WINTER FOOD OF THE SHORT-EARED OWL, *ASIO FLAMMEUS*, IN ILLINOIS

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ABSTRACT.—A series of 451 pellets and contents of three stomachs of short-eared owls collected in extensively cultivated areas of central Illinois during the winters of 1962-63, 1963-64 and 1964-65 contained remains of at least 1,013 small mammals, 12 birds and a few insects. *Peromyscus* sp. formed the major prey or about 70% of the total minimum number of animals eaten. Additional mammals included *Mus musculus*, *Microtus* spp., *Rattus norvegicus*, *Blarina brevicauda*, *Cryptotis parva* and *Mustela rixosa*. Juncos (*Junco hyemalis*), house sparrows (*Passer domesticus*), horned larks (*Eremophila alpestris*) and a red-winged blackbird (*Agelaius phoeniceus*) were also eaten. The use of pellets in studying food habits is discussed.

Analyses of owl pellets provide information on distribution and abundance of prey species as well as food habits of owls. Occasionally evidence of rare or not easily collected animals is found. The results of an analysis of owl pellet material representing winter food of short-eared owls from five roosting areas in central Illinois (Coles, McLean, and Woodford counties) are reported here. Additional information on food of these owls in this region occurs in reports by Cahn and Kemp (1930) and Graber (1962) who analyzed pellets from Champaign County.

ROOSTS AND PELLET ANALYSIS

Pellet material was collected during the winters of 1962-63, 1963-64 and 1964-65. All roosts were conifers near open fields where corn, soybeans, alfalfa, sweet clover and oats were principal crops. A few fields in each area had been plowed and a few others were in stubble. During the first winter, in Woodford County, one owl habitually roosted in a white spruce in a small cemetery immediately north of Minonk and another in one of a pair of large junipers bordering a small yard in an outlying residential area about a mile to the south. Most pellets from these areas were found beneath the preferred trees. During February and March of the second winter (1963-64), I found pellets under a dozen trees used as roosts by three owls in another cemetery about one mile east of Bloomington, McLean County.

Two additional samples of pellets were analyzed. Although small, they provided useful comparative data. Both were collected by competent, experienced, local birders. One sample, collected on March 1, 1964, represented food of an unusually large flock of short-eared owls that wintered in a small evergreen nursery near Mattoon, Coles County. I counted 40 owls in the area on March 4 but estimates by other observers ranged as high as 150 during mid-December when they first appeared (Irwin, 1964). The other sample, collected on February 1, 1965, came from the Minonk cemetery where I had previously collected; four short-eared owls were seen in and near the cemetery during the winter of 1964-65. Stomach contents of three owls were also analyzed. They were collected (one on November 19, 1960, and two on November 17, 1964) by Paul W. Parmalee and M. K. Hoffman of the Illinois State Museum staff from roosts in fields of corn stubble three and one-half miles east of Minonk. Species identified from bony remains in all pellets and the amounts of material collected from each roost are shown in Table 1.

TABLE 1.—Remains of Vertebrates in Short-eared Owl Pellets from Central Illinois.

PREY SPECIES	Woodford County Minonk Area					McLean County Bloomington Area	Coles County Mattoon Area	TOTALS FROM ALL AREAS
				3½ Miles East Minonk[1]				
	Cemetery (1962-63) 1 Owl	Cemetery (1964-65) 4 Owls	Residential (1962-63) 1 Owl	Nov., 1960 1 Owl	Nov., 1964 2 Owls	Cemetery (1963-64) 3 Owls	Tree Nursery (1963-64) 40-150 Owls	
Cryptotis parva	1	.....	.....	.....	.....	1	.....	2
Blarina brevicauda	1	.....	2	.....	.....	1	.....	4
Peromyscus sp. (Prob. *P. maniculatus*)	208	50	229	1	.....	178	55	721
Microtus sp. (Prob. *M. ochrogaster*)	3	2	10	.....	.....	22	45	82
Microtus pennsylvanicus	7	.....	24	.....	.....	28	.....	59
Mus musculus	24	17	18	1	2	80	1	143
Rattus norvegicus	.....	.....	.....	.....	.....	1	.....	1
Mustela rixosa	.....	.....	.....	.....	1	.....	.....	1
Eremophila alpestris	2	.....	1	.....	.....	.....	.....	3
Passer domesticus	4	1	1	.....	.....	.....	.....	6
Agelaius phoeniceus	.....	.....	.....	.....	1	.....	.....	1
Junco hyemalis	1	1	.....	.....	.....	.....	.....	2
Total Prey Items	251	71	285	2	4	311	101	1,025
No. of Pellets (and fragments)	85(1)	10(18)	56(99)	1	2	71(62)	23(26)	248(206)
Dry weight of pellet material (grams)	267.0	66.4	335.9	.....	.....	373.6	159.5	1,202.4
Ave. weight of entire pellets (grams)	3.12	3.57	3.14	.....	.....	3.49	4.00	.....
Ave. No. Prey Items per entire pellet	2.85	3.30	2.71	.....	.....	2.80	2.40	.....

[1] Stomach contents of three owls analyzed as unbroken pellets.

All pellet material was dried at room temperature for several weeks and then weighed. Linear dimensions of unbroken pellets collected in the Minonk cemetery during the first winter were also recorded. Although water content and changes in shape due to weathering, drying, etc. were unchecked, these measurements adequately expressed the more obvious differences in weight and size of the pellets. Each pellet was placed in a shallow tray of water; when soaked, the softened pellet was removed and carefully teased apart with fine forceps and a needle probe. This method is reliable and moistened pellets are easily dissected. Major long bones, skulls and lower jaws of the mammals and/or major skeletal elements of the birds were removed, identified and counted.

Reference skeletons in the Illinois State Museum were utilized in the identification of remains. Meadow voles (*Microtus pennsylvanicus*) were separated from other voles by differences in last upper molars (described by Hoffmeister and Mohr, 1957, p. 129-130). Since size and shape of unbroken adult skulls are the major diagnostic characters, separation of *Peromyscus maniculatus* (prairie deer mouse) from *P. leucopus* (woodland white-footed mouse) and *Microtus pinetorum* (pine vole) from *M. ochrogaster* (prairie vole) proved infeasible; all skulls of these animals were broken and represented varying ages. Prairie deer mice and prairie voles, however, are probably more common in the hunting areas of the owls. While both species were abundantly represented in pellets collected in Champaign County by Cahn and Kemp (1930) and Graber (1962) remains of white-footed mice and pine voles occurred in only a few of the pellets (those collected by Graber).

Computations and Analysis of Data. Two methods of determining relative abundance of prey species in pellet material were used: (1) In establishing the content of entire or unbroken pellets, the completeness of remains was considered; for example, a pellet containing four nearly complete or four complete mouse skeletons, plus an extra lower jaw or a long bone, contained four mice. (2) In an entire batch of both broken and unbroken pellets, the highest total of skulls (occasionally pairs of unmatched maxillary bones counted as single skulls) or lower jaws (left and right counted separately) indicated the minimum number of animals eaten.

Graber (1962), Weller, Fredrickson and Kent (1963) and others have used another computation where the number of pellets containing a certain prey species is divided by the total number of pellets examined, the figure when multiplied by 100 representing a "per cent frequency of occurrence." While probably not as accurate in reflecting species composition of the prey population as a minimum numbers method, the frequency of occurrence method does provide, according to Weller, et al. (1963), an indication of regularity with which an animal was taken. When applied to my data on entire pellets, no significantly different interpretations were noted, but the method should be used with caution for it does not properly include the important contents of broken pellets.

Results and Discussion

Food. The pellets and stomachs contained remains of 1,025 mammals and birds and four or five insects (Table 1). Rodents of at least five species comprised 98.1% of the prey. Of these, white-footed or prairie deer mice (*Peromyscus* sp.) formed the major prey in all areas or about 70% of the total minimum number of animals eaten. Voles (*Microtus* spp.) were also taken in all areas during the three winters but their importance varied from about 3% to 12% of the animals eaten in the Minonk area to over 44% in the Mattoon area where a minor irruption of mouse populations had apparently occurred. House mice (*Mus musculus*) were also taken in all areas and a juvenile Norway rat (*Rattus norvegicus*) was eaten in or near the Bloomington cemetery. A few least shrews (*Cryptotis parva*) and short-tailed shrews (*Blarina brevicauda*) were taken by owls near Minonk and Bloomington and a nearly complete, partially digested carcass of a least weasel (*Mustela rixosa*), a rare mus-

telid in Illinois, was found in the stomach of an owl collected 3½ miles east of Minonk.

Bones of two juncos (*Junco hyemalis*), six house sparrows (*Passer domesticus*) and three horned larks (*Eremophila alpestris*) occurred in pellets collected in the vicinity of Minonk and remains of a redwinged blackbird (*Agelaius phoeniceus*) were found in one owl's stomach. These species occur as fall migrants and/or winter residents in considerable numbers in the area.

Pellets collected in the Minonk cemetery on December 2, 1962, contained traces of a few large grasshoppers and at least two beetles. Vegetable remains included a soybean in a Minonk cemetery pellet, a corn seed in a Bloomington cemetery pellet and 105 seeds of prickly sida (*Sida spinosa*) in a pellet from the Minonk residential area; all were probably being eaten or transported by rodents when ingested by the owls.

Weather, Roost Selection and Prey. Periodic collection of pellets during the first winter near Minonk facilitated association of one owl's roosting habits and catch with changing weather conditions as shown in Figure 1. During one particularly severe period, from January 17 to February 1, when a deep snow cover and extremely low temperatures prevailed, nearly continuous use of one roost (a thickly foliaged spruce) was observed. This shelter-seeking behavior has been discussed by Hendrickson and Swan (1938), Banfield (1947) and Craighead and Craighead (1956, p. 96). The singularly heavy predation on *Peromyscus* that occurred during this period may be related to the observation (cited authors and others) that white-footed and deer mice travel exposed on the surface of a deep snow while voles burrow beneath in relative protection.

Short-eared owls are well known for their predation on *Microtus*

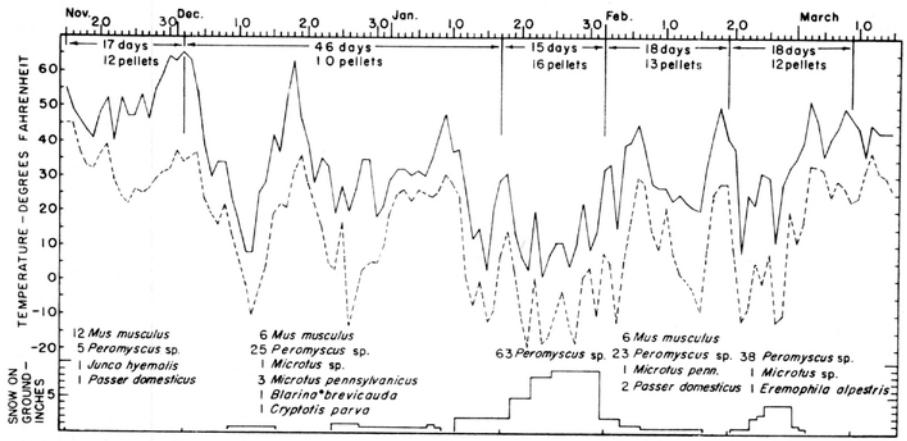

FIGURE 1.—Remains of vertebrates in pellets ejected by one short-eared owl during the winter of 1962-63 in a cemetery near Minonk, Illinois. Of 86 pellets collected, these 63 were found beneath one tree. The solid line represents maximum temperatures and the broken line the minimum temperatures. Depth of snow is also shown.

(Bent, 1938, p. 174; and many others). Therefore the importance of *Peromyscus* in the winter diet of short-eared owls in Illinois as indicated here may be questioned since a higher proportion of *Microtus* might have occurred if pellets ejected in the open fields had been collected. However, pellets collected from open areas in Champaign County by Cahn and Kemp (1930) and Graber (1962) also contained proportionately higher numbers of *Peromyscus* than that commonly recorded from other parts of North America.

Size and Contents of Entire Pellets. Average number of prey items in and weights of unbroken pellets are shown in Table 1. Irregular shapes and compact texture of pellets agreed with descriptions by Stegeman (1957), Reed (1959), Short and Drew (1962) and others. Variation in size was obvious even in small samples of pellets. The average dimensions of the pellets from Minonk were 43.8 mm. by 18.9 mm.; they ranged from 12 to 25 mm. wide and 15 to 84 mm. long. Differences in average number of prey items per pellet depend on size of major prey; where larger prey is involved, averages are smaller (Weller, et al., 1963). The heaviest pellets and those with the lowest average number of prey items were from the Mattoon area where larger mice (*Microtus*) were eaten.

Considering only the smaller rodents (*Mus, Microtus* and *Peromyscus*) as prey items, 39 unbroken pellets from all roosts during all winters contained one, 66 contained two, 52 contained three, 40 contained four, 25 contained five, 4 contained six and 6 contained seven. A few of the pellets containing remains of seven rodents included at least four species. Two of these large pellets contained complete skeletons of seven mice.

Irregularities (missing or extra bones) in short-eared owl pellets have been stressed in many published accounts. While I noted some evidence of this, I found a suprisingly high degree of regularity. The completeness of bony remains (humerii, ulnae, radii, innominate bones, femora, tibiofibulae) in all unbroken pellets suggested that 82% of the mice were consumed in their entirety. If greater care could have been exercised in dissection, the percentage would possibly be even higher. A few radii, ulnae and innominate bones (the latter are unfused in younger mice and hence are occasionally missed) were found after remains of 10 dissected pellets were treated with a potassium hydroxide solution (see Connell, 1962). Extra or missing elements in some pellets are often attributed to the owl's habit of tearing prey apart, but other factors are apparently also involved: Chitty (1938) found small bones sometimes remaining in the stomach after pellet ejection and Short and Drew (1962) observed production of several pellets with irregular contents after a single feeding. Weathering and handling may also cause a loss or gain of bones and further complications arise if parts of broken pellets are counted as entire pellets.

I found no evidence to corroborate the reports by Moon (1940), Kirkpatrick and Conway (1947) and Short and Drew (1962) who found limited amounts of osseous material, extremely efficient bone digestion and

many "thoroughly pulverized" bones, respectively. Working with a captive owl, Chitty (1938) noted a "remarkably low" calcium intake; bone material was well preserved. The bones in pellets of short-eared owls are generally considered an excellent source of data on food habits (Errington, 1930; Craighead and Craighead, 1956; and many others). Differences in age of owls may explain these inconsistent findings. Immature great horned and barred owls, with greater calcium needs, seemingly retain residues of meals for longer periods with a higher level of bone digestion than older birds (Errington, 1930; 1932) and their stomach acidity also differs, being distinctly acidic in younger birds and approaching neutrality in adults (Grimm and Whitehouse, 1963 and cited references).

Analysis of Broken Pellets. Reed (1959) and Short and Drew (1962) suggested that pellets containing *Peromyscus* were not as durable as those with *Microtus*, possibly due to a difference in binding qualities of fur. My observations agree with this but also indicate that pellets containing birds and house mice are likewise more fragile. Broken pellets should be analyzed along with entire pellets for the most reliable data. I found remains of two of the four *Blarina*, one of the two juncos, two of the six house sparrows and one of the three horned larks in broken pellets. Percentages of *Mus* in broken pellets were consistently higher than corresponding figures for entire pellets. In two batches, remains of four species (shrews and birds) were present only in broken pellets. A few workers have rejected broken pellets or have chosen for analysis a sample of pellets (presumably those not broken) from a large batch. This procedure may introduce a bias and considering the many unknown factors already associated with a pellet analysis and its interpretation—a bias of some importance.

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