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The Impact of Seed Consumers in a Desert Ecosystem

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THE IMPACT OF SEED CONSUMERS IN A DESERT ECOSYSTEM

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ABSTRACT

Studies were initiated to determine the impact of seed consumers (harvester ants and rodents) on the structure of a Chihuahuan Desert plant community. Emphasis was on dispersion patterns of annual forbs and grasses to serve as baseline data. Replicate sets of rodent- and ant-proof enclosures were constructed (some water-amended and others unwatered) and rodents and ants were differentially excluded in order to examine their impact on seed removal rates and to identify and measure changes in dispersion patterns of annual forbs and grasses. Distribution of shrubs in each enclosure was plotted after rodents had been trapped out but prior to other faunal manipulations. Permanent sampling points were established in each enclosure. At each point the distance to the nearest plant in each quarter was measured to the nearest centimeter and the distance to the nearest plant of the species recorded. These data were used to compute the dispersion or "coefficient of aggregation" and serve as a baseline for changes in patterns of summer annuals as the result of activities of seed harvesters. Since no experiments were completed in 1974, conclusions cannot yet be drawn on the efficacy of the experimental design in producing the requisite data for interpreting the effect of seed consumers on vegetation patterning. The studies will continue in 1975.

INTRODUCTION

Studies conducted in the Chihuahuan Desert (Whitford et al. 1973; Whitford and Kay 1974; Ludwig and Whitford in press) provided data suggesting that only a small fraction of the total seed production was removed by seed consumers. Whitford et al. (1973) suggested that harvester ants may affect the density of one or two species of annuals for which they exhibited high preference as forage. Franz et al. (1973) provided data on forage preferences of rodents and Reichman (pers. comm.) and Rosenzweig (pers. comm.) suggested that rodent activity could result in redistribution of seeds through seed-caching behavior. Since we conclude that seed predators consume only a small fraction of total seed production, the logical effect of consumer activity is spatial redistribution of seeds. Hence, under differing regimes of seed predation we expect that plant dispersion patterns will be sufficiently altered to be measurable; also, that the activities of seed consumers are important as modifiers of structural relationships within the plant community, which has important implications for the dynamics of competitive interactions among animal species.

These studies complement the studies of Brown and Reichman (unpublished Desert Biome studies 1974) on the impact of seed consumers in the Sonoran Desert and are directly related to continuing studies on the Jornada Validation Site, in the Chihuahuan Desert in New Mexico.

OBJECTIVES

General Objectives:

1. To determine the impact of seed consumers (harvester ants and rodents) and their interactions as consumers on the structure of a Chihuahuan Desert plant community with emphasis on dispersion patterns of annual forbs and grasses.
2. By differential exclusion of granivores in rodent- and ant-proof enclosures to examine seed removal rates, identify patterns of dispersion and measure changes in dispersion patterns.

Specific Objectives:

For 1974, the specific objectives were to construct exclosures, trap out mammals and measure dispersion patterns of annuals in the enclosures to serve as baseline data.

PROCEDURES

One procedure involves the construction of replicate sets of enclosures (Figure 1) to which the following treatments could be applied: 1) rodents and ants excluded (water amended and unwatered); 2) rodents only excluded -- ants present (water amended and unwatered); 3) ants only excluded -- rodents present (water amended and unwatered).

Another procedure is the measurement of dispersion patterns of annual forbs and grasses and plot distribution of shrubs in each enclosure after rodents had been trapped out but prior to other manipulations of fauna. Each enclosure with rodents present will have a population of two *Dipodomys merriami* and two *Perognathus penicillatus.*

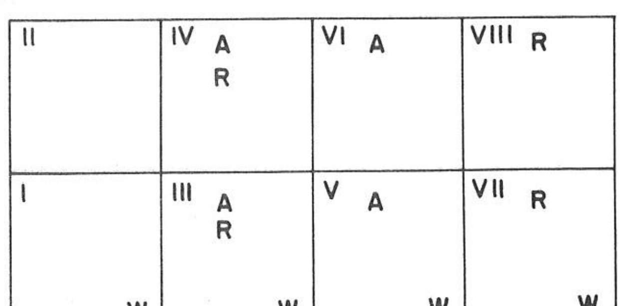

Figure 1. Research design -- enclosures. "A" indicates ants present in enclosure; "R" -- rodents present in enclosure; "W" -- enclosures receiving water amendment.

METHODS

A site for construction of enclosures was selected 1 km NNW of the bajada site in an area with scattered grama grass, *Bouteloua eriopoda*, and which supports a high density and diversity of annual grasses and forbs, three species of harvester ants and the full complex of heteromyid species characteristic of the bajada site. The enclosures were aligned as shown in Figure 1 to conserve on construction materials and ensure, as much as possible, similarity of vegetation, soil, etc., within each enclosure.

Each enclosure, measuring 20 x 20 m, was constructed of ¼-inch mesh wire buried 45.72 cm. The lower portion of the fence was double with fine mesh hardware cloth 36 inches wide, 18 inches below the surface and 18 inches above, to produce a rodent-proof enclosure. Construction of the enclosures was not completed until mid-July which was not much of a problem since spring and early summer drought resulted in a lack of production of spring annuals.

Rains began in July following completion of the enclosures. Rodents in the enclosures were trapped out using live traps and trapping continued until no animals were captured in four successive nights.

Peak summer annual production occurred in late August. Permanent sampling points were established in each enclosure. Five points were established at random along each of five lines which were evenly spaced along the 20-m boundary of each enclosure. At each point, the distance to the nearest plant in each quarter was measured to the nearest centimeter, and the distance to the nearest plant of that species recorded (Greig-Smith 1964). These data were used to compute the dispersion or "coefficient of aggregation." The data were recorded by point and enclosure; hence future measurements from the same reference point can be made and each point treated individually to evaluate changes in dispersion pattern.

RESULTS AND DISCUSSION

The data on the nearest neighbor analysis are presented in Table 1. These data serve as baseline for changes in patterns of summer annuals as the result of activities of seed harvesters. The most common annual in each of the enclosures was a six-week grama, *Bouteloua aristidoides*, which typically exhibited an aggregated distribution. $R = 0$ is perfect aggregation; $R = 1$ is perfectly random (Table 1).

Since no experiments were completed in 1974, we are unable to draw conclusions on the efficacy of the experimental design in providing the requisite data for interpreting the effect of seed consumers on vegetation patterning.

EXPECTATIONS

The fall and winter rains of 1974-75 should ensure spring annuals since the late February soil moisture is near field capacity at 2-10 cm. Rodent introductions will be made in the enclosures as soon as we have collected the data on dispersion patterns of spring annuals and have made estimates of seed production. Ant poisoning and exclusion will be initiated in March and data collection on foraging rates of rodents and ants conducted on a weekly basis. Early in the season, we intend to use the four enclosures not allocated for dispersion experiments for manipulative studies on effects of varying densities of rodents on total seed reserves, survivorship of annuals and designing experiments to examine rodent and ant activity with respect to spatial distribution of varying types of seeds. These experiments will be designed to answer questions on success of cache location when caches are not emplaced by the resident rodent, interactive use of limited seed resources and influence of canopy dispersion patterns on success in cache location. All of the types of data will be useful in interpreting the results of the enclosure experiments.

ACKNOWLEDGMENTS

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Table 1. Density of annuals (August 14, 1974). Asterisk indicates nearest neighbor statistic noncomputable

Species	Frequency	Density (ind/ha)	No. of plants (total for census)	Nearest neighbor statistic
		Pen 1		
		Total density = 194969.90 ind/ha		
		Total number of plants = 155		
Ammocodon chonopodioides	0.00645	1257.87	1	*
Aristida adscensionis	0.07097	13836.57	11	0.024
Bouteloua aristidoides	0.71613	139623.63	111	0.034
Euphorbia micromera	0.10968	21383.79	17	0.033
Galium sp.	0.06452	12578.71	10	0.017
Kallstroemia parviflora	0.01935	3773.61	3	0.043
Panicum sp.	0.01290	2515.74	2	0.048
		Pen 2		
		Total density = 322584.70 ind/ha		
		Total number of plants = 160		
Aristida adscensionis	0.05000	16129.24	8	0.016
Bahia absinthifolia	0.00625	2016.15	1	*
Bouteloua aristidoides	0.69375	223793.16	111	0.033
Bouteloua barbata	0.06250	20161.55	10	0.007
Euphorbia micromera	0.01875	6048.46	3	0.015
Euphorbia setiloba	0.10000	32258.46	16	0.023
Linum sp.	0.01250	4032.31	2	0.028
		Pen 3		
		Total density = 145874.30 ind/ha		
		Total number of plants = 152		
Allionia incarnata	0.00658	959.70	1	*
Amaranthus palmeri	0.07895	11516.39	12	0.065
Ammocodon chonopodioides	0.00658	959.70	1	*
Aristida adscensionis	0.03947	5758.20	6	0.083
Bahia absinthifolia	0.00658	959.70	1	*
Bouteloua aristidoides	0.56579	82534.15	86	0.038
Croton pottsii	0.00658	959.70	1	*
Euphorbia micromera	0.09868	14395.49	15	0.065
Galium sp.	0.09868	14395.49	15	0.032
Kallstroemia parviflora	0.01316	1919.40	2	0.023
Panicum sp.	0.07237	10556.69	11	0.040
Tribulus terrestris	0.00658	959.70	1	*
		Pen 4		
		Total density = 160967.00 ind/ha		
		Total number of plants = 160		
Allionia incarnata	0.00625	1006.04	1	*
Amaranthus palmeri	0.01250	2012.09	2	0.028
Ammocodon chonopodioides	0.01250	2012.09	2	0.021
Aristida adscensionis	0.03750	6036.26	6	0.035
Bouteloua aristidoides	0.72500	116701.07	116	0.036
Bouteloua barbata	0.06250	10060.44	10	0.015
Croton pottsii	0.10625	17102.74	17	0.030
Euphorbia micromera	0.00625	1006.04	1	*
Galium sp.	0.01875	3018.13	3	0.009
Kallstroemia parviflora	0.01250	2012.09	2	0.024

Table 1, continued

Species	Frequency	Density (ind/ha)	No. of plants (total for census)	Nearest neighbor statistic
		Pen 5 Total density = 160607.10 ind/ha Total number of plants = 159		
Allionia incarnata	0.03145	5050.54	5	0.090
Allium sp.	0.00629	1010.11	1	*
Amaranthus palmeri	0.02516	4040.43	4	0.169
Aristida adscensionis	0.05031	8080.86	8	0.045
Bahia absinthifolia	0.02516	4040.43	4	0.176
Baileya multiradiata	0.00629	1010.11	1	*
Boerhaavia spicata	0.01887	3030.32	3	0.024
Bouteloua aristidoides	0.61006	97980.48	97	0.037
Bouteloua barbata	0.05660	9090.97	9	0.043
Cassia bauhinioides	0.00629	1010.11	1	*
Croton pottsii	0.00629	1010.11	1	*
Eriogonum abertianum Rub	0.00629	1010.11	1	*
Eriogonum rotundifolium	0.00629	1010.11	1	*
Euphorbia albomarginata	0.00629	1010.11	1	*
Euphorbia micromera	0.06918	11111.18	11	0.050
Galium sp.	0.02516	4040.43	4	0.027
Lepidium lasiocarpum	0.00629	1010.11	1	*
Linum vernale	0.01258	2020.22	2	0.028
		Pen 5A Total density = 109195.90 ind/ha Total number of plants = 152		
Allionia incarnata	0.01316	1436.79	2	0.025
Amaranthus palmeri	0.19079	20833.43	29	0.064
Aristida adscensionis	0.02632	2873.58	4	0.026
Bahia absinthifolia	0.00658	718.39	1	*
Boerhaavia spicata	0.02632	2873.58	4	0.032
Bouteloua aristidoides	0.38158	41666.87	58	0.038
Bouteloua barbata	0.13158	14367.88	20	0.027
Croton pottsii	0.05921	6465.55	9	0.067
Euphorbia micromera	0.09211	10057.51	14	0.141
Kallstroemia parviflora	0.1316	1436.79	2	0.036
Proboscidea parviflora	0.00658	718.39	1	*
Psilostrophe sp.	0.00658	718.39	1	*
		Pen 5B Total density = 88548.31 ind/ha Total number of plants = 150		
Allionia incarnata	0.08667	7674.19	13	0.054
Amaranthus palmeri	0.03333	2951.61	5	0.131
Aristida adscensionis	0.02000	1770.97	3	0.061
Bahia absinthifolia	0.06667	5903.22	10	0.031
Boerhaavia spicata	0.01333	1180.64	2	0.033
Bouteloua aristidoides	0.52000	46045.12	78	0.051
Bouteloua barbata	0.00667	590.32	1	*
Cassia bauhinioides	0.01333	1180.64	2	0.113
Euphorbia micromera	0.11333	10035.47	17	0.058
Kallstroemia parviflora	0.05333	4722.58	8	0.062
Panicum sp.	0.03333	2951.61	5	0.061
Solanum elaeagnifolium	0.02000	1770.97	3	0.105
Tidestromia lanuginosa	0.00667	590.32	1	*

Table 1, continued

Species	Frequency	Density (ind/ha)	No. of plants (total for census)	Nearest neighbor statistic
		Pen 6 Total density = 119574.10 ind/ha Total number of plants = 157		
Amaranthus palmeri	0.01274	1523.24	2	0.033
Ammocodon chonopodioides	0.01911	2284.86	3	0.064
Aristida adscensionis	0.03185	3808.09	5	0.051
Bahia absinthifolia	0.00637	761.62	1	*
Boerhaavia spicata	0.09554	11424.28	15	0.047
Bouteloua aristidoides	0.53503	63975.99	84	0.056
Bouteloua barbata	0.01274	1523.24	2	0.044
Cassia bauhinioides	0.00637	761.62	1	*
Croton pottsii	0.03185	3808.09	5	0.030
Euphorbia micromera	0.10191	12185.90	16	0.054
Galium sp.	0.00637	761.62	1	*
Kallstroemia parviflora	0.07643	9139.42	12	0.139
Panicum sp.	0.01274	1523.24	2	0.034
Solanum elaeagnifolium	0.00637	761.62	1	*
Tidestromia lanuginosa	0.01911	2284.86	3	0.051
		Pen 6A Total density = 91250.31 ind/ha Total number of plants = 146		
Allionia incarnata	0.06164	5625.02	9	0.117
Amaranthus palmeri	0.04795	4375.01	7	0.089
Ammocodon chonopodioides	0.01370	1250.00	2	0.509
Aristida adscensionis	0.02055	1875.01	3	0.009
Bahia absinthifolia	0.03425	3125.01	5	0.180
Boerhaavia spicata	0.04110	3750.01	6	0.046
Bouteloua aristidoides	0.58219	53125.18	85	0.059
Bouteloua barbata	0.02055	1875.01	3	0.024
Euphorbia micromera	0.08219	7500.02	12	0.048
Kallstroemia parviflora	0.06849	6250.02	10	0.068
Pectis papposa	0.00685	625.00	1	*
Tidestromia lanuginosa	0.01370	1250.00	2	0.023
		Pen 6B Total density = 109397.40 ind/ha Total number of plants = 156		
Allionia incarnata	0.07692	8415.19	12	0.148
Ammocodon chonopodioides	0.01282	1402.53	2	*
Aristida adscensionis	0.05128	5610.12	8	0.072
Bahia absinthifolia	0.01282	1402.53	2	0.058
Boerhaavia spicata	0.04487	4908.86	7	0.056
Bouteloua aristidoides	0.64103	70126.56	100	0.058
Bouteloua barbata	0.02564	2805.06	4	0.008
Cassia bauhinioides	0.00641	701.27	1	*
Euphorbia micromera	0.05128	5610.12	8	0.043
Kallstroemia parviflora	0.07051	7713.92	11	0.065
Panicum sp.	0.00641	701.27	1	*

Table 1, continued

Species	Frequency	Density (ind/ha)	No. of plants (total for census)	Nearest neighbor statistic
		Pen 7 Total density = 156710.10 ind/ha Total number of plants = 160		
Allionia incarnata	0.07500	11753.26	12	0.044
Amaranthus palmeri	0.01250	1958.88	2	0.048
Ammocodon chonopodioides	0.01250	1958.88	2	0.047
Aristida adscensionis	0.05625	8814.94	9	0.037
Bahia absinthifolia	0.03750	5876.63	6	0.047
Boerhaavia spicata	0.00625	979.44	1	*
Bouteloua aristidoides	0.53125	83252.25	85	0.049
Bouteloua barbata	0.09375	14691.57	15	0.023
Euphorbia micromera	0.09375	14691.57	15	0.044
Kallstroemia parviflora	0.02500	3917.75	4	0.061
Tidestromia lanuginosa	0.00625	979.44	1	*
		Pen 8 Total density = 181613.10 ind/ha Total number of plants = 160		
Allionia incarnata	0.07500	13620.99	12	0.136
Ammocodon chonopodioides	0.01250	2270.16	2	0.021
Aristida adscensionis	0.01250	2270.16	2	0.058
Bahia absinthifolia	0.00625	1135.08	1	*
Boerhaavia spicata	0.02500	4540.33	4	0.063
Bouteloua aristidoides	0.74375	135074.80	119	0.047
Bouteloua barbata	0.01250	2270.16	2	0.042
Cassia bauhinioides	0.00625	1135.08	1	*
Euphorbia micromera	0.05000	9080.66	8	0.042
Galium sp.	0.01875	3405.35	3	0.053
Kallstroemia parviflora	0.01250	2270.16	2	0.064
Tidestromia lanuginosa	0.01250	2270.16	2	0.068