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COMMUNICATION

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COMMUNICATION

Seasonal prey availability and diet composition of Lesser Asiatic Yellow House Bat *Scotophilus kuhlii* Leach, 1821

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Abstract: Diet is an important factor in understanding bat ecology and conservation. This study assessed seasonal prey availability and diet composition of the Asiatic Lesser Yellow House Bat *Scotophilus kuhlii* in various districts of Uttar Pradesh between January 2016 to December 2018. Fecal and insect samples were collected seasonally using sweep nets between 1800 and 1900 h. From each location 20 fecal pellets were selected for analysis and searched for taxonomically recognizable remnants. The analysis revealed that *S. kuhlii* fed on Coleoptera, Diptera, Hymenoptera, Isoptera, Orthoptera, Odonata, Blattodae, Lepidoptera, and Hemiptera, identified from legs, antennae and wings/elytra in fecal pellets. Seasonal variation in the presence of isolated insect remnants and insect abundance at foraging grounds was observed. Thus *S. kuhlii* is a voracious feeder and plays an important role as a pest control agent.

Keywords: Food item, insect abundance, remnants, season

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Competing interests: The authors declare no competing interests.

Author details: Shani Kumar Bhartiy has completed his PhD on “Effect of urbanization of roosting, feeding and reproductive behaviour of Asiatic Lesser Yellow Bat, *Scotophilus kuhlii*” and currently working on roosting ecology of insectivorous bats. V. Elanovan is Professor in the Department of Zoology, Babasaheb Bhimrao Ambedkar University, Lucknow, Uttar Pradesh and working on behavioural ecology of bats for the last two decades. VE is currently working on “conventional and alternative reproductive strategies of Indian Flying Fox”.

Author contributions: SKB performed the experimental work and data analysis and drafted the manuscript. VE designed the experiment and edited the manuscript.

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INTRODUCTION

Foraging behavior has a vital role in evolutionary biology and ecology, with major contributions to survival, growth and reproductive success (Kramer 2001). Bats are nocturnal animals with many endangered and declining species throughout the world (Voigt et al. 2016). They are important components of ecosystems, acting as predators and seed dispersing agents (Kalka & Kalko 2006; Tang et al. 2008). Insectivorous bats are usually classified according to their foraging strategy as aerial hawkers, or as foliage gleaners such as *Myotis nattereri. Barbastella barbastellus* (Findley 1993; Patterson et al. 2003). Several kinds of nocturnal insects, such as moths, mantids, lacewings, orthopterans, and beetles, have evolved tympanic organs that are sensitive to bat echolocation calls (Fenton et al. 1998).

One of the important factors in understanding bat ecology and conservation is diet. Insect abundance can change due to factors such as climate changes and variation in the availability of food resources in surrounding habitats (Wolda 1988), which ultimately effects diversity and abundance of bat food resources (Hails 1982; Janzen & Pond 1975; Kingslover 1989; Tulp & Schekkerman 2008). Several studies have reported that tropical insects undergo seasonal changes in abundance, at least for those parts of the tropics where seasons are alternate (Dobzhansky & Pavan 1950; Owen & Chanter 1970, 1972; Janzen & Pond 1975; Wolda 1978). Whitaker (1995) suggested that insectivorous bats generally select among available food, but become more opportunistic when food becomes limited.

Michal et al. (2012) reported that *Myotis nattereri* consumed food highest in late summer and early autumn and lowest in cold weather. The most common insect orders consumed by bats are Coleoptera, Lepidoptera, Diptera, Hymenoptera, and Isoptera (Verts et al. 1999; Pavey et al. 2001). Bats have several morphological adaptations that allow them to capture and handle prey in flight and their teeth are also a more important component for chewing (Evans & Samson 1998). While wing morphology helps the bats to do various maneuvers during flight (Norberg & Rayner 1987) direct observation of foraging behaviour of insectivorous bats typically is not possible hence most authors have necessarily used fecal pellet analyses to quantify diet compositions (Whitaker et al. 1977). However, a thorough understanding of prey use among insectivorous bats requires knowledge of prey availability in surrounding habitats. Understanding the foraging ecology of insectivorous bats is further hindered by limited knowledge of how diet varies within species.

Diet composition is influenced by food availability, seasonal variations, and strategies with which a particular bat species responds to these changes (Swift & Racey 1983; Shiel et al. 1991; Catto et al. 1994). Insectivorous bats may indicate flexible exploitation of available food resources in the diet composition, foraging occasionally and less selective feeding (Belwood & Fenton 1976; Swift et al. 1985; Rydell 1986; Hoare 1991). Among the prey categories, they consume large quantities of lepidopterans (moths), coleopterans (beetles), dipterans (flies), homopterans (cicadas, leafhoppers), and hemipterans (true bugs) (Anthony & Kunz 1977; Ross 1961; Leelapaibul et al. 2005) which are mostly pests of agro crops (Harris 1970). Bats are therefore known as ravenous feeders of nocturnal insects which damage a large number of crops annually (Harris 1970).

Several earlier studies reported that *Scotophilus kuhlii* foraged predominately in open environments, as well as at the edge of the cluttered environments such as the crowns of trees within the urban environment, around street lights, agriculture fields, and over water bodies (Zhu et al. 2012). It echolocates at a frequency of 45.72 kHz, can detect prey over long distances in open habitats, and may catch relatively large prey (Zhu et al. 2012). Its echolocation calls were relatively broadband frequency-modulated with the fourth harmonic up to 200 kHz during the flight (Neuweiler 1984). Thus we predicted the diet composition of *S. kuhlii* varied with season. Therefore, the main aim of this study was to access the seasonal food preference and diet composition of *S. kuhlii* in Uttar Pradesh.

MATERIALS AND METHODS

Study area

The study was carried out in various districts of Uttar Pradesh between January 2016 and December 2018. The geographical area of the state is 240,928 km^2 which constitutes 7.3% of the total area of the country. The climate of Uttar Pradesh is characterized by temperature ranging from 5°C in winter to 45°C in summer. Annual rainfall varies from 1,000 mm to 1,200 mm of which about 90% occurs from June to September which is the south-west monsoon. India is home to an extraordinary variety of climatic regions, ranging from tropical in the south to temperate and alpine in the Himalayan north, where elevated regions receive sustained snowfall in the winter.

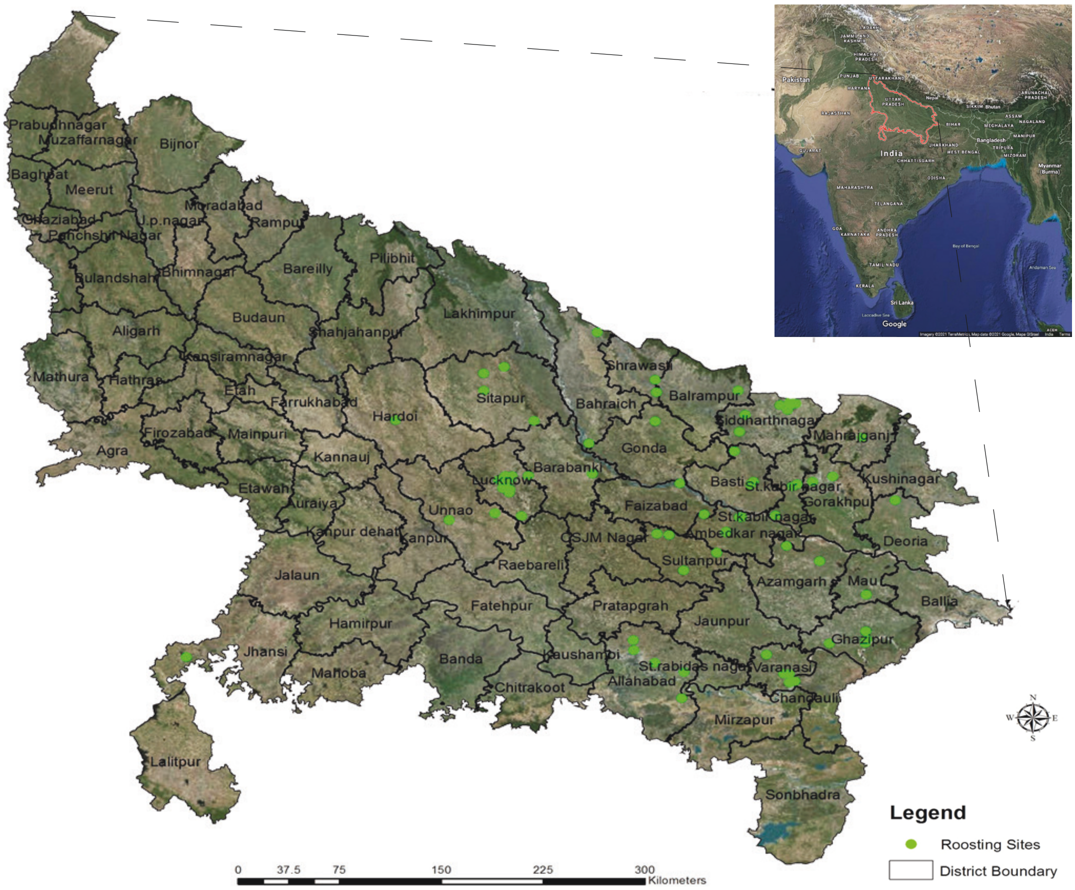

Figure 1. Map of the study area (Uttar Pradesh). Green circles represent sampling locations.

Sample collection

The fecal pellets were collected seasonally by spreading polythene sheets (10 x 14 cm) on the attic floor and in front of the roost entrance at 216 roosts in 24 districts (Figure 1). Fecal pellets from these roosts were collected in the summer months (March–June), monsoon (July–October) and winter (November–February). Sampling was performed in the morning after the bats returned to the roost, at about one-month interval at various roosting sites of Uttar Pradesh, which is the biggest state of India. Simultaneously, we collected insects from foraging grounds surrounding the roosting sites using sweep nets (radius 20 cm) from 1800 to 1900 h in the evenings where possible. All investigated roosts were located near man-made structures including monuments, abandoned buildings, temples, and trees where bats hunted for prey. From each location, average one gram pellets approximately 25 to 50 pellets were collected, and among them, only 20 pellets were taken at random and analyzed monthly.

Pellet analysis

We collected fresh guano pellets only, and thus the date of collection reflected recent diets. Fecal pellets were soaked in distilled water, then completely dissected with a needle, forceps, and tweezers and searched for recognizable remnants. The analysis was done using a light microscope (BR BIOCHAM, 1402923) with 10x magnification. The identification of remnants was done examining legs, antennae, and wings or elytra. Members of Arthropoda were identified to the order as well as family level using published identification guides and keys (Mroczkowski 1955; Trojan 1957; Pławilszczikow 1972; Smreczyński 1976; Stebnicka 1978; Trautner & Gaigenmuller 1987; Prashad 2010). We made permanent slides of identified insect parts and matched the remnants for confirming order and families. The remaining pellets were kept at -4 °C for further analysis. Results are expressed in terms of relative frequency of occurrence;

Percentage frequency (%F): This is the number of occurrences of the category, divided by the number of samples analyzed, multiplied by 100. Whereas for percentage volume (%V): Sum of individual volume divide by total volume of the sample multiplied by 100 following the formulae given by Whitaker (1988). The food items were categorized into three classes based on the frequency of remnants: basic food (>20%), constant food (5–20%), chance food (<5%) as described by Ramanujam & Verzhutskii (2004). Insect availability was categorized based on the total captured insects a month, namely, absent (0), rare (<5), common (5 to 10) and abundant (>10). Kruskal Wallis H test (KW) was applied to determine diet variation and seasonal variation based on the frequency of each dietary item, at p <0.05 significance level (SPSS, 21).

RESULTS

Seasonal food preference by *S. kuhlii*

A total of 11 families of insects were identified corresponding to nine insect orders based on the leg, antenna, and wing or elytral fragments (Table 1). About 3,048 isolated remnants from a total of 720 pellets were analyzed. A total of 26.83% of remnants could be identified to order and family level; the remaining 73.5% remnants were unidentified.

Insect orders consumed by *S. kuhlii*

The percentage frequency of identified remnants of prey items consumed by *S. kuhlii* during summer, showed that Order Coleoptera (39%), Diptera (25%), and Lepidoptera (23%) formed basic food, followed by Orthoptera (19%), Isoptera (14%), Hemiptera (11%), Hymenoptera (11%), Odonata (5.8%), and Blattodea (7.8%) forming the constant food of total frequency in the sample, while no chance food items were encountered in the fecal pellets in summer (Figure 2). Followed by monsoon, two most important insect orders such as Lepidoptera (47%). Coleoptera (43%), Orthoptera (27%), and Diptera (21%) were forming the basic food of the total frequency of the sample. While Hymenoptera (13.5%), Isoptera (10%), and Hemiptera (10%) were forming the constant food and Odonata (6.7%) and Blattodae (1.5%) formed the chance food of the total frequency in the sample (Figure 2). In winter, Coleoptera (30%) and Hemiptera (25%) were forming the basic food of the total frequency of consumed diet in the sample. Orders Diptera (5.1%), Orthoptera (8.3%), and Lepidoptera (14%) were forming the constant food, and, Hymenoptera (2.6%), Isoptera (1.5%), and Odonata (1.5%) formed the chance food of the total frequency of consumed diet in the sample (Figure 2).

The percentage volume of remnants of prey items consumed by *S. kuhlii* during the summer showed that the orders Coleoptera (11%), Diptera (6.3%), Lepidoptera (5.632%), Orthoptera (5.3%), Isoptera (3.5%), Hemiptera (2.8%), Hymenoptera (2.5%), Blattodea (2.3%), and Odonata (1.3%) total percentage volume in the summer sample (Figure 4). Monsoons, followed by Coleoptera (10%), Lepidoptera (9.8%), Orthoptera (5.9%), Diptera (5.1%), Hemiptera (2.9%), Hymenoptera (2.7%), Isoptera (2.3%), Odonata (1.7%) Hymenoptera (2.7%), and Blattodea (0.28%) total percentage volume in the monsoon sample (Figure 4). In winter, Coleoptera (7.3%), Hemiptera (4.6%), Lepidoptera (2.9%), Orthoptera (1.8%), Odonata (1.4%), Diptera (0.75%), Hymenoptera (0.46%), and Isoptera (0.37%) the total percentage volume in the winter samples, consumed by *S. kuhlii* (Figure 4).

Insect families consumed by *S. kuhlii*

The percent frequency of insect families consumed by *S. kuhlii,* such as Gryllidae (25.18%) formed basic food, while Cerambycidae (7.03%), Culicidae (8.88%), Apidae (5.92%), Termitidae (10.37%), Acrididae (15.18%), Erebidae (13.33%), and Pentatomidae (5.55%) formed constant food, and, Formicidae (4.07%) and Crambidae (4.44%) formed chance food of the total frequency in the sample in summer (Figure 3). In the monsoon, Crambidae (21.70%) formed basic food, followed by families Culicidae (9.75%), Formicidae (11.95%), Termitidae (10.24%), Acrididae (7.07%), Gryllidae (14.14%), Erebidae (8.04%), & Pentatomidae (9.02%) forming constant food, and Cerambycidae (4.14%), & Apidae (3.90%) formed chance food (Figure 3) of the total frequency of the sample. In the winter, families Cerambycidae (15.52%), Apidae (6.21%), Acrididae (10.55%), Erebidae (18.01%), Crambidae (17.39%), Lasiocampidae (11.80%), & Pentatomidae (12.42%) formed constant food, and Culicidae (3.72%) & Termitidae (1.86%) formed chance food (Figure 3).

A significant variation was observed over seasons among the families of insects consumed by *S. kuhlii* such as Culicidae (H= 19.16, p <0.001), Formicidae (H= 22.92, p <0.001), Termitidae (H= 6.67, p <0.035), Acrididae (H= 5.74, p <0.05), Gryllidae (H= 24.51, p <0.0001), Crambidae (H= 24.86, p <0.0001), Lasioampidae (H= 22.82, p <0.0001), & Pentatomidae (H= 8.52, p <0.014) except Cerambycidae (H= 1.38, p <0.50), Apidae (H= 1.83, p >0.399), & Erebidae (H= 1.74, p <0.41) (Figure 3).

Table 1. The mean and SD of partially digested insect fragments consumed by *Scotophilus kuhlii* in three different seasons in Uttar Pradesh, India.

		Summer			Monsoon			Winter	
	Wings	Antenna	Legs	Wings	Antenna	Legs	Wings	Antenna	Legs
Order	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Col	15.8 ± 2.87	18.0 ± 9.12	2.5 ± 1.73	21.7 ± 2.08	19.7 ± 6.65	2.7 ± 3.78	10.2 ± 3.83	10.8 ± 5.93	0.6 ± 0.89
Dip	5.8 ± 2.21	6.5 ± 2.38	0.7 ± 0.95	16.7 ± 1.52	9.0 ± 3.46	-	5.8 ± 1.30	3.4 ± 0.54	0.8 ± 1.30
Hym	14.3 ± 3.77	12.0 ± 1.25	0.3 ± 0.50	11.3 ± 4.16	13.3 ± 3.21	-	6.6 ± 4.15	7.4 ± 2.88	-
Iso	3.0 ± 1.82	4.5 ± 1.20	0	5.0 ± 2.64	6.7 ± 1.52	-	5.0 ± 2.64	6.7 ± 1.52	-
Ort	10.3 ± 3.68	10.5 ± 1.91	2.5 ± 3.00	11.3 ± 5.68	14.3 ± 3.21	0.3 ± 0.577	5.4 ± 2.07	7.4 ± 2.70	-
Odo	8.5 ± 2.88	10.5 ± 3.31	1.5 ± 1.91	10.0 ± 3.00	12.0 ± 2.00	0.7 ± 0.577	3.8 ± 2.04	6.4 ± 2.70	0.4 ± 0.89
Bla	11.5 ± 30	3.8 ± 2.36	0.25 ± 0.50	6.7 ± 1.15	9.7 ± 6.42	-	3.8 ± 2.38	3.4 ± 1.14	-
Lep	7.3 ± 3.09	7.0 ± 2.94	0.5 ± 1.00	6.3 ± 1.52	10.3 ± 5.68	-	5.6 ± 1.51	5.2 ± 1.09	0.4 ± 0.54
Hem	10.0 ± 2.94	6.5 ± 0.57	0.75 ± 0.95	7.3 ± 4.04	7.3 ± 4.50	-	3.2 ± 0.44	4.4 ± 1.51	-

Col—Coleoptera | Dip—Diptera | Hym—Hymenoptera | Iso—Isoptera | Ort—Orthoptera | Odo—Odonata | Bla—Blattodea | Lep—Lepidoptera | Hem—Hemiptera.

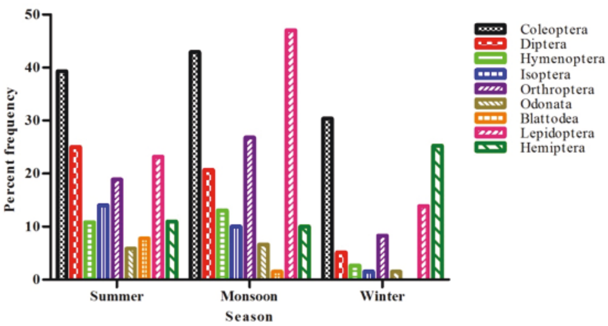

Figure 2. The percent frequency of insect orders consumed by *Scotophilus kuhlii*.

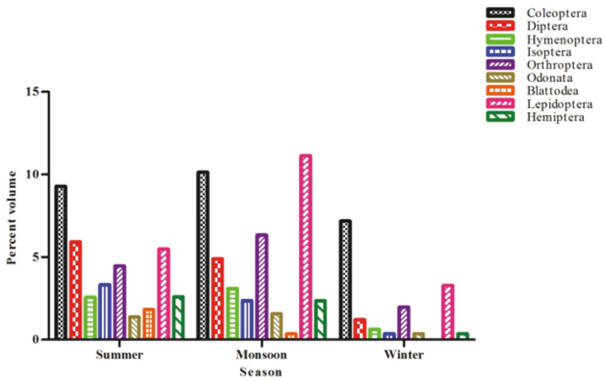

Figure 4. The percent volume of insect remnants consumed by *Scotophilus kuhlii*.

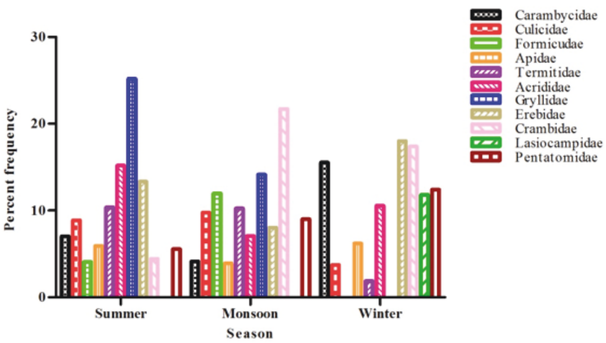

Figure 3. The percent frequency of insect families consumed by *Scotophilus kuhlii*.

Seasonal prey availability at foraging grounds

A total of 23 insect families corresponding to nine orders were captured from various foraging grounds. A statistically significant variation in insect abundance was observed with respect to seasons in the foraging grounds. Lepidopterans were the most dominant at all locations with family Erebidae (H= 2.07, p >0.35) being abundant in March, October and November and common in January months, followed by Crambidae (H= 1.32, p >0.51) which was more abundant in October and November and common in February. Family Geometridae (H= 5.34, p >0.69) was more abundant in April and October, while in the remaining months it was rare or absent, similarly, family Noctuidae (H= 0.29, p >0.96) was more abundant in May and October while in remaining months, it was rare or absent. Family Limcadidae (H= 5.96, p <0.05) was more abundant in October month and rare in September and November months. Family Lasiocampidae (H= 3.08, p >0.21) was more abundant in December and common in March and September months (Table 2). Hemiptera, was second most captured in the whole sampling, with family Cicadellidae (H= 3.14, p >0.200) being more abundant in October and common in December; family Reduviidae (H= 1.56, p >0.45) was more abundant in

Table 2. Insect abundance at various study sites.

Taxon		Summer				Monsoon				Winter			
Order	Family	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb
Coleoptera	Elmidae	0	0	0	*	***	*	*	0	0	0	0	0
Coleoptera	Cerambycidae	0	0	0	0	0	0	0	*	**	**	0	0
Coleoptera	Carabidae	**	***	*	0	0	0	0	0	0	0	0	0
Diptera	Culicidae	*	**	0	**	***	**	0	0	0	0	0	0
Diptera	Tipulidae	0	0	*	**	***	**	*	*	*	0	0	0
Hymenoptera	Apidae	0	*	***	**	***	*	0	0	0	0	0	0
Hymenoptera	Formicidae	0	0	*	**	***	*	0	0	0	0	0	0
Isoptera	Termitidae	0	0	*	***	***	*	0	0	0	0	0	0
Orthoptera	Acrididae	***	***	***	**	**	0	***	0	0	0	0	**
Orthoptera	Gryllidae	0	***	***	***	***	0	***	0	0	0	0	0
Odonata	Anisoptera	0	0	0	*	**	**	***	0	0	0	0	0
Lepidoptera	Erebidae	***	*	0	0	0	0	0	***	***	0	**	*
Lepidotera	Crambidae	*	*	*	0	*	*	*	***	***	0	0	**
Lepidotera	Geometridae	*	***	*	0	0	0	0	***	0	0	0	0
Lepidotera	Noctuidae	0	*	***	*	0	0	0	***	*	*	0	0
Lepidotera	Limcadidae	0	0	0	0	0	0	*	***	*	0	0	0
Lepidotera	Cicadillidae	0	0	0	0	0	0	0	***	*	**	0	0
Lepidotera	Lasiocampidae	**	0	0	0	0	0	**	0	*	***	0	0
Hemiptera	Reduviidae	***	*	*	0	*	0	***	*	*	*	0	0
Hemiptera	Pentatomidae	0	***	0	0	***	*	***	0	0	0	0	0
Hemiptera	Lygacidae	0	0	0	0	0	***	**	*	0	0	0	0
Hemiptera	Ischneumonidae	*	0	0	0	0	0	***	0	0	0	*	*
Mantodea	Mantidae	*	0	0	0	0	0	0	0	0	0	*	***

The insect abundance was classified as: Absent (0), Rare (*), Common (**), Abundant (***).

March and September, while in remaining months it was rare, followed by, Pentatomidae (H= 10.15, p >0.006) that was more abundant in April, July, and August. Family Lygaeidae (H= 11.22, p <0.004) was more abundant in August and common in September month, whereas Ischneumonidae (H= 0.58, p >0.74) was more abundant only in September. Coleoptera, was the third most captured insect order during sampling, including family Elmidae (H= 10.30, p <0.006) was more abundant in July and rare in June, August, and September; Carambycidae (H= 8, p <0.014) was common in November and December, and Carabidae (H= 1.32, p >0.51) was more abundant in April and common in March. Among Dipterans, family Culicidae (H= 6.91, p <0.031) was more common in April, June, and August, and abundant in July, whereas, Tipulidae (H= 13.61, p <0.001) was more abundant in July and common in June and August (Table 2). Among Hymenopterans, Apidae (H= 10.71, p <0.005) was more abundant in May and July and common in June, whereas Formicidae (H= 6.09, p <0.047) was more common in June and abundant in July month (Table 2). Among Isoptera, Termitidae (H= 4.94, p >0.08) was more abundant in June and July while rare in May and August than any other month (Table 2). Among Orthopterans, Acrididae (H= 11.38, p <0.003) was more abundant in March to May and September, while it was common in June, July, and February. Family Gryllidae (H= 12.03, p <0.002) was abundant in April to July and September than any other month (Table 2). Among Odonata, Anisoptera (H= 19.02, p <0.001) was more common in July and August while more abundant in September. Among Mantodea, family Mantidae (H= 5.14, p >0.76) was more abundant in February and rare in March than any other month (Table 2).

DISCUSSION

In the present study, a clear seasonal variation was observed in the diet of *S. kuhlii*. Studies by Barclay (1985), Ramanujam & Werzuski (2004), and Zhu et al. (2012) showed that *S. kuhli* fed mainly on Hemiptera and Coleoptera; Coleoptera (most often); Hemiptera, Coleoptera, Odonata, Homoptera and Trichoptera, respectively. Srinivasulu et al. (2010) reported that this species mainly feeds on Diptera, Coleoptera, and Hymenoptera, which include Anisopodidae, Chironomidae, Culicidae, Scatophagidae, Carabidae, Scarabidae, and Ichnemonidae. The results of our study showed that in Uttar Pradesh, *S. Kuhlii* fed mainly Coleoptera, Lepidoptera, Orthoptera, Diptera, Hemiptera, and Hymenoptera in all seasons. Our study showed that families Gryllidae and Acrididae were major foods in the diet of *S. kuhlii*, while Erebidae, Termitidae, and Culicidae were secondary foods in summer. Family Acrididae (Grasshopper) was maximum captured in March to September, and disappeared August to January, while Gryllidae (Crickets) were maximum captured in April to September and disappeared from August to March, and Culicidae was maximum captured in July, June, and April. Some small insect groups are not consumed by bats even if they are very abundant in their habitats (Pereira et al. 2002; Jaskuła & Hejduk 2005) because they provide lower energy content compared to larger prey items. Our study showed that Apidae and Formicidae were preferred by *S. kuhlii* in summer. Andreas et al. (2012) reported low diversity and abundance of the food supply during the winter, with diversity and abundance peaking in the summer season. Our result showed Crambidae, Gryllidae, Formicidae were major food items in the diet of *S. kuhlii* in the monsoon season. Though, Crambidae (Grass-moths) was captured maximum in October and November and totally absent in December and January and again appeared in February to May but was rare, Gryllidae (Crickets) were maximum captured in April to July and September, Formicidae (Ants) were captured maximum in July, disappeared September to April and appeared again in May as the third major food item in the diet of *S. kuhlii* in the monsoon. Lynch et al. (1988) reported that Formicidae peak in June, but species richness was nearly as high in May, July and August. Whitaker et al. (1994) reported that ants were the most consumed prey, followed by Coleoptera and Lepidoptera. Our result showed Erebidae, Crambidae, Lasiocampidae, Cerambycidae, Pentatomidae, and Acrididae were the major food items in *S. kuhlii's* diet in the winter when other prey were limited. Kunz et al. (1995) reported that moths have highly fatty body and are a more energy-rich source, therefore bats feed maximum on them. More moths were fed on by *S. kuhlii* in winter, which helps during breeding when more energy is required.

Insectivorous bats deliver economically valuable ecological services and decrease health risks to humans by reducing dependence on pesticides. Leelapaibul et al. (2005) reported that insectivorous bats act as biological pest control agents in the agricultural fields, feeding on pests belonging to Homoptera, Lepidoptera, Hemiptera, and Coleoptera in farms. Our study showed that *S. kuhlii* consumed several types of insects belonging to Coleoptera, Diptera, Isoptera, Hymenoptera, Orthoptera, Odonata, Blattodae, Lepidoptera, and Hemiptera and may be a good pest controlling agent. A study on *Scotophilus leucogaster* by Barclay (1984) showed that it had a varied diet from throughout the year as well as from season to season and night to night. These changes in diet and dietary diversity likely correspond to changes in insect abundance and distribution. The diet of *S. kuhii* and collected insect abundance showed a correlation in the seasonal variation which occurred due to choice of prey related to habitat use by *S. kuhlii* and climatic conditions.

CONCLUSION

Scotophilus kuhlii is a medium sized insectivorous bat. It fed on 11 families of insects corresponding to nine orders. Although 23 families of insects belonging to eight orders were collected from the foraging grounds, it was observed that this species consumed few families among the captured insect families at the foraging grounds. The diet of *S. kuhii* and collected insect abundance showed a correlation between seasonal variations in diet choice. The results revealed that *S. kuhlii* is an opportunistic feeder, and its diet varied from season to season.

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