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Influence of rodent predation on antelope bitterbrush seedlings

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Abstract

Antelope bitterbrush (*Purshia tridentata*(Pursh) DC) is the most important browse species on many mule deer (*Odocoileus hemionus*) ranges. California-Nevada interstate mule deer herds are critically dependent on antelope bitterbrush stands, in which many of these stands have been and are currently exhibiting little recruitment. Lassen is the only established cultivar of antelope bitterbrush. Rodent predation on Lassen antelope bitterbrush seedlings was studied in burned and unburned antelope bitterbrush communities in northeastern California during 1993. Rodent population densities were 15/ha and 14/ha in the burned and unburned habitats, respectfully. Rodent compositions consisted of the Ord's kangaroo rat (*Dipodomys ordii*), deer mouse (*Peromyscus maniculatus*), and the Great Basin pocket mouse (*Perognathus parvus*). Rodents significantly decreased antelope bitterbrush recruitment through grazing and disturbance of antelope bitterbrush seedlings. Ord's kangaroo rats preyed on higher numbers of antelope bitterbrush seedlings than did the other 2 common rodent species.

Key Words: *Purshia tridentata*, granivores, harvest, recruitment, shrub

Plant-animal interactions have assumed increasing importance in our understanding of population and community ecology (Janzen 1971). Plant population and community ecology can be fully appreciated by understanding the details of how animals interact with plants as herbivores, pollinators, and handlers of seeds. How plant and animal populations influence one another is not well understood. The obvious advantage to the animal, in the case of seed caching rodents, is a nutritious food source. The obvious advantage to the plant is seed dispersal, and may include enhancement of germination and establishment.

Antelope bitterbrush (*Purshia tridentata* (Pursh) DC), endemic to North America, is an important browse species for native ungulates and livestock. Many existing stands have no seedling recruitment, and are becoming decadent with little browse production (Hubbard 1956, Sanderson 1962, Nord 1965, F. Hall pers. comm.).

The natural regeneration of antelope bitterbrush is closely related to the seed caching activities of rodents. Granivorous rodents often benefit antelope bitterbrush seeds by dispersing them through their caching behavior (Hormay 1943,p Nord 1965, Evans et al. 1982, Vander Wall 1994). Granivorous rodents exhibit 2 types of caching; they cache some seeds in larders deep within their burrows ("larder hoarding"), and bury others in scattered shallow depressions they dig throughout their home ranges ("scatter hoarding") (Vander Wall 1990). Seeds not recovered for future consumption may germinate, and therefore scatter hoarding by rodents has been found to be an important mechanism of recruitment of antelope bitterbrush plants (Sanderson 1962, Nord 1965, Evans et al. 1982, Scholten 1982, Vander Wall 1994). Increased population densities of rodents may bring about the reduction, or even the elimination, of certain plant species preferred by them (Horn and Fitch 1942). Heske et al. (1993) reported that kangaroo rats have a dramatic effect on plant cover and species composition. Evans et al. (1982) speculated that rodents not only benefit from antelope bitterbrush seed caches as a future seed source, but also benefit from the sprouting of their caches as they return to graze the cotyledons of germinating seeds. Seedlings high in carotene are presumed to be a vital component of rodent diets in the spring. However, the effects of rodent consumption of antelope bitterbrush seedlings are not well known. This study was initiated with the following objectives: 1) determine the effects of rodent consumption of antelope bitterbrush seedlings on recruitment, and 2) determine species-specific effects of rodent predation on antelope bitterbrush seedlings.

Materials and Methods

Study Area

The study area is located inside the Doyle Wildlife Management Area, 72.4 km north of Reno, Nevada along U. S. 395, in northeastern California. The site is at 1292 m and has a burned and unburned plant community. The unburned habitat is dominated by antelope bitterbrush (*Purshia tridentata*(Pursh) DC), big sagebrush (*Artemisia tridenta* Nutt.), and desert peach (*Prunus andersonii A. Gray*). The burned habitat, most recently burned in 1985 and consumed some 100,000 hectares, is domi-

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nated by cheatgrass (*Bromus tectorum L.*), skeleton weed (*Lygodesmia spinosa Nutt.*), buckwheat (*Eriogonum nudum* Benth.), and desert peach. The site receives an average of 243 mm of annual precipitation, mostly during the winter months (Clements, unpublished data). The soils are sandy, mixed, mesic, Torripsammentic Haploxerolls with inclusions of loamy, mixed, mesic, Xerollic Haplargrids (R.R. Blank pers. comm.)

Censusing of Rodent Populations

Rodents were censused at least twice per month using mark-and-release live-trapping during the duration of this study, which was March 1993 through May 1993. Sherman livetraps were the type of trap used. Two grids were established, one on the burned habitat and one on the unburned habitat. Each grid had 5 transects spaced 15 m apart. Each transect had 10 stations that were also spaced 15 m apart. At each station 2 Sherman rodent livetraps were set out (100 traps/grid), baited with millet (*Panicum* spp.) seed in the evening, and checked the following morning. All captured animals were identified by species and sex, marked with a numbered eartag, and released at the point of capture.

Monitoring of Seedling Predation

Seedling predation by various species of rodents was investigated using portable livetrap enclosures. These enclosures, 60 cm by 30 cm by 35 cm, were constructed having solid plywood bottoms, fronts, and backs and were covered with 0.7 cm mesh hardware cloth. A hole was cut out of the front plywood panel to allow for the placement of a modified Sherman livetrap, with the back door of the livetrap removed, to allow the rodent to enter but not exit the enclosure. The back plywood piece was removable to allow for the placement and removal of a 5 cm deep soil flat. One transect was added to each grid, resulting in 6 transects per grid, equally spaced 15 m apart, to accommodate all 12 enclosures.

Lassen antelope bitterbrush seeds were stratified using cool-moist prechilling to promote germination. A gravelly, sandy soil type was placed into soil flats 5 cm deep, into which 50 antelope bitterbrush seedlings in the dicotyledon stage were transplanted into each soil flat 3 cm deep. Soil flats were then placed into enclosures. The enclosures were placed randomly along the transects, with the flats of seedlings inside, on both grids at 1600 hours (4:00 pm), and baited with 4g of millet seed (620 seeds) inside the livetrap. Twenty four hours later the enclosures were checked. If there was a capture then the species, sex, and eartag number was recorded and the rodent was set free. The soil flat was then removed and the number of seedlings preyed upon and present were recorded and the soil flat was marked by date, grid, transect, station, rodent species, and marked as an experimental unit. If there was no capture the soil flat was removed and the number of seedlings were recorded and the soil flat marked by date, and as a control unit. These soil flats were then transported back to the greenhouse. Another 12 soil flats with 50 fresh seedlings were placed into the enclosures and the enclosures randomly placed out along the transects again. This process was repeated for 4 consecutive days (i.e. placed out Monday–Thursday) of 4 separate weeks over 2 months (1/4 and 3/4 moon phases of March and April) that coincided with seedling emergence for this area. Those soil flats were taken back to the greenhouse, given adequate water and observed for 10 days. Seedlings that survived were recorded. Any antelope bitterbrush seedling that had reached the true-leaf stage at that time were recorded as recruited.

Data were analyzed using a Randomized Complete Block Design, single factor. Analysis of variance using PROC GLM in SAS (SAS Institute Inc. 1989). The blocking factors were moon phase and weeks. The treatments were rodents captured .versus rodents not captured in the enclosures. Least Square Means was used to find pairwise treatment differences when a significant F-Test was found.

Results

Rodent Censusing

A total of 1,200 trap nights (600/grid) were equally divided between the burned and unburned grids during this study. This resulted in 79 captures of 29 separate individuals of 4 species. There were slightly more captures of rodents in the burned habitat than in the unburned habitat (Table 1). Species densities of the 2 grids were similar although species-specific densities were highly different. Rodent densities were estimated at 15/ha in the burned habitat, and 14/ha in the unburned habitat, using the minimum known number alive method. Rodent densities may be an over-estimate since there is a possibility that rodents outside the grid area roamed into the grid area and were captured. The possibility of not capturing rodents, because of certain individual rodents being trap shy, would result in under-estimating the rodent densities. Ord's kangaroo rat was the species captured the most (n=13), followed by deer mice (n=8), and Great Basin pocket mice (n=7). The least chipmunk (*Eutamius minimus*) was captured on one occasion during our live-trapping efforts.

Table 1. Species captured per hectare grid through livetrapping.

Species	Burned grid	Unburned grid
Ord's kangaroo rat	30	9
Deer mouse	11	14
Pocket mouse	1	15
Least chipmunk	0	1
Total	42	37

Seedling Consumption

There were no differences in seedling recruitment between the burned habitat grid and the unburned habitat grid, therefore the data for the 2 habitats were combined. Rodents in this study readily consumed antelope bitterbrush seedlings as they consistently grazed the cotyledons, even though highly preferred millet seed was available as an alternative food source. This suggests a preference of antelope bitterbrush seedlings by these rodents at this site. During this study rodents decreased bitterbrush seedling recruitment ($P < 0.0001$). Without rodent predation (n=116), 87% of the antelope bitterbrush seedlings reached the true leaf stage. With rodent predation (n=74) this was reduced to 47%. On 2 occasions antelope ground squirrels (*Ammospermophilus leucurus*) were captured in our enclosures, but were not statistacally analyzed.

Differences in seedling recruitment between flats preyed upon by different rodent species were highly significant ($P<0.0001$). Recruitment was significantly ($P<0.05$) lower when seedlings

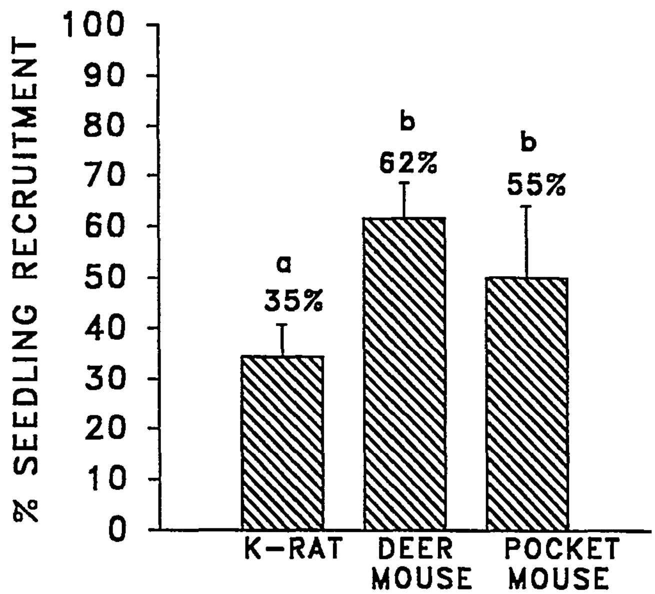

Fig. 1a. Species specific predation effect on antelope bitterbrush seedling recruitment. Species with the same letter are not significantly different (P>0.05).

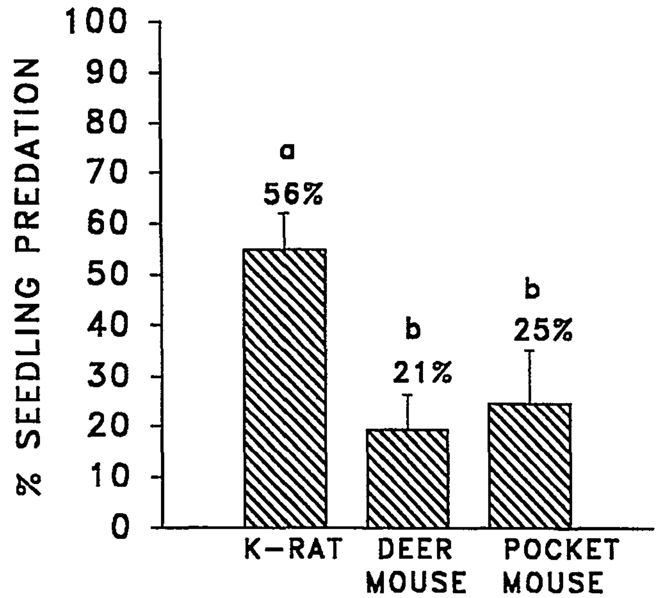

Fig. 1b. Species specific predation on antelope bitterbrush seedlings. Species with the same letter are not significantly different (P>0.05).

were preyed upon by Ord's kangaroo rats (n=34), than when they were preyed upon by deer mice (n=27), and pocket mice (n-11), (Fig. 1a). Significant differences existed in species-specific predation of antelope bitterbrush seedlings (P<0.0001). Seedling predation was higher (P<0.05) by Ord's kangaroo rats (n=34), than by deer mice (n=27), and pocket mice (n=11) (Fig. 1b).

Discussion

Rodents captured during this study were primarily nocturnal. Antelope ground squirrels and least chipmunks, both diurnal rodents, were caught very rarely, therefore were not statistically analyzed in this experiment. Total numbers of rodents captured in the 2 habitats were very similar, although numbers of individual species were different. Ord's kangaroo rats were most abundant in the burned habitat, while Great Basin pocket mice were most abundant in the unburned habitat. Deer mice were equally abundant in both habitats. Visual sightings of diurnal rodents led us to design this experiment in a manner that would allow us to capture and record data concerning the influence these rodents had on antelope bitterbrush seedlings. Antelope bitterbrush seedling recruitment at this site is minimal. Increases in rodent numbers, particularly Ord's kangaroo rats, could possibly decrease this recruitment further, whereas recruitment may increase as rodent density, and predation decreases.

Rodents captured in the enclosures readily ate antelope bitterbrush seedlings as they consistently grazed the cotyledons of antelope bitterbrush seedlings, even though millet seed was available as an alternative food source. In every observation, seedlings were consumed while millet seed was practically ignored, suggesting that the rodents at this site prefer antelope bitterbrush seedlings. Antelope bitterbrush seedling recruitment was lower when grazed by Ord's kangaroo rats than by other 2 species. Antelope bitterbrush seedlings appear to be very palatable to Ord's kangaroo rats, as individuals of this species would graze a soil flat of antelope bitterbrush seedlings like a "combine" going through a corn field. This may be because of a carotene requirement in their diet (Evans et al. 1982), palatability, or some other dietary value. Deer mice and pocket mice predation of antelope bitterbrush seedlings was different than that of the Ord's kangaroo rat. Deer mice and pocket mice appear to associate seedlings with ungerminated seeds, and therefore destroyed a number of seedlings through their digging for ungerminated antelope bitterbrush seeds.

Antelope bitterbrush seedling predation by rodents may be as high in a natural environment. Antelope bitterbrush seedlings are not as dense in the natural environment as they were inside the trial enclosures, therefore providing these rodents with a monoculture of seedlings to choose from. But, rodents may search for individual antelope bitterbrush seedlings because of their palatability or dietary value. If antelope bitterbrush seedlings do provide an essential dietary value (Evans et al. 1982), rodents may harvest and cache seeds to increase the number of seedlings, in part, available the following spring. From personal observations it appears that when antelope bitterbrush seedlings reach the true-leaf stage, rodent preference for the seedling decreases. In a natural environment it takes about 10 days for antelope bitterbrush seedlings to reach the true-leaf stage. Even at 10 days old these seedlings are very vulnerable to other causes of mortality (e.g. jackrabbits) (McAdoo and Young 1980).

Different species of rodents may affect antelope bitterbrush seedlings in different ways. Vander Wall (1994) reported good antelope bitterbrush seedling recruitment, compared to the minimul recruitment experienced at our study site, at higher elevations in western Nevada, from rodent caches by chipmunks, squirrels, and some deer mice. Areas that receive periodic good winter snow fall may benefit antelope bitterbrush communities by increasing germination of antelope bitterbrush seedlings and providing the necessary conditions for antelope bitterbrush seedling survival. Additional research is needed on the effects of rodents on the seed fates and seedling establishment of antelope bitterbrush. Such research should be directed at looking at the effects that livestock grazing and the changes in plant composition as it relates to the composition of rodent communities, and investigate how those vegetational changes affect antelope bitterbrush. Further research can be directed towards the dietary value of antelope bitterbrush seeds and how that dietary value changes with such factors as season, moisture, and the dietary needs of individual rodent species.

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