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Cover Photo of founder of BIONOTES *Late* Dr. R.K. Varshney

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FEEDING ECOLOGY OF THE INDIAN EAGLE OWL *BUBO BENGALENSIS* (AVES: STRIGIDAE) IN LUCKNOW DISTRICT, UTTAR PRADESH, INDIA

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Reviewer: Peter Smetcek

Abstract

A study was undertaken to discover the food habits of *Bubo bengalensis* in a densely populated landscape. Mammals accounted for an estimated biomass of 86.4%; of which rodents comprised 65.1%. The diet of the owl species comprised different rodent species like *Tetera indica* (27.06%), *Rattus rattus* (24.16%), *Bandicota bengalensis* (11.60%), *Funumbulus pennanti* (0.50%) as principal food; however, *Lepus nigricolis* (18.03%), and *Suncus murinus* (1.22%) were other mammalian prey. Birds were almost significant non-mammalian prey items which formed a source of persistent food followed by anurans (3.20%) and reptilians (3.06%). Chiropterans contributed only a small portion of biomass consumed i.e. 0.96%. This study might confirm the niche components supportive of *Bubo bengalensis* populations.

Keywords: Indian Eagle Owl, Regurgitated food, Seasonal difference, Diet range, Percentage biomass

Introduction

The Indian Eagle Owl (*Bubo bengalensis*) is a large owl with prominent brown ear-tufts and is largely crepuscular and nocturnal in nature. They occur throughout peninsular India. *Bubo bengalensis* is also called the Rock Eagle Owl, the Bengal Eagle Owl or Indian Great Horned Owl. The genus *Bubo* comprises some of the world's largest species of owls which enjoy tertiary level in the food chain and are also excellent indicator organisms of the ecosystem they inhabit. The prey spectrum of only two species have been extensively studied in the northern hemisphere, *viz*., the Eurasian Eagle Owl *Bubo bubo* and *B. bengalensis* (Herrera & Hiraldo, 1976; Martinez *et al*., 1992; Martinez, 2003). The Indian Eagle Owl has received little attention in India. Owls of genus *Bubo* are nearly cosmopolitan, found everywhere except the Australian region and on south west Pacific islands, where they are replaced by *Ninox* owls, and in the Arctic. There are many short communications concerning the diet of the species that are based on casual observations (Ali, 1969, 1996; Ali & Ripley, 1987).

The aim of this study is to identify the prey spectrum and prey selection by *Bubo bengalensis* which can lay the cornerstone for further investigation. Foraging behavior of *B. bengalensis* was considered while evaluating habitat requirements and also documentation of prey species available within the foraging range of owls, because prey species availability reflects diet composition. The entire study was conducted from February, 2016 to January, 2019.

Study Area

The entire study was conducted in Lucknow district. There are some forest patches along the river Gomti like Kukrail, Musabagh, Banshigarhi, Rehmankheda, PGI campus. All these forest patches provide a good habitat for owl species. A few nesting and roosting sites were located in these forest patches. On the boundary of the forest, there are extensive agricultural fields which provide a good prey base for the owl species.

Lucknow, the capital of Uttar Pradesh, is situated 123 m above sea level. It is situated between 26.30° & 27.10° North latitude and 80.30° & 81.13° East longitude. It covers an area of 3,244 sq.km. It is surrounded on the eastern side by the district of Barabanki, on the western side by the district of Unnao, on the southern side by Raebareli and on the northern side by Sitapur and Hardoi districts. The Gomti river flows through the city. Some of the tributaries of this river are Kukrail, Loni, Beta etc. The Sai river flows south of the city and in the east enters Raebareli district. The major towns of Lucknow district are Malihabad, Gosainganj, Mohanlalganj, BakshiKaTalaab, Amethi etc. The distance from the sea gives Lucknow an extreme continental climate with the prevalence of continental air during major parts of the year. Only during the four months from June to September about 75 % of the total rainfall is realized. The summers in Lucknow are very hot and winters very cold. The temperature may rise up to about 46° Celsius in summers, though the average temperature is around 38-39° Celsius. Though the winters are not bitterly cold on most days, the temperature may fall to 3-4° Celsius for a few days in winters when the cold winds from the Himalayan region make the winters chilly. The winters are also marked by mist and fog in the mornings. (Anonymous ,2012).

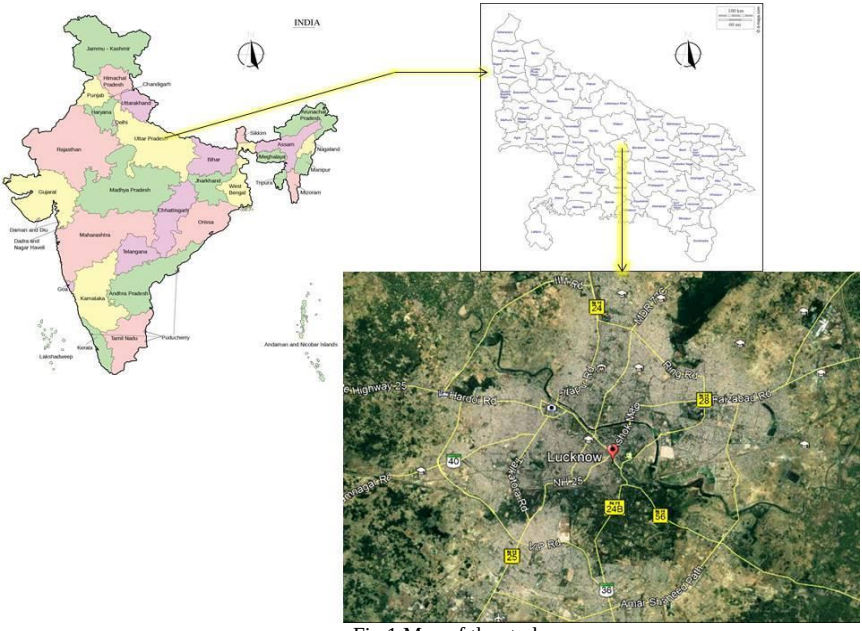

Fig.1 Map of the study area

Materials and Methods

Spots were located by secondary survey from the general public, usually residents of the areas concerned. Suspected habitats were located through discussions with Forest Department officials and villagers. Owl habitats have been surveyed throughout the district on foot at night, equipped with powerful flashlights, a DSLR Camera (Canon 70D) and binoculars (Bushnell 10x70x70). Most of the surveys were conducted along the periphery of forests on calm nights from March to October when owls are most responsive.

Although, the pellet analysis method (Errington, 1930) was the standard method for the identification of composition of diet of owls, adhering to that method will yield inaccurate estimates of overall diet of the owls, hence carcass leftovers too were analyzed (Simmons *et al*., 1991). A simple key for identification of rodents in pellets (based on structure of lower mandibles) was used to produce unbiased data of prey consumed by *Bubo bengalensis* (Ramanujam, 2004). This method was well grounded to give accurate figures of rodents and other vertebrates and non-vertebrates by including cadaver remains with heads found within their territory. Identification of prey remains in pellets considered on the reference collection and with a guide to related species (Anonymous, 1995). To identify the carcass remains of different prey items on the basis of morphological characteristics, literature was followed, *viz.*, for amphibians (Daniels, 2005), reptiles (Daniels, 1992), birds (Ali, 1996; Ali & Ripley, 1987), bats (Bates & Harrison, 1997). Arthropods were identified to family level using existing literature (Borror, 1992).

Broadcast surveys were also conducted during night to determine the presence of owls. Broadcast surveys consisted of playing breeding calls to elicit a response from owls. The collection of pellets and carcass remains were done during the day time mostly from March to August. Pellets were collected from the different locations within the study area. Each site was visited repeatedly depending upon the presence of owls.

Pellets were soaked in water and then gently teased apart. Unbroken pellets were analyzed individually. Prey species were isolated carefully and each was then separated to many sets of skull with right and left mandibles as much as possible. These along with all incomplete skeletal sets (skull, left and right mandible), were counted as an individual. The intact ones were included for dry weight analysis (Yalden & Morins, 1990). Biomass (Quantitative percentage) of food ingested was measured by dry weight analysis. The prey biomass was determined assigning to each species its average weight reported in the literature, e.g. Macdonald & Barret (1993) for mammals. For this, each food item was dried in sun for a few days so that no moisture was left. Dry weight was chosen as the standard criterion because differences in moisture content of prey items could prejudice the values (Sugden, 1973), and also because of more direct nutritional rendition (Reinecke, 1979). Standard trapping method was used to estimate the Murid population in the study area (Barnett & Dutton, 1995).

The following parameters were also calculated:

1. The percentage of the biomass of prey from pellets observed
2. The correlation between prey items in different seasons.

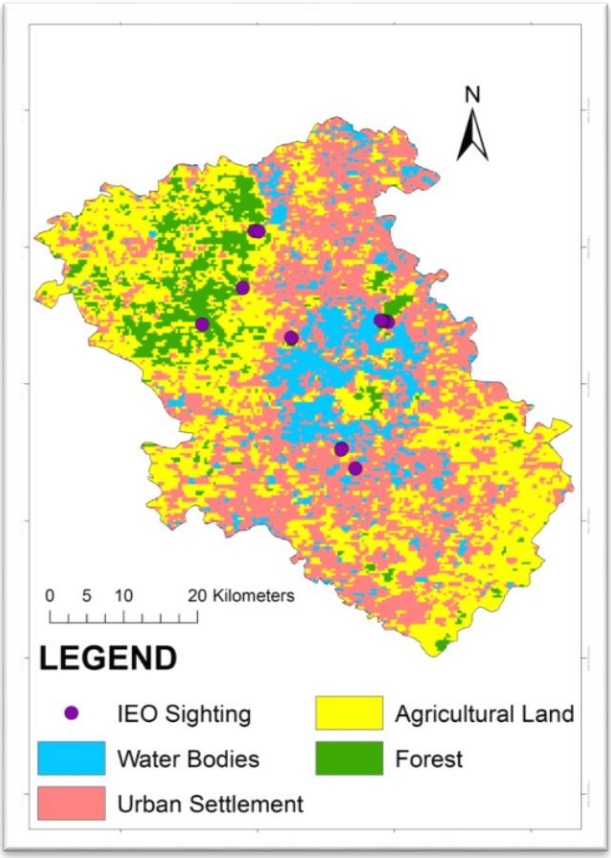

Fig.2: Map of Lucknow District

Results

A total of 1231 prey items were identified from pellets and carcass remains, accounting for a biomass (dry weight) of 63,742.27 g. Three general classes of prey were mammals, non-mammalian vertebrates and arthropods. *Tetera indica* comprised of 27.06% of biomass which was highest among all the prey items while *Rattus rattus* was the second highest prey item that accounted for 24.16% of biomass. *Lepus nigricollis* was the third highest prey biomass comprising 18.03%. Among all the prey items, *Tetera indica* & *Rattus rattus* were staple food items since the availability and habitat of these species were most suitable, while *Lepus nigricollis, Bandicota bengalensis* and Aves were constant food. Some other mammals, Anurans and arthropods fall in the Auxiliary and Opportunistic food items prey category for Indian eagle owls.

Table 1. The prey of *Bubo bengalensis*: compiled data from all sites

S.N.	Prey species	Total nos.	Percentage	Estimated Biomass (g)	% of biomass	Category
1	*Mus* (Linnaeus, 1758) sp., the Indian mouse	206	16.73	3 143.11	4.93	AF
2	*Rattus rattus* (Linnaeus, 1758), the black house rat	115	9.34	15 400.7	24.16	SF
3	*Milardia meltada* (Gray 1837), the soft – furred rat	33	2.70	129.9	0.20	OF
4	*Tetera indica* (Hardwicke, 1807), the Indian gerbil	286	23.23	17 250.4	27.06	SF
5	*Bandicota bengalensis* (Gray, 1835), the lesser bandicoot rat	288	23.40	7 394.5	11.60	AF
6	*Funambulus pennanti* (Wroughton 1905), the northern palm squirrel	36	2.91	319.2	0.50	OP
7	*Lepus nigricollis* F. Cuvier, 1823, the Indian hare	26	2.10	11 494.2	18.03	CF
8	*Suncus murinus* (Linnaeus, 1766), Asian House Shrew	87	7.09	779.73	1.22	OF
9	Chiroptera	13	1.05	607.62	0.96	OF
10	Aves	27	2.20	3 233.68	5.08	CF
11	*Calotes* sp.	75	6.09	160	0.26	OF
12	*Varanus bengalensis* (Daudin, 1802), Bengal monitor	14	1.13	1 786.96	2.80	AF
13	Anurans	5	0.40	2 042.25	3.20	AF
14	Coleopterans	11	0.90	*	*	OF
15	Orthoptera	9	0.73	*	*	OF

Total		1 231	100	63 742.27	100

SF (Staple food) - prey frequency >20%; CF (Constant food)- Prey frequency between 5-20%; AF (Auxiliary food) – Prey frequency between 1-5%; OF (Opportunistic food) - >1%

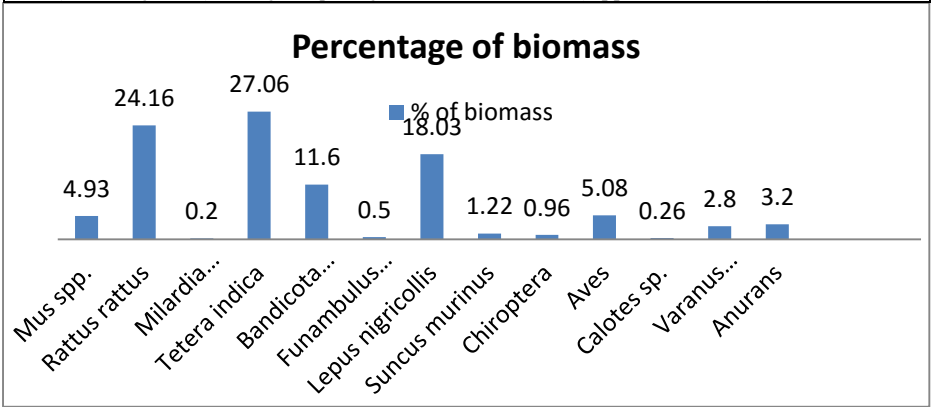

Fig.2 Percentage of biomass of the prey items

Seasonal variation in Indian eagle owl food, Lucknow, 2016-2018

Table 2. Showing seasonal variation of prey items in pellets

S. N.	Species	2016			2017			2018		Total
		Winter	Summer	Rainy	Winter	Summer	Rainy	Winter	Summer	
1	*Mus spp.*	12	24	38	15	32	41	16	28	206
2	*Rattus rattus*	36	42	23	29	51	26	42	39	288
3	*Milardia meltada*	-	1	-	-	2	-	-	-	3
4	*Tetera indica*	43	52	31	36	42	35	42	25	306
5	*Bandicota bengalensis*	16	4	19	6	17	22	13	8	115
6	*Funambulus pennanti*	-	1	2	-	2	-	-	1	6
7	*Lepus nigricollis*	7	3	-	5	1	-	8	2	26

8	*Suncus murinus*	5	8	1	1	6	-	7	9	37
9	*Chiroptera*	1	3	1	2	4	-	3	-	13
10	Aves	7	1	2	6	5	4	2	-	27
11	*Calotes sp.*	-	2	-	1	2	-	-	-	5
12	*Varanus bengalensis*	-	1	6	-	2	4	-	1	14
13	Anura	-	-	42	-	-	33	-		75
14	Coleoptera	-	29	18	-	27	22	-	2	98
15	Orthoptera	-	2	5	-	2	3	-	-	12
Total		127	176	188	107	195	190	133	115	1231

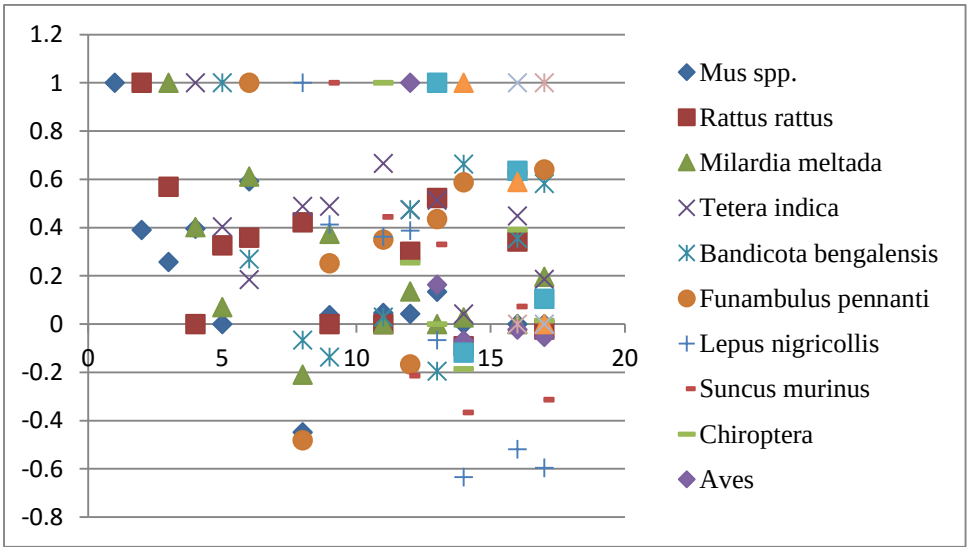

Fig. 3 Value of correlations between prey items

Table 3. Correlation between prey items

	Mus spp.	*Rattus rattus*	*Milardia meltada*	*Teterai ndica*	*Bandicota bengalensis*	*Funambulus pennanti*	*Lepus nigricollis*	*Suncus murinus*	Chiroptera	Aves	*Calotes sp.*	*Varanus bengalensis*	Coleoptera	Orthoptera
Mus spp.	1													
Rattus rattus	0.39	1												
Milardia meltada	0.257	0.569	1											
Teterai indica	0.395	.836**	0.402	1										
Bandicota bengalensis	.719*	0.327	0.071	0.40300	1									
Funambulus pennanti	0.592	0.358	0.612	.18400	0.269	1								
Lepus nigricollis	-0.448	0.422	-0.209	.48900	-0.066	-0.481	1							
Suncus murinus	0.037	.776*	0.374	.488	-0.137	0.252	0.413	1						

Chiroptera	0.047	.695*	.742*	0.6660	0.0291	0.351	0.362	0.445	1					
Aves	0.043	0.3	0.136	.47400	0.475	-0.167	0.388	-0.213	0.255	1				
Calotes sp.	0.134	0.523	.869**	0.5130	-0.195	0.436	-0.066	0.331	.772*	0.164	1			
Varanus bengalensis	.827**	-0.091	0.028	0.043	0.663	0.588	-0.634	-0.366	-0.186	-0.068	-0.118	1		
Coleopterans	.702*	0.342	.694*	0.449	0.356	0.627	-0.519	0.073	0.391	-0.023	0.636	0.589	1	*
Orthoptera	.783*	-0.023	0.196	0.186	0.582	0.641	-0.596	-0.313	0.015	-0.053	0.105	.956**	.743*	1

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Discussion

An aggregate of 166 prey articles were identified from pellets, pellet remains 84 from Arunachala Hill and 82 from Pondicherry University campus with biomass from pellet and prey remnants was 22,620.17g, 11,240.59g from Arunachala and 11,379.58g from Pondicherry University. Out of the 166 prey items 102 were small mammals accounting for a biomass of 13,973.90g, 5,616.83g (49.94%) from Arunachala and 8,357.07g (73.42%) from Pondicherry University. The murid rodents dominated 44.99% in Arunachala and 70.13% in Pondicherry University while the anurans followed for a collective biomass of 12.87% in

both areas. The others Coleoptera, Orthoptera and *Paratelphusa* sp. accounted for an insignificant biomass of 0.51% (Ramanujam *et al.,* 2017). Siva *et al.* (2019) studied and analyzed 1082 regurgitated pellets returned 2077 prey items with a mean of 1.91. The diet constituted 65.1% of rodent prey and the remaining 34.83% of vertebrate and invertebrate animals. The mean percentage of prey composition was maximum 31.15% *Millardia meltada* Soft-furred Field Rat, 12.95% *Bandicota bengalensis* Lesser Bandicoot Rat, 10.25% *Mus booduga* Indian Field Mouse, and 10.24% of other rodent species progressively. The 34.83% of non-rodent prey, the owls ingested insects (Rhinoceros beetles, 9.58%), Arachnida (Solifugae or Sun spider, *Galeodes* sp., 9.58%), reptiles (*Calotes* sp., 3.7%), amphibians (3.56%), shrews (*Suncus murinus*, 2.84%), and others (5.57%).The studies and analysis of the diet suggests that the Indian Eagle Owl is a dietary generalist (Ali & Ripley, 1969; Ramanujam, 2006). The various species of rodent prey, which formed the major part of the diet of the owls were 55% relative abundance and 85% total biomass (Jain *et al*. 1993; Parshad, 1999). Different samples of pellets show significant highly positive relationship (α =0.01) include *Tetera indica* with *Rattus rattus* (r=0.836), *Milardia meltalda* with *Calotes* spp. (r=869), *Mus* spp. with *Varanus bengalensis* (r=.827) and Orthoptera with Coleopterans. Other sample of pellets show significant relationship (α=0.05) include *Mus* spp. with *Bandicota bengalensis* (r=.719), *Suncus murinus* with *Rattus rattus* (r=.776), Chiroptera with *Rattus rattus* (r=.695), Chiroptera with *Milardia meltada* (r=.742), Calotes with Chiroptera (r=.772), Coleopterans with *Rattus rattus* (r=.702), and Orthopteran with Coleopterans (r=.743).

Conclusion

In the present study, the diet constituted 65.1% of rodent prey and the remaining 34.83% of vertebrate and invertebrate animals. Among all the prey items *Tetera indica* & *Rattus rattus* were found to be staple food items due to its availability while *Lepus nigricollis, Bandicota bengalensis* & Aves were constant food. Some other mammalian, Anurans and arthropods were found in Auxiliary and Opportunistic food items category. *Tetera indica* were included in most abundant food item preyed upon by Indian Eagle Owl. After *Tetera indica*, *Rattus rattus* was the second highest prey item in food that accounted for second highest biomass. *Lepus nigricollis* was the third highest prey biomass comprising 18.03%.

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