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Community composition of aquatic insects in relation to water quality in a pond in Midnapore town, West Bengal, India

Priti Ranjan Pahari[1], Tapan Kumar Pandit[2], Subhadeep Maiti[1*], Tanmay Bhattacharya[3]
[1] Department of Zoology, Tamralipta Mahavidyalaya, Tamluk, West Bengal, India
[2] Department of Zoology, Midnapore College, Midnapore, West Bengal, India
[3] Professor, Department of Zoology, Vidyasagar University, Midnapore, West Bengal, India

Abstract
Twenty five species of aquatic insects have been recorded from a small weed infested water body in Midnapore town, West Bengal, India. Hemiptera was the most abundant order comprising 51.93% of total entomofauna followed by Odonata (16.12%), Coleoptera (15.15%), Ephemeroptera (13.68%) and Diptera (3.12%) in that order. *Anisops breddini* was the only dominant species along with 11 subdominant, 12 recedent and one sub-recedent species. Most of the species were found to be either positively or negatively correlated with the physico-chemical properties of the water. Existence of 13 species of macrophytes provided ample scope of niche differentiation for the coexistence of the insect species.

Keywords: Entomofauna, dominance status**,** correlation with water parameters

Introduction

Aquatic insects play important role not only in the trophic dynamics of the ecosystem but also in the indication of changes in the quality of habitats and their degradation because of their ability to respond quickly to such changes and thus serve as reliable bioindicator of aquatic ecosystem [1]. In India about 5000 species of insects are estimated to inhabit inland waterbodies [2]. Most of these constitute the food for many commercially important fish while some are predacious, feeding upon the spawn and fry or competing with them for natural food. Several species are known to predate upon mosquito larvae and are used as potential biocontrolling agent for mosquito larvae [3, 4]. Aquatic insects also play a crucial role in providing various ecosystem services [5]. Some notable contributions on aquatic insects in recent years are those by Sharma and Agarwal [6], Majumder *et al*. [7], Barman and Baruah [8], Choudhury and Gupta [9], Choudhary and Ahi [10]. Work done in undivided Midnapore district and West Midnapore districts are those by Pahari *et al*. [11-15] and Jana *et al*. [16]. In the present study an investigation has been undertaken to analyse the insect diversity and community structure of a weed infested man made pond.

Materials and Methods

The present investigation was carried out in a manmade perennial pond (22°25'08.7"N 87°19'54.2"E), 1134.75 m^2 with an average depth of 5.4 meter (Figure 1). The water body was infested with 13 species of aquatic weeds *viz*., *Eclipta alba* Hassk., *Nymphaea nouchali* Burm., *Marsilea minuta* Linn., *Nymphoides indica* (Linn.), *Eichhornia crassipes* (Mart.), *Commelina benghalensis* Linn., *Hydrilla verticillate* Casp., *Vallisneria spiralis* Linn., *Ceratophyllum demersum* L., *Ipomoea carnea* (Mart.), *I. aquatica* Forrsk., *Hygrophila schulli* (Hamilt.), *Lemna perpusilla* (Torr.). Insects were collected at monthly interval from January 2020 to December 2020 between 7 am to 10 am from four sampling sites of the pond using a circular net with an area of 4208 cm^2 having 245 µm mesh size. Collected samples were preserved in 70% ethanol.

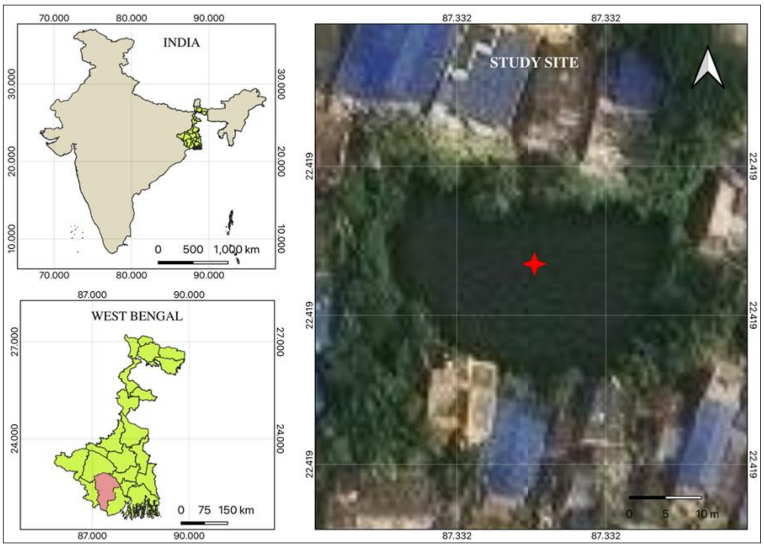

Fig 1: Study site

Aquatic insects were identified up to species level. Dominance status of the each species was determined through the analysis of relative abundance following Englemann [17]. Dissolve oxygen (DO), free carbon dioxide (CO_2), Biological oxygen demand (BOD) and total alkalinity (TA) were measured following APHA [18]. Temperature and pH were measured by portable digital meters. Statistical analyses were done by SPSS (Ver. 26), and Ms Excel 2021 software.

Result and Discussion

25 species under 5 orders, 15 families and 20 genera were recorded from the study site. Hemiptera was the most common order comprising 52.93% of the total recorded aquatic insects. This order was represented by 6 families and 10 species. Preponderance of Hemiptera in aquatic ecosystem has also been reported by Majumdar *et al.* [7] in Tripura, Barman and Baruah [8] in Assam Choudhury and Gupta [9] and Pahari *et al.* [13] in Purba Medinipur district, West Bengal. Diversity and abundance of macrophytes is known to influence the abundance and diversity of aquatic hemipteran insect Pahari *et al.* [14]. Odonata was the second most abundant order (16.12%) represented by 3 families and 6 species. This was followed by Coleoptera (15.15%), Ephemeroptera (13.68%), Diptera (3.12%) in that order (Figure 2). Order Coleoptera was represented by 4 families and 6 species while Ephemeroptera and Diptera were represented by a single family each and 2 and 1 species respectively. Family level analysis revealed that Family Notonectidae (Order Hemiptera) was the most predominating family (27.13%) followed by Baetidae (13.68%), Libellulidae (7.90%), Nepidae (7.76%), Belostomatidae (6.93%), Dytiscidae (5.92%), Platycnemididae (4.32%), Pleidae (4.04%), Aeshenidae (3.90%), Gyrinidae (3.72%), Chironomidae (3.12%), Corixidae (2.39%) and Hydrophilidae (2.20%) in that order respectively (Figure 3). Order Odonata is also known to prefer freshwater habitats with luxuriant growth of macrophytes [10]. Turning to species wise analysis it was seen that *A. breddini* was the only dominant species which might be considered as the best exploiter in that pond. There were also 11 subdominant, 12 recedent and 1 sub-recedent species in that pond (Table 1).

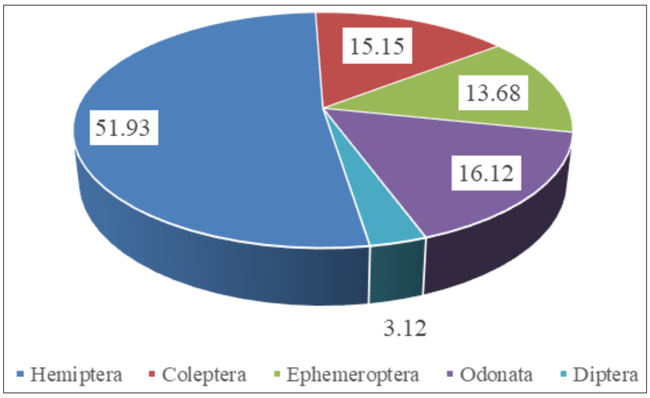

Fig 2: Relative abundance of various insect Orders (%)

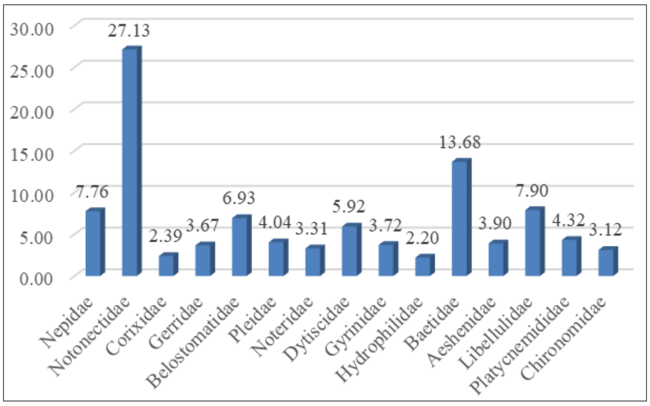

Fig 3: Number and relative abundance (%) of Families

Table 1: Abundance, relative abundance (%) and dominance status of species

Sl. No.	Species	X±SE	RA	DS
Order: Hemiptera				
Family: Nepidae				
1	*Laccotrephes ruber* (Linnaeus, 1764)	2.29±0.35	2.53	R
2	*Ranatra filiformis* Fabricius, 1790	3±0.32	3.31	SD
3	*Ranatra sordidula* Dohra,1860	1.75±0.26	1.93	R
Family: Notonectidae				
4	*Anisops breddini* Kirkaldy, 1901	24.63±3.04	27.13	D
Family: Corixidae				
5	*Micronecta scutellaris* (Stål, 1858)	2.17±0.41	2.39	R
Family: Gerridae				
6	*Gerris spinolae* Lethierry & Severin 1896	3.33±0.42	3.67	SD
Family: Belostomatidae				
7	*Diplonychus annulatum* (Fabricius, 1781)	3.54±0.44	3.90	SD
8	*Diplonychus rusticus* (Fabricius, 1781)	2.08±0.37	2.30	R
9	*Lethocerus indicus* (Lepeletier & Serville, 1825)	0.67±0.12	0.73	SR
Family: Pleidae				

10	*Plea liturata* (Fieber, 1844)	3.66±0.46	4.04	SD
Order: Coleoptera				
Family: Noteridae				
11	*Canthydrus luctuosus* (Aubé, 1838)	3±0.33	3.31	SD
Family: Dytiscidae				
12	*Laccophilus purvulus* Aubé, 1838	3.17±0.46	3.49	SD
13	*Hydrovatus bonvouloiri* Sharp, 1882	2.21±0.28	2.43	R
Family: Gyrinidae				
14	*Orectochilus cylindricus* Régimbart, 1892	1.75±0.43	1.93	R
15	*Orectochilus cardoni* Régimbart, 1892	1.63±0.38	1.79	R
Family: Hydrophilidae				
16	*Sternolophus rufipes* (Fabricius, 1792)	2±0.39	2.20	R
Order: Ephemeroptera				
Family: Baetidae				
17	*Cloeon bicolor* Kimmins, 1947	7.83±1.91	8.63	SD
18	*Cloeon bengalense* Kimmins, 1947	4.58±1.14	5.05	SD
Order: Odonata				
Family: Aeshenidae				
19	*Anaciaeschna jaspidea* (Burmeister, 1839)	1.75±0.24	1.93	R
20	*Anax guttatus* (Burmeister, 1839)	1.79±0.28	1.97	R
Family: Libellulidae				
21	*Brachythemis contaminata* (Fabricius, 1793)	3.29±0.41	3.63	SD
22	*Crocothemis servilia* (Drury, 1773)	2.25±0.24	2.48	R
23	*Pantala flavescens* (Fabricius, 1798)	1.63±0.18	1.79	R
Family: Platycnemididae				
24	*Copera marginipes* (Rambur, 1842)	3.92±0.36	4.32	SD
Order: Diptera				
Family: Chironomidae				
25	*Chironomus plumosus* (Linnaeus, 1758)	2.83±0.55	3.12	SD

[Relative abundance (RA) <1 = Subrecedent (SR); 1–3.1 = Recedent (R); 3.2–10 = Subdominant (SD); 10.1–31.6 = Dominant (D); >31.7 = Eudominant (ED)] [10].

Aquatic insects are good indicator of water quality and they are mostly affected by the nature of the waterbody [10]. Analysis of the simple correlation revealed that most of the species *viz., L. ruber, R. sordidula, A. breddini, M. scutellaris, D. rusticus, C. luctosus, L. purvulus, O. cyndricus, C. servilia* were positively correlated with water temperature. 2 ephemeropteran species *viz., C. bicolor and C. bengalense* on the contrary, were found to be negatively correlated with the water temperature. Water temperature is an important physical factor that influence growth rate [19-22] and success of egg development which ultimately leads to higher abundance of aquatic insects in higher temperature [23-25]. Significant negative correlation of Ephemeroptera with water temperature as in present study has also been previously shown by Choudhary and Ahi [10] in Madhya Pradesh. pH plays an important role in many biological and chemical properties of freshwater [26]. Many species in the present study *viz., L. ruber, R. sordidula, M. scutellaris, D. annulatum, L. indicus, P. liturata, C. luctuosus, L. purvalus, H. bonvoulairi, O. cylindricus, O. cardoni, S. rifipes and C. marginipes* were found to be positively correlated with pH of the water revealing their preference for alkaline water. Similar observation has also been made by Jenila and Nair [27]. Two coleopteran species, *O. cardoni* and *S. rufipes* exhibited a significant positive correlation with DO while *P. flavescens* (Odonata) had a significant negative correlation with DO. Pahari *et al.* [13] observed a significant negative correlation of two odonate species *viz., Anax imperator* and *Aeshna fabricius* with DO. Prommi and Payakka [28] reported that DO negatively affected taxa richness. While Barman and Gupta [1] observed significant positive correlation between species richness of aquatic insects and DO. Some species *viz., L. ruber, R. sordidula, M scutellaris, D. annulatum, D. rusticus, P. liturata, C. luctuosus, L. purvulus, H. bonvouloiri, O. cylindricus, O. cardoni, S. rufipes, A. guttatus, C. marginipes, C. plumosus* showed a significant positive correlation with BOD. These are tolerant species and can survive in organically polluted water. *C. plumosus* is one such species. Several species like *R. sordidula, M. scutellaris, D. annulatam, P. liturata, C. luctuosus, B. contaminata, C. marginipes* and *C. plumosus* showed a significant positive correlation with TA while *A. bridini* alone exhibited a significant negative correlation with TA. Significant positive correlation between arthropods and bicarbonate alkalinity was also explained by Sharma and Chowdhary [29]. Interestingly none of the species exhibited any correlation with CO_2 of water. Nasiruddin *et al.* [30], on the contrary opined that free CO_2 concentration and aquatic insect abundance is inversely correlated.

Table 2: Correlation coefficient between species and abiotic factors

Sl. No.	Specimen	Temperature	pH	DO	CO_2	BOD	TA
1	*Laccotrephes ruber*	.484*	.734**	0.164	0.280	.704**	0.252
2	*Ranatra filiformis*	0.158	-0.174	0.027	0.344	0.378	0.174
3	*Ranatra sordidula*	.405*	.518**	0.268	0.152	.779**	.512*
4	*Anisops breddini*	.656**	-0.147	-0.146	0.054	-0.103	-.529**
5	*Micronecta scutellaris*	.431*	.739**	0.277	0.073	.776**	.453*
6	*Gerris spinolae*	0.225	-0.208	0.203	-0.091	0.280	0.210

7	*Diplonychus annulatum*	0.333	.510*	0.183	0.261	.520**	.629**
8	*Diplonychus rusticus*	.532**	0.390	0.165	0.264	.728**	0.308
9	*Lethocerus indicus*	0.214	.438*	0.217	0.385	0.210	0.369
10	*Plea liturata*	0.354	.644**	0.332	0.156	.772**	.566**
11	*Canthydrus luctuosus*	.444*	.638**	0.146	0.025	.681**	.578**
12	*Laccophilus purvulus*	.531**	.630**	0.225	0.347	.678**	0.272
13	*Hydrovatus bonvouloiri*	0.383	.507*	0.170	0.245	.649**	0.270
14	*Orectochilus cylindricus*	.551**	.627**	0.357	0.320	.789**	0.305
15	*Orectochilus cardoni*	0.357	.543**	.416*	0.371	.655**	0.372
16	*Sternolophus rufipes*	0.247	.585**	.568**	0.292	.579**	0.193
17	*Cloeon bicolor*	-.909**	-0.279	0.017	-0.121	-0.242	0.141
18	*Cloeon bengalense*	-.808**	-0.138	0.149	-0.082	-0.225	0.280
19	*Anaciaeschna jaspidea*	0.397	-0.008	-0.235	0.274	0.292	0.063
20	*Anax guttatus*	0.316	0.278	0.269	0.310	.462*	0.009
21	*Brachythemis contaminata*	0.208	0.403	0.146	0.159	0.394	.759**
22	*Crocothemis servilia*	.426*	0.074	-0.241	0.264	-0.191	-0.243
23	*Pantala flavescens*	0.334	0.250	-.466*	0.400	0.288	0.272
24	*Copera marginipes*	0.143	.473*	0.029	0.212	.513*	.779**
25	*Chironomus plumosus*	0.346	0.351	0.401	0.280	.651**	.447*
*. Correlation is significant at the 0.05 level; **. Correlation is significant at the 0.01 level.							

Macrophyte diversity in the waterbody makes it a heterogenic habitat providing increased ecological niches that permitted co-existence of different insect species in such a small pond. Physico-chemical parameters ultimately determine the hypervolume niche.

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