Colegio de Postgraduados

Rodents in Xerophilous Shrubland and Semi-Desert Grassland Communities of Southeastern Coahuila, Mexico

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ABSTRACT

Objective: To assess the diversity of rodent communities in semi-desert grasslands and xerophilous shrubland at the "Los Ángeles" Ranch in southeastern Coahuila.

Design/methodology/approach: Monthly samplings were carried out from May to November 2020 using Sherman traps. The capture-recapture method was used to estimate species richness and abundance. Non-parametric estimators, species rarefaction curves, and rank abundance plots were utilized to measure species diversity. The Whittaker index was employed to assess species turnover between sampled communities.

Results: A total of 205 individuals from three families and eight species of rodents were recorded, with the Cricetidae family being the best represented. The species rarefaction curve showed that the shrubland exhibited greater diversity compared to the grassland. The dominant species were *Onychomys arenicola* in the semi-desert grassland and *Peromyscus zamorae* in the xerophilous shrubland.

Limitations/implications: There remains a need to extend long-term monitoring efforts to detect how anthropogenic activities influence species composition.

Findings/conclusions: The study highlights the importance of grasslands for the conservation of rodents in the state. Semi-desert grasslands and shrublands provide natural resources that should be preserved to maintain biodiversity in semi-arid ecosystems.

Keywords: Rodentia, habitat, grassland, semi desertic ecosystem, diversity.

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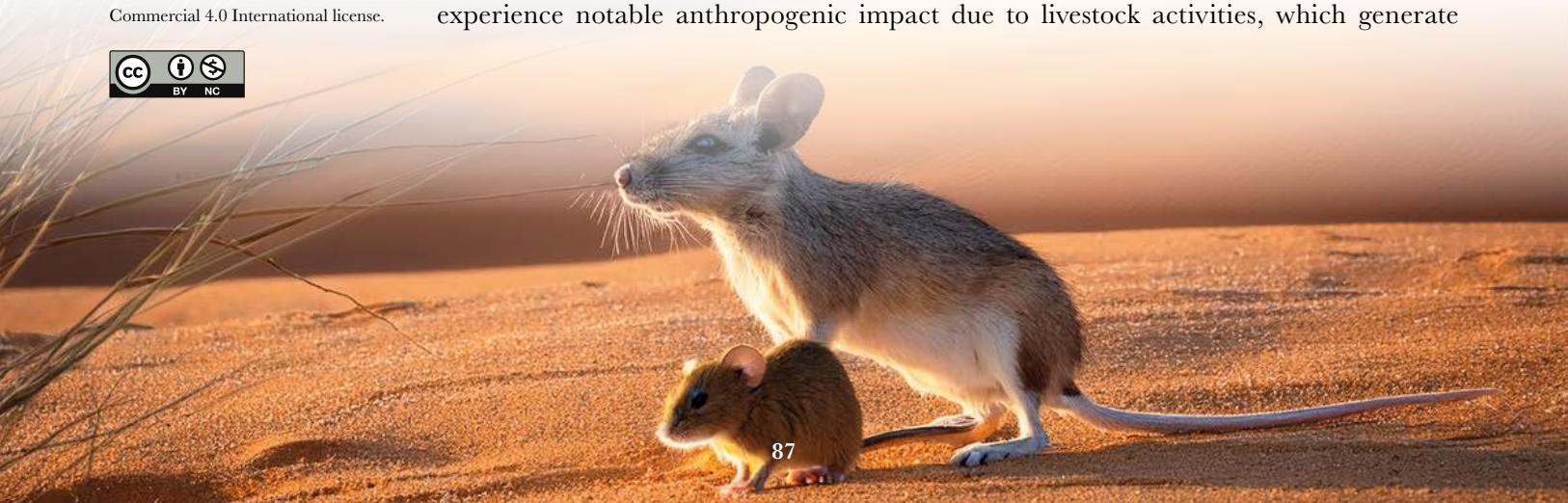
INTRODUCTION

Coahuila is an important part of the arid and semi-arid ecosystems of northern Mexico, as the majority of its surface is immersed in the Chihuahuan Desert (Villarreal-Quintanilla and Encina-Domínguez, 2005). However, some areas within this region experience notable anthropogenic impact due to livestock activities, which generate



modifications in the structure and vegetation cover, thus affecting the availability of habitats for various wildlife species (Hernández-Betancourt *et al.*, 2012). Therefore, it is essential to have information about the composition of the different faunistic groups that these ecosystems harbor. Among these, rodents are particularly interesting for understanding the functioning of ecosystems, as they are vulnerable to habitat disturbances and require specific physical and climatic conditions for establishment (Aragón *et al.*, 2012). Additionally, this faunistic group plays an important role as seed dispersers and consumers (Godó *et al.*, 2022) and constitutes a significant part of the biomass for predators (Hernández *et al.*, 2011). Although various studies on mammals have been conducted in Coahuila, most of them have focused on the central and northern regions of the state (Sierra Mojada and San Buenaventura), primarily addressing aspects of population dynamics and faunistic inventories (González-Uribe *et al.*, 2023; Valdés-Alarcón *et al.*, 2023). Meanwhile, in other areas of the state, studies have been conducted on distribution patterns (Ramírez-Pulido *et al.*, 2018; Pineda *et al.*, 2024). Therefore, it is essential to increase knowledge in other regions to understand the diversity and composition of mammal communities, such as rodents in the state (Ramírez-Pulido *et al.*, 2016). In this context, the objective of this study was to evaluate the diversity of rodent communities in semi-desert ecosystems, such as semi-desert grasslands and xerophilous shrubland at the "Los Ángeles" Ranch in southeastern Coahuila. This was done to generate basic information about the species that inhabit this region and to fill gaps in the knowledge of species richness and population abundance, there by contributing to the conservation of local biodiversity in the arid and semi-arid ecosystems of Coahuila.

MATERIALS AND METHODS

The study was conducted at the "Los Ángeles" Ranch located in the municipality of Saltillo, Coahuila (25° 04' 12" to 25° 08' 51" N, 100° 58' 07" to 101° 03' 12" W) (Figure 1), at an average altitude of 2,150 m (Heredia-Pineda *et al.*, 2017). This area covers 7,000 hectares and features elevated zones and valleys. The climate is dry, arid-semi-warm, with a cool winter, and the average annual temperature varies between 18 and 22 °C (García, 2004). The average annual precipitation ranges from 450 to 550 mm, with rainfall primarily occurring during summer and winter (López-Santos *et al.*, 2008). The main activity in the area is extensive beef cattle production through rotational grazing.

The dominant types of vegetation are xerophilous shrubland and semi-desert grassland (Encina-Domínguez *et al.*, 2018).

Fieldwork: Sampling was conducted monthly from May to November 2020, where four sampling sites were established (two sites in semi-desert grassland and two in xerophilous shrubland). At each site, a quadrant of 4,000 m^2 was established with 40 trapping stations distributed at equal distances of 10 m. At each station, a Sherman trap was placed (González-Romero, 2011). Capturing was conducted over three consecutive nights at each site. The capture and recapture method was used (Krebs, 1985), where each individual was marked by ectomizing phalanges (Pacheco *et al.*, 2000; Romero-Almaraz *et al.*, 2007). For species identification, the somatic measurements of the

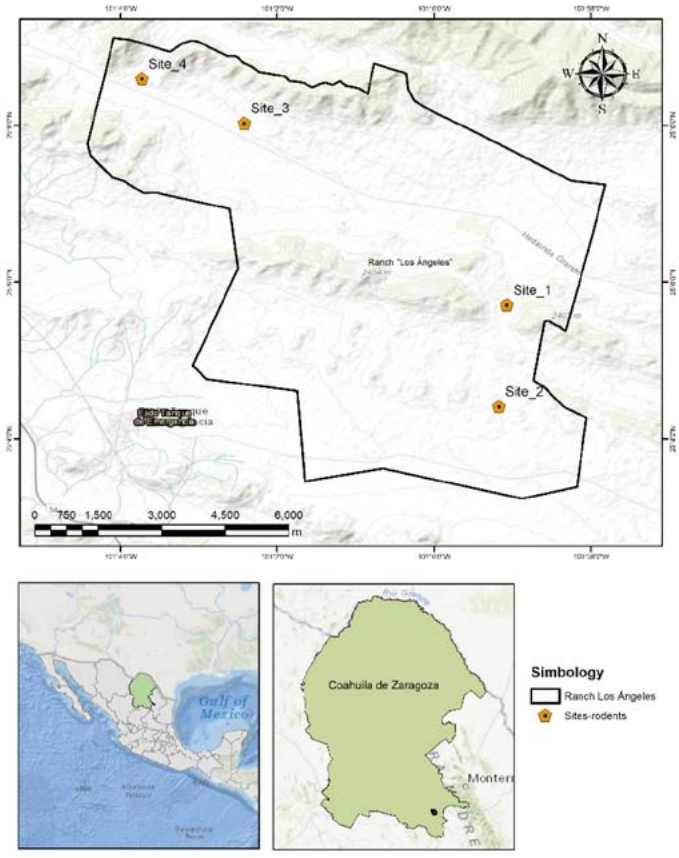


Figure 1. Location of the Los Ángeles Ranch in southeastern Coahuila.

captured individuals were recorded. Subsequently, guides with specialized taxonomic keys were utilized (Ceballos, 2014; Álvarez-Castañeda *et al.*, 2015). Once identified, the individuals were released *in situ*.

Statistical analysis: To estimate species richness, non-parametric estimators ICE and Jackknife 1 were employed (Gotelli & Colwell, 2011), calculated using the EstimateS 9.10 program (Colwell, R. K. 2013). For the analyses, true diversity was used at three levels, where q=0 corresponds to species richness, q=1 is the exponential of Shannon, and q=2 is the inverse of Simpson's index (Jost, 2006). The rarefaction curve was calculated using RStudio 4.3.0 (RStudio Team, 2023) with the iNEXT package (Hsieh *et al.*, 2016), with 95% confidence intervals (Moreno, 2001; Jiménez-Valverde and Hortal *et al.*, 2003). True diversity at each site was measured using the exponential of the first-order Shannon index (1D) (Jost, 2006; García-Morales *et al.*, 2011; Moreno *et al.*, 2011). Rank-abundance graphs were generated to observe the structure of species within the different sites. Finally, to evaluate species turnover among the sampled plant communities, the Whittaker index (Beta diversity) was used, which is defined as the ratio between gamma diversity (at the regional level) and alpha diversity (at the local level), expressed as gamma divided by alpha ($\beta=\gamma/\alpha$). This index measures the degree of differentiation among biological communities (Baselga and Gómez-Rodríguez, 2019).

RESULTS AND DISCUSSION

The recorded rodent species in the study area constitute 15.4% of what has been reported for Coahuila, 9.7% for the Chihuahuan Desert (Ramírez-Pulido *et al.*, 2018), and 3.3% at the national level (Ceballos, 2014; Ramírez-Pulido *et al.*, 2014). A total of 205 individuals were recorded, belonging to three families (Cricetidae, Heteromyidae, and Sciuridae) and eight species (Table 1). The dominance of the Cricetidae family was observed in the "Los Ángeles" Ranch, reflecting their fundamental role in the ecosystem; they have developed physiological and behavioral adaptations, such as fat and water storage in their bodies, allowing them to thrive in environments with limited resources (Harris & Pritchard, 2012) (Table 1).

The Mexican prairie dog (*Cynomys mexicanus*), the spotted ground squirrel (*Xerospermophilus spilosoma*), and the yellow harvest mouse (*Reithrodontomys fulvescens*) were recorded outside the sampling period; however, they were included in the species richness list (Figure 2).

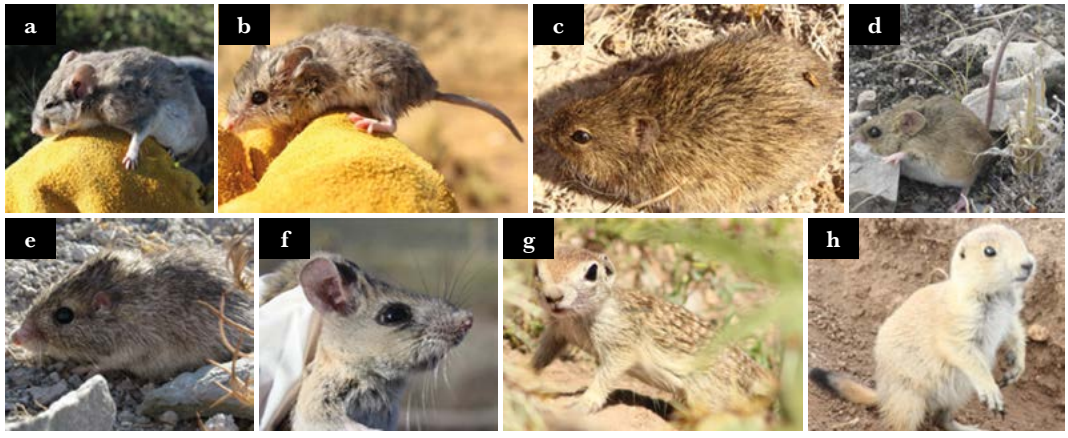


Figure 2. Rodents recorded at the "Los Ángeles" Ranch: *a*=*Neotoma leucodon*; b=*Onychomys arenicola*; c=*Sigmodon hispidus*; d=*Reithrodontomys fulvescens*; e=*Chaetodipus nelsoni*; f=*Peromyscus zamorae*; g=*Xerospermophilus spilosoma*; h=*Cynomys mexicanus*.

Table 1. Recorded species in each studied plant community.

Species	Name	Distribution	UICN/NOM-59-SEMARNAT-2010	Types of vegetation	
				Grassland	Scrub
Neotoma leucodon	White-toothed woodrat				✓
Onychomys arenicola	Chihuahuan grasshopper mouse			✓	✓
Peromyscus zamorae	Zamora deer mouse	Endemic		✓	✓
Sigmodon hispidus	Hispid cotton rat				✓
Chaetodipus nelsoni	Nelson's pocket mouse			✓	✓
*Reithrodontomys fulvescens**	Fulvous harvest mouse				✓
*Cynomys mexicanus**	Mexican prairie dog	Endemic	EN, P	✓	
*Xerospermophilus spilosoma**	Spotted ground squirrel			✓	

* Species recorded outside the sampling period; IUCN=International Union for Conservation of Nature (species included in the Red List of Threatened Species); NOM-059-SEMARNAT-2010=Species with some risk category under the Official Mexican Standard-059; Types of vegetation: ZAC=Semidesert Grassland (Species recorded in grassland); MAT=Xerophytic Shrubland (Species recorded in shrubland).

In relation to the species classified as at risk under the Official Mexican Standard 059-2010 (NOM-059-SEMARNAT-2010), the Mexican prairie dog was recorded in the endangered category (P) and also holds the same status (EN) within the International Union for Conservation of Nature (IUCN) Red List of Threatened Species. This species plays a fundamental role in the structure of grassland communities as an umbrella species, as it modifies the landscape by creating habitats for other species through its burrowing activities. The decline in population, attributed to habitat fragmentation, can have negative repercussions on the structure and functionality of the ecosystem, affecting species that depend on the habitats created by this rodent (Castellanos-Morales *et al.*, 2016; O'Brien & Kinnaird, 2016). The species rarefaction curve showed the highest richness for the xerophilous scrub community with five species, while the semidesertic grassland recorded the highest number of individuals (93). Although the rarefaction curve reached the asymptote, there is a probability of recording greater species richness if sampling continues. Regarding the number of effective species, differences in species richness (q=0) were observed: five species in the xerophilous scrub and three in the semidesertic grassland. The exponential of the Shannon index (q=1) indicated that the xerophilous scrub vegetation exhibited the highest diversity (2.62) compared to the semidesertic grassland (1.74). For the inverse Simpson value (q=2), it was higher in the semidesertic grassland (0.69) compared to the scrub (0.54). The wider confidence intervals for Shannon and Simpson diversity in the scrub indicate greater variability in species evenness compared to the grassland (Figure 3).

Regarding the abundance-rank curve in the two plant communities (Figure 4), the semidesert grassland was dominated by the sandy chapuliner mouse (*Onychomys arenicola*), as it is a carnivorous species with fossorial habits that requires open areas for its burrows.

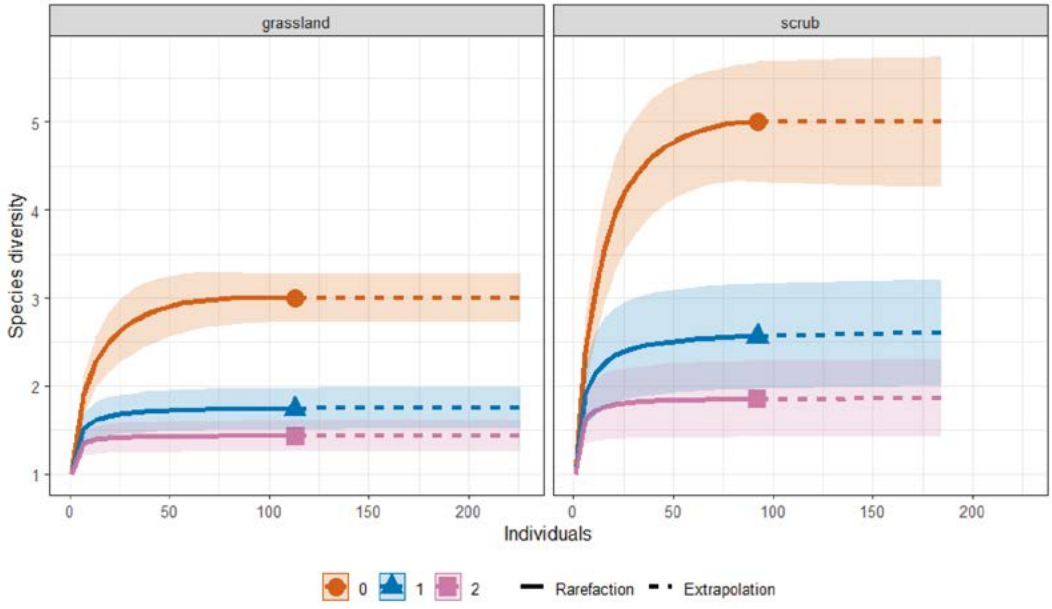


Figure 3. Species rarefaction curve in the two studied plant communities: 0=richness, 1=exponential of Shannon, 2=inverse of Simpson.

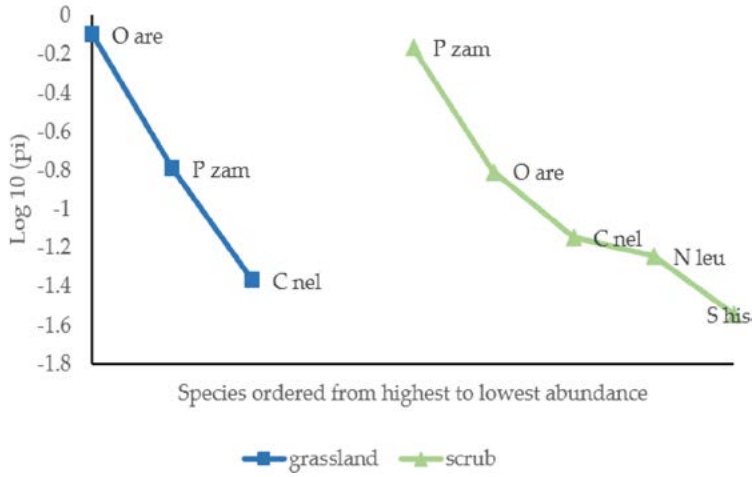


Figure 4. Species abundance rank curve recorded in each type of vegetation. O are=*Onychomys arenicola*; P zam=*Peromyscus zamorae*; C nel=*Chaetodipus nelsoni*; N leu=*Neotoma leucodon*; S his=*Sigmodon hispidus*.

This allows for soil aeration and visibility of potential predators, as well as foraging opportunities (Martín-Regalado *et al.*, 2019; Langley, 2021). In the xerophytic scrub, the dominant species was the Zamora deer mouse (*Peromyscus zamorae*), which is due to its populations being associated with the productivity of resources provided by the plant community (vegetation cover that serves as refuge and raw material for food) (Whitford & Steinberger, 2010, Ceballos, 2014). Among the species with low dominance in the grassland, the Nelson's pocket mouse (*Chaetodipus nelsoni*) was recorded, possibly due to the type of habitat where it is distributed, which is associated with areas featuring rocky slopes and grasslands with shrubs such as governadora and hojasén, which serve as protection against predators and as food sources (Neiswenter *et al.*, 2019; Martínez-Calderas *et al.*, 2023). The record of the cotton rat (*Sigmodon hispidus*) may be attributed to its ability to adapt to conditions with anthropogenic impact, as its populations establish themselves in agricultural areas and regions with livestock activities (Wright & Russell, 2010; Tomé *et al.*, 2020). Regarding species turnover (Beta Diversity), it resulted in 1.25, indicating low differentiation between the vegetation communities, as they share most of their species with low turnover values.

CONCLUSIONS

The information generated in this research provided a baseline on knowledge about the richness and abundance of rodents in the "Los Ángeles" Ranch, highlighting the importance of grasslands as key areas for the protection and maintenance of rodent populations, as well as the conservation potential that both vegetation communities offer for protection in southeastern Coahuila. It is recommended that future studies evaluate other environmental variables such as soil (texture, nutrient content, porosity, and permeability), altitude, diversity of grasses and shrub species, as well as the establishment of a greater number of sampling sites to broaden conservation efforts, particularly for species with conservation status, thereby ensuring the continuity of natural resources.

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