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The "Significant Others" of American Kestrels: Cohabitation with Arthropods

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ABSTRACT.—We examined the arthropod fauna that coexists in nest boxes with American Kestrel chicks (*Falco sparverius*) in northwestern New Jersey. Of the seven arthropod species present, five were scavenging beetles, including carrion beetles (*Silpha inaequalis*), hister beetles (*Atholus americanus* and *Phelister subrotundus*), dermestid beetles (*Dermestes caninus*), and skin beetles (*Trox foveicollis*), which apparently were attracted to prey remains that accumulated in the nest boxes. Arthropod density and species richness were significantly greater for nest boxes in which kestrels bred than for unoccupied nest boxes. *Received 30 June 1998, accepted 16 Nov. 1998.*

Studies of the association between American Kestrels (*Falco sparverius*) and arthropods have focused primarily on (1) the occurrence of these invertebrates in kestrel diets and the predatory behavior kestrels direct toward them and (2) parasitic arthropods reported to infest kestrels (for reviews see Sherrod 1978 and Smallwood and Bird in press, respectively). However, arthropods interact with kestrels in another functional role, that of symbiotic scavengers. Kestrels are a cavity nesting species; typical brood size is four or five, and the nestling period lasts about 30 days (Johnsgard 1990). During this time prey remains, regurgitated pellets, and other organic material accumulates in the nest cavity (Balgooyen 1976; Smallwood, pers. obs.). Balgooyen (1976) observed dermestid beetles (*Dermestes* spp.) in each of approximately 40 kestrel nests in northern California and commented on their role in nest sanitation. The objectives of the present study were to examine the arthropod community that coexists with kestrels breeding in nest boxes in New Jersey and to compare them to the invertebrate fauna in nest boxes not occupied by kestrels.

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STUDY AREA AND METHODS

The study area was located in rural northwestern New Jersey, bordered to the north and west by the Kittatinny Ridge and Delaware River, and to the east and south by residential and commercial development. This area is characterized by mixed agriculture, including corn, hay, and cattle production, and forestland in the ridge and valley physiographic region (Sauer et al. 1997). Sixty wooden nest boxes (internal dimensions: 20 × 23 cm floor, ca 34 cm in height) were erected in open habitats in Sussex County (centered approximately 41° 11′ N, 74° 38′ W) between 1 April 1995 and 25 April 1997, and 69 nest boxes in Warren County (approximately 40° 47′ N, 75° 04′ W) between 5 August 1995 and 26 March 1997. Because kestrels do not bring any nesting material into the nest cavity (Bird and Palmer 1988), we covered the floor of each nest box with approximately 6 cm of wood shavings to provide a cushion and insulation for the eggs.

Each nest box was monitored at 4-week intervals from 23 March through 13 July 1997 to determine occupancy status; a nest box was considered occupied by breeding kestrels if at least one egg was observed. Kestrels require 7–9 days to produce and 28–30 days to incubate a clutch (Bird and Palmer 1988); thus, all kestrel nesting attempts were discovered during the laying or incubation stage. Nest boxes in which kestrels bred (herein "kestrel nest boxes") were visited 3–7 times throughout the nesting attempt. During the final visit chicks were banded and the bedding (including cohabiting arthropods, prey remains, pellets, and any other material) was collected and replaced with fresh wood shavings. Final visits occurred between 21 June and 1 August 1997 when nestlings were 16–23 days old (75% were 20–22 days old).

In addition to kestrels, other vertebrates that bred in the nest boxes included five avian species (Great Crested Flycatcher, *Myiarchus crinitus*; Tree Swallow, *Tachycineta bicolor*; Eastern Bluebird, *Sialia sialis*; European Starling, *Sturnus vulgaris*; and House Sparrow, *Paser domesticus*) and four species of mammals (eastern gray squirrel, *Sciurus carolinensis*; red squirrel, *Tamiasciurus hudsonicus*; southern flying squirrel, *Glaucomys volans*; and white-footed mouse, *Peromyscus leucopus*). Only four nest boxes remained unoccupied by any vertebrate species, including kestrels, during the breeding season (herein "unoccupied nest

TABLE 1. Taxonomy and abundance of arthropods co-inhabiting nest boxes with American Kestrel broods in northwestern New Jersey.

Taxonomy	Nest boxes occupied (%)	Individuals per occupied[a] nest box		
		Mean	SD	Range
Arachnida				
Araneida				
Aglenidae				
Tegenaria derhamii, funnel spider	6.3	1.0	0.0	1–1
Insecta				
Coleoptera				
Silphidae				
Silpha inaequalis, carrion beetle	68.8	41.0	30.8	3–114
Histeridae				
Atholus americanus, hister beetle	31.3	4.8	3.4	2–9
Phelister subrotundus, hister beetle	37.5	8.8	11.1	1–24
Dermestidae				
Dermestes caninus, dermestid beetle	12.5	5.0	5.7	1–9
Trogidae				
Trox foveicollis, skin beetle	6.3	3.0	0.0	3–3
Hymenoptera				
Formicidae				
Camponotus pennsylvanicus, black carpenter ant	6.3	1.0	0.0	1–1

[a] Nest boxes in which a particular arthropod species was present.

boxes"). The bedding was collected from unoccupied nest boxes on 11 and 13 July 1997.

All bedding samples were stored at −22° C in airtight plastic bags to preserve any arthropod specimens present. We subsequently extracted all arthropods visible at 1.75× magnification, preserved them in 70% ethanol, and identified them with information from Comstock and Gertsch (1948), Emerton and Frost (1961), Borrer and White (1970), Headstrom (1977), Kaston (1978), Milne and Milne (1980), and Arnett (1985).

Data on arthropod density and richness were tested for normality. Because significant deviations were detected, we used nonparametric statistical treatments exclusively, including the Wilcoxon rank sum test, Spearman's correlation coefficient, and Fisher's exact test (Snedacor and Cochran 1980). Analyses were performed using SAS 6.12 on a Sun Solaris 2.6 platform.

RESULTS

A total of 567 individual arthropods were extracted from the bedding collected from 16 kestrel (Table 1) and four unoccupied nest boxes. Arthropod density ranged from 0 (for two kestrel and two unoccupied nest boxes) to 115 individuals in one kestrel nest box. Mean arthropod density for kestrel nest boxes (35.3 ± 31.0 SD) was significantly greater than that for unoccupied nest boxes (0.50 ± 0.58 SD; two-tailed Wilcoxon rank sums test: $Z = 2.421$, $P = 0.016$). Maximum arthropod density in unoccupied nest boxes was 1: a crab spider (Thomsidae, *Xysticus triguttus*) in one nest box and a European earwig (Forficulidae, *Forficula auricularia*) in one other.

Species richness per nest box ranged from 0–3 and mean richness for kestrel nest boxes (1.69 ± 0.87 SD) was significantly greater than that for unoccupied nest boxes (0.50 ± 0.58 SD; two-tailed Wilcoxon rank sum test: $Z = 2.258$, $P = 0.024$). No significant correlation was detected between arthropod species richness and kestrel brood size ($r_S = 0.17$, $P > 0.05$, $n = 16$), or between kestrel brood size and arthropod density ($r_S = -0.14$, $P > 0.05$, $n = 16$).

DISCUSSION

Of the seven arthropod species observed in kestrel nest boxes in New Jersey, five (all the beetles) are considered scavengers (Headstrom 1977), and the carpenter ant is known to forage primarily on insects (Palmer 1975). The dermestid beetle (*D. caninus*), found in two of the nest boxes, was the same species commonly used in museums for cleaning flesh from skeletal specimens (Headstrom 1977).

The mean and maximum densities of arthropods in the kestrel nest boxes in New Jersey were considerably less than those observed in northcentral Florida (Smallwood,

pers. obs.). In Florida, dermestid beetles and other species typically occurred in large numbers, such that by the end of the nestling period the substrate upon which the chicks stood visibly pulsated as the result of the motion of these arthropods. In an experiment to determine if high arthropod densities in nest cavities discourages second clutches, Smallwood (unpubl. data) replaced the bedding for a randomly selected group of nest boxes after kestrel chicks had fledged. Kestrels renested in 11.1% of the cleaned nest boxes (n = 27) and 14.0% of the control nest boxes (n = 50); these percentages were not significantly different (one-tailed Fisher's exact test, P = 0.76).

We saw no evidence of kestrel chicks bitten or otherwise harmed by the arthropods living in the New Jersey nest boxes. Rather, the removal of much of the decaying organic material (i.e., uneaten scraps of insects, small birds, and rodents) may benefit kestrels by reducing the risk of disease or infestation with parasites. The significant difference in the number and species of arthropods present between kestrel and unoccupied nest boxes, and the fact that nearly all the arthropods were scavengers, suggest that breeding kestrels are producing the conditions that attract these invertebrates.

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