

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

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AND

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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

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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.

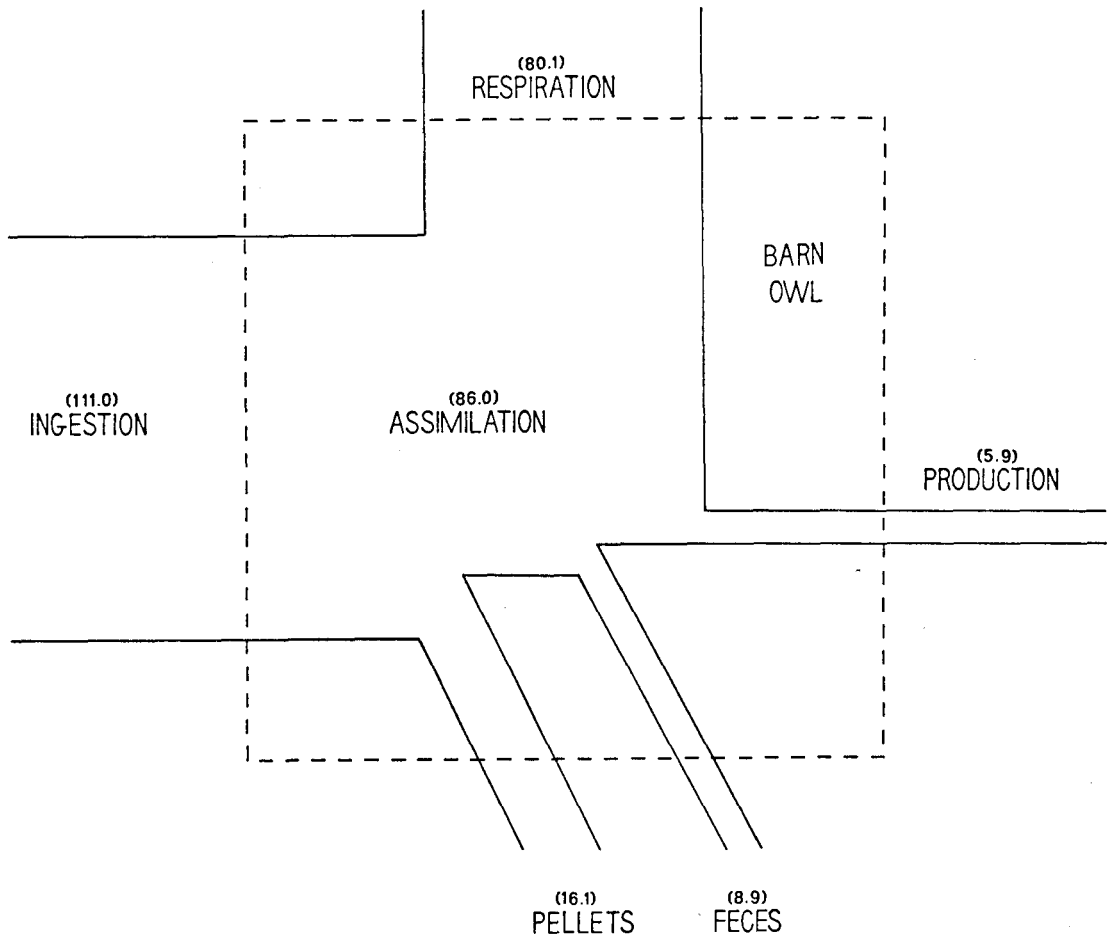


FIGURE 1. Energy flow diagram for juvenile Barn Owls under semi-natural aviary conditions. All values in parentheses expressed as mean kcal/bird/day.

The mean daily ingestion rate was  $74.1 \pm 57.0$  SD g wet weight per owl, which converts to 21.5 g dry weight (Golley 1960). Using an average caloric value for small mammals of 5.163 kcal/g dry weight (Golley 1961), the mean ingestion rate was 111.0 kcal/day. Marti (1973) reported a mean daily ingestion rate of 60.5 g wet weight for a mature female Barn Owl kept in a  $2 \times 2 \times 2.5$  m cage. He also estimated that wild Barn Owls consume about 110 g daily (Marti 1970). Thus, the mean daily ingestion of 74.1 g found in our study of Barn Owls kept under semi-natural conditions compares well with Marti's results.

Owl pellets were oven-dried at  $40^\circ\text{C}$  for 48 hr, weighed, and finely ground in a Wiley mill. Pellets from each bird were then combined in order to provide a homogeneous mixture. Six aliquots, each approximately 1 g in weight, were pelletized from the ground material for each owl. Caloric determinations for the 12 sample pellets were made with a Parr adiabatic bomb calorimeter. The mean dry weight of the pellets cast daily was  $5.35 \pm 3.63$  SD g. Six caloric determinations for each Barn Owl's pellets gave a mean value of  $3.01 \pm 0.13$  SD kcal/g dry weight. Thus, mean energy lost in the form of pellets was 16.1 kcal/bird/day. Eight percent of the gross food intake (ingestion) must also be subtracted in the form of urine and fecal matter in order to correct

for assimilated energy (Graber 1962), i.e., assimilation = ingestion minus pellets minus excreta. Therefore, we estimated daily Barn Owl energy loss in the form of waste products to be 8.9 kcal. The mean daily weight gain (i.e., production) was 2.25 g. Using Brisbin's (1968) value of 2.61 kcal/g live weight, as determined for adult Mourning Doves (*Zenaidura macroura*), production accounted for 5.9 kcal of the Barn Owls' daily energy budget.

Figure 1 summarizes mean daily energy flow values for the experimental birds. Assimilation energy (ingestion minus pellets minus feces) was 86.0 kcal/day. The assimilation efficiency (ingested energy minus pellet energy minus fecal energy/ingested energy  $\times 100$ ) was 77%.

Assimilation energy is also equal to production plus respiration (Odum 1968). Thus, daily Barn Owl respiration (assimilation minus production) was found to be 80.1 kcal.

Herzog (in Lasiewski and Dawson 1967) reported a daily standard metabolic rate of 43.0 kcal for the Tawny Owl (*Strix aluco*), a bird of comparable size. Daily standard metabolic rates determined for the Long-eared Owl (*Asio otus*) and for the Great Horned Owl (*Bubo virginianus*) were found to be 19.7 kcal and 108.0 kcal, respectively (Graber 1962, Benedict and Fox 1927). Thus, the daily respiration value of 80.1 kcal appears representative of Barn

TABLE 1. Summary of prey selection per day by Barn Owls in captivity. Days 1-5 represent acclimated prey feeding period; days 6-10 represent non-acclimated prey feeding period.

| Day | Owl I             |                 | Owl II            |                 |
|-----|-------------------|-----------------|-------------------|-----------------|
|     | <i>Peromyscus</i> | <i>Microtus</i> | <i>Peromyscus</i> | <i>Microtus</i> |
| 1   | 0                 | 0               | 0                 | 0               |
| 2   | 7                 | 3               | 8                 | 1               |
| 3   | 0                 | 0               | 2                 | 0               |
| 4   | 3                 | 4               | 0                 | 1               |
| 5   | 0                 | 3               | 0                 | 1               |
| 6   | 2                 | 3               | 2                 | 3               |
| 7   | 1                 | 4               | 2                 | 2               |
| 8   | 1                 | 2               | 0                 | 2               |
| 9   | 2                 | 1               | 3                 | 6 <sup>a</sup>  |
| 10  | 2                 | 0               | 2                 | 0               |

<sup>a</sup> Four of these *Microtus* came from the original acclimated group.

Owl metabolic activity, especially since these birds were functioning under semi-natural conditions.

Table 1 summarizes prey selection by each owl for the study period. Neither bird fed the first night that prey were provided, but during the second night of the study both owls fed heavily on *Peromyscus*. Published information indicates that 64-85% of the Barn Owl's diet is composed of *Microtus* species (Pearson and Pearson 1947, Phillips 1951, and others). However, during the first two days of the study, our owls ate 15 (79%) acclimated *Peromyscus* and only four (21%) acclimated *Microtus* ( $\chi^2 = 6.36$ ,  $df = 1$ ,  $P \leq 0.01$ ). On the sixth and seventh days of the study (i.e., the first two days after non-acclimated animals were put into the aviary), 12 (63%) of the animals eaten were meadow voles and 7 (37%) were deer mice ( $\chi^2 = 1.32$ ,  $df = 1$ ,  $P > 0.05$ ). Thus, it appears that acclimation of these prey species differentially affected their ability to avoid capture. Seven of the ten initial *Microtus* avoided being captured during the acclimation period by Barn Owl II. In fact, it was not until day 9 that four of these voles were caught (table 1). Captive conditions may have altered the owls' pattern of prey selection, but our data suggest that *Microtus*, which constitute the bulk of the Barn Owl's diet under natural conditions, are captured from manipulated habitats before prey species are able to reestablish their normal activity patterns (e.g., from mowed hay fields or from grain fields during harvest time). It remains for further studies under natural field conditions to resolve the importance of acclimation in predator-prey relationships.

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