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Food Item Use by Three Sympatric Canids in Southern Illinois

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ABSTRACT

I investigated use of food resources among coyotes (*Canis latrans*), red foxes (*Vulpes vulpes*), and gray foxes (*Urocyon cinereoargenteus)* in southern Illinois. All three species used similar food items; coyote and red fox diets were most similar while coyote and gray fox diets were least similar. Gray fox diets also exhibited greater diversity and omnivory. The high dietary overlap among species results in the potential for resource competition. Competition with coyotes may have reduced red fox abundance in southern Illinois. Despite competition for food resources, gray foxes appear able to coexist with coyotes possibly through habitat segregation and avoidance of antagonistic encounters by climbing trees.

INTRODUCTION

Three canid species, coyote, red fox, and gray fox, are sympatric in southern Illinois, and potentially compete for similar resources. Both fox species are native to Illinois, and are relatively abundant. Red fox numbers even may have benefitted from the clearing of forests for agriculture (Hoffmeister and Mohr 1972). The historical distribution of coyotes in Illinois is less clear. Coyotes may have always been present in Illinois, but were never abundant until recently, particularly in southern Illinois. In 1969, coyotes were reported to be widespread but scarce in southern Illinois (Klimstra and Roseberry 1969). Coyote abundance appears to have increased significantly in the 1970's (Ellis 1985), and coyotes are now abundant throughout southern Illinois.

Competitive interactions between coyotes, red foxes, and gray foxes are poorly understood. Coincident with the increase in coyote abundance, fur trappers began reporting a decline in fox abundance, particularly red foxes (Ellis 1985). Although coyotes and foxes consume a diversity of food items, many items are used by all three species. Thus, competition for food resources may result in competitive exclusion of one or both fox species by the larger coyote. I assessed the potential for resource competition

among coyotes, red foxes, and gray foxes in southern Illinois by comparing food item use and measuring dietary overlap.

METHODS

Food item use by coyotes and foxes was determined by collecting gastrointestinal and scat samples in winter 1988-89 and 1989-90. Gastrointestinal (stomach and large intestine) samples were collected from carcasses obtained from four furbuyers in southern Illinois. Scat samples and additional gastrointestinal samples were obtained from trapsites and carcasses, respectively, of coyotes and gray foxes captured as part of an investigation of coyote ecology at Crab Orchard National Wildlife Refuge in Williamson and Jackson Counties (Cypher 1991). To facilitate handling, stomach samples were washed in a strainer, and large intestine and scat samples were oven-dried.

Mammalian remains in scats were identified from teeth and bone fragments (Glass 1981, Roest 1986) and guard hair characteristics (Stains 1958, Adorjan and Kolenosky 1969, Moore et al. 1974). Seeds of fleshy fruits were identified by comparison to known specimens (U.S. Department of Agriculture 1974).

Frequency of occurrence of items in samples and use of animal prey versus fruit were compared among coyotes and foxes using contingency table analysis and a chi-square test. To compare diets among species, items were grouped into the following categories: deer, rabbit, small rodent, bird, insect, persimmon, and other. Dietary diversity was compared by calculating a Shannon diversity index (Brower and Zar 1984):

$$H' = -\sum p_i \log p_i$$

where p_i is the proportional occurrence of item i in the sample. A t-test was used to test whether diversity indices differed between species (Hutcheson 1970). Horn's similarity index (Horn 1966) was used to estimate dietary overlap between species.

RESULTS

In coyote samples (Table 1), rabbit (*Sylvilagus floridanus*) was the most frequently occurring item followed by microtine rodents (prairie vole [*Microtus ochrogaster*] and southern bog lemming [*Synaptomys cooperi*]), persimmon (*Diospyros virginia*), bird, and white-tailed deer (*Odocoileus virginianus*). Other items included pig (*Sus scrofa*), squirrel (*Sciurus* spp.), deer mouse (*Peromyscus* spp.), Canada goose (*Branta canadensis*), grasshopper (Orthoptera), corn, and wild pear (*Malus communis*). In red fox samples, rabbit occurred most frequently followed by persimmon, bird, and white-tailed deer. Other items included microtine rodent, deer mouse, muskrat (*Ondatra zibethicus*), shrew (Soricidae), cardinal (*Cardinalis cardinalis*), domestic chicken, grasshopper, beetle (Coleoptera), corn, and crabapple (*Malus* spp.). In gray fox samples, persimmon was the most frequently occurring item followed by rabbit, bird, and white-tailed deer. Other items included microtine rodent, deer mouse, shrew, Canada goose, cardinal, grasshopper, corn, wild pear, wild grape (*Vitis* spp.), rose hip (*Rosa* spp.), and flowering dogwood (*Cornus florida*). White-tailed deer in samples was probably from carrion resulting from the fall deer harvest.

Frequency of occurrence of items did not differ among the three canid species (coyote-gray fox: $\underline{X}^2 = 9.03$, 6 df, $\underline{P} = 0.17$; coyote-red fox: $\underline{X}^2 = 1.08$, 6 df, $\underline{P} = 0.98$; gray fox-red fox: $\underline{X}^2 = 7.60$, 6 df, $\underline{P} = 0.26$).

Coyote samples had a significantly higher proportion of animal items compared to gray foxes ($\underline{X}^2 = 7.37$, 1 df, $\underline{P} < 0.01$). Frequency of occurrence of animal items versus fruits did not differ between coyotes and red foxes ($\underline{X}^2 = 1.02$, 1 df, $\underline{P} = 0.31$) or between fox species ($\underline{X}^2 = 2.52$, 1 df, $\underline{P} = 0.11$).

The number of different food items totaled 14 for coyote samples, and 16 for both gray fox and red fox samples. Dietary diversity was highest for gray foxes (Table 1), but diversity indices did not differ significantly among species ($\underline{P} > 0.05$ for all pairwise comparisons). Horn's similarity indices indicated that dietary overlap was high between all species. The similarity index was 0.93 among coyote and red fox diets, 0.92 among gray fox and red fox diets, and 0.89 among coyote and gray fox diets.

DISCUSSION

High dietary overlap indices among coyotes, red foxes, and gray foxes indicate a high potential for resource competition. Coyote and red fox diets were most similar while coyote and gray fox diets were least similar. Thus, resource competition may be most intense between coyotes and red foxes. This competition may be a contributing factor to the observed decline in red fox abundance in Illinois.

Gray fox diets were slightly more diverse than those of either coyotes or red foxes. Also, gray foxes consumed a significantly greater proportion of fruit. The greater degree of omnivory by gray foxes is consistent with most other fox food habit comparisons (e.g., Scott 1955, Hockman and Chapman 1983). The combination of greater omnivory and euryphagy may confer a competitive advantage to gray foxes over red foxes (Hockman and Chapman 1983).

Competitive interactions other than competition for food likely contribute to observed canid abundance and distribution trends. Coyotes occasionally kill foxes which constitutes interference competition (Case and Gilpin 1974). Reports of coyotes killing red foxes are common (e.g., Major and Sherburne 1987, Sargeant and Allen 1989). Coyotes also kill gray foxes although reports are less common (Wooding 1984, Cypher unpublished data). Additionally, gray foxes are reportedly more aggressive than red foxes, and may even exclude red foxes from some habitats (Carey 1982).

Such antagonistic interactions would explain declining fox abundance in Illinois concomitant with increasing coyote abundance. However, competitive interactions between coyotes and foxes appear to impact red foxes more severely, even resulting in local extirpation of red foxes. Competitive exclusion of red foxes by coyotes has been reported in Maine (Major and Sherburne 1987, Harrison et al. 1989), North Dakota (Sargeant et al. 1987), Ontario (Voigt and Earle 1983), Yukon (Theberge and Wedeles 1989), and Alberta (Dekker 1989). The decline in number of red foxes harvested was sharper in southern Illinois where coyotes are more abundant than in east-central Illinois

where coyotes are less abundant (Ellis 1985). During efforts to trap coyotes at Crab Orchard National Wildlife Refuge in southern Illinois, 19 gray foxes were incidentally captured whereas only 1 red fox was captured (Cypher unpublished data). In North Dakota, coyote and red fox population trends were inversely related (Johnson and Sargeant 1977). Fur trappers in Mississippi also reported an inverse relationship between coyote and red fox abundance, but no such relationship between coyotes and gray foxes (Wooding 1984). Similarly, red foxes declined in Alabama as coyotes increased, but gray foxes remained abundant (Wooding 1984).

Gray foxes apparently have a greater capacity to coexist with coyotes. Although coyotes, red foxes, and gray foxes have overlapping habitat-use patterns, coyotes and red foxes prefer more open habitat types (e.g., pastures, agricultural fields - Follman 1973, Priest 1986, Cypher 1991) while gray foxes prefer brushier types (e.g., woody old fields, deciduous forests - Follman 1973, Wooding 1984). Thus, some degree of habitat segregation may reduce interactions between coyotes and gray foxes. Finally, the tree-climbing ability of the gray fox probably provides this species with an escape strategy during aggressive encounters with coyotes (Wooding 1984).

CONCLUSIONS

High dietary overlap among coyotes, red foxes, and gray foxes may result in high potential for food competition, particularly between coyotes and red foxes. Such competition may contribute to competitive exclusion of red foxes by coyotes resulting in decreased red fox abundance. Gray foxes may avoid similar exclusion through a variety of mechanisms, such as greater omnivory, habitat partitioning, and an ability to climb trees and elude coyotes.

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Table 1. Frequency of occurrence and diversity of dietary items in gastrointestinal and scat samples from coyotes, red foxes, and gray foxes in southern Illinois, winter 1988-89 and 1989-90.

	Frequency of Occurrence (%)		
	Coyote (n=44)	Red Fox (n=55)	Gray Fox (n=42)
Animal	93.2	94.5	90.5
White-tailed deer	20.5	14.5	14.3
Eastern cottontail	47.7	41.8	40.5
Microtine rodent	36.4	9.1	9.5
Other small rodent	11.4	7.3	9.5
Pig	9.1	0.0	0.0
Other mammal	4.6	3.6	2.4
Bird	29.5	32.7	19.0
Insect	4.5	5.5	4.8
Fruit	38.6	41.8	54.8
Persimmon	36.4	36.4	42.9
Wild grape	0.0	0.0	9.5
Corn	2.3	5.5	2.4
Wild pear	2.3	0.0	9.5
Other fruit	0.0	1.8	4.8
Diversity Index	2.03	1.91	2.11