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Hymenopteran diversity in a deciduous forest from South India

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Hymenoptera diversity was investigated in a deciduous forest from South India during July 2009 to June 2010. Among the 38 collected species, the identified 36 species belong to 21 genera and nine families. The dominant families include Vespidae, Apidae, Formicidae, Sphecidae and Megachilidae, respectively. In the present study, the hymenopterans like the carpenter bees, honey bees, leaf cutter bees and ants were abundantly seen during March, April and May. The highest hymenopteran diversity was found during May 2010, where the Shannon's overall index of diversity was 1.95. The evenness index (E1) was high during September indicating that there is less variation in communities between the species. Most of the Hymenopterans recorded were good pollinators and were seen in plants such as *Ancardium occidentale*, *Lantana camara* and *Calotropis gigantea* present in the study area. The study indicates a rich and diverse hymenopteran fauna in the deciduous forest.

Key words: Hymenoptera, biodiversity, deciduous forest.

INTRODUCTION

In recent decades, humans have more than ever been changing the world's ecosystems to meet the growing demands for food, fresh water, timber, fiber, fuel and minerals (Anonymous, 2005). Forests are among the most important repositories of terrestrial biological diversity. The tropical forests, constituting only 7% of the total land surface are known to harbour about two third of the world's biological diversity (Suresh et al., 1999). Biodiversity in itself provides a range of services, including aesthetic, cultural and recreational values, as well as goods that have direct use value, and also enhances many other ecosystem services on which humans depend (Bulte et al., 2005). Along with plants and higher animals, insects form an important component of biodiversity in the tropical forests. Insects are the most diverse group of animals comprising nearly 80% of the living animal species. Hymenoptera are not only diverse in terms of structure, size and numbers of species, but also in their habits and life histories. Of all the insect orders, the order Hymenoptera includes the commonest, diverse, best known insects and perhaps the most important insects for mankind. They are the most evolved and probably most diverse of all the terrestrial organisms (La Salle and Gauld, 1993).

Pollinators have a key part in the survival of terrestrial ecosystem integrity through their major role in plant reproduction, thereby providing services and goods to the society, because many of the world crop plants are dependent upon pollination for their productivity (Potts et al., 2009). Many empirical studies have found positive

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correlations between pollinator diversity and plant functioning (Perfectti et al., 2009). Pollination by insects and other animals is significant in most terrestrial habitats. It involves 67% of species of flowering plants and a relatively high diversity of insect taxa (Forup et al., 2008). On the other hand, 35% of crop production world-wide (Kremen et al., 2007) and 70% of major global crop species rely on animal pollination (Steffan-Dewenter and Westphal, 2008).

Hymenopterans are also important to the balancing and functioning of most ecosystems in the planet. They are also most beneficial orders for the human economy. Not only does the bee pollinate many crops but also they produce wax and honey. Mass release of parasitic wasps sometimes has been most successful way to control insect pests without using excessive insecticides.

Not much detailed information is available on the hymenopteran fauna of our forests. Pioneer work on the Hymenoptera of Indian region was made by Bingham (1897, 1903) which found reference to species found in Kerala. Subsequent to this, some studies have been made specifically on species found in different regions of Kerala (Narendran, 1989, 1994).

The diversity of life forms present in tropical forests in Tamilnadu is incredible and has not yet been fully scientifically documented. The present paper forms part of a study which was carried out in the hemipteran fauna in a deciduous forest in South India.

MATERIALS AND METHODS

Study area and insect sampling

Various sites were selected in the proposed deciduous forest and a random sampling was conducted during the period from July 2009 to June 2010. The study area namely the Kuthiraimozhi Theri deciduous forest is located in Thoothukudi District, Tamil Nadu. This forest area has its boundaries with different villages like Mele Kanam, Nalumavadi, Katchanavilai and Kanam. It comprises tropical thorn forests, which occupy a considerable area of about 1440 hectares. The forests are open, sandy, low tree lands with predominance of thorny, usually hard wood species. The insects were collected by various direct collections and light trapping method in the present study.

Collecting net

Two types of nets (aerial and sweeping) were used for insect collection. The aerial net was used for collecting flying insects. In the present study, aerial nets that were prepared entirely of white meshed material with light weight handle were used for effective collection. Sweep nets made of canvas with heavy handles were dragged through dense vegetation without being damaged. By using sweep net the random insects which were not seen easily were collected by sweeping the net through the vegetation. Grass-hoppers, moths and few coleopterans were collected by this net.

Light traps

The light traps were installed at five different sites of the study area. Light trap was employed during new moon and full moon nights of every month. In light trap insect collection jar, carbon tetra chloride (CCl_4) was used for killing the insects. The light trap was installed in an open field with a light source 1 m above the ground level. It was operated from dusk to dawn. The insects collected were set and preserved for subsequent identification.

Collecting jars

In the present study, 500 to 1000 ml wide mouthed jars with killing agent (carbon tetra chloride) were used as collecting jars. A thin layer of sawdust (about 0.5 inch thick) was taken in a jar and a layer of plaster of paris (0.5 inch thick) was poured over it. Then, the jar was placed under a vented fume hood with the lids off until the plaster of paris was thoroughly dried (usually a couple of days or so). Before collection, carbon tetra chloride (5 to 10 ml) was added. At the time of collection, carbon tetra chloride was activated by adding two to three drops of water to the dried plaster of paris to release the deadly fumes.

Collecting forceps

Collecting forceps are quite useful in the field, depending on the type of insect collected. During the study period, sharp forceps between 10 and 30 cm were used for collecting ants and other insects. The collected insects were transferred into the killing bottle. The insects were then taken out gently and pinned, identified, named, labeled and arranged in a systematic manner in the insect boxes.

Statistical analysis

The diversity indices viz. Shannon Index (H'), species abundance (N1 and N2), species richness (R1and R2) and evenness indices (E1, E2, E3, E4 and E5) were calculated. The quantitative indices of species diversity were computed using the software programme.

RESULTS AND DISCUSSION

Altogether, 38 species (including two unidentified species) of hymenopterans belonging to 21 genera and 9 families were recorded. Similar findings were also reported by Mathew et al. (2005) with 30 species from Peechi Vazhani Wildlife Sanctuary, Kerala. Lesser number of hymenopterans was recorded by Mathew et al. (2004) at Peppera Wildlife Sanctuary, Mathew et al. (2007) at Neyyar Wildlife Sanctuary, Kerala and Singh et al. (2010) at Kane Wildlife Sanctuary.

Out of 36 species identified, nine species belonged to the family Vespidae, seven species to Apidae, 8 to Formicate, five to Sphecidae and three to Megachilidae. The families Halictidae, Pompilidae, Chrysilidae and Mutilidae represented one species each. Mishra et al. (2004) and Kato et al. (2008) reported that on number basis the most abundant insect group was hymeno-pterans among the plant visitors.

In the present study, the carpenter bees, honey bees, leaf cutter bees and ants were most abundant during

Table 1. The month wise representation of individual species per hectare in the order Hymenoptera in the deciduous forest.

S/N	Family	July 2009	August	Sep	Oct	Nov	Dec	January 2010	Feb	March	April	May	June	Total
I	**Vespidae**													
1	*Phimenes flavopictus*					2								2
2	*Vespula flavopilosa*			5			35				2			42
3	*Vespula maculifrons*				5									5
4	*Vespa tropica*	2											5	7
5	*Vespa affinis*		2											2
6	*Vespa ducalis*	2	2						5		2		2	13
7	*Vespa crabro*										2		2	4
8	*Polistes carolina*										2			2
9	*Eumenes petiolata*	2			8			5	7	14				36
II	**Halictidae**													
10	*Halictus vicinus*							5	7	15				27
III	**Apidae**													
11	*Apis mellifera*	2		5		2	2			2	5	4	5	27
12	*Apis florea*		2		5				5	4	2	4		22
13	*Apis indica*		4			4		2	10	8	10	2		40
14	*Melipona iridipennis*	20	18						2	15	20	35	10	120
15	*Xylocopa violacea*			54	10		15		5	15	40		32	171
16	*Xylocopa fenestrata*			17	5					5	20	2	22	71
17	*Xylocopa aestuan*			5	7		12			5	5			34
IV	**Pompilidae**													
18	*Pepsis* sp.						2				2			4
V	SPHECIDAE													
19	*Ammophila humbertiana*				2					2	2			6
20	*Sceliphron curvatum*									2	2			4
21	*Sceliphron cementarius*								2	5	20		2	29
22	*Tachytes monetarius*						2							2
23	*Sphex lobatus*							2						2
VI	**Chrysididae**													
24	*Chrysis* sp.												2	2
VII	**Megachilidae**													

Table 1. Contd.

25	*Megachile anthracina*					5		12	22	15				54
26	*Megachile lanata*							2						2
27	*Megachile disjuncta*								2					2
VIII	**Mutillidae**													
28	*Darylabris argentipes*		4			1				2	2			9
IX	FORMICIDAE													
29	*Monomorium minimum*	300	200	250	300	100	50	500	140	180	240	250	300	2810
30	*Monomorium destructor*	1000	1600	1000	1000			500	800	1000	1800	2100	2100	12900
31	*Monomorium pharaonis*	1000	100	600	800			1000			300	400		4200
32	*Polyrachis sp.*	500	400	700				1000		500	200	200	500	4000
33	*Myrmica rubra*			500	400			300	400	300	300	200	400	2800
34	*Crematogaster contempta*				400	300		250	400	750	500	500		3100
35	*Solenopsis germinate*									250	600	100		9050
36	*Oecophylla longinoda*		200	300					300		500			1800
37	Unidentified -1												2	2
38	Unidentified -2									2				2

March, April and May (Table 1). In the tropical monsoon forest, the mean temperature gradually increases from January to April and many trees bloomed during this season and this might be the reason for the abundance of hymenopterans during this season in the study area. Most of the hymenopterans recorded were good pollinators and were seen in *Ancardium occidentale*, *Lantana camara* and *Calotropis gigantea* plants. Higher number of *Borassus flabillifer* trees is seen in this habitat, which might also be one of the reasons for the abundance of hymenopterans in summer season. Itioka et al. (2001) reported that the number of honey bee colonies rapidly increases generally during the flowering period. The seasonality of insects depends upon the floral species diversity (Sparks and Parish, 1995), diet (Assad et al., 1997) and shade (Sparks et al., 1996). In general, many pollinator taxa visit more than one plant species; generalization is the most common pattern, one-to-one links are rare in plant-pollinator relations and could be caused by temporal or spatial variation in population densities of particular pollinator species or by changes in plant community (Lázaro et al., 2009; Perfectti et al., 2009), which is more likely to happen in conditions of altered environment. Pollinators has expanded since studies illustrated the effects of habitat fragmentation on the diversity of this group of organisms and addressed the significance of wild pollinators for reproduction of crops (Biesmeijer et al., 2006; Steffan-Dewenter and Westphal, 2008).

Species richness (R1) was higher (2.84) in April and lower (0.83) in November. Shannon's Diversity Index (H') was maximum (1.95) in April and minimum (0.68) in November. Evenness indices (E1, E2, E3, E4 and E5) showed that they were uniformly distributed (Table 2).

The study indicates a rich and diverse hymenopteran fauna in the Kuthiraimozhi Theri deciduous forest. As this study covered only macrofauna and the microforms remain unrecorded, further faunistic survey are recommended for the area to discover its rich hymenopteran diversity.

Table 2. Diversity of the order hymenoptera in the deciduous forest (per hectare).

Index	July 2009	Aug	Sep	Oct	Nov	Dec	Jan 2010	Feb	March	April	May	June
NO	9	11	11	12	6	8	9	15	21	25	13	14
R1	1.007	1.276	1.228	1.377	0.831	1.455	0.997	1.831	2.488	2.846	1.456	1.600
R2	0.169	0.219	0.108	0.221	0.297	0.724	0.163	0.328	0.377	0.368	0.211	0.241
λ	0.292	0.438	0.191	0.235	0.597	0.267	0.256	0.243	0.208	0.207	0.345	0.429
H’	1.335	1.103	1.792	1.584	0.684	1.541	1.489	1.615	1.813	1.953	1.486	1.181
N1	3.800	3.263	6.003	4.872	1.981	4.667	4.434	5.027	6.129	7.046	4.419	3.258
N2	3.420	2.282	5.240	4.226	1.676	3.747	3.911	4.116	4.807	4.819	2.903	2.332
E1	0.608	0.493	0.747	0.637	0.382	0.741	0.678	0.596	0.595	0.606	0.579	0.448
E2	0.422	0.297	0.546	0.406	0.330	0.583	0.493	0.335	0.292	0.281	0.340	0.233
E3	0.350	0.226	0.500	0.352	0.196	0.524	0.429	0.288	0.257	0.252	0.285	0.174
E4	0.900	0.699	0.873	0.867	0.8455	0.803	0.882	0.818	0.785	0.684	0.657	0.716
E5	0.864	0.567	0.848	0.833	0.6880	0.749	0.848	0.773	0.743	0.631	0.552	0.590

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