(Grant awarded 2005)

Accomplishments of the funded research. The short-term goal of the funded research was to test the preference of the harvester ant, *Pogonomyrmex occidentalis*, for seeds of the introduced cheatgrass, *Bromus tectorum*, relative to those of other species. To address the long-term effects of interactions between ants and cheatgrass, we also were funded to begin two sets multi-year experiments. One set of experiments will measure whether ant foundresses avoid areas with high densities of cheatgrass, leading to lower recruitment in these areas, and whether young colonies in sites with high cheatgrass density grow more slowly and have lower survival relative to recuits in sites with low cheatgrass denisty. A second set of experiments compares the changes in cheatgrass density in plots where harvester ant colonies have been removed versus controls.

Response to cheatgrass seeds. Two locations in the desert belonging to the Bureau of Land Managament between Fruita and Loma, Colorado were used (see Wiernasz & Cole 1995 for a general description of the habitat). Each location had areas where the density of cheatgrass was high (greater than 70% cover) as well as low density areas (less than 30% cover). At each location, five colonies in the high density cheatgrass area and five in the low density area were selected for study (20 colonies total). For each colony, we measured the percent cover of sample quadrats taken at 1m, 3m, 5m, 7m, 9m, and 15m from the nest site, and averaged over all sample quadrats to characterize vegetation at the colony. Harvester ants collect seeds from the soil surface, but also climb into plants to harvest seeds directly. Soil samples (5 cm x 10 cm x 1 cm deep) were taken at the same distances to determine seed availability in the soil. To quantify what seeds each colony was harvesting, we used enclosures. Enclosures were constructed after the design of MacKay (1981) and Crist and MacMahon (1991) from 30 cm aluminum flashing riveted into a ring and custom-fitted to extend 2 m beyond the nest in all directions. Four pairs of entrance and exit slits measuring 1 cm x 4 cm were cut 8 cm from the top of each enclosure at 90^o angles around its circumference. Colonies were habituated to the enclosures for several days before data collection. Sampling was initiated approximately 15 min after a colony began foraging in the morning. Covered plastic cups were placed inside the entrance slits to serve as pitfall traps for returning foragers, they were opened for 4 min sampling periods at 20 min intervals until the morning foraging period ended. Trapped ants were separated from their food and returned to their colony. To compensate for the removal of food, we added an equivalent quantity of sunflower seeds to the surface of the nest mound.

We identified 42 species of plants from the percent cover samples, 27 species from the soil samples, but only 20 species of seeds were collected from foraging ants. Species diversity was significantly higher in the low density cheatgrass areas (species from ants = 20 vs. 9, species from percent cover = 38 vs. 23, species from soil samples = 26 vs. 21), but most species were relatively uncommon as assayed by at least one of the sampling measures. We therefore focused on six common species: *Bromus tectorum*, *Chorispora tenella*, *Eremopyrum triticeum*, *Ceratocephala orthoceras*, *Poa sandbergii*, and *Malcolmia africana*, to compare among sites.

For all species but *C. orthoceras*, the number of seeds collected by foragers was significantly positively correlated with the number of seeds available in the soil (*B. tectorum*: $r = 0.869$, $p < 0.01$; *C. tenella*: r = 0,768, $p < 0.01$; *E. triticeum*: $r = 0.807$, $p < 0.01$; *C. orthoceras*: $r = -0.035$, NS; *P. sandbergii*: $r = 0.932$, $p < 0.001$; *M. africana*: $r = 0.984$, $p < 0.001$). For most species, the number of seeds collected by foragers was significantly positively correlated with percent cover (*B. tectorum*: $r = 0.898$, $p < 0.001$; *C. tenella*: r = 0,676, $p < 0.05$; *E. triticeum*: $r = 0.776$, $p < 0.01$; *C. orthoceras*: $r = -0.619$, $p < 0.08$; *P. sandbergii*: $r = 0.920$, $p < 0.001$; *M. africana*: $r = 0.358$, NS). We tested for preference and avoidance by determining for each species of seed whether the regression coefficient for seeds collected as a function of seeds available had a slope significantly different from one. Significantly greater slopes implied preference, significantly lower ones suggested avoidance. Three species were preferred: *P. sandbergii* ($b = 1.59$, $p < 0.01$); *E. triticeum* ($b = 1.57$, $p < 0.01$); *C. tenella* ($b = 3.59$, $p < 0.001$). One species, *M. africana*, was taken proportionately ($b = 0.998$, NS), and in one, *C. orthoceras*, there was no pattern ($b = -0.04$, NS). *Bromus tectorum* was strongly avoided ($b = 0.04$, $p < 0.005$), and never exceed 3% of seeds collected by foragers, even in high density areas. These last results are especially interesting given that *C. tenella* is reported to be increasing in frequency in cheatgrass-dominated grasslands and shrublands. It is possible that harvester ants are facilitating this spread.

Effects of ant removal on cheatgrass density. In 2005, we set up ten pairs of 0.25 ha plots to measure the effect of harvester ant presence/absence on cheatgrass density. In one plot, all harvester ant colonies were killed by applications of Amdro©, an ant-specific poison. The other member of the pair was a control. These plots were located in two blocks about 1.5 km apart. Density of cheatgrass and other species was determined in July of 2005 and 2006, using 163 m^2 sample quadrats which were divided into four subquadrats. Samples were taken at regular intervals over the entire plot area. For each quadrat, the number of subquadrats in which a species was present determined its score (0 – 4). For a plot, scores were pooled over all quadrats. We identified 26 species that were sufficiently common (present in > 50% of plots) for analysis. Overall there were no significant differences in vegetation composition across years. The density of cheatgrass was not significantly different between years ($r = -0.075$, NS). The two blocks did not show the same pattern of response, however. In one block, the direction of the initial difference in density remained the same, although the overall density of cheatgrass changed, almost certainly reflecting differences in rainfall patterns between years. In the other block all but one of the pairs of blocks the difference in density changed sign. With only one year of data, it is difficult to be conclusive. Harvester ant removal may affect cheatgrass density, but the effect may not be apparent unless ants are excluded for several years. Ant removal may have affected the frequency of another seed-eating species (ant or rodent) which was more common in one block, leading to the block difference that we observed.

Effect of cheatgrass density on ant recruitment and population dynamics. The size of the 20 colonies used in the seed preference study was determined using standard methods (Wiernasz & Cole 1995). Within each block, colonies varied in size, but the variance in size and mean size did not differ between blocks. Due to constraints (see the cover letter) these colonies were not measured in 2006.

To determine whether cheatgrass density affects initial habitat selection by harvester ant foundresses, we compared the density of queen burrows in areas of high and low cheatgrass abundance. Five pairs of 10m x 10m plots (high, low cheatgrass) were laid in areas near predicted mating swarm hills. After mating flights, each plot was censused for the nest burrows of foundress queens—these have a distinct morphology. Unfortunately summer rainfall in 2005 (which is the trigger for mating flights) was sparse and only partial flights occurred. Although the number of plots is small, low cheatgrass plots had consistently higher numbers of foundress burrows (14 - 45) than plots with high cheatgrass density (0 – 6). These results need to be repeated and expanded, but suggest that areas with high percent cover of cheatgrass are avoided by harvester ant foundresses.

Conclusions. Some of our results are preliminary, in particular results from a single year of a multiple-year experiment should be interpreted with caution. Taken together, however, our results suggest that the interaction between harvester ants and cheatgrass is not reciprocal—cheatgrass affects harvester ant demography, but is largely unaffected by ant behavior. Harvester ant colonies in areas in/near dense cheatgrass stands have a less diverse food supply, and must search for food through a more complicated environment than colonies in low density areas. As cheatgrass increases in density, the number of potential recruits (new colonies) may decline as a consequence of habitat avoidance by foundress queens. Cheatgrass thus reduces plant community diversity directly, through the exclusion of other species, and indirectly by reducing the density of ant colonies.

References

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Future of the project: eventual submission of a USDA proposal on the interaction between annual wheat grass (*Eremopyrum triticeum*) and harvester ants

Publications: Davis, B.N. and D.C. Wiernasz. Seed use by harvester ants—a preference for invasive species? (in prep. for submission to Oecologia)

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