Blacktail Prairie Dogs, Desert Cottontails and Cattle Trophic Relations on Shortgrass Range

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Highlight: The trophic relations among blacktail prairie dogs, desert cottontails, and cattle were determined among three dogtowns at the Central Plains Experimental Range near Nunn, Colo. Sedges were the most important food of prairie dogs and cottontails and the second most important food of cattle on an annual basis. There was a high percentage similarity in the diets of the three herbivores studied; and they consumed large percentages of sedges and grass. The amount of aboveground herbage eaten and made unavailable because of soil disturbances by prairie dogs and cottontails was about 24% of the total potential annual production.

Millions of dollars have been spent in attempting to reduce prairie dog (*Cynomys* spp.) numbers (McNulty 1971). The most frequently cited "reservoirs" of human infections for sylvatic plague in the western United States are prairie dogs, followed by ground squirrels (*Spermophilus* spp.) and cottontails (*Sylvilagus* spp.) (Kartman 1960, 1970). Stoddard and Smith (1955) and Vallentine (1971) state that prairie dogs are highly competitive with livestock for range forage. Kelso (1939) estimated that 78% of the plant species consumed by prairie dogs were valuable forage for livestock. The numerous eradication campaigns against prairie dogs and other small mammals were formerly justified because of safety for human health and conflicts with livestock for forage (Committee 1970). The scientific and lay communities have been recently alerted to the need for "protective management" of our natural resources, including wild animals. Such conservation periodically conflicts with the interest or welfare of certain segments of society. There is great need for proper management of prairic dogs in areas where they may be considered "pest" or "desirable" animal species by the conflicting interests of society.

The purpose of this study was to determine the seasonal trophic relations of blacktail prairie dogs (*Cynomys ludovicianus*), desert cottontails (*Sylvilagus audubonii*), and cattle which have free choice of available range plants on the same range and for the same dates in northeastern Colorado.

Study Area

The study was conducted at the Central Plains Experimental Range 14.5 km north of Nunn, Colo. The topography of the area is gently rolling hills. The average annual precipitation is 30 cm with 80% occurring from May through September (Bement 1968). The mean annual maximum temperature is 25°C; the minimum is 8°C.

The study areas were dominated by blue grama (*Bouteloua gracilis*) and buffalograss (*Buchloe dactyloides*). Western wheatgrass (*Agropyron smithii*), threadleaf sedge (*Carex filifolia*), needleleaf sedge (*C. eloeocharis*), red threeawn (*Aristida longieseta*), Indian ricegrass (*Oryzopsis hymenoides*), and sand dropseed (*Sporobolus cryptandrus*), needleandthread (*Stipa comata*), and common sixweeksgrass (*Vulpia octoflora*) are common. The common forbs and shrubs were scarlet globemallow (*Sphaeralcea coccinea*), tansyleaf aster (*Aster tanacetifolius*), silky loco (*Oxytropis sericia*), woolly plantain (*Plantago purshii*), fringed sagewort (*Artemisia frigida*), spreading wildbuckwheat (*Eriogonum effusum*), and plains pricklypear (*Opuntia polycantha*).

Blacktail prairie dogs were transplanted onto two adjacent vegetation types during the spring of 1973. No prairie dogs had occurred on these areas for over 50 years (R. E. Bement, personal communication). Cattle had been grazed at a moderate stocking rate on both study areas from November 1 to April 30 each year. They had free access between the adjacent vegetation types for 40 years prior to the study. The two study areas were separated by a barbed wire fence when the prairie dogs were introduced. The western area was a native shortgrass vegetation type where the "Native dogtown" was studied, and the eastern revegetating area was the site of the "Oldfield dogtown." The transplanted prairie dogs were distributed continuously between both adjacent vegetation types soon after they were introduced. Gold (1976) studied the patterns of plant regulation around the burrows of prairie dogs for the two adjacent dogtowns that became established. The dogtowns covered a total of 20 ha in 1973 and the prairie dog density averaged 6.0/ha. Prairie dogs occupied about 30 ha with an average of 7.3 dogs/ha in the summer of 1975.

A naturally occurring population of blacktail prairie dogs (Swale dogtown) was located 1.2 km south of the Native and Oldfield dogtowns. This dogtown had been established for many years when studied by Koford (1958). The Swale dogtown covered about 30 ha in 1975 with an average of 1 dog/ha. The pasture had been moderately grazed by cattle from May 1 to October 30 for the previous 10 years.

Desert cottontails could not be found prior to the transplanting of prairie dogs into the Native and Oldfield study areas. However, previous studies have shown desert cottontail density in this area averaged about 0.03 per ha on pastures moderately grazed by cattle in summer or in winter (Flinders and Hansen 1975). Desert cottontail density averaged 1.33/ha within the Native and Oldfield dogtowns and 0.81/ha in the Swale dogtown in the late summer of 1975. Desert cottontails averaged 0.05/ha on the shortgrass prairie adjacent to the prairie dogtowns in late summer 1975.

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Methods and Procedure

Plant composition in diets for prairie dogs, cottontails, and cattle was determined by microhistological analysis of fecal material. Plant cuticle fragments in fecal samples can be identified by species with microscopic analysis (Storr 1961; Williams 1969). The relative proportions of each kind of plant fragment were assumed to be an adequate estimate of relative amounts of each plant species consumed (Todd and Hansen, 1973; Dearden et al. 1975).

Samples of recently dropped feces were collected twice a month from each of the three dogtowns. Each fecal sample was composed of at least 25 different "fresh" fecal droppings obtained systematically throughout each dogtown. Prairie dog samples were taken from June, 1973, through June 1975 (N = 127). Desert cottontail fecal samples were taken from June, 1974, through June, 1975 (N = 61). Fecal samples of cattle were obtained when they were grazing in a dogtown over the period from June, 1973, through June, 1975 (N = 31).

Microscope slides for each fecal sample were prepared as described by Sparks and Malechek (1968), Ward (1970), and Flinders and Hansen (1972). Twenty microscope slides were prepared per sample. Twenty microscope fields per slide were systematically located and magnified 100× for identification of plant fragments. The number of classified fragments per field averaged about three. Each plant fragment was classified if its characteristics matched those on a reference slide of the same species made from plants on the study areas.

The diversity of plants in diets was calculated by Shannon's formula (Hurtubia 1973). Dietary similarity indexes (Gauch 1973) and Spearman's rank-order correlation coefficients (Snedecor and Cochran 1973) were used to compare food habits between years, between seasons of the years, between dogtown study areas, and among species of herbivore. Statistical difference was accepted at the 5% level of significance unless stated otherwise in the text. Scientific and common names of plants follow those recommended by Beetle (1970).

Table 1. Average (±SE) percentages of major foods in the seasonal diets of blacktail prairie dogs, 14.5 km north of Nunn, Colo., June 1973–June 1975.

Plant name[1]	Spring (Apr.–May)	Summer (June–Aug.)	Autumn (Sept.–Nov.)	Winter (Dec.–Mar.)
Sedges	51 ± 6	14 ± 2	39 ± 4	42 ± 5
Blue grama	19 ± 4	45 ± 4	14 ± 1	3 ± 1
Sand dropseed	7 ± 1	24 ± 4	9 ± 1	12 ± 2
Fringed sagewort	5 ± 2	<1	5 ± 2	21 ± 4
Scarlet globemallow	1 ±<1	5 ± 1	15 ± 2	6 ± 2
Buffalograss	2 ± 1	8 ± 1	2 ± 1	2 ±<1
Western wheatgrass	4 ± 2	1 ±<1	5 ± 1	2 ± 1
Needleandthread	4 ± 2	<1	2 ± 1	1 ±<1
Indian ricegrass	1 ±<1	<1	4 ± 1	3 ± 1

[1] There were more than 28 additional plant species averaging 1% or less in the seasonal diets.

Table 2. Average (±SE) percentages of major foods in the seasonal diets of desert cottontails inhabiting blacktail prairie dogtowns, 14.5 km north of Nunn, Colo., June 1974–June 1975.

Plant names[1]	Spring (Apr.–May)	Summer (June–Aug.)	Autumn (Sept.–Nov.)	Winter (Dec.–Mar.)
Sedges	60 ± 8	32 ± 5	18 ± 3	9 ± 2
Scarlet globemallow	5 ± 1	12 ± 2	28 ± 3	14 ± 2
Fringed sagewort	9 ± 3	<1	12 ± 5	40 ± 5
Western wheatgrass	5 ± 1	26 ± 3	16 ± 4	3 ± 1
Needleandthread	6 ± 2	3 ± 1	9 ± 3	5 ± 1
Plains pricklypear	5 ± 2	<1	2 ± 1	15 ± 4
Blue grama	1 ± 1	6 ± 1	1 ±<1	3 ± 2
Sand dropseed	<1	8 ± 7	2 ± 1	1 ± 1
Common sixweeksgrass	<1	1 ±<1	5 ± 1	1 ±<1
Silky loco	3 ± 1	5 ± 2	<1	<1

[1] There were more than 29 additional plant species averaging 1% or less in the seasonal diets.

Results

Plants in the seasonal diets of prairie dogs were similar between the three dogtowns, and among comparable seasons of the 2 years. The most important plants in the annual diets were sedges (36%), blue grama (20%), sand dropseed (13%), fringed sagewort (8%), and scarlet globemallow (7%) (Table 1).

Desert cottontail seasonal diets were similar among the three dogtowns during the 1 year of study. The plants with the highest proportions in the annual diets were sedges (30%), scarlet globemallow (15%), fringed sagewort (15%), western wheatgrass (13%), needleandthread (6%), and plains pricklypear (6%), which together comprised 85% of the foods eaten by desert cottontails (Table 2).

Cattle use in the pastures containing the three dogtowns was seasonally variable because of the rotation management grazing system followed at the Central Plains Experimental Range. Unequal numbers of seasonal diets of cattle were obtained from the three study areas. Too few comparable diets were obtained for testing of cattle diet differences among the three study areas. Seasonal cattle diets were averaged and may be confounded because of unequal samples among the pastures (Table 3). The major plants eaten by cattle were western wheatgrass (26%), sedges (23%), blue grama (10%), sand dropseed (10%), needleandthread (6%), scarlet globemallow (6%), and buffalograss (2%) (Table 3).

The rank orders for the proportions of the different plant species consumed by prairie dogs and cattle were similar between consecutive seasons, but the summer diets of desert cottontails were different from both their spring and autumn diets (Table 4). The order of foods selected was significantly different between winter and summer diets for both prairie dogs and cottontails but not for cattle. The seasonal trophic diversity indexes of the three herbivores were similar, averaging 1.66 for

Table 3. Average percentages of major foods in the seasonal diets of cattle from three pastures containing blacktail prairie dogtowns, 14.5 km north of Nunn, Colo., June 1973–June 1975.

Plant names[1]	Spring (Apr.–May)	Summer (June–Aug.)	Autumn (Sept.–Nov.)	Winter (Dec.–Mar.)
Western wheatgrass	20	23	20	43
Sedges	41	25	11	15
Blue grama	5	12	13	12
Sand dropseed	5	10	14	13
Needleandthread	2	3	15	4
Scarlet globemallow	7	11	3	2
Buffalograss	1	3	3	1

[1] There were more than 20 additional plant species averaging 1% or less in the seasonal diets.

Table 4. The average seasonal dietary overlaps for foods of blacktail prairie dogs and desert cottontails and Spearman's rank correlation coefficients with corresponding confidence values, 14.5 km north of Nunn, Colo.

Seasonal relationships[1]	Blacktail prairie dogs 1973–75			Desert cottontails 1974–75		
	Percentage similarity N = 32	Spearman's RHO values	P values[2]	Percentage similarity N = 15	Spearman's RHO vaues	P values[2]
Spring vs summer	46	+0.7	0.001	54	+0.3	0.12[3]
Spring vs autumn	78	+0.8	> 0.001	50	+0.6	0.01
Spring vs winter	66	+0.7	0.005	40	+0.7	0.005
Summer vs autumn	48	+0.8	> 0.001	57	+0.4	0.08[3]
Summer vs winter	39	+0.5	0.025[3]	34	+0.1	0.42[3]
Autumn vs winter	73	+0.8	> 0.001	52	+0.6	0.01

[1] Spring = Apr.-May; Summer = June-Aug.; Autumn = Sept.-Nov.; Winter = Dec.-Mar.
[2] Rank order correlation coefficients were of paired mean seasonal diets.
[3] Not significantly correlated.

prairie dogs, 1.79 for cottontails, and 1.67 for cattle. The variety of plants eaten by cottontails was greater than it was for the other two herbivores although the mean trophic diversity of cottontails was not statistically different. The seasonal selection of foods by cattle appears to vary less than the other two herbivores. Desert cottontails vary their seasonal selections more than either prairie dogs or cattle. Some authors have previously reported a high variety of plants in diets of cottontails (Fitch 1947; Turkowski 1975).

The supply of a particular forage has not been found critical to successful productivity of broad-spectrum feeders such as prairie dogs, cottontails, and cattle. Most authors have reported blue grama and western wheatgrass to be the two most important foods of prairie dogs (Koford 1968; Costello 1970). Sedges are seldom reported as important in herbivore diets; but sedges were the most important forage used by prairie dogs and cottontails and were second most important in use by cattle in this study.

The ranked order in which the three species of herbivores selected was similar during the summer and for their mean annual diets (Table 5). Prairie dog and cattle selections were similar in each season. Prairie dogs and desert cottontails selected foods in a significantly different order in the spring and autumn, and desert cottontails and cattle selected differently in autumn and winter. Although there was a high percentage similarity for the mean annual diets among the three herbivores, seasonal preference differences for the same plant species existed. The three consumers were not feeding strictly at the courtesy of the basic system of plant growth cycles and were not eating each species in proportion to its presence.

Discussion

The amounts of aboveground herbage annually harvested within the Native and Oldfield dogtowns can be estimated by days of use by prairie dogs and cottontails since it was observed that their feeding occurs almost entirely within the dogtowns. Little information was available to estimate the daily intake rates of blacktail prairie dogs and desert cottontails. Hansen and Cavender (1973) reported blacktail prairie dogs consumed 3.3 g/day of dry laboratory feed per 100 g live body weight, and Lechleitner (1969) reported 940 g as the average body weight. Drake and Sime (1941) reported cottontails (*Sylvilagus floridanus*) consume about 22 g/day of food fresh weight per 100 g live body weight in the laboratory. Lechleitner (1969) reported 1,050 g as the average body weight of desert cottontails in Colorado. If we assume the food in the studies by Drake and Sime (1941) averaged 65% water, the cottontail probably consumes about 3.4 g/day of dry matter per 100 g live body weight.

Little has been published about consumers as regulators of ecosystem functioning (Chew 1974). Gold (1976) described how prairie dogs regulated the plants surrounding their burrows. She reported plant biomass was decreased about 10% as a result of denudation around mounds while the overall plant diversity increased. Prairie dogs, by their own feeding behavior plus the added influences of cottontails who benefit from the presence of prairie dog burrows, should be credited to prairie dog regulation of this shortgrass ecosystem. Gold (1976) estimated the annual aboveground plant production was 1,020 kg/ha of dry weight within the dogtowns. Therefore the annual herbage removed and attributed to the influence of prairie dogs and cottontails would be 245 kg/ha (102 = denudation, 83 = foods of prairie dogs, 60 = foods of desert cottontails) or about 24%.

If we assume that cattle used the pastures uniformly in their 6 months of winter feeding, at their known stocking rates they may have consumed 160 kg/ha/year. Cattle averaged no gains or losses in body weight on the pastures containing the Native and Oldfield dogtowns during 1973 through 1974 and 1974 through 1975 winter grazing periods (Marvin Shoop, Agr. Res.

Table 5. The average seasonal dietary overlaps for foods among blacktail prairie dogs, desert cottontails, and cattle with Spearman's rank correlation coefficients and corresponding confidence values, 14.5 km north of Nunn, Colo., 1973–75.

Seasons[1] of diets	Prairie dogs vs cottontails[2]			Prairie dogs vs cattle[3]			Cottontails vs cattle[4]		
	Percentage similarity	Spearman's RHO valucs	P values	Percentage similarity	Spearman's RHO values	P values	Percentage similarity	Spearman's RHO values	P values
Spring	75	+0.4	0.10[5]	69	+0.8	0.01	65	+0.6	0.01
Summer	40	+0.6	0.01	49	+0.8	0.001	84	+0.8	> 0.001
Autumn	52	+0.3	< 0.10[5]	53	+0.6	0.01	50	+0.3	0.12[5]
Winter	66	+0.7	0.005	41	+0.6	0.01	27	+0.4	0.08[5]
Annual	60	+0.6	0.01	64	+0.8	0.002	61	+0.6	0.008

[1] Spring = Apr.-May; Summer = June-Aug.; Autumn = Sept.-Nov.; Winter = Dec.-Mar.
[2] Numbers of pairs of samples June 1974–June 1975; Spring N = 14; Summer N = 15; Autumn N = 18; Winter N = 14.
[3] Numbers of samples compared by seasons June 1973–June 1975; Spring (cattle N = 5, prairie dogs N = 29); Summer (cattle N = 4, prairie dogs N = 32); Autumn (cattle N = 4, prairie dogs N = 36); Winter (cattle N = 18, prairie dogs N = 30).
[4] Numbers of samples compared by seasons June 1973–June 1975; Spring (cottontails N = 15, cattle N = 5); Summer (cottontails N = 15, cattle N = 4); Autumn (cottontails N = 18, cattle N = 4); Winter (cottontails N = 14, cattle N = 18).
[5] Not significantly correlated.

Serv., personal communication). Therefore, the combined annual removal of dry herbage by the feeding of the three herbivores studied was assumed to have been 405 kg/ha in the dogtowns. The prairie dogs may have consumed about 53 kg/ha and the cottontails about 39 kg/ha of potential cattle forages within the dogtowns each year. However, because the plant species selected by prairie dogs and cottontails were quite similar to those of cattle, their feeding influences could have made dogtown areas less attractive to cattle than adjacent areas.

Food competition in the broadest sense refers to the interaction of two organisms selecting the same foods. The tendency to bring about a partial separation for common feeding areas may exist in prairie dogtowns. If the desired foods of cattle become scarce, cattle may choose to graze between or away from dogtowns. Our observations are not adequate to judge whether or not the cattle use in the Native and Oldfield dogtown areas was influenced by prairie dogs and cottontails. Before the blacktail prairie dogs were transplanted into the Native and Oldfield study areas (May 1973), there were no resident desert cottontails which could be found. During this study the annual days of use by cattle were kept at a moderate grazing intensity during this study. Flinders and Hansen (1975) found significantly higher densities of cottontails on shortgrass ranges that had been grazed moderately by cattle than on adjacent ranges grazed at either light or heavy stocking rates.

This study, when compared with previous research, provides evidence that blacktail prairie dgs are an important ecosystem regulator as they disturb the soil, increase plant diversity (Gold 1976), increase animal diversity, and cause a decrease in the primary production of the areas they use. Within a shortgrass ecosystem, they may depress the habitat suitability for cattle grazing and enhance the habitat for desert cottontails, burrowing owls (*Speotyto cunicularia*), rattlesnakes (*Crotalis viridus*), and some species of plants. Much of the confusion in the literature on prairie dog and cattle grazing relationship arises because of the interspecific regulatory roles of these two herbivores in the exchange between the shortgrass ecosystem where the prairie dog is the dominant regulator and the tallgrass prairie where the cattle grazing intensity regulates the presence or absence of blacktail prairie dogs. Circumstantial evidence and observed natural events have shown heavy cattle use in tallgrass prairies is necessary for the propagation of prairie dogs (Osborn and Allan 1949; Allan and Osborn 1954; Koford 1958). If this kind of range is excessively grazed by cattle, the prairie dogs may become extremely widespread and abundant (Smith 1967; Costello 1970). This is in contrast to the shortgrass range, where cattle grazing does not influence prairie dog numbers but may be affected by the presence of prairie dogs.

In shortgrass ecosystems the vegetation composition within and outside dogtowns is significantly different (Koford 1958; Bonham and Lerwick 1976). More species of both perennial and annual plants occur within dogtowns and certain plants such as blue grama, buffalograss, and several annual forbs are more abundant inside than outside. Continuous clipping of some tall shrubs such as wildbuckwheats (*Eriogonum* spp.), fourwing saltbush (*Atriplex canescens*), and rubber rabbitbrush (*Chrysothamnus nauseosus*) results in fewer of these plants within a dogtown than outside. Without proof, some authors have ascribed all of these differences directly to prairie dog feeding and clipping effects. However, we suspect that a substantial amount of the clipping and feeding activities of desert cottontails has influenced the vegetation differences.

It is difficult to determine the nocturnal clippings of cottontails from the diurnal clippings of prairie dogs. An obvious approach to answering controversial questions about prairie dogs is by manipulative experimentation within natural ecosystems. This study has shown some new consumer interactions that may have been overlooked in the past.

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