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OWL FEEDING HABITS ON SMALL MAMMALS

By

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The composition of 375 small mammal skulls found under a long-eared owl (*Asio otus*) roost was compared to three years of winter live-trap data on two nearby experimental grids in northeast Kansas. Overall, *Peromyscus maniculatus* was overrepresented in the owl diet while *Reithrodontomys megalotis* was underrepresented. These differences are generally explainable by the foraging behavior of *P. maniculatus* and the small size of *R. megalotis*.

INTRODUCTION

The composition of a predator's diet may differ from the community composition of the available prey species for many reasons. For example, a predator may select prey on the basis of their size or nutritive value, some prey species may be better able to avoid capture than others, or a predator may encounter some prey species more frequently than others due to the activity patterns of the prey species or the predator. We report here a large difference between the diet of owls, as determined by a collection of small mammal skulls, and the species composition of the available small mammal community as determined by three years of live-trap samples in two adjacent grids.

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STUDY AREA AND METHODS

A total of 375 small mammal skulls were collected in a small area (approximately 4 m^2) under a large eastern red cedar tree (*Juniperus virginiana*) which is part of a planted grove of cedar trees near the University of Kansas Nelson Experimental Area northeast of Lawrence, Kansas. The skulls had been deposited in owl pellets in the past but were nearly free of cast debris when collected. Adjacent to the cedar stand is a brome field of approximately five hectares. Because of the location of a large number of small mammal skulls in the red cedar grove, it is highly likely that the small mammals were caught by long-eared owls overwintering there and using the tree as a common roost (R. Johnston, pers. comm.).

As part of an ongoing research program, the numbers of small mammals have been monitored by live trapping every two weeks on two grids (A and I; see Johnson and Gaines, 1985 for details) in the Nelson Experimental Area about 0.5 km from the owl roost. The grids were in a two-hectare brome field similar to the field adjacent to the cedar grove containing the owl roost. The data from this census over three winters provide an indicator of the community composition of the small mammals available to the owls.

RESULTS AND DISCUSSION

Seven mammalian species were present in the collection of skulls from the owl roost (see Table 1). *Microtus ochrogaster* was the most common species, comprising 59.5 percent of the sample, and *Peromyscus maniculatus* was second most common at 21.6 percent of the sample. In examining the adult *Peromyscus* skulls, no *P. leucopus*, a congeneric species found

Table 1. Small mammal skulls identified from an owl roost.

Species	Number	Proportion
Microtus ochrogaster	223	0.595
Peromyscus maniculatus	81	0.216
Synaptomys cooperi	28	0.075
Reithrodontomys megalotis	25	0.067
Sigmodon hispidus	12	0.032
Blarina hylophaga	3	0.008
Cryptotis parva	3	0.008
	375	1.000

locally, were identified. Three other species, *Synaptomys cooperi*, *Reithrodontomys megalotis*, and *Sigmodon hispidus* composed between 3 and 8 percent of the total, while both species of shrews in the sample, *Blarina hylophaga* and *Cryptotis parva* were less than 1.0 percent.

Seven species were also found in the live-trap sampling (see Table 2). Again *M. ochrogaster*, was most common, although *R. megalotis* was nearly as common in the winter 1980–1981 captures. *Peromyscus maniculatus* was much less common (we should note that one *P. leucopus* was caught and it is included with *P. maniculatus*), followed in number by *S. cooperi* and *S. hispidus*, respectively. All three of these species showed substantial year to year variation with *P. maniculatus* in higher numbers in 1979–1980 and *S. cooperi* and *S. hispidus* in higher numbers in 1981–1982. *Blarina hylophaga* was again less than 1.0 percent, *C. parva* was missing, and a few *Mus musculus* were caught in the winter of 1980–1981. Because we do not know the year(s) that the owls used the roost, we used both the values for the individual years and the average proportions over the three winters in the ensuing discussion.

Table 2. Numbers of small mammals and proportions of each species caught in the winter on two adjacent grids for three different years.

	Numbers (proportions) of animals			
Species	1979–1980	1980–1981	1981–1982	Average Proportion
M. ochrogaster	116(0.458)	115(0.471)	233(0.553)	0.494
P. maniculatus	44(0.174)	14(0.057)	3(0.007)	0.079
S. cooperi	2(0.008)	3(0.012)	68(0.162)	0.061
R. megalotis	85(0.336)	100(0.410)	88(0.209)	0.318
S. hispidus	5(0.020)	7(0.029)	27(0.064)	0.038
B. hylophaga	1(0.004)	0(0.0)	2(0.005)	0.003
M. musculus	0(0.0)	5(0.02)	0(0.0)	0.007
	253(1.0)	244(1.0)	421(1.0)	1.000

In other published studies, *Microtus* spp. generally have been the major prey of long-eared owls (see references in Marti, 1974) except in two studies in Colorado (Catlett *et al.*, 1958; Marti, 1974) in which *Peromyscus* spp. were more important. However, in his trapping survey, Marti (1974) found 0.805 and 0.089 of the small mammals were *Peromyscus* and

Microtus, respectively, a reversal in the abundance we observed in eastern Kansas.

In terms of the total number of species (species richness), the owl sample and the live-trap data had seven species each. Each yearly live-trap sample had only six species. Both the Shannon-Wiener diversity index, H,

$$= -\sum_{i=1}^{s} p_i \ln p_i \,, \tag{1}$$

where p_i is the frequency of the *i*th species in a community of *s* species, and Simpson's index of concentration, λ,

$$= \sum_{i=1}^{s} p_i^2 \,, \tag{2}$$

are similar for the owl sample and for the average of the three years of live trapping. H and λ values were 1.187 and 0.412 in the owl's diet and 1.260 and 0.356 using the average proportions in the live-trap samples. The H values for the three years were 1.167, 1.118, and 1.22 and the λ values were 0.353, 0.394, and 0.424, bracketing that observed in the owl's diet.

We also compared the numbers in the two samples to determine if they are statistically different. To avoid small sample size problems, we compared the five most common species using a heterogeneity χ^2 test. The χ^2 values from the numbers of the five most common species in Table 1 and the three winters in Table 2 are 83.8, 126.2, and 127.5, respectively. With four degrees of freedom, all these values are significant at the 0.001 level, demonstrating that small mammals caught by owls have a very different composition from those live-caught in all three winters.

Assuming that the difference in proportions is the result of selective predation by the owls, we can determine the extent of selective predation necessary to explain these differences. One measure of food selectivity is the maximum likelihood estimator given by Chesson (1983),

$$\hat{a}_i = \frac{r_i/n_i}{\sum_{j=1}^{s} r_j/n_j} \,, \tag{3}$$

where r_i is the proportion of the *i*th species in the predator's diet and n_i is the proportion of the *i*th species in the environment. The selectivity values are scaled so that they "can be interpreted as the proportion of the diet which would consist of type i if all food types were present in equal numbers in the environment" (Chesson, 1983). In other words, $\hat{a}_i$ should equal $1/s$ if there is no selective predation.

Food selectivity values for the five most common species are given in Table 3 for the three years separately and for the overall proportion. *Peromyscus maniculatus* was the most captured species relative to its abundance overall and in 1981–1982. The selectivity value indicates that *S. cooperi* was the most preferred species in both 1979–1980 and 1980–1981 but these high preference values occur partly because so few *S. cooperi* were live-trapped in those two years. The selectivity values for both *M. ochrogaster* and *S. cooperi* were close to the value of 0.2 which indicates no preference. *Reithrodontomys megalotis* had by far the lowest selectivity value for each year and overall.

TABLE 3. The food preference values ($\hat{a}_i$) and the relative encounter values (e_i) for each year and using the average proportion over years.

Species	1979–1980		1980–1981		1981–1982		Average Proportion	
	$\hat{a}_i$	e_i	$\hat{a}_i$	e_i	$\hat{a}_i$	e_i	$\hat{a}_i$	e_i
M. ochrogaster	0.095	0.139	0.101	0.203	0.032	0.034	0.194	0.441
P. maniculatus	0.090	0.131	0.302	0.608	0.929	1.000	0.440	1.000
S. cooperi	0.685	1.000	0.497	1.000	0.014	0.015	0.197	0.448
R. megalotis	0.015	0.022	0.013	0.026	0.010	0.011	0.034	0.077
S. hispidus	0.115	0.168	0.087	0.175	0.015	0.016	0.135	0.307

One possible explanation for these values is that the encounter frequencies of the predator with various prey species vary due to prey behavior or other factors. We can calculate the relative encounter values by

$$e_i = \frac{\hat{a}_i}{a_{i\,(\max)}}, \qquad (4)$$

where a_i (max) is the largest a_i value (see Table 3). Overall these values suggest that the owls encounter *P. maniculatus* most frequently, *M. ochrogaster* and *S. cooperi* about one-half as often and *R. megalotis* quite infrequently. There is some observational support for these differences. First, *P. maniculatus* is more nocturnal than *M. ochrogaster* (e.g., Danielson and Swihart, 1987), and second, *P. maniculatus* feeds on seeds and may forage in more exposed positions while climbing on herbaceous stems. Both these factors would make *P. maniculatus* relatively more vulnerable to owl predation (see also Kotler, 1985).

Another explanation for these preference values is to assume that owl predation is determined in part by prey size. The average weights of the five small mammal species are given in Table 4 along with the average proportion $\hat{a}_i$ values from Table 3. Note that the species are ordered here based on their weights rather than their skull number below the owl roost. The smallest species, *R. megalotis*, has the lowest $\hat{a}_i$ value and the largest species, *S. hispidus* the second lowest. *Microtus ochrogaster* and *S. cooperi* have very similar weights and also very similar $\hat{a}_i$ values.

TABLE 4. The average weight and the food preference values using the average proportion over years.

Species	Average weight (g)	$\hat{a}_i$
S. cooperi	42.0	0.197
P. maniculatus	19.1	0.440
R. megalotis	10.2	0.034
M. ochrogaster	41.0	0.194
S. hispidus	92.9	0.135

An obvious interpretation of these data is that the owls selectively feed on prey of intermediate size. For example, the small size of *R. megalotis* may make it a more difficult prey for long-eared owls to detect and capture. Furthermore, the weights of adult long-eared owls are 245.3 g and 279.4 g for males and females, respectively (Earhart and Johnson, 1970), suggesting that the size of *S. hispidus* may be at the upper limit of the ordinary diet of the owls. In fact, Marti (1974) estimates that less than one percent of the long-eared diet in his Colorado study weighed less than 9 g and less than one percent weighed more than 80 g.

Another possible explanation of the underrepresentation of *R. megalotis* in the owl sample is that small skulls are more likely to be digested or degraded than larger skulls. Although we have no direct information on this point, the skulls of all the small mammals regardless of size, were in essentially the same condition.

Finally, it is possible that the live-trap samples do not reflect the composition of the small mammal community which the owls are encountering. For example, there may be greater spatial variation in the distribution of small mammal species than reflected in the two grids or the owls may be foraging in other habitats. However, we did observe extensive temporal variation in the live-trap samples and the diet of the owls did not reflect the composition found in any year of the live-trap data. Furthermore, we did not observe any *P. leucopus* (found principally in woody habitats, e.g., Clark *et al.*, 1987) in the owl's diet, suggesting that the owls were primarily foraging in brome fields, the only other major habitat type nearby.

In summary, the feeding habits of long-eared owls are quite different from that expected using the composition of the small mammal community. In particular, *P. maniculatus* is overrepresented in the owl diet while *R. megalotis* is underrepresented. These findings are consistent with differences in the relative behavior of *P. maniculatus* and *M. ochrogaster* and with a model that assumes the owls selectively feed on prey of an intermediate size.

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