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Study on the diversity of insects fauna associated with mangrove plants in three selected localities of sundarban biosphere reserve, West Bengal, India

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Abstract
The present paper documents the insect diversity associated with mangrove forest in three different localities under Sundarban Biosphere Reserve, West Bengal conducted during September 2021 to April 2022. A total of 392 insects from 7 orders, 23 families were recorded. At each site, during low tide, different types of insects were observed and were recorded. This study shows that Hymenoptera (33.93%) was the most dominant order according to total number of individuals, followed by Hemiptera (19.39%), and the least were Odonata (5.87%) and Ephemeroptera (0.51%) respectively. The Diversity of insects was highest in Locality1 (Hemnagar) and lowest in Locality3 (Canning).

Keywords: mangrove ecosystem, diversity, insects, mangroves, sundarban biosphere reserve

Introduction
The mangrove trees shelter a wealth of wildlife, protecting different fish species. Mangroves also serve as storm buffers by reducing wind and wave action in shallow shoreline areas [1]. Mangrove roots help anchor shorelines around the world, protecting coasts from the devastating impacts of storm waves – much more effectively than concrete sea walls [2].
According to India state of forest report 2019[3], West Bengal has 42.45% of India's mangrove cover, followed by Gujarat 23.66% and A&N Islands 12.39%. Gujarat shows a maximum increase of 37 sq km in mangrove cover [(over 9,000 acres)].South 24 Parganas district of West Bengal alone accounts for 41.85% mangrove cover of the country. Mangrove cover in the country has increased by 54 sq km (1.10%) as compared to the previous assessments. The current assessments shows that mangrove cover in the country is 4,975 sq km [(1.2 million acres)], which is 0.15% of the country's total geographical area.
Several studies has been made regarding insects associated with the mangrove plants of SBR [4,5,6,7,8], at different places of SBR, West Bengalbut no work was recorded before on the insect diversity of mangrove plants from the selected three localities: Hemnagar, Canning and Jharkhali under Sundarban Biosphere Reserve, West Bengal. This is the first such attempt to collect information of this kind on plant insect fauna from these three regions under SBR studied during September, 2021 to April, 2022.

Materials and Methods
1. Collection site
The collection site for and insects on various mangrove plants, was the Sundarban Biosphere Reserve in West Bengal. The collection was done during the period from September 2021 to April 2022 and field was visited twice a month.
These insects were collected from 3 selected areas *viz*., Hemnagar, Canning and Jharkhali under Sundarban Biosphere Reserve (SBR) and also visited these places twice a month from September 2021 to April 2022, during low tide.

2. Collection and preservation of insects
Small sucking insects like aphids and mealy bugs and large sized caterpillars were collected by hand- picking method. The small insects were preserved in glass vials consisting of 70-90% ethyl alcohol. Large insects were collected by Sweep net technique. In many cases, the leaves were brought to laboratory in polythene bags covering the mouth tightly and examined under a stereo binocular microscope for identification. The mangrove plants were identified by the help of book on Indian Mangrove written by Ragavan *et al*. [9].

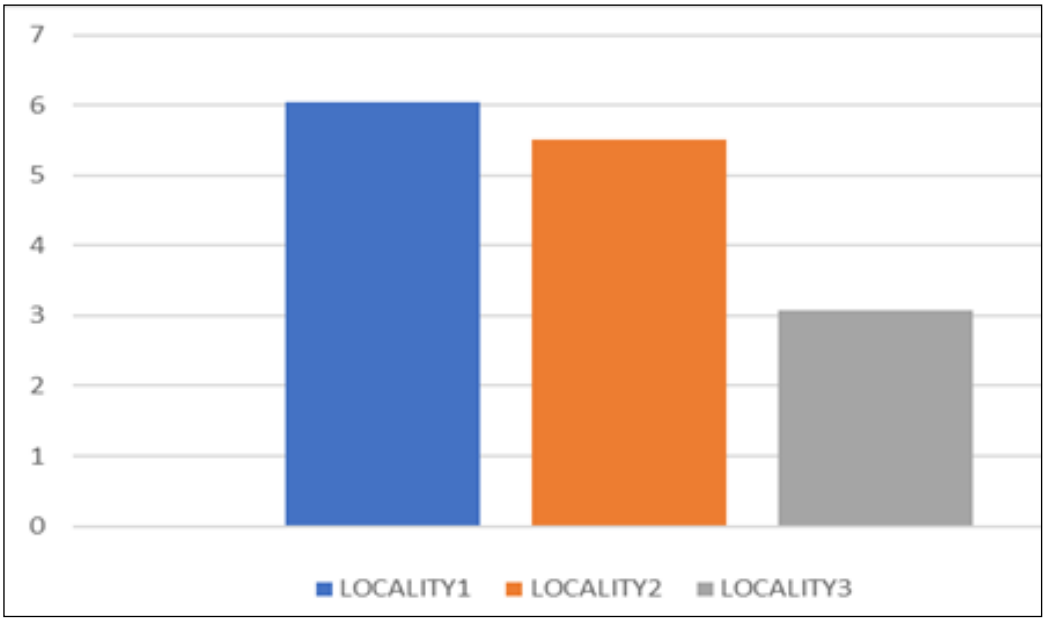
3. Data Analysis
During the present study, the relative abundance of the insects was calculated using the following formula:

$$\text{Relative Abundance (\%)} = \frac{\text{Total Number of Individual insect species}}{\text{Total Number of insect Species Population}} \times 100$$

One-Way ANOVA was calculated using Microsoft Excel 2021 to observe the difference in insect species composition across the three localities under SBR.

Results
The identification of the insect specimens collected from different mangrove trees at Sundarban Biosphere Reserve, during the present study shows the occurrence of 27 species of insects which belong to 27 genera 7 orders.
These includes 7 species from Hymenoptera,5 species from Hemiptera, 5 species from Diptera, 4 species from Lepidoptera, 3 from Coleoptera, 2 species from Odonata, 1 species from Ephemeroptera were recorded (Table1).
In this study it has been observed that, among all the insect populations recorded the insect belonging to the family Formicidae under order Hymenoptera were higher and the family Tabanidae under the order Diptera were lower.
Moreover when the total number of individual insects collected during the present study in 3 different study sites were compared, it was observed that the Locality 1 (Hemnagar) was higher in insect diversity followed by Locality 2 Jharkhali and Locality 3 (Canning) as shown in Table:1 & Fig: 1.

Fig 1: Comparative study of insect diversity associated with mangrove plants in three localities under SBR, during the present study period (September 2021 to April 2022)



Where Locality 1 = Hemnagar; Locality 2= Jharkhali: Locality 3=Canning

Table 1: List of insect species associated with mangrove plants recorded in three localities under SBR, during the present study period (September 2021 to April 2022)

Sl. No.	Order	Family	Insect species observed		Host plants	Number of individual insect species recorded		
			Scientific Name	Common Name		(Hemnagar)	(Jharkhali)	(Canning)
1	Hymenoptera	Apidae	*Apis mellifera*	Western Honey Bee	*Exoecariaagallocha*	7	6	2
			Apis dorsata	Giant Honey Bee	*Exoecariaagallocha*	10	8	4
			Xylocopa fenestrata	Carpenter Bee	*Alzebialebbeck*	5	4	1
		Scoliidae	*Scolia affinis*	wasp	*Aegialitiscorniculatum*	4	4	4
		Formicidae	*Tetraponera rufonigra*	Bi-coloured Arboreal Ant	*Phoenix peludosa*	6	7	6
			Camponotus compressus	Indian Black Ant	*Phoenix peludosa*	10	10	5
			Solenopsis germinata	Fire Ant	*Phoenix peludosa*	11	10	9
2	Hemiptera	Coreidae	*Homoecerus* sp.	Leaf-footed Bug	*Exoecariaagallocha*	7	6	6
		Lygaeidae	*Lygaeus equestris*	Red Bug	*Exoecariaagallocha*	8	6	4
		Pentatomidae	*Nezara viridula*	Green Sting Bug	*Exoecariaagallocha*	4	7	3
		Alydidae	*Leptocorisa oratorius*	Slender Rice Bug	*Heriteria fomes*	8	6	2
		Reduviidae	*Endochus inornatus*	Asian Bug	*Heriteria fomes*	6	4	1
3	Diptera	Syrphidae	*Eristalis arvorum*	Hoverfly	*Heriteria fomes*	4	3	2
		Sarcophagidae	*Sarccophaga dux*	Flesh fly	*Exoecariaagallocha*	3	3	2
		Tabanidae	*Tabanus striatus*	Horse Fly	*Exoecariaagallocha*	3	3	1
		Psycodidae	*Psycoda bengalensis*	Moth Fly	*Exoecariaagallocha*	8	7	5
		Chironomidae	*Chironomus* spp.	Nonbiting Midges	*Acunthusilicifolis*	6	7	2
4	Lepidoptera	Nymphalidae	*Junoniaalmana*	Peacock Pancy	*Heriteria fomes*	8	7	1
		Nymphalidae	*Melanitis leda*	Rice Butterfly	*Exoecariaagallocha*	3	4	3
		Papilionidae	*Papilio polytes*	Common Mormon	*Exoecariaagallocha*	4	4	2
		Nymphalidae	*Danaus chrysippus*	Tiger Milkweed Butterflies	*Heriteria fomes*	6	4	2
5	Coleoptera	Scarabaeidae	*Adoretus lacustris*	Scarab beetles	*Phoenix peludosa*	5	4	3
		Cerambydae	*Xystrocera globosa*	Lebbek Borer	*Phoenix peludosa*	6	4	2
		Scutelleridae	*Chrysocoris patricius*	Jewel Bug	*Exoecariaagallocha*	10	12	6
6	Odonata	Libellulidae	*Urothemis signata*	Greater Crimson Glider	*Heriteria fomes*	5	5	3
		Coenagrionidae	*Agriocnemis keralensis*	Kerala Dartlet	*Heriteria fomes*	4	4	2
7	Ephemeroptera	Baetidae	*Cloeon* sp.	Mayfly	*Exoecariaagallocha*	2	0	0

The present study observed that the relative abundance of the order Hymenoptera (33.93%) was highest followed by Hemiptera (19.39%), Diptera (15.05%); Coleoptera (13.27%), Lepidoptera (11.99%), Odonata (5.87%) and Ephemeroptera (0.51%) When all the total number of Insects recorded in the three localities under the SBR (Table: 2).

Table 2: Relative Abundance of different insect species associated with mangrove plants observed during the present survey

Sl. No.	Order	Family	Insect Species Recorded	Number of Individuals	Relative Abundance
1	Hymenoptera	Apidae	*Apis mellifera*	15	11.28
			Apisdorsata	22	16.54
			Xylocopa fenestrata	10	9.02
		Scoliidae	*Scolia affinis*	12	7.51
		Formicidae	*Tetraponera rufonigra*	19	18.80
			Camponotus compressus	25	14.28
			Solenopsis germinata	30	22.56
2	Hemiptera	Coreidae	*Homoecerus* sp.	17	22.36
		Lygaeidae	*Lygaeus equestris*	18	23.68
		Pentatomidae	*Nezara viridula*	14	18.42
		Alydidae	*Leptocorisa oratorius*	16	21.05
		Reduviidae	*Endochus inornatus*	11	14.47
3	Diptera	Syrphidae	*Eristalis arvorum*	9	15.25
		Sarcophagidae	*Sarccophaga dux*	8	13.56
		Tabanidae	*Tabanus striatus*	7	11.86
		Psycodidae	*Psycoda bengalensis*	20	33.89
		Chironomidae	*Chironomus* spp.	15	25.42
4	Lepidoptera	Nymphalidae	*Junonia almana*	15	31.91
		Nymphalidae	*Melanitis leda*	10	21.28
		Papilionidae	*Papilio polytes*	10	21.28
		Nymphalidae	*Danaus chrysippus*	12	25.53
5	Coleoptera	Scarabaeidae	*Adoretus lacustris*	12	26.08
		Cerambydae	*Xystrocera globosa*	12	26.08
		Scutelleridae	*Chrysocoris patricius*	28	60.86
6	Odonata	Libellulidae	*Urothemis signata*	13	56.52
		Coenagrionidae	*Agriocnemis keralensis*	10	43.47
7	Ephemeroptera	Baetidae	*Cloeon* sp.	2	100

Again during this study the Analysis of Variant (ANOVA) results showed that there was a significant variation among the insect orders (Hymenoptera, Hemiptera, Diptera, Coleoptera, Lepodeptera, Odonata and Ephemeroptera) at $P< 0.05$ in case of three different localities under SBR (Table3).

Table 3: One-Way ANOVA showing difference in insect species composition across the three localities under SBR, during the present study period (September 2021 to April 2022)

Source of Variation	***SS***	***df***	***MS***	***F***	***P-value***	***F crit***
Between Groups	135.2098765	2	67.60493827	12.1068027	2.635	3.11379226
Within Groups	435.5555556	78	5.584045584			
Total	570.7654321	80				

Discussion

The results of this study showed that the Sundarban Mangrove Forest, West Bengal, India has high insect diversity. The rich number of species available in the forest ecosystem could be mainly because of availability of different tree species and vegetation cover with a forest-like nature.

In this study the identifying orders are Hymenoptera (apidae, scoliidae, formicidae), Hemiptera (coreidae, lygaeidae, pentatomidae, aldydae, reduiividae), Diptera (syrphidae, sarcophagidae, tabanidae, psycodidae, Chironomidae), Lepidoptera (nymphalidae, papiloidae), Coleoptera (scarabaeidae, cerambydae, scutelleredae), Odonata (libellulidae, coenagrionidae). In Hymenoptera order 7 species are present, 5 species in Hemiptera, 5 species in Diptera, 4 species in Lepidoptera, 3 species in Coleoptera, 2 species in Odonata and 1 species in Ephemeroptera also present (Table:1; Figure:1)

The present study reported two families (Nymphalidae and papilodae), with four species (*Junonia almana*, *Melanitis leda*, *Papilio polytes*, *Danaus chrysippus*), these lepidopteran species were also reported by Das, Shah and Pathania [8] they also reported on Lepidoptera from Mangrove plants of Sundarbans.

The result of diversity indices across habitats showed that, Locality 1 (Hemnagar) area had the higher value of insect species diversity which implies that the availability of different plants influences the diversity and abundance of insect species.

Moreover, It is often assumed that the insect diversity in mangroves is low because high salinity and low plant diversity are thought to interfere with insect diversification But the present research work shows that mangroves are species-rich despite of low plant diversity.

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