

Interaction between Ground Squirrels with rattlesnakes in arid zones

Interacción entre ardillas terrestres con serpientes de cascabel en zonas áridas

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The predation of ground squirrels by rattlesnakes has influenced the development of specialized anti-predatory strategies by squirrels. This note describes two cases of encounters of squirrels with rattlesnakes in México, captured photographically. The first event is the interaction between an individual of *Xerospermophilus spilosoma* and one of *Crotalus atrox* in the Mapimí Biosphere Reserve, Durango, an arid area of the Chihuahuan Desert in northern México. The second event involved two individuals of *X. perotensis* and one of *C. scutulatus salvini* in the Perote Valley, a semi-arid zone of Veracruz. Both squirrel species displayed anti-predation behaviors reported for the genus, as well as the ability to spot snakes and communicate the alert status to other group members; thus, these observations contribute to the knowledge of the natural history of these species.

Key words: arid and semi-arid areas; behavior; México; predator-prey; *Xerospermophilus*.

La depredación de ardillas terrestres por serpientes de cascabel ha influido en el desarrollo de estrategias antidepredatorias especializadas por parte de las ardillas. En esta nota se describen dos casos de encuentros de ardillas con serpientes de cascabel, capturados fotográficamente en México. El primer evento es la interacción entre un individuo de *Xerospermophilus spilosoma* y uno de *Crotalus atrox* en la Reserva de la Biósfera de Mapimí, Durango, zona árida del Desierto Chihuahuense al norte del país. El segundo evento lo componen dos individuos de *X. perotensis* y uno de *C. scutulatus salvini* en el Valle de Perote, zona semiárida de Veracruz. Ambas especies de ardillas presentaron comportamientos antidepredadores reportados para su género, así como la capacidad para identificar a las serpientes y transmitir el estado de alerta a sus congéneres; por lo que estas observaciones contribuyen con el conocimiento de la historia natural de dichas especies.

Palabras clave: comportamiento; depredador-presa; México; *Xerospermophilus*; zonas árida y semiárida.

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Ground squirrels are an important food source for rattlesnakes, representing up to 60 % of their diet (Fitch 1949). As a result, some sciurids have developed specialized anti-predator strategies (e.g., resistance to venom, alerting and deterrence behaviors such as tail flagging; Clark et al. 2016). However, the knowledge of these strategies comes from the study of a limited number of species (i.e., *Otospermophilus beecheyi*; Barbour and Clark 2012; Ayón et al. 2017), while others, such as those of the genus *Xerospermophilus*, have received less attention in spite of their higher vulnerability from their lesser physical capacity when facing an attack (Hersek and Owings 1993; Clark et al. 2016). In addition, most of their natural history is still unknown, including interactions with predators. Thus, this study aims to describe the anti-predator behaviors of the spotted ground squirrel, locally known as juancito (*Xerospermophilus spilosoma*) and the endemic Perote ground squirrel, commonly known as chichilote or moto (*X. perotensis*), during encounters with rattlesnakes in two different locations in México. *X. perotensis* is considered as endangered by the International Union for the Conservation of Nature (IUCN) and as threatened by the Official Mexican Norm NOM 059 (SEMARNAT 2010).

Study Area. The sightings occurred in the Mapimí Biosphere Reserve (MBR) and in the Perote Valley (PV). The MBR is a natural protected area in the Chihuahuan Desert located in the convergence of the states of Durango, Chihuahua, and Coahuila. Its elevation range is 1,100 to 1,400 m (CONANP 2006). The climate is dry semi-warm, with a mean annual precipitation of 264 mm and mean annual temperature of 20 °C (CONANP 2006). The dominant vegetation comprises halophilous grassland and xerophilous shrubland (CONANP 2006). The PV stretches across the border between the states of Veracruz and Puebla. Its elevation ranges between 2,300 and 2,500 m (Gerez 1985). Its climate is semi-arid temperate (García 2001), with a mean annual temperature of 14 °C and a mean annual precipitation of 500 mm. The vegetation includes pine forests with tascate juniper (*Juniperus deppeana*), thorny bushes, natural grasslands and induced pastures, hayfields, and halophilous vegetation (Gerez 1985).

Record collection. *X. spilosoma* was recorded in the MBR on September 10th 2018 through a camera trap (Cuddeback Black Flash®, Model 1231; 26° 45' 37" N, 103° 41' 03" W) used for sampling carnivore mammals (Andrade-Ponce

[et al. 2020](#)) and set to capture photographs at 10-second intervals, approximately. The habitat was a shrubland bordering a semi-stabilized dune and dominated by *Larrea tridentata* and *Opuntia imbricata*. The record of *X. perotensis* was a direct observation recorded and digitally photographed on 21th August 2013 near the town of San Antonio El Limón, Perote, Veracruz (19° 31' 05" N, 97° 19' 40" W), while conducting car trips searching for the species ([Montero-Bagatella et al. 2017, 2018](#)).

In the MBR, we recorded the agonistic encounter between *X. spilosoma* and *C. atrox*. The event occurred at 18:50 h and lasted 3 minutes; with a total of 14 photographs captured. The first photos show an individual of *C. atrox* in motion; one minute later, the presence of one specimen of *X. spilosoma* was recorded, which presumably made the snake to change the direction of its displacement (Figure 1). The squirrel intercepted the path of the snake and then adopted a posture that suggests a movement characterized by a rapid tail flagging. In the last frames, the squirrel remained approximately 30 cm away from the snake until the latter moved out of the camera's field of view.

In the PV, at approximately 14:00 h we observed the interaction between an individual of *X. perotensis* and an individual of *C. scutulatus salvini* in a short grassland (*Bouteloua* spp., *Aristida divaricata*, *Bidens anthemoides*). The squirrel deployed alerting behaviors while the snake moved across the vegetation. The squirrel adopted a bipedal posture accompanied by cervical movements in search of the snake, with the tail erect, tail flagging, and a repetition of short vocalizations. This behavior was received and replicated by another individual located 30 cm away. The squirrels kept a distance of 30 to 40 cm from the snake while moving quickly, in a parallel direction to it (Figure 2; Appendix 1). On several occasions, the squirrels crossed their paths, they stopped, adopted a bipedal position and vocalized. The vocalizations continued for some additional 1 to 2 minutes, despite the snake already being far away. The event lasted approximately 4 to 5 minutes.



Figure 1. Enlarged photograph of the encounter between the Spotted ground squirrel (*Xerospermophilus spilosoma*) and a Western diamond-backed rattlesnake (*Crotalus atrox*) in the Mapimí Biosphere Reserve, México.



Figure 2. Photographic records of the encounter between a Perote ground squirrel (*Xerospermophilus perotensis*) and a Perote grassland rattlesnake (*Crotalus scutulatus salvini*) at Perote Valley, México.

The squirrels exhibited anti-predator behaviors as reported for species of the same genus, including tail flagging, inspection of the predator, and vocalizations to alert other squirrels ([Clark et al. 2016](#)). In the case of *X. perotensis*, the vocalizations and alertness status were maintained after the withdrawal of the predator, which is likely to increase the chances of survival in future attacks ([Putman and Clark 2014](#)). Nevertheless, this was not evidenced for *X. spilosoma* due to methodological limitations of camera-traps. *Ictidomys mexicanus*, a species of similar size to those studied, is resistant to rattlesnake venom and can even get to counterattack the snake ([Martinez et al. 1999](#)). However, the records obtained are not conclusive as to the presence of these traits in the studied species. Nonetheless, the observations reported here suggest the ability of both species to detect the presence of snakes and producing communication alerts to other nearby squirrels. The above provides approximations about the natural history and evolution of interacting species, as characteristics such as size, physiology, habitat, and coevolution with the predator influence anti-predator behaviors; which may differ in species of close lineages ([Clark et al. 2016](#)). Therefore, further research efforts are needed to characterize the anti-predator strategies of species of the genus *Xerospermophilus*.

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Appendix 1

Video of the encounter between *Xerospermophilus perotensis* and *Crotalus scutulatus salvani* at Perote Valley, México.

https://drive.google.com/file/d/1LUWZ61QOBCuFLoeJ6v8Rd_1_5kLce/view

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