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Diversity of hymenopteran insects in contrasting coastal environment of Midnapore (East), West Bengal, India

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Abstract
The insect species belonging to the order Hymenoptera are the third largest insect order. An extensive survey and sampling of Hymenopteran insects of coastal areas of Midnapore (East) district were made from November 2013 to October 2016. A total of 13 species of 11 genera belonging to 5 families have been documented. Diversity and distribution of these insects have been studied in different ecozones indicating some site specific and bioindicator species for eco assessment of the environment.

Keywords: bioindicator, coastal areas, diversity, hymenoptera

Introduction

Insects being a diversified group of organisms on earth [1], have found to inhabit in a large scale by successfully adjusting and finding their own niche and play a major role in ecological balance. Jana *et al* [2]. and Jana *et al* [3]. explained that insects are such a group which have the ability to differentiate the polluted environment from the non-polluted one and may change their host plant for survival after influencing by the non-conducive environmental condition.

Insects are found to occur in different types of environment and it ranges from very hot climate to very cold Arctic region. Insects in different regions are probably related to environmental temperatures where they lived [4].

Terrestrial Biodiversity may be estimated by Extrapolation method [5]. We can estimate the local richness of insect species by extrapolating species accumulation curves, fitting parametric distribution of relative abundance or using non-parametric techniques based on the distribution of individuals along species.

Different ecological and meteorological parameters like temperature, rainfall, humidity, vegetation growth and composition of soil characteristics, etc may affect the diversity and distribution of coastal insects. Studies on the biodiversity of the insect revealed that the natural environmental stresses play an important role in the community structure of some beetles [6].

Hymenoptera is an extremely diverse insect order including bees, wasps, ants, saw flies etc. Approximately 1, 15,000 described species are found in the world although huge amount of species are undescribed. Their presence in the world placed it after the Coleoptera and Lepidoptera. About 10,000 hymenopteran species have been recorded in India [7]. Insects of this order are found to inhabit in all terrestrial habitats such as soil, leaf litter and also on various vegetations, although some of the parasitic hymenopterans are found in aquatic habitats. The adult hymenopterans are mostly feed on nectar and honey dew of different plants species indicating their polyphagous nature. Besides polyphagous insects some are entomophagous in their food habit.

Hymenopterans are highly significant as pollinators and natural enemies of other insects. The diversity and abundance of hymenopteran insects may be closely linked to the anthropogenic activities like forest disturbance and establishment of plantation [8]. They also modify the soil structure and increase the soil fertility by aeration and water infiltration of agricultural interest. Honey, bee-wax, propolis and royal jelly, all these Bee byproducts have high economic value.

The coastal areas of Midnapore (East) district supports the macro terrestrial fauna of which a major population part is being shared by the insects, a bio energetically significant faunal component. They play a significant role in maintaining the steady state of coastal ecosystem of Midnapore and enhance the biological productivity [9]

In the present study we used three medicinal plants for quantitativestudy *viz*. *Calotropis procera*, *Croton bonplandium*, and *Clerodendron infortunatum* and plants of common vegetation were considered for qualitative assessment.In this context,the present study was undertaken to documentor record the occurrence of hymenopteran insects in differentecozones of coastal and non-coastal zone of Midnapore(East).

Selection of the study sites

For assessment of the diversity and distribution of hymenopteran insects eight study sites (*Viz.* Petuaghat-site I, Junput-site II, Soula-site III, Mandarmoni-siteIV, Sankarpur-site V, Digha-site VI, Bajkul-site VII and Contai-site VIII) which are located incontrasting coastal areas have taken into consideration (Fig.1). In Midnapore (East) district coastal tract extends over 60 km comprising 27%coastal biotopes of West Bengal (Longitudinally $87^0 5'$E to $88^0 5'$E and Latitudinallly $21^0 30'$N to $22^0 2'$ N) [10, 11]. Sixstudy sites (site-I to site-VI) have been selected which are located within the5 km of the shore and two (site-VII and site-VIII) beyondthe 25 km towards the mainland. The eight study sites may be categorisedas virgin coastal belt (S-I, S-II, S-III) whilesome are under places of tourism (S-IV, S-V, S-VI) along with some semi urbanized area (S-VIIand S-VIII).

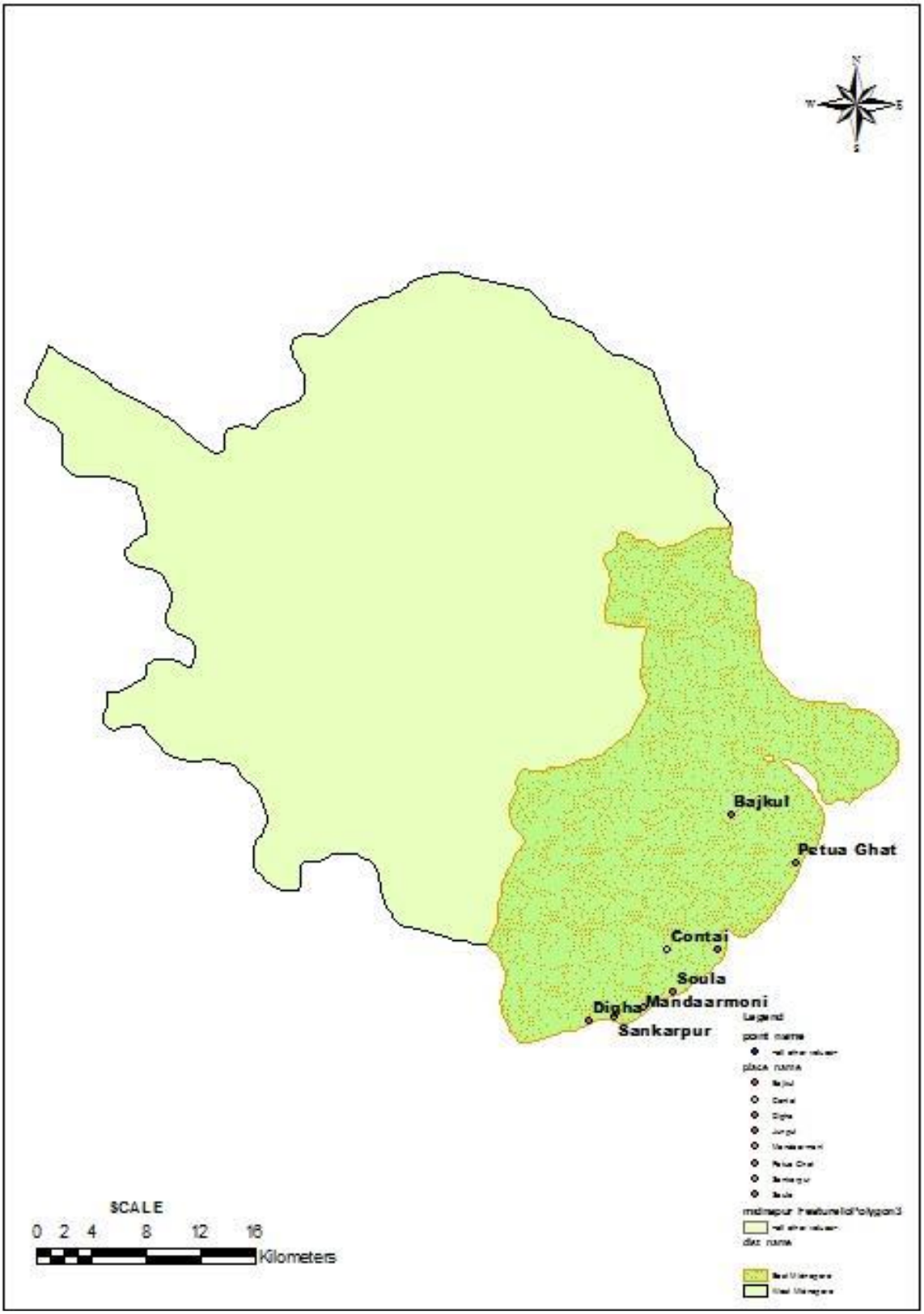

Fig 1: Map showing the coastal tract of Midnapore district

Materials and Methods

Sample collection along with species identification was initiated during November 2013 with the plot survey qualitatively whereas quantitative assessment was made from November 2014 to October 2016. Three transects were established in the proposed ecozones for the study of insect biodiversity [12].Visual observation is also standard method adopted by me for sampling [13, 14, 15, 16]. For quantitative analysis, the documentation was made bycounting the abundance of the insect fauna as number ofinsects per 100 leaves of host plant [17, 18, 19].

Wingless Hymenopteran insects were collected by hand picking and sweeping nets were used for winged one. The specimens were killed by Exposure to benzene vapor and preserved in dry condition. Then they were relaxed in the relaxing chambers and after being soft, they were pinned

with entomological pins of good quality. After proper preservation the insects were identified subsequently by following standard literatures [20, 21, 22, 23] and in consultation with the scientist of Zoological Survey of India, Kolkata.

Results

Altogether 13 insects under 5 families havebeen recorded From the eight study sites which are beingpresented in Table-1 highlighting their distribution pattern. Linnean system of Hierarchial classification [24, 25].

Super Phylum: Arthropoda
Phylum: Entoma
Sub Phylum: Uniramia
Super class: Hexapoda
Class: Insecta

Table 1: Binary data (Presence/Absence) of insects belonging to the Order Hymenoptera

Insects		Site of Occurrence							
Family	**Species**	**S-I**	**S-II**	**S-III**	**S-IV**	**S-V**	**S-VI**	**S-VII**	**S-VIII**
1. Formicidae	1. *Camponotus compressus* Fabr	+	+	+	+	+	+	+	+
	2. *Polyrhachis* sp	-	+	+	-	-	-	-	-
	3. *Diacamma rugosum* Le G.	-	-	+	-	+	+	-	-
	4. *Solenopsis geminate* Fabr	+	+	+	+	+	+	+	+
	5. *Meranoplus bicolor* Guer	-	-	-	-	-	+	+	-
	6. *Crematogaster rothneyi* Mayr	-	+	-	+	+	+	+	+
	7. *Sima* sp	-	+	-	-	-	+	-	+
2. Mutillidae	8.*Dasymutilla occidentalis* Linn	-	+	-	-	-	+	+	+
3. Xylocopidae	9.*Xylocopa latipes* Drury	+	+	+	+	+	+	+	+
4. Vespidae	10.*Vespa* sp	-	+	-	-	-	-	+	+
5. Apidae	11.*Apis* sp	+	+	+	+	+	+	+	+
	12.*Apis indica* Fabr	+	+	+	+	+	+	+	+
	13.*Apis dorsata* Fabr	+	+	+	+	+	+	+	+

S-I = Petuaghat; S-II = Junput; S-III = Soula; S-IV = Mandarmoni; S-V = Sankarpur;
S-VI = Digha; S-VII = Bajkul;S-VIII = Contai

Family: Formicidae

Species: 1 *Camponotus compressus* Fabr, 1787

1787. *Formica compressa* Fabricius, *Mant. Insect.* 1:307, W.

2003. *Camponotus compress us*, Tiwari *et al.*, *Zool. Surv. India, State Fauna Series* 9, *Fauna of Sikkim*, (Part 4): 500.

Materials Examined: 10 Exs, from all the study sites.

Habitat: Found to inhabit on *Calotropis procera, Mikania cordata, Croton bonplandianum, Datura metel, Solanum melongena, Solanum tuberosum, Clerodendron infortunatum*.

Distribution

India: Andaman and Nicobar Islands Arunachal Pradesh, Assam, Bihar, Delhi, Goa, Gujarat, Haryana, Himachal Pradesh, Jammu & Kashmir, Jharkhand, Karnataka, Kerala, Maharashtra, Manipur, Meghalaya, Mizoram, Nagaland, Orissa, Punjab, Rajasthan, Sikkim, Tamil Nadu, Tripura, Uttar Pradesh, Uttarakhand, West Bengal

West Bengal: Kolkata, Midnapore

Species: 2 *Polyrhachis* sp

Materials Examined: 5 Exs, from Petuaghat and Junput.

Habitat: Found to reside on *Clerodendron infortunatum*.

Distribution

India: West Bengal

West Bengal: Kolkata, Midnapore

Species: 3. *Diacamma rugosum* Le Guillou, 1842

1842. *Ponera rugosa* Le Guillou, *Ann. Ent. France*, 10: 318, w.

1995. *Diacamma rugosum*, Bolton, *A New Genl. Cat. Ants World*: 170.

Materials Examined: 5 exs, from Petuaghat, 3exs. From Sankarpur and 2 exs. From Digha.

Habitat: Found to Resides on *Croton bonplandianum*.

Distribution

India: Maharashtra, Orissa, Sikkim, West Bengal

West Bengal: Kolkata, Midnapore

Species: 4. *Solenopsis geminate* Fabricius

1804. Atta geminate Fabricius, *Syst. Piez.*: 423.

1840. Solenopsis geminata, Westwood, *Ann. Mag. Nat. Hist.*, 6: 87. *2003. Solenopsis geminata*, Tiwari *et al. Zool. Surv. India, State Fauna Series* 9, *Fauna of Sikkim* (Part 4): 491. 2005. *Solenopsis geminata*, Ghosh *et al., Records of the Zool. Surv. Ind. Ants of Ravindra sosovar,occasional paper no.234.*

Materials Examined: 5 exs, from all the study sites.

Habitat: Found to resides on *Mangifera indica,Calotropis procera, Croton bonplandianum, Datura metel and Clerodendron infortunatum*.

Distribution

India: Andaman and Nicobar Islands, Karnataka, Kerala, Manipur, Meghalaya, Orissa, Sikkim, Tamil Nadu and West Bengal.

West Bengal: Kolkata, Midnapore.

Species: 5. *Meranoplus bicolour* Guer, 1844

1844. *Cryptoeerus bicolor*Guer, *Cuv. Ieonogr. Regn. Anim Ins.*, 3: 425.

1903. *Meranoplus bicolor*, Bingham, *Fauna Brit. India, Hym*, 2: 168

1995. *Meranoplus bicolor*, Bolton, A *New Genl. Cat. Ants World*: 250.

2005. *Meranoplus bicolour* Ghosh *et al., Records of the Zool.Surv.Ind.Ants of Ravindra sosovar,occasional paper no.234.*
Materials Examined: 5 exs, from Digha, and 2 exs. From Bajkul.
Habitat: Found to inhabit on *Calotropis procera, and Solanum melongena*.

Distribution
India: West Bengal, and maximum part of India.
West Bengal: Kolkata, Midnapore.
Species: 6. *Crematogaster rothneyi* Mayr
1878. Crematogaster rothneyi Mayr, *Verh. Zool.-Bot. Ges. Wien*, 28: 681 & 685, W.
2003. Crematogaster rothneyi, Tiwari *et al., Zool. Surv. India, State Fauna Series* 9, *Fauna of Sikkim* (part4): 488.
2005. *Crematogaster rothnei* Ghosh *et al., Records of the Zool.Surv.Ind.Ants of Ravindra sosovar,occasional paper no.234.*
Materials Examined: 5 exs, from all the study sites except Petuaghat and Soula.
Habitat: Found to inhabit on *Calotropis procera, Mikania cordata, Croton bonplandianum, Datura metel, Solanum melongena, Clerodendron infortunatum*.

Distribution
India: Gujarat, Maharashtra, Meghalaya, Sikkim, Tamil Nadu, West Bengal.
West Bengal: Kolkata, Midnapore.
Species: 7. *Sima*sp
Materials Examined: 5 Exs, from Junput, 2 exs from Digha and 4 exs. From Contai.
Habitat: Found to inhabit on *Clerodendron infortunatum*.

Distribution
India: West Bengal.
West Bengal: Midnapore
Family: Mutillidae
Species: 8. *Dasymutilla occidentalis* Linnaeus, 1758
1758. *Dasymutilla occidentalis* Linnaeus *Syst. Nat. Vol. Tomus I, Editio decima, reformata: i-ii, 1-824.*
Materials Examined: 3exs, from Junput, 2 exs from Digha, and 4 exs. From Bajkul and Contai.
Habitat: Found to inhabit on *Clerodendron infortunatum*.

Distribution
India: West Bengal.
West Bengal: Midnapore
Family: Xylocopidae
Species: 9. *Xylocopa latipes* Drury, 1773
1773. Xylocopalatipes (Drury) Maa. Ree. Indian Mils, 40: 325-327. 1773. *Apislatipes*, Drury, Ill. Exot. Ins. ii. p. 98.
1773. *Xylocopalatipes*,Drury, Maa, ReeIndian,Mils 40:325-327, 1773. Xylocopalatipes (Drury) Maa. Ree. Indian Mils, 40: 325-327.
1773. Xylocopalatipes (Drury) Maa. Ree. Indian Mils, 40: 325-327.
1773. Xylocopalatipes (Drury) Maa. Ree. Indian Mils, 40: 325-327. 1773. Xylocopalatipes (Drury) Maa. Ree. Indian Mils, 40: 325-327.
1773. Xylocopalatipes (Drury) Maa. Ree. Indian Mils, 40: 325-327
1773. Xylocopalatipes (Drury) Maa. Ree. Indian Mils, 40: 325-327
Materials Examined: 5 exs. From all the study sites.
Habitat: Found to inhabit on*Calotropis procera, Mikania cordata and Solanum tuberosum*

Distribution
India: West Bengal.
West Bengal: Midnapore
Family: Apidae
Species: 10. *Apis* sp
Materials Examined: 8exs. From all the study sites.
Habitat: Found to inhabit on *Calotropis procera.*

Distribution
India: West Bengal.
West Bengal: Midnapore
Species: 11. *Apis cerna indica* Fabr, 1793
1793.
Apiscerna Fabr: 327
Materials Examined: 5exs. From all the study sites.
Habitat: Found to inhabit on *Calotropis procera.*

Distribution
India: Throughout the India.
West Bengal: Midnapore
Species: 12. *Apis dorsata* Fabr, 1793
1793. Apis dorsata Fabr: 328
Materials Examined: 3exs. From all the study sites.
Habitat: Found to inhabit on *Calotropis procera.*

Distribution
India: Throughout the India.
West Bengal: Midnapore
Family: Vespidae
Species: 13. *Vespa* sp
Materials Examined: 3exs. From Junput,5 exs. each from Bajkul and Contai.
Habitat: Found to inhabit on *Calotropis procera.*
Distribution
India: West Bengal.
West Bengal: Midnapore

Table 2: Distribution pattern of the insects belonging to the order Hymenoptera in the study sites

Insects				Site of occurrence							
Family	**Species**	**Host plant**	**Family**	**S-I**	**S-II**	**S-III**	**S-IV**	**S-V**	**S-VI**	**S-VII**	**S-VIII**
Formicidae	*Camponotus compressus* Fabr	*Calotropis procera*	Asclepiadaceae	+	+	+	+	+	+	+	+
		Mikania cordata	Compositae	+	+	+	+	+	+	+	+
		Croton bonplandianum	Euphorbiaceae	+	+	+	+	+	+	+	+
		Datura metel	Solanaceae	+	+	+	+	+	+	+	+
		Solanum melongena	Solanaceae	+	+	+	+	+	+	+	+
		Solanum tuberosum	Solanaceae	+	+	+	+	+	+	+	+
		Clerodendron infortunatum	Verbenaceae	+	+	+	+	+	+	+	+
	Polyrhachis rastellata Lat.	*Clerodendron infortunatum*	Verbenaceae	-	+	+	-	-	-	-	-
	Diacamma rugosum Le G	*Croton bonplandianum*	Euphorbiaceae	-	-	+	-	+	+	-	-
	Solenopsis geminate Fabr	*Mangifera indica*	Anacardiaceae	+	+	+	+	+	+	+	+
		Calotropis procera	Asclepiadaceae	-	-	+	-	+	+	-	-
		Croton bonplandianum	Euphorbiaceae	+	+	+	+	+	+	+	+
		Datura metel	Solanaceae	-	+	-	-	+	+	-	-
		Clerodendron infortunatum	Verbeneceae	-	+	+	+	+	+	-	+
	Meranoplus bicolor Guer	*Colotropisprocera*	Asclepiadaceae	-	-	-	-	-	+	+	-
		Solanum melongena	Solanaceae	-	-	-	-	-	+	-	-
	Crematogaster rothneyi Mayr	*Calotropis procera*	Asclepiadaceae	-	+	-	+	+	+	+	+
		Mikania cordata	Compositae	-	-	-	-	+	+	-	-
		Croton bonplandianum	Euphorbiaceae	-	-	-	-	+	-	-	-
		Datura metel	Solanaceae	-	+	-	-	-	-	+	+
		Solanum melongena	Solanaceae	-	+	-	-	+	-	+	+
		Clerodendron infortunatum	Verbenaceae	-	+	-	-	+	-	-	-
	*Sima*sp.	*Clerodendron infortunatum*	Verbeneceae	-	+	-	-	-	+	-	+
Mutillidae	*Dasymutilla occidentalis*Linn.	*Clerodendron infortunatum*	Verbenaceae	-	+	-	-	-	+	+	+
Xylocopidae	*.Xylocopa latipes* Drury	*Calotropis procera*	Asclepiadaceae	+	+	+	+	+	+	+	+
		Mikania cordata	Compositae	+	+	+	+	+	+	+	+
		Solanum tuberosum	Solanaceae	+	+	+	+	+	+	+	+
Vespidae	*Vespa* sp.	*Calotropis procera*	Asclepiadaceae	-	+	-	-	-	-	+	+
Apidae	*Apis* sp.	*Calotropis procera*	Asclepiadaceae	+	+	+	+	+	+	+	+
	*Apis indica*Fabr	*Calotropis procera*	Asclepiadaceae	+	+	+	+	+	+	+	+
	*Apis dorsata*Fabr	*Calotropis procera*	Asclepiadaceae	+	+	+	+	+	+	+	+

S-I = Petuaghat; S-II = Junput; S-III = Soula; S-IV = Mandarmoni; S-V = Sankarpur;
S-VI = Digha; S-VII = Bajkul;S-VIII = Contai

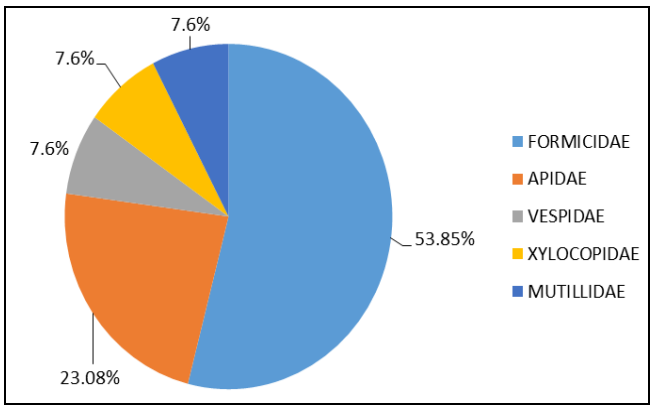

Fig 2: Family wise species distribution pattern of insect species belonging to the order Hymenoptera

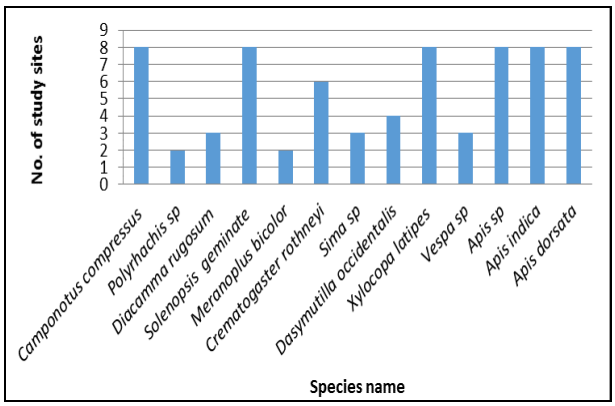

Fig 3: Distribution of insect species within the study sites

Table 3: Percentage of occurrence insects belonging to the order Hymenoptera in the study sites

Study sites	No. of species occurrence	Percentage of species occurrence
S-I	6	46.15
S-II	11	84.61
S-III	8	61.53
S-IV	7	53.84
S-V	8	61.53
S-VI	11	84.61
S-VII	10	76.92
S-VIII	10	76.92

Ecology and Discussion

Insects having the power of perceive the environmental stimuli as they are intimately associated with different structural components of their habitats, both aquatic and terrestrial. The present research work is designed to document the diversity pattern of hymenopteran insect fauna in eight ecozones (S-I to S-VIII) having contrasting features in connection with the physicochemical parameter of water, soil, Flora and Fauna of the studied biotopes along the coastal tract of Midnapore (East) District,West Bengal, India [26]. The insect species belonging to the order Hymenoptera were recorded from 9 host plants comprising of 7 families (Table-1).

A total of 13 species of insects under 10 genera, and 5 families were documented (Table-1, 2). Maximum number of species (7) were found to belong under the family Formicidae (53.85%) followed by family Apidae (23.08%) represented by 3 species of insects. Only one species of each family (7.60%) of Vespidae, Xylocopidae and Mutillidae was observed (Fig.-2). Out of 13 species of insects, 2 were observed from only coastal areas and 11 from both coastal and non-coastal areas but no species was documented from only non-coastal areas. Among these species of insects, *Camponotuscompressus*, *Xylocopalatipes*, *Apis*sp, *Apisindica* and *Apisdorsata* were found to be the most common species in all the study sites inhabiting the host plants under five families (Table-2, Fig.-3). *Polyrhachis*sp and *Diacammarugosum* residing on *Clerodendron infortunatum* and *Croton bonplandianum* respectively were observed only in coastal areas. *Meranoplusbicolor* was found to inhabit on host plant of family Solanaceae only at Digha(S-VI). Out of these 13 species of insects, 84.61% were documented at Junput(S-II) and Digha (S-VI), 61.53% at Soula (S-III) and Sankarpur(S-V),76.92% at Bajkul(S-VII) and Contai(S-VIII), and 46.15% and 53.84% were observed at Petuaghat (S-I) and Mandarmoni(S-IV) respectively(Table-3). Out of the 13 insect species *Polyrhachis*sp and *Meranoplus bicolor* may be regarded as two site specific species as their occurrence were restricted to the limited biotopes.

Due to increasing salinity fluctuation, anthropogenic pollution stress, ecodegradation, unscientific landmass use complications have been noticed in biogeographic zones of coastal Midnapore(East).Improvement in socio-economic condition of human beings indirectly may lead to the eco degradation at an accelerated rate due to the establishment of fishing harbour, tourism place, thermal power plants, petrochemical industries, unscientific fishery. Insects being extremely sensitive to several ecological and meteorological parameters respond quickly to environmental alterations,they may change their diversity patternalong with host plant [27, 28].

Coclusion

From the above ecoassessment, it may be concluded a good number of Hymenopteran insects were found to occur in its different diversity pattern in Midnapore (East) coastal tract. Havoc tourism and anthropogenic stresses leads to the rapid destruction of host plants of these insect species may alter the diversity pattern. So proper conservation is to be needed.

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References

1. Booth RG, Cox ML, Madge, RB. International Institute of Entomology, the Natural History Museum, United Kingdom, 1979.
2. Jana G, Mishra KK, Bhattacharya T. Journal of Insect Conservation. 2006; 10(3):249-260.
3. Jana D, Tamili DK, Chakraborty SK. Science and Culture. 2014; 80(5-6):139-138.
4. Downes JA. Adaptations of Insects in the Arctic. Annual Review of Entomology. 1965; 10:257-274.
5. Colwell RK, Coddington JA. Series B: Biological Sciences. Philosophical Transactions of Royal Society of London. 1994; 345(1331):101-118.
6. Papov VV, Krusteva IA, Sakalian VP. Acta Zoologica Bulgerica. 1998; 50:79-80.
7. Watt AD, Stork NE, Balton B. Journal of Applied Ecology. 2000; 39:18-30.
8. Jonathan JK. Hymenoptera: Collection and preservation of Animals. Zoological Survey of India, Calcutta, 1990, 147-150.
9. Chakraborty SK. Journal of Coastal Environment. 2010; 1:1.
10. Chakraborty SK. Journal of Coastal Environment. 2010; 1:1.
11. Jana D, Tamili DK, Chakraborty SK. Science and Culture. 2014; 80(5-6):139-138.
12. Southwood TRE. Ecological Methods. Chapman and Hall pub, 1991, 236.
13. Barnes BM and Barnes RD. Ecology. 1954; 35:25-35.
14. Macan TT. Mitt. Int. Ver. Limnol. 1958; 8:1-21.
15. Murray WD. Proc. 27th Conf. Calif. Mosq. Contr. Ass. 1963, 1959, 67-71.
16. Duffey E. J. Anim. Ecol. 1968; 37:641-674.
17. Broadbent L. Ann. Appl. Biol. 1948; 35:551-566.
18. Jana G, Chaki KK, Misra KK. Ecological Research. 2012; 27:153-162.
19. Jana D, Tamili DK, Chakraborty SK. Science and Culture. 2014; 80(5-6):139-138.
20. Mani MS. The fauna of India and adjacent countries, Chalcidoidea (Hymenoptera. Part I). Zoological Survey of India, Calcutta, 1989, 1067.
21. Jonathan JK. Hymenoptera: Collection and preservation of Animals. Zoological Survey of India, Calcutta.1990; pp147-150.
22. Tiwari RN. Ants. Memories of the Zoological Survey of India.1999; 18(4):1-96.
23. Sheela S. Hand Book of Hymenoptera, Formicidae, Zoological Survey of India Publication. 2008.
24. William DD, Feltmate BW. *Aquatic insects*. CAB International. ISBN:0-85198-782-706. 1992; 13:358.
25. Jana D, Tamili DK, Chakraborty SK. *Science and Culture*. 2014; 80(5-6):139-138.
26. Jana D, Tamili DK, Chakraborty SK. Science and Culture. 2014; 80(5-6):139-138.
27. Annon. Project report on “Studies on bio-resources assessmentand management of degraded mangrove ecosystem of Medinipur Coast, West Bengal, India and sanctioned by Ministry of environment and forest. (Sanction No.3/6/2000/CSC(M),dated05.11.2001) (2004).
28. Jana D, Tamili DK, Chakraborty SK. Science and Culture. 2014; 80(5-6):139-138.