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Habitat Preference of Microchiropteran Bats in three Districts of Tamilnadu, South India

Paramanatha Swamidoss D.[1], Sudhakaran M.R.[2] and Parvathiraj P.[2]
[1]Department of Environmental Science, PSN College of Engg and Tech, Tirunelveli, Tamilnadu, INDIA
[2]Department of Zoology, Sri Paramakalyani College, Alwarkurichi, Tamilnadu, INDIA

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Abstract

Habitat preference on ten species of microchiropteran species in southern districts of Tamilnadu, south India revealed that their exists some discrimancies in habitat selection. There exhibit a variation in selection of roosting site by bats. City limit habitat was the most favoured by bats like H. speoris, T. melanopogon, and P. mimus, where as species like R. hardwickaii and T. nudiventris prefers hillock habitats. M. lyra and H. ater prefers agricultural field as habitat. Bats were observed to prefer their roosting habitat, where they have foraging resources in the close vicinity. Even though the study revealed a higher priority of habitat selection towards one habitat, they were also found to use another habitat too. This may because of the foraging and roosting opportunities it gains from the habitat.

Keywords: Habitat, microchiropteran bats, richness, evenness and dominance.

Introduction

Bats are the second largest group of mammals in the world. They are distributed all round the globe except in Polar Regions and in some remote islands in eastern pacific. At present there are about 1200 recognized species in the world in 17 families[1]. In India, 113 species of bats are present in seven families[2,3]. Habitat selection is an important feature of behavior and population dynamics, and it has therefore received much attention[4-6]. In many organisms habitat preference may be inferred through the disproportional use of some habitats over others[7-9] and by several spatial scales[8,10,11]. Many organisms face the problem of roosting environment that many habitats do not have favorable combinations of essential patches[11]. A suitable habitat must contain a mixture of patches that provide opportunities for all essential activities required for successful reproduction e.g. reproduction, foraging[12]. A number of studies on different taxonomic groups describe situations in which animals experience trade-off situations affecting habitat selection, when areas for different activities, e.g., foraging and escape from predators, are spatially segregated[13,14].

A diversity index is a mathematical measure of species diversity in a community. Diversity indices provide important information about rarity and commonness of species in a community. The ability to quantify diversity in this way is an important tool for biologists trying to understand community structure[15].

We restrict our consideration to habitat selection at the home range scale, i.e., how individuals allocate their habitat types available within the home range. Measuring habitat preference often has been done simply by relating use of a habitat to its availability[16,17,18]. It is necessary to protect not only bat specimens and their roosts, but also habitat types, which they use[19]. These incorporate the fact that when one habitat is used less, others must be more used[8]. Although compositional analyses establish habitat rankings, the focus for this method also is an overall test of use relative to availability[9].

The importance of different habitat types to bats has not been analysed. The lack of such kind of information must be fulfilled. In order to protect bat habitat types, we must find out which habitat types are the most important to each bat species and to chiropterofauna on the whole. This was the main aim of the present study. We also aimed at determining the status of bat species in the habitats of preferable types.

Material and Methods

Study Area: The study area comprises of the plains of Tirunelveli, Tuticorin and Kanyakumari district (Map) of Tamilnadu State, the southernmost part of the Indian sub continent.

Tirunelveli District: Tirunelveli the penultimate southern most district of Tamil Nadu, is described as a microcosm of the state, owing to its mosaic and diverse geographical and physical features such as lofty mountains and low plains, dry teri structures, rivers and cascades, seacoast and thick inland forest, sandy soils and fertile alluvium, a variety of flora, fauna, and protected wild life. Tirunelveli district lies between 08° 8' and 09° 23' E latitude and 77° 09' and 77° 54' N longitude. The total geographical area of the district is 6,823 sq. km. The mean daily maximum temperature is 37.1ºC. The weather is quite hot in May and June and the maximum temperature sometimes reaches 45ºC. The mean daily minimum in these months is about 22 to 23º C. Main rainy season is from October to the middle of

January. During the southwest monsoon season the rainfall is more in the western parts of the district. November is generally the rainiest month. The average rainfall in the district is 814.8 mm per annum.

Tuticorin district: Tuticorin district is bounded by the Bay of Bengal and the districts of Tirunelveli, Kanyakumari and Ramanathapuram. This district has also got a diverse geographical and physical feature such as lofty mountains and low plains, dry Teri structures, seacoast and thorny scrub jungles, sandy soils and fertile alluvium and a variety of flora and fauna. A bulky number of trees of palm, *Borrassus flabellifer* could be seen in this district. It lies in the 8º N and 78 º 13' E longitudes. The weather is quite hot in the months of May and June and the maximum temperature sometimes reaches 45ºC.The average minimum temperature is 23º to 24º C in these months. The average daily maximum temperature was 38.1º C. Rainy seasons is from October to mid December, but generally November is the rainiest month. It experiences rainfall during the South West monsoon with a total average rainfall of 803.15mm per annum.

Kanyakumari district: Kanyakumari is the southernmost district of Tamil Nadu. The district lies between 77º 15' and 77º 36' E longitudes and 8º 03' and 8º 35' N Latitudes. The District is bound by Tirunelveli District, Gulf of Mannar, Indian Ocean, Arabian Sea and Kerala state. The District has a favourable agro-climatic condition, which is suitable for growing a number of crops. Unlike other district in Tamil Nadu, it has a rainfall both during the South West and the North East monsoons. The South West monsoon period starts from the month of June and ends in September, While the North East monsoon period starts from October and ends in the middle of December. The average rainfall is around 915.3mm per annum. The mean daily maximum temperature is around 34.1º C.

Survey on distribution of microchiropteran bas was conducted in the plains of Tirunelveli, Tuticorin and Kanyakumari districts of Tamilnadu, South India for a period of one year from September 2009 to August 2010. Periodic visits were made to identify the bat roosting sites throughout the study area. In each identified roosts the physical parameters such as habitat back round, surrounding environments and nature of the roosts were studied.

The habitat of the roost were classified in to the following four types, they are

Water Bodies: The roosting place is nearer to pond, river and irrigation channel.

Farm Land: The roosting place is surrounded by cultivable plant field like paddy and banana.

Human Settlement: The roosting place is situated in an inhabited place of smaller and greater size of human population.

Hillock: The bat roost situated in hill/rocks.

The preference of roosts by various microchiropteran bat species depending on their roosts habitat was studied and analysed by using Jacobs Preference Index[20]. The index ranges from -1 (complete avoidance) to +1 (exclusive use). Varieties of indices are available to quantify biological communities. The diversity measures can be divided into 3 main categories. They are i. Species richness ii. Species dominance and iii. Evenness[21]. Species richness was calculated by using Margalef's index, species evenness was calculated by using Sheldon index, and species dominance was calculated by using Berger-Parker index. They were calculated by using the formulas given below,

Margalef's index: Species richness measures provide an instantly comprehensible expression of diversity. It is calculated using the formula, $D_{mg} = (S - 1)/ \ln N$

Where, S = number of species present in each taluk, N = number of individuals.

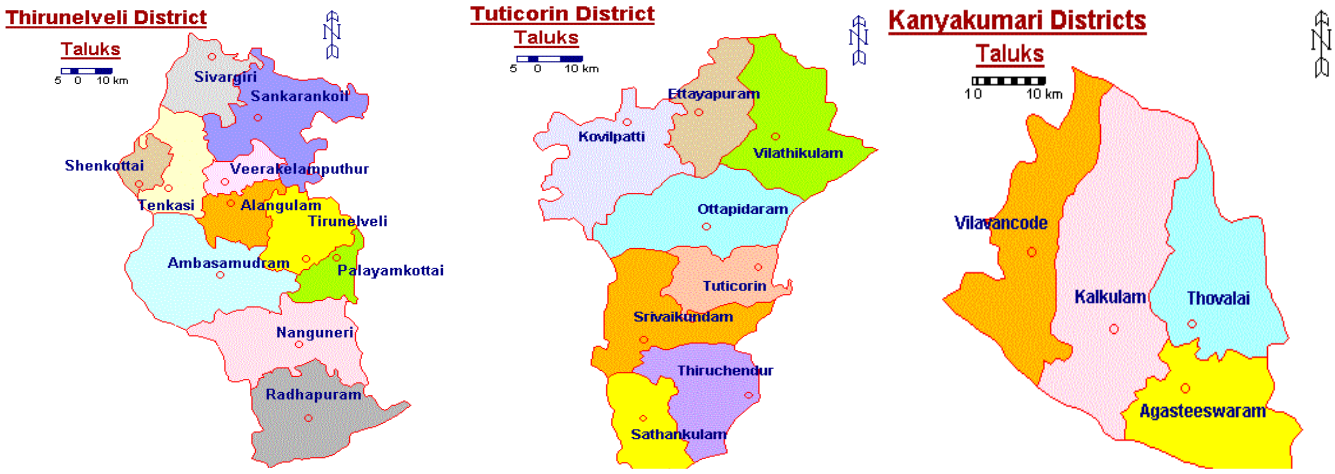

Figure-1
Study Map

Sheldon Evenness Index: Species evenness (or equitability) is a measure of the number of individuals within the species population. Evenness is greatest when species are equally abundant. It is calculated by using the formula

$$E = H'/S$$

Where, H' = the value of Shannon index, S = Total no of individuals in each taluk.

Berger-Parker diversity index: Berger-Parker index is employed to determine whether there is any change in the dominance of species in each taluk. It expresses the proportional importance to the most abundant species. The formula for calculating the Berger-Parker index is

$$d = N_{max}/N$$

Where, N = the total number of individuals, Nmax = Number of individuals in the most abundant species.

Results and Discussion

The distribution of microchiropteran bats covering various taluks of Tirunelveli, Tuticorin and Kanyakumari was studied during September 2009 to August 2010. The overall study revealed that a total of 10 species of microchiropteran bats were found to present. 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 Rhinopomatidae (*Rhinopoma hardwickaii*).

In Tirunelveli district 108 roosts was identified in 11 taluks. Out of 108 roosts, 37 roosts were occupied by *H. speoris*, 15 roosts were occupied by *H. ater*, 19 roosts were occupied by *M. lyra*, 6 roosts were occupied by *T. melanopogon*, 2 roosts were occupied by *T. nudiventris*, 13 roosts were occupied by *P. mimus*, 2 roosts were occupied by *P. dormeri*, 6 roosts were occupied by *R. hardwickaii*, 4 roosts were occupied by *S. heathi* and 2 roosts were occupied by *S. kuhli*.

In Tuticorin district 61 roosts was identified in 8 taluks. Out of 61 roosts, 24 roosts were occupied by *H. speoris*, 4 roosts were occupied by *H. ater*, 12 roosts were occupied by *M. lyra*, 8 roosts were occupied by *T. melanopogon*, 2 roosts were occupied by *T. nudiventris*, 6 roosts were occupied by *P. mimus*, 2 roosts were occupied by *P. dormeri*, 1 roost was occupied by *R. hardwickaii,* 2 roosts were occupied by *S. heathi* and 3 roosts were occupied by *S. kuhli*.

In Kanyakumari district 44 roosts was identified in 4 taluks. Out of 44 roosts, 9 roosts were occupied by *H. speoris*, 3 roosts were occupied by *H. ater*, 6 roosts were occupied by *M. lyra*, 5 roosts were occupied by *T. melanopogon*, 2 roosts were occupied by *T. nudiventris*, 12 roosts were occupied by *P. mimus*, 1 roosts was occupied by *P. dormeri*, 3 roosts were occupied by *R. hardwickaii*, 3 roosts were occupied by *S. heathi* (table - 1). The studies made to determine the habitat selection by the ten species of microchioropteran bats in the study area showed some discrimancies in habitat ranking according to the relative importance of habitats.

Diversity measures of microchiropteran bats in the three districts revealed that the highest degree of richness of *H. speoris*, *H. ater*, *P. mimus*, *R. hardwikaii*, *S. heathi* was observed in Tirunelveli district, whereas the highest degree of richness of M.lyra and *T. melanopogon* was at Tuticorin and Kanyakumari districts respectively. The greatest degree dominance of *H .speoris*, *H. ater*, P. *mimus*, *P.dormeri*, *R. hardwickaii* and *S. heathi* was observed at Tirunelveli district, the greatest degree of dominance of *T. melanopogon* and *M. Lyra* was at Tuticorin district. The highest evenness of microchiropteran bats was observed at Kanyakumari district (figure - 1). The most adaptable bat species may take advantage of roosting and foraging opportunities offered by urban areas [22].

The importance of habitat types to the majority of the microchiropteran bats significantly differed in the three districts. In Tirunelveli district, five of the ten species prefer to roost in the city limit habitat (*H.speoris* (RPI 4.27), *T.melanopogon* (RPI 2.13), *P. mimus* (RPI 4.27), *P. dormeri* (RPI 2.13) and *S. heathi* (RPI 2.13), and only *R. hardwickaii* (RPI 10.8) was more common in hillock habitat. *M.lyra* (RPI 3.2) and *H. ater* (RPI 5.3) preferred to roost in centre of the field habitat and *T. nudiventris* (RPI 0.09) and *S. kuhli* (RPI 0.09) preferred village limit habitat.

In Tuticorin district, *H. speoris* preferred to roost in city limit (7.69) and centre of the field habitat (7.69). *R. hardwickaii* (2.44), *H. ater* (4.88) and *T. nudiventris* (4.88) preferred to roost in hillock habitat and *M.lyra* (7.69) prefers to roost in centre of the field habitat. *S. heathi* (0.21) prefers to roost in isolated habitat and *P. mimus* (0.64) and *P. dormeri* (0.21) preferred village limit habitat.

In Kanyakumari district, *H. speoris* (2.15) and *M. lyra* (1.72) prefer to roost in isolated habitat. *T. melanopogon* (1.72) and *P. mimus* (6.88) prefer to roost in city limit habitat and *R. hardwickaii* (0.89) prefers to roost in hillock habitat. *H. ater* (1.19) and *T. nudiventris* (2.35) prefer to roost in centre of the field habitat and *P. dormeri* (0.43) and *S. heathi* (1.29) prefer to roost in village limit habitat (table - 2).

On studying the surrounding environment of the roost in Tirunelveli district, *M. lyra* (1.45) prefers to roost in riverside. *H. speoris*, *T. melanopogon*, *P. mimus*, *P. dormeri* and *S. heathi* (4.29, 2.14, 4.29, 2.14 and 2.14 respectively) prefers to roost in heart of the city. *R. hardwickaii* prefers to roost both in the paddy field (2.23) and heart of the village (2.22). *S. kuhli* (0.22) and *T. nudiventris* (0.22) prefers to roost in the heart of the village. The pond side environment was preferred by *H. ater* (2.33).

Table–1
Distribution of Microchiropteran Bats

S. No	District	Taluk	Bat Species																			
			H. speoris		H. ater		M. lyra		*T.melanopogon*		*T.nudiventris*		*P. mimus*		*P. dormeri*		*R.hardwickaii*		*S. heathi*		*S. kuhli*	
			A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
1	Tirunelveli	Alangulam	0	0	2	5	0	0	0	0	0	0	0	0	0	0	0	0	1	6	0	0
		Ambasamudram	13	2655	6	420	6	1035	0	0	2	23	1	5	0	0	2	550	0	0	1	5
		Nanguneri	5	483	0	0	3	255	0	0	0	0	0	0	0	0	0	0	0	0	1	1
		Palayamkottai	4	925	2	110	5	453	2	1030	0	0	3	10	1	13	1	100	2	23	0	0
		Radhapuram	5	835	1	50	0	0	1	50	0	0	1	5	0	0	0	0	0	0	0	0
		Sankarankoil	1	150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Senkottai	3	115	1	20	0	0	0	0	0	0	0	0	0	0	3	152	0	0	0	0
		Sivagiri	1	500	1	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Tenkasi	2	65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Tirunelveli	2	300	2	150	5	230	3	90	0	0	0	0	1	6	0	0	1	4	0	0
		V. K. Pudhur	1	500	0	0	0	0	0	0	0	0	8	14	0	0	0	0	0	0	0	0
2	Tuticorin	Ettayapuram	1	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Kovilpatti	2	350	1	25	0	0	1	200	2	5	0	0	0	0	1	2	0	0	0	0
		Ottapidaram	1	40	0	0	2	130	0	0	0	0	3	7	0	0	0	0	0	0	0	0
		Sattankulam	3	675	0	0	2	80	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Srivaikundam	6	900	1	150	4	335	1	100	0	0	2	6	1	10	0	0	2	8	2	8
		Thiruchendur	9	2340	2	35	2	620	5	610	0	0	0	0	0	0	0	0	0	0	1	2
		Tuticorin	2	100	0	0	1	30	1	50	0	0	1	3	0	0	0	0	0	0	0	0
		Villathikulam	0	0	0	0	1	100	0	0	0	0	0	0	1	8	0	0	0	0	0	0
3	Kanyakumari	Agasteeswaram	4	265	0	0	2	160	2	405	0	0	4	10	1	8	0	0	0	0	0	0
		Kalkulam	1	30	0	0	2	30	2	400	0	0	8	22	0	0	0	0	2	10	0	0
		Thovalai	3	110	2	40	1	24	0	0	2	14	0	0	0	0	3	21	1	4	0	0
		Vilavancodu	1	70	1	40	1	50	1	30	0	0	0	0	0	0	0	0	0	0	0	0

A : No of roost, B : Total population

Table-2
Roost preference of microchiropteran bats in relation to different habitat types inTirunelveli District (Jacobs Index)

S. No.	Bat Species	Habitat											
		Water Bodies			Farm Land			Human Settlement			Hillock		
		r	p	D	R	p	D	r	p	D	r	p	D
1	*Hipposideros speoris*	0.36	0.51	-0.33	0.47	0.27	0.42	0.18	0.19	-0.04	0.00	0.03	-0.90
2	*Hipposideros ater*	0.39	0.60	-0.41	0.45	0.27	0.38	0.17	0.13	0.13	0.00	0.00	0.00
3	*Megaderma lyra*	0.29	0.21	0.22	0.58	0.68	-0.22	0.13	0.11	0.10	0.00	0.00	0.00
4	*Taphozous melanopogon*	0.04	0.17	-0.64	0.91	0.50	0.83	0.04	0.33	-0.84	0.00	0.00	0.00
5	*Taphozous nudiventris*	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.50	-0.39	0.70	0.50	0.39
6	*Pipistrellus mimus*	0.06	0.08	-0.14	0.00	0.00	0.00	0.94	0.92	0.14	0.00	0.00	0.00
7	*Pipistrellus dormeri*	0.00	0.00	0.00	0.32	0.50	-0.37	0.68	0.50	0.37	0.00	0.00	0.00
8	*Rhinopoma hardwickaii*	0.04	0.17	-0.68	0.00	0.00	0.00	0.00	0.00	0.00	0.96	0.83	0.68
9	*Scotophillus heathi*	0.00	0.00	0.00	0.70	0.50	0.39	0.30	0.50	-0.20	0.00	0.00	0.00
10	*Scotophillus kuhli*	0.00	0.00	0.00	0.17	0.50	-0.67	0.83	0.50	0.67	0.00	0.00	0.00

In Tuticorin district, *S. heathi* prefers to roost in riverside (3.4). *T. nudiventris* (0.23) and R. *hardwickaii* (0.11) prefers to roost in the paddy field. *H. speoris* (15.24) and *H. ater* (15.24) prefers to roost in heart of the city. *P. mimus* (0.64) and *P. dormeri* (0.21) prefers to roost in the heart of the village. The pond side environment was preferred by *M. lyra* (15.24) and *T. melanopogon* (15.24).

In Kanyakumari district, the riverside environment was preferred by *H. speoris* (10.64) and *M. lyra* (10.64), the paddy field environment was preferred by *H. ater* (0.16), *T. nudiventris* (0.16) and *R. hardwickaii* (0.24). *T. melanopogon* (1.72) and *P. mimus* (6.88) prefers to roost in heart of the city, *P. dormeri* (0.43) and *S. heathi* (1.29) prefers to roost in the heart of the village (table - 3).

It has been ascertained that various water bodies from small ponds to large rivers, channels and lakes attracts bats as suitable foraging sites[23] and majority of bat species forage near water bodies[24], because diet available [25] for *M. lyra* naturally

accumulate around water bodies. Most of the species were observed to roost in the areas that provides foraging opportunity. The presence of foraging area in the close vicinity of roost may offer foraging opportunities[26]. This was also confirmed by comparing the data available for species such as *M. lyra*, *R. hardwickaii* and *P. mimus*[27]. *S. heathi* and *S. kuhli*, the tent roosting vespertilionids mostly prefer to roost in the village limit habitat, in the heart of the village environments. As it is a tent roosting bat it procures tents only in such habitats, where its tent forming tree, Palmyra palm (*Borrassus flabellifer*) was found to be more. The foraging limits and the tent roosting behaviour suit this bat to select the village limit habitat and environments. Unlike other species which favours to roost in undisturbed, unused and abandoned roosts which were free from anthropogenic disturbances, *H. speoris* was found to prefer the "used' nature of roost. Because, *H. speoris* roosted mostly in the large temple roosts which differ several other ruined unoccupied man-made buildings and temples in several features and also prefers city limit habitat. The human activities like worship and festival were frequent in city limit temples and *H. speoris* was found to adapt to such circumstances.

With reference to the roost selection depending on its nature a variation was observed in three districts. In Tirunelveli district, *H. speoris* (8.2) prefers to roost mostly in the used roost and had a random selection of unused, abandoned and used/undisturbed roosts. The unused roosts were preferred by *H. ater* (3.29), *T. nudiventris* (0.04), *R. hardwickaii* (0.13), *S. heathi* (0.09) and *S. kuhli* (0.02). *M. lyra* (5.12), *P. mimus* (0.73) and *P. dormeri* (0.73) prefers abandoned roosts and *T. melanopogon* (0.93) prefers to roost in the used/undisturbed roosts. In Tuticorin district, *H. speoris* (9.75) prefers to roost mostly in the used roost. The unused roosts were preferred by *H. ater* (2.43), *T. nudiventris* (0.09), *R. hardwickaii* (0.04), *S. heathi* (0.09) and *P. dormeri* (0.09). *M. lyra* (5.00) and *P. mimus* (2.49) prefers abandoned roosts and *T. melanopogon* (0.85) prefers to roost in the used/undisturbed roosts. In Kanyakumari district, the unused roosts were preferred by *T. nudiventris* (0.07), *R. hardwickaii* (0.11), *S. heathi* (0.11), *P. mimus* (0.42) and *P. dormeri* (0.04). *H. speoris* (10.64) and *M. lyra* (10.64) prefers abandoned roost and *T. melanopogon* (1.72) and *H. ater* (1.72) prefers to roost in the used/undisturbed roosts (table - 4).

Table – 3
Roost preference of microchiropteran bats in relation to different habitat types in Tuticorin District (Jacobs Index)

S. No	Bat Species	HABITAT											
		Water Bodies			Farm Land			Human Settlement			Hillock		
		r	p	D	R	p	D	r	p	D	r	p	D
1	*Hipposideros speoris*	0.51	0.17	0.68	0.27	0.42	-0.33	0.15	0.38	-0.54	0.07	0.04	0.24
2	*Hipposideros ater*	0.07	0.25	-0.63	0.83	0.25	0.88	0.02	0.25	-0.86	0.07	0.25	-0.63
3	*Megaderma lyra*	0.68	0.33	0.62	0.24	0.58	-0.63	0.08	0.08	-0.04	0.00	0.00	0.00
4	*Taphozous melanopogon*	0.36	0.25	0.27	0.42	0.38	0.09	0.22	0.38	-0.36	0.00	0.00	0.00
5	*Taphozous nudiventris*	0.25	0.33	-0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.75	0.67	0.20
6	*Pipistrellus mimus*	0.13	0.17	-0.17	0.00	0.00	0.00	0.88	0.83	0.17	0.00	0.00	0.00
7	*Pipistrellus dormeri*	0.00	0.00	0.00	0.44	0.50	-0.11	0.56	0.50	0.11	0.00	0.00	0.00
8	*Rhinopoma hardwickaii*	0.20	0.50	-0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.80	0.50	0.60
9	*Scotophillus heathi*	0.25	0.50	-0.50	0.75	0.50	0.50	0.00	0.00	0.00	0.00	0.00	0.00
10	*Scotophillus kuhli*	0.00	0.00	0.00	0.80	0.67	0.33	0.20	0.13	-0.33	0.00	0.00	0.00

Table-4
Roost preference of microchiropteran bats in relation to different habitat types in Kanyakumari District (Jacobs Index)

S. No.	Bat Species	HABITAT											
		Water Bodies			Farm Land			Human Settlement			Hillock		
		r	p	D	r	p	D	r	p	D	r	p	D
1	*Hipposideros speoris*	0.37	0.33	0.08	0.34	0.44	-0.22	0.29	0.22	0.19	0.00	0.00	0.00
2	*Hipposideros ater*	0.13	0.33	-0.56	0.50	0.33	0.33	0.00	0.00	0.00	0.38	0.33	0.09
3	*Megaderma lyra*	0.04	0.17	-0.67	0.15	0.17	-0.06	0.00	0.00	0.00	0.11	0.17	-0.22
4	*Taphozous melanopogon*	0.00	0.00	0.00	0.12	0.20	-0.28	0.88	0.80	0.28	0.00	0.00	0.00
5	*Taphozous nudiventris*	0.00	0.00	0.00	0.43	0.50	-0.14	0.00	0.00	0.00	0.57	0.50	0.14
6	*Pipistrellus mimus*	0.00	0.00	0.00	0.00	0.00	0.00	0.31	0.40	-0.19	0.69	0.60	0.19
7	*Pipistrellus dormeri*	0.00	0.00	0.00	0.38	0.50	-0.25	0.63	0.50	0.25	0.00	0.00	0.00
8	*Rhinopoma hardwickaii*	0.24	0.33	-0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.76	0.67	0.23
9	*Scotophillus heathi*	0.29	0.33	-0.11	0.71	0.67	0.11	0.00	0.00	0.00	0.00	0.00	0.00
10	*Scotophillus kuhli*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Most obvious pattern in the distribution of bats is the decrease in species richness with increase in latitude[28]. The species richness is a measure used as one indicator of bat[22]. Richness and dominance of the bat depends on the availability of food sources and identical roost sources[22]. Study on the distribution of microchiropteran shows that there is a greater variation in the richness, dominance and evenness of microchiropteran bats with in the study area. A greatest degree of dominance and richness of *H. speoris*, *H. ater*, *P. mimus*, *P. dormeri*, *R. hardwickaii* and *S. heathi* was observed in the Tirunelveli district. The topography of the Tirunelveli district revealed that it is on the bank of perennial Thamiraparani River and on the foothills of Western Ghats, and it has a vast area of agricultural fields. Also it has got diverse environment habitats from village limits to city limits, from agricultural lands to barren lands, and which consist of good water resources provides sumptuous amount of food and roost sources for this bats. Whereas the richness and dominance of *M. lyra* and *T. melanopogon* was observed in Tuticorin district.

The distribution of *S. kuhli* and *T. nudiventris* was found to be very low, hence its measures was neglected. In contrast to the richness of species in Tirunelveli and Tuticorin districts, the evenness of all the species was observed in Kanyakumari district. The factor for this may be the area was found to be small when compared to the other two district. Nine species of microchiropteran bats were uniformly distributed in kanyakumari districts. Even though the study revealed a favourable habitat selection by microchiropteran bats, they were also found to use more than one habitat too. This may because of the foraging and roosting opportunities if gains from the certain habitat. Echolocation frequencies and flying range of this microchiropteran bats[29] also satisfies our account on this bat for such habitat and environment selections.

Conclusion

Habitat preference by bats were observed to be mostly depend on the foraging resources and roosting resources the bat acquired from the habitat. Bats were observed to have preferential roost selection on their roost environment. All the bats were observed to have their roosting sites nearer to the human settlements, nearer to water sources and agriculture fields.

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Reference

1. Koopman K.F., Chiroptera, in Mammal Species of the World: A Taxonomic and Geographic Reference (D. E. Wilson and D. M. Reeder, ed.). 2nd edition, Smithsonian press, Washington, 137-241 **(1993)**

2. Bates P.J.J. and Harrison D.L., Bats of Indian subcontinent, *Harrison Zoological Museum.,* **(1997)**

3. Kumar Das P., Studies on Some Indian Chiroptera from West Bengal, *Occ. Pap. Rec. Zool. Sur. India*, 217 **(2003)**

4. Fretwell S.D. and Lucas H.L., On territorial behaviour and other factors influencing habitat distribution in birds. *Acta Biotheoretica.,* **19,** 16-36 **(1970)**

5. Rosenzweig M.L.A., Theory of habitat selection, *Ecology.,* **62**,327-335**(1981)**

6. Bell S. Mccoy S.E.D. and Mushinski H.R., Habitat structure, *Chapman and Hall, London, UK.,* **(1994)**

7. Neu C.W. Byers C.R. and Peek J.M., A technique for analysis of utilization-availability data, *Journal of Wildlife Management .,* **38,**541-545**(1974)**

8. Johnson D.H., The comparison of usage and availability measurements for evaluating resource preference, *Ecology.,* **61,** 65-71 **(1980)**

9. Aebischer N. Robertson J.P.A. and Kenward R.E., Compositional analysis of habitat use from animal radio-tracking data, *Ecology.,* **74,** 1313-1325 **(1993)**

10. Morris D.W., Ecological scale and habitat use, *Ecology*, **68,** 362-369 **(1987)**

11. Orians G.H. and Wittenberger J.F., Spatial and temporal scales in habitat selection, *American Naturalist*, **137**, 29 - 49 **(1991)**

12. Lima S.L. and Dill L.M., Behavioral decisions made under the risk of predation: a review and prospectus, *Canadian Journal of Zoology,* **68,** 619-640 **(1990)**

13. Brown J.S., Patch use under predation risk: I Models and predictions, *Annales Zoologica Fennici,* **29,** 301-309 **(1992)**

14. Moody A.L. Houston A.I. and Mcnamara J.M., Ideal free distributions under predation risk, *Behavioral Ecology and Sociobiology,* **38**, 131-143 **(1996)**

15. Begon M., Harper J.L. and Townsend C.R., Ecology: Individuals, Populations, and Communities, 3rd edition, *Blackwell Science Ltd., Cambridge, MA***, (1996)**

16. Alldredge J.R. and Ratti J.T., Further comparison of some statistical techniques for analysis of resource selection, *Journal of Wildlife Management,* **56,** 1-9 **(1992)**

17. Thomas D.L. and Taylor E.J., Study designs and tests for comparing resource use and availability, *Journal of Wildlife Management*, **54,** 322-330 **(1990)**

18. Manly B.F. Mcdonald J.L.L. and Thomas D.L., Resource selection by animals: statistical design and analysis for field studies, *Chapman and Hall, London, UK,* **(1993)**

19. Hutson A.M., The bat conservation trust, *London* **(1993)**

20. Jacobs J., Quantitative measurement of food selection, *Oecologia,* **14,** 413–417 **(1974)**

21. Magurran A.E., Ecological diversity and its measurement, *Croom Helm Ltd., London* **(1988)**

22. Kunz T.H., Ecology of Bats, Plennum Press, New York **(2003)**

23. Walsh L.A. and Harris St, Foraging habitat preferences of vespertilionid bats in Britain, *Journal of Applied Ecology,* **33**, 508-518 **(1996)**

24. Fenton M.B., A technique for monitoring bat activity with results obtained from different environments in southern Ontario, *Canadian Journal of Zoology,* **48,** 847-851 **(1970)**

25. Smith P.G., Habitat preference, range use and roosting ecologyof Natterer's bats (Myotis nattereri) in a grassland–woodland landscape, Dissertation, University of Aberdeen, 297 **(2000)**

26. Swift S.M. and Racey P.A., Resource partitioning in two species of vespertilionid bats (Chiroptera) occupying the same roost, *Journal of Applied Zoology,* **200**, 249-259 **(1983)**

27. Isaac S.S. and Marimuthu G., Early out flying and late home flying in the Indian pygmy bat under natural conditions, *Oecologia,* **96**, 426430 **(1993)**

28. Findley J.S., Bats: a community perspective, (Cambridge studies in ecology), *Cambridge University Press, Cambridge,* **(1993)**

29. Neuweiler G., The biology of bats. Oxford University Press, Oxford, United Kingdom, **(2000)**

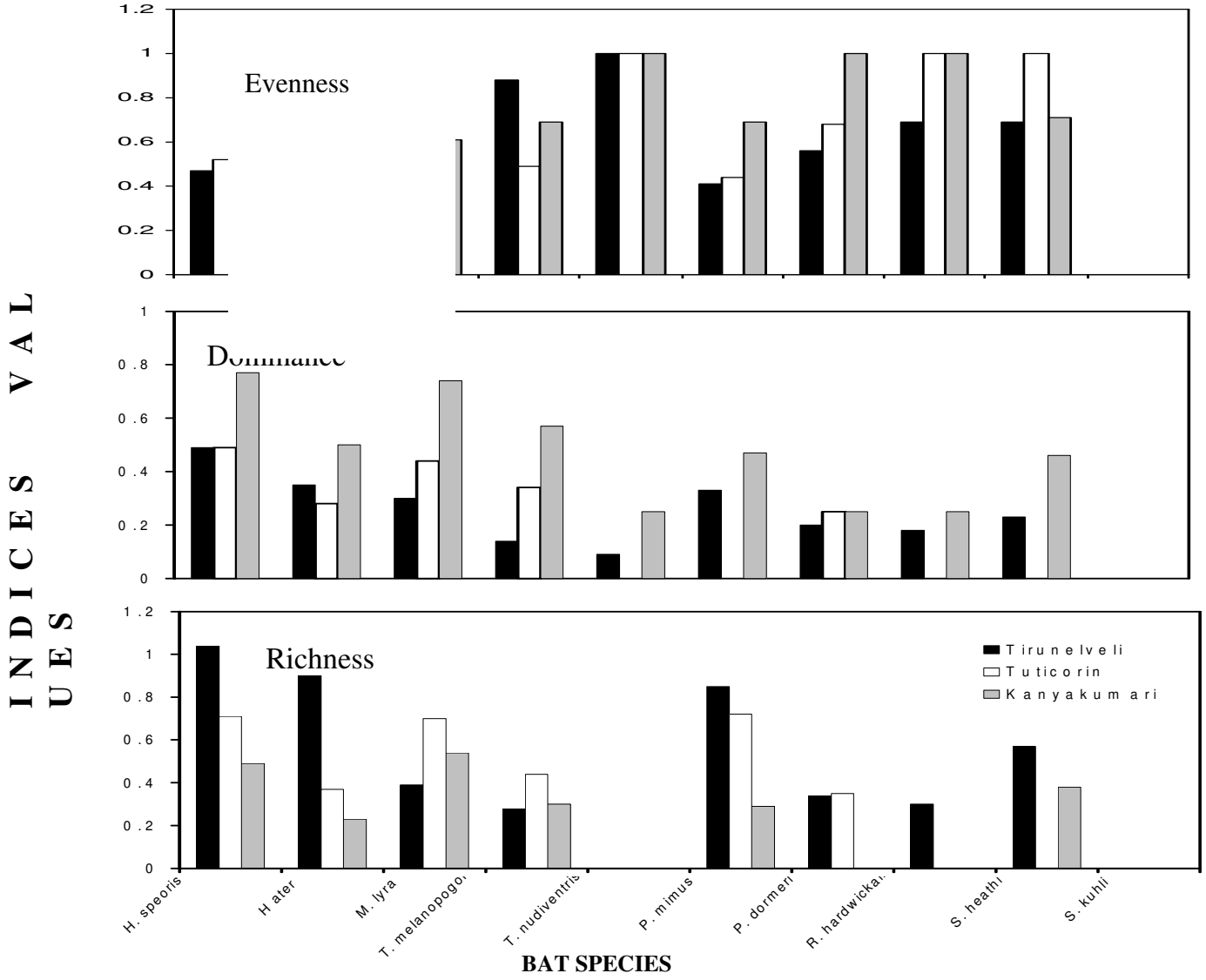

Figure-1
Diversity indices of microchiropteran bats in three districts