

Insect diversity profile of Chippaleru Mangroves in South-East India

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Abstract

The study on the diversity of insects of Chippaleru mangrove ecosystem identified 19 species of insects belonging to 5 orders encompassing 10 families. The study happened in 2023 reporting the orders Hemiptera, Diptera, Lepidoptera, Orthoptera and Odonata. The families identified were (Apidae, Corixidae, Gerridae, Culicidae, Nymphalidae, Crambidae, Pyralidae, Pieridae, Acrididae and Libellulidae). The calculated Shannon Wiener Diversity Index was 2.76 which indicates the moderate and somewhat balanced mix of insects.

Keywords: Mangrove insect fauna biodiversity South-East coast

Introduction

Mangroves are coastal ecosystems mainly located in tropical and subtropical regions of the globe. The flora of these ecosystems is salt-tolerant. These are trees and shrubs that inhabit the inter-tidal zones (Koka, E. G., *et al.*, 2025) ^[1]. These main trees and plants constitute the foundation of the ecosystem. There are other plants present on the edges of the ecosystem. These are mangrove associates which are also found in other coastal ecosystems.

Mangroves render umpteen ecosystem services such as offsetting GHG emissions; fixing carbon of 218 trillion grams annually (Kathiresan *et al.* 2013) ^[2] etc. Significant extent of mangrove habitats is found on the coasts of 9 states and 4 Union Territories in India. The extent of these pristine forests is 4, 991.68 sq. km. This is 0.15% of the total geographical area of India (ISFR 2023). The Indian mangroves constitute 3% of the world's mangroves (Singh, N., Joseph, J., Fayaz, M. 2025) ^[4].

Mangroves are one of the rich habitats of biodiversity. The species richness, diversity and distribution of mangrove are the parameters of the health of these forests (Latumahina, F. S., *et al.*, 2024) ^[5]. Diverse faunal groups such as invertebrates like Arthropods, Molluscs and vertebrates like fishes, amphibians, birds, reptiles and mammals inhabit these mangrove ecosystems (Arulnayagam, A., 2021; Palita, S. K. 2019) ^[7, 8]. Notably, the insects and crabs are important groups that play a significant role in pollination and nutrient cycling respectively.

The specialized adaptations of mangrove flora with pneumatophores and viviparous propagules help organize microhabitats where conditions are suitable for diverse fauna, including insects, crabs, and fish to inhabit (Pandey & Brahma, 2019) ^[10]. The mangrove habitats act as fish nurseries and also the fishing grounds contributing 30 million tonnes of global fish catch annually (Arulnayagam *et al.*, 2021; UNEP, 2023) ^[7, 11]. Despite the countless number of benefits that mangroves render, they are continually facing a threat of rapid decrease in the cover extent. The causes for the degradation and shrinking of these pristine coastal habitats are mainly anthropogenic and stochastic as well (Goldberg *et al.* 2020) ^[6]. Anthropogenic pressures include agriculture, aquaculture, pollution and coastal development and stochastic causes include climate

change. These are the causes that threaten these groups, reducing diversity and ecosystem services.

The mangrove ecosystems form interdependent networks where flora and fauna interact with each other and establish a delicate balance to maintain ecological stability and high productivity. The very survival and sustainability of these ecosystems is possible with the intricate relationships happening among diverse groups of organisms (Arulnayagam *et al.*, 2021; FSI, 2019) ^[7, 9]. Each group of organisms has its own unique niche in the ecosystem. For example, the animal groups are engaged in mutualistic, predatory, and decompositional relationships with flora. The bees and birds are the telling example for a mutualistic relationship with mangrove flora. The flowers like those of *Avicennia*, in the Sundarbans, attract *Apis mellifera* offering nectar and benefiting the insects and the insects benefiting the flora by pollination, in return.

Insects are one of the groups of fauna which is critical for the maintenance of the ecosystem stability by playing their role as pollinators and decomposers. They are integral to mangrove productivity and faunal-floral interactions. These roles of the insects underscore the need to study and protect their diversity (Pandey & Brahma, 2019) ^[10]. It is the insect species that contribute significantly to nutrient cycling in the ecosystem, pollination, and the formation of complex food webs. Insect diversity and abundance serves as bio-indicator about the health and the quality of the mangroves. Any Changes in the structure of insect communities might indicate the stress in the ecosystem (Semiun, C. G., 2020) ^[12]. This helps the conservationists identify the regions of mangroves needing restoration or any sort of intervention because insect diversity is considered the functional component of the mangrove management strategies.

The study of the insect diversity of mangrove ecosystems helps in the guidance for the restoration of these habitats. This can be done by the identification of the key insect species which are involved in the pollination and decomposition. This can pave the way for the design of the restoration projects which could enhance the conditions for the suitability of the insects. Increasing the density of the canopy might help increasing the diversity of insects as per some studies. This study aims to explore the diversity profiles of the insects in these mangrove habitats to assess the health of the ecosystem and inform conservation efforts.

Materials and Methods

Study area and time of the study: The study area is adjacent to the village Lakshmipuram of Annagaripalem of Kavali Mandal. These mangrove swamps are 1 Km from the village which is a fishermen hamlet. These mangroves are fed by Chippaleru, a riverlet on the coast of Kavali, Nellore District of Andhra Pradesh. The duration of the study was from January, 2024 to December, 2024. Four thick mangrove locations were marked as Station 1, 2, 3 and 4. The study area lies in the coordinates: Coordinates: 14°49'25.94"N, 80°04'37.34" E.

Field visits and sample collection: The area of study was visited every week during all the seasons of the year. The researcher used various instruments for trapping, carrying and preserving the insects that were caught. These instruments and materials include yellow traps, plastic bags, bottles, digital camera and 70% alcohol etc., Insect traps were placed both at the inter-tidal places and at those areas where dominant true mangrove flora like Avicennia and Rhizophora were dense.

Identification of the specimens: The investigators identified the insects by morphology first and determined

their correct taxonomical status by Timothy J. Gibb & Christian Oseto's (2019) [13] manual "Insect collection and identification: Techniques for the field and laboratory". And those which are difficult to identify were clearly photographed in various angles and the photographs were uploaded to "iNaturalist" for identification. The study employed the AI based identification applications such as "InsectNet" and "Picture Insect". These AI powered tools utilize AI algorithms that analyze photographs of insects in order to determine their species with high accuracy. Additionally, other books consulted for precise identification were:

A Field Guide to Insects (1970) of Donald J. Borror and Richard E. White Introduction of Insect Lessons (1996) of Donald J. Borror, Charles A. Triplehorn, and Norman F. Johnson

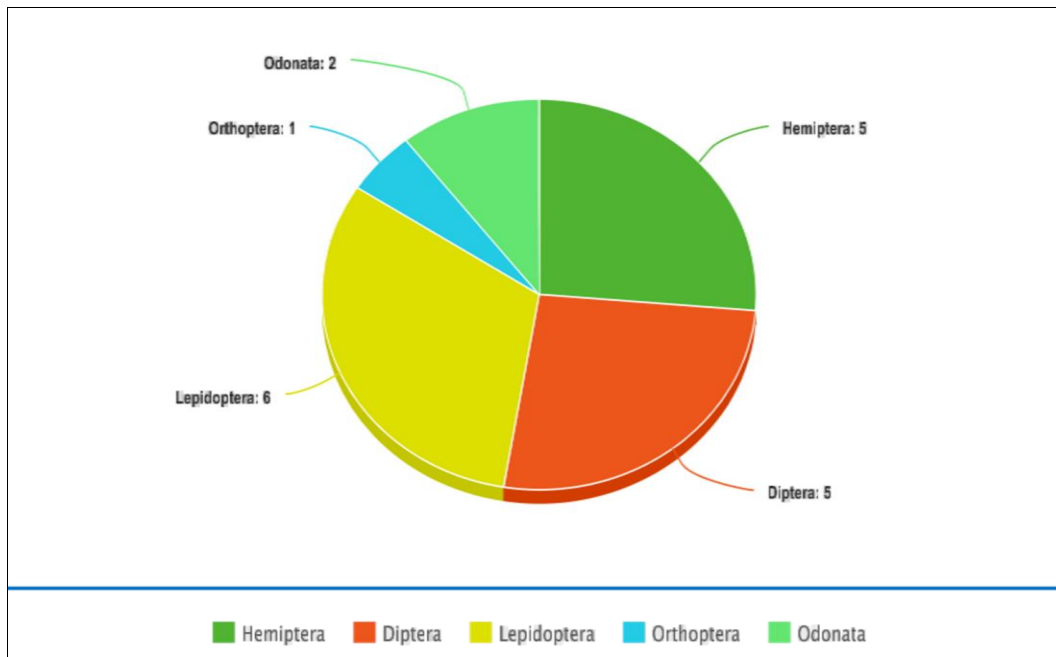
Hymenoptera of the World: An Identification Guide to Families (1993) of Henry Goulet and John T. Huber.

Diversity indices employed: The profiling of insect diversity was done by the indices such as species richness index, the Shannon-Wiener diversity index; evenness index etc.,

Result and Discussion

Order	Family	Species	Common name	Habitat
Hemiptera	Apidae	<i>Apis dorsata (Fabricius, 1793)</i>	Giant honey bee	Trees
		<i>Apis florea (Fabricius, 1787)</i>	Red dwarf honey bee	Trees
		<i>Xylocopa aestuans (Linnaeus 1758)</i>	Oriental carpenter bee	Large flowers
	Corixidae	<i>Sigara semistriata (Fieber, 1848)</i>	Water boat man	Algae and detritus feeding
	Gerridae	<i>Halobates germanum (White, 1883)</i>	Sea skater	Mangrove edges
Diptera	Culicidae	<i>Aedes albopictus (Meigen, 1818)</i>	Asian tiger mosquito	Water soil and
		<i>Anopheles subpictus (Grassi, 1899)</i>	Subpictus mosquito	Water soil and
		<i>Anopheles fluviatilis (James, 1902)</i>	Fluviatilis mosquito	Water soil and
		<i>Culex quinquefasciatus (Say, 1823)</i>	Southern house mosquito	Water soil and
		<i>Culex tritaeniorhynchus (Giles, 1901)</i>	Rice field mosquito	Water soil and
Lepidoptera	Nymphalidae	<i>Danaus chrysippus (Cramer 1777)</i>	Plain tiger butterfly	Herbs
		<i>Danus flexippus</i>	Monarch Butterfly	Plants
	Crambidae	<i>Maruca testualis (Geyer 1832)</i>	Pod borer	Legume plants and some mangrove trees
	Pylalidae	<i>Nephterix syntaractis (Turner 1904)</i>	Caterpillar	Leaf miner
	Pieridae	<i>Appias albina (Boisduva 1836)</i>	Common albatross	Leaf or flower of mangrove edge trees
		<i>Delias hyparete</i>	Indian Jezebel Butterfly	Loranthaceae and Santalaceae
Orthoptera	Acrididae	<i>Locusta migratoria manilensis</i>	Oriental migratory locust	Trees, grass
Odonata	Libellulidae	<i>Pachydiplax longipennis</i>	Blue dasher dragonfly	Trees
		<i>Sympetrum vulgatum</i>	Common Darter	Vegetated areas near water

Shannon Diversity Index (H)			
2.76			
Evenness/Equitability Index	0.9363	Richness	19
Total Number of individuals	260	Average Population Size	13.6842
Margalef Richness Index	3.237	Berger-Parker Dominance Index	0.1346
Inverted Berger-Parker Dominance Index	7.4286	Simpson Index	0.0713
Dominance Index	0.9287	Alternate Reciprocal Simpson Index	14.0189
Menhinick Index	1.1783	Simpson Index Approximation	0.0752
Reciprocal Simpson Index	13.3018	Dominance Index Approximation	0.9248
Buzas and Gibson's Index	0.82902564326096		



Discussion

The study identified 19 species of insects belonging to 10 families under 5 main orders - Hemiptera, Diptera, and Lepidoptera, Orthoptera and Odonata. These insects inhabit a range of ecological niches, from core mangroves to mangrove edges, playing a significant role in the complexity and stability of the ecosystem. The order Hemiptera is represented by 3 families, Apidae, Corixidae, and Gerridae with 5 species. Apidae encompasses 3 species which could play a role of pollinators. The presence of these suggests a strong pollination network.

Corixidae family is represented by *Sigara semistriata* (Water boatman), a species that feeds on algae and detritus, thus aiding in nutrient cycling within the aquatic regions of the mangrove. The Gerridae's representative, *Halobates germanum* (Sea skater), resides at the edges of mangroves, utilizing the water surface for locomotion and feeding. This species is specifically adapted to saline environments, illustrating the mangrove's function as a transitional habitat bridging terrestrial and marine ecosystems.

The order Diptera includes the family Culicidae, which comprises five species of mosquitoes: *Aedes albopictus*, *Anopheles subpictus*, *Anopheles fluviatilis*, *Culex quinquefasciatus* and *Culex tritaeniorhynchus*. These species thrive in aquatic and terrestrial environments, utilizing stagnant or slow-moving water sources found within mangrove ecosystems for their reproductive processes. Their abundance highlights the significance of mangroves as breeding sites for mosquitoes, which may pose risks for disease spread among adjacent human communities.

Four families namely Nymphalidae, Crambidae, Pyralidae, and Pieridae represent the order Lepidoptera. The *Danaus melanippus* which consumes herbs, likely taking advantage of the herbaceous undergrowth found in mangrove clearings or along edges represents the family Nymphalidae; Crambidae is represented by *Maruca testualis* targets leguminous plants and certain mangrove trees, highlighting its function as a herbivore that may affect plant community dynamics. Pyralidae, which is represented by *Nephterix syntaractis* (Caterpillar), operates as a leaf miner, impacting

the foliage of mangrove vegetation and playing a role in decomposition processes. *Appias albina* (Common albatross) of Pieridae feeds on the leaves or flowers of trees at the mangrove edge, further underscoring the significance of Lepidoptera in herbivory and pollination. The orders Orthoptera and Odonata are represented by 1 and 2 species respectively.

The Shannon Diversity Index (H) value 2.76 signifies a moderate to high level of insect diversity. In ecological terminology, an H' value ranging from 1.5 to 3.5 generally indicates a diverse community characterized by a favourable mix of species. In the context of mangrove ecosystems, where plant diversity is limited yet insect diversity can thrive due to unique niches (such as mudflats and water bodies), this value shows that the diversity is moderate. Similar value (H') was reported by Sembiring, J., *et al.* (2024) [18] in their study at Payum beach, Papua. In respect of the dominating order (Lepidoptera) also, both the studies show similarity.

The high evenness index value of 0.9363, which is close to 1, implies that the insect species are fairly evenly distributed throughout the community, without any one species significantly dominating. This reflects a balanced ecosystem in which resources are equitably shared among species, indicating a favourable condition for stability within the mangrove habitat. The low Simpson Index = 0.0713 value indicates a low probability that two randomly selected individuals belong to the same species, further supporting high diversity and evenness. The current study differs with the study of Sembiring, J., *et al.* (2024) [18] in respect of evenness index (0.41 vs. 0.9363). The mangrove area of the current study is small and whatever the species of insects were found, they were confined to this area despite the anthropogenic activities causing significant destruction of the habitat. The Simpson dominance index (0.9287) shows the domination of some insects despite the moderate diversity existing in the ecosystem.

Balakrishnan *et al.*, (2016) recorded twenty seven species of mangrove dwelling insects in the south-east coast mangroves, Parangipettai and Pichavaram. Among the orders, Lepidoptera dominates the others and the current

study also corroborates with those results. It is also similar to the studies done elsewhere such as (Abdul Rahaman 2002)^[17].

The study contradicts the study done by Rajasekhar, M *et al.* (2015)^[19] in the aspects of number of species and the dominating order. The said study reported 90 species of

insects and found Coleoptera as the dominating order of all. This could be due to the fact that the study was conducted in all the mangroves of the same Nellore district where the current study was also done. But the current study was carried out in only one mangrove habitat of several such mangroves of the district.



Conclusion

The intricate interplay between mangrove ecosystems and their insect populations underscores the critical importance of conserving these unique habitats along the South-East Coast of India. A comprehensive analysis of the insect diversity inhabiting the Chippaleru mangroves of South-East India has been conducted, resulting in the identification of over 19 species of insects with Shannon Wiener Diversity Index of 2.76 which indicates the moderate and somewhat balanced mix of insects.

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