. cinereoargenteus* and *M. macroura* (Pérez-Irineo et al. 2020).

Water availability varies with the rainfall regime, nearby rivers have water only during the rainy season, and other deposits are small and temporary runoffs. There is, therefore, a severe water shortage for several months of the year. Thus, it is possible that the need to meet their water requirements outweighs the negative interactions among

the species in our study site. In previous studies it has been recorded that the probability of negative interactions between species might increase especially when there are limited resources such as water (Rosenstock *et al.* 1999; Krausman *et al.* 2006; Perera-Romero *et al.* 2021). However, negative interactions, such as kicking, pushing, or chasing among species, when using waterholes were not recorded in our study site as in other studies (Rosenstock *et al.* 2004).

We recorded a high frequency of visits to the waterhole by *Mephitis macroura*. We also observed that it was possible to identify individuals through the coloration pattern of the back and tail, and at least four individuals were identified during the sampling period (Figure 2). Our records raise the possibility of carrying out population and ecological studies. These could include estimation of population size using capture-recapture models, and activity, residence and reproduction patterns, in order to establish conservation strategies for these species (Cuarón *et al.* 2016). The use of this variation in skunk coloration for the identification of individuals has been previously mentioned for striped skunks, *Mephitis mephitis* (Theimer *et al.* 2017), although it has not been applied for either of the two species thus far.

Waterholes contribute to the survival of several species and they serve as sites for resting and refuge against predators (Rosenstock *et al.* 1999; Martínez-Kú *et al.* 2008; Delgado-Martínez *et al.* 2018; Rich *et al.* 2019). Our records showed that they may also function as play and grooming areas and for interactions among species, then its conservation should be considered a priority in our study site.

Our study also emphasizes a basic aspect, but perhaps underestimated in recent years for the sake of quantitative analysis of a large amount of data resulting from the use of camera traps: the qualitative observation of animals through photos. These observations can reveal basic and interesting aspects of the natural history of species that allow us to improve the knowledge we have about them and infer hypotheses in this case about coexistence in the same place. Observation of wildlife was an essential part of the development of modern science through “natural historians” such as Aldo Leopold (Piccolo 2020). This knowledge is also important for conservation actions. The camera traps offer us the opportunity to observe the animals in activities that are not easy to record. Recent works where these “curious observations” are reported, such as those by López-Tello and Mandujano (2016), Farías-González and Vega-Flores (2019), Pérez-Irineo *et al.* (2020), Mejenes-López *et al.* (2021) are examples of what is discussed here.

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Figure 2. Observation of different individuals of *Mephitis macroura* in the waterhole in the Ejido Rancho El Salado, Puebla, in central México. The coloration pattern varied from almost white (a, b) to almost black (c, d).

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