Life Science Informatics Publications

Research Journal of Life Sciences, Bioinformatics, Pharmaceutical and Chemical Sciences

Journal Home page http://www.rjlbpcs.com/

RJLBPCS

ISSN 2454-6348

Original Research Article **DOI:10.26479/2019.0501.78**

PREY CONSUMPTION AND DIETARY COMPOSITION OF FOUR YANGOCHIROPTERN SPECIES IN TIRUNELVELI DISTRICT

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ABSTRACT: The present study reveals that dietary composition of the *Megaderma lyra, Pipistrellus mimus, Hipposideros ater* and *Hipposideros speoris* from study area, by collecting weekly fecal samples from beneath a roosts for one year and comparing these samples. Between 2018 and 2019, we sampled droppings at 12 sites and carried out a morphological identification of prey remains. Faecal pellets samples were collected from four Yangochiropterans species were teased apart in petridishes and insect remains were identified to lowest taxonomic level possible. The result revealed that beetles, true flies, moths, butterflies, wasps, ants, bees, termites, grass hoper, cricket, aphids, true bugs and dragon flies, which belongs to the order of Coleoptera, Blattaria, Dermaptera, Diptera, Lepiptera, Isoptera, Hymenoptera, Hemiptera, Orthroptera, Homoptera, Aranae, Odonata and Neuroptera. The insect prey most frequently preyed by *H. ater* (Coleoptera 30.86%), *H. speoris* (Diptera36.24%), *M. lyra* (Blattaria 38.98%) and *P. mimus* (Coleoptera 23.17%) was respectively. The most interesting aspect of this study was that Coleoptera appeared in the diet of all species and that, albeit rarely, *M. lyra* also ate spiders. The preys were mostly preferably in beetles by Yangochiroptern bats. Yangochiropterans major select prey preference of insects (Order: Coleopetra 22.96 percent) was identified in faces.

KEYWORDS: Yangochiroptern bats, food consumption, arthropods and faecal analysis.

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1.INTRODUCTION

Of the rich diversity of vertebrate fauna, bats are unique in being the only group of mammals that, like birds, have sustained flight. One of the 26 mammalian orders, with 1300 known species worldwide, Order Chiroptera is the second largest order of mammals, comprising more than 20% of the species in the class Mammalia. The bats were divided into two sub ordinal groups Yinpterochiroptera and Yangochiroptera. Total of 128 species of bats are reported from South Asia, among the countries representing South Asia, India has more than 90% of the total bat diversity. A total of 10 species of Microchiropteran or Yangochiropterans bats was present in study area, Tirunelveli district. These bats found to roost in 211 roosts that include godowns, caves, abandoned houses, tree tents and temples. Out of 10 species 2 belongs to the family Hipposideridae (*Hipposideros speoris* and *H. ater*), one belongs to the family Megadermatidae (*Megaderma lyra*), two belongs to the family Emballonuridae (*Taphozous melanopogon* and *T. nudiventris*), four belongs to the family Vespertilionidae (*Pipistrellus mimus, P. dormeri, Scotophilus heathi* and *S. kuhli*) and one belongs to the family (*Rhinopoma hardwickaii*) Rhinopomatidae. Most of the bats were observed to inhabit in agricultural environment as it provides food and water resources. Bats have an important role in supporting global ecosystems through their dietary preferences. This is evidenced primarily through the consumption of nocturnal insects and dispersal of nutrients, pollen, and seeds. Trophic linkages can strongly influence ecosystem functioning and diversity and diet studies within predator communities can supply information on prey types and quality as well as prey overlap among predator species. Regional diet studies are especially important in understanding roles that prey availability and competition play in trophic relationships. Although dietary studies of bats are fairly common, traditional methods for determining diet of bats, such as manual examination of fecal material for insect fragments and examination of discarded fragments under feeding posts or roosts, have well-documented biases towards larger prey and/or prey with harder exoskeletons [9], [10]. Beetles (Coleoptera) and Moths (Lepidoptera) are often listed as the most common orders in bat diets [2], perhaps because they are the most abundant orders of night-flying insects. The diet of Insectivorous bats had well documented in India E.g., *Taphozous melanopogon* – [5]; *Megaderma lyra* – [14]; *Hipposideros ater*- [11]; *P. mimus* **–** [26]. The diet of Insectivorous bats had well documented in other countries; *Hipposideros speoris* – [15]; *Corynorhinus rafinesquii* - [10]; *P. subflavus, N. humeralis, L. seminolus* and *L. borealis*- [8] The objective of the present study was to investigate the diet of four species (*H. ater, H. speoris, M. lyra* and *P. mimus*), presenting the results of the analysis of a one-year collection of droppings and remnants.

2. MATERIALS AND METHODS

Study area

The diurnal roosts of Yangochiroptern bats were found to be abandoned houses, caves, roof tiles,

mines, dark hollows, disused buildings, crevices and temples from different geographical locations in Southern Tamil Nadu, India. We collected droppings at 12 roosts: 4 roosts of *H. ater* (Alwarkuichi –Sivanthiyappar temple, Sivasilanathur temple, Sankaran temple and Keelaambur Cave), 2 roosts of *H. speoris* (Alwarkurichi - Vaniayappar temple and Ambasamudram - Thirumoolanathar Thiru temple), 2 roosts of *M. lyra* (Pananchadi and Adachani abandoned houses) and 4 roost of *P. mimus* (Alwarkurichi - Agni Thirthakari temple & House, Ambasamudram & Urkadu Houses) We collected droppings at all sites between 2018 and 2019 at intervals of one or two weeks. Dietary habit study on *H. ater, H. speoris, M. lyra* and *P. mimus* was done by faecal pellet analysis and examination of culled parts collected beneath the roost. Stomach content analysis was not preferred to avoid unnecessary killing of bats. Fresh faecal pellets were collected from the day roost by spreading polythene sheets once in a fortnight. Faecal pellets was randomly selected and their dried weight (0.15gm) was taken to 0.01gm accuracy by using digital balance (OHAUS-USA). Each pellet was placed in a petri dish and four or five drops of 10 percent KOH were added directly to the pellet. The pellet was teased apart with in two to three minutes and covered in 70 percent ethanol. We systematically searched each pellet for identifiable material under a low power (10-40X) bionucular microscope. Prey items were identified to the lowest taxonomic level possible. We did not record Lepidoptera as present in a pellet if only traces of scales were identified. We counted all identifiable wings, legs and head fragments of each taxon in each pellet and measured the length (mm) of each intact wing. We collected discarded remains of prey items of bats from the floor of the day roosts at least once weekly. Percent volume was established visually, and data were expressed accordingly (sum of individual volumes each food item, divided by the sum of total volume, times 100). Percent volume indicated the relative amount of each food in each sample (Whitaker, 1988). We collected remains after bats departed the roosts at dusk (day roosts) or at dawn (night roost), by thoroughly searching the floor of the roost with the aid of a head light. Reference collections of insects from the study area were made using light traps and sweep nets for species identification. Beetles entangled in mist nets were also collected. The frequency of particular components of food consumed was assessed according to a pre-established system in place for calculating the tropic connections of fauna in this region [24]. This methodology recognizes four class: basic food (>20 %), constant food (5-20 %), Supplementary food (1-5%) and chance food (<1%). A binocular microscope established literature on insects (Borror, 1992) allowed an analysis of all arthropod remains.

3. RESULTS AND DISCUSSION

We analysed 7,154 droppings, 1123 for *H. ater*, 1269 for *H. speoris*, 4227 for *M. lyra* and 535 for *P. mimus* respectively (Table 1). The result of seven thousand one hundred fifty-four prey items were identified in the faecal and analysis show that important insect orders belonging to of Coleoptera, Blattaria, Dermaptera, Diptera, Lepiptera, Isoptera, Hymenoptera, Hemiptera, Orthroptera,

Homoptera, Aranae, Odonata and Neuroptera were consumed as major and constant dietary of *H. ater, H. speoris, M. lyra* and *P. mimus* (Table 2-4). The overall composition of food items taken by Leaf nosed bat *H.* ater an identified faecal pellet including representative of 09 insect orders. Coleoptera ranked with the large population of individual and percentage of basic food (30.81%). Constant food consisted of Diptera (19.59%), Lepidoptera (19.41%), Hymenoptera (15.31%), and Dermaptera (6.23%). Supplementary food taken was Homoptera (2.67%), Hemiptera (2.40%), Orthoptera (2.22%) and Odonata (1.33%), table 2. The similarly report in dietary selection of *H. ater* mainly includes coleopterans, lepidopteran, dipteran, orthopteran and hemipteran group of insects [14]. In pellet analysis, Lepidopterans were represented by scales. The identification of the moth species is a very difficult task [13]. This is indication that *H. ater* to help in control of mosquitoes is the major and complex problem in the urban ecosystem. It is also that in general, mosquitoes that bite human and other mammals prefer to sky to fly at a highest less than 25 ft [27] which is the foraging area canopy for the Hipposiderid bats [22]. The prey of the *H. ater* is said to be beetles and low-flying insects such as gnats and mosquitoes [4]. This result suggested that are the species feed at different levels on different insects *H. ater* at ground level and feeding on small insects. The overall composition of food items taken by Leaf nosed bat *H.* speoris an identified faecal pellet including representative of 10 insect orders. Diptera ranked with the large population of individual and percentage of basic food (36.24%) and second select prey item Coleoptera was (25.61%). Constant food consisted of Lepidoptera (13.55%) and Hymenoptera (11.03%). Supplementary food taken was Dermaptera (4.33%), Homoptera (2.55%), Odonata (2.55%), Hemiptera (2.12%) and Orthropoda (1.41%). Chance food was Isoptera (0.63%) respectively table-2. The most common insect orders consumed by bats are coleopteran, dipteral, Hymenoptra and isopteran [23], [15]. *H. speoris* is one of many tropical bats that prey on swarms of nuptial termites and ants [19]. Such swarms may be a particularly profitable food source for insectivores because they are concentrated in space and time and individuals contain large quantities of stored nutrients [25]. Our dietary data showed that *H. speoris* feed heavily on such insect groups during twilight activity. Bats captured both diurnal insects that are active at dusk and dawn. Based on both percent by occurrence and number of fragments in faces, dipteral were the major prey of *H. speoris* during twilight activity. Analysis of 66 bat species across 11 families, which showed that species that feed mainly on small, aerial prey and therefore that are largely dependent on the dusk peak that in flight activity of Diptera, most species do not eat large numbers of mosquitoes [22]. Our data indicated that *H. speoris* captured many mosquitoes at study area. *H. fulvus* in the canopy and feeding on insects of the intermediate size and *H. speoris* close to the tree line and feeding on large insects. Other authorities and categorically state that all the three-hunt close to ground. It has specifically been mentioned that through they all hunt close to ground, the flying styles vary *H. ater* is moderated fast and fluttering *H. fulvus* is slow and fluttering, whereas *H. speoris* is slow, skilful and with

continual changes of directions [4]. Hence, it stands to reason that all three species can co-exist without competition, simply by feeding on insects at different species in different styles. The overall composition of food items taken by False vampire bat *M. lyra* an identified faecal pellet including representative of 11 insect orders, 1 order of blattodea and 1 order of Araneae. Blattodea ranked with the large population of individual and percentage basic food (38.98%) and followed by Coleoptera (20.06%). Constant food consisted of Dermaptera (17.08%) and Isoptera (10.10%). Supplementary food was Lepidoptera 3.35%, Hymenoptera 3.02%, Araneae1.93%, Diptera (1.86%) and Orthroptera (1.84%). Chance of food was Hemiptera (0.78%), Homoptera (0.56%), Odonata (0.21%) and Neuroptera (0.16%) observed table-3. Scaraebidae, carabidae and elateridae beetles were the major coleopterans. Apart from Vertebrates consumed during monsoon and post monsoon period, Hemipterans formed the second major food item which was also consumed throughout the year but was consumed more in September-October. Even lepidopterans are preferred throughout the year but they form major food through June to August. Orders like Neuroptera, Isoptera, Dermaptera, Thysanoptera, Ephemeroptera and Aranae (spiders) were found in lower amount throughout the study period. *M. lyra* guano is reported to contain fish, frogs and mice which are in agreement with the study [20]. *M. lyra* always is a foraging close to the flies low over ground, rivers and ponds in search of large insects and small vertebrate and such as mice, rats, frogs, lizards, birds etc. The prey of *M. lyra* has been well documented in general [17], as well as in certainarea, e.g., in Rajastan [1], Central and Western India [7], Bihar [21], Bangladesh [12] and Kaliveli area of Tamilnadu in southern India [18]. Diagnoses form vertebrate carcass remains 65 sample were collected. Frog dominated was observed (36.98%). Among the 25 bats carcasses 12 *H. speoris* (16.43%), *P. mimus* 08 (10.95%) and *H. ater* 05 (6.84%) was identified. The lower amount of remains Garden lizard 3 (4.10%) and mice 18 (24.65%) was observed Table-4. *H. lankadiva* and *M. lyra* [3] also prefer coleopteran insects as their major dietary items. The collection of culled insects' parts like wings in the roost and faecal pellet analysis together have confirmed that, these bats have consumed many varieties of moths which were available in the foraging area. Much more insect's availability in the winter season can be easily captured by bats. *M. lyra* has been recorded feeding on fish [17] and birds [12]. Here, both fishes and birds were conspicuous by their absence through both are plentiful in the study area. Even more striking was the quantities of cockroaches predated on by *M. lyra* (48.75%) and similarly recorded at Kaliveli, Tamilnadu [14]. The overall composition of food items taken by Indian pygmy bat *P. mimus* an identified faecal pellet including representative of 10 insect orders. Coleptera was the largest group basic food of (23.17%) and followed by Lepidoptera (22.05%). Constant food consists of Diptera (11.21%), Hemiptera (10.84), Isopters (11.96%) and Dermaptera (3.46%). Supplementary food was Homoptera (3.92%), Hymenoptera (3.55%) and Orthroptera (3.55%). Chance food Odonata (0.74%) was observed Table-5.

Table 1: Number of droppings per month per species for the total of sites

S.No	Bat species	Feb 2018	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan 2019	Total
1	*H. ater*	60	57	48	44	29	36	42	115	224	190	168	110	1123
2	*H. speoris*	58	65	62	76	88	97	107	118	134	210	166	88	1269
3	*M. lyra*	349	397	335	386	548	202	242	287	532	364	384	200	4227
4	*P. mimus*	28	22	26	32	43	30	38	47	88	80	56	45	535
	Dropping totals													7154

Table 2: The Prey of *Hipposideros* species as diagnosed from faecal matter

S. No	Prey items	*Hipposideros ater*			*Hipposideros speoris*		
		(≠)	(%)	Category	(≠)	(%)	Category
1	Coleoptera (Beetles, Anthous and Fire fly)	346	30.81	BF	325	25.61	BF
2	Diptera (Mosquito, Musca and Drosophila)	220	19.59	CF	460	36.24	BF
3	Dermaptera (Ear wings-Arixeniina)	70	6.23	CF	55	4.33	SF
4	Hemiptera (Tree hopper, Rice ear bug and white bug)	27	2.40	SF	27	2.12	SF
5	Homoptera (Aphids, Cicadas)	30	2.67	SF	32	2.52	SF
6	Hymenoptera (Wasps, ants, and bees)	172	15.31	CF	140	11.03	CF
7	Lepitoptera (Rice moth, army worm, skipper and butterflies)	218	19.41	CF	172	13.55	CF
8	Orthoptera (Grass-copper and House Cricket)	25	2.22	SF	18	1.41	SF
9	Odonata (Dragon flies and Comphide)	15	1.33	SF	32	2.52	SF
10	Isoptera (Termites)	-	-	-	08	0.63	OF
	Total	1123			1269		

(≠)-Number consumed; (%)-Percent frequency; Four class: BF-Basic food (>20 %), CF-Constant food (5-20 %), SF-Supplementary food (1-5%) and OF-Chance food (<1%).

Table 3: The Prey of *Megaderma lyra* as diagnosed from faecal matter

S. No.	Prey items	(≠)	(%)	Category
1	Coleoptera (Beetles, Anthous and Fire fly)	848	20.06	BF
2	Diptera (Mosquito, Musca and Drosophila)	79	1.86	SF
3	Dermaptera (Ear wings-Arixeniina)	722	17.08	CF
4	Hemiptera (Tree hopper, Rice ear bug and white bug)	33	0.78	OF
5	Homoptera (Aphids, Cicadas)	24	0.56	OF
6	Hymenoptera (Wasps, ants, and bees)	128	3.02	SF
7	Lepitoptera (Rice moth, army worm, skipper and butterflies)	142	3.35	SF
8	Orthoptera (Grass-copper and House Cricket)	78	1.84	SF
9	Odonata (Dragon flies and Comphide)	09	0.21	OF
10	Isoptera (Termites)	427	10.10	CF
11	Blattaria (Cockroaches)	1648	38.98	BF
12	Araneae (Spiders)	82	1.93	SF
13	Neuroptera (Lacewings)	07	0.16	OF
	Total	4227		

(≠)-Number consumed; (%)-Percent frequency; Four class: BF-Basic food (>20 %), CF-Constant food (5-20 %), SF-Supplementary food (1-5%) and OF-Chance food (<1%).

Table 4: Vertebrate Prey of *Megaderma lyra* as diagnosed from Carcass remains

S. No	Prey/ Scientific Name	(≠)	(%)	Category
1	Leaf-nosed bats *Hipposideros speoris*	12	16.43	CF
2	*Pipistrellus mimus*	05	6.84	CF
3	*Pipistrellus dormeri*	08	10.95	CF
4	Garden Lizard *Calotes versicolor*	03	4.10	SF
5	Mice	18	24.65	BF
6	Frog	27	36.98	BF
	Total	73		

(≠)-Number consumed; (%)-Percent frequency; Four class: BF-Basic food (>20 %), CF-Constant food (5-20 %), SF-Supplementary food (1-5%) and OF-Chance food (<1%).

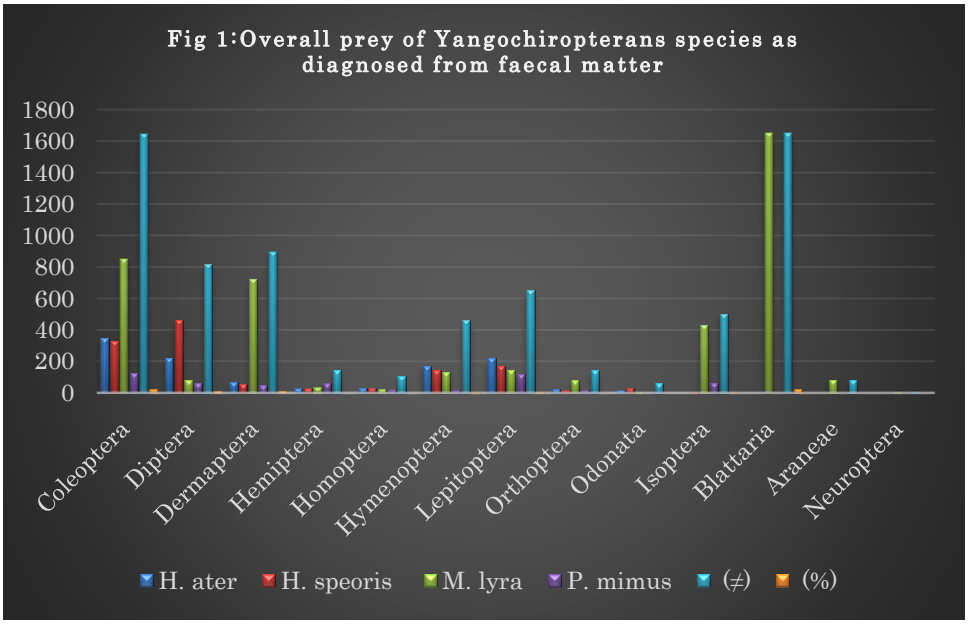
Table 5: The Prey of *Pipistrellus mimus* as diagnosed from faecal matter

S.No	Prey items	(≠)	(%)	Category
1	Coleoptera (Beetles, Anthous and Fire fly)	124	23.17	BF
2	Diptera (Mosquito, Musca and Drosophila)	60	11.21	CF
3	Dermaptera (Ear wings-Arixeniina)	48	08.97	CF
4	Hemiptera (Tree hopper, Rice ear bug and white bug)	58	10.84	CF
5	Homoptera (Aphids, Cicadas)	21	3.92	SF
6	Hymenoptera (Wasps, ants, and bees)	19	4.55	SF
7	Lepitoptera (Rice moth, army worm, skipper and butterflies)	118	22.05	BF
8	Orthoptera (Grass-copper and House Cricket)	19	4.55	SF
9	Odonata (Dragon flies and Comphide)	04	0.74	OF
10	Isoptera (Termites)	64	11.96	CF
	Total	535		

(≠)-Number consumed; (%)-Percent frequency; Four class: BF-Basic food (>20 %), CF-Constant food (5-20 %), SF-Supplementary food (1-5%) and OF-Chance food (<1%).

Table 6: Overall Prey of Yangochiropterans Bats as diagnosed from faecal matter

S.No.	Prey items	*H. ater*	*H. speoris*	*M. lyra*	*P. mimus*	(≠)	(%)
1	Coleoptera	346	325	848	124	1643	22.96
2	Diptera	220	460	79	60	819	11.44
3	Dermaptera	70	55	722	48	895	12.51
4	Hemiptera	27	27	33	58	145	2.02
5	Homoptera	30	32	24	21	107	1.49
6	Hymenoptera	172	140	128	19	459	6.41
7	Lepitoptera	218	172	142	118	650	9.08
8	Orthoptera	25	18	78	19	140	1.95
9	Odonata	15	32	09	04	60	0.83
10	Isoptera	-	08	427	64	499	6.97
11	Blattaria	-	-	1648	-	1648	23.03
12	Araneae	-	-	82	-	82	1.14
13	Neuroptera	-	-	07	-	07	0.09
	Total					7154	



Eastern *Pipistrelles* generally eat homoptera, dipteral and Lepidoptera in Indiana [6]. Silver-haired bats been known to eat Lepidoptera and hemerobiidae in Indiana. Seasonal variation in the diet of the Indian pygmy bat, *P. mimus*, in Southern India. Indian pygmy bats P. *minus captured* termites during only 3 of 24 fortnightly sampling periods, but termites made up 48.4 and 59.5 percent by volume of faecal samples during two of these periods [16], [26]. Overall average prey items were identified in faeces. Coleoptera was major basic food (22.96%) and followed by Blattoda (23.03%). Constant food consisted of Dermaptera (12.51%), Diptera (11.44%), Lepidoptera (9.08%), Isoptera (6.97%) and Hymenoptera (6.41%). Supplementary food was Hemiptera (2.02%), Othroptera (1.95%), Homoptera (1.49%), and Aranae (1.14%). Chance food was taken Odonata (0.83%) and Neuroptera (0.09%) respectively (Table-6; Fig-1). Yangochiropteran bats consumption of coleopteran rate top of dietary preference of during August to January which is their parturition and lactation period. Insect abundance Would be for greater following rain and activity patterns of the colony counter are markedly different. Much more insect abundance in the winter season during moth of (August to January) can be easily captured by bats. Less amount of insect abundance in the summer season during the month of (February to April) captured by bats.

4. CONCLUSION

Four species, Leaf nosed Bats (2), False vampire bat (1), and *Dormer bat* (1), depend heavily on beetles, mosquito, bug spider, lace wings moths, butterflies, etc., are and considered specialists, while leaf nosed bat and Dormer bat are generalists. The information concerning feeding habits of 4 bat species inhabiting Southern India has been recorded and is available to foresters and biologists with responsibility for conservation and management. The overarching goal of this work was to gain a better understanding of how vegetation influences activity of bats and nocturnal flying insects in Agricultural areas of the Western Ghats range, so that land managers planning vegetation manipulations might better predict the influence of their actions on these two components of

biodiversity. We investigated relationships between plants and insects, between insects and bats, and between plants and bats.

ACKNOWLEDGEMENT

The authors are thankful to the principal and faculty member of Sri Paramakalyani College, Alwarkurichi, for providing facilities to carry out the research work.

CONFLICT OF INTEREST

Authors have no any conflict of interest.

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