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DIVERSITY OF LEPIDOPTERAN INSECTS IN THE COASTAL REGIONS OF MIDNAPUR (EAST), WEST BENGAL, INDIA

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ABSTRACT ■ Altogether 29 lepidopteran insect species belonging to 26 genera and 10 families have been recorded from eight different sites having contrasting ecological characters in the coastal areas of Midnapore (East),District of West Bengal, India. This study is the first attempt to document the insects under the order Lepidoptera which represents the second largest insect's order after the order Coleoptera from this coastal environment. The diversity and distribution of these insects have been studied.

Key Words: Lepidoptera , Midnapore(East),Coastal area, Diversity, Distribution.

INTRODUCTION

Insects being the most abundant and diversified faunal group (Williams and Feltmate,1992) act as an important bioindicator of environmental changes (Jana *et al*,2005).Out of several holometabolous insect's orders , lepidoptera has drawn the attention of human being because of their roles as pollinators (Noubissie *et al*., 2012), agricultural pests (Racke, 2012), provider of fibers (Sehnal and Zurovec, 2004) and also because of their aesthetic appeal (Kumar, 2013). This order mostly includes butterflies and moths which are of great economic importance in the larval stages. Many species devour the foliage, shoots and roots of trees and crops; a smaller number bore into stems and several species damage timber; others attack manufactured goods such as carpets, clothings and other fabrics, while a few are extremely destructive to stored food products, including grains, flour, etc. One or two species live in beehives, destroying and fouling the combs. On the other hand, several moths contribute direct benefit by yielding silk of commercial value - the so called 'silk-worms' (Kendel, 2010).

Holloway *et al*. (1992) have recognized the order lepidoptera as to be the second largest order after the coleoptera. Although many lepidoptera are valued for their colorful appearance, while a few are useful in commerce (the silkworm, *Bombyx mori*), and the larvae of these insects are probably more destructive to agricultural crops and forest trees than any other group of insects (Meyer, 2009). Butterflies are often used as bioindicators of ecosystem health and as surrogates for overall biodiversity (Sisk *et al*.,1994). Sensitivity to changes in microclimate and habitat make them particularly good indicators for monitoring

of natural areas undergoing change (Erhard, 1985 and Kremen, 1992). The present paper has attempted to record the diversity of lepidopteran insects inhabiting in different biotopes of coastal zone of Midnapore (East),West-Bengal,India.

STUDY SITES

In order to document the diversity of lepidopteran insects , eight study sites (Petuaghat – Site I,Junput –Site II,Soula-Site III,Mnadarmoni-Site IV ,Sankarpur –Site V,Digha –Site VI ,Bajkul -SiteVII and Contai-SiteVIII)(Fig.-1) have been selected which are located in contrasting eco-zones (Jana *et al*, 2014a). The Coastal tract of Midnapore (East) extends over 60 km representing 27 % coastal environment of West Bengal (longitudinally 87 ^{0}5 / E to 88^{0}5 / E and latitudinally 21^{0}30/ N to 22^{0}2/ N) (Chakraborty, 2010, Jana *et al*, 2014b).

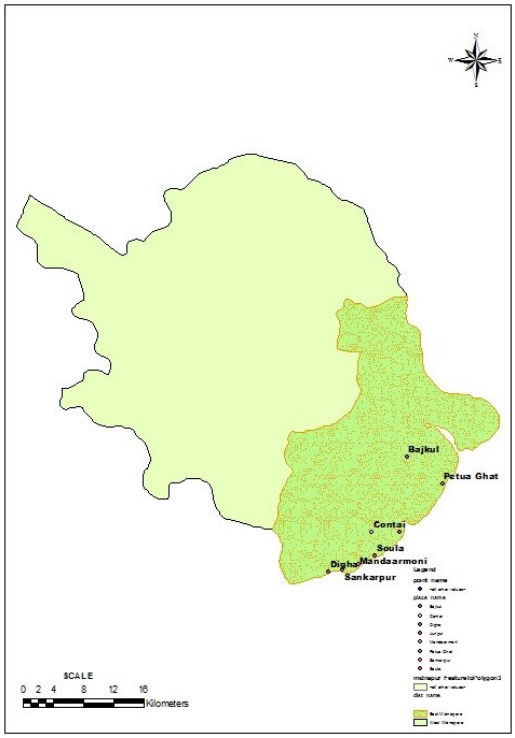

Figure-1:Map showing the eight study sites.

MATERIALS AND METHODS

Method of Samplings:

The adult butterflies were collected with the help of sweeping nets(circumference 93 cm, handle length 87 cm,and bag depth 77 cm) . One transect for each site was laid based on available trails and focused on prominent nectar source and mud puddles (Horner-Devine *et al*, 2003; Bonebrake and Sorto, 2009). Collections have been executed during sunny days having negligible wind flow because the lepidopteran insects prefer to fly in such condition (Bonebrake and Sorto, 2009). The method as adopted by Macan (1958), Barnes and Barnes (1954), Duffey (1968) and Murray (1963) based on visual observation of insects have been followed. The present study spanned a period of three years (November, 2007 to October,2010) with the plot survey for the collection and identification of lepidopteran insects.

The collected specimens were properly preserved in dry condition using camphor, carbolic acid, naphthalene etc and paper packets, made up of tracing papers have been used for transportation of the lepidopterans to the laboratories as well as for sorting. The identification of the collected insect samples was done in consultation with the Scientists of Zoological Survey of India, Kolkata and following standard literatures (Bell, 1911; Arora, 1990; Bonebrake and Sorto, 2009; Das *et al* 2010 and Alagumurugan, 2011).

RESULTS

Diversity and Distribution

Altogether 29 lepidopteran insects under 10 families have been recorded following **Linnean system of hierarchial classification (William and Feltmate,1992)** from the eight study sites which are being presented in the Table- 1 highlighting their distribution patterns .The systematic position is- **Super**

Phylum-Arthropoda, Phylum-Entoma; Sub Phylum-Uniramia; Super class- Hexapoda and Class- Insecta.

Table 1: Distribution of Lepidopteran insect species in different contrasting coastal areas

Families under the order lepidoptera	Lepidopteran insect species	Study sites							
		SI	SII	SIII	SIV	SV	SVI	SVII	SVIII
1.Lycaenidae	1.*Castalius rosimon (*Fabricius*)*	-	-	-	-	-	+	-	-
	2.*Euchrysops* sp	+	+	+	+	+	+	+	+
	3.*Loxura atymnus* (Cramer)	+	-	-	-	-	+	-	-
	4.*Chilades laius* (Stoll)	-	-	-	-	-	-	+	+
2.Satyridae	5.*Melanitis leda* (Linn)	-	-	-	-	-	+	-	-
3.Papilionidae	6.*Papilio polytes* (Linn)	+	+	+	+	+	+	+	+
	7.*P.demoleus* (Linn)	-	+	+	+	+	+	-	-
4.Nymphalidae	8. *Junonia almana* (Linn.)	-	+	-	-	-	+	+	+
	9. *Ergolis* sp	-	-	-	-	-	+	-	-
	10.*Phalanta phalantha (*Drury*)*	-	-	-	-	-	-	+	+
	11.*Junonia atlites* (Linn)	-	+	-	-	+	+	-	-
	12.*Junonia lemonias*	+	-	-	-	-	+	-	-
5.Danaidae	13.*Euploea core* (Cramer)	+	+	+	+	+	+	+	+
	14.*Danaus limniace (*Cramer)	+	+	-	-	+	+	-	-
	15.*D.chrysippus*(Linn.)	+	+	+	+	+	+	+	+
6.Pieridae	16.*Catopsilia florella*(Fabr)	+	+	+	+	+	+	+	+
	17.*Eurema* sp	-	-	-	+	+	+	+	+
	18.*Ixias pyrene* (Linn.)	-	-	-	-	-	-	+	-
	19.*Pareronia valaria* (Cramer)	+	+	-	+	-	-	+	+
	20.*Appias libythea* (Fabr)	-	-	-	-	-	-	+	+
	21.*Leptosia nina nina* (Fabr)	-	-	-	-	-	-	+	+
	22.*Cepora nerissa*(Fabr)	-	-	-	-	-	-	+	+
	23.*Colotis amata* (Fabr)	-	-	-	-	-	-	+	+
7.Acraeidae	24.*Acraea violae* (Fabr)	-	+	-	-	-	-	-	-
8.Hesperiidae	25.*Tagiades japetus ravi* (Moore)	-	-	-	-	-	-	+	+
	26.*Cephrenes* sp	-	-	-	-	-	-	+	+
	27.*Baoris* sp	-	-	-	-	-	-	+	+
9.Ctenuchidae	28.*Amata passalis* (Fabr)	-	-	-	-	-	-	+	+
10.Noctuidae	29.*Spirama? vestclio* (Fabr)	-	-	-	-	-	-	+	+

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

Order- Lepidoptera:

I. Family: Lycaenidae

Species: 1.*Castalius rosimon (*Fabricius,1775)

Castalius rosimon Fabricius, 1775. *Syst. Ent*.: 832, India.

Papilio rosimon Fabricius, 1775. *Syst.Ent*.:523. Transqueber, India.

Materials Examined : 2 exs.,from Digha.

Habitat :Flying insects and some times settle on the flowers of different plants .

Distribution: India : South India, Assam, Andaman Island and West Bengal (Midnapore, Kolkata) .

Species: 2. *Euchrysops* sp

Materials Examined : 2 exs.,from each of the study site .

Habitat : Flying insects and some times settle on the flowers of different plants .

Distribution: India : Throughout the India,alongwith West Bengal (Midnapore, Kolkata) .

Species: 3. *Loxura atymnus* Cramer, 1782

Materials Examined : 2 exs.,from Petuaghat and Digha.

Habitat :Flying insects and sometimes settle on the flowers of different plants .

Distribution:India : West Bengal (Midnapore Kolkata).

Species: 4. *Chilades laius* Stoll,1780

Chilades lajus Cramer,1782

Materials Examined : 2 exs., from Contai and Bajkul.

Habitat :Flying insects and sometimes settle on the flowers of different plants .

Distribution: India : West Bengal(Midnapore ,Kolkata) .

II. Family: Satyridae

Species: 5. *Melanitis leda* (Linn)

Materials Examined : 3 exs.,from Digha study site only .

Habitat :Flying insects and sometimes settle on the flowers of different plants .

Distribution: India : Throughout the India alongwith West Bengal(Midnapore, Kolkata).

III. Family:Papilionidae

Species: 6. *Papilio polytes* Linnaeus, 1758

Papilio polytes Linnaeus,1758. *Syst. Nat(Edn.X)*:460,n 7.

Materials Examined : 3 exs., from all study sites.

Habitat :Flying insects and sometimes settle on the flowers of different plants .

Distribution: India : Andamans, Nicobars, Raipur and West Bengal (Midnapore, Kolkata).

Species: 7. *Papilio demoleus* Linnaeus, 1758

Papilio demoleus Linnaeus, 1758. *Syst. Nat(Edn.X)*:464,n 35.

Materials Examined : 3 exs.,from Junput, Soula,2 exs.,from each of Mandarmoni, Sankarpur and Digha.

Habitat :Flying insects and sometimes settle on the flowers of different plants.

Distribution: India : Ceylon , Himachal Pradesh and West Bengal (Midnapore, Narendrapur, Kolkata).

IV. Family:Nymphalidae

Species: 8. *Junonia almana* Linnaeus, 1758

Junonia almana Linnaeus, 1758. *Syst. Nat(Edn.X)*:472,n 89.

Materials Examined : 3 exs.,from Junput, 2 exs.,from each of Bajkul, Contai and Digha.

Habitat :Flying insects and sometimes settle on the flowers of different plants.

Distribution: India : Ceylon , Himachal Pradesh and West Bengal(Midnapore, Kolkata).

Species: 9. *Ergolis* sp
Materials Examined : 3 exs.,from Digha.
Habitat :Flying insects and sometimes settle on the flowers of different plants.
Distribution: India : West Bengal(Midnapore).

Species: 10. *Phalanta phalantha (*Drury, 1773)
Papilio columbina Cramer, [1779]
Materials Examined : 3 exs.,from Bajkul and 1ex.from Contai.
Habitat :Flying insects and sometimes settle on the flowers of different plants.
Distribution: India : Andhra Pradesh, Karnataka ,and West Bengal(Midnapore, Kolkata).

Species: 11. *Junonia atlites* (Linnaeus,1763)
Precis atlites atlites Linneaus,1763. *Amoen. Acad*.6:407,n.72.
Materials Examined : 3 exs.,from each of Junput, Sankarpur and Digha.
Habitat :Flying insects and sometimes settle on the flowers of different plants.
Distribution: India : Himachal Pradesh and West Bengal(Midnapore, Kolkata).

Species: 12. *Junonia lemonias* Linnaeus,1758
Precis lemonias lemonias Linneaus,1758. *Syst. Nat(Edn.X)*:473.
Materials Examined : 6 exs.,from Petuaghat and Digha.
Habitat :Flying insects and sometimes settle on the flowers of different plants.
Distribution: India : Himachal Pradesh and West Bengal(Midnapore, Kolkata).

V. Family:Danaidae

Species: 13. *Euploea core* (Cramer,1780)
Materials Examined : 3 exs.,from Petuaghat and Junput, 2 exs.,from each of Bajkul, Contai and Digha,Sankarpur , Mandarmoni and Soula.
Habitat :Flying insect and sometimes settle on the flowers of different plant.
Distribution: India : Andhra Pradesh, Kerala, Mumbai and West Bengal(Midnapore, Kolkata, Narendrapur).

Species: 14. *Danaus limniace (*Cramer,1775)
Materials Examined : 3 exs.,from Petuaghat and Junput, 2 exs.,from each of Digha and Sankarpur.
Habitat :Flying insects and sometimes settle on the flowers of different plants.
Distribution: India : Andhra Pradesh, Kerala, Mumbai and West Bengal (Midnapore, Narendrapur, Kolkata).

Species: 15. *Danaus chrysippus* Linnaeus,1758
Danaus chrysippus Linnaeus,1758. *Syst. Nat. (Edn.X)*
Papilio chrysippus Linnaeus,1758. *Syst. Nat. (Edn.X)*
Materials Examined : 3 exs.,from Petuaghat and Junput, 2 exs.,from each of Bajkul, Contai and Digha,Sankarpur, Mandarmoni and Soula.
Habitat :Flying insects and sometimes settle on the flowers of different plants.
Distribution: India : Arunachal Pradesh, Kerala, Mumbai and West Bengal **(**Midnapore, Narendrapur, Kolkata).

VI. Family: Pieridae

Species: 16. *Catopsilia florella (*Fabr.1775)
Papilio florella Fabricius, 1775. *Syst. Ent.*: 479, TL: Sierra Leone
Materials Examined : 3 exs.,from Petuaghat and Junput, 2 exs.,from each of Bajkul, Contai and Digha,Sankarpur, Mandarmoni and Soula.
Habitat :Flying insects and sometimes settle on the flowers of different plants.
Distribution: India : Kerala, and West Bengal **(** Midnapore,Narendrapur, Kolkata).

Species: 17. *Eurema* sp (Hubner,1819)

Eurema sp(Hubner,1819), Verz.bek.Schmett.:96.

Materials Examined : 3 exs.,from each of Bajkul, Mandarmoni, Contai, Digha, and Sankarpur .

Habitat :Flying insects and sometimes settle on the flowers of different plants.

Distribution: India : West Bengal (Midnapore).

Species: 18. *Ixias pyrene* Linnaeus,1764

Ixias pyrene cingalensis Linnaeus,1764. *Mus.Ulr* :241.

Materials Examined :2 exs., from Bajkul.

Habitat : Flying insects and sometimes settle on the flowers of different plants.

Distribution: India : Andra Pradesh, Karnataka, Tamil Nadu, Haryana,and West Bengal (Midnapore, North Bengal, Kolkata).

Species: 19. *Pareronia valeria* Crammer,1776

Nepheronia valeria leona Fruhstorfer, 1903.

Materials Examined :3 exs., from Petuaghat, Junput , Mandarmoni and 2 exs., from Bajkul,Contai.

Habitat :Flying insects and sometimes settle on the flowers of different plants.

Distribution: India : Andhra Pradesh, West Bengal (Midnapore, Kolkata).

Species: 20. *Appias libythea* Fabricius,1775

Appias libythea Fabricius,1775, *Syst.Ent.*

Materials Examined :1 ex., from Bajkul and Contai.

Habitat :Flying insects and sometimes settle on the flowers of different plants.

Distribution: India : Karnataka, Tamil Nadu , Maharastra,and West Bengal (Midnapore, Kolkata).

Species: 21. *Leptosia nina nina* Fabricius,1793

Papilio nina Fabricius,1793.

Bingham, C. T. (1907) *The Fauna of British India, Including Ceylon and Burma*. Butterflies. Vol 2

Materials Examined :1 ex., from Bajkul and Contai.

Habitat :Flying insects and sometimes settle on the flowers of different plants.

Distribution: India : Cyelon , Assam, Andaman, and West Bengal (Midnapore, Durgapur, Kolkata).

Species: 22. *Cepora nerissa* Fabricius,1775

Papilio nerissa Fabricius, 1775. *Syst. Ent.*: 479, **TL**: Sierra Leone

Materials Examined :1 ex.,each from Bajkul and Contai.

Habitat :Flying insects and sometimes settle on the flowers of different plants.

Distribution: India :Sikkim, Haryana, Ceylon,and West Bengal (Midnapore, Jalpaiguri).

Species: 23. *Colotis amata* Fabricius,1775

Colotis amata Fabricius, 1775; *Syst. Ent.*: 479, **TL**: Sierra Leone

Papilio amata Fabricius, 1775 Bingham, C. T. (1907) *The Fauna of British India, Including Ceylon and Burma*. Butterflies. Vol 2

Materials Examined :1 ex., from Bajkul and Contai.

Habitat :Flying insects and sometimes settle on the flowers of different plants.

Distribution: India :Sikkim, Ceylon, and West Bengal (Midnapore, Kolkata).

VII. Family : Acraeidae

Species: 24. *Acraea violae* Fabricius,1775

1775. *Acraea violae* Fabricius, – Tawny Coster. *In* K. Kunte, S. Kalesh & U. Kodandaramaiah (eds.). *Butterflies of India, v. 2.00.* Indian Foundation for Butterflies

Acraea violae Fabricius, 1793.

Materials Examined : 3 exs., from Junput only.

Habitat :Flying insects and sometimes settle on the flowers of different plants.
Distribution: India : Maharashtra, Madhya Pradesh, Kerala, Odisha, Karnataka, Tamil Nadu, Andhra Pradesh and West Bengal (Midnapore, Jalpaiguri, Kolkata).

VIII. Family : Hesperiidae

Species: 25. ***Tagiades japetus ravi*** **(Moore ,1866)**
1866. ***Tagiades japetus ravi*** **Moore. Proc. zool. Soc. Lond. 1865(3):779**
Materials Examined : 3 exs., from Bajkul and 2 exs., from Contai..
Habitat :Flying insects and sometimes settle on the flowers of different plants.
Distribution: India : Karnataka ,Tamil Nadu ,Andhra Pradesh, Meghalaya ,Arunachal Pradesh ,and West Bengal(Midnapore, Kolkata, North Bengal) .

Species: 26. ***Cephrenes*** **sp Waterhouse & Lyell, 1914**
1914. *Cephrenes* Waterhouse & Lyell, *Butts Australia*: 8, 199, 206,
Materials Examined : 2 exs., from Bajkul and 4 exs., from Contai..
Habitat :Flying insects and sometimes settle on the flowers of different plants.
Distribution: India : West Bengal (Midnapore).

Species: 27. ***Baoris*** **sp**
Materials Examined : 2 exs., from Bajkul and 3 exs., from Contai..
Habitat :Flying insects and sometimes settle on the flowers of different plants.
Distribution: India : West Bengal(Midnapore).

IX. Family :Ctenuchidae

Species: 28. ***Amata passalis*** **Fabricius, 1807**
1807.*Amata passalis* Fabricius, urn:lsid:lepidoptera.pro:taxname:874571781.
Zygaena passalis Fabricius, Ryngota.In:Insect,2.p:33-331.
Materials Examined : 5 exs., from Bajkul and 3 exs., from Contai..
Habitat :Flying insects and sometimes settle on the flowers of different plants.
Distribution: India :Mizoram, Kerala,and West Bengal(Midnapore, Kolkata).

X. Family :Noctuidae

Species: 29. ***Spirama vestclio*** **Fabricius,**
Materials Examined : 3 exs., from Bajkul and 2 exs., from Contai..
Habitat :Flying insects and sometimes settle on the flowers of different plants.
Distribution: India : Mizoram, Kerala,and West Bengal (Midnapore, Kolkata).

ECOLOGICAL PARAMETERS
Recording of meteorological parameters like air temperature (dry and wet), relative humidity and rainfall, and physicochemical parameters like soil pH and soil salinity have been made during the study period in all the study sites. Among the eight study sites, two study sites (Bajkul and Contai) are regarded as the semiurbanized areas based on the rapid conversion of agricultural lands for human settlement and other institutional developments. In these two semiurbanized areas, salinity of soil and dew drops was less in comparison to the other six study sites. Another three study sites *viz*. Digha, Sankarpur and Mandarmoni have been under the anthropogenic pressure from tourisms. Rest of the three study sites are the virgin coastal belt. Variations in the results of air temperature, relative humidity and salinity have been noticed during the study period in all study sites (Table-2).

Table 2: Seasonal meteorological and physicochemical parameters based on monthly data

Study sites	Year	Postmonsoon				Premonsoon				Monsoon			
		R.H. (%)	Temp (^{O}C)	Soil salinity (^{O}%)	Soil pH	R.H.(%)	Temp (^{O}C)	Soil Salinity (%)	Soil pH	R.H. (%)	Temp (^{O}C)	Soil Salinity (%)	Soil pH
S-I	2008-09	76.25	24.25	1.03	7.54	85.75	29.25	1.26	7.59	84.5	31.88	0.90	6.93
	2009-10	76.0	22.38	1.01	7.68	83.25	32.63	1.26	7.06	84.25	26.25	0.90	6.89
S-II	2008-09	64.5	20.88	1.04	7.56	84.75	29.42	1.26	7.65	87.25	31.25	0.91	6.93
	2009-10	71.5	24.38	1.03	7.66	85.75	31.13	1.26	7.05	83.5	25.0	0.90	6.90
S-III	2008-09	68.5	23.5	1.04	7.55	75.75	30.25	1.26	7.65	83.75	33.0	0.90	6.93
	2009-10	68.75	21.75	1.04	7.7	73.0	33.75	1.25	7.04	84.25	26.0	0.88	6.90
S-IV	2008-09	69.25	23.38	1.04	7.55	80.75	30.25	1.26	7.66	82.0	33.75	0.91	6.94
	2009-10	69.0	23.75	1.05	7.7	80.25	33.88	1.27	7.04	81.5	27.0	0.90	6.90
S-V	2008-09	68.5	25.13	1.04	7.57	79.0	30.08	1.26	7.66	85.0	33.25	0.91	6.94
	2009-10	63.25	22.25	1.05	7.7	80.25	33.0	1.26	7.06	83.75	28.0	0.91	6.90
S-VI	2008-09	63.25	22.75	1.02	7.56	80.75	29.08	1.28	7.66	87.75	33.25	0.91	6.94
	2009-10	63.0	21.25	1.05	7.7	80.75	33.88	1.28	7.07	83.25	26.0	0.91	6.90
S-VII	2008-09	72.5	23.5	0.57	7.52	82.0	27.08	0.62	7.35	87.5	31.38	0.40	6.93
	2009-10	68.5	22.75	0.56	7.52	82.75	34.75	0.62	7.04	86.25	23.5	0.39	6.89
S-VIII	2008-09	73.25	19.25	0.57	7.52	85.75	32.83	0.63	7.33	90.0	29.13	0.40	6.93
	2009-10	72.25	23.0	0.57	7.5	83.26	34.0	0.63	7.05	89.5	28.5	0.39	6.89

R.H.= Relative humidity; Temp.= Temperature
Postmonsoon : November, December , January and February;
Premonsoon : March, April, May and June;
Monsoon : July, August, September and October

DISCUSSION

The present investigation was undertaken to record the diversity of different lepidopteran insect fauna in eight contrasting study sites (S-I to S-VIII) along the coastal tract of East Midnapore District, West Bengal. Similar types of investigations have been done by Pathania and Kumari (2011).

The eight study sites of the coastal tract of East Midnapore were found to be contrasting with regard to their meteorological parameters (Air temperature, Relative humidity) and physicochemical parameters of water, soil (salinity and pH), flora and fauna (Jana *et al*,2014b).

All total 29 insect species were recorded belonging to the order lepidoptera which was represented by 10 families in the present investigation. Maximum number of species (8) were found to belong to the family pieridae whereas only one (1) species was recorded to belong to each family of satyridae, acraeidae,

ctenuchidae, and noctuidae. Out of 29 insect species, 9 were recorded from only in the site-I to site-VI while 12 were documented only from non-coastal areas (site VII to site VIII). Eight(8) species have been observed to be common in both coastal and non-coastal areas. Among these insect species, *Castalius rosimon, Melanitis leda* and *Ergolis* sp were recorded only in the Digha (site-VI), *Acraea violae* in the Junput(site- II) and *Ixias pyrene* in the Bajkul(site-VII) which are regarded as the site specific species because of their microclimate preference (Erhardt, 1985).

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REFERENCES

Alagumuran, C., Pavaraj, M. and Rajan, M.K. (2011) : Seasonal and relative abundance of butterflies in a scrub jungle habitat of Peraiyur Taluk, Madurai District,Tamilnadu. *Journal of research in Biology*, 1: 44-50.

Arora, G.S. (1990) : Collection and preservation of animals : Lepidoptera : Publ. by *Zoological Survey of India, Calcutta* :131-138

Barnes, B.M. and Barnes, R.D.(1954) : The ecology of the spiders of maritime drift lines. *Ecology*, 35: 25-35 .

Bell ,T.R. (1911) : The common butterflies of plain in India. *Journal of Bombay Natural History Society*, 20:1115-1136 .

Bonebrake,T.C. and Sorto, R. (2009) : Butterfly (Papilionoidea and Hesperioidea) rapid assessment of coastal countryside in El Salvador.*Tropical Conservation Science*, 2(1) : 34-51.

Chakraborty, S. (2010) : Coastal environment of Midnapore,West Bengal:Potential ,Threats and Management .*Journal of Coastal Environment* 1(1):27-40

Das, S., Mukhopadhyay, A. and Roy, S. (2010) : Morphological diversity ,developmental traits and seasonal occurrences of looper pests (Lepidoptera :Geometridae) of tea crop. *Journal of Biopesticides,* 3:16-19.

Duffey, E.(1968) : An ecological analysis of spider fauna of sand dunes . *Journal of Animal Ecology*, 37: 641-674.

Erhardt, A. (1985) : Diurnal Lepidoptera: sensitive indicators of cultivated and abandoned grassland. *Journal of Applied Ecology*, 22: 849-862.

Holloway, J.D., Bradley, J.D. and Carter, D.J.(1992) : The Guide of Insects of importance to man (Lepidoptera) : *Wallingford: Chinese journal of agricultural biotechnology International publishing*, 1-21.

Horner-Devine, M.C., Daily, G.C., Ehrlich, P.R. and Boggs, C.L.(2003): Countryside biogeography of tropical butterflies. *Conservation Biology*, 17:168-177.

Jana, D., Tamili, D.K. and Chakraborty, S.K. (2014a) : Diversity Of Dragonflies (Insecta: Odonata) in Contrasting Coastal Environment Of Midnapore (East), West Bengal, India. *A Journal of Radix International Educational and Research Consortium*, 3(4): 1-11.

Jana, D., Tamili, D.K. and Chakraborty, S.K. (2014b) : Diversity of Hemipteran insects in the coastal and non coastal environment of Midnapore (East), West Bengal, India. *Science and Culture*, 80 (5–6): 173-178.

Jana,G., Mishra, K.K. and Bhattacharya, T.(2005) : Diversity of some insect fauna in industrial and non industrial areas,West Bengal, India . *Journal of Insect Conservation,* 10: 249-260.

Kremen, C. (1992) : Assessing the indicator properties of species assemblages for natural areas monitoring. *Ecological Applications,* 2: 203-217.

Kumar, A. (2013) : Butterfly (Lepidoptera:Insecta) Diversity from Different Sites of Jhagadia, ankleswar, District-Bharuch, Gujrat. *Octa Journal of Environmental Research*,1(1) : 9-18.

Macan, T.T.(1958) : Methods of sampling the bottom fauna in stony streams. *Mitteilungen international association of theoretical and applied Limnology*, 8:1-21.

Meyer, J.R. (2009) : Lepidoptera : General Entomology, *NC State University*.:1-234

Noubissié, J.B.T., Fohouo, F.N.T. and Tchako, S.L.T. (2012) : Role of Lepidoptera as Pollinators on the Breeding Systems of *Striga hermonthica* (Del.) Benth under the Guinea Savannah Zone Conditions. *Annals of Biological Research*, 3 (6):2821-2828.

Pathania, P.C. and Kumari, A.(2011) : Some notes on Rhopaloceran diversity (Lepidoptera) of Himachal Pradesh. *Halteres*, 3:71-78.

Racke, K.D. (2012) : Cranberry Pest Management and Karner Blue butterfly Protection: A Wisconsin Case Study, *American Chemical Society Symposium* (III): 101-118.

Sehnal, F. and Zurovec, M.(2004) : Construction of Silk Fiber Core in Lepidoptera. *Biomolecules,* 5 : 666-674

Sisk, T.D., Launer, A.E., Switky, K.R. and Ehrlich, P.R. (1994) : Identifying extinction Threats: global analyses of the distribution and the expansion of the human enterprise. *Bioscience,* 44: 592-604.

Williams, D.D. and Feltmate, B.W. (1992). Aquatic Insects. *Wallingford: Chinese journal of agricultural biotechnology International publishing*, ISBN: 0-85198 - 782-6. xiii, 358p.