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ASSEMBLAGE DIVERSITY AND MULTIVARIATE ANALYSIS OF INSECTS AND ARACHNIDS FROM SANDSPIT MANGROVE FORESTS *AVICENNIA MARINA* FORSK

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ABSTRACT

The study deals with population diversity and multivariate analysis of insects and spiders of Sandspit mangrove forest dominated by grey mangrove *Avicennia marina*. In order to get informations about the seasonal variations and the distribution of insects and arachnids of Sandspit mangrove forest monthly data was collected from 2007 to 2008. A total of 33 species of insects and arachnids were recorded. Among them 28 species associated with class insecta; most of the species belong to orders Diptera. Only six species of spiders were recorded from the study area belonging to five families. Few insects are biting type causing irritation and pain to the human being; however they live frequently in the mangrove forests. Species diversity (H') of class insecta species is 1.406 while species richness and evenness were 0.422 and 7.02 respectively. Species diversity (H'), Species richness, evenness and dominance of Arachnida species are1.212, 0.753, 1.020 and 0.365 respectively. The Dendrogram resulting from Ward s clustering strategy shows no clear cut grouping due to chaining effect of taxa. The pattern of species on the ordination axes were disclose on monthly basis.

Keywords: population diversity, insects, spiders, Sandspit, *Avicennia marina*

INTRODUCTION

Mangrove forests are considered to be a diverse habitat for fauna and have an immense significance. Likewise other forests of the world Mangrove forest of Pakistan has significance with regards of different habitats for animals. Many physical conditions vary widely within the mangrove areas so it is possible that the fauna may show a discrepancy in mangrove forest. Insects and arachnids are one of them. Insects constitute a significant portion of the fauna in many mangroves communities. They may be permanent residents of the mangle or only transient visitors. Mangrove insects are diverse and abundant and they occupy number of niches. The herbivorous insects feed on leaves, flowers, seeds or mangrove propagules; the detritivorous eat dead wood or decaying leaves; more general foragers; and predators. Some insects play crucial roles as pollinators and all in turn represent a major food source for predators. The mangrove insect fauna resembles that of terrestrial forests with many species in common to both. However some exceptions of unique species. In general insects are harmful however their beneficial aspects are not negligible. Especially herbivorous insects may cause considerable damage to the mangrove vegetation.

The spiders are another important arthropods of mangrove forests which are ubiquitous and their densities are high in mangrove forests. They play an important role in trophic dynamics. All spiders are predatory and their diet predominantly consists of insects (Riechert and Joel, 1987). There are some published data available regarding the ability of spiders to limit the growth of associated insect population (Clarke 1968, Van Hook 1971, Moulder and Reichle 1972, Mansour *et al*., 1980).

In mangrove forests of Pakistan the information about the significance of insects and spiders are scanty, although they play important ecological roles in the mangrove ecosystem. This paper evaluates the current status of diversity of insecta and the arachnida at Sandspit mangrove area. Multivariate analysis, the cluster analysis and ordination Nonparametric Multidimensional Scaling techniques were applied on data to understand the grouping pattern of these fauna and to acquire knowledge about the relationship between these two classes. We hope that this paper will be helpful to assess the ecological significance of insects and spiders in a mangrove system so that a sound and suitable strategy for the protection and management of the mangrove ecosystem could be evolved to conserve our diversity and the valuable mangrove ecosystem.

MATERIALS AND METHODS

The present research work was conducted during Nov, 2007 to Oct; 2008. This work was carried out at Sandspit mangrove forests. The specimens were collected by fixing sticky pad imported from USA. Most of the insects and arachnids were collected from their natural habitats on monthly basis by swap-net. The collected specimens were brought to the laboratory, narcotized, sorted out, identified and selected for detailed study. The specimens were preserved.

One of the simplest measures of the structure of a community that takes into account both the abundance pattern and the number of species is proposed by famous Simpsons's (1949). This is obtained as follows,

$$\textbf{Diversity} = H' = -\Sigma\, p_i \ln p_i$$

Where H′= Total number of species in the community (i.e., the richness) and the p_i= is the proportion of individual of i^{th} species in the sample.

The formula of species richness was developed by Menhinick (1964)

$$\textbf{Species richness} = d_1 = S/\sqrt{N}$$

The equitability indices was measured by the following formula,

$$\textbf{Equitability} = H'/H_{max} = H'/\ln S$$

Concentration of dominance was also measured (Simpson's, 1949),

$$\textbf{Concentration of Dominance} = D = \sum ni\,(ni-1)/N\,(N-1)$$

Where n_i and N are the same as those for the Shannon-Weaver information function.

RESULTS

During the present study a total of 33 species of insects and spiders were recorded. Among them 28 insects species belonging to eight orders and 28 families viz., *Cicendela histrio, Chrysochroa chinensis, Pericoma fuliginosa, Dilophus febrilis, Holorusia sp., Empis tessellata*, Bibio marci, *Calliphora vicina ,Anopheles sp. ,Culex sp., Aedes sp. ,Apanteles glomeratus, Musca domestica, Nemopoda nitidula ,Ledra aurita, Aphrophora alni, Pycna repanda , Dactylopius tomentosus, Formica rufa, Apis mellifica, Apis mellifera, Vespidae sp.* Pieris sp., Danaus plexippus, , *Carduligaster baltonii* and *Acrididae acrotylus.* Mangroves also contain numerous spiders, which descend from the trees at low tide and forage over the mud for insects. Web building spiders from the family Gasteracanthidae have brightly colored bodies with projecting spikes occurs abundantly in mangrove forests of Pakistan. Belonging five species of spiders related with 2 orders and 5 families were *Gasteracantha sp1., Gasteracanthasp2., Euophrys sp., Cryptophora cicatrosa, Aphonoplene sp., an Unidentied sp.* and *Galeodes sp.* recorded from mangroves forests (Table 1).

Table2.provides the type of mouth parts and modes of nutrition of the recorded insects and spiders. The most conspicuous insects and arachnids of the inter-tidal lagoon are Phytophagous, Herbivorous, Carnivorous and Predaceous having biting and chewing type, sponging type, siphoning type, biting and sucking and chewing and lapping type of mouth parts. The mouth parts of mangrove insect's species have been modified quite dramatically according to other feeding habitat.

Simpson's Species Diversity Index

There are two main factors of diversity, the richness and evenness show Species diversity and concentration of dominance are generally inversely related. Table 2 depicts the species richness, evenness, Simpson's diversity index, and concentration of dominance of two classes of phylum Arthropoda, i.e. Insecta and Arachnida. Species diversity (H′) of class insecta is 1.406 while species richness and evenness of insects were 0.422 and 7.02 respectively. Spider diversity was less (0.422) than that of insects whereas species richness, evenness, and dominance values were 1.212, 0.753, 1.020 and 0.365 respectively.

Cluster Analysis and Ordination

Cluster analysis is aimed to organize data to expose the underlying group structure or to impose a group structure according to some priori specifications. The Dendrogram resulting from agglomerative cluster analysis by

Ward's method is shown in Fig. 1. The groups obtained from Wards Cluster analysis was superimposed on the ordination axes 1 and 3 which showed more or less continuous pattern based on the seasonal gradients. The spherical group structure can not be recognized in the Dendrogram because of chaining effect of the indiviuals. This can be attributed to continuity in the distribution pattern of the insects and spiders fauna over the time.

Table1. Recorded insects and arachnids species from Sandspit mangrove forest.

CLASS 1: INSECTA		
ORDER 1: COLEOPTERA		
SPECIES	**COMMON NAME**	**FAMILY**
Cicendela histrio	Tiger beetle	Cicendelidae
Chrysochroa chinensis	Jewel beetle	Buprestidae
ORDER 2: DIPTERA		
Pericoma fuliginosa	Moth fly	Pshychodidae
Dilophus febrilis	Fever fly	
Tipula paludosa.	Crane fly	Tipulidae
Empis tessellata	Dance fly	Empididae
Bibio marci	March fly	Bibionidae
Calliphora vicina		Calliphoridae
Anopheles sp.	Mosquito	Culicidae
Culex fuscanus	Mosquito	Culicidae
Aedes aegypti	Mosquito	Culicidae
Apanteles flavipes	Ichneumon fly	Ichneumonidae
Musca domestica	House fly	Muscidae
Nemopoda nitidula	Black scavenger fly	Sepsidae
Unidentified sp.	Black flies	Simulidae
ORDER 3: HEMIPTERA		
Ledra aurita	Leaf hopper	Cicadellidae
Aphrophora alni	Spittle bug	Aphrophoridae
Pycna repanda	Cicada	Cicadidae

Dactylopius tomentosus	Aphids	Coccoidea
ORDER 4: HYMENOPTERA		
Formica rufa	Ant	Formicidae
Apis mellifica	Honey bee	Apidae
Apis mellifera	Honey bee	Apidae
Vespa sp.	Wasp	Vespidae
ORDER 5: LEPIDOPTERA		
Pieris rapae	Lemon Butterfly	Pieridae
Danaus plexippus	Monarch butterfly	Nymphalidae
ORDER 6: MANTOIDEA		
Mantis religiosa	Praying mantis	Mantidea
ORDER 7: ODONATA		
Cordueigaster boltonii	Dragon fly	Cordulegastridae
ORDER 8: ORTHOPTERA		
Acrididae acrotylus	Grass Hopper	Acrididae

CLASS 2:ARACHNIDA

ORDER 1: ARANEAE

SPECIES	COMMON NAME	FAMILY
Gasteracantha sp1.	Web spider	*Gasteracanthidae*
Gasteracantha sp2.	Web spider	*Gasteracanthidae*
Euophrys sp.	Jumped spider	Salticidae
Cryptophora cicatrosa	Tent web spider	
Aphonoplene sp.	Tarantula	Theraphosidae
ORDER 2: SOLIFUGAE		
Galeodes sp.	Sun Spider	Galeodidae

Table 2: Type of mouth parts and modes of nutrition of recorded orders:

CLASS 1: INSECTA		
Order	**Mouth parts**	**Mode of nutrition**
Coleoptera	Biting and Chewing type	Phytophagous, Predaceous and Scavenger
Diptera	Sponging type	Herbivorous and Scavenger
Hemiptera	Piercing- Sucking	Herbivorous, Predaceous and Parasitic
Hymenoptera	Chewing and Lapping	Herbivorous and Parasitic
Lepidoptera	Siphoning type	Phytophagous
Mantoidea	Biting and Chewing type	Carnivorous and Predaceous
Odonata	Biting and Chewing type	Predaceous
Orthoptera	Biting and Chewing type	Herbivorous
CLASS 2:ARACHNIDA		
Order	**Mouth parts**	**Mode of nutrition**
Araneae	Biting and Chewing type	Predator
Solifugae	Biting and Chewing type	Predator

Table 3. Shannon and Weaver diversity index of insecta and arachnida species of Sandspit mangroves forests:

Diversity Indices	Insecta	Arachnida	Combined
Diversity (H)	1.406	1.212	2.702
Equitability (evenness) (J)	0.422	0.753	0.773
Species richness (d1)	0.725	1.020	1.540
Dominance (D)	0.477	0.365	0.109

Table 4. Correlation of NMS ordination axis with environmental variables.

S. No	Variables	Axes		
		1	2	3
1	**pH**	0.11ns	0.02 ns	0.14 ns
2	**Salinity**	0.13 ns	0.07 ns	0.12 ns
3	**Temperture**	0.17 ns	0.11 ns	0.16 ns
4	**Nitrate**	0.06 ns	0.17 ns	0.18 ns

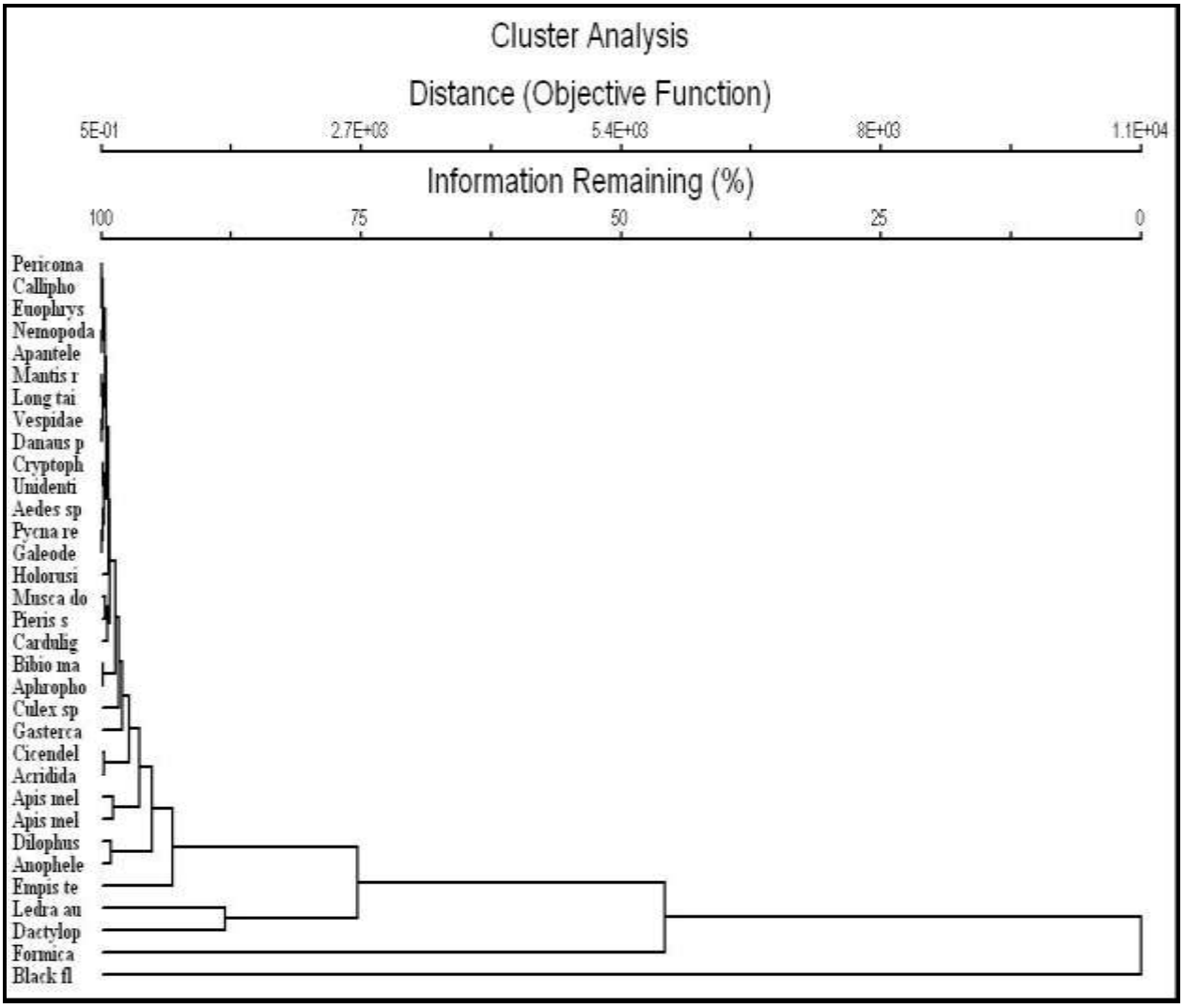

Fig.1.Cluster Analysis of insects and spiders species recorded from Sandspit mangrove forest.

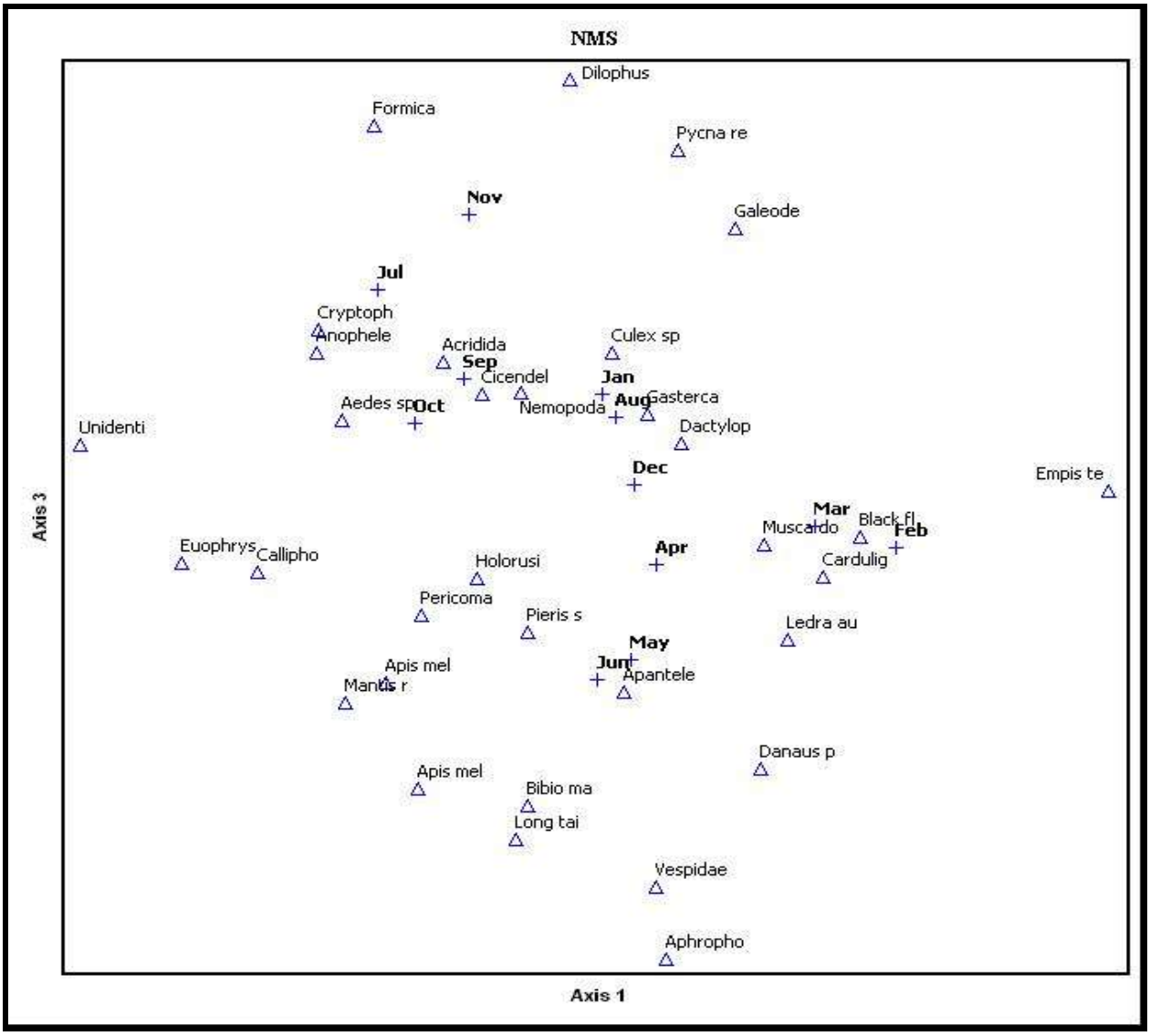

Fig. 2. Non-Parametric Multidimensional Scaling (NMS) ordination of insects and spiders species recorded from Sandspit mangrove forest.

Fig.2 shows the distribution pattern of the taxa in two-dimensional Non-Parametric Multidimensional Scaling (NMS) ordination plane. The ordination essentially repeats the chaining of species depicted by the cluster analysis group. The higher number of black flies (94 numbers) was recorded in the month of March while in January *F.rufa* (22) and *L. aurita* (21) showed almost similar number of individual. The remaining months did not show any marked changes in the number of species. During the whole study four species *F.rufa* (88), *L. aurita (79)*, black flies (88) and D.tomentosus (77) were found with maximum numbers

The correlation of Ordination axes (1,2 and3)with environmental variables is given in Table 4 which show no significant correlation with soil pH, salinity, conductivity and temperature.

DISCUSSION

The results clearly showed that Sandspit area has rich and diverse fauna of insects. This may be due to the fact that Sandspit area is covered with thick mangroves, the canopy cover very humid or wet due to proximity to the level of tidal water which favors insect's activity and growth. Sandspit is a polluted area due to domestic sewerage is dumped in this area. The other possible reason of high diversity is that many of the mangrove insects lay their eggs

in the fruits of particular, domestic sewerage which is rich in nutrients; therefore it increases the productivity of mangrove and hence increases the growth of insects. According to Franceworth and Ellison (1991) leaves of shaded seedlings are more consumed by insects than the exposed ones. According to Saifullah and Mehra (2004) polluted area encourages insect growth. According to Hutching and Recher 1974, Spencer 1977) Dipterans specialize on the fruits and propagules of mangroves. Four members of Hymenoptera *Formica rufa, Apis mellifera, Apis mellifica* and a *Vaspidae* sp. (not yet identified) and two species of Lepidoptera Danaus plexippus and Pieris sp (unidentified species) are commonly associated with mangroves, these were the seasonally visitors of mangroves forests, may occur during the flowering season.

Apis mellifica

Acrididae acrotylus

Cicendela histrio

Dactylopius tomentosus

Ledra aurita

Pieris rapae

Tipula paludosa

Cryptophora cicatrosa

Gasteracantha sp1

Pericoma fuliginosa

Some of them are important pollinating agents, The *Apis mellifera* feeds heavily on *Avicennia marina* when they were filled with flower. During the mangrove flowering season April to August honey bees appear busier in foraging activities, however on mangrove flora the bees were found to be uniformly busy throughout the day. This may be due to dense forests that provide shade and comfortable conditions in the heat of the day or it may be that the nectar concentration time of mangrove flowers is different from others. It would investigated that honey bees would be kept for five months in the mangroves which are the flowering months while in remaining months of the year they would be transported inland. Ants live on the floor of the mangrove forests have adapted to the daily tidal inundation by ploughing their burrows with mud and trapping bubble of air inside the burrow. A dead wood provides suitable habitats for ants (Ellway, 1974). Other arborescent species of ants survive by sheltering in the hollow twigs of Avicennia marina (Taylor, 1974). Stagnant pools are ideal places for mosquitoes. In Sandspit area stagnant pools are created within forests as a result of dredging and filling. Large number of Diptera occurs in mangroves, are the diverse components of the mangrove fauna.

Less number of spiders was recorded from study area; two families are well represented Arachnida (Orb-web) and Slilicidae (Jumping spider). This may be simply that these spiders are so well camouflaged that they are difficult to see and collect. The Gasteracantha species of the family Gasteracanthidae occurred abundantly among mangrove vegetation. It was noticed that collection of insects from Sandspit included several beneficial insects like butterflies, wasps and honey bee while many of them were harmful such as Fever fly, March fly, Black scavenger fly and so on.

Conclusion

This paper will provide exciting and productive answers to understand the diversity and interaction exhibit between insecta and arachnida. It thus provides a useful frame work for organizing research on different aspects in different areas of mangrove forests. Plant feeding insects have contributed greatly to understand interactions among organisms. Many species showed advanced forms of social behaviour and play a vital role in various types of ecosystem as predators, parasites and plant pollinators.

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