# Prairie dog effects on harvester ant species diversity and density

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#### Abstract

The purpose of this study was to determine if black-tailed prairie dogs (Cynomys ludovicianus Ord) influence harvester ant nest density and species composition within the shortgrass prairie biome of southwestern Kansas. Two treatments were established: areas colonized by prairie dogs and areas not colonized by prairie dogs. We recorded 183 harvester ant nests of 3 species. Harvester ant nest density did not differ significantly between prairie dog colonies (3.08 nests ha<sup>-1</sup>) and non-colonized shortgrass prairie sites (4.54 nests ha<sup>-1</sup>), but species composition did. Pogonomyrmex rugosus Emery was the most frequent species on prairie dog colonies where it accounted for 87% of ant nests present, as opposed to 33% on sites where prairie dogs were absent. Pogonomyrmex barbatus Smith was the most abundant species on non-colonized areas, making up 49% of the ant nests sampled. Pogonomyrmex occidentalis Cresson comprised 11% of ant nests sampled, and was nearly absent from prairie dog colonies (20 nests on non-colonized sites vs. 1 nest on prairie dog colonies). The average number of harvester ant species found per site was consistently greater on sites where prairie dogs were absent.

# Key Words: *Cynomys ludovicianus, Pogonomyrmex,* diversity, shortgrass prairie, Kansas

Harvester ants (*Pogonomyrmex* spp.) are widespread in the arid and semi-arid regions of western North America. Harvester ants are locally abundant and are considered pests in rangelands where densities are high. These ants may alter plant community structure by denuding vegetation and harvesting seeds and litter surrounding colonies (Rogers and Lavigne 1974). Hewitt et al. (1974) state that harvester ants have the most consistent impact on rangeland of any insect other than grasshoppers. Ants also are considered important contributors to soil formation (Rogers and Lavigne 1974). Because earthworms are not abundant in semiarid rangelands, the ant is the most important invertebrate that moves soil vertically (Jacot 1936).

Black-tailed prairie dogs (*Cynomys ludovicianus* Ord) are native herbivores that are capable of dramatically altering grassland habitats (King 1955, Koford 1958, Hoogland 1995, Winter 1999) and are considered by some to be keystone species (Miller et al. 1994, Wuerthner 1997, Kotliar et al. 1999). Because of serious declines in the past, and ongoing declines over large portions

#### Resumen

El propósito de este estudio fue determinar si los perros de la pradera (Cynomys ludovivianus Ord.) influyen en la densidad y diversidad de especies de hormigas cosechadoras de la bioma de praderas de zacates cortos del sudoeste de Kansas. Se establecieron dos tratamientos: áreas colonizadas por perros de la pradera y áreas no colonizadas. Registramos 183 hormigueros de 3 especies de hormigas cosechadoras. La densidad de hormigas cosechadoras no difirió significativamente entre las áreas colonizadas por perros de la pradera (3.08 hormigueros ha<sup>-1</sup>) y las no colonizadas (4.54 hormigueros ha<sup>-1</sup>), pero la composición de especies si difirió. La especie de hormiga Pogonomyrmex rugosus Emery fue la más frecuente en las áreas colonizadas por perros de la pradera en la que el 87% de los hormigueros registrados fueron de esta especie, en contraste con el 33% de los hormigueros de los sitios donde los perros de la pradera estuvieron ausentes. La especie de hormiga Pogonomyrmex barbatus Smith fue la más abundante en las áreas no colonizadas con el 49% de los hormigueros muestreados. La especie Pogonomyrmex occidentalis Cresson comprendió el 11% de los hormigueros y estuvo casi ausente en las colonias de perros de la pradera (20 hormigueros en las áreas no colonizadas vs.1 en las áreas colonizadas). El promedio del número de especies de hormigas cosechadoras encontradas por sitio fue consistentemente mayor en los sitios donde los perros de la pradera estuvieron ausentes.

of their range, the Fish and Wildlife Service conducted a status review of black-tailed prairie dogs that found the species warranted but precluded for listing under the Endangered Species Act (USDI 2000).

In addition to alterations in vegetative communities, black-tailed prairie dog activities can cause significant changes in the species composition and densities of a variety of vertebrate groups occupying mixed-grass prairie habitats (O'Meilia et al. 1982, Agnew et al. 1986); however, there currently are only a few detailed studies describing the influence of prairie dogs on invertebrate communities. In mixed-grass prairies of South Dakota, total density of soil nematodes was higher in prairie dog colonies than in uncolonized sites (Ingham and Detling 1984). Conversely, in northern Oklahoma, arthropod biomass was lower on prairie dog colonies than on uncolonized areas (O'Meilia et al. 1982).

The purpose of this research was to determine if black-tailed prairie dogs influence harvester ant (*Pogonomyrmex* spp.) species composition and nest density. We documented the density and species composition of harvester ant nests at study sites on and off black-tailed prairie dog colonies at the Cimarron National Grassland, Kans.

We were assisted in the field by Dwayne Winslow. Bobby Brown confirmed ant species identification, and Jeffrey Pontius provided valuable statistical advice. Research was funded by the U.S.D.I. Fish and Wildlife Service, U.S.D.A. Forest Service, and Kansas State University.

Manuscript accepted 18 Apr. 2000.

### Methods

This study was conducted on the Cimarron National Grasslands in Morton County, Kans. (Latitude 37° 07'N-Longitude 102° 00'W), during July 1997. Two treatments were established with 5 sample sites each scattered across the northern half of the grassland: areas colonized by prairie dogs and areas of similar habitat not colonized by prairie dogs. We selected 5 prairie dog colonies, which varied in size from 30 to 54 ha. These sites were selected because they were among the largest prairie dog colonies on the grasslands. Five non-colonized study sites, which varied in size from 32 to 65 hectares were selected in pastures with slope and vegetation similar to the prairie dog sites, but without prairie dogs. All study sites were shortgrass community type dominated by buffalograss (Buchloe dactyloides (Nutt.) Engelm.) and blue grama (Bouteloua gracilis (H.B.K.) Lag. Ex Griffiths), with low topographic relief. Soil types at all sites were characterized by loamy and silty-loam soils in the Richfield (fine, smectite, mesic Aridic, Arguistolls)-Ulysses (fine-silty, mixed, superactive, mesic Aridic, Haplustolls) association with slopes between 0-6%(Dickey et al. 1963).

Livestock was managed on the Cimarron National Grasslands under rotational grazing, with intensity adjusted to the available forage; therefore, not all study sites were grazed at the same time each year. One prairie dog colony, and 2 non-colonized sites were not grazed by livestock during 1996 or 1997. The combination of prairie dogs and livestock creates a situation where grazing intensity and soil disturbance may be very high.

Prairie dog burrow density was calculated at each colony using a plotless density estimator modified from Cook and Stubbendieck (1986). Because nearest neighbor estimates of density are appropriate only for randomly distributed objects, and we have evidence that prairie dog burrows are regularly dispersed (Cully, unpublished data), we adapted a point to burrow estimator as follows. One hundred meter long tapes were laid at random at 8 locations in each colony. Random points were selected in each 10 m section of the tape for 75 points at each colony. The distance from the random point to the nearest burrow opening was measured to the nearest 0.1 m. Density was calculated as D = $10,000/\pi d^2$  where D = density ha<sup>-1</sup>, and d = mean point to burrow distance, which forms the radius of a circular area.

Harvester ant nest density and species composition was quantified along 8 strip transects, 300 m long x 20 m wide at each study site. Two people walked parallel along the transects, 20 m apart, for a total of 4.8 ha sampled per study site. Within this area, all harvester ant nests were counted and identified to species according to Cole (1968). Voucher ant worker collections were made and species identifications were verified by Mr. Bobby Brown, Museum of Entomological and Prairie Arthropod Research at Kansas State University where specimens are preserved. Differentiation of species in the field was simple and accurate due to differences in size and color of workers, as well as different clearing and mound shapes among species (Table 1).

not equal among treatments a Satterthwaite t-test was used instead of Cochran t-test (SAS Inst. Inc. 1993).

#### **Results**

Black-tailed prairie dog burrow density at the 5 colonies was moderate ( $\bar{x} = 81$ , SD = 56 burrows ha<sup>-1</sup>). A total of 183 harvester ant nests of 3 species was recorded. The total density of harvester ant nests did not differ significantly between prairie dog colonies and non-colonized shortgrass prairie sites (Table 2). *Pogonomyrmex rugosus* Emery was encountered most often and accounted for 55% of the ant nests sampled, followed by *P. barbatus* Smith (34%), and *P. occidentalis* Cresson

 Table 1. Characteristics of the 3 species of harvester ants found at the Cimarron National Grassland in Morton Co., Kans., USA.

Species	Color	Size	Mound shape
Pogonomyrmex rugosus	black with red abdomen	large	flat
P. barbatus	red	large	flat
P. occidentalis	red	small	dome

At prairie dog sites, sampling transects began at the boundary of the prairie dog colony. In areas where prairie dogs were absent, sampling began at the edge of the study site. If the study site was 45 ha or smaller, the second transect was offset 75 m at the opposite side of the study site. At non-colonized sites, and at prairie dog colonies where the study site was larger than 45 ha, the second transect was similarly offset and started at the approximate mid-point of the site and ran in the same direction as the first. The third transect was again offset, then started at the opposite edge and ran back towards the center of the study site. This ensured that all parts of the site were thoroughly sampled as opposed to just sampling the edges or middle portions. These data were used to estimate the density of ant nests at each study site, which was the sample unit.

Total harvester ant nest density (nests ha<sup>-1</sup>) and species composition were compared between prairie dog colonies and non-colonized shortgrass prairie sites. T-tests were used to statistically test for differences in total harvester ant nest density, nest density of each species sampled, and harvester ant species richness between the 2 treatments ( $\alpha$ = 0.05). A nonparametric Wilcoxon exact test was used when deviations from normality occurred. When normality was met but variances in data were

(11%). Although total harvester ant nest density was not significantly different on black-tailed prairie dog colonies, species composition was influenced by prairie dogs. Mean nest densities of P. rugosus and P. occidentalis did not differ significantly between treatments. However, mean species richness and nest densities of P. barbatus were significantly different between treatments. The nest density of P. barbatus was greater on study sites where prairie dogs were absent. While all 3 species of harvester ants were sampled both on and off prairie dog colonies, mean species richness was significantly greater on non-colonized shortgrass prairie sites  $(\overline{x} = 2.6, SE = 0.25, df = 4)$  than at prairie dog colonies ( $\overline{x} = 1.4$ , SE = 0.25, df = 4; P = 0.0476).

# Discussion

Total harvester ant nest densities, as well as the density of each individual species, were lower than those reported in other studies with a variety of land-use types (Whitford et al. 1976, Soulé and Knapp 1996). On the Cimarron National Grassland, total harvester ant densities were similar to densities of *P. occidentalis* in heavily grazed pastures of northeastern Colorado (Rogers and Lavigne 1974). However, *P. occidentalis* densities on the

Table 2. Total number of harvester ant nests sampled, and mean (+/-SE) nest density on prairie dog colonies (PDOG) and shortgrass prairie sites where prairie dogs are absent (NODOG) at the Cimarron National Grassland, Kansas.

	Number of Nests		Mean Density			
Species	PDOG	NODOG	PDOG	NODOG	P-value and test	
	(nests/ha)					
Pogonomyrmex rugosus Emery	64	36	2.67 (1.46)	1.50 (0.54)	0.4760 Cochran	
Pogonomyrmex barbatus Smith	9	53	0.38 (0.19)	2.21 (0.65)	0.0470* Satterthwaite	
Pogonomyrmex occidentalis Cresson	1	20	0.04 (0.04)	0.83 (0.54)	0.1270 Wilcoxon	
Total <i>Pogonomyrmex</i> spp.	74	109	3.08 (1.29)	4.54 (0.43)	0.3152 Cochran	

\*Significant at the 0.05 level.

Cimarron National Grasslands were lower than in Colorado (Rogers and Lavigne 1974) and Oklahoma (O'Meilia et al. 1982) where *P. occidentalis* has been reported previously. Nagel (1969) reported lower densities of *P. occidentalis* in Morton County, Kansas, compared to other western Kansas counties.

Livestock grazing may or may not influence ant abundance and density. Nagel (1969) suggested that mated queen P. occidentalis select areas of rangeland with sparse vegetation and soils with high light reflectance, typical of over-grazed areas. In the Chihuahuan Desert in southeastern Arizona, ant abundance was not affected by livestock grazing (Heske and Campbell 1991). Likewise, Kirkham (1967) did not find any differences in *Pogonomyrmex* owyheei Cole densities in Wyoming due to different grazing intensities over a 10-year period. Likewise, in northern Colorado, light and moderate grazing resulted in 22% and 33% increases in harvester ant colony densities, but heavy grazing reduced colony density by 87% (statistical analyses were not presented) compared to the ungrazed sites (Rogers and Lavigne 1974). In northern Colorado P. occidentalis densities are negatively associated with vegetative succession on abandoned fields, with the greatest concentrations found in areas with abundant forbs and perennial grasses, and lower densities in late succession shortgrass stages (Costello 1944).

In northern Oklahoma, O'Meilia et al. (1982) did not detect any differences in *P. occidentalis* densities between prairie dog towns and non-colonized pastures. Because of the extreme rarity of *P. occidentalis* on prairie dog colonies and variance in numbers found on non-colonized sites, we did not detect a statistical difference between treatments in this study, however, there was a trend towards greater abundance of *P. occidentalis* nests on non-colonized shortgrass prairie sites compared to prairie dog colonies (20 vs. 1 nest encountered respectively).

Pogonomyrmex rugosus and P. barbatus are closely related species with a wide niche overlap. These 2 species have similar habitat and forage requirements. Both species prefer seeds from grasses and forbs but will also collect a variety of other materials (Whitford et al. 1976, Hölldobler and Lumsden 1980, Gordon 1993). In New Mexico grasslands, nest densities of P. rugosus and P. barbatus were approximately 20 nests per ha in areas supporting one or both species (Whitford et al. 1976), which is higher than we found. Despite the close relationship between the 2 species, they responded to prairie dog activities in different ways. Pogonomyrmex rugosus nest density was similar between the 2 treatments; whereas, P. barbatus nest densities were significantly higher in areas without prairie dogs.

Harvester ant species richness was significantly lower on prairie dog colonies. Although all 3 species of ants were encountered both on and off prairie dog colonies, non-colonized shortgrass sites consistently had 2 or 3 species present, whereas only 1 or 2 species were usually found on prairie dog colonies. Pogonomyrmex rugosus was the most frequent species on prairie dog colonies where it accounted for 87% of ant colonies encountered, as opposed to 33% where prairie dogs were absent. Pogonomyrmex barbatus was the most abundant species on non-colonized areas, making up 49% of the ant nests sampled there. Pogonomyrmex barbatus and P. occidentalis were nearly absent from prairie dog colonies. Pogonomyrmex barbatus was 5 times as frequent and P. occidentalis was 20 times more frequent on non-colonized prairie sites.

Crist and Wiens (1994) reported reduced seed harvesting of *P. occidentalis* in shortgrass pastures occupied by prairie dogs. They attributed this pattern of lower seed removal to the presence of shorthorned lizards (*Phrynosoma douglassi* Bell) on prairie dog colonies, rather than to the vegetative structure of those sites. Whitford and Bryant (1979) and Munger (1984a, 1984b) demonstrated that horned lizard (*Phrynosoma cornutum* Harlan) predation decreases the foraging activity of harvester ants. However, we do not believe that a reduction in foraging activi ty of these ants, due to predation by horned lizards, is responsible for the observed decrease in species richness or in *P. barbatus* and *P. occidentalis* densities found on prairie dog colonies during this study. In a concurrent study in 1997, there was no difference in relative abundance of horned lizards between prairie dog colonies and non-colonized shortgrass prairie sites (Kretzer and Cully in press).

Our results are that prairie dog colony habitats are marginal, or unattractive to P. barbatus and P. occidentalis, but are attractive to P. rugosus. We do not know what factors are responsible for these species differences. Long-term disturbance by black-tailed prairie dogs alters plant community structure (Bonham and Lerwick 1976, O'Meilia et al. 1982, Coppock et al. 1983, Agnew et al. 1986, Archer et al. 1987, Winter 1999). Harvester ants exploit patchy but relatively stable food supplies (Hölldobler and Lumsden 1980). It is possible that changes in vegetative composition and cover, that result from prairie dog activities affect soil characteristics, food availability, and suitable nest sites in ways that have a negative influence on densities of P. barbatus and P. occidentalis with concomitant reductions in harvester ant species richness.

Black-tailed prairie dogs are known to alter the distribution, abundance, and species composition of a wide variety of plant and animal groups (Agnew et al. 1986, Archer et al. 1987, Koford 1958, Bonham and Lerwick 1976, Coppack et al. 1983, Ingham and Detling 1984, O'Meilia et al. 1982, Miller et al. 1990, Miller et al. 1994). Prairie dogs create patches of habitat that differ from the surrounding grasslands and add heterogeneity to shortgrass prairie landscapes (Whicker and Detling 1988, 1993). Our results show that prairie dogs influence closely related ant species in dramatically different ways. They also demonstrate that it is inappropriate to make broad generalizations about the positive or negative influences that prairie dogs have on other grassland organisms.

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