Black-tailed Prairie Dog Mounds: Do they contribute to plant species diversity and nitrogen cycling?

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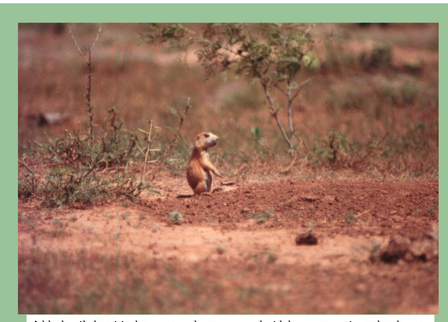
The Black-tailed Prairie Dog (*Cynomys ludovicianus*), a species indigenous to the Great Plains of North America.

ABSTRACT

Soil mounds around burrows are natural disturbances in plant communities where prairie dogs (*Cynomys* spp.) occur. We hypothesized that one or more sub-dominant plant species are more abundant on black-tailed prairie dog (*C. ludovicianus*) mounds than on inter-mound areas or off-prairie-dog-town areas, and that soil mixing results in enhanced N-mineralization which increases N-content of plants growing on mounds. During summer 2000, we measured plant cover and biomass by species in on-mound, inter-mound, and off-town plots on three active prairie dog towns in each Texas, Colorado, and Montana. In Montana and Colorado, *Solanum triflorum* was found only on mounds, and *Sphaeralcea coccinea* was more frequent on prairie dog mounds than on inter-mound and off-town areas. In Texas, *Achillea millefolium* and *Amaranthus blitoides* was found only on prairie dog mounds, and *Hoffmanseggia glauca* was more frequent on mounds than on inter-mound and off-town areas. Biomass of grasses increased from on-mound to off-town sites while biomass of most forbs decreased. Plant nitrogen concentration showed a general decline from mounds to off-town areas. These findings support the hypothesis that soil disturbance caused by *C. ludovicianus* during construction and maintenance of their mounds contributes to plant species diversity and enhanced N-mineralization in grasslands.



A black-tailed prairie dog pup on a burrow mound with honey mesquite and rush-pea.

INTRODUCTION

Grasslands experience many types of disturbance from large scale fires, floods and erosion, to small scale disruptions such as fecal pats or ant mounds that produce irregularities in the plant community. These alter the community by creating gaps in the plant canopy, overturning the soil, or burying or uprooting individual plants (Coffin and Lauenroth 1988). Disturbances often kill the plants directly affected and promote turnover of plant species within the community. Disturbance on small scales (0.01 to 1 m^2) provide the opportunity for subordinate species to become established on the affected areas (Coffin and Lauenroth 1988). Black-tailed prairie dog (*Cynomys ludovicianus*) soil mounds, which are usually 1-2m in diameter (Whicker and Detling 1988), are such a disturbance. This study was conducted to ascertain whether:

HYPOTHESES

1. One or more sub-dominant, plant species are found in greater abundance on black-tailed prairie dog (*Cynomys ludovicianus*) mounds than in inter-mound areas or off prairie dog town areas, and

2. Soil mixing results in enhanced N-concentration of plants growing on mounds.

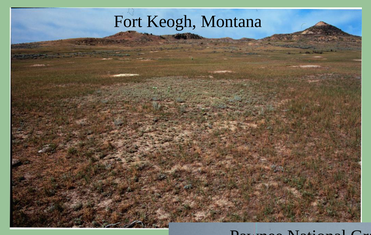
STUDY SITES

Field data collection took place from June to July 2000. We selected three active black-tailed prairie dog towns each at:

1. Texas A&M Agricultural Experimental Station, Vernon, Texas

2. The Shortgrass Steppe LTER, Pawnee National Grasslands, Colorado.

3. The USDA Agricultural Research Station, Fort Keogh, Montana.



METHODS

• On each town, we staked out a 200x100m "town plot". All sub-plots within the town plot were located at random points within this plot. We also randomly located a 50x50m plot and measured burrow density.

• Within the town plot, 25 dome mounds were randomly selected and their basal area and plant cover were estimated. With the short side of a Daubenmire frame (0.2 x 0.5m) at the burrow entrance in a randomly selected compass direction, we estimated percent cover for all plant species within the frame.

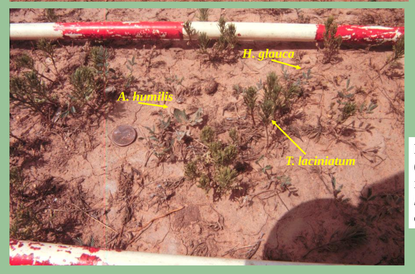
• For the first five Daubenmire plots on each prairie dog town, we overlaid the Daubenmire frame with a 0.25m^2 clipping ring and clipped all vegetation rooted within the ring. Samples were then oven-dried at 80C for at least 2 days until completely dry. Samples were weighed on a Sartorius balance.

• At each study site, three species abundant in all three locations (on-mounds between mounds and off-town.) were selected for nitrogen analysis and five aboveground samples of each species were collected at each location at each town (15 total samples per species per town). Species at the Colorado and Montana sites overlapped greatly, and the same three species, *Agropyron smithii*, *Sphaeracea coccinea*, and *Verbena bracteata*, were collected at these sites. In Texas, we collected *Argythamnia humilis*, *Hoffmanseggia glauca*, and *Teucrium laciniatum*.

Samples were homogenized in a Wiley Mill through a 20-mesh screen. All N-analyses were performed on a LECO-1000 CHN gas auto-analyzer.

Statistical Analyses

Frequency, Cover, Biomass, and Nitrogen data were input to SAS (ver 8.0) code separately by State and species for ANOVAs for position (on, inter, off), town (3 per state), and position x town interaction effects.



Daubenmire frame (0.1m^2) and clipping ring (0.25m^2) in position on-mound (top left) and inter-mound (above). All 3 species (*A. humilis*, *H. glauca*, and *T. laciniatum*) collected for N analysis in Texas (left).

RESULTS

A few species exhibited greater frequency on prairie dog mounds than in inter-mound and off-town areas. In Montana and Colorado, *Solanum triflorum* was found only on mounds, and *Sphaeralcea coccinea* was more frequent on prairie dog mounds than on inter-mound and off-town areas. (Figs. 1 & 2) In Texas, *Achillea millefolium* and *Amaranthus blitoides* were found only on prairie dog mounds, and *Hoffmanseggia glauca* was more frequent on mounds than on inter-mound and off-town areas. (Fig. 2) In general, biomass of grasses increased from on-mound to off-town sites while biomass of most forbs decreased.(Fig. 3) This was also true for grasses and forbs frequencies. Plant nitrogen concentration showed a general decline from mounds to off-town areas. (Fig. 4) At Ft. Keogh, N-concentration of *Agropyron smithii* was significantly different at all three locations, and at all thee sites, most species showed a significant difference between on-mound and off-town N concentrations.

Figure 1. A dome mound in Montana on which *Sphaeralcea coccinea* is growing (arrow).

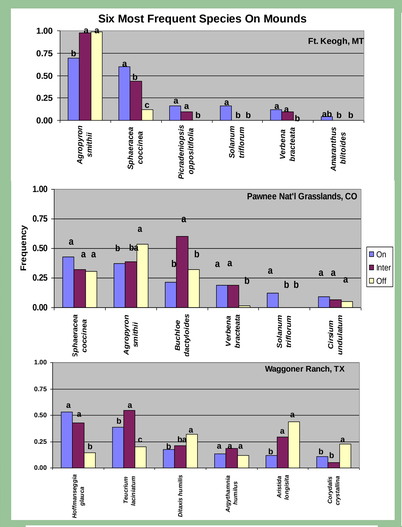


Figure 2. Six Most Frequent On Mound Species. Number of occurrences of species averaged over three towns for each sampling location for each site. Letters denote significant differences between location for each species.

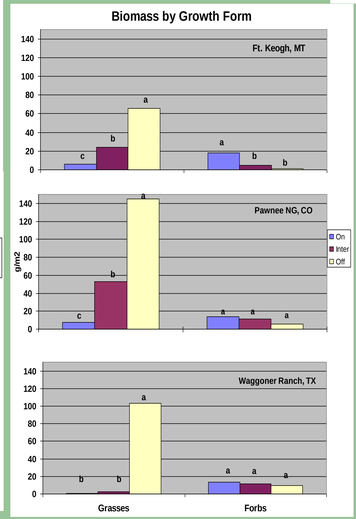


Figure 3. Biomass of Grasses and Forbs. Grasses increased from on-mound plots to off-town plots while forbs decreased. Biomasses include standing dead mass which may explain the high values seen on the Pawnee National Grasslands in Colorado.

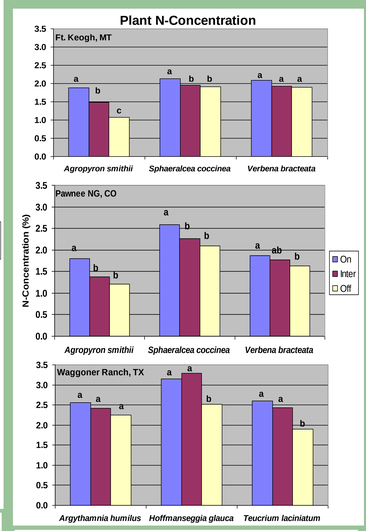


Figure 4. N-concentrations. Nitrogen concentrations as a percent of total aboveground biomass.

DISCUSSION

Disturbances to grassland communities can alter the dominance balance between species competing for resources of light, nutrients, and water. (Coffin & Lauenroth, 1988) We found several plant species to occur in greater abundance in the disturbed soil of black-tailed prairie dog mounds. Our biomass data show similar trends as those of Coppock et al. (1983) who found grass biomass to increase on-town to off while that of forbs decreased. Though not always statistically significant, a trend appears to show that the soil disturbance of the mounds enhances N-concentration in plants beyond that of those growing between mounds. These results support our hypotheses that soil disturbance caused by *C. ludovicianus* during construction and maintenance of their mounds contributes to plant species diversity in grasslands and to enhanced N-concentration of plants growing on mounds.

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