FOOD HABITS OF BADGERS IN EAST CENTRAL MINNESOTA

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Previous food habit studies of badger (*Taxidea taxus*) in Michigan (Dearborn 1932), Iowa (Errington 1937, Snead and Hendrickson 1942), South Dakota (Jense 1968), Utah (Lindzey 1971), Alberta (Salt 1976), and Idaho (Mesick and Hornocker 1981) emphasized the importance of fossorial, semifossorial, and burrow-visiting mammals. In addition, seasonal variation in diets have been noted (Snead and Hendrickson 1942, Jense 1968, Salt 1976). The objectives of my study were to examine the food habits of badgers in east central Minnesota.

STUDY AREAS

This study was conducted at the Cedar Creek Natural History Area (CCNHA) and at the Sherburne National Wildlife Refuge (SNWR) in Minnesota. CCNHA is 48 km north of Minneapolis, in Anoka and Isanti counties. SNWR is 48 km west of CCNHA and 70 km northwest of Minneapolis. Both study areas are within a region physiographically known as the Anoka Sand Plain, a 2,200 km² triangular alluvial sand plain of glacial origin (Cooper 1935). The topography is flat to gently rolling. Both study areas include tall grass prairies, cultivated fields, deciduous and mixed coniferous uplands, marshes, creeks, rivers, and numerous pothole lakes. At both areas, wooded uplands, wetlands, and fields occur in approximately equal proportions.

METHODS

Burrows and sites of predation by radio-marked badgers were examined periodically for scats as were dens located from the ground and from an airplane. Badger scats were identified using any 2 or more of the following criteria: location

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on or near the perimeter of a mound of a badger-like excavation, presence of badger tracks near scat, presence of a radio-marked badger near site of scat, and diameter and length of scat. Scats of differing ages were found at frequently used burrows. Age of the scat was determined by comparison with known-age scats obtained from radio-marked badgers. Scats older than 3 weeks were categorized by season of occurrence as spring, summer, or autumn; others were categorized by month. Scats were placed in envelopes, oven-dried, and weighed.

Collections were made at CCNHA during summer and autumn 1972 and from June 1973 until November 1975. In 1975, scats were collected at SNWR from mid-July through October. Scats were obtained from an estimated 3 badgers/year at CCNHA and 4 badgers at SNWR.

Because of the manner in which scats were found and the frequent movements of badgers from den to den (Sargeant and Warner 1972, Lampe and Sovada 1981), it is unlikely that consecutively produced scats were obtained. Therefore, it is not likely that single prey items contributed to more than 1 collected scat. Also, it is assumed that the presence of a prey species in 1 scat did not influence its appearance in any other.

Scats were soaked in water and searched manually for teeth. Teeth were identified and their position in the tooth row was determined. In approximately 9% of the collected scats, no teeth or other identifiable skeletal material could be found. For these scats, prey identification was based on comparisons of color, size, and cuticular formation of selected hairs with a reference collection. Unidentifiable teeth, mostly small rodent incisors, were recorded as "unidentifiable rodents". Three scats were not included in the analysis. One collected in December contained only voles. Two scats found in June had no identifiable components.

Carcasses of 16 badgers trapped within 30 km of CCNHA and SNWR were obtained in October and November 1975 and 1976. Gastrointestinal contents were examined using the same methods as for scats. Differences of prey occurrence in scats were compared statistically with a goodness-of-fit test for binomial proportions, using an alpha of 0.05.

RESULTS

Prey species in a collection of 167 scats and 16 stomach contents varied (Table 1). Of these species, 5 mammals, 1 bird, 2 reptiles, and 1 insect have not been reported previously in diets of badgers. Among all mammals, 3 were fossorial or semifossorial, 9 were terrestrial, 2 were semiarboreal, and 1 was semiaquatic. Remnants of hymenopterans were present in 10 scats collected during summer. Three were identified as *Bombus*, 1 was an ichneumonid, and the rest were small apids.

Seasonal Variation

At CCNHA, scats and stomach contents were grouped by season. Six species of mammals occurred in each seasonal sample (Table 2). Four species were eaten only during summer and 1 species occurred only in autumn. *Geomys bursarius* occurred most frequently in each season although its occurrence in spring was only slightly greater than the southern red-backed vole (*Clethrionomys gapperi*) and eastern chipmunks (*Tamias striatus*). In summer and autumn, no other species approached the occurrence of pocket gophers in the diet.

Diversity of prey in the diet was greatest during summer. Total number of

Table 1. Prey species of badgers[a] in east central Minnesota.

Mammals
Masked shrew (*Sorex cinereus*)[b]
Short-tailed shrew (*Blarina brevicauda*)[b]
Eastern cottontail
Eastern chipmunk[b]
Woodchuck
Thirteen-lined or Franklin's ground squirrel
Red squirrel (*Tamiasciurus hudsonicus*)
Plains pocket gopher
White-footed mouse or deer mouse
Southern red-backed vole[b]
Meadow vole or prairie vole
Muskrat[b]
Meadow jumping mouse (*Zapus hudsonius*)
Rat (*Rattus norvegicus*)
Birds
Red-winged blackbird (*Agelaius phoenicus*)[b]
Reptiles
Northern prairie skink (*Eumeces septentrionalis*)[b]
Bullsnake (*Pituophis* sp.)
Garter snake (*Thamnophis* sp.)
Turtle eggs (*Chelydra* or *Chrysemys*)
Insects
Orthoptera, Acrididae
Coleoptera, Scarabidae
Coleoptera, Carabidae
Hymenoptera, Apidae
Hymenoptera, Ichneumonidae[b]

[a] Sample includes 167 scats and 16 stomach contents.
[b] Not previously reported in the diet of badgers.

Table 2. Seasonal comparison of badger food habits at Cedar Creek Natural History Area, east central Minnesota.

	Spring (N = 10) (%)	Summer[a] (N = 99) (%)	Autumn[b] (N = [illegible]) (%)
Masked shrew		1	
Short-tailed shrew		1	
Eastern chipmunk	40[c]	8	5
Woodchuck		2	2
Franklin's or 13-lined ground squirrel		5	5
Red squirrel			1
White-footed or deer mouse	20[d]	2	9
Southern red-backed vole	40[c]	4	9
Meadow or prairie vole	10	8[e]	21
Plains pocket gopher	50[d]	85	76
Meadow jumping mouse	10	3	2
Rat			2
Unidentified rodent	40[c]		2
Avian	10	3	2
Reptilian		6[f]	
Insect		11[g]	7
Vegetation	10	4	9

[a] Sample includes 96 scats and 3 stomach contents
[b] Sample includes 31 scats and 13 stomach contents.
[c] Frequency of occurrence in spring is different ($P < 0.05$ [illegible] summer or autumn
[d] Frequency of occurrence in spring is different ($P < 0.05$ [illegible] summer.
[e] Frequency of occurrence in summer is different ($P < 0.05$ [illegible] autumn
[f] Frequency of occurrence in summer is different ($P < 0.05$ [illegible] spring and autumn.
[g] Frequency of occurrence in summer is different ($P < 0.05$ [illegible] spring

mammalian species in the diet during spring, summer, and fall was 6, 11, and 9, respectively.

The multiple occurrence of pocket gophers in badger scats indicated a seasonal trend. By identifying bones and teeth within each scat, the minimum number of prey individuals occurring in the scat could be determined. In June and July (Table 3), most scats with pocket gopher material contained 1 individual with no scats containing 3 or more pocket gophers. However, in August and September the occurrence of more than 1 pocket gopher per scat increased. The occurrence of pocket gophers during June and July was different ($P < 0.05$, chi-square goodness-of-fit test) from that in August and September.

The occurrence of 3 small mammal species (*Peromyscus* sp., *Clethrionomys gapperi*, and *Microtus* sp.) in the diet of badgers was clumped. Their simultaneous presence in a single scat was different ($P < 0.05$, goodness-of-fit to Poisson distribution) from random.

Locality Variation

At CCNHA and SNWR, badger diets included 7 and 8 species of mammals, respectively (Table 4). Badgers at each site ate prey not found in the diet at the other site; at CCNHA badgers ate woodchucks

Table 3. Occurrence of pocket gophers in badger scats at Cedar Creek Natural History Area, east central Minnesota.

	No. scats examined	No. scats containing pocket gophers	Pocket gophers/scat (%)			
			1	2	3	>3
Jun	27	23	82.6	17.4	0	0
Jul	10	8	87.5	12.5	0	0
Aug	19	18	66.7	27.8	5.6	0
Sep	16	15	26.7	26.7	33.3	13.3

Table 4. Comparison of badger food habits at Cedar Creek Natural History Area and Sherburne National Wildlife Refuge, July through October.

	CCNHA (N = 97) (%)	P	SNWR (N = 26) (%)
Masked shrew	1		
Short-tailed shrew	1		4
Eastern cottontail			4
Eastern chipmunk	4		4
Woodchuck	4	<0.01	
Franklin's or 13-lined ground squirrel	5		4
White-footed or deer mouse			4
Southern red-backed vole	1	<0.01	15
Meadow or prairie vole	7	<0.01	31
Plains pocket gopher	89		81
Jumping mouse	2		8
Muskrat		<0.01	12
Unidentified rodent	4		8
Avian	2		
Reptilian	4		4
Insect	18	<0.01	50
Vegetation	2	<0.05	12

(*Marmota monax*) and ground squirrels (*Spermophilus* sp.), whereas badgers at SNWR ate muskrats (*Ondatra zibethicus*) and eastern cottontails (*Sylvilagus floridanus*). *Peromyscus* were present in badger diets at CCNHA although only in stomach contents or infrequently in scats in spring or late autumn. Pocket gophers were the most frequently occurring prey at both localities. Analysis of frequency of occurrence of prey indicated that scats for SNWR included more ($P < 0.05$) *Clethrionomys*, *Microtus*, insects, and plant material, whereas scats from CCNHA included more ($P < 0.05$) *Marmota* and *Spermophilus*.

DISCUSSION

Geomys bursarius was the major prey during all time periods analyzed at both localities. High occurrence of pocket gophers in the diet of badgers has not been reported previously. Although badgers in Iowa (Snead and Hendrickson 1942) and South Dakota (Jense 1968) eat pocket gophers, they are a minor dietary component. The northern pocket gopher (*Thomomys talpoides*) is a major food item of badgers in Alberta during midsummer (Salt 1976).

Food habits of badgers in Iowa (Errington 1937, Snead and Hendrickson 1942) and South Dakota (Jense 1968) suggest that seasonally abundant small mammals are important dietary components. Small mammal populations at CCNHA, although variable, peaked in autumn (Birney et al. 1976); such availability seemingly would warrant opportunistic feeding and a corresponding increase in prey diversity. However in east central Minnesota, prey diversity in badger diets was greatest in summer and decreased in autumn. Reduced diversity was partially due to the disappearance of insects and reptiles in autumn. However, the paradoxical absence from the diet of certain small mammal prey species may be explained by a change in activity by badgers.

Studies of badgers in Minnesota (Sargeant and Warner 1972, Lampe and Sovada 1981) indicate an abrupt shift in late summer or early autumn from frequent movements to sedentary behavior. By becoming sedentary and remaining in 1 meadow for many days, a badger could spend its entire activity period hunting pocket gophers, which are plentiful in

the area. This would account for the increase in multiple occurrence of pocket gophers in the diet during August and September (Table 3). It also would contribute to rapid weight gain during autumn (Lampe and Sovada 1981, Mesick and Hornocker 1981), an adaptation for winter when preferred fossorial prey are unavailable for extended periods. However, during sedentary activity small mammal prey normally encountered opportunistically would be captured less often thus causing the apparent decrease in prey diversity.

The clumped occurrence of mice (*Peromyscus* sp., *Clethrionomys gapperi*, and *Microtus* sp.) in badger scats implies that badgers fed on these species during the same foraging period. However, their limited occurrence in the diet suggests that badgers relied on other prey, such as pocket gophers.

Differences in the diet of badgers at the 2 study areas emphasize the opportunistic nature of badger foraging. Muskrats were present in the diet of badgers at SNWR during autumn, a season when muskrats disperse on land (Stolen 1974). SNWR supports more muskrats because of more acres of marshland. Although badgers are good swimmers (Wood 1921, Hall 1946:221, Duebbert 1967) and because muskrats were not present in the diet at other times of the year or at CCNHA, badgers at SNWR probably preyed opportunistically on this species.

Opportunism probably was a factor in the capture of other prey, particularly species that frequent old badger excavations. Skinks and snakes may be obtained by badgers in this manner. I frequently observed these reptiles at old diggings and occasionally a skink would flee into the burrow. Snead and Hendrickson (1942) noted that thirteen-lined ground squirrels (*Spermophilus tridecemlineatus*) often dug burrows inside old badger excavations in Iowa, and I observed this at CCNHA. Hymenopterans sometimes build nests in badger burrows and revisitation of such burrows by badgers may be an important means of encountering bees. However, predation upon bees was noted at locations other than at old burrows. Examinations of hunting excavations of badgers twice revealed vespid wasp colonies wherein large nests had been opened but not completely destroyed. An adult male badger killed by a car in August 1975 had 129 *Bombus* larvae in its stomach. Such nonmammalian prey may provide valuable nutritional resources.

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LITERATURE CITED

BIRNEY, E. C., W. E. GRANT, AND D. D. BAIRD 1976. Importance of vegetative cover to cycles of *Microtus* populations. Ecology 57:1043–1051.

COOPER, W. S. 1935. The history of the Upper Mississippi River in late Wisconsin and postglacial time. Minn. Geol. Surv. Bull. 26. 116pp.

DEARBORN, N. 1932. Foods of some predatory furbearing animals in Michigan. Univ. Michigan Sch. For. Cons. Bull. 1. 52pp.

DUEBBERT, J. F. 1967. Swimming by a badger. J. Mammal. 48:323.

ERRINGTON, P. L. 1937. Summer food habits of the badger in northwestern Iowa. J. Mammal. 18:213–216.

HALL, E. R. 1946. Mammals of Nevada. Univ. California Press, Berkeley. 710pp.

JENSE, G. K. 1968. Food habits and energy utilization of badgers. M.S. Thesis. South Dakota State Univ., Brookings. 39pp.

LAMPE, R. P., AND M. SOVADA. 1981. Seasonal var-

ation in home range of a female badger (*Taxidea taxus*). Prairie Nat. 13.55–58.

LINDZEY, F. G. 1971. Ecology of badgers in Curlew Valley, Utah and Idaho with emphasis on movement and activity patterns. M.S. Thesis. Utah State Univ., Logan. 50pp.

MESICK, J. P., AND M. G. HORNOCKER. 1981. Ecology of the badger in southwestern Idaho. Wildl. Monogr. 76. 53pp.

SALT, J. R. 1976. Seasonal food and prey relationships of badgers in east-central Alberta. Blue Jay 34:119–122.

SARGEANT, A. B., AND D. W. WARNER. 1972. Movements and denning habits of a badger. J. Mammal. 53:207–210.

SNEAD, E., AND G. O. HENDRICKSON. 1942. Food habits of the badger in Iowa. J. Mammal. 23:380–391.

STOLEN, R. D. 1974. Fall and winter movements and activity of muskrats in east-central Minnesota. M.S. Thesis. Univ. Minnesota, St. Paul. 75pp.

WOOD, N. A. 1921. The badger as a swimmer. J. Mammal. 2:170.

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