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Diet and Prey Selection of Nonbreeding Peregrine Falcons in an Urban Habitat of Italy

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Key Words: *Peregrine Falcon; Falco peregrinus brookei; prey selection; urban habitat; seasonal variation of diet; prey vulnerability; flight height of prey.*

The Peregrine Falcon (*Falco peregrinus*) has been described to opportunistically capture a broad spectrum of prey species according to their abundance, its diet reflecting the seasonal composition of the local avian community (Cramp and Simmons 1989, Ratcliffe 1993, Cade et al. 1994). However, little information is available about quantitative assessment of prey selection by peregrines outside of the breeding season. Hunter et al. (1988) and Rosenfield et al. (1995) have shown prey selection by breeding peregrines according to species, but selection by weight class of prey has been investigated only for *Accipiter* spp. (Cresswell 1995, Tornberg 1997). There is also very little quantitative information on how the vulnerability of prey differs according to their behavior (Thiollay 1988, Cresswell 1995).

Our study focused on a single pair of Peregrine Falcons that occurred regularly in urban habitat outside the breeding season. Our goal was to describe seasonal variations in the composition of the diet relative to changes in the availability of prey and to assess prey selection according to the different heights at which prey typically flew.

Methods

Two adult Peregrine Falcons have regularly occurred during the nonbreeding season (from late May to beginning of February) within the historical center of Florence, Italy, since at least 1993. Each year, they use the same habitual perches located on tops of the three historical monuments that tower over the city center. Using individual variations in morphological characters, we were able to distinguish the two individuals through a 60× spotting scope. Observations on frequency with which they roosted close together at the same perches and their behavioral interactions, indicated that they were an established pair.

A total of 26 monthly samples of prey remains and pellets were collected below the peregrine roost sites between January 1997–February 1999. We analyzed the prey remains and pellets according to Oro and Tella (1995) and Rosenfield et al. (1995) and identified a total of 46 different prey items taken by the falcons. Bird species identification was made through comparisons with specimens of the zoological collection of Istituto Nazionale Fauna Selvatica (INFS, Bologna, Italy). Bat hairs were identified through 40× microscope analysis (Keller 1986). The number of prey individuals identified for each species represented the minimum number consumed by the falcons. The composition of the diet over the two nonbreeding seasons May 1997–February 1998 and May 1998–February 1999 was determined either as the relative frequency of capture or as the relative biomass consumed of each species over the total of individuals captured/biomass consumed by falcons. Average weights of bird species (Cramp and Simmons 1989) and bat species (Schober and Grimmberger 1993) were used as approximations for biomass consumed by falcons. The Friedman test for paired data was used to test for difference in the rank of prey types (i.e., resident breeder, migrant breeder, passage migrant, and winter visitor) consumed during the three periods from May–July 1997 and 1998, August–November 1997 and 1998, December–February 1997–98 and 1998–99. An α level of 0.05 was used in all statistical tests.

Selection of diurnal avian prey breeding within a 3-km radius of peregrine perches was also analyzed from May–July 1997 and 1998 according to Baker (1967), Treleaven (1977), Hunter et al. (1988), and Cramp and Simmons (1989). Hereinafter, this circular area is simply referred to as "Florence center." Prey selection was assessed according to the following categories: (1) flight height – 162 hr of observations from elevated points enabled us to rank the bird community breeding within Florence center as either commonly observed flying high above the roof level of Florence center (high-fliers), sometimes observed flying high above the roof level (mid-fliers), birds rarely or never observed flying high above the roof level (low fliers); (2) species—the five most abundant high-flying species with relative abundance estimates > 1 0 % of the total breeding pairs counted within Florence center, N = 9533 (House Martin [*Delichon urbica*], Swift [*Apus apus*], European Starling [*Sturnus vulgaris*], Jackdaw [*Corvus monedula*], and Pigeon [*Columba livia*]); (3) weight—we recognized three weight classes (1–100, 101–200, and >201 g) within the five most abundant high-flying species, whose average weight ranged between 35–300 g.

We tested two null hypotheses: that relative prey consumption (expressed either by frequency and by biomass) occurred in proportion to prey abundance, considering all the prey classes simultaneously and that prey consumption occurred in proportion to prey abundance within the same prey class. To test the former hypothesis, we used either Chi-squared goodness-of-fit or Kolmogorov-Smirnov goodness-of-fit tests according to data and to test the latter hypothesis we used a Bonferroni's test. An α level of 0.05 was adopted as the minimum value for rejection the null hypotheses.

RESULTS

We identified a total of 18 species of prey in the nonbreeding diet of the peregrine pair we studied. Pigeons were the most important prey both by frequency of capture (30.4%) and by biomass (54.0%). Two species of bats (Savi's pipistrelle [*Hypsugo savii*] and Kuhl's pipistrelle [*Pipistrellus kuhlii*]) and Swifts were also frequently-captured prey (15.1 and 8.7% of total prey, respectively). Wintering Black-headed Gulls (*Larus ridibundus*) were also important prey both by frequency (8.7%) and biomass (13.1%). The average weight of prey taken ranged from 7 g (Savi's pipistrelle) to 305 g (Woodcock [*Scolopax rusticola*]), but 53% were <150 g.

Prey taken by the peregrines varied seasonally, although this variation was not statistically significant either by frequency or biomass (Friedman test = 0.37 and 0.87, respectively, $N = 3$, $P > 0.1$). During May–July, the pair fed mainly on resident breeders (70% by frequency and 88% by biomass) and to a lesser extent on migrant breeders (30% by frequency and 12% by biomass). The percent of resident breeders in the diet decreased progressively during August–November and December–February (53 and 43% by frequency, 58 and 39% by biomass), while winter visitors increased to 16 and 57% by frequency and 20 and 61% by biomass. Moreover, during August–November passage migrants became a considerable component of the diet (31% by frequency and 22% by biomass).

Among the 54 bird species breeding in Florence center (both resident and migrant), those that we commonly observed flying high above roof level were taken by peregrines significantly more frequently (frequency of capture = 0.800) than expected based on their relative frequency of occurrence (0.512). The opposite was true for those species sometimes or rarely observed flying high above roof level which were far less frequently captured than expected (χ^2 with Yates's correction = 4.56, df = 1, $P < 0.05$). Likewise, consumption of prey types within categories differed from that which was expected with more high-flying species taken than mid- to low-flying species Bonerroni confidence interval = 0.569–1.0 vs. an expected frequency of 0.512 for high-flying prey and Bonferroni confidence interval = 0–0.431 vs. an expected frequency of 0.489 for mid- to low-flying species. Among most abundant bird species commonly flying high above the roof level of Florence, peregrines showed no significant preference for any species (Kolmogorov-Smirnov goodness-of-fit test = 0.06, $N = 5$, $P > 0.1$) or weight (Kolmogorov-Smirnov goodness-of-fit test = 0.06, $N = 3$, $P > 0.2$). Our results were the same when we analyzed the data expressed as biomass of prey consumed.

DISCUSSION

There is little information about the diet of Peregrine Falcons outside the breeding season (Baker 1967, Mearns 1982), mainly due to its variable use of numerous perches and roosts during this period (Ratcliffe 1993). Despite the relatively small size of the sample of prey that we collected, we felt that it was representative of the nonbreeding diet of Florentine peregrines. We identified a total of 18 prey species and this fell within the range of 10–22 species in the diets of other European Peregrine Falcons in urban habitats which were based on larger sample sizes (Mocci Demartis and Murgia 1986, Ranazzi 1995). Our study confirmed that peregrines fed opportunistically during the nonbreeding season adjusting their diet in accordance with season variations in prey abundance and the height at which they flew in the Florence city center.

Although not significantly different and likely due to our small sample size, the proportion of prey captures characterized by different residence status did not vary from that which was expected. Resident breeders were important prey, especially during the period May–July, both by frequency and by biomass. During this period, the migrant breeder, the Swift, was an important prey species by frequency (Ranazzi 1995). Between August and January, resident breeders were conspicuously replaced by passage migrants and winter visitors in the diet. In particular, between December and January, the proportion of winter visitors was greater than that of resident breeders, especially when captures of Black-headed Gulls increased.

Considering all the bird species breeding in Florence center and their relative abundance, high-fliers appeared to be significantly more vulnerable to peregrine predation than mid- and low-fliers. Among high-flying birds, no significant preference for any one prey species was found. Even prey that were most important in peregrine diets were captured in proportion to their relative abundance. Our findings were not consistent with findings of Hunter et al. (1988) and Rosenfield et al. (1995) who found significant preferences of breeding peregrines for certain taxa. We also found no significant preference according to weight classes of prey. Nutritional requirements of young and daily temporal constraints may force Peregrine Falcons to be more selective with respect to prey classes during the breeding rather than the nonbreeding season.

RESUMEN.—La dieta de una pareja de halcones peregrinos (*Falco peregrinus brookei*) que estacionalmente habitan en el centro de Florencia, Italia, fue investigada durante la época no reproductiva (desde finales de mayo hasta principios de febrero). Los halcones peregrinos ajustaron su dieta en forma oportunista de acuerdo a la variación estacional en la disponibilidad de presas. Las comparaciones entre el consumo y la disponibilidad relativa de las diferentes clases de presas desde mayo–julio mostraron que en un habitat urbano con construcciones altas la altura a la cual volaban las presas fue la mayor limitante en la dieta de este cazador aéreo. Las aves que típicamente volaban por encima del nivel del techo de Florencia fueron capturadas mas frecuentemente que lo esperado de acuerdo con su abundancia relativa. Lo contrario sucedió con las aves que ocasionalmente volaban mucho mas alto que el nivel del techo. Los halcones peregrinos no mostraron ninguna preferencia entre clases y pesos de clases.

[Traducción de César Márquez]

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BALD EAGLES KILLED BY TRAINS IN NEW YORK STATE

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KEY WORDS: *Bald Eagle;* Haliaeetus leucocephalus; *mortality; trains.*

High-speed passenger trains were first introduced into the Hudson River valley rail corridor in eastern New York State in 1980. As of October 2000, there were 20 train trips per day during daylight hours between Albany and New York City on a set of tracks along the eastern shore of the river. Over the same period, use of the lower Hudson River valley by nesting, migrating, or overwintering Bald Eagles (*Haliaeetus leucocephalus*) greatly increased. Sightings of Bald Eagles during annual January aerial surveys of the lower Hudson River have risen from none in the early 1980s to 28 in 2000 (Nye unpubl. data). These two developments have resulted in the deaths of Bald Eagles killed by high-speed trains. Between 1986 and October 2000, we examined the carcasses of 10 Bald Eagles apparently struck and killed by trains, eight in the last four years. At least eight of the incidents occurred on the Albany–New York City tracks in the mid-to-lower Hudson River valley. A ninth bird was recovered from the front of a high-speed locomotive which traveled this route, but which also traveled to and from Vermont during the period in question. The tenth eagle was killed along a railbed that parallels the western shore of Lake Champlain and supports high-speed train traffic to Montreal, Canada. Based on two reports by rail personnel, it is likely that one other eagle (an adult) was struck (presumed killed) in the lower Hudson River valley in August 1996.

Most of the train mortalities we examined occurred during periods of fall migration or overwintering in September (1 mortality), October (2), November (1), December (1), and January (3). The two exceptions were immatures killed in late June 1997 and late July 2000 Nine of the eagles were immatures (five female, three male, one unknown sex), and one was an adult male. All were in good nutritional condition except for one immature struck in September.

Analyses for organochlorine pesticides and polychlorinated biphenyls (PCBs) completed at Hazleton Labs, Madison, WI U.S.A.; EnChem, Inc., Madison WI U.S.A.; Illinois Animal Disease Laboratory, Centralia, IL U.S.A , and University of Mississippi, MS U.S.A. on various tissues from eight eagles (brain [4 birds], liver [3], subcutaneous fat [3]) did not reveal levels that might implicate them as predisposing factors in these train mortalities. DDE was detected in seven birds (0.02–0.73 ug/g in brain, 0.13–0.19 ug/g in liver, 1.4–3.73 ug/g in fat). PCBs were present in six birds (0.13–13.8 ug/g in brain, 0.45–4.3 ug/g in liver, 3.7–71 ug/g in fat). Highest levels were found in the immature from June 1997 supporting suspicions that it fledged from a nest near the PCB-contaminated Hudson River. Other organochlorines detected less frequently and at much lower levels included DDD