



Foraging Ecology of Wintering Black-billed Magpies

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Potential advantages to individuals foraging in groups have been reviewed and include avoidance of predation and increased feeding efficiency (Rubenstein 1978, Caraco 1979a, Pulliam and Caraco 1984). In parts of the American West an avian-scavenging guild exists where Bald Eagles (*Haliaeetus leucocephalus*), Common Ravens (*Corvus corax*), and Black-billed Magpies (*Pica pica*) feed in groups at carrion during winter. Of these species, the Black-billed Magpie is the subordinate guild member. Because a dominant species may prevent a subordinate species from gaining access to food resources (Gauthreaux 1978), subordinate species may gain access to food by foraging in flocks (Heinrich 1988). Indeed, interspecific competition may be one of the selection pressures underlying the formation of winter flocks by corvids (Bossema et al. 1986, Eden 1987).

We examined feeding, vigilance, and intraspecific interactions of Black-billed Magpies at carrion in winter as a function of group size, both with and without the presence of dominant species (i.e. Bald Eagles and Common Ravens). Because carrion is a spatially concentrated food source, an increase in group size may result in a decrease in food availability resulting in an increase in aggressive interactions, an increase in watchfulness, and a subsequent decrease in feeding rates (e.g. Knight and Knight 1986, Knight and Knight Skagen 1988).

We hypothesized that magpie feeding and vigilance rates, and agonistic interactions, were a function of group size. We predicted a negative relationship between group size and feeding rates, and a positive relationship of group size with vigilance rates and agonistic interactions. In addition, we hypothesized that the presence of a dominant species affected a subordinate species' feeding and vigilance rates, as well as agonistic interactions. Here we made three predictions. First, in the presence of a dominant species, magpie feeding rates would be lower than in the absence of the dominant. This reduction in feeding rate would be due to a dominant species denying the subordinate scavenger access to the food (Knight et

al. 1991, Skagen et al. 1991). Second, the presence of a dominant species would result in increased watchfulness of magpies. Subordinate species, in the presence of a dominant species, should stay alert for an opportunity to feed. Third, aggressive interactions among magpies would increase in the presence of a dominant. The presence of a dominant will limit access of magpies to the carrion, resulting in increased conflict for access to the limited feeding opportunities.

Methods.—We collected data from 23 December 1987 to 17 February 1988 at Lory State Park, Larimer County, Colorado. The dominant vegetation consists of low-growing grasses (*Bromus* spp., *Poa* spp., *Muhlenbergia* spp.) and shrubs (*Cercocarpus montanus*, *Rhus trilobata*, *Chrysothamnus* spp.).

Mule deer (*Odocoileus hemionus*) and elk (*Cervus canadensis*) carcasses were positioned approximately 130 m from an observation blind. On average, one carcass was placed out per week and was located at least 40 m from the closest shrubs and trees. Carcasses were confiscated animals and road kills provided by the Colorado Division of Wildlife. Most of the carcasses were skinned prior to our use; we partially skinned those that were not. This ensured that magpies and ravens were not precluded from using the carrion due to the thick skin (Skagen et al. 1991).

During 13 days, we videotaped 4 h and 51 min of magpie foraging behavior using a 300-mm lens. Filming occurred at various times of day, and with different numbers of individuals and species present. We analyzed the video tapes using a color-television receiver and noted the behavior of all birds that fed for greater than 1 min. Birds observed were those less than 40 cm from carcasses, and feeding or attempting to feed; birds perched or standing further away from carcasses were not evaluated. Individuals were not observed for greater than 3 min to eliminate the effects of food-satiation on behavior. We calculated the following variables for each focal bird: (1) vigilance (total seconds magpie's head raised above horizontal divided by total seconds bird observed); (2) feeding rate (number of pecks at food divided by total seconds bird observed [pecks/min]); and (3) agonistic interactions per minute. Agonistic interactions were defined as supplanting, physical contact, wing flashes, and charging.

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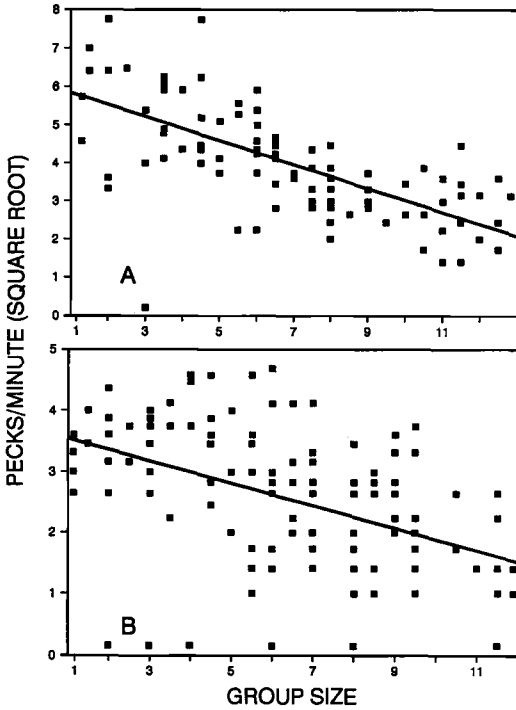


Fig. 1. Effect of magpie group size on feeding rate: (A) without a dominant present, $Y = 6.153 - 0.313X$ ($r^2 = 0.66$, $P < 0.001$, $n = 91$); (B) with a dominant present, $Y = 3.726 - 0.184X$ ($r^2 = 0.45$, $P < 0.001$, $n = 109$).

Magpie group size was determined by averaging the number of birds less than 3 m from the carcass at the beginning and end of each focal bird's feeding period. If, while observing a focal bird, the group size varied by more than four birds, separate observations were taken for the different group sizes.

Linear regression was used (PROC REG; SAS Institute 1987) to analyze the effect of group size on vigilance, feeding, and aggressive interactions (both with and without a dominant species present). By treating dominant presence/absence as an independent class variable we used multiple regression (PROC GLM; SAS Institute 1987) to examine the differences in vigilance, feeding rates, and aggressive interactions as a function of the presence or absence of a dominant. A quadratic effect was tested for entry into or deletion from each model. Interaction effects were tested in the multiple regression analyses to check for differences in rates of behavior among the two treatments (presence vs. absence of a dominant). The vigilance data were arcsin square-root transformed and the feeding-rate data were square-root transformed. All tests were one-tailed and considered significant at the 0.05 probability level. Residuals of each regression model were plotted and examined and re-

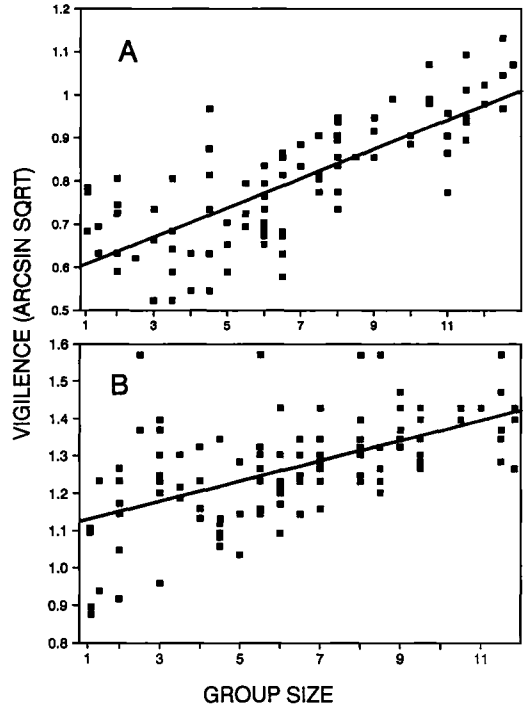


Fig. 2. Effect of magpie group size on vigilance: (A) without a dominant present, $Y = 0.569 + 0.034X$ ($r^2 = 0.77$, $P < 0.001$, $n = 91$); (B) with a dominant present, $Y = 1.098 + 0.027X$ ($r^2 = 0.57$, $P < 0.001$, $n = 109$).

sults were interpreted according to Zar (1984) and Neter et al. (1985). Magpies in our experiment were not marked so the possibility for pseudoreplication existed.

Results.—Two of our predictions were supported with regard to feeding rates. First, feeding rates of magpies decreased with increasing group size, both with and without a dominant species present (Fig. 1). Second, feeding rates of magpies were lower in the presence of a dominant species ($T = -6.54$, $df = 1$, $P < 0.001$; Fig. 1B).

Our prediction that vigilance would show a positive relationship with group size was sustained (Fig. 2). The presence of a dominant species resulted in increased magpie vigilance when compared with vigilance rates in the absence of a dominant species ($T = 31.94$, $df = 1$, $P < 0.001$; Fig. 2B).

The prediction that agonistic interactions would increase with increasing group size was supported (Fig. 3). We did not find support for our prediction that agonistic interactions would increase in the presence of a dominant scavenger; indeed, aggressive interactions were lower when ecological dominants were present ($T = -3.01$, $df = 1$, $P < 0.003$; Fig. 3B).

Discussion.—Most studies on group foraging have

reported that some aspect of foraging success (e.g. peck rates) increases with increasing group size (e.g. Powell 1974, Caraco 1979b, Barnard 1980, Keys and Dugatkin 1990). In our study, however, magpie feeding rates declined with increasing group size. We attribute this difference to the increased number of intraspecific interactions and increased time devoted to watchfulness with increasing group size. Stalmaster and Gessaman (1984) observed that aggressive interactions among scavenging Bald Eagles occurred at a rate of 0.05 interactions per bird-minute in feeding groups of 5, a rate that more than doubled in groups of 8 and increased by a factor of four in groups of 10.

Vigilance and agonistic interactions may have increased with increasing group size because magpies were scavenging at food that was spatially constrained. When European Starlings (*Sturnus vulgaris*) fed at a single discrete site, there was an increase in agonistic interactions with increasing flock size and a resulting decrease in peck rates (Feare and Inglis 1979).

Magpies had lower feeding rates when a dominant species was present than when feeding in intraspecific flocks. The decrease in feeding rates may be due to decreased scavenging opportunities when a dominant species is present. A raven or eagle standing on a carcass limits scavenging opportunities for other individuals. Skagen et al. (1991) found that American Crows (*Corvus brachyrhynchos*) and Glaucous-winged Gulls (*Larus glaucescens*) altered their scavenging behavior in the presence of a dominant species (Bald Eagles). When eagles were present, more crows and gulls were farther away from the carcass than when eagles were absent.

Magpie vigilance may have increased when a dominant species was present because, with fewer foraging opportunities, magpies may have been more alert for an opportunity to feed. Skagen et al. (1991) found that when a dominant species was present, crows and gulls were more likely to be waiting for an opportunity to feed than when the dominant species was absent. The presence of a dominant species in our study reduced intraspecific aggression but increased vigilance among magpies. Thus, a magpie might increase its feeding rate by watching for an opportunity to feed instead of fighting for a similar opportunity.

We suggest that magpies may not gain a feeding-rate advantage when scavenging at carrion in groups. Food that is spatially concentrated, and in limited supply, is highly contested. This situation may lead a bird to make decisions that are not normally considered "optimal" but which will allow the bird to feed even though at a reduced rate.

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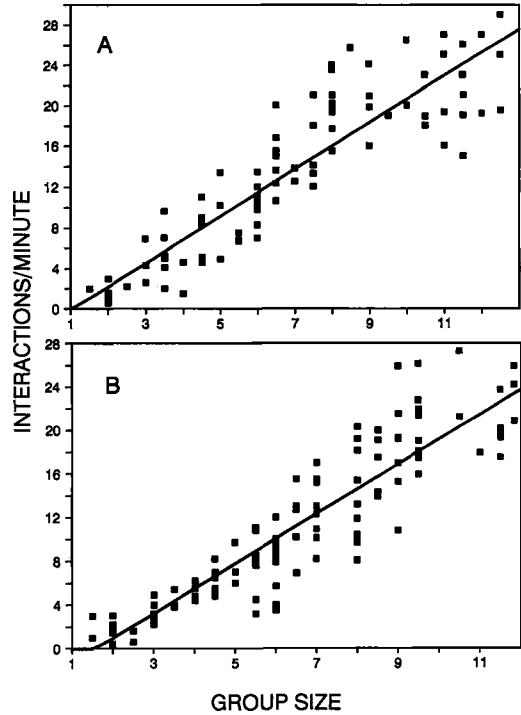


Fig. 3. Effect of magpie group size on interactions: (A) without a dominant present, $Y = -2.384 + 2.3X$ ($r^2 = 0.82$, $P < 0.001$, $n = 91$); (B) with a dominant present, $Y = -3.593 + 2.275X$ ($r^2 = 0.84$, $P < 0.001$, $n = 109$).

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Male and Female Choice in Zebra Finches

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Females usually have a higher reproductive investment in their brood than males, so they should exercise more discrimination in choice of mate (Trivers 1972, Clutton-Brock and Vincent 1991). In monogamous birds, males provide substantial parental investment and they may also be expected to choose, or compete for, high-quality females (Trivers 1972, Burley 1977). The sex roles of Zebra Finches (*Taeniopygia guttata*) are weakly defined, with both sexes participating in incubation, feeding of the offspring, and nest defense (Burley and Coopersmith 1987). The male's contribution is roughly 40 to 45% of the total effort (Morris 1954, El-Wailly 1966, Delesalle 1986, Burley and Coopersmith 1987). Therefore, male choice might be expected and, indeed, there have been several studies demonstrating male choice in Zebra Finches (Burley et al. 1982, Burley and Coopersmith 1987). In this study we assess the relative strength of male and female choice in Zebra Finches by comparing such choice under controlled conditions.

Many cues are likely to be involved in mate assessment (Burley 1981, ten Cate 1985), including courtship behavior, song, and visual appearance. Recent sexual-selection studies have emphasized that these cues are often correlated with condition or general health of the prospective mate (Hill 1991, McComb 1991, Price et al. 1993). Individuals in good condition are expected to be favored as mates, either because these individuals are of high genetic quality (Hamilton and Zuk 1982, Iwasa et al. 1991), in which case the benefits of choice accrue in the fitness of offspring, or because they provide direct material benefits (Reynolds and Gross 1990, Price et al. 1993). In our experiments we first manipulated the condition of the finches in order to maximize the likelihood of demonstrating choice.

Methods.—We purchased or hand-raised 20 female and 20 male Zebra Finches. Birds of each sex were separated into two groups of 10 by mass. Mass has been shown to be correlated with nutrition during