

## Diet Variations of the Barn Owl *Tyto alba* (Scopoli, 1769) in Madurai District, Tamil Nadu, Southern India

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**Abstract:** Diet variations of Barn Owl *Tyto alba* were determined by the analysis of 3,133 regurgitated pellets collected from ten different roost-sites in Madurai District from 2007 to 2009. The overall diet comprised 85.5% small mammals, 2.2% birds, 0.1% reptiles, 0.9% amphibians and 2.4% insects. Among small mammals, *Suncus murinus* and *Rattus rattus* were predominant: they comprised 37.2% and 23.0% of the 4,295 prey taken by Barn Owls. The number of prey items per pellet varied from one to 16 with an overall mean of 1.37 prey items/pellet. The percentage of small mammal in the pellets varied seasonally from 82.5% to 87.5%. *Suncus murinus* was taken in large numbers from post-monsoon (30.2%) to monsoon (51.1%). The occurrence of small mammals in the diet varied from 75.0% to 90.4% among the years. The consumption of *Suncus murinus* showed a decreasing trend from 2007 to 2009, whereas the *Bandicoota bengalensis*, *Millardtia meltada*, *Tatera indica*, *Mus* spp. and chiropterans showed an increasing trend. Consumption of *Rattus rattus*, *Tatera indica*, *Suncus murinus* and amphibians were significantly differed among the years. *Suncus murinus* was chief prey in both rural and urban habitats. *Bandicoota bengalensis* (18.6%), *Millardtia meltada* (7.8%), *Tatera indica* (1.8%), *Mus* spp. (8.5%) and bats (4.2%) were found more frequently in the diet of owls in rural habitat, whereas, *Rattus rattus* contributed an important fraction of the prey (26.4%) in urban habitat. There were statistical differences in percent frequency of *Bandicoota bengalensis*, *Millardtia meltada*, *Rattus rattus*, *Tatera indica*, amphibians and isopteran insects between the habitats.

**Keywords:** Barn Owl, diet, India, prey composition, *Rattus rattus*, small mammals, *Suncus murinus*, *Tyto alba*.

### INTRODUCTION

The Barn Owl *Tyto alba* is one of the most widely distributed owl species in the world (Burton 1984). The diet of Barn Owl is well known throughout the world because of their cosmopolitan distribution and ease of pellet analysis (Taylor 1994). Food habit studies can provide the foundation for additional investigations, besides documenting the existence of certain prey species within the owl's range, its capability to take such prey, and relative abundance of prey species in the owl's diet. In particular, these studies may be used in the process of evaluating their habitat requirements (Colvin *et al.* 1984), predator-prey interactions (Marti 1974), secondary poisoning hazards (Colvin 1984) and the use of owls as biological control agents (Lenton 1978, Santhanakrishnan 1995).

Food habits of Barn Owls have been described from many regions of the world (Santhanakrishnan 1995, Alivizatos & Gounter 1999, Mushtaq-ul-Hassan *et al.* 2004, Leonardi & Arte 2006, Magrini & Facure 2008). Local variation in diet of Barn Owl in different habitats has also been described by several authors in Europe, USA and Southeast Asia (Taylor 1994, Rodriguez & Salvador 2007, Mahmood-ul-Hassan *et al.* 2007b,c).

Though considerable publications on various aspects of the Barn Owls are available throughout the world, very few research attempts have been taken in India. Available literature on Indian Barn Owls focus mainly on nest-sites (Nagarajan *et al.* 1995), utilization of man-made nest boxes (Neelananarayanan *et al.* 1995), sexual dimorphism (Kanakasabai *et al.* 1996), nestling growth patterns (Nagarajan *et al.* 2002), prey biomass estimation

(Neelanarayanan 2007a) and the diet composition (Neelanarayanan 2007b). All the above studies are short-term and have been carried out in a particular locality of Cauvery delta of Tamil Nadu, which is known for its large scale of agricultural operations and commonly known as granary of South India.

In the present study, we analysed the diet variations of Barn Owl in Madurai District, Tamil Nadu, India, over a period of three years and compared our data among different seasons, years and between habitats.

## STUDY AREA

The present study was conducted in the Madurai District (9°56'N, 78°07'E) of Tamil Nadu, India, covering an area of 1,088,622 sq km. Topographically the area is mostly flat with few hilly tracts. The climate is dry and hot, with rains during October to December (northeast monsoon). During our research summer temperature reached a maximum of 40°C and a minimum of 26.3°C while winter temperature reached a maximum of 22.5°C and minimum of 19.7°C. The average annual rainfall is about 850 mm. Paddy is the predominant cultivated crop in the study area; however other crops such as sugarcane, banana, jasmine, betlevine, groundnut and sorghum are also cultivated in different regions. The study area has four distinct seasons namely pre-monsoon (July–September), monsoon (October–December), post-monsoon (January–March) and summer (April–June). The data collected in each of those periods were pooled together and subjected to statistical analyses and interpretations.

## MATERIALS AND METHODS

### Pellet collection and analysis

In order to estimate the dietary composition of the Barn Owl regurgitated pellets were collected from ten roosting-sites and analysed. Pellets were collected from June 2007 to September 2009. Fresh pellets were collected separately during each visit and packed in plastic bags along with tags indicating the site name and date of collection before being

brought to the laboratory. Pellets were kept at 70°C in a hot air oven for 24 hours to kill the associated invertebrates. The length and width of the pellets were measured using a Vernier Caliper (to nearest mm) and the weight was measured with a digital balance with an accuracy of 1 mg. Pellets were analysed following Schueler (1972) and Yalden (2003). The pellets were placed in 3% by weight of Sodium Hydroxide (NaOH) solution held at 60° to 65°C. Hair and other debris were dissolved by NaOH solution, leaving only the osseous and chitinous remains. NaOH solution was then decanted and the remaining material such as mandibles, skulls, bones, beaks and insect remains were separated for identification.

### Prey identification

Based on the available literature, a list of mammalian prey species of Barn Owl was prepared. Species available at the study site were collected and killed. Bones, beaks and the like were preserved for future reference in the lab. Mammalian prey in the pellets was identified down to species level. Birds, reptiles and amphibians were identified by their feathers, beaks, skulls, synsacrum, mandibles and parasphenoid processes (Naranthiran 1989, Daniel 1992, Daniels 2005). We were not able to identify the bats, birds and amphibians down to species level. Arthropods were identified down to order using their heads, mandibles, wings, legs, stings and body segments (Naranthiran 1989, Yalden 2003, Asokan *et al.* 2009).

### Biomass estimation

The biomass of the prey of all mammalian species recovered from the pellets were estimated using a standard log-log regression of right mandible length as a function of body weight following Hamilton (1980), Santhanakrishnan (1987, 1995) and Neelanarayanan (2007a). For this study, the locally available mammalian species such as House Rat *Rattus rattus*, Lesser Bandicoot Rat *Bandicoota bengalensis*, Soft-furred Field Rat *Millardia melstada*, Indian Gerbil *Tatera indica*, Indian Mice *Mus* spp. and the Grey Musk Shrew *Suncus murinus* and their corresponding log-log regression values for the calculation of biomass were used as described by Santhanakrishnan (1995). Mandible

measurements recovered from the Barn Owl pellets were then applied to the following regression equation to estimate the biomass of each prey species represented in the pellets.  $\text{Log } y = \text{Log } a + b (\text{log } x)$  where  $\text{Log } y$  is unknown body weight;  $\text{log } a$  known mandible length of museum specimen;  $\text{log } b$  known body weight of museum specimen; and  $\text{log } x$  mandible length of rats obtained from pellets (Hamilton 1980). Most of the remains of birds were not intact and important parts for body mass calculation were missing. Hence birds were left out in the biomass calculation. We had not any museum specimens of bats for identification, therefore it was also not included in the calculations.

### Statistical analysis

Basic statistics such as arithmetic mean and standard deviation were calculated for all the replicate variables and are given as mean  $\pm$  SD. One-way Analysis of Variance (ANOVA) was used to estimate the variation of the prey remains between seasons and years. An unequal variance *t*-test was used to compare the diet composition between rural (area covered by more than 60% agricultural lands) and urban (covered by more than 60% human habitations) habitats. The MINITAB (version 13.1) statistical software was used for all the data analyses. Results are reported as significant if they are associated with at a value of  $P < 0.05$ . Statistical inferences were made following Sokal & Rohlf (1981).

## RESULTS

### Pellets

Fresh Barn Owl pellets were dark green in colour and covered with mucous. Pellets were compact and had many bones in them. Old pellets were dry, pale grey in colour, with no wet mucous covering and were quick to fall apart. Average length is  $37.4 \pm 9.1$  mm ( $N = 930$ ; range 10.0–80.0 mm), average width  $24.7 \pm 5.4$  mm ( $N = 930$ ; range 8.0–40.0 mm). Average dry weight is  $3.34 \pm 1.24$  g ( $N = 98$ ; range 1.15–6.85 g). The number of prey items per pellet varied from one to 16 with an overall mean of 1.37 prey/pellet. Over 69% of the pellets contained only one prey ( $N = 2,170$ ), two preys were found in 800 pellets (25.3%), three preys in 117

pellets (3.7%) and all other remaining pellets represented less than 1%.

### Overall composition of the diet

A total of 4,295 prey items were found in the analysis of 3,133 pellets collected during the study period (Table 1). Barn Owls preyed to different extents on mammals, birds, amphibians, reptiles and insects (Table 1). Small mammals (Rodentia, Insectivora and Chiroptera) were the main food of the Barn Owl constituting 85.5% of the total number of prey items. Amphibians (0.9%), reptiles (0.1%) and birds (2.2%) jointly constituted only 3.2% of the diet and the remaining 8.9% were unidentified prey items. Of the mammals, the most intensively consumed prey was *Suncus murinus* (37.2%), followed by *Rattus rattus* (23.0%), *Bandicoota bengalensis* (11.5%) and *Mus* spp. (7.6%). Other mammalian prey comprised less than 4% of the total diet (Table 1). The total biomass of all mammalian prey items excluding bats consumed by the Barn Owls was 100%. Of all the species consumed, the biomass contributed by *Rattus rattus* was the highest (41.0%), followed by the *Suncus murinus* (33.7%) and *Bandicoota bengalensis* (17.9%) (Table 1).

### Seasonal variation of diet

Small mammals were the predominant prey in all four seasons as they contributed more than 80% of prey items (Table 2). The consumption of *Suncus murinus* increased from 30.2% (post-monsoon) to 51.1% (monsoon). The consumption of *Rattus rattus* increased from post-monsoon (18.7%) to pre-monsoon (28.2%) and decreased during monsoon (18.9%). Other mammals such as *Bandicoota bengalensis* (14.1%) and *Tatera indica* (1.5%) were taken in large numbers during summer, while *Mus* spp. (11.3%), *Millardia meltada* (5.0%) and bats (4.1%) were higher during post-monsoon. Birds and insects were taken mostly during summer. Amphibians were more often taken in post monsoon. There were differences between percent frequency of prey of *Tatera indica* ( $F = 5.05$ ;  $P < 0.05$ ), *Mus* spp. ( $F = 2.75$ ;  $P < 0.05$ ), *Suncus murinus* ( $F = 3.57$ ;  $P < 0.05$ ) and amphibians ( $F = 3.49$ ;  $P < 0.05$ ) in the four seasons (Table 2).

**Table 1.** Overall frequency and proportions of various prey items in the diet of Barn Owl ( $N=3,133$ ). \*Not calculated.

Prey species	Number	Percentage	Biomass in gram	Biomass in percentage
<b>MAMMALIA</b>				
<b>RODENTIA</b>				
<i>Bandicoota bengalensis</i>	492	11.5	33,534.3	17.9
<i>Millardia meltada</i>	144	3.35	7,904.5	4.2
<i>Rattus rattus</i>	990	23.05	76,799.5	41.0
<i>Tatera indica</i>	29	0.7	1,943.9	1.0
<i>Mus spp.</i>	327	7.6	4,040.2	2.2
<b>INSECTIVORA</b>				
<i>Suncus murinus</i>	1596	37.2	63,157.4	33.7
<b>CHIROPTERA</b>				
	95	2.2	*	*
<b>AVES</b>				
	94	2.2	*	*
<b>REPTILIA</b>				
	6	0.1	*	*
<b>AMPHIBIA</b>				
	37	0.9	*	*
<b>INSECTA</b>				
Coleoptera	40	0.9	*	*
Isoptera	64	1.4	*	*
<b>UNIDENTIFIED PREY</b>				
	381	8.9	*	*
<b>TOTAL</b>	<b>4,295</b>	<b>100</b>	<b>187,379.8</b>	

**Table 2.** Seasonal variations in the frequency and proportion of various prey items in the Barn Owl diet. \*Significantly differed (One-way ANOVA;  $P<0.05$ ) among the seasons.

Prey species	Post-monsoon		Summer		Pre-monsoon		Monsoon		ANOVA	
	N	%	N	%	N	%	N	%	F	P
<b>MAMMALIA</b>										
<b>RODENTIA</b>										
<i>Bandicoota bengalensis</i>	140	12.4	170	14.1	122	9.2	58	9.3	1.20	0.308
<i>Millardia meltada</i>	57	5.0	50	4.1	13	1.0	23	3.7	1.57	0.197
<i>Rattus rattus</i>	212	18.7	286	23.7	376	28.2	118	18.9	1.24	0.295
<i>Tatera indica</i>	8	0.7	18	1.5	2	0.2	1	0.2	5.05	0.002*
<i>Mus spp.</i>	128	11.3	90	7.5	87	6.5	22	3.5	2.75	0.044*
<b>INSECTIVORA</b>										
<i>Suncus murinus</i>	342	30.2	384	31.8	552	41.5	319	51.1	3.57	0.015*
<b>CHIROPTERA</b>										
	46	4.1	31	2.6	15	1.1	3	0.5	0.72	0.536
<b>AVES</b>										
	19	1.7	40	3.3	27	2.0	8	1.3	1.61	0.189
<b>REPTILIA</b>										
	---	---	3	0.2	3	0.2	---	---	1.34	0.262
<b>AMPHIBIA</b>										
	22	1.9	11	0.9	3	0.2	1	0.2	3.49	0.017*
<b>INSECTA</b>										
Coleoptera	4	0.4	18	1.5	16	1.2	2	0.3	2.43	0.067
Isoptera	---	---	26	2.2	13	1.0	25	4.0	1.17	0.321
<b>UNIDENTIFIED PREY</b>										
	155	13.7	80	6.6	102	7.7	44	7.1	1.63	0.183
<b>TOTAL PREY ITEMS</b>		<b>1,133</b>		<b>1,207</b>		<b>1,331</b>		<b>624</b>		
<b>NO. OF PELLETS</b>		<b>756</b>		<b>846</b>		<b>969</b>		<b>562</b>		
<b>MEAN PREY / PELLET</b>		<b>1.50±0.45</b>		<b>1.43±0.58</b>		<b>1.37±0.47</b>		<b>1.11±0.21</b>		
		<b>(0–4)</b>		<b>(0–15)</b>		<b>(0–13)</b>		<b>(1–16)</b>		

**Annual variation of diet**

The contribution of small mammals in the diet of Barn Owl among the years varied from 75.0% to 90.4% (Table 3). *Suncus murinus* (31.0% to 43.9%) and *Rattus rattus* (18.1% to 27.2%) were predominant prey items over the three years. Predation on *Suncus murinus* decreased from 2007 to 2009. During this period predation on other mammals

(*Bandicoota bengalensis*, *Millardia meltada*, *Tatera indica*, *Mus spp.* and bats) increased. At the same time, the consumption of non-mammalian prey increased as well. Percent proportion of *Rattus rattus* ( $F=3.78$ ;  $P<0.05$ ), *Tatera indica* ( $F=9.33$ ;  $P<0.05$ ), *Suncus murinus* ( $F=7.11$ ;  $P<0.05$ ) and amphibians ( $F=6.06$ ;  $P<0.05$ ) were significantly differed among the years (Table 3).

**Table 3.** Yearly variations in the frequency and proportion of various prey items in the diet of Barn Owl. \*Statistically differed (One-way ANOVA;  $P < 0.05$ ) among the years.

Prey species	2007		2008		2009		ANOVA	
	N	%	N	%	N	%	F	P
<b>MAMMALIA</b>								
<b>RODENTIA</b>								
<i>Bandicoota bengalensis</i>	64	8.7	229	11.5	199	12.7	0.24	0.779
<i>Millardia meltada</i>	11	1.5	36	1.8	97	6.2	2.98	0.053
<i>Rattus rattus</i>	133	18.1	541	27.2	316	20.1	3.78	0.025*
<i>Tatera indica</i>	1	0.1	3	0.2	25	1.6	9.33	0.000*
<i>Mus</i> spp.	17	2.3	178	9.0	132	8.4	2.96	0.054
<b>INSECTIVORA</b>								
<i>Suncus murinus</i>	323	43.9	786	39.6	487	31.0	7.11	0.001*
<b>CHIROPTERA</b>								
	3	0.4	22	1.1	70	4.5	1.24	0.291
<b>AVES</b>								
	9	1.2	39	2.0	46	2.9	0.88	0.416
<b>REPTILIA</b>								
	---	---	---	---	6	0.4	4.59	0.011*
<b>AMPHIBIA</b>								
	1	0.1	2	0.1	34	2.2	6.06	0.002*
<b>INSECTA</b>								
Coleoptera	8	1.1	12	0.6	20	1.3	1.02	0.361
Isoptera	59	8.0	5	0.3	---	---	0.32	0.856
<b>UNIDENTIFIED PREY</b>	107	14.5	133	6.7	141	9.0	2.48	0.087
<b>TOTAL PREY ITEMS</b>	<b>736</b>		<b>1,986</b>		<b>1,573</b>			
<b>NO. OF PELLETS</b>	<b>533</b>		<b>1,410</b>		<b>1,190</b>			
<b>MEAN PREY / PELLET</b>	<b>1.38±1.29 (0–16)</b>		<b>1.41±0.73 (0–13)</b>		<b>1.32±0.57 (0–4)</b>			

**Table 4.** Variations in the frequency and proportion of various prey items in the diet of Barn Owl among the habitats. \*Statistically differed ( $t$ -test;  $P < 0.05$ ) between habitats.

Prey species	Rural		Urban		t-test	
	N	%	N	%	t	P
<b>MAMMALIA</b>						
<b>RODENTIA</b>						
<i>Bandicoota bengalensis</i>	284	18.6	208	7.5	-3.66	0.000*
<i>Millardia meltada</i>	119	7.8	25	0.9	-3.54	0.000*
<i>Rattus rattus</i>	259	17.0	731	26.4	3.71	0.000*
<i>Tatera indica</i>	27	1.8	2	0.1	4.44	0.000*
<i>Mus</i> spp.	130	8.5	197	7.1	0.05	0.478
<b>INSECTIVORA</b>						
<i>Suncus murinus</i>	414	27.1	1182	42.7	1.65	1.290
<b>CHIROPTERA</b>						
	64	4.2	31	1.1	1.10	0.135
<b>AVES</b>						
	34	2.2	60	2.2	-0.54	0.294
<b>REPTILIA</b>						
	4	0.3	2	0.1	1.25	0.106
<b>AMPHIBIA</b>						
	26	1.7	11	0.4	1.76	0.041*
<b>INSECTA</b>						
Coleoptera	15	1.0	25	0.9	-0.20	0.417
Isoptera	---	---	64	2.3	-2.17	0.016*
<b>UNIDENTIFIED PREY</b>	151	9.9	230	8.3	0.02	0.490
<b>TOTAL PREY ITEMS</b>	<b>1,527</b>		<b>2,768</b>			
<b>NO. OF PELLETS</b>	<b>1,173</b>		<b>1,960</b>			
<b>MEAN PREY / PELLET</b>	<b>1.30±0.55 (0–4)</b>		<b>1.41±0.92 (0–16)</b>			

**Variation of diet between habitats**

Small mammals were the main prey of Barn Owls in both rural (84.9%) and urban (85.8%) habitats (Table 4). The *Suncus murinus* was important prey among small mammals in both habitats and was greater in urban habitats (42.7%). The *Bandicoota bengalensis* (18.6%),

*Millardia meltada* (7.8%), *Tatera indica* (1.8%), *Mus* spp. (8.5%) and bats (4.2%) were appeared more frequently in the diet of rural habitat, where *Rattus rattus* contributed an important fraction of the prey (26.4%) in urban habitat. The other vertebrates like aves, reptiles and amphibians were also comparatively higher

in rural habitat. There were differences in the percent frequency of *Bandicoota bengalensis* ( $t=-3.66$ ;  $P<0.05$ ), *Millardia meltada* ( $t=-3.54$ ;  $P<0.05$ ), *Rattus rattus* ( $t=3.71$ ;  $P<0.05$ ), *Tatera indica* ( $t=4.44$ ;  $P<0.05$ ), amphibians ( $t=1.76$ ;  $P<0.05$ ) and isopteran insects ( $t=-2.17$ ;  $P<0.05$ ) between the two habitats (Table 4).

## DISCUSSION

Morphometric measurements of Barn Owls pellets in the present study were similar to previous reports by Glue (1967), Santhanakrishnan (1995) and Mahmood-ul-Hassan *et al.* (2007a). Length and width were different to the reports by Buxton & Lockley (1950) 110×50 mm and Glue (1967) 45×26 mm. The size and shape of pellets were determined usually by the size of the prey that was consumed in the previous day as well as the quality and quantity of indigestible body parts of the prey. The variation of pellet size may indicate that Barn Owls prey on adults as well as young, as suggested for other owls by Mikkola (1976). In that case, pellets containing one or two prey items would represent predation on adults. More prey items per pellet would indicate predation on young. In some pellets we recorded up to 16 juvenile *Rattus rattus*. Love *et al.* (2000) have suggested that a high number of prey items per pellet may indicate longer hunting times and predation on energetically poor species. We recorded a mean of 1.37 prey/pellet. Similar numbers have been recorded previously by Neelanarayanan (2007b), Travaini *et al.* (1997), Bellocq (1998), Charter *et al.* (2007), Magrini & Facure (2008). Owls raising young catch more prey. Pearson & Pearson (1947) a “family” of owls hunts up to 5 prey/night while nestlings were still present. Glue (1967) recorded a minimum of 2.25 prey/pellet and up to 4.87 prey/pellet when six young were being raised.

We found that small mammals comprised nearly 86% of the total diet of Barn Owls. Earlier, investigations on food habits of Barn Owl throughout the world confirmed the occurrence of smaller mammals in higher proportions (Marti 1974, Santhanakrishnan 1987, Gubanyi *et al.* 1992, Pezzo & Morimando 1995, Santhanakrishnan 1995,

Travaini *et al.* 1997, Alivizatos & Gounter 1999, Love *et al.* 2000, Bose & Guidali 2001, Muthukumar 2003, Mushtaq-ul-Hassan *et al.* 2004, Alivizatos *et al.* 2005, Leonardi & Arte 2006, Mahmood-ul-Hassan *et al.* 2007c, Magrini & Facure 2008).

*Suncus murinus* and *Rattus rattus* constituted more than 60% of the diet. Barn Owls probably prefer shrews and House Rats or are more adept at catching such mammals or both. Santhanakrishnan (1995) reported that field rodents of agricultural value such as *Bandicoota bengalensis*, *Tatera indica*, *Millardia meltada* and *Mus* spp. were consumed predominantly (>64%). *Suncus murinus* constituted <23% of the diet in the Cauvery Delta region, Tamil Nadu, India. In contrast to our findings, another study on the Barn Owl in the Nagapattinam District, Tamil Nadu revealed that >68% of diet consists of *Bandicoota bengalensis*, *Tatera indica*, *Millardia meltada* and *Mus* spp. *Rattus rattus* and *Suncus murinus* contributed only 16% to the diet of Barn Owls (Neelanarayanan 2007b).

Heavy consumption of bats in the diet of Barn Owls has previously been described by some authors in different geographic locations (Bellocq 2000, Escarlate-Tavares & Pessoa 2005, Sommer *et al.* 2005). We found that bats make up 2.2% of the diet of Barn Owls in Madurai. This is not a significant amount, but it does confirm that Barn Owls hunt chiropterans. In fact, on five occasions during this study we witnessed Barn Owls hunting bats on the wing.

Barn Owls had consumed an insignificant amount of small birds (2.2%). This, as well as other studies indicate that Barn Owls may specialize on birds when other prey is scarce (Bose & Guidali 2001, Alivizatos *et al.* 2005, Leonardi & Arte 2006, Mahmood-ul-Hassan *et al.* 2007c).

Reptiles and amphibians are taken in much smaller numbers (0.1% and 0.9% respectively). These animals have been shown to be prey to Barn Owls (Pezzo & Morimando 1995, Sommer *et al.* 2005, Mahmood-ul-Hassan *et al.* 2007c, Neelanarayanan 2007b).

The insects belonging to the orders Coleoptera and Isoptera represented 2.4% of the Barn Owls diet in the present study. Rifai *et al.* (1998) reported that arthropods constitute <2.5% of the diet of Barn Owl in the Middle East. Presence of insects in the diet of Barn

Owls has been described by many authors in different locations (Santhanakrishnan 1995, Travaini *et al.* 1997, Alvarez-Castaneda *et al.* 2004, Alivizatos *et al.* 2005, Charter *et al.* 2007, Neelanarayanan 2007b).

The variation in the diet of Barn Owls depends on seasonal, habitat and climatic changes (Santhanakrishnan 1995, del Guasta 1999, Bose & Guidali 2001), except in tropical countries where the climatic conditions are tend to be more stable throughout the year (Taylor 1994). Variation in the diet of Barn Owls among seasons, years and habitats were noticed in Madurai District. The consumption of small mammals in the diet of Barn Owls among different seasons was more or less similar as they ranged from 82.4% to 87.7%, but changes were noticed among the prey species within the small mammals.

The contribution of *Suncus murinus* (insectivore) and *Rattus rattus* (rodent) in the diet of Barn Owl increased from 48.9% (post-monsoon) to 69.9% (monsoon). The consumption of field rodents (*Bandicoota bengalensis*, *Millardia meltada*, *Tatera indica*, *Mus* spp.) as 29.4% (post-monsoon) against 16.7% (monsoon) decreased correspondingly. Similar patterns of seasonal changes of prey species in the Barn Owl diet have been recorded in Pakistan (Mushtaq-ul-Hassan *et al.* 2004, Mahmood-ul-Hassan *et al.* 2007c). Earlier, Santhanakrishnan (1995) and Neelanarayanan (2007b) also reported the reversed patterns of seasonal changes of prey preferences by Barn Owl in Cauvery Delta region of Tamil Nadu. The prey composition of Barn Owls showed variation among the years. During 2007, *Rattus rattus* and *Suncus murinus* constituted 62.0% of the diet increasing to 66.8% in 2008 and significantly declining in 2009 to 51.0%. The consumption of field rodents increases 12.6%, 22.4% and 28.8% respectively. During 2009, relatively higher proportion of other prey groups such as bats, birds and amphibians were recorded in the diet of Barn Owl. The lower presence of field rodents pellets collected from urban areas suggests that *Bandicoota bengalensis*, *Tatera indica*, *Millardia meltada* and *Mus* spp are less abundant in urban areas than in rural areas. The differences in the prey importance in the Madurai District may reflect opportunistic hunting by Barn Owls: in each habitat and season more abundant prey is taken

more readily (Santhanakrishnan 1995, del Guasta 1999, Bose & Guidali 2001, Mahmood-ul-Hassan *et al.* 2007c). The relative abundance and behavior of prey species is in turn influenced by factors such as reproductive schedules, vegetation cover, climate and weather, as well as agricultural practices (Santhanakrishnan 1995, Huebschman *et al.* 2000, Cameron 2003, Mushtaq-ul-Hassan *et al.* 2004, Mahmood-ul-Hassan *et al.* 2007c).

## CONSERVATION

Barn Owls hunt rodents of agricultural value. Owls are deemed to play an important role in the biological control of these potential agricultural pests. The number of pellets collected at all sites was not uniform. On some sites Barn Owls appear and disappeared erratically, probably due to anthropogenic pressure, predation (for example by cats) and disturbance (by birds and monkeys). As the owls often congregate in and around the temples for roosting and nesting they are subject to anthropogenic pressures, particularly during festival time and when temples are being renovated. In South India are thought to be bad omens and portents of death. Public awareness is vital to conservation, as owls are subject to prosecution by local people. Recent literature on pesticide residue analyses in the tissues of Barn Owls show that they are at the risk of pesticide contamination (secondary poisoning hazards). The Agriculture Department should therefore take measures to reduce or to avoid the usage of hazardous pesticides in agricultural lands. Barn Owls readily occupy wooden nest boxes, where they are safe from predation. Nest boxes (10 boxes per hectare) and "T"-shaped perching poles would attract Barn Owls to farms. Barn Owls would predate on rodents and thus reduce the need for pesticides in farms.

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