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ECOLOGICAL NOTES ON THE PREY SELECTED BY A BARN OWL

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A small Washingtonia palm (*Washingtonia filifera*) on the University Farm at Davis, California, has served as a daytime roosting site for Barn Owls (*Tyto alba*) for a number of years. Only one owl used the roost from January, 1942, through January, 1943, as indicated by repeated observations and by the accumulation of pellets at the rate of approximately one per day. Pellets collected beneath the tree during this period provided the material for the present paper.

The hunting range of the owl, determined by a number of night observations, seemed to cover an area of about 165 acres, of which 140 were in open fields planted largely to grain and alfalfa and the remaining 25 were in woodland, primarily of cottonwood, valley oak and willow, along the banks of Putah Creek (fig. 1). Shrubby growth was sparse in the wooded areas and absent from the fields. Annual grasses and weeds were luxuriant in winter and spring, sparse in summer and autumn.

Weather conditions for the period of study were characteristic of the locality. Mild winter temperatures prevailed; the mean for December, 1942, the coldest month, was 46.3°F., and the lowest temperature recorded was 27°F. Summer temperatures reached a maximum of 111°F. at noon, but hot days were generally offset by cool nights, and the mean for July, the warmest month, was only 76.4°F. The total precipitation of 18.35 inches recorded for 1942 somewhat exceeded the average 15.88 inches of a 40-year record. The summer months were typically dry; only 0.02 inches of the total precipitation fell between May 26 and October 11. Annual vegetation along the creek banks became dry and brown by June but in the open fields was kept green throughout the summer by surface and overhead irrigation.

Methods.—All pellet material was collected under the palm tree roost and taken to the laboratory for detailed analysis. Early in January, 1942, the ground was cleared of all previous material, and fresh pellets were then allowed to accumulate for two months, at the end of which period they were collected *en masse*. This was followed by daily pellet collections for a period of one month. Regular alternation of these two collecting methods provided a daily series and a bulk collection of pellets for each of the four quarters of the year and gave a fairly continuous food record of the owl throughout the year.

The daily collections were analyzed as individual pellets in dry condition, while the mass collections were treated with dilute ammonium hydroxide, washed carefully, and analyzed in bulk. Identification of food items was based upon the bone and chitin content of the pellets and was checked by both of us, first independently, then together.

Food items.—Pellets were occasionally broken or poorly formed, making exact enumeration impossible, but a total of approximately 280 pellets was collected from January, 1942, to January 19, 1943 (table 1), 167 in the bulk collections, 113 in the

daily series. These contained 749 separate food items (individual animals) belonging to 15 different species. The number of items per pellet averaged 2.7.

When daily collections were made, a single pellet was taken on 81 occasions, two pellets in 7 cases, three in 6 cases, and no pellets in 24 cases. Single day collections contained from 1 to 8 or an average of 2.4 vertebrate items representing from 1 to 5 species (table 2). Five different species were included in one case, four species were found in 7 cases, three species in 23 cases, two species in 46 cases, and a single species in 18 cases.

Mammals comprised 715 separate food items, or 95.5 per cent of the total food. All of the small terrestrial species of the area were represented, with the exception of the ground squirrel (*Citellus beecheyi*). House mice (*Mus musculus*), pocket gophers

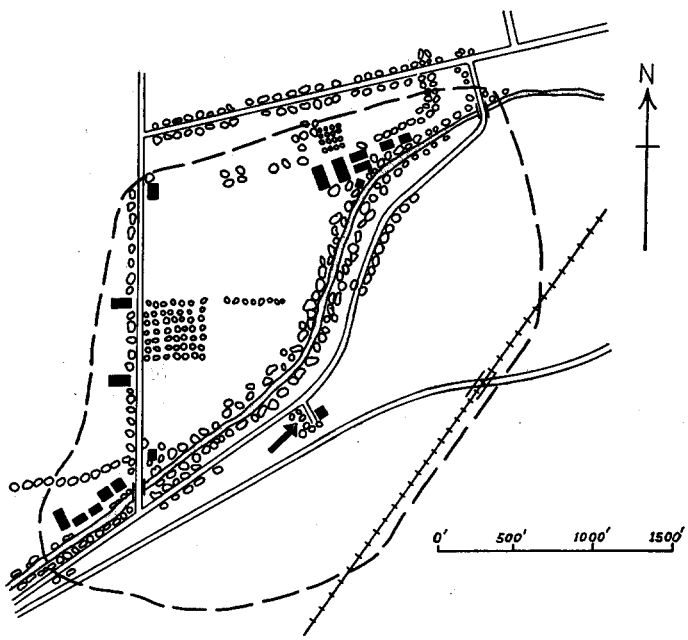

Fig. 1. Map showing approximate boundaries (dashed line) of hunting range of Barn Owl at Davis, California. Roosting site in palm indicated by arrow.

(*Thomomys bottae*), meadow mice (*Microtus californicus*), and deer mice (*Peromyscus maniculatus*), the four most numerous mammals on the area, contributed 94.8 per cent of the mammalian items and 90.6 per cent of the total of all items. The scarcer and more localized harvest mice (*Reithrodontomys megalotis*), roof rats (*Rattus rattus*) and shrews (*Sorex* sp.) were represented by 33 individuals. Four skulls of jack rabbits (*Lepus californicus*) were also found in the pellets, all of them belonging to very small, juvenal animals; adult jacks, numerous in the area, were probably immune to Barn Owl attack because of their size.

Six species of birds contributed 19 items or 2.5 per cent of the total. The Savannah Sparrow (*Passerculus sandwichensis*), a common wintering bird in the Davis area, was the only species represented in appreciable numbers—11 specimens. Crowned sparrows (*Zonotrichia leucophrys* and/or *coronata*) contributed 3 specimens, and the Mockingbird (*Mimus polyglottos*), Pipit (*Anthus spinoletta*), Western Meadowlark (*Sturnella neglecta*), and House Finch (*Carpodacus mexicanus*) were each represented by a single specimen.

The only invertebrate items found in the pellets belonged to a species of Jerusalem or sand cricket (*Stenopelmatus*). Of the 15 individuals represented in the total, 8 were included in a single day's collection.

Habits and habitat relationships of prey species.—Of the 749 animals recovered from the pellets, 730 or 97.5 per cent belonged to nocturnally active species. All of the mammals taken were nocturnal; the ground squirrel, the only resident rodent not represented, is almost exclusively diurnal in habit. The 19 specimens of diurnal animals were all birds belonging to species which roosted at night on the owl's feeding range.

All habitat types in the area contributed to the owl's bill of fare. Animals typically associated with wooded or brushy cover comprised 57 per cent of the total food items. These included the shrew, deer mouse, harvest mouse, house mouse, roof rat, and, among the birds, the Mockingbird, House Finch, and crowned sparrows. Open field habitats, more than six times as extensive on the owl's range, contributed the remaining 43 per cent of the items. These included the pocket gopher, meadow mouse, jack rabbit, and the Pipit, Western Meadowlark and Savannah Sparrow which commonly roosted at night in the grassy fields.

In the 94 daily collections, inhabitants of wooded and open habitat types were taken together in 39 instances, 29 collections contained field dwellers only, and 26 had woodland types only. This appeared to be a random distribution, and there was no sequence of occurrence to suggest seasonal or other regulated changes in the choice of hunting grounds.

Fluctuations in relative abundance of prey species.—Pronounced changes in the relative abundance of prey species in the pellets occurred during the period of study (table 3, fig. 2). Some of these appeared to be of seasonal origin; others were probably of a longer-term nature. Animals of woodland and woodland border habitats, notably house mice and deer mice, were heavily represented in the first quarter of the study period but were

Table 1

Food Items in Barn Owl Pellets

	Number of items	Per cent of total
Mammals		
Mus	283	37.8
Thomomys	193	25.8
Microtus	110	14.7
Peromyscus	92	12.3
Reithrodontomys	19	2.5
Rattus	8	1.1
Sorex	6	.8
Lepus	4	.5
Total mammals	(715)	(95.5)
Birds		
Passerculus	11	1.5
Zonotrichia	3	.4
Mimus	1	.1
Anthus	1	.1
Sturnella	1	.1
Carpodacus	1	.1
Unidentified	1	.1
Total birds	(19)	(2.5)
Insects		
Stenopelmatus	15	2.0
Total insects	(15)	(2.0)
Total food	749	100.0

Table 2

Contents of Barn Owl Pellets Collected Daily for Monthly Periods at Different Seasons of the Year

Beginning of collection period	Days of collection period																													
March 17, 1942	1				5					10					15					20					25					30	
Thomomys	..	..	..	..	2	..	..	1	1	..	1	1	..	1	1	..	..	..	..	..	..	..	..	..	..	1	1	..	1	1	..	1
Microtus	..	..	..	..	1	..	..	1	..	..	..	..	..	1	..	..	..	..	..	..	..	1	..	2	..	..	1	..	..	1	..	1
Peromyscus	..	..	5	..	..	7	3	..	1	..	..	1	2	..	..	..	1	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..
Mus	5	..	2	..	..	1	1	1	2	3	..	..	..	..	1	4	1	3	1	4	..	..	..	..	..	..	..	..	..	..	..	..
Reithrodontomys	1	..	..	.	..	..	2	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Lepus	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Passerculus	..	..	..	..	..	..	..	..	1	..	1	1	1	..	..	..	..	..	1	..	..	1	..	..	..	..	..	..	..	..	..	..
Number pellets	1	0	1	x	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	0	1	1	0	1	1	0	1
June 17, 1942																																
Thomomys	..	..	1	1	2	..	..	1	1	..	..	1	..	..	..	..	1	3	1	1	1	..	1	1	..	1	1	..	2	4	2	4
Microtus	2	..	1	..	..	2	4	1	1	3	1	2	3	1	..	..	..	..	2	1	..	..	..	..	..	2	..	..	..	1	..	..
Peromyscus	..	..	1	1	..	1	..	..	..	..	..	1	3	..	..	..	..	..	2	1	..	1	2	..	..	..	..	2	..	..	..	1
Mus	1	..	1	..	..	..	..	..	..	..	..	4	..	3	..	1	..	..	..	..	..	1	2	1	2	..	5	2	1	..	1	..
Rattus	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Reithrodontomys	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	2	..	..	..	..	1	..	..	..	1	
Stenopelmatus	..	..	..	1	..	..	..	..	..	1	..	..	1	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..
Number pellets	1	0	3	1	1	2	1	1	1	3	1	2	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	2	2	1	1	
September 23, 1942																																
Thomomys	..	..	2	..	1	1	..	1	..	..	..	..	..	1	1	..	..	..	..	..	2	..	1	..	..	..	2	..	..	1	1	..
Microtus	..	1	1	..	..	1	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2	..
Peromyscus	1	..	1	..	1	..	1	..	..	..	..	..	1	..	..	2	..	1	..	1	..	1	1	..	..	..	..	..	..	..	1	..
Mus	3	2	4	..	..	1	2	..	3	3	..	3	1	1	3	1	1	..	2	1	1	1	..	..	1	..	..	..	..	..	..	..
Rattus	..	..	..	..	..	..	..	..	..	..	1	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Reithrodontomys	..	..	..	..	1	..	2	..	..	..	..	1	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..
Sorex	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2	..	..	..	..	..	..	..	..	..	..	..
Mimus	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..
Unidentified	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Stenopelmatus	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..
Number pellets	1	2	2	0	1	1	1	1	1	1	1	1	1	1	1	1	x	1	1	1	1	0	0	1	3	x	0	1	2	0		
December 19, 1942																																
Thomomys	..	..	..	..	..	1	..	1	..	1	..	1	2	..	..	1	..	..	..	2	3	..	..	..	..	..	2	1	1	..	1	1
Microtus	..	..	..	..	..	..	..	1	1	..	..	..	..	..	..	..	..	1	..	3	2	..	..	..	..	..	1	..	..	..	1	1
Peromyscus	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	3	..	..	..	
Mus	..	..	3	..	..	1	..	..	..	1	..	2	..	..	..	..	..	..	..	1	..	..	..	..	..	..	1	1	..	..	..	
Reithrodontomys	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Lepus	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1
Anthus	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..
Passerculus	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..
Stenopelmatus	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	8	..	..	..	..	..	..	..	..	..	..	..	..	..
Number pellets	0	x	1	0	0	1	x	1	1	1	0	1	1	x	0	1	0	1	0	3	3	0	x	0	0	0	1	1	3	x	1	1

x = No collection made.

much reduced in the last. The decline in house mice corresponded roughly with a marked reduction of this species in the area as indicated by live-trapping studies (Evans and Storer, 1944). On the other hand, pocket gophers, living in the open fields, rose steadily from less than 10 per cent of the food items in the first quarter to nearly 50 per cent in the last. Increased surface activity of gophers was observed in the late autumn. Meadow mice, also field dwellers, likewise reached their maximum representation in the late autumn and early winter.

Larger mammal species occurred infrequently in the pellets. Of the 8 roof rats taken, 7 were young individuals and were caught between July and September when young rats were most frequently captured in live-traps. Young jack rabbits were found in the

pellets principally in April and May when they were most in evidence in the fields; a single specimen was taken in a January pellet.

Birds occurred most frequently in the pellets in winter and early spring when field-roosting species, notably the Savannah Sparrow, were numerous in the area.

Table 3

Food Items Taken by a Barn Owl

	Jan. to April 17	April 18-July 17	July 18-Oct. 23	Oct. 24-Jan. 19	Total
Mammals					
Thomomys	18	41	59	75	193
Microtus	17	41	11	41	110
Peromyscus	36	22	27	7	92
Mus	102	75	78	28	283
Rattus	0	1	7	0	8
Reithrodontomys	6	6	6	1	19
Lepus	2	1	0	1	4
Sorex	0	1	3	2	6
Birds					
Mimus	0	0	1	0	1
Anthus	0	0	0	1	1
Sturnella	1	0	0	0	1
Carpodacus	0	0	1	0	1
Passerculus	7	2	0	2	11
Zonotrichia	0	1	0	2	3
Unidentified	0	0	1	0	1
Insects					
Stenopelmatus	2	3	2	8	15
Number food items	191	194	196	168	749
Number pellets	60	64	85	71	280

Day-to-day fluctuations in occurrence of the various food items (table 2) were compared with weather data for the corresponding periods, but no correlation was obtained.

Total food consumption.—That bones of small birds and mammals are well preserved in the process of owl pellet formation has been shown by various authors (Errington, 1930; Chitty, 1938; Glading, Tillotson and Selleck, 1943). Hence pellet analysis provides a fairly satisfactory clue to the number of these food items taken.

Table 4

Bulk Contribution of Prey Species to Pellets

Species	Total items in pellets	Estimated average weights of animals eaten	Bulk contribution
House mouse	283	15 grams	4,245 grams
Pocket gopher	193	85	16,405
Meadow mouse	110	40	4,400
Deer mouse	92	20	1,840
Harvest mouse	19	15	285
Roof rat	8	65	520
Shrew	6	5	30
Jack rabbit	4	75	300
Birds	19	30	570
Insects	15	2	30
Total	749		28,625

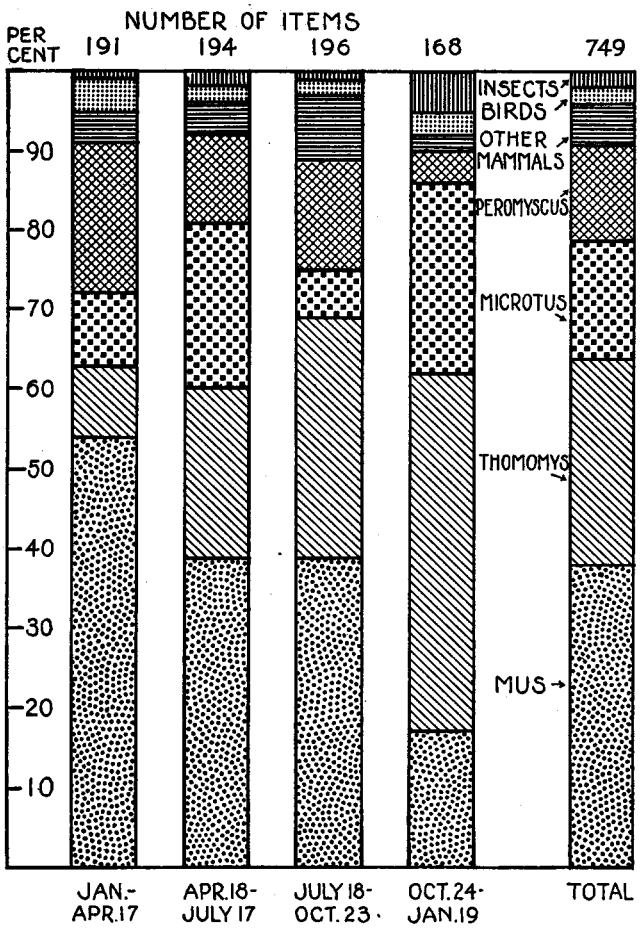

Fig. 2. Percentage representation of food taken by Barn Owl from January, 1942, to January, 1943.

Cowan (1942) and others have stressed the importance of the bulk contribution of the various prey species in predator food habit studies. Small species that are numerically abundant may provide relatively little bulk; larger species are not always completely devoured and may therefore be inaccurately represented in the pellets. Using measurements of the pellet material collected during the period of study as a basis, we have attempted to calculate the bulk contribution of each species to the food consumed by our owl (table 4).

Observations by Guerin (1928) of Barn Owls in France indicated that at least two pellets are produced in a 24-hour period; one, containing the remains of food taken during the previous evening and night, is dropped about dawn at some undetermined site in the hunting territory, while the second, comprising food taken after regurgitation of the first pellet, is dropped at the diurnal roosting site during the course of the day. Moon (1940) found evidence of both day and night pellets dropped by Barn Owls in Kansas. Our data probably represent the food intake of the morning feeding period only, and it is likely that the total food intake during the period of study is roughly twice that

indicated above. This would mean that our owl ate approximately 57 kilograms or 126 pounds of food in the 384 days of the study. The average amount of food consumed daily was thus about 150 grams, roughly one-quarter of the weight of an average adult Barn Owl.

Summary.—Pellets of a Barn Owl at Davis, California, were collected from January, 1942, through January, 1943. The hunting range of the owl included 140 acres of open fields and 25 acres of wooded creek bank. A total of approximately 280 pellets was collected: these contained 749 separate food items, of which mammals comprised 95.5 per cent, birds 2.5 per cent, and insects 2 per cent. All the species represented were nocturnal except for the birds; these latter may well have been caught on or near their night roosts. Animals typically associated with wooded or brushy cover comprised 57 per cent of the total food items, while open field habitats contributed 43 per cent. Woodland inhabitants, notably house mice and deer mice, were heavily represented at first but were much reduced at the end of the study period; the house mouse decrease corresponded roughly with an observed population reduction in the area. Pocket gophers and meadow mice, field-dwelling species, reached their maximum representation in the late autumn and early winter. An estimate of the bulk contribution of each prey species indicated a total consumption by the owl of approximately 126 pounds of food during the period of study, or roughly one-fourth of its body weight per day.

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