DIET OF BARN OWL *TYTO ALBA STERTENS* HARTERT, 1929 IN A PORTION OF CAUVERY DELTA, TAMIL NADU, INDIA

P. Neelanarayanan

Post Graduate and Research Department of Zoology, Nehru Memorial College (Autonomous), Puthanampatti, Tiruchirappalli District, Tamil Nadu 621007, India
Email: pnn31@hotmail.com, pnn31@yahoo.co.in

ABSTRACT

The diet of Barn Owls was studied between February 1993 and January 1995. The analysis of 4,030 regurgitated pellets yielded 6,157 prey items, of which the mean percentage of prey composition of Barn Owl comprising rodents were to the tune of 32.79 for *Bandicota bengalensis*, 29.40 for *Millardia meltada*, 3.90 for *Mus booduga*, 2.15 for *Tatera indica*, 6.38 for *Rattus rattus* and 6.99 for unidentified species. The Barn Owls consumed 352.18g of prey comprising six species of small mammals during this period. Among these, *B. bengalensis* was 45.13% followed by *M. meltada* (32.84%), *R. rattus* (10.98%), *Suncus murinus* (6.43%), *T. indica* (3.73%) and *M. booduga* (0.89%). The observed mean prey items/pellet was 1.51 in the first year and 1.46 in the second year of study suggesting the fact that Barn Owls consume more than one prey/day. The results of the present study indicate that the Barn Owls are potential hunters of rodent pests and are good controlling agents in crop fields and fallow lands.

KEYWORDS

Bandicota bengalensis, diet, *Millardia meltada*, prey biomass, pellet analysis, small mammals, *Tyto alba*

The food habit of the Barn Owl has been studied in detail and more extensively than that of any other bird of prey, because of its wide distribution and the ease with which regurgitated pellets containing non-digestible remains of prey items can be found for analysis (Taylor, 1994). The literature review on major diet of barn owls from six continents was reported to be rodents, the most important small mammalian group. Out of 52 key studies, on the Barn Owl's diet by Taylor (1994), rodents constituted more than 50% of all prey items in 47 studies and they formed more than 75% of all prey items in 33 studies, suggesting that Barn Owls are excellent rodent hunters in nature.

The remarkable diversity of rodent fauna of the Indian subcontinent is shown by 46 genera, 135 species and about 300 subspecies (Ellerman, 1961), of them 14 species have been found to be of economic importance (Prakash, 1988). Rodents are very well known to be the major pests of agricultural crops and stored food grains (Prakash & Mathur, 1987). In addition, they are also reservoirs of a large numbers of pathogens many of which, if transmitted to human and domestic animals, may cause outbreaks of diseases often with high morbidity and mortality (Gratz, 1994).

In the Cauvery delta, 'the granary of southern India', four species of field rodents are found. They are (i) The Lesser Bandicoot Rat *(Bandicota bengalensis)*, (ii) The Soft-furred Field Rat (*Millardia meltada*), (iii) The Indian Field Mouse (*Mus booduga*) known to inhabit the crop fields (Sivaprakasam, 1988 & Neelanarayanan *et al*., 1996), and (iv) The Indian Gerbil (*Tatera indica*) found in barren lands around the crop fields (Sivaprakasam, 1988; Neelanarayanan *et al*., 1996).

Prakash (1992) also stated that no concrete effort has so far been undertaken towards biological control of rodents in India, and he has further emphasized the need for undertaking such studies to estimate correctly their role in effective control of various field rodent pests. In order to fill up this lacuna, the present study, *i.e*., the predatory role of Barn Owl over rodent pests was designed with the objective to study the prey composition of Barn Owl in wild through regurgitated pellet analysis,

MATERIAL AND METHODS

The present study was carried out in an area of 35km^2 in Tranquebar taluk, Nagappattinam district, Tamil Nadu state (10°40'-11°06'N & 79°22'-79°49'E, 13.11m) for 24 months from February 1993 through January 1995. The population estimation of Barn Owls was carried out in the daytime as suggested by Anon (1993), *i.e*., when they are in their roosting/nesting sites. The Barn Owls' roosting/nesting sites were identified by using indirect signs, such as regurgitated pellets, milky white droppings and prey remains as suggested by Nagarajan *et al*. (1993), Taylor (1994) and Santhanakrishnan (1995). Besides, the information given by the local residents were also useful in locating the roosting/nesting sites of Barn Owls.

Population estimation was made in nine temple towers (Fig. 1): Thirukkalacheri - Sri Naganatha Swamy Temple (TSNST), Poraiyar - Sri Ayyanar Temple (PSAT), Poraiyar - Sri Perumal Temple (PSPT), Poraiyar - Sri Kumaran Temple (PSKT), Poraiyar - Sri Viswanatha Swamy Temple (PSVST), Erukkattancheri - Sri Kalakaleshwarar Temple (ESKT), Thillaiyadi - Sri Sarntharaikatha Swamy Temple (TSSaST), Thillaiyadi - Sri Perumal Temple (TSPT) and Thiruvidaikazhi - Sri Subramanya Swamy Temple (TSSST). The observed number of adult Barn Owls, sub-adults, nestlings and eggs were recorded from the above roosting/nesting sites once a month during the two-year study period.

The diet of Barn Owls over different prey spectrum was studied by an indirect method, namely, the regurgitated pellet analysis, which is a reliable technique than other techniques as far as owls are concerned (Errington, 1932; Glading, *et al*., 1943) and particularly for Barn Owls (Marti, 1987). The pH of the Barn Owl's stomach is higher (less acidic) than that of many other predatory birds and hence most of the bones of ingested prey are left undigested (Smith & Richmond, 1972).

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Further, the skulls and mandibles of even the most delicate small mammal and bird prey are found intact in the pellets and can easily be identified (Taylor, 1994).

The regurgitated pellets of Barn Owls were collected from the nine roosting/nesting sites. They were bagged separately and labelled and brought to the laboratory for analysis. Before analysis, the pellets were kept in an oven at 70°C for 24hr to kill the associated invertebrate parasites (Santhanakrishnan, 1995). The pellets were then analysed, individually by using 8% NaOH as suggested by Neelanarayanan *et al.* (1998), a modified method of Scheuler (1972) and Marti (1987) who suggested 3% and 10% NaOH (mass analysis), respectively.

The identification of small mammalian representatives in the diet of Barn Owl up to species level was made by using the keys developed by Neelanarayanan *et al.* (1998). In the absence of mandibles, other bones like skulls, limb bones, pectoral and pelvic girdles and synsacra (in the case of birds) were useful, especially for identifying and quantifying the mammalian (rodents), avian and amphibian prey. A hand lens or low power binocular microscope was employed to identify insect exoskeleton (Marti, 1987; Neelanarayanan *et al.*, 1995). In a pellet, one set of mandibles (left and right) was counted as one prey species.

In order to know the contribution of each prey species in the Barn Owl's diet, they were converted into proportions and presented in tables. The mean prey items per pellet were calculated as follows:

$$\text{Mean prey items/pellet} = \frac{\text{Total no. of prey items observed in a month}}{\text{Total no. of pellets collected in a month}}$$

Results and Discussion

Population of Barn Owl

The total number of adult Barn Owls, subadults and chicks were found to be 249, 64, and 99 during February 1993 to January 1994 while they were 168, 9 and 38 during February 1994 to January 1995, respectively. It should also be noted that the population of Barn Owls (adults + subadults + chicks) were high (approximately 50%) during the first year of study (February '93-January '94) than during second year of study (February '94-January '95). The total number of eggs observed during first and second year of study was 152 and 111, respectively (Tables 1).

Barn Owl prey items and frequency

The diet composition of Barn Owls in terms of frequency observed during February 1993 to January 1995 is presented in Table 1. Analysis of 4030 regurgitated pellets revealed that small mammals, *viz.*, *B. bengalensis*, *M. meltada*, *M. booduga*, *T. indica* and *Rattus rattus*; an insectivorous mammal, *Suncus murinus*; amphibians, birds and insects were the constituents of the diet of Barn Owls. Of these, *B. bengalensis* (1953nos.) and *M. meltada* (1908 nos.) were found to be consumed by the Barn Owls in great numbers during both years of study. *S. murinus* (567), unidentified rodent species (461), *R. rattus* (393), *M. booduga* (254), *T. indica* (129), insects (21) and birds (1) formed the diet in addition, for both years of study (Table 1).

Analysis of 4030 regurgitated pellets yielded 6157 prey items. The magnitude of predatory pressure of Barn Owl was found to be high (3636 prey items) during the first year of study and low (2521 prey items) during the next year. The total prey consumption of rodents of agricultural importance constituted, 3199+1899 (total 5098 prey items) during the study period (Table 1).

Prey items - proportion

The prey spectrum observed in the diet of Barn Owls, in terms of proportion is summarized in Table 2. The mean percentage of prey composition of Barn Owl's diet were to the tune of 32.79 for *B. bengalensis*, 29.40 for *M. meltada*, 3.90 for *M. booduga*, 2.15 for *T. indica*, 6.38 for *R. rattus* and 6.99 for unidentified rodent species. Among the total prey items, the rodents of agricultural importance accounted for 81.61% of total prey consumption during both years of study. It should also be noted here that during the first year of study, *M. meltada* were consumed by the Barn Owls in great numbers than *B. bengalensis*, though, during the second year, *M. meltada* was replaced by *B. bengalensis* (Table 2).

Earlier, consumption of small mammals by Barn Owls have been reported by Evans & Emlen (1947), Marti (1974), Colvin (1984), Knight & Jackman (1984), Lenton (1984), Pikula *et al.* (1984), Colvin & McLean (1986), Rosenberg (1986), Campbell *et al.* (1987), Smal (1987), Marti (1988), Manning & Knox Jones (1990), Neelanarayanan *et al.* (1995), Taylor (1994), Santhanakrishnan (1995). The observed dominance of *B. bengalensis* and *M. meltada* in food composition of Barn Owl could be attributed to their high incidence in different crop fields. Sivaprakasam (1988) and Kanakasabai *et al.* (1995) have also found that *B. bengalensis* was a dominant vertebrate pest of different crops cultivated in Cauvery delta, Tamil Nadu, followed by *M. meltada* and *M. booduga*. These three rodent pests formed 66.09% of total food composition of Barn Owl as reported in the present study. In addition to small mammals, the Barn Owl's diet comprised representatives of amphibians, birds and insects and this observation is in concurrence with those of Santhanakrishnan (1987, 1995) Taylor (1994) and Neelanarayanan *et al.* (1995).

The results of the present study imply that Barn Owls have their own prey option, but still are opportunistic predators, which is in accordance with those of Mikkola (1983), Hegdal & Blaskiewicz (1984) and Manning & Knox Jones (1990)

Prey items - biomass

Earlier, Kanakasabai *et al.* (1998) reported that the wet mean prey body weight of the six species of small mammals as 81.39±56.55 (Range=10-250 & n=142) for *B. bengalensis*, 60.61±35.84 (Range=10-95 & n=153) for *M. meltada*, 12.33±2.13 (Range=8-16 & n=26) for *M. booduga*, 101.81±44.79 (Range=20-210 & n=47) for *T. indica*, 98.48±40.92 (Range=25-190 & n=51) for *R. rattus* and 39.89±10.77 (Range=20-55 & n=23) for *S. murinus*. For obtaining the mean prey weight of each species, the prey frequency of each species was multiplied by the aforesaid calculated mean prey weight of that species (Kanakasabai *et al.*, 1998).

Table 1. Prey composition (in frequency from nine nesting / roosting sites) of Barn Owls revealed from pellet analysis.

	Prey Items	February 1993 To January 1994	February 1994 to January 1995	Total (February 1993 to January 1995)	Rank
Total number of pellets analysed		2288	1742	4030	
Total number of Barn Owls observed	Adults	249	168	417	
	Sub adults	64	09	73	
	Chicks	99	38	137	
	Eggs	152	111	263	
Rodents	*B. bengalensis*	977	976	1953	1
	M. meltada	1386	522	1908	2
	M.booduga	188	66	254	7
	T. indica	66	63	129	8
	R. rattus	227	166	393	6
	Unidentified Rodent Species	355	106	461	5
	Total (Rodents)	3199	1899	5098	
Insectivore	*S. murinus*	269	298	567	3
Amphibians		168	302	470	4
Birds		0	1	1	10
Insects		0	21	21	9
	Grand Total	3636	2521	6157	

Table 2. Mean percentage (based on prey frequency from nine nesting / roosting sites) of different prey items in the diet of Barn Owls

	Prey Items	February 1993 To January 1994	February 1994 to January 1995	Total (February 1993 to January 1995)	Rank
Total number of pellets analysed		2288	1742	4030	
		Values are in Mean Percentage			
Rodents	*B. bengalensis*	26.85	38.73	32.79	1
	M. meltada	38.11	20.70	29.40	2
	M.booduga	5.17	2.63	3.90	7
	T. indica	1.81	2.48	2.15	8
	R. rattus	6.24	6.53	6.38	6
	Unidentified Rodent species	9.77	4.22	6.99	5
	Total (Rodents)	87.96	75.30	81.61	
Insectivore	*S. murinus*	7.39	11.81	9.60	3
Amphibians		4.62	11.99	8.30	4
Birds		0.00	0.04	0.02	10
Insects		0.00	0.82	0.41	9
	Grand Total	99.97	99.95	99.94	

The total biomass of all small mammalian prey of Barn Owl during 24 months study period is given in Table 3. The Barn Owls consumed 3,52,184.13g of prey comprising six species of small mammals during this period; 1,58,954.67g of *B. bengalensis*, 1,15,643.88g of *M. meltada*, 3,131.82g of *M. booduga*, 13,133.49g of *T. indica*, 38,702.64g of *R. rattus* and 22,617.63g of *S. murinus*. Of these, the observed proportion of consumption of *B. bengalensis* and *M. meltada* was 45.13% and 32.84% respectively, which is more than three-fourth (77.97%) of total prey intake by the Barn Owls. It is thus confirmed that in terms of both frequency and biomass, the Barn Owls consumed rodent pests of economic importance in Cauvery delta, namely, *B. bengalensis* and *M. meltada* in larger quantities than other prey items.

Regarding total prey (g) consumption, five rodents of economic importance alone accounted for 93.57% in 24 months. Earlier, Perrins (1982), and Smith and Cole (1989) reported that five species of rodents formed 80% of diet (in terms of biomass) of Barn Owl.

According to Marti (1987), both prey frequency and biomass quantification methods are equally valuable because the former provides better information on the relative impact a raptor upon various prey species, while the latter may give a more accurate evaluation of the relative importance of different prey species in the diet. Only the small mammal representatives were considered for prey biomass quantification in the present study.

Mean prey items/pellet

The observed mean prey items/pellet (from February 1993 through January 1995) is presented in Table 4. In the present investigation, a maximum of 2.02 prey items/pellet was observed during April 1993 while a minimum of 1.06 prey items/pellet was observed during April 1994. The average observed mean prey items/pellet was 1.51 in the first year and 1.46 in the second year of study (Table 4). These results apparently reveal the fact that the Barn Owls consume more than one prey per day since they regurgitate every day and after every meal. The observations of the present investigation

Table 3. Total biomass (g) (estimated by using mean body weight of respective species) and the proportions of the small mammalian prey consumed by the Barn Owls between February 1993 and January 1995

Prey species	Total Biomass (g)	%	Rank
B. bengalensis	1,58,954.67	45.13	1
M. meltada	1,15,643.88	32.84	2
M. booduga	3,131.82	0.89	6
T. indica	13,133.49	3.73	5
R. rattus	38,702.64	10.98	3
Total (Rodents)	3,29,566.50	93.57	
S. murinus (Insectivore)	22,617.63	6.43	4
Grand Total	3,52,184.13	100.00	

Table 4. Mean prey / pellet items observed during the pellet analysis

Year/Month	1993-1994	1994-1995
February	1.22	1.46
March	1.68	1.46
April	2.02	1.06
May	1.63	1.46
June	1.41	1.63
July	1.45	1.63
August	1.43	1.75
September	1.40	1.35
October	1.69	1.48
November	1.25	1.26
December	1.12	1.38
January	1.76	1.62
Mean	**1.51**	**1.46**

are in accordance with the observations of Hamilton & Neil (1981) and Neelanarayanan *et al.* (1995).

In conclusion, the results of the present study indicate that the Barn Owls are potential hunters of rodent pests and can therefore be used for controlling rodent pests in crop fields and fallow lands. Steps should be initiated not only to protect and conserve Barn Owls but also to increase their population *in situ* by way of installing nest boxes. They should also be bred in captivity for release near crop fields after thorough investigation and in compliance with scientific reintroduction protocol base don the guidelines of the Reintroduction Specialist Group. Solid efforts are needed to include Barn Owl as one of the major components in Integrated Rodent Pest Management (IRPM), at the earliest possible opportunity.

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ENZYMATIC AND HORMONAL STUDIES IN *ACACIA EBURNEA* INFECTED WITH *RAVENELIA ESCULENTA*

K.R. Gandhe [1] and Aniket Kuvalekar [2]

[1] Reader, PG Research Centre, Department of Botany, Modern College of Arts, Science and Commerce, Shivajinagar, Pune, Maharashtra 411005, India; [2] UGC - SRF, PG Research Centre, Department of Botany, Modern College of Arts, Science and Commerce, Shivajinagar, Pune, Maharashtra 411005, India
Email: [1] kanchan.gandhe@gmail.com (corresponding author)

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Abstract

Ravenelia esculenta Naras. and Thirum. infects *Acacia eburnea* Willd. producing hypertrophy in infected parts, mainly thorns, inflorescence, flowers and fruits. The hypertrophied parts are edible and consumed with relish. The severe stages of the disease are marked by pronounced hypertrophy in the infected parts, frequently 10 times or more. The disease progress is marked by gradual increase in hypertrophy and severe stages show presence of brown aecial cups. The process of disease development was studied to analyse various biochemical changes. Enzymatic studies showed significant shifts in the activities of enzymes like Polyphenol oxidase (PPO) (EC 1.14.18.1), Peroxidase (POX) (EC 1.11.1.7) and IAA Oxidase (IAAO). Activity of PPO was found to be in accordance with the quantity of total phenols. POX activity was found to be maximum during severe infection stage. Maximum IAAO activity was noticed during initiation of hypertrophy. These studies help to reveal the enzymatic changes during disease development by fungi. Changes in IAAO activities are suggestive of possible involvement of IAA, its derivatives and GA interaction in development of hypertrophied structures.

Keywords

Acacia eburnea, disease development, GA, IAA Oxidase, Peroxidase, Polyphenol Oxidase, *Ravenelia esculenta*.

Ravenelia esculenta Naras. and Thirum. is a rust fungus that infects *Acacia eburnea* Willd. (Narasimhan & Thirumalachar, 1961). The infected organs show hypertrophy at various stages of disease development (Narasimhan & Thirumalachar, 1961). The hypertrophy is marked by presence of brown coloured aecial cups visible on the infected organ (Image 1[w]). The hypertrophied structures are edible and are consumed along with liquor. This hypertrophy is an outcome of altered host physiology and hormonal metabolism. There are reports of various host-fungus interactions that lead to alterations in the overall physiology of host. Gandhe *et al.* (2004) have screened the infected host to analyse the host-fungus interaction in *Ravenelia esculenta*. From these studies it was found that besides other metabolic alterations, the infected parts accumulate enormous amounts of aluminium and hence consumption of these infected structures pose potential threat of neural diseases like Alzheimer's disease. Shaw & Samborski (1957) have discussed the physiological changes in mildew and rust infected wheat leaves, initial increase in respiration rate being one of the early physiological responses to pathogen attack. It has been observed that fungal, bacterial and viral diseases also lead to alterations in the biochemical constituents of hosts. These may range from change in chlorophyll contents (Prasanna *et al.*, 2004) due to infection of Citrus Yellow Mosaic virus in leaves of *Citrus sinensis*, accumulation of soluble and reducing sugars due to infection of *Alternaria brassicae* to *Brassica*

[w] See Image 1[w] in the web supplement at www.zoosprint.org

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