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Interaction Between a Fossorial Rodent (The Pocket Gopher, Thomomys Bottae) and a Desert Plant Community

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INTERACTION BETWEEN A FOSSORIAL RODENT (THE POCKET GOPHER, *THOMOMYS BOTTAE*) AND A DESERT PLANT COMMUNITY

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ABSTRACT

Previous studies in Rock Valley, near Mercury, Nye County, Nevada, indicated Botta's pocket gopher (*Thomomys bottae centralis*) was a significant component of the biomass of terrestrial vertebrates. Favored foods are *Ephedra funerea* and *E. nevadensis*, which are frequently damanged severely by cropping. To assess the effect of this cropping on the success and distribution of *Ephedra*, two studies were initiated. In an artificial grazing study, *E. funerea* plants were cut 0, 25, 50, 75 and 100% of their above-ground volume and monitored for primary production and shoot growth. Shoot growth and primary production were lowest in *E. funerea* cut 100%, shoot growth highest in those cut 75%, primary production highest in those cut 50% and 25%. In the UCLA/CETO enclosure, Plot C, a manipulative study was conducted by removing 18 pocket gophers from the north side while leaving 11 pocket gophers in place on the south side of the plot (overall density 3.3 gophers/ha, mean live weight 76.0 $\pm$ 18.8 g, mean dry weight 22.8 g). A survey of plants made four months after the initiation of the trapping program indicated a significantly greater number of damaged plants on the south side than on the north ($P < .005$). New stem production was higher on the south side. Visual assessment of damage utilized the method developed in the artificial grazing study. Density and biomass of *E. funerea* on the study plot were: 866.7 plants/ha, 742.2 kg/ha, 0.54488 $\pm$ .26472 kg mean plant weight. Density and biomass of *E. nevadensis* were: 308.2 plants/ha, 128.13 kg/ha, 0.41573 $\pm$ .25664 kg. No method was devised to relate distribution of *Ephedra* to the distribution of *T. bottae*.

INTRODUCTION

Previous studies by Dingman and Bandoli (1973) and Dingman and Byers (1974) have indicated that the pocket gopher, *Thomomys bottae centralis* (Hall and Kelson 1959), may be a significant component of the biomass of terrestrial vertebrates at the Rock Valley site, Mercury, Nevada. Although these rodents are fossorial, field observations and laboratory studies indicate that they frequently consume the shoots of plants in Rock Valley and that a favored food is *Ephedra* (both *E. nevadensis* and *E. funerea*). Although other plants are consumed, the grazing or cropping damage appears to be the most severe on *Ephedra*; in fact the plants frequently are cut to a stump as far as visible effects are concerned. With these facts in mind, one may ask the questions: Does this cropping affect the distribution, primary production and success of *Ephedra* in the plant community? Do pocket gophers in Rock Valley tend to be tied in their distribution to the distribution of *Ephedra*? This study is an attempt to answer these questions; that is, to assess the interaction between these two elements of this desert biome.

OBJECTIVES

1. To determine the effects of grazing by a *T. bottae* population on the annual production and success within the plant community of *E. nevadensis* and *E. funerea*.
2. To devise a means to assess and quantify, in the field, the damage to *Ephedra* when cropped by *T. bottae*.
3. To determine the relationship between the distribution of *Ephedra* and *T. bottae* in Rock Valley.

METHODS

Study Site

The study site is in Rock Valley, Nevada Test Site, Nye County, Nevada, and lies in a basin paralleling the western slope of the Specter Mountains. Various areas were utilized in the study, the most definitive being the UCLA/CETO enclosure, Plot C, located at the western end of the valley.

The study area is at an elevation of approximately 1050 m above sea level on a bajada leading to the Amargosa Valley drainage. The vegetation is mixed Mohave Desert shrub with creosotebush (*Larrea tridentata*) as the dominant shrub. The soils are on an unconsolidated, calcareous alluvium overlaying a cement-like layer of caliche at depths of 30-70 cm.

Methodology Concerning *T. bottae*

The methodology and technique utilized in collecting and handling pocket gophers, as well as the procedures for determining density, biomass, food consumption and dietary preference have been reported by Dingman and Bandoli (1973) and Dingman and Byers (1974). (DSCODES A3UDB01, 04)

Artificial Grazing

The establishment of this study is described by Dingman and Byers (1974). Briefly, 60 plants (*E. funerea*) were divided into five categories and either no cutting was made or 25, 50, 75 or 100% of the plant was cut. Assessment of primary production, as an indication of success, or of the effect of grazing, was determined by two procedures which are described below.

New Stem Growth

At the beginning of the observation period (August 1973 to June 1974), three branches on each of the sample plants were labeled and new stem growth measured with vernier calipers. Stem growth was measured monthly until the onset of dormancy (about mid-May of 1974). An exception to this procedure was that any new shoot growth on a plant cut 100% was monitored. Any damage resulting in a reduction in length to the shoots being studied was recorded as negative growth and summed with increases in length to give total growth.

New Biomass

At the height of new production, approximately May 1, a single healthy branch was cut from the base of each plant within each category. The branches were then dismembered

into their component parts, i.e., new stem, old stem, dead wood; the parts for each category were grouped, oven-dried and weighed. This provided an estimation of primary production in terms of biomass for each category of cropped plants in the study.

In addition to the data acquired through the two procedures described above, the categories (100% cut, 75% cut, etc.) allowed us to establish an index to assess damage to *Ephedra* actually cropped by *T. bottae*. This index is based on the structure of *Ephedra*, which roughly forms a cylinder, and estimating the percentage of the cylinder removed.

Manipulative Study of Plot C

Plot C is a circular enclosure of 8.86 ha divided into equal north and south portions. Stakes have been placed at 15-m intervals to form a grid within the enclosure. Both *E. nevadensis* and *T. bottae* occur within the confines of Plot C, so a manipulative study was initiated by removing the pocket gophers from one side of the plot and contrasting plant damage and primary production with the other side inhabited by pocket gophers.

A map of Plot C was drawn and *E. nevadensis* within the plot (on both sides of the dividing fence) were counted and plotted on the map in relationship to the existing grid system. Next, a preliminary survey of active systems of burrows of *T. bottae* was made and from these data it was decided to remove the animals from the north side of the plot. Trapping was initiated in January 1974, and continued throughout the program to keep this side of the plot free of pocket gophers. Weekly patrols were made to guard against reinvasion. Animals on the south side were live-trapped, toe-clipped for identification and released at the site of capture. By March 19, 1974, 13 pocket gophers had been removed from the north side; the remaining five by May 24, 1974.

On May 5, 1974, a single healthy branch was collected from each of 40 randomly selected plants within the plot (20 from each side). These branches were divided into the following parts: old shoot, new shoot, buds, cones, old stem, new stem. The parts were grouped from each side, oven-dried at 60 C for 24 hr and then weighed. In this manner, primary production could be measured.

On May 15 and 16, 1974, a series of 100 quadrats (50/side), covering a total area of 3750 m^2, was surveyed to determine the amount of damage caused by cropping to the *E. nevadensis* in Plot C. The visual index of damage developed in the artificial grazing study was used to categorize the plants, but only those *E. nevadensis* damaged during the 1973-74 growing season were scored. Since not all of the pocket gophers were removed from the north side before the 1973-74 growing season, some plants were damaged on that side also.

In addition, the capture records kept on the pocket gophers trapped provided an estimate of density and biomass based on a sample from a known area.

Biomass of *Ephedra*

In both the artificial grazing study and in Plot C, samples of *E. funerea* and *E. nevadensis* (whole shoots) were collected, oven-dried at 60 C for 24 hr and weighed to give the mean biomass per plant. If densities are known, standing crop may be estimated. In the case of Plot C, the plants were collected immediately adjacent to the plot so as not to interfere with the study. The plants cut as 100%-damaged in the artificial grazing study were to be utilized for this determination, but unfortunately a faulty balance necessitated collection of a new sample on December 15, 1974, and redetermination of this value.

RESULTS

Artificial Grazing

As may be seen in Table 1, shoot production in those *E. funerea* cut 100% was low compared to other plants in other categories. Plants cut 75% of their volume had the highest shoot production (based on length) while the other categories did not differ significantly. The probability that this is a homogeneous sample, i.e., all categories from the same population of shoot production, is low ($P < 0.1$). This may be attributed to the 100 and 75% categories.

Primary production (Table 2), expressed in grams of new plant material or a percentage of total plant biomass, does not follow the pattern seen in shoot growth (although the two should be related). Here the greatest new production was in plants cut 25 to 50%, although not much significance is shown (P between .75 and .50). Here also, those plants cut 100% had very low new stem production.

Density and biomass of *E. funerea* are shown in Table 3. Biomass is based on a mean dry weight of *E. funerea* from a sample of 15 plants of $0.54488 \pm .26472$ kg.

The visual index of damage to plants appears to be useful for evaluating damage to *Ephedra* caused by natural processes, such as grazing.

Manipulative Study of Plot C

A comparison of damaged plants in the north and south portions of Plot C (Table 4) indicates that there was significantly more damage ($P > .005$) to plants in the south, where pocket gophers were left in place, than in the north were they were removed. This is to be expected. Curiously enough, the data on production (Tables 5 and 6) indicate that the south side had a higher production of new stems than the north, 5.4 to 0.01%, although the percentage of live wood on the north was greater, 78.0 to 67.3%.

As may be seen in Table 7, a greater number of *E. nevadensis* plants are found on the north side (over 100 more) than on the south, with concomitantly higher density and greater biomass. Whether this is caused wholly or in part by the action of *T. bottae* on the plants, or is related to some other parameter is not known. Biomass of *E. nevadensis* in Plot C is based on a mean dry weight per plant of $0.41573 \pm .25664$ kg.

Table 1. Artificial grazing. Shoot growth (mm) in *E. funerea*

Category	No. Shoots	Total Pos. Change	Total Neg. Change	Total Growth	Av. Growth
100% cut	7	10.3	0.1	10.2	1.5
75%	10	105.1	5.3	99.8	10.0
50%	10	56.4	10.0	46.4	4.6
25%	10	46.2	13.0	33.2	3.3
0%	10	51.1	8.1	43.0	4.3

Table 2. Artificial grazing. Production in *E. funerea* (weight in g). Number in parentheses is percentage composition

Category	No. Branches	Total Weight	New Stem	Live Wood	Dead Wood
100% cut	3*	0.4	0.4 (100)	-	-
75%	10	62.6	0.6 (1.0)	58.0 (92.6)	4.0 (6.4)
50%	10	93.0	1.7 (1.8)	76.2 (81.9)	15.1 (16.1)
25%	10	92.4	3.9 (4.2)	59.0 (63.8)	29.5 (31.9)
0%	10	62.9	1.0 (1.6)	51.7 (82.2)	10.2 (16.2)

*Only new stems were found in this category and only 3 plants evidenced any production.

Table 3. Artificial grazing. Density (plants/ha) and biomass (kg/ha) of *E. funerea*

Total Plants	ha	Density	Biomass*
52	.06	866.7	472.2

*Based on a mean dry weight of .54488 $\pm$ .26472 kg per plant.

Table 4. Plot C. Comparison of numbers of damaged plants (*E. nevadensis*) in each category on north and south sides. Number in parentheses is percentage composition

	Category of Cutting					
Side	100%	75%	50%	25%	0%	Sample
North	0 (0)	2 (2.3)	4 (4.7)	5 (5.9)	74 (87.1)	85
South	12 (16.7)	13 (18.1)	10 (13.9)	6 (8.3)	31 (43.1)	72

Table 5. Plot C. Production in *E. nevadensis* (weight in g). Number in parentheses is percentage composition

Side	Total Weight	Cones	New Stem	Live Wood	Dead Wood
North	1238.1	0.1 (0)	1.1 (.01)	966.3 (78.0)	270.6 (21.9)
South	147.4	- 0 -	8.0 (5.4)	99.2 (67.3)	40.2 (27.3)

Table 6. Plot C. Production in *E. nevadensis* in kg/ha

Side	Total Biomass	Cones	New Stem	Live Wood	Dead Wood
North	132.97	0.02	0.12	103.78	29.06
South	123.31	- 0 -	6.69	82.99	33.63

Table 7. Plot C. Density (plants/ha) and biomass (kg/ha) of *E. nevadensis*

Side	Total Plants	ha	Density	Biomass*
North	1417	4.43	319.9	132.97
South	1314	4.43	296.6	123.31
Total	2731	8.86	308.2	128.13

*Based on a mean dry weight of 0.41573 $\pm$ .25664 kg.

Table 8. Plot C. Density (animals/ha) and biomass (g/ha) of *T. bottae* (A3UDB03)

Side	No. Animals	ha	Density	Biomass* Live Wt.	Dry Wt.
North	18	4.43	4.1	311.6	93.5
South	11	4.43	2.5	190.0	57.0
Total	29	8.87	3.3	250.8	75.2

*Based On: 76.0 $\pm$ 18.8 g/gopher live wt.
22.8 g/gopher dry wt.

Trapping of pocket gophers in known numbers in a known area provides an opportunity to determine density and biomass as a check or comparison against other methods. Plot C had a density of 3.3 gophers/ha as compared with 3.8 gophers/ha (Dingman and Bandoli 1973) and 4.7 gophers/ha (Dingman and Byers 1974). The prior studies have depended upon excavation as a major means of determining density. The results from Plot C may be closer to an actual value.

Since density is lower, it follows that the figure for biomass will be lower. Also mean weight of *T. bottae* in Plot C was lower than that in the overall study, 76.0 $\pm$ 18.8 g as compared to 77.8 $\pm$ 20.7 g (Table 8). Biomass of *T. bottae* in Plot C is:

Live weight 76.0 g/gopher x 3.3 gophers/ha = 250.8 g/ha
Dry weight 76.0 g/gopher x 0.3* x 3.3/ha = 75.24 g/ha

DISCUSSION

It appears as if the grazing activities by *T. bottae* do have an effect on the success of *Ephedra* cut 100%; primary production and shoot growth were reduced. However, some grazing or cropping appeared to lead to greater production and shoot growth in those categories cut between 75 and 25%. We know from our experience in agriculture that pruning seems to be a beneficial process and perhaps what we see here (cutting of stems by pocket gophers) is not wholly deleterious to the plant. This study was too short to follow the long-term effects of completely cropping the plant to a stump but some field observations indicate that, although some plants cut to this extreme in the past have resprouted, others have died.

We have no information on the reworking of a plant at various times by pocket gophers but this could cause greater damage than a single cropping. Also, the time of year of cropping, the severity of cropping and the nature of the growing season are parameters influencing the success of the plant. Wallace and Romney (1972) characterize *Ephedra* as a plant that grows slowly and flowers irregularly so that if the cropping occurred at the beginning of a series of dry years, the effect might be much more severe than in a series of wet years.

A manipulative study such as that conducted in Plot C, if monitored over a three-year (or longer) period, might give the best results for testing the nature of interactions between *T. bottae* and *Ephedra*. Although this study indicates difference between the two sides of the plot, not enough time has elapsed to determine long-term effects such as testable reduction in biomass and/or density, effects on production, etc. Our study indicates that these effects can be studied by manipulation, provided sufficient time is budgeted.

Two major areas which we were not able to explore effectively were the nature and effect of grazing on roots and the relationship of *Ephedra* distribution to pocket gopher distribution. A few field observations and some laboratory tests indicated that the roots of *Ephedra* are not particularly preferred as a food source. Little or no root damage to *Ephedra* was noted in the field. The second problem, that of seeking a relationship between the distribution of *Ephedra* and *T. bottae*, never was resolved as to methodology in this study. It might be assumed that the distribution, i.e., burrowing activities of pocket gophers, is tied more closely to the distribution of *Ephedra* in dry years than in wet years when annuals become a major source of food (Dingman and Byers 1974).

*See Golley 1960.

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