Mechanisms of niche partitioning between desert rodents in the East Mojave

Ciera Castillo¹, Katherine Hernandez², Isabelle Panza¹, Alexa Rowland¹

¹University of California, Santa Cruz, ²University of California, San Diego,

ABSTRACT

Understanding how species can coexist in light of competition has long been a focus of ecological study. One of the many mechanisms that have been proposed to explain how species with overlapping niches can coexist is that they differ in their behavioral patterns. In our study we investigated how rodents in the genera Dipodomys and Peromyscus partition their habitat spatially and how their behaviors differ. To test for behavioral differences and spatial habitat partitioning in these species we monitored animals using traps and wildlife cameras and mapped their habitat use in space. We found that Peromyscus displayed risk averse strategies in their foraging and habitat use whereas Dipodomys displayed more variability in their movements and were more likely to take risks. These interspecific patterns help us to better understand community ecology as a whole, and can have broad implications for the structure of communities in sensitive desert habitats.

INTRODUCTION

Co-occurring species can avoid costly competitive interactions via spatial, temporal, or resource-associated niche partitioning (Schoener 1974; Wiens 1977), and which can further lead to stable species coexistence (Albrecht and Gotelli 2001). The mechanisms allowing for coexistence of species, and particularly the number of species coexisting in a given habitat, have been explored from many viewpoints (Hafner 1977). Horn and MacArthur (1972) found that spatial partitioning can enable coexistence on a single resource. Schroder and Rosenzweig (1974) trapping records suggest that one species of Desert Kangaroo rat prefers a grassier habitat, and D. merriami a habitat dominated by creosote bush. Their findings suggest that these species avoid competition through habitat selection which is one mechanism of species coexistence. Desert rodents have been fundamental in exploring the underlying mechanics of community ecology given
the coexistence of a diverse assemblage of granivorous rodent species within a relatively simple desert ecosystem (Kotler and Brown 1988). The Mojave Desert houses diverse assemblages of granivorous rodents, including several species of *Dipodomys*, *Peromyscus*, etc., and whose communities vary with micro and macro-habitat heterogeneity (Stevens and Tello 2009). Coexistence among these granivorous rodents occur via a combination of mechanisms, including spatial and temporal niche partitioning (Kotler and Brown 1988). *Dipodomys* and *Peromyscus* are two major genera of nocturnal rodents in the Mojave whose diets rely on heavily on seeds and whose ranges often overlap (Kotler and Brown 1988; Stevens and Tello 2009). The use of shared habitat, resources, and similar foraging behavior between *Dipodomys* and *Peromyscus* presents a unique system in which to explore the different mechanisms leading to species coexistence. Despite an abundance of studies examining niche partitioning in desert rodents, there remains a lack of clarification on the mechanisms underlying the coexistence of *Dipodomys* and *Peromyscus* in the Mojave Desert.

In this study, we investigated spatial and temporal mechanisms of niche partitioning in *Peromyscus* and *Dipodomys*. Specifically we ask if *Peromyscus* and *Dipodomys* exhibit spatial partitioning in home range and habitat use. Secondly, we ask if *Peromyscus* and *Dipodomys* exhibit temporal partitioning in foraging behavior. Understanding how these mechanisms contribute to the coexistence of these two competing rodent genera can help further elucidate the outcomes of shared niches, and furthermore adds to our understanding of community-level patterns of resource use.

**METHODS**

**Study Area**

We conducted our study at the Sweeney Granite Mountains Desert Research Center in the East Mojave Desert, California, U.S.A. (34° 48’ 20” N, 115° 39’ 50” W). We conducted our study during the fall (November 3–8, 2017), with average nightly temperatures ranging from 13 degrees C. Our study area was located in mixed desert scrub, with dominant plant species consisting of creosote bush (*Larrea tridentata*), Mojave yucca (*Yucca schidigera*), and buckhorn cholla (*Cylindropuntia acanthocarpa*).

**Experimental Design**

In order to investigate mechanisms of spatial partitioning among *Peromyscus* and *Dipodomys* rodents, we conducted mark-recapture sampling and tracked individual movements over the course of 5 nights. We conducted mark-recapture sampling within a 48 m x 48 m grid containing 25 plot points regularly spaced 12 m apart. At each plot point, we placed a Sherman live trap filled with cotton balls to provide warmth and baited with oats and peanut butter to attract granivorous rodents. We set traps at sunset (~5
p.m.) and returned at approximately 8:30 p.m. each night to check traps. Captured rodents were identified to species. Rodents not identified as Dipodomys or Peromyscus were released without further processing as they were not focal in our study. Rodents identified as Dipodomys or Peromyscus, were processed according to the following protocol. First, we recorded life history characteristics to assist with species identification, including the weight of the rodent, the length of its tail (and length of the apical tuft for Dipodomys), the length of the hind foot, the length of the ear, and count of toes for Dipodomys. Secondly, we individually marked rodents at their first capture with a unique pattern consisting of a series of dots and lines marked using black and blue sharpie on the ventral side of the tail. Lastly, we dipped the rodent into a bag of UV dust (pink for Peromyscus and yellow for Dipodomys), and released them at the spot where they were captured. We followed their path with a UV flashlight (51 LED, 395 nM) for as far as possible, often ending at the entrance of a burrow. We recorded these burrows on a gridded map, giving each burrow a unique identifier and spatial coordinates in reference to our trapping grid. We also recorded the estimated distance (as the crow flies) of the UV trail, which we used as a proxy for foraging distance or home range. On subsequent trapping days, recaptured individuals were identified by their unique symbol on the ventral side of the tail but no other life history characteristics were recorded. However, recapped individuals were again dipped in UV dust and associated information regarding burrow location and distance traveled were recorded as additional information on the home range of that individual. In order to investigate temporal niche partitioning between Dipodomys or Peromyscus and to monitor rodent foraging behavior, we placed four camera traps in an area away from our grid, each with a quarter cup of bait (oats and peanut butter). We set camera traps to record 30 s videos with 5 seconds gaps in-between triggered recordings. For three consecutive nights, we turned on the cameras around 4:45 p.m., baited camera traps, and returned the following morning around 9 a.m. to retrieve the camera memory cards. From the camera trap data, we recorded the time of a visit from Peromyscus and Dipodomys, the frequency of visits, and duration of a visit measured as the number of times a camera was consecutively triggered by an individual before it left the site. Data from camera traps and Sherman live traps were analyzed in JMP using a t-test comparing number of recordings of an individual per visit, and by chi-squared test comparing the average proportion of visits to the baited camera trap sites between genus. Recapture rates between genus was analyzed using a chi-squared test. We used R Statistical Software programming (v. 3.4.2) to conduct all spatial visualization and analyses. In order to visualize individual home range we generated Minimum Convex
Polygons (MCP; package ggConvexHull) around locations where individuals were trapped by Sherman live trapping or followed by UV dust trails to burrows. We calculated home range using MCP methodology (package “adehabitatHR”, function mcp, percent = 100). Home range estimates required a minimum of five tracking points, and thus, we were only able to estimate home range for four *Peromyscus* and a single *Dipodomys* individual.

**RESULTS**

Estimated spatial territories of *Peromyscus* and *Dipodomys* indicated little overlap between home ranges and habitat use between the two genera (Fig 1). Home range estimates ranged between 5 m$^2$ and 400 m$^2$ in *Peromyscus* and 22 m$^2$ for a single *Dipodomys* individual. We found significantly more visits to baited camera traps by *Dipodomys* than by *Peromyscus* (N = 52, P = 0.04; Fig 2). We also found that there was a marginally significant difference in duration time of visits between *Dipodomys* and *Peromyscus*; specifically, *Dipodomys* were observed spending more time foraging at camera trap sites than the *Peromyscus* (P = .08, t = -1.8; Fig 3). Finally, *Dipodomys* had a significantly lower rate of recaptures than *Peromyscus* (N = 48, P = 0.03; Fig 4).

![Figure 1. Habitat partitioning between Dipodomys and Peromyscus.](image)

Figure 1. Habitat partitioning between Dipodomys and Peromyscus. Grid represents our study plot in the field with dimensions extended from 48 m x 48 m to 60 m x 60 m in order to incorporate burrows found outside of our study plot. Each unit represents a meter. Minimal convex polygons were made following individuals from traps at

which they were captured to the burrows they retreated to. Shaded regions are the calculated home ranges of an individual.

**Figure 2.** Average proportion of visits to camera trap sites between *Dipodomys* and *Peromyscus*. Shaded bars are representations of mean from individuals with standard error bars included.

**Figure 3.** Average duration of *Dipodomys* and *Peromyscus* visits to baited camera traps. Shaded bars are representations of mean from individuals with standard error bars included.

**Figure 4.** Average duration of *Dipodomys* and *Peromyscus* visits to baited camera traps. Shaded bars are representations of mean from individuals with binomial error bars included.
DISCUSSION

Our results suggest that coexistence between *Dipodomys* and *Peromyscus* may be mediated by spatial niche partitioning of habitat. *Dipodomys* are considerably larger than *Peromyscus*, and consequently have much larger home ranges (what are their estimated home ranges?) that exceed the area of our trapping grid (Scheibe 1984). Larger granivores, such as *Dipodomys*, tend to create “patches” in which they forage, relative to their size and other neighboring rodents (Price and Brown 1983). Our results concur with these studies, and suggests that spatial partitioning does occur between *Dipodomys* and *Peromyscus*, and that their foraging territories are likely relative to their respective sizes.

In addition, we did not find evidence for temporal niche partitioning between *Dipodomys* and *Peromyscus*. However, we did find that *Dipodomys* were approaching and spending a longer amount of time feeding at camera traps than *Peromyscus*. This suggests a difference in foraging behavior that extends beyond temporal or spatial partitioning. *Peromyscus*, by having a specific territory and visible hesitancy while feeding, is more risk averse in its foraging behavior than *Dipodomys*. However, *Peromyscus* were recaptured far more than *Dipodomys*, and were consistently recaptured in the same area of the grid. Thus, the differences in foraging behavior between these two genera also likely contribute to further niche partitioning. *Peromyscus* may be more likely to give up a food resource not directly within their territory, while *Dipodomys* may not. Thus, *Dipodomys* likely are able to exploit high-risk foraging opportunities while *Peromyscus* may be restricted to low-risk foraging opportunities. These observations concur with a study by Price and Brown (1983), which found that the interspecific differences in microhabitat affinity in desert rodents contributes to their coexistence and genus characterization.

Overall, our study reveals complex niche partitioning in *Dipodomys* and *Peromyscus*. The two genera have very similar diets and life histories, but by partitioning their habitat through spatial and behavioral means they may reduce costly energy expenditures associated with competition. Because of the harsh conditions and limited resources in the Mojave desert, it is unsurprising to find such dynamic interactions arise. However, it is worth researching how similar multi-level partitioning occurs in other desert habitats, where other rodent genera take precedence.

ACKNOWLEDGEMENTS

This work was performed at the University of California’s Sweeney Granite Mountains Desert Research Center, doi:10.21973/N3S942.

REFERENCES


