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RESPONSES OF OPOSSUMS AND RACCOONS TO BOBCAT AND COYOTE FECES

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Key words: attractant, bobcat, coyote, feces, Fort Riley Military Reservation, mesopredator release hypothesis.

Behavioral observations and dietary studies of top predators suggest that they commonly harass and kill mesopredators (Parker 1995). According to the mesopredator release hypothesis, when top carnivores such as wolves (*Canis lupus*) and cougars (*Puma concolor*) decline, numbers of smaller carnivores tend to increase (Crooks and Soulé 1999, Henke and Bryant 1999). In the absence of top carnivores, coyotes, bobcats, or other relatively large mesopredators may become surrogate top predators and control numbers of smaller predators through interference competition (Terborgh et al. 1999, Gipson and Kamler 2001). In midwestern states an inverse relationship has been shown between the abundance of raccoons, *Procyon lotor*, and coyotes, *Canis latrans* (Sargeant et al. 1993). There are several accounts of coyotes killing raccoons and opossums, *Didelphis virginiana* (Kamler 1998, Gipson and Kamler 2001), and even small bobcats, *Felis rufus* (Gipson and Kamler 2002).

Detection of potential predators is typically through sight or smell, and predator detection by prey species often results in the avoidance of a particular area (Boag and Mlotkiewicz 1994, Lindgren et al. 1997). Feces and urine of dominant predators have been used to keep potentially damaging species out of protected areas (Boag and Mlotkiewicz 1994, Lindgren et al. 1997, Swihart et al. 1997, Tobin et al. 1997). Some prey species (i.e., mountain beaver, *Aplodontia rufa*) have habituated to synthetic chemicals designed to mimic predator scents (Epple et al. 1995). Other species (i.e., snowshoe hare, *Lepus americanus*) apparently have not habituated to either synthetic predator odors or predator feces and urine, thus making these materials effective repellents (Lind-

gren et al. 1997). Similarly, the occurrence of top predator feces in an area may provide a strong indication to mesopredators that a top predator is present and initiate avoidance reactions by mesopredators. We investigated responses of raccoons and opossums to feces from coyotes and bobcats, to a known attractant (fatty-acid scent; FAS), and to no scent applied (control) at tracking stations.

The study took place in a mixed tallgrass prairie and forest area on Fort Riley Military Reservation in northeastern Kansas. We constructed sifted-soil stations to record presence of species visiting feces and other scents placed in the center of the stations. Stations were placed >0.5 km apart in 6 geographically distinct zones (Howard et al. 2002) to discourage visitation by individuals to multiple stations within a zone and to eliminate visitations by a single animal to stations in different zones of Fort Riley.

Three treatments—bobcat feces, coyote feces, and FAS tablets—were placed on tracking stations. We also established control tracking stations with no scent applied. Each treatment type was assigned to 10 randomly selected stations in prairie and 10 in forest, for a total of 60 treated stations; the non-lure control was assigned to 6 stations in prairie and 6 in forest. Individual stations consisted of a 1-m-diameter area covered with sifted soil and masonry sand to record tracks of visiting animals. After clearing vegetation, we sifted a mixture of sand and soil on top of each station to a depth of approximately 2 cm. We then placed an individual scat or FAS tablet in the center of each treated station. Stations were checked after 24 hours (Roughton and Sweeney 1982) and tracks were identified to species.

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Stations were set and checked 4 times during the year. We collected bobcat scats from Sunset Zoological Park, Manhattan, Kansas, and coyote scats from Dickerson Park Zoo, Springfield, Missouri. Scats were frozen within 24 hours of removal from exhibits and remained frozen until no more than 6 hours prior to placement on a station. Captive bobcats were fed Feline Diet (18% crude protein) available from Central Nebraska Packing, Inc., North Platte, Nebraska. Captive coyotes were fed a diet of PMI Adult Formula dog food (18% crude protein) available from Purina Mills, Inc., St. Louis, Missouri. FAS tablets were purchased from the USDA Pocatello Supply Depot, Pocatello, Idaho. We performed 2 ANOVAs using SAS Proc GLM (SAS Institute, Inc. 2000) for both opossums and raccoons. The 1st ANOVA compared all 3 treatments; post-hoc pair-wise comparisons using least square means were performed. Since there was no detectable difference in visitation rates to coyote feces and bobcat feces by either opossums or raccoons, in the 2nd ANOVA we combined coyote and bobcat feces as a single treatment for comparison with FAS.

The majority of visitations occurred within forested habitat for opossums (26 of 27 total visits) and raccoons (20 of 26 total visits). ANOVAs for all 3 treatments indicated no significant preference for any bait by opossums ($F = 0.460$, $P = 0.635$, $df = 2,21$) or by raccoons ($F = 3.320$, $P = 0.056$, $df = 2,21$). The post-hoc multiple comparison of treatments for opossums further supported this finding of no preference for baits (FAS-coyote feces: $t = 0.481$, $P = 0.635$; FAS-bobcat feces: $t = 0.481$, $P = 0.635$; coyote feces-bobcat feces: $t = 0.963$, $P = 0.347$). For raccoons there was a significant difference between FAS and bobcat feces ($t = 2.564$, $P = 0.018$) but not between FAS and coyote feces ($t = 1.496$, $P = 0.149$) or between coyote feces and bobcat feces ($t = 1.068$, $P = 0.298$).

Our 2nd ANOVA for FAS compared to coyote or bobcat feces for opossums indicated no preference for either bait ($F = 0.0$, $P = 1.0$, $df = 1,22$). Opossums visited stations baited with feces and stations baited with FAS in proportion to their availability. A significant difference was detected for raccoons ($F = 5.46$, $P = 0.029$, $df = 1,22$); they visited stations baited with FAS proportionally more than stations baited with feces.

Non-baited control stations were not visited by opossums or raccoons and were not considered in statistical analyses.

FAS, coyote feces, and bobcat feces all attracted opossums and raccoons to tracking stations, especially in forests; 46 of 53 total visits by both species were recorded in forest habitat. The high visitation rate by raccoons and opossums to stations in forest habitat agrees with other research showing that seasonally raccoons and opossums use forest habitats more often than prairie (Sanderson 1987, Gipson and Kamler 2001). Coyotes were the major cause of death among opossums and raccoons studied on Fort Riley (Gipson and Kamler 2001). Kamler (1998) found a shift in habitat use by raccoons from predominantly forest during spring to predominantly prairie during autumn. Kamler (1998) hypothesized the preference for forest during spring might be due to the presence of young with females and the shift to prairie in autumn might be related to soft mast availability.

Although no significant differences between baits were detected, opossums generally visited stations baited with coyote feces more often than those baited with FAS or bobcat feces. This was surprising because, as noted, predation by coyotes was the major cause of death among opossums on Fort Riley (Gipson and Kamler 2001). A possible explanation is that opossums seek coyote feces rich in insects, seeds, by-products of partially digested fruits and meat as a source of food, minerals, and vitamins (Meriwether and Johnson 1980). An investigation of coprophagy on Fort Riley showed opossums consumed more coyote feces than any other species, including other coyotes (Livingston 2001). It is also possible that feces from captive coyotes used in this study contained lower levels of sulfurous volatiles than typically found in feces from carnivores with a diet high in meat because of the relatively high vegetable content of the diet of zoo coyotes.

Raccoons visited fewer stations baited with captive bobcat feces than stations baited with feces from coyotes, although not significantly less. The visitation rate by raccoons to stations baited with bobcat feces was significantly less than to stations baited with FAS tablets. This reduced visitation to bobcat feces may be due to the vulnerability of small female raccoons and their young to predation by bobcats (Edwards

1996). The meat-rich content of bobcat feces may also have contained high levels of sulfurous volatiles that often deter prey species (Mattina et al. 1991, Epple et al. 1995, Lindgren et al. 1997).

Feces and urine from predators have been used to keep damaging rodents and lagomorphs out of sensitive areas (Boag and Mlotkiewicz 1994, Swihart et al. 1997, Tobin et al. 1997). Our results indicate that feces from coyotes and bobcats have qualities attractive to mesopredators like raccoons and opossums, despite the fact that often they are killed by these larger carnivores. We feel it is unlikely that feces or urine from dominant predators would be an effective repellent to smaller mesopredators. Additional research is needed to evaluate the responses of small predators to feces and urine from dominant predators.

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