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Effects of Two Prairie Dog Rodenticides on Ground-Dwelling Invertebrates in Western South Dakota[1]

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Abstract.--Immediate and long-term effects of 3 rodenticide treatments on nontarget invertebrates were evaluated on prairie dog colonies. Immediate impacts indicated zinc phosphide reduced ants, strychnine alone reduced wolf spiders, and prebaited strychnine had no impacts. Long-term changes showed increases in wolf spiders and ground beetles and densities were contributed to biotic and abiotic habitat alterations due to lack of prairie dog activities. Among comparisons for efficacy, zinc phosphide was more efficacious at immediately reducing ant densities than either strychnine treatment; long term impacts for insects in general were minimal.

INTRODUCTION

Immediate and long-term effects of rodenticides on nontarget invertebrates has not been fully evaluated. Many rodenticides are nonspecific and a margin of safety to nontarget invertebrates is often overlooked by applicators when selecting toxic baits. Control of black-tailed prairie dogs (Cynomys ludovicianus) in western South Dakota provided an opportunity to study rodenticide impacts on nontarget invertebrates and to compare efficacy of 3 rodenticide treatments.

Prairie dogs create niches for invertebrates in rangeland ecosystems (Wilcomb 1954, Koford 1958, Smith 1967, O'Meilia et al. 1982, Agnew 1983). For example, prairie dogs act as ecosystem regulators by maintaining habitat patches of diverse vegetation (Detling and Whicker 1987) suitable for invertebrates that are associated with bare soils, sparse vegetative cover, and short-grass habitats. Invertebrate habitat provided by burrows is disturbed when prairie dogs are poisoned and prairie dog activity ceases. Burrows are no longer maintained, soil erodes into the hole and vegetation recaptures mounds (Potter 1980). It is unknown how induced changes on short-grass habitat effects invertebrates associated with prairie dog burrows.

This study assessed immediate and long-term responses (1 year after rodenticide application) of invertebrate densities on poisoned prairie dog towns. Secondly, efficacy of zinc phosphide-with prebaiting, prebaited strychnine, and strychnine alone were compared for reduction of nontarget invertebrates. Information will provide further understanding of prairie dog town ecology and management guidelines for minimizing nontarget invertebrate losses due to prairie dog rodenticides.

STUDY AREA

The study was conducted south of Wall and east of Rapid City on Buffalo Gap National Grasslands and in the Badlands National Park of western South Dakota. Vegetated table top buttes and gently rolling mixed grasslands scattered throughout the Badlands formations characterize much of the area and support prairie dog towns (See Deisch 1986 for complete description).

The National Grasslands located in Conata Basin were grazed by cattle at stocking levels set by the Forest Service. American bison (Bison bison) were located in Badlands National Park but cattle were absent.

METHODS

Invertebrates were sampled with pitfall traps (Greenslade 1964, Gist and Crossley 1973). Eighteen permanent sites were established on 15 prairie dog colonies. Metal cans (15 cm x 15 cm) lined

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with plastic buckets were buried flush with soil surface. Pitfall traps were arranged within a grid design with 10 m spacing. Traps were opened (lid removed) for 4 consecutive nights (196 trap nights/session) on each site. Trapping sessions were from May through October of 1983 and May through August of 1984. Mean of each taxa per trap session was estimated for relative density.

Immediate impacts of rodenticides were sampled on each site 1 week before poison application in September 1983. Posttreatment counts were taken the fourth day after rodenticides were applied. Long-term impacts of rodenticides were evaluated from data collected during September 1983 and all 1984 trap sessions. Rodenticides were not applied in 1984.

Rodenticides and Bait Application

Steam-rolled oats used for prebait (4 g) and poisoned bait (4 g) were formulated at U.S. Fish and Wildlife Service Pocatello Supply Depot. A 2.0% by weight active zinc phosphide and 1.5% Alcolec S (American Lecithin Co., Inc.)[5] adhesive were applied to oats. Strychnine alkaloid was applied to oats as 0.5% by weight. Nontreated oats were applied as prebait for zinc phosphide and for 1 strychnine treatment. Active rodenticides on oats were applied 3 days after prebaiting. Both prebait and rodenticides were applied to large areas from bait dispensers affixed to Honda ATV's (Schenbeck 1982). Smaller areas were poisoned on foot and bait was distributed onto mounds with teaspoons.

Statistical Analysis

Each rodenticide was evaluated for effects on nontarget invertebrates by comparing the change of mean relative density on each cluster of treated sites with the change observed on respective control sites. Five comparisons through time included immediate impacts (September 1983) measured between pretreatment and posttreatment poisoning. The remaining 4 comparisons were differences in years from pretreatment (1983) to posttreatment (1984). When a significant correlation existed between pretreatment and posttreatment observations, analysis of covariance was used (Deisch 1986, Uresk et al. 1987) and if non significant, subtraction (Green 1979) was used.

Comparisons among rodenticides for efficacy were produced by forming pairwise contrasts of individual rodenticide treatments. Randomization procedure was used to estimate statistical significance of various contrasts (Edgington 1980, Romesburg 1981, Uresk et al. 1986, Uresk et al. 1987). Rejection of any rodenticide impact (Type II error) to nontarget invertebrates was considered more serious than potential incorrect acceptance of a significant treatment effect (Type I error) (Tacha et al. 1982).

[5]Reference to trade name does not imply endorsement of product.

After significant (P=0.10) treatment differences were detected, Type II error protection was produced by testing each contrast individually. Type I error protection was afforded by testing for a significant (P=0.10) individual contrast of treatment differences with analysis of variance or covariance (Carmer and Swanson 1973).

Individual contrasts were considered biologically significant at P=0.20. Although an alpha of 0.20 is not a standard level of significance, it is becoming more accepted for ecological field studies (Hayne 1976). The number of sites available for this study produced a power of 0.80. This was an acceptable combination of Type I and Type II error protection (Carmer 1976) and allowed for reasonable biological inferences to be drawn from the data.

RESULTS

Five invertebrate classes were collected: Insecta, Arachnida, Chilopoda, Diplopoda, and Crustacea. The 7 most abundant invertebrate families used in statistical analysis were spider mites (Tetranychidae), ants (Formicidae), wolf spiders (Lycosidea), crickets (Gryllidae and Gryllacrididae), ground beetles (Carabidae), dung beetles (Scarabaeidae), and darkling beetles (Tenebrionidae).

Immediate Effects of Rodenticides

Zinc phosphide immediately reduced ant densities on treated sites (fig. 1). Spider mite, cricket, wolf spider, ground beetle, darkling beetle, and dung beetle densities were not immediately affected by zinc phosphide. There were no immediate effects of prebaited strychnine on the 7 invertebrate families (fig. 2). Only wolf spiders were immediately affected by strychnine (fig. 3). Densities decreased 13% on treated sites.

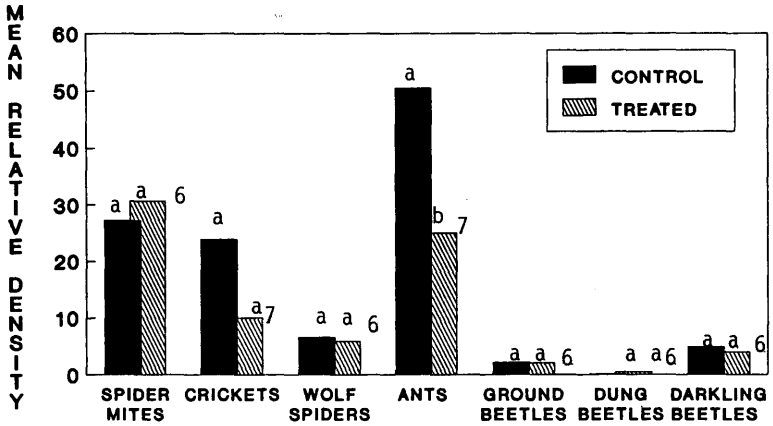
Long-term Effects of Rodenticides

Wolf spiders and ground beetles showed increases after one year on zinc phosphide and strychnine with pre baiting respectively (Deisch 1986). Other insects were variable among rodenticide treatments with no consistant patterns. Generally long-term impacts were minimal for these insects.

Efficacy of Rodenticides

Comparisons of efficacy among 3 rodenticide treatments were made when an immediate or long-term treatment effect was detected. Zinc phosphide was more efficacious at immediately reducing ant densities than either strychnine treatment. Other efficacy comparisons showed no significant differences in reductions of nontarget invertebrates. There were no efficacy differences between strychnine and prebaited strychnine treatments for immediate impacts. Long-term efficacy effects were extremely variable and no consistent pattern in rodenticide effectiveness was detected. Long-term "effects" were not directly related to rodenticides, but more to habitat changes (Deisch 1986).

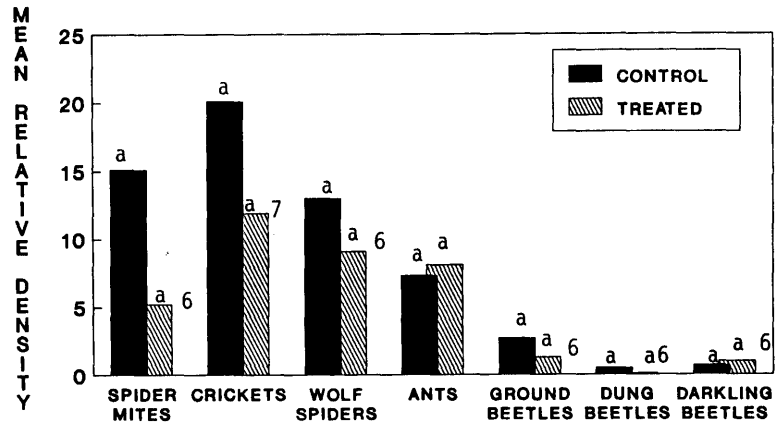
Figure 1.--Comparisons of invertebrate means/196 trap nights on sites treated with zinc phosphide and control sites, September 1983. Adjusted means (bars) were estimated by analysis of covariance.



[6]Means followed by same letter were not significant at P=0.20 after F-protection at P=0.10. Pretreatment (covariate) means were used to adjust posttreatment means for statistical comparisons.

[7]Posttreatment minus pretreatment was used to adjust data for statistical analysis.

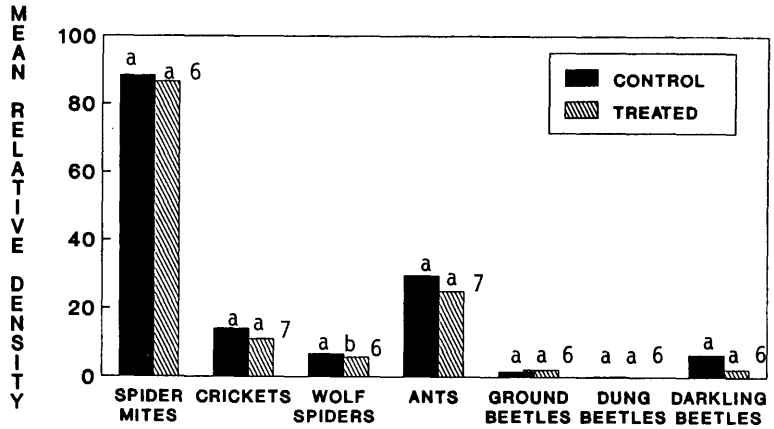
Figure 2.--Comparisons of invertebrate means/196 trap nights on sites treated with prebaited strychnine and control sites, September 1983. Adjusted means (bars) were estimated by analysis of covariance.



[6]Means followed by same letter were not significant at P=0.20 after F-protection at P=0.10. Pretreatment (covariate) means were used to adjust posttreatment means for statistical comparisons.

[7]Posttreatment minus pretreatment was used to adjust data for statistical analysis.

Figure 3.--Comparisons of invertebrate means/196 trap nights on sites treated with strychnine and control sites, September 1983. Adjusted means (bars) were estimated by analysis of covariance.



[6]Means followed by same letter were not significant at P=0.20 after F-protection at P=0.10. Pretreatment (covariate) means were used to adjust posttreatment means for statistical comparisons.

[7]Posttreatment minus pretreatment was used to adjust data for statistical analysis.

DISCUSSION

Immediate effects

Ecological literature lacks supportive information on direct and indirect effects of zinc phosphide and strychnine on nontarget invertebrates. Invertebrates will carry off and consume poisoned grain distributed for rodent control (Marsh 1962). Invertebrates on prairie dog towns that consume seeds were immediately effected by rodenticidal grain.

Ants were immediately reduced on zinc phosphide sites. Harvester ants (Pogonmyrex spp.) in western states feed principally on seeds and can be exterminated with poisoned grain (Furniss and Carolin 1977). Strychnine alone showed immediate reductions of wolf spider relative densities. It is questionable that strychnine directly reduced wolf spiders since these arachnids do not consume seeds (Lowrie 1973, Milne and Milne 1980). However, it is suggested that strychnine influenced the food base of the predatory spider.

Spider mites, crickets, darkling beetles, ground and dung beetles were not affected by the 3 rodenticides because of their food preference (Borror and White 1970, Milne and Milne 1980). Spider mites are equipped with piercing mouth parts for sucking plant juices and usually feed on live green vegetation. Crickets do not depend upon grain for their survival and feed on plant foliage, seedlings, dead and dying insects, hair, hide and carrion. Darkling beetles are detritivores but will consume small amounts of seeds (Kramm and Kramm 1972). Ground beetles are voracious predators. Dung beetles are scavengers and recycle dung, carrion, and decaying vegetative matter (Kramm and Kramm 1972).

Long-term impacts

In this study very few long term impacts occurred. Wolf spider densities increased the year following treatment with zinc phosphide and an increase ground beetles occured on the strychine treated areas. Vegetation height on treated prairie dog towns increases after elimination of prairie dogs (Klatt 1971, Potter 1980). Wolf spiders are active on soil surface and seek cover under vegetation and debris to hunt (Lowrie 1973). Change in vegetation structure provided greater cover and prey diversity (Murdock et al. 1972).

Dramatic ecological changes occur on prairie dog towns once these rodents have been poisoned and eliminated. Changes in plant communities (Uresk 1985), lack of suitable prairie dog borrows, and lack of continual soil mixing by prairie dogs, can influence insect density and diversity (Koford 1958).

Invertebrates have been overlooked in most ecological studies that pertain to nontarget losses due to rodenticides. These small fauna are important components of rangeland ecosystems (Hamm 1972, HeWitt et al. 1974, Agnew 1983, Sieg et al. 1985). Insects and archnids often make up a large percentage of animal protein matter in diets of mammal species that are associated with prairie dog towns. These include swift fox (Vulpes velox) (Uresk and Sharps 1986), burrowing owl (Athene cunicularis) (MacCracken et al. 1985), northern grasshopper mouse (Bailey and Sperry 1929), deer mouse (Flake 1973), and other insectivorous mammalian and avian species.

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