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Diet of the Barn Owl (*Tyto alba*) in Central Punjab (Pakistan)

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Abstract.- From June 1996 through May 1998, 1694 pellets of the barn owl (*Tyto alba*) were collected from 24 localities (predominantly canal rest houses) in six districts of central Punjab (Pakistan). An analysis of these pellets revealed that the barn owl depended for its food mainly on shrews (65%), rodents (27.5%), bats (2.0%) and birds (5.1%) which jointly constituted more than 99% of all the prey specimens recorded from their remnants in the pellets. The diet of the owl varied significantly from locality to locality ($P<.05$) and from season to season ($P<.01$). In the fall and winter seasons, during which most of the owl's breeding takes place, the house shrew (*Suncus murinus*) was the chief staple of its diet.

Key words: Cultivations, diversity indices, seasonal variations.

INTRODUCTION

The extent of damage caused by rats and mice to farm crops and stored grains (Durr-e-Shahwar, 1998; Mushtaq-ul-Hassan *et al.*, 1998) is a matter of great concern for agriculturists all over Pakistan. Vertebrate pest managers heavily depend on toxicants for inhibiting the populations of rodent pests. The natural control factors seem to have rarely been used in Pakistan against rats and mice. Owls fall within the general area of natural control factors. They form a group of widely distributed predacious birds. The barn owl (*Tyto alba*) feeds almost exclusively on small mammals and yet little attention has been paid in Pakistan towards its conservation and possible use in rodent pest suppression.

Inspite of the fact that the barn owl for most of the time is a generalist (polyphagous) predator, it has been found effective against rats in the oil palm plantations (Lenton, 1980; Smal, 1987; Smal *et al.*, 1990) and in the paddy fields of Malaysia (Muhammad *et al.*, 1991). Mederios (1990) estimated that 15-20 breeding pairs of barn owl introduced and established in caves near Bermuda consumed more than 15000 rats per year. Unfortunately, this natural rat catching device is being severely persecuted in Pakistan on the false belief that it portends bad omen (Beg and Irshad, 1998).

So far about 35 subspecies of the barn owl have been identified. The subspecies *Tyto alba stertens* (Hertert) is found in South Asia (Taylor, 1994). In Pakistan, it is erratically distributed in the Indus plain (Roberts, 1991). In the central Punjab, the owl is common in the premises of the canal rest houses built on the banks of the major irrigation canals (Beg and Irshad, 1998). This paper provides information about the food habits of the barn owl in the cultivations of central Punjab.

MATERIALS AND METHODS

The owls regurgitate undigested parts of their prey in the form of pellets. The pellets of the barn owl were recorded from 47 different localities in six districts (*viz.*, Faisalabad, Jhang, Hafizabad, Okara, Sheikhupura and Toba Tek Singh) of the province of the Punjab (Pakistan). Of the 47 localities, 43 were canal rest houses (CRHs), two were the minarets of village mosques, one was the building of a shrine of a 'pir' and the last one was the Faisalabad Campus of the University of Agriculture where a pair of barn owl was introduced in 1996. The data from a total of 1694 pellets collected from only 24 of the 47 localities was used in this study during the period extending from June 1996 through May 1998.

From each of the pellets, the remnants of the preys of the owl, *viz.*, the bones of vertebrates, feathers and beaks of birds, hairs of mammals and hard parts of insects were removed and examined to identify them. In case of mammals, the skulls and particularly the teeth were used to determine their species. To facilitate identification, reference skulls and teeth of most of the small mammals found in the study area were made available in the laboratory for comparison.

The data obtained from the examination of the

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spatial changes in the diversity of the prey fauna represented in owl's pellets. The following three indices were used to assess diversity in the diet of the owl: Species richness (S), Shannon's index (H'), and Pielou's evenness (E).

Species richness (S)

The faunal richness of the owl's diet was measured as a direct count of the prey species or higher taxa using the Hill's diversity number 0 which is defined as follows: Number 0 = N0 = S.

Shannon's diversity index (H')

H' was calculated using the following equation: $H' = \Sigma$ Pilnpi, where Pi is estimated as ni/N, ni being the number of individuals in the ith species and N being the total number of species in the sample. The variance of H' was calculated as follows:

$$\text{Var } H' = \frac{\Sigma \text{ Pi } (\ln Pi)^2 - (\Sigma \text{ Pi} \ln Pi)^2}{N} + \frac{S-1}{2N^2}$$

Where, N is the number of individuals in the sample and S is the total number of species. To compare diversity index values of the various samples 't' values were computed as indicated below:

$$t = \frac{H'1 - H'2}{(\text{VarH}'1 - \text{VarH}'2)^{1/2}}$$

Where H'1 and H'2 are the diversity index values of the sample 1 and 2, and VarH'1 and VarH'2 are their variances. The degree of freedom was calculated employing the following equation:

$$\text{d.f.} = \frac{(\text{VarH}'_1 + \text{VarH}'_2)}{(\text{VarH}'_1/N_1 - \text{VarH}'_2/N_2)^2}$$

Peilou's evenness (E)

Peilou evenness is the ratio of the observed diversity (H') to maximum diversity (H_{max}) as indicated below:

$$E = H'/H_{max}$$

For the above indices and statistical methods Magurran (1983) was followed.

RESULTS

An analysis of the remnants of 1694 pellets revealed that the barn owls of the present study area depended for their food mainly on small mammals *viz.*, shrews (65.0%), rodents (27.5%) and bats (2.0%) which jointly accounted for 94.5% of the total number of the specimens of the preys recorded (Table I). The birds contributed 5.1% while the contribution of frogs and toads (0.3%), and insects (0.1%) was negligibly small. Among the rodents were included such important pests of stored grains and farm crops as *Rattus rattus, R. meltada, Mus musculus, M. booduga, Bandicota bengalensis, Nesokia indica* and *Tatera indica*. Jointly all these seven species constituted 23.5% of the total number of prey species recorded in the annual samples.

Seasonal changes

The owls exhibited considerable seasonal changes in their diet. The house shrew (*Suncus murinus*) which was the chief staple of their diet was best utilized during the fall (72.5%) and the winter (77.9%) seasons. The intensity of utilization of this insectivore mammal declined in the spring (52.2%) and the summer (21.5%) seasons (Table I).

The relative importance of rats and mice in the diet of the barn owl varied from season to season. Two species, namely, *R. meltada* and *T. indica* were relatively better utilized during the summers. *B. bengalensis* was eaten most intensively during the springs. The mice *viz.*, *M. musculus* and *M. booduga* were eaten relatively more intensively during the summers and the falls than during the other two seasons. *R. rattus* and *N. indica* appeared in the seasonal samples in comparable proportions during all the four seasons of the year. *Rattus* sp. and *Golunda ellioti* and especially the former was most intensively preyed upon during the summer season. The contribution of such preys as *Suncus etruscus, Funambulus pennanti*, frogs and toads, and insects to the diet of the barn owl was very little.

Table II compares species richness, diversity and evenness indices calculated for the assemblage of animals forming the diet of the barn owl in different seasons. Species richness varied little from season to season while species evenness was maximum in the summer, less in the spring, lesser in the fall and the least in the winter samples. The diversity indices of all the seasonal samples were significantly different from each other ($P < .01$).

Table I.- Seasonal changes in the relative abundance of vertebrate preys in the diet of the barn owl.

Preys	% Relative abundance (N)				
	Summer (n = 174)	Fall (n = 340)	Winter (n = 834)	Spring (n = 346)	Combined (n = 1694)
Shrews					
S. murinus	21.5 (64)	72.5 (374)	77.9 (890)	52.2 (239)	64.9 (1567)
S. etruscus	0.7 (2)	-	-	-	0.1 (2)
Squirrel					
F. pennanti	0.7 (2)	0.4 (2)	0.1 (1)	-	0.2 (5)
Rats and Mice					
R. rattus	3.4 (10)	2.5 (13)	4.4 (50)	3.9 (18)	3.7 (91)
Rattus sp.	16.2 (48)	1.9 (10)	1.5 (17)	1.7 (8)	3.4 (83)
R. meltada	10.0 (30)	1.6 (8)	6.0 (68)	7.4 (34)	5.9 (140)
M. musculus	2.4 (7)	3.3 (17)	1.5 (18)	1.3 (6)	1.9 (48)
M. booduga	5.4 (16)	3.3 (17)	0.6 (7)	1.1 (5)	1.8 (45)
B. bengalensis	8.1 (24)	2.5 (13)	4.4 (51)	17.0 (78)	7.0 (166)
N. indica	1.3 (4)	1.0 (5)	1.6 (18)	1.5 (7)	1.4 (34)
T. indica	4.4 (13)	1.7 (9)	0.9 (10)	2.4 (11)	1.8 (43)
G. ellioti	2.0 (6)	0.6 (3)	-	0.2 (1)	0.4 (10)
Bats	9.8 (29)	3.1 (16)	0.1 (1)	0.7 (3)	2.0 (49)
Birds	13.8 (41)	5.4 (28)	0.8 (9)	9.6 (44)	5.1 (122)
Amphibians	0.3 (1)	0.2 (1)	0.2 (2)	0.5 (2)	0.3 (6)
Insects	-	-	-	0.5 (2)	0.1 (2)
Total specimens (N)	297	516	1142	458	2413

(n = number of pellets; N = number of specimens of the preys)

Table II.- Diversity indices for the seasonal diets of the barn owl in central Punjab.

Season	Richness (S)	Diversity (H')	Evenness (E)
Summer	15	2.29	0.84
Fall	14	1.27	0.48
Winter	13	0.97	0.38
Spring	14	1.81	0.69

Spatial variation

About 69% of the 1694 pellets collected from the 24 localities came from the following eight localities: (1) Ukbana CRH, Rakh Branch Canal. Teh. and Dist. Faisalabad. (2) Mudh Baluchan CRH, Rakh Branch Canal, Teh. Safderabad and Dist. Sheikhupura. (3) Nanuana CRH, Rakh Branch Canal, Teh. and Dist. Hafizabad. (4) Newan CRH, Jhang Brand Canal, Teh. and Dist. Faisalabad. (5) Kot Khuda Yar CRH, Rakh Branch Canal, Teh. and Dist. Faisalabad. (6) Narwala CRH, Jhang Branch Canal, Teh. and Dist. Faisalabad. (7) Muradwala CRH, Chak No. 175 Teh. and Dist. Jhang. (8) Chimbranwali CRH, Faisalabad - Jhang Road, Teh. and Dist. Jhang.

The samples from these localities were used to assess locality related changes in the owl's diet. The criterion for this selection was that these samples comprised, at least, 79 pellets collected during all the four seasons.

S. murinus was recorded from all the eight

Table III.- **Relative abundance of various vertebrate preys found in the pellets of the barn owl at eight selected localities.**

Preys	% Relative abundance (N) in localities							
	1 (n = 218)	2 (n = 227)	3 (n = 105)	4 (n = 200)	5 (n = 81)	6 (n = 112)	7 (n = 147)	8 (n = 79)
Shrews								
S. murinus	75.1 (225)	74.3 (228)	49.3 (67)	57.2 (159)	74.0 (74)	57.9 (84)	48.4 (108)	64.1 (66)
S. etruscus	-	-	-	-	-	-	0.9 (2)	-
Squirrel								
F. pennanti	0.7 (2)	-	-	-	-	-	0.9 (2)	-
Rats and Mice								
R. rattus	4.0 (12)	3.3 (10)	8.8 (12)	7.2 (20)	5.0 (5)	4.8 (7)	3.1 (7)	1.0 (1)
Rattus sp.	0.3 (1)	3.3 (10)	4.4 (6)	2.5 (7)	0.0 (0)	2.2 (4)	3.6 (8)	1.0 (1)
R. meltada	3.3 (10)	2.0 (3)	8.1 (11)	14.7 (41)	3.0 (3)	9.7 (14)	2.7 (6)	1.9 (2)
M. musculus	1.3 (4)	1.6 (5)	0.7 (1)	0.7 (2)	3.0 (3)	5.5 (8)	1.9 (4)	2.9 (3)
M. booduga	1.7 (5)	3.6 (11)	0.7 (1)	2.5 (7)	1.0 (1)	4.8 (7)	2.2 (5)	-
B. bengalensis	10.3 (31)	6.8 (21)	8.8 (12)	5.4 (15)	8.0 (8)	4.8 (7)	9.0 (20)	3.9 (4)
N. indica	1.3 (4)	1.6 (5)	2.2 (3)	2.2 (6)	-	0.7 (1)	0.9 (2)	-
T. indica	1.0 (1)	0.6 (2)	-	4.0 (11)	2.0 (2)	5.5 (8)	0.9 (2)	4.9 (5)
G. ellioti	-	-	-	-	-	0.7 (1)	2.2 (5)	-
Bats	-	1.5 (6)	5.1 (7)	1.1 (3)	-	2.8 (4)	8.5 (19)	-
Birds	0.7 (2)	1.3 (4)	11.0 (15)	2.5 (7)	4.0 (4)	1.1 (2)	13.9 (31)	20.4 (21)
Amphibians	0.3 (1)	-	0.7 (1)	-	-	-	0.9 (2)	-
Total specimens (N)	300	307	76	278	100	145	223	103

(n = number of pellets; N = number of specimens of the preys)

localities where its proportions ranged from 48.4% to 75.1% (Table III). Other species recorded in all the locality samples were *R. rattus, R. meltada, M. musculus* and *B. bengalensis* whose proportions ranged from 1.0% to 8.8%, 1.9 to 14.7%, 0.7% to 5.5% and 3.9% to 10.3%, respectively. *Rattus* sp., *M. booduga* and *T. indica* were recorded from seven of these localities in which their proportions varied from 0.3% to 4.4%, 0.7% to 4.8% and 0.6% to 5.5%, respectively. *N. indica* was recorded from six localities, *F. pennanti, G. ellioti* from two localities, and *S. etruscus* just from one locality. The bats were represented in five and the amphibians in three of the locality-samples. The birds were represented in all the locality - samples and their proportions ranged from 0.7% to 20.4%.

Thus the shrews were eaten intensively by the owl at all the localities. *B. bengalensis, R. meltada, R. rattus* and *M. musculus* were the second order staples in the owl's diet. The other species were utilized neither consistently or intensively.

Minimum richness was recorded in the samples from the localities numbered as 5 and 8; these samples were relatively small as they respectively comprised 81 and 79 pellets only. Maximum richness comprising 15 prey items was recorded in the sample from the locality number 7. At the remaining five localities richness varied from 11 to 12 (Table IV).

For the samples from the localities 3, 4, 6 and 7 both evenness and diversity index values were relatively high as compared to the samples from the localities 1, 2, and 5. In the sample from locality 8

evenness index value was high but diversity index value was low possibly because of low richness value (Table IV).

Table V depicts the statistical relationship between the diversity values of the eight locality-samples. The majority of the samples were different from each other ($P \geq .05$). But none of the samples from the localities 1, 2, 5 and 8 was different from each other. The diversity values for the samples from the localities 3 and 4, and 4 and 6 were also not different at a statistically significant level.

Table IV.- Diversity indices for the diet of the barn owl at the eight selected localities in central Punjab.

Site number	Richness (N0)	Diversity (H')	Evenness (E)
1	12	1.02	0.41
2	11	1.12	0.47
3	11	1.70	0.71
4	11	1.52	0.64
5	8	1.04	0.50
6	11	1.57	0.66
7	15	1.83	0.68
8	8	1.15	0.69

Table V.- Results of t-tests comparing the diversity index values (H') calculated for the vertebrate fauna represented in the diet of the barn owl at the eight selected localities in central Punjab.

1							
NS	2						
S**	S**	3					
S**	S**	NS	4				
NS	NS	S**	S**	5			
S**	S**	S*	NS	S**	6		
S**	S**	S*	S**	S**	S*	7	
NS	NS	S**	S**	NS	S**	S*	8

S* = Level of significance = 95% or more.

S** = Level of significance > 95% or more.

DISCUSSION

Bony remains of twelve species of small mammals were represented in the present sample of the pellets of the barn owl. It was not possible to identify the birds and bats to species level from their remnants. However, the former belonged to the order Passeriformes and the latter to the suborder Microchiroptera. The bulk of the food of the owl was due to small mammals comprising two species of shrews, ten species of rodents, and an unknown number of bat species. These three groups jointly accounted for 94.5% of all the specimens of prey recorded from the pellets.

The present data indicated drastic seasonal changes in the diet of the owl. During the springs and the summers, rodents, bats and birds were better utilized than during the falls and the winters. During the latter two seasons, the house shrew predominated in the owl's diet. The population of the mammals (listed in Table I) and the passerine birds greatly improve in size during the spring and summer seasons as a result of intensive reproduction and subsequent recruitment of the young to the populations (Chaudhry and Beg, 1977; Beg *et al.*, 1980; Beg, 1986; Khan and Beg, 1986; Roberts, 1992; Mushtaq-ul-Hassan *et al.*, 1998). Being naive and inexperienced, the young animals are more prone to the owl's predation than the older ones. Another factor which promotes vulnerability to predators of such rodent pests of field crops as *B. bengalensis*, *R. meltada*, *T. indica* and *Mus* spp. is the removal of the vegetation cover from the fields following harvesting of the wheat crop in April and May.

In the present study area most of the rats and mice cease to reproduce or slow down the process of reproduction during the period extending from late November to early February (Beg, 1986). The breeding season of the house shrew is even shorter being more or less restricted to six months of the spring and summer seasons (Mushtaq-ul-Hassan *et al.*, 1999). Consequently the size of the population of these small mammals is much smaller during the colder months of the year. Trapping data show that in the villages and farm houses, the shrew attains maximum abundance during the fall (Mushtaq-ul-Hassan *et al.*, 1998), during late summer and winter in the croplands and during late summer in the urban environment of Faisalabad city (Beg *et al.*, 1986). During the colder months both the rodents and the shrews living in the croplands populate the sugarcane fields densely where the former outnumber the shrews overwhelmingly yet they

contribute just 11% to 13% of the fall and winter diets of the owl as compared to contributions of 76% and 78% of the house shrew during these seasons. Perhaps the shrew's high level of activity, its squeaking disposition during the intraspecific interactions and encounters with its prey during hunting (Roberts, 1977) make it more likely to fall prey to the owl as it has been suggested for other species of shrews (Peters, 1983; Clark, 1956; Churchfield, 1990).

The owl hunts either by flying low above the ground or by employing perches (Taylor, 1994). In either case it is very unlikely that it will detect and capture a rodent or a shrew active under the cover of tall crop plants. Possibly the shrew uses the open microhabitats (*e.g.* inter-field verges, embankments of irrigation diches, trails and dirt roads) in the croplands more frequently than the rodents and hence falls prey to the owls more frequently.

The outskirts of the villages, and the environs of farm houses and hutments in the agroecosystems should logically constitute a part of the foraging ground of the barn owl. Here *R. rattus, M. musculus, T. indica* and *S. murinus* occur; *R. rattus* is numerically the most dominant species (Mushtaq-ul-Hassan, 1998). *R. rattus* frequents the croplands very rarely (M.A Beg, pers. Comm.) while the other three species affect both the settlements and the croplands. Occurrence of the remnants of *R. rattus* in all the seasonal samples of the pellets in relatively good numbers give credence to the idea that the owl also hunts regularly around the human settlements round the year. The trap success of *S. murinus* in the villages and farm houses during the fall and winter seasons and especially during the latter is relatively high (Mushtaq-ul-Hassan *et al.*, 1998). This might be the result of migration of the cropland shrews to human dwellings during the cold months of fall and winter. It is during the winters that the vegetation cover is widespread in the croplands where the crop plants are tall enough to prevent the owl from catching its mammalian preys. Furthermore, fall and winter seasons are very critical for the owl for its process of reproduction is largely completed during these two seasons (Beg and Irshad, 1998). The fall and winter nutritional requirements of the adult owls and the chicks is largely fulfilled by the shrews. Thus, the house shrew plays an important role in sustaining the barn owl in central Punjab.

The owl's preference for the shrew was, however, not constant over time. When the cropland rodents were forced to use open areas after the harvesting of the wheat crop in April and May and when the size of their populations was relatively large, they appeared in the spring and summer diets of the owl in much greater numbers than in the fall and winter diets. Overall preponderance of rats and mice in the spring and summer diets of the owl seems to be related to larger populations dominated by young individuals and the paucity of the vegetation cover in the croplands in late spring and summer. However the shrew is undoubtedly the most important round the year source of nutriment to the owl in the present study area.

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