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Diets of prairie dogs (*Cynomys mexicanus*) co-existing with cattle or goats

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Abstract

Diets of prairie dogs (*Cynomys mexicanus*) co-existing with goats or cattle were examined using microhistological fecal analysis in a 1-year study on a grassland of northern Mexico. Consumption of forbs was generally higher (33% versus 21% across all seasons; $P < 0.05$) in prairie dog diets co-existing with cattle compared to prairie dogs co-existing with goats. The diet of prairie dogs grazing with goats was based around grasses (79% of total forage ingested versus 68% for prairie dogs on the pasture grazed by cattle all seasons; $P < 0.05$). In general, prairie dogs showed a higher preference for forbs in the pasture grazed by cattle than in the pasture grazed by goats. Data for dietary overlap (69% across all seasons) pointed to a moderate diet similarity between prairie dogs grazing with goats or cattle. Prairie dogs co-existing with goats had a higher ($P < 0.05$) fecal N concentration in the fall than prairie dog co-occurring with cattle (2.4 ± 0.1 versus 2.1 ± 0.1). In spring and summer, prairie dogs in the pasture shared with goats had higher ($P < 0.05$) fecal P concentrations than prairie dog co-existing with cattle (3.0 ± 0.4 versus 2.5 ± 0.2 and 1.6 ± 0.1 versus 1.0 ± 0.1, respectively). The results of this study indicate distinct differences in diets of prairie dogs co-existing with goats or cattle, although these foraging differences did not affect negatively the diet quality of prairie dogs (based on fecal N and P data) grazing with goats, despite the highly degraded range in this site. Prairie dogs showed a high feeding adaptability, which allowed them to meet their nutritional needs in a highly degraded site around the goat's pens in a settlement with communal grazing land.

Keywords: Diet preference; Foraging; Microhystological analysis

Introduction

The majority of goats in Mexico are managed under traditional extensive village systems and are grazed on natural communal rangelands throughout the year. Due to the aridity and fragile plant communities of Chihuahuan Desert rangelands, these ecosystems are easily damaged by goat grazing (Manzano and Navar 2000), because under the traditional goat production systems, season of grazing, stocking rate and intensity and distribution of grazing are not controlled. The uncontrolled grazing of several large herds of goats invariably creates barren areas near the households (Mellado et al. 2005), and these areas subjected to intense defoliation are sometimes utilized by prairie dogs (*Cynomys mexicanus*) for grazing; thus, these areas become sites of intense biological activity and strong competition for food resources.

On the other hand, common use of grazing between prairie dogs and cattle occurs in beef cattle operations

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with conservative grazing, where frequency and intensity of defoliation is tightly controlled through the number of animals present per unit land area for a specified time. Under these contrasting range sites it is likely that different vegetational composition or different height and density of plant species set limits on diet selection and nutrient intake of prairie dogs. Most of the studies on food habits of prairie dogs have been conducted in National Parks (Fagerstone et al. 1977; Summers and Linder 1978) or in areas grazed by cattle (O'Meilia et al. 1982; Uresk 1984), therefore dietary studies aimed to asses the diets of prairie dogs in sites of intense biological activity and strong competition for food resources in unmanipulated field studies are very scarce. The objective of this study was to assess whether changes in the prairie dog diets are related to changes in vegetation in areas where these herbivores co-exist with goats or cattle.

Materials and methods

Study area

The study was conducted on natural rangelands in the Chihuahuan desert biome of northeast Mexico (101°6′W, 26°26′N) with an average elevation of 2100 m. The growing season (frost-free days) in this area extends from March to November. Average yearly precipitation was 307 mm, occurring primarily from June to October (75% of total precipitation). Mean annual temperature was 13.4 °C. Soils of the study site are mainly light loamy with depths varying from 2 to 2.5 m. Primary grass species were *Bouteloua curtipendula* (Michx) Torr, *Bouteloua gracilis* (Willd. ex Kunt) Lag., *Buchloe dactyloides* (Nutt.) and *Stipa clandestina* Hack. Other abundant plant species included *Croton dioicus* Cav., *Sphaeralcea angustifolia* (Cav.) D. Don. and *Solanum elaeagnifolium* Cav. Scattered populations of the shrub *Quercus pringley* Seemen are found on high sites.

There were two adjacent sites: one grazed by beef cattle and other grazed by goats. In both areas there were large active prairie dog colonies (>100 burrows/ha) which are at least 50-year old. There was only one prairie dog town per pasture and it occupied the entire pasture. In one of the sites prairie dogs and cattle grazed in common on a mixed grass community with a light stand of shrubs. On the other site, the rangeland was grazed by both goats and prairie dogs.

In the beef cattle operation, there were 150 multiparous Charolais cows (with young) which calved in the spring (March–April of 2003) and calves were weaned in the fall (October). The general grazing management has been the removal of about 50% of the perennial grass production (15 ha/animal unit) using a rotational scheme in 20 pastures on the ranch. The study site within the cattle ranch comprised a 222-ha paddock in a level terrain. The goat flock was composed of approximately 250 adult animals of undefined genotype. Goats grazed on open range (approximately 1000 ha) year round driven by a herdsman for 8 h per day (from 1000 to 1800 h).

Sampling procedure

Vegetation sampling was conducted before the start of fecal collections for each of the four seasonal periods. Standing crop was determined by clipping to ground level individual plant species from 25, 1 m × 1 m plots randomly scattered throughout the pasture. Browse biomass was estimated considering only the foliage of these plants. Clipped samples were oven dried at 60 °C for 48 h and then weighed to estimate air-dry standing crop.

There were four periods of fecal sampling: mid-January (winter), mid-April (spring), mid-July (summer) and mid-November (fall). In each sampling period, 10 fresh single defecations (single group of pellets) of prairie dogs were collected in each site, during 5 consecutive days (50 fecal samples from each site), in the proximity of 10 different active burrows scattered around the pastures. In each sampling period, the fecal samples were separated into two sub-samples; one was used for botanical and one for chemical analysis. The sub-samples for botanical and chemical analysis were composited by samples across days, within each collection period.

Laboratory methods

Fecal samples were dried at 60 °C for 48 h. Feces were then ground in a micro-Willey mill with a 1-mm screen. Five slides were prepared from each composed sample using Hoyer solution as the mounting medium. Approximately 5 g of ground samples were soaked in hot water for 10 min to soften cell tissues, drained and rinsed in a 200 mesh standard screen. Next, fecal material was cleared of chlorophyll and other compounds with 4% sodium hypochlorite (5 min soaking), which rendered the epidermis and cuticle identifiable. Samples were then spread on microscopic slides and covered with a coverslip. Five slides were prepared from each composed sample and 40 microscopic fields per slide were systematically viewed using 100 × magnifications. Epidermal fragments were identified to species level using fecal microhistological procedures (Sparks and Malechek 1968). Test slides (references) were prepared for all plants species present in the areas grazed by goats or cattle, in order to identify plant fragments.

The Kjeldahl method was utilized to determine nitrogen content of feces (AOAC 1984). Phosphorus was determined by the method of Fiske and Subbarow (1925).

Data analysis

Botanical composition data were arcsine-transformed before analysis, to satisfy assumptions of normality of variances. Diet botanical composition was analyzed by analysis of variance in a split-plot design (SAS 1989). Sites (rangeland grazed by goats or cattle) were main plots and periods subplots. Whenever there was animal species by season interaction, the Least significant difference test was performed to determine the effect of animal species within season. Each main plant species was analyzed separately. Residuals from analysis of variance were normally distributed.

Dietary overlap between prairie dogs co-existing with goats and prairie dogs co-existing with cattle was determined

with the proportional similarity index (PSI) (Feinsinger et al. 1981):

$$\mathrm{PSI} = 1 - 0.5 \sum (P_i - Q_i),$$

where P_i is the proportion of species i in the diet of animal P, and Q_i is the proportion of species i in the diet of animal Q. The non-parametric Mantel test (Mantel 1967) was used to compare dietary overlap between prairie dogs co-existing with goats or cattle.

A diet selectivity index was calculated for each plant present in feces as the ratio of each plant percentage in the diet to its percentage availability in the rangeland (Plumb and Dodd 1993). An index value approaching 1.0 indicated non-selective use of a plant; values >1.0 or <1.0 indicated grazing selectivity for or against a particular plant, respectively. Selectivity was tested by calculating a 95% confidence interval for each mean selectivity value according to the procedure of Hobbs and Bowden (1982). Selectivity was significant if the interval did not contain the value 1.0.

Fecal nitrogen and phosphorus were compared between prairie dogs in different pastures. These data were analyzed in a repeated measures design (SAS 1989) with seasons as main effects.

Results

Forage availability

To develop a perspective of the plant community structure, the forage availability in the pastures grazed by prairie dog co-existing with goats or cattle is presented in Fig. 1. The pasture grazed by prairie dogs and cattle was characterized by an average of 50% more forage compared to the pasture utilized in common by prairie dogs and goats. This is attributed to decades of heavy and continuous goat grazing around the goat's pen (an area of more intense use by goats than the rest of the prairie dog town). In terms of biomass of forage classes, forbs were the dominant source of available forage most of the year in the site shared by prairie dog and goats, whereas grasses were the dominant forage throughout the year in the pasture utilized by prairie dogs and cattle. A marked reduction in availability of forage in winter and spring in both pastures was also apparent.

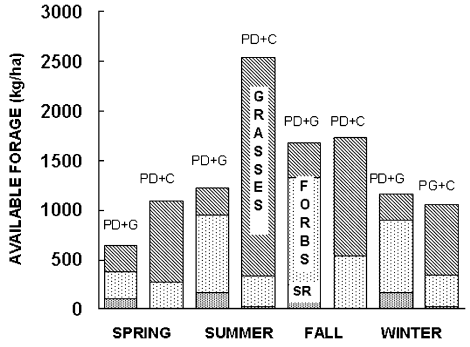

Fig. 1. Available vegetation, by forage class, during each season of the year. PD + G = prairie dogs + goats; PD + C = prairie dogs + cattle; SR = shrubs.

Diet botanical composition

Forbs were consistently an important dietary constituent of prairie dogs, regardless of pastures, comprising 11–43% of the prairie dog diets (Table 1). In summer, prairie dogs in cattle pasture utilized almost two times more ($P<0.01$) forbs than prairie dogs sharing the pasture with goats. In the fall, prairie dogs co-existing with cattle had three times more ($P<0.01$) forbs in their diets than prairie dogs sharing the pasture with goats. During spring and winter, about equal amounts of forbs were utilized by prairie dogs in both pastures. In fall and winter, *Ceratoides lanata* content of diets was higher ($P<0.05$) for prairie dogs co-existing with cattle compared to prairie dogs co-existing with goats. In spring and fall, goats co-existing with cattle consumed six and three times more ($P<0.01$) *C. dioicus*, respectively, than prairie dogs co-existing with goats. During fall and winter prairie dogs co-existing with cattle consumed more ($P<0.01$) *S. elaeagnifolium* than prairie dogs sharing the pasture with goats. The herbaceous species with the highest contribution to the prairie dog diets was *S. angustifolia*, which was an important forage source for prairie dog in both pastures, particularly in winter.

Irrespective of pasture, grasses dominated diets of prairie dogs throughout the year. Equal proportions of grasses occurred in the diets of prairie dog in both pastures in spring and winter. For the rest of the study prairie dogs co-existing with goats consistently consumed more ($P<0.05$) grasses than prairie dogs grazing with cattle. Prairie dogs co-occurring with goats consumed more ($P<0.05$) *Aristida curvifolia* than prairie dog co-existing with cattle during most of the study. During winter, the proportion of *B. dactyloides* in the prairie dog diet in the site grazed by goats was three-fold higher ($P<0.01$) than prairie dogs co-existing with cattle. Equal proportions of *B. curtipendula* occurred in the diets of prairie dogs in both pastures for most of the year. Exception was summer, when the consumption of this grass was two-fold higher ($P<0.01$) by prairie dogs co-existing with goats, than prairie dogs grazing with cattle. Two and three-fold higher proportion of *B. gracilis* occurred in diets of prairie dogs co-existing with goats in summer and fall, compared to prairie dogs sharing the site with cattle. *S. clandestina* was the most utilized grass species by prairie dogs co-existing with cattle. Prairie dogs in both pastures ignored browse species throughout the year.

Table 1. Seasonal diets (%) of prairie dogs (PD), co-existing with goats (G) or cattle (C) in a Chihuahuan desert grassland in northern Mexico. Values are means ± SE

Species[a]	Spring		Summer		Fall		Winter	
	PD + G	PD + C	PD + G	PD + C	PD + G	PD + C	PD + G	PD + C
Forbs								
Ceratoides lanata	2 ± 1	2 ± 2	2 ± 1	3 ± 2	1 ± 1	4 ± 2**	1 ± 2	5 ± 3*
Croton dioicus	1 ± 1	4 ± 1**	—	2 ± 3	1 ± 1	6 ± 2**	2 ± 2	6 ± 3*
Solanum elaeagnifolium	5 ± 3	5 ± 3	4 ± 2	5 ± 2	1 ± 1	7 ± 3**	2 ± 2	7 ± 3**
Sphaeralcea angustifolia	8 ± 3	4 ± 1*	4 ± 3	6 ± 2	2 ± 1	5 ± 3**	7 ± 2	10 ± 2
Other forbs	2	4	8	14	6	16	24	15
Total forbs	18 ± 8	19 ± 4	18 ± 5	30 ± 5**	11 ± 4	38 ± 6**	36 ± 8	43 ± 7
Grasses								
Aristida arizonica	6 ± 2	4 ± 2	7 ± 3	5 ± 2*	3 ± 2	7 ± 2**	5 ± 2	4v2
Aristida curvifolia	4 ± 3	4 ± 2	6 ± 2	4 ± 2*	6 ± 3	2 ± 2**	7 ± 1	5 ± 1
Buchloe dactyloides	4 ± 3	2 ± 2	4 ± 2	3 ± 3	3 ± 2	1 ± 2	10 ± 2	3 ± 3**
Bouteloua curtipendula	7 ± 3	8 ± 3	8 ± 2	4 ± 3**	6 ± 4	7 ± 3	7 ± 3	7 ± 2
Bouteloua gracilis	5 ± 3	6 ± 3	8 ± 3	4 ± 2**	9 ± 3	3 ± 2**	7 ± 2	5 ± 2
Erioneurum avenaceum	6 ± 2	3 ± 2**	6 ± 3	5 ± 3	4 ± 1	3 ± 2	2 ± 2	6 ± 2**
Muhlenbergia arenicola	4 ± 3	4 ± 3	5 ± 4	5 ± 3	8 ± 2	5 ± 2*	6 ± 3	3 ± v2**
Muhlenbergia repens	4 ± 3	5 ± 4	5 ± 2	3 ± 2*	2 ± 2	4 ± 3	4 ± 2	4 ± 2
Setaria leucophyla	4 ± 2	8 ± 4*	6 ± 2	7 ± 3	5 ± 3	4 ± 3	3 ± 3	3 ± 2
Sporobolus airoides	3 ± 3	2 ± 2	8 ± 4	4 ± 2*	3 ± 2	3 ± 2	1 ± 2	1 ± 1
Stipa clandestina	6 ± 3	12 ± 5**	6 ± 2	4 ± 2	9 ± 3	10 ± 3	7 ± 3	6 ± 2
Stipa leucotricha	5 ± 3	2 ± 2*	5 ± 2	4 ± 3	3 ± 2	3 ± 2	4 ± 2	4 ± 3
Other grasses	24	21	8	18	28	10	1	6
Total grasses	82 ± 4	81 ± 4	82 ± 5	70 ± 6*	89 ± 6	62 ± 9**	64 ± 7	57 v ± 10

Sample size for all means = 10. Empty cells indicate that plants were not utilized by animals. Values in the same line within season $*P < 0.05$ or $**P < 0.01$ differ.

[a]Only main species are included.

Diet preference and overlap

The selectivity indices showed that *S. elaeagnifolium* and *S. angustifolia* tended to be preferred by prairie dogs co-occurring with cattle, whereas prairie dogs co-existing with goats in general utilized these forbs in proportion to their availability in the pasture (Table 2). Prairie dogs co-existing with cattle rejected *Aristida arizonica* and *A. curvifolia*, whereas prairie dogs co-existing with goats did consume these grasses. In winter, prairie dogs co-existing with goats showed a greater ($P < 0.05$) preference for *Buchloe dacyloides* compared to prairie dogs sharing the pasture with cattle. Throughout the year this grass was used in lower proportion to its availability by prairie dogs co-existing with cattle. *B. curtipendula* and *B. gracilis* were preferentially grazed in certain season of the year by prairie dogs in both pastures. With the exception of fall, there was a moderate overlap in diets between prairie dogs grazing with goats or cattle (dietary overlap in spring, summer, fall and winter was 68%, 67%, 63% and 65%, respectively). The Mantel test did not detect differences in overall diets.

Fecal N and P

Prairie dogs co-existing with goats had a higher ($P < 0.05$) fecal N concentration in the fall than prairie dog co-occurring with cattle (Table 3). In spring and summer, prairie dogs in the pasture shared with goats had higher ($P < 0.05$) fecal P concentration than prairie dog co-existing with cattle. Fecal N concentrations showed that prairie dog diet quality was highest in summer and fall and lowest in winter and spring.

Discussion

Overall, prairie dogs co-existing either with goats or cattle selected fairly similar species in their diets, but in different proportions. Diets of prairie dogs co-existing with cattle were highly variable among seasons: forbs ranged from 19% to 43% and grasses from 57% to 81%, whereas grasses were the staple food of prairie dogs co-existing with both goats and cattle most of the year. Differences in botanical composition of diets between prairie dogs co-existing with goats or cattle

Table 2. Selectivity index for main species utilized by prairie dogs (PD) co-existing with goats (G) or cattle (C) in a desert rangeland over 1 year

Species	Spring		Summer		Fall		Winter	
	PD + G	PD + C	PD + G	PD + C	PD + G	PD + C	PD + G	PD + C
Solanum elaeagnifolium	1.3	2.5*	1.0	2.5*	1.0	2.3*	0.7	2.0
Sphaeralcea angustifolia	2.7*	1.5	1.0	2.6*	1.0	3.0*	2.3	4.0*
Aristida arizonica	2.0	0.5*	1.2	0.3*	1.5	0.7	1.7	1.1
Aristida curvifolia	2.0	0.4	1.5	0.2*	0.9	0.3*	1.0	0.8
Buchloe dactyloides	1.3	0.3	2.0	0.6	1.0	0.2	3.3*	1.1
Bouteloua curtipendula	2.3*	4.0*	1.0	1.0	2.0	1.4	2.3	1.2
Bouteloua gracilis	1.5	3.0*	4.0*	0.8	1.5	0.8	3.5*	1.1
Erioneurum avenaceum	1.0	0.9	3.0*	0.8	2.0	0.7	2.0	0.7
Muhlenbergia arenicola	2.0	0.5	2.5	0.5*	3.0*	0.3*	3.0	0.5
Stipa clandestina	1.5	0.8	1.5	0.9	1.5	1.0	1.8	0.6

Values with asterisks indicate that 95% confidence intervals for seasonal diets do not contain the value 1.

Table 3. Fecal nitrogen and phosphorus concentration (percentage of dry matter) for prairie dogs (PD) co-existing with goats (G) or cattle (C) for four seasons on desert rangeland. Values are means ± SD

Season	Animal species	Fecal N[a,b]	Fecal P[a,b]
Spring	PD + G	1.8 ± 0.2^{a}	3.0 ± 0.4^{a}
	PD + C	1.9 ± 0.2^{a}	2.5 ± 0.2^{b}
	Mean	1.9 ± 0.2^{A}	2.8 ± 0.4^{A}
Summer	PD + G	2.4 ± 0.3^{a}	1.6 ± 0.1^{a}
	PD + C	2.6 ± 0.4^{a}	1.0 ± 0.1^{b}
	Mean	2.5 ± 0.3^{B}	1.3 ± 0.3^{B}
Fall	PD + G	2.4 ± 0.1^{a}	1.2 ± 0.1^{a}
	PD + C	2.1 ± 0.1^{b}	1.3 ± 0.3^{a}
	Mean	2.3 ± 0.3^{B}	1.2 ± 0.1^{B}
Winter	PD + G	2.0 ± 0.3^{a}	1.3 ± 0.1^{a}
	PD + C	2.0 ± 0.4^{a}	1.5 ± 0.4^{a}
	Mean	2.0 ± 0.3^{A}	1.4 ± 0.3^{B}

[a]Means for PD coexisting with G or C within columns and seasons with different small case letters are different ($P < 0.05$).

[b]Means for seasons within columns with different capital letters are different ($P < 0.01$).

were attributed to differences in the floristic composition and forage dry matter produced in these pastures, and to the competition for resources use between these herbivores. It is well documented that land degradation occurs around rural settlements due to excess of small ruminant densities in the vicinity of settlements with communal grazing land (Perevolostsky 1991; Mellado et al. 2005). Thus, decades of continuously grazing at heavy rates of stocking around the goat's pen have led to divergent plant structure, and consequently to diet selection patterns by prairie dogs co-existing with goats.

The lowest utilization of forbs by prairie dogs co-existing with goats, even though the greater availability of forb biomass in the pasture grazed by goats, may reflect the intense competition for this forage class between these herbivores. In some plant communities the contribution of actively growing forbs to the goat diets is over one-half of the total forage consumed (Fajemisin et al. 1996; Mellado et al. 2003), whereas forbs normally make up over one-third of the diet of black-tailed prairie dogs on rangelands (Kelso 1939; Summers and Linder 1978). Thus, as forbs became less available during the progressive defoliation by goats, prairie dogs were less selective for this forage class. This high adaptability of prairie dogs to changes in floristic composition was demonstrated by Fagerstone et al. (1977), who reported that prairie dog diets changed drastically from forbs to grasses after forb coverage was reduced by spraying herbicide, without adverse effect on body weight of prairie dogs. One forb of singular importance for prairie dogs in both pastures was *S. angustifolia*, which constituted up to 8% of the diet. These results are supported by the finding of others relative to the importance of this forage species for prairie dogs (Uresk 1984) and jackrabbits (Daniel et al. 1993) in arid zones.

The apparent competition for forbs in the goat pasture forced prairie dog to depend heavily on grasses. Availability of biomass of grasses in the pasture shared by prairie dogs and goats was substantially lower than that found in the pasture used by prairie dogs and cattle, but this difference was not an obstacle for the higher utilization of grasses by prairie dog co-existing with goats compared to prairie dogs co-existing with cattle. This is explained by the low utilization of this forage class by goats (<15% of the total diet) in this type of landscape (Mellado et al. 1991, 2003) and the high preference of prairie dogs for grasses (Hansen and Gold 1977; Summers and Linder 1978; Uresk 1984). *B. gracilis* was the grass most consistently consumed by prairie dogs co-existing with goats during the four

collection periods. During the rainy season (summer and fall) the consumption of this grass was two to three times higher for prairie dogs grazing with goats compared to that of prairie dogs grazing with cattle. The overall consumption of *B. gracilis* in the present study generally agrees with Summers and Linders (1978) in western South Dakota. However, Fagerstone et al. (1977) and Uresk (1984) in Colorado did report higher levels of this grass in black-tailed prairie dogs diet than in the present study, although forbs were less available on their study area.

By looking at the selectivity indices it was clear that differences in plant structure and availability did affect diet preference. In general, prairie dogs showed a higher preference for *S. elaeagnifolium* and *S. angustifolia* in the pasture grazed by cattle than in the pasture grazed by goats. The greater forb preference by prairie dogs co-existing with cattle was due to the reduced availability of forbs in those pastures shared by prairie dogs and cattle.

In general, *Muhlenbergia arenicola* and *Muhlenbergia repens* were not preferred items for prairie dogs co-existing with cattle, in fact, *M. arenicola* in particular was rejected by prairie dogs grazing with cattle. However, under restricted availability of forage (pasture shared by prairie dogs and goats) prairie dogs showed a preference for these grasses. Other grasses avoided by prairie dogs co-existing with cattle, but eaten in proportion higher than their relative availability by prairie dogs co-existing with goats were *A. arizonica*, *A. curvifolia* and *B. dactyloides*. Regarding the latter grass, Lerwick (1974) and Kelso (1939) reported that black-tailed prairie dogs did not consume this grass even though it was abundant in the habitat of this herbivore. However, Summers and Linder (1978) found that *B. dactyloides* was one of the most important forages utilized by black-tailed prairie dogs in a grassland of southwestern South Dakota. *S. clandestina*, a grass not considered a good forage for herbivores due to their thick cell wall and marginal levels of protein in certain periods of the year (Ganskopp 1998), was an important component of prairie dogs in both pastures throughout the year, although its selectivity index was low, indicating that prairie dogs were not seeking for this grass. These results indicate that differences in standing crop biomass, structure, intensity and frequency of use between pastures resulted in contrasting diet preference by prairie dogs, a phenomenon well documented in herbivores with variable availability of plant material (Crawley 1983).

The dietary overlap values were not different between prairie dogs co-existing with goats or cattle. Such indices are useful in summarizing overall diet of herbivores, but in this study they did not identify biological meaningful differences in the diets of prairie dogs with ruminant competitors.

Concentrations of nitrogen (Holecheck et al. 1982; Blanchard et al. 2003) and phosphorus (Holecheck et al. 1985; Hakkila et al. 1988) in the feces are related to the nutritional status of grazing ruminants. Thus, it is likely that diet and fecal N and P are also correlated for prairie dogs. Assuming this, fecal N and P concentrations in the present study showed that prairie dog diet quality was higher in prairie dogs co-existing with goats in spring and summer. The seemingly illogical higher diet quality of prairie dog grazing in a denuded and degraded pasture is ascribed to the marked increase in soil N and P near the goat's pen due to the continuous nutrient inputs from goat dunging (Mellado et al. 2005). Additionally, because forage on the site shared by prairie dogs and goats was continually cut down or consumed, prairie dogs may have benefited by facilitating access to forage at an earlier phenological stage and in a state of regrowth.

These data indicate that the utilization of grasslands by goats or cattle had a bearing on the foraging behavior of prairie dogs co-existing with these ruminants. Habitat change by the heavy grazing of goats around their pen and the high competition between prairie dogs and goats for herbaceous vegetation forced prairie dogs to concentrate on grasses for most of the year. Although prairie dogs co-existing with cattle consumed large amounts of forbs, they continued to follow a foraging behavior based on grasses. The lack of evidence for a negative nutritional change in the diet of prairie dogs grazing a degraded pasture due to excess goat densities in the vicinity of settlements with communal grazing, indicates that prairie dogs are highly adaptable feeders. Thus, although prairie dog foraging on the goat pasture was evidently affected, these herbivores showed a high adaptation capacity to meet their nutritional needs in poor condition ranges overstocked with goats.

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Zusammenfassung

Futterzusammensetzung von *Cynomys mexicanus* auf Rinder- und Ziegenweiden in Nordmexiko

Die Futterzusammensetzung von *Cynomys mexicanus*, die ihr Habitat mit Rindern oder Ziegen teilen, wurde mit Hilfe mikrohistologischer Untersuchung von Kotproben in einer einjährigen Studie bestimmt. *C. mexicanus* auf Rinderweiden konsumierten mehr Kräuter (33% vs. 21% im Durchschnitt über alle

Jahreszeiten, $P<0.05$) als *C. mexicanus* auf Ziegenweiden. *C. mexicanus* auf Ziegenweiden konsumierten hauptsaechlich Gräser (79% des Gesamtkonsums), verglichen mit 68% auf Rinderweiden (Durchschnitt über alle Jahreszeiten, $P<0.05$). Die Futterzusammensetzung von *C. mexicanus* auf Rinder- und Ziegenweiden überschnitt sich nur moderat (69% über alle Jahreszeiten). Die fäkale N-Konzentration war höher ($P<0.05$) in *C. mexicanus* auf Ziegenweiden verglichen mit *C. mexicanus* auf Rinderweiden (2.4 ± 0.1 vs. 2.1 ± 0.1%). *C. mexicanus* auf Ziegenweiden im Frühling und im Sommer hatten höhere ($P<0.05$) fäkale P-Konzentrationen (3.0 ± 0.1 vs. 2.5 ± 0.2, und 1.6 ± 0.1 vs. 1.0 ± 0.1) als *C. mexicanus* auf Rinderweiden. Die Ergebnisse zeigen, daß *C. mexicanus* in der Lage ist, seine Nahrungszusammensetzung der Konkurrenz mit anderen Herbivoren anzupassen. Selbst auf hochgradig degradierten Ziegenweiden war die Qualität der Nahrungszusammensetzung von *C. mexicanus* nicht beeinträchtigt. *C. mexicanus* scheint in der Lage, seine Nahrungszusammensetzung extrem flexibel anpassen zu können.

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