PREY SELECTION AND CALORIC INGESTION RATE OF CAPTIVE AMERICAN KESTRELS

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Numerous studies concerned with the natural history of the American Kestrel (*Falco sparverius*) have been published (see Willoughby and Cade 1964, Heintzelman and Nagy 1968, and references cited therein). The feeding habits of the kestrel are well known and much of the literature dealing with this subject is aptly summarized by Heintzelman (1964). Studies to date have provided much information regarding prey selection and feeding habits of this raptor, but no studies have been directly concerned with the rate of energy ingestion or prey selection strategy under semi-natural experimental conditions. Such information was the major objective of this investigation.

METHODS

This study was conducted at the Ecology Research Center located on the Bachelor Wildlife Estate in close proximity to Miami University, Oxford, Ohio. The experimental site consisted of an aviary (9.1 m $\times$ 6.1 m $\times$ 3.7 m) divided equally to provide replicate systems. Thus, each system consisted of 100.8 m^3 of space. The bottom portion of each structure was constructed of 20-gauge galvanized steel to restrict small mammal populations (Barrett 1968). The remainder of each enclosure was constructed of 2.54 cm poultry mesh attached to a superstructure of 2.54 cm galvanized pipe.

Two wooden perches, each 2.7 m high, were situated in opposite corners of each enclosure. In addition, a perch spanned the middle of each enclosure approximately 2.1 m above ground level. A roost box was added to the west side of each structure approximately 3.0 m above ground level.

Experimental design.—In mid-June, 1970, each enclosure was planted in fescue (*Festuca* sp.) and left undisturbed until mid-July. A swath of vegetation approximately 0.8 m wide was kept mowed just inside the perimeter of each enclosure. This habitat modification provided for equal amounts (13.8 m^2) of cover versus open space within each enclosure.

On 29 July 1970 an adult male American Kestrel was introduced into each experimental area. Males have previously been shown to adapt better to captivity than females (Roest 1957 and others cited therein). These birds were then permitted to acclimate to this new environment for 3 days during which time they preyed on laboratory mice (*Mus musculus*). On 1 August 1970 both kestrels and remaining laboratory mice were removed and the wild prey species were introduced into each enclosure.

The prey species in each enclosure were 10 (5 male and 5 female) prairie deer mice (*Peromyscus maniculatus*) and 9 (5 male and 4 female) meadow voles (*Microtus pennsylvanicus*). Either *Peromyscus* or *Microtus* constitutes a staple diet for kestrels (Breckenridge and Errington 1938, Heintzelman 1964). Due to an inadequate supply of female *Mircotus* only 4 were released into each enclosure. Each prey individual was marked and weighed before being released. Mean body weights for the *Microtus* released into enclosures I and II were 27.9 and 24.9 g, respectively. Mean body weights for the

Peromyscus were 20.3 and 18.3 g, respectively. We found no significant difference ($P > .05$, t-test) in weights between enclosure groups for either species. The prey species were provided a 3-day acclimation period before being subjected to avian predation.

Ample food was available for the *Microtus* in the form of fescue and fox tail (*Setaria faberii*). The *Peromyscus* diet was supplemented with wild bird seed randomly hand-sown at the rate of 100 g per day during the initial 10 days of the study.

Census procedures.—We censused the prey populations with 20 live-traps arranged in a grid pattern within each enclosure. Traps were baited with peanut butter each night after predatory activity had subsided and checked early each morning before the kestrels became active. Captive animals were identified and immediately released at the site of capture. The calendar of catches method described by Petrusewicz and Andrzejewski (1962) was used to estimate the mammal populations within each enclosure. This method is well suited for the census of animals restricted to a particular habitat and corrects for those animals that are not captured each night.

The kestrels were weighed at the beginning (4 August) and end (18 August) of the experiment. Weights of each bird ranged from 95 to 104 g providing a mean weight value of 100.8 g. This value compares favorably with the 102.5 g mean weight value reported by Roest (1957) based on a large (88) sample size. A caloric equivalent for wild-caught small mammals of 1.37 kcal/g live weight as reported by Golley (1960) was employed in the computation of kestrel caloric ingestion rates.

RESULTS

Observations at numerous times during the day indicated that both small mammal species were quite active in early morning and late afternoon, i.e., at a time when the kestrel is also most active at hunting and feeding (Roest 1957). The diurnal activity patterns of *Microtus pennsylvanicus* have been well defined (Ambrose 1973). However, since *Peromyscus maniculatus* is considered a nocturnal species (Falls 1968), it appears that either the initial high population density or the brief, 3-day acclimation period, or both, contributed to their increased diurnal activity. Voles, when seen, were always in the high vegetation habitat, whereas the deer mice were located in the mowed habitat approximately 75–80% of the time. Trapping results confirmed these observations.

It appeared that the feeding strategy of the kestrels was divided into 3 phases (Fig. 1). During the first 5 days of predation, the kestrels consumed 9 meadow voles and 2 deer mice. During the next 5 days the kestrels consumed twice as many deer mice (10 to 5) as they did meadow voles. Finally, during the last 5 days the kestrels consumed equal numbers of each prey species (4 each). Our observations revealed that, in all instances, the kestrels consumed the entire animal once a successful capture was made. Daily searching in each aviary revealed no food-caching behavior as previously reported by Stendell and Waian (1968) and Mueller (1973).

Statistical analysis of the data support this 3-phase feeding strategy. The removal pattern of *Peromyscus* followed a cubic function ($r^2 = 0.96$; $p < .0001$), while that of *Microtus* followed a linear function ($r^2 = 0.89$; $p <$

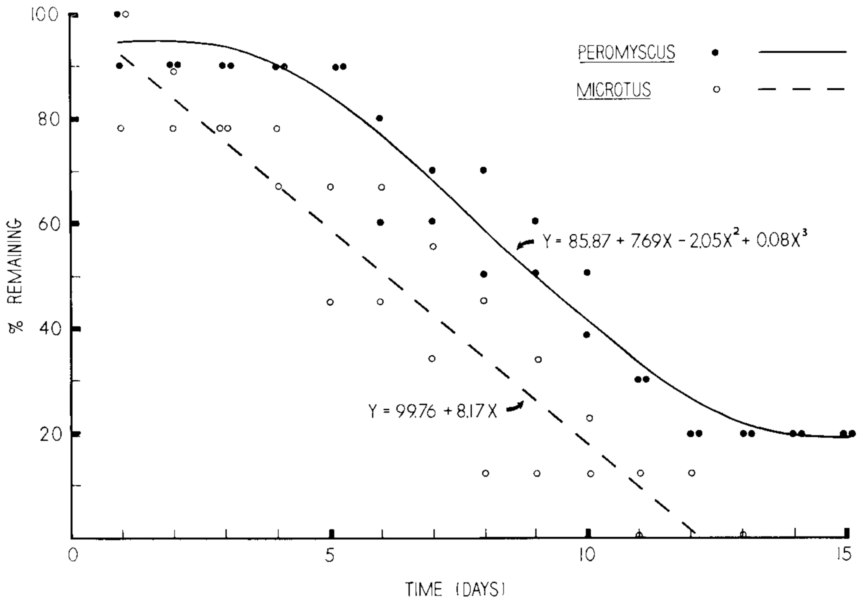

Fig. 1. Graph showing the decline in small mammal population densities when subjected to American Kestrel predation under semi-natural aviary conditions.

.0001). The cubic function for *Peromyscus* was $Y = 85.87 + 7.69\ x - 2.05\ x^2 + 0.08\ x^3$ while the linear function for *Microtus* was $Y = 99.76 - 8.17\ x$. In both equations Y equals percent remaining and x equals time in days. In essence, the kestrel feeding strategy represents a continuous (linear) prey selection pattern for *Microtus* in contrast to an "intermediate" (inverse sigmoid) selection pattern for *Peromyscus* (see Fig. 1).

These equations suggest a more uniform population activity pattern for the meadow voles than for the deer mice, i.e., individuals within the vole populations were consistently captured until each population was eliminated, whereas certain individuals within the deer mouse populations appeared to be able to avoid kestrel predation. For example, there were 2 deer mice left in each enclosure that the kestrels appeared unable to capture. The study was terminated on day 16 because both birds began losing weight, apparently due to energy limitation.

Food consumption rates, expressed in kcal/g wet wt/day, were computed for the kestrels while feeding exclusively on the mammal populations. Each bird consumed an average of 0.42 kcal/g wet wt/day during the 15-day study period. This consisted of 0.17 kcal/g wet/day of *Peromyscus* and 0.25 kcal/g wet wt/day of *Microtus*. The 0.42 kcal value is based on the initial 13 days of the study since no predation occurred beyond this date. At this time the meadow voles were eliminated and the deer mice were reduced to 2 individuals per aviary.

DISCUSSION

It has previously been assumed that prey selection by American Kestrels is due to local variations in both prey vulnerability and density (Heintzelman 1964) with, presumably, the predator selecting the most vulnerable and abundant food source. Our findings do not verify these assumptions. In this study the densities of *Peromyscus* and *Microtus* were similar but the kestrels selected the *Microtus* during the initial 5 days of the study even though the *Peromyscus* were considered to be equally vulnerable due to their predilection for the mowed part of the habitat. In other words, each bird under the habitat conditions of the present study, initially selected voles with the result being a greater total energy reward when successful. It appears that the feeding strategy of these 2 kestrels was to spend much of their energy in seeking a larger prey species even though another species might be just as abundant and, perhaps, equally vulnerable. This may help to explain the selection of microtines by kestrels even when these individuals are located in an area of good habitat cover.

The behavioral aspects of predator-prey interactions are poorly understood. Therefore, the vulnerability of the *Peromyscus* population in regard to kestrel feeding strategy should be viewed in terms of several parameters, e.g., energy content (Emlen 1966), habitat cover (Sparrowe 1972), behavioral activity patterns (Mueller 1973), and prey acclimation time (Metzgar 1967). Although the kestrels in our study initially selected *Microtus*, the fact that these birds were unable to capture 2 *Peromyscus* in each enclosure lends support to the variation and complexity of these predator-prey interactions.

The food-intake requirement per unit of weight of kestrels, 0.42 kcal/g wet wt/day, is less than those values reported for other raptors of comparable size and maintained under comparable conditions. For example, Graber (1962) reported an ingestion rate of 0.63 kcal/g/day for the Saw-whet Owl (*Aegolius acadicus*) also maintained in an aviary at 18°–19° C. The mean temperature in our study was 23°–24° C, which might account for part of this difference. However, Collins (1963) reported a mean Saw-whet ingestion rate of 1.17 kcal/g/day for birds maintained under outdoor conditions.

Our food-intake values are comparable to values for the Long-eared Owl (*Asio otus*) and the Burrowing Owl (*Speotyto cunicularia*) as reported by Graber (1962) and Marti (1973). Graber estimated an ingestion rate for Long-eared Owls of 0.36 kcal/g/day as compared to a value of 0.51 kcal/g/day determined by Marti for this same species. Marti reported an ingestion rate for the Burrowing Owl of 0.67 kcal/g/day. Both the Long-eared Owl and the Burrowing Owl reported by Marti were maintained under outdoor caged conditions between 19 June and 16 July.

Perhaps one of the discrepancies in these related food-intake studies is the caloric density equivalent. Birds in the above-mentioned studies were fed a diet of laboratory mice (*Mus musculus*) and the caloric intake equivalents were based on the 3.95 kcal per gram dry weight determined for *Mus* by Graber (1962). Brisbin (1970) points out the difference in caloric density values between wild-caught mice, used in the present study, and laboratory raised mice, employed in the above studies.

SUMMARY

This study was designed to measure and evaluate prey selection and food intake of 2 male American Kestrels (*Falco sparverius*) under semi-natural aviary conditions. The kestrels selected the meadow vole (*Microtus pennsylvanicus*) as their primary food source during the initial 5 days of the study even though the deer mice (*Peromyscus maniculatus*) were equally abundant and were considered by the authors to be equally vulnerable to capture. On this basis, the feeding strategy of these kestrels resulted in the capture of a larger energy reward.

The kestrels exhibited a mean ingestion rate of 0.42 kcal/g wet wt/day, a value slightly lower than for owls of comparable size and maintained under comparable outdoor conditions. From these data it appears that the American Kestrel is more efficient in using its food than are similar-sized owls.

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NEW LIFE MEMBER

Dr. Walter Kingsley Taylor has recently became a life member of the Wilson Ornithological Society. Dr. Taylor is presently an Associate Professor of Biology at Florida Technological University in Orlando. His ornithological interests include various aspects of breeding biology and migration, and he has published a number of papers on birds of the southeastern and southwestern United States. He is married and has one child. In addition to his ornithological interests, Dr. Taylor enjoys gardening and music.