

SNOW, B. K., AND D. W. SNOW. 1972. Feeding niches of hummingbirds in a Trinidad valley. *J. Anim. Ecol.* 41:471-485.

WOLF, L. L., F. R. HAINSWORTH, AND F. G. STILES. 1972. Energetics of foraging: rate and effi-

ciency of nectar extraction by hummingbirds. *Science* 176:1351-1352.

*Department of Zoology, University of Reading, Reading, England.* Accepted for publication 27 May 1975.

## ENVIRONMENTAL FAMILIARITY AND ACTIVITY: ASPECTS OF PREY SELECTION FOR A FERRUGINOUS HAWK

RON L. SNYDER  
WILLIAM JENSON  
AND  
CARL D. CHENEY

Prey animal activity was first suggested as a major factor in prey selection by Cushing (1939) and by Ingles (1940). Metzgar (1967) showed that Screech Owls (*Otus asio*) capture more transient than resident mice (*Peromyscus leucopus*) and suggested that this preference was due to differential activity levels of the prey. Kaufman (1974) reported that Barn Owls (*Tyto alba*) selected more live (and therefore presumably more mobile) mice (*Mus musculus*) than dead ones, when offered a choice in a field enclosure. Snyder (1975) in a laboratory setting showed that a Red-tailed Hawk (*Buteo jamaicensis*) also selected the more active of two prey animals. The present paper reports selection preferences by a Ferruginous Hawk (*Buteo regalis*) offered a choice between two mice (*Mus musculus*) on each of 60 trials. Each trial consisted of presenting pairs of mice selected so as to include 6 combinations of 4 experimental treatment groups. The treatments manipulated the mice's familiarity with their environment and also their activity levels. The purpose of this experiment was to determine the effects of these manipulations on the hawk's choices and if the two treatments could be isolated as predation parameters.

One three-year-old, hand-reared, female Ferruginous Hawk was used. Its weight remained at 1650 g ( $\pm 30$  g) throughout. The experiment was conducted in an outdoor enclosure measuring 10  $\times$  10  $\times$  3 m. The hawk was retained between trials on a perch in a wire mesh cage, attached to the roof of the east end of the enclosure. A remotely operated door allowed the hawk to leave this cage during selection trials and fly to either of 2 open-topped prey pens. These pens measured 2.6  $\times$  1.3  $\times$  0.6 m and were placed in opposite corners of the west end of the enclosure. Plexiglass was used in the ends of the prey pens facing the hawk to facilitate observation of the prey. Albino mice were divided into 4 treatment groups of 30 mice each for paired presentations, one in each prey pen. Two trials per day were conducted, one 4 hr after sunrise, and the second 3 hr before sunset. The 4 mouse treatment groups were: (1) "pen familiar" (F), (2) "pen unfamiliar" (U), (3) "drugged familiar" (DF), and (4) "drugged unfamiliar" (DU). All F group mice were allowed to move freely within a pen for 1 hr before the trial. The hawk's view of the pens was obscured by a drape during this familiarity time. The U mice were given no pre-trial pen exploration time. DF and DU mice were injected

intraperitoneally with 0.05 mg/kg Stelazine (Trifluoperazine HCl, a tranquilizer) 65 min before the trial in order to reduce their activity. Individual mice were randomly assigned to the left or right prey pens on each trial.

Each trial procedure was as follows: first, the door of the hawk cage was closed with the hawk inside and an opaque drape lowered. If a familiarity period was scheduled, the cover prevented the hawk's observing the mouse during this time. At the conclusion of the 1-hr mouse familiarity period, the appropriate mouse was placed in the other pen, the cage cover removed and the hawk allowed to observe both pens for 5 min. The door of the hawk cage was then opened and the hawk allowed to capture and consume one mouse. After capture the experimenter entered the enclosure and removed the other mouse, which was not used again. The data included the hawk's choice, and the latency to strike, measured from the opening of the cage to contact between the hawk and mouse.

To determine if there were in fact activity differences among prey groups, ten additional pairs of mice were prepared in the same manner as in the selection trials, and their activity was monitored during a 5-min period. Activity was measured by an observer recording the number of 25-cm<sup>2</sup> blocks on the floor of the prey pens that each mouse entered. This procedure provided a measure of mouse mobility comparable to the periods in which the hawk observed both mice in the main experiment. The hawk was not allowed to select the mice in this experiment.

The preference percentages in the table were analyzed in terms of the significance of a preferred proportion (Bruning and Kintz 1968). The unfamiliar mice were selected more often than familiar whether these familiar animals were tranquilized or not. Unfamiliar mice were also preferred over tranquilized-unfamiliar mice. When the choice was between two tranquilized mice, the hawk selected the unfamiliar; when between two familiar mice, the choices were equally divided. Latencies illustrated adaptation to the situation with a mean latency of 135 sec for the first 20 trials, 80 sec for the second 20, and 7 sec for the final 20. Side preferences were 34 left and 26

TABLE 1. Preference percentages for each of 6 pairings of the 4 mouse treatment groups with 10 trials per pairing.

Pairing	Condition and Hawk's preference percentages		Probability*
	Familiar	Unfamiliar	
1	F—20%	U—80%	<0.05
2	DF—10%	DU—90%	<0.05
3	DF—50%	F—50%	**
4	DU—0%	U—100%	<0.05
5	DU—30%	F—70%	**
6	DF—10%	U—90%	<0.05

\* Probability determined by a sign test for the significance of a proportion (Bruning and Kintz, 1968).

\*\* Not significant.

right, which was statistically insignificant. The mean number of grid line crossings for the 4 mouse treatment groups in the second experiment were: F, 24.0; U, 52.2; DF, 0.6; and DU, 18.0 ( $N = 5$  in each group). These means were significantly different ( $P < 0.05$ ), (Bruning and Kintz 1968).

These results indicate that relative prey mobility was most probably responsible for the selection against unfamiliar and undrugged mice. When activity levels alone were used to predict choices, with higher mobility associated with higher probability of selection, the data from the second experiment accounted for most of the selection results. For example, U mice were preferred over the other groups and were the most active. DU mice were more active than DF animals and were also taken more often. If activity levels of the mice in the selection trials were similar to those in the activity monitoring experiment, (and observation suggests this was the case), two conclusions may be drawn. First, Kaufman's (1974) and Snyder's (1975) results, concerning the conspicuousness of activity and selection against relatively more mobile prey, are extended to a third raptorial species. Second, Metzgar's (1967) finding that his transient white-footed mice were more active than residents is supported by our house mice in a similar apparatus. Our experiment indicates that a prey animal's familiarity with its environment may be a factor in conspicuousness, but only insofar as this is reflected in mobility relative to alternative same-species prey animals.

## BIOENERGETICS AND PREY SELECTION OF CAPTIVE BARN OWLS

LORNA G. WALLICK  
AND  
GARY W. BARRETT

We report here on daily energy requirements and prey selection of two young female Barn Owls (*Tyto alba*) fed on deer mice (*Peromyscus maniculatus*) and meadow voles (*Microtus pennsylvanicus*). Previous field studies indicate that these small mammals, especially voles, are a major constituent of the Barn Owl's diet (Bent 1938, Pearson and Pearson 1947, Phillips 1951, Boyd and Shriner 1954, Parmalee 1954, Marti 1973). The owls were collected near Canton, Ohio, in early spring. At the time of the study, 7-17 August 1971, they were approximately six months old.

The aviary ( $9.1 \times 6.1 \times 3.7$  m), described in detail by Barrett and Mackey (1975), was divided into two equal enclosures. Shelter boxes measuring  $0.6 \times 0.5 \times 0.9$  m were placed in the southwest corner of each enclosure, and those corners were covered on both sides and on the top with burlap to provide shade. Perches were placed in the three other corners of each enclosure. The aviary was densely grown with old-field plants—fox tail (*Setaria faberii*), daisy fleabane (*Erigeron annuus*), and common ragweed (*Ambrosia artemisiifolia*) being the dominant species. When the vegetation became about 1 m tall in summer, it was mowed at ground level and raked. Cut material was spread over a  $1.5 \times 3.0$  m rectangular area in the center of each enclosure, leaving an 0.8-m open swath around the edge. This habitat design provided a central covered area and an outside

This research was supported in part by Utah State University Environment and Man Grant V-58-41. We thank David Balph, Director, Green Canyon Ecology Research Center, USU, for facilities and grounds.

### LITERATURE CITED

- BRUNING, J. D., AND KINTZ, B. L. 1968. Computational handbook of statistics. Glenview, Ill. Scott, Foresman and Co.
- CUSHING, JOHN E., JR. 1939. The relation of some observations upon predation to theories of protective coloration. Condor 41:100-111.
- INGLES, LLOYD C. 1940. Some observations and experiments bearing upon the predation of the Sparrow Hawk. Condor 42:104-105.
- KAUFMAN, D. W. 1974. Differential predation on active and inactive prey by owls. Auk 91:172-173.
- METZGAR, L. M. 1967. An experimental comparison of owl predation on resident and transient white-footed mice (*Peromyscus leucopus*). J. Mammal. 48:387-391.
- SNYDER, R. L. 1975. Some prey preference factors for a Red-tailed Hawk. Auk 92:547-552.

*Institute of Animal Behavior, Department of Psychology, Utah State University, Logan, Utah 84322. Accepted for publication 30 September 1974.*

open area, each containing 4.6 sq m. The mowed area afforded ideal habitat for the deer mice (Hayne 1936, Blair 1951), while the area with vegetative cover was suitable for the meadow voles (Eadie 1953, Golley 1960). Daily observations confirmed that both species of mammals did, indeed, conform to their recorded habitat preferences.

The owls were acclimated to the aviaries for two weeks and then removed. They were fed laboratory white mice during the acclimation period. The birds weighed 483 g and 525 g before the study began, and 487 g and 566 g after it ended. These weights fall within the 382-580 g range summarized for female Barn Owls by Earhart and Johnson (1970).

Forty female mice were weighed, marked with monel #1 ear tags, and released into the aviary to acclimate. Ten *Microtus* and 10 *Peromyscus* were introduced into each enclosure. After two days, one owl was returned to each enclosure. Additional non-acclimated small mammals were added on the sixth day of the study, due to the high rate of prey removal. Eight male and 2 female voles were put in each enclosure. Five male and 4 female mice were added to Aviary I, and 5 male and 5 female mice to Aviary II. The difference in prey sex ratios was the result of available animals at the time. However, we noticed no difference in selection of prey by sex in either enclosure. At the end of ten days, live-trapping revealed that a single deer mouse was left in Aviary I and one deer mouse and four voles remained in Aviary II.

We collected owl pellets daily and examined them for the metal tags in order to identify individual animals consumed (Southern and Lowe 1968). Where tags had been lost, which occurred in only three instances, examination of skull fragments identified the animal species consumed.