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Insect Diversity and Water Quality Parameters of Two Ponds of *Chatla* Wetland, Barak Valley, Assam

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ABSTRACT

An investigation was carried out on two ponds of Chatla floodplain, Barak valley, Assam with special reference to aquatic insects. Pond 1 is purely a fish pond where as pond 2 is a community pond too. Present study revealed the status of water quality and in turn diversity, density, dominance and abundance of aquatic insects in both the ponds. Almost all the physico chemical parameters of both the ponds were found within permissible range for aquatic life .However in pond 2 level of phosphate was found little higher than pond 1 due to release of soaps and detergents by human influence. In both the ponds order Hemiptera showed maximum relative abundance (98% in pond 1 and 94% in pond 2). The study revealed lower diversity of aquatic insects in pond 2 than that in pond 1.

Key words: Chatla floodplain, Pond, Human interference, Water quality, Aquatic insects.

INTRODUCTION

Among different ecosystems, wetlands constitute one of the most important ecosystems for man offering numerous regulating services. Water quality assessment of small water bodies of the wetlands are of immense importance in the management of fisheries, water supply, and irrigation. Pollution status of water bodies are usually expressed as biological and physico-chemical parameters[1]. Several authors have extensively documented the responses of macro-invertebrates to organic and inorganic pollution [2,3]. Chatla floodplain (24^{0}42′697″ N and 92^{0}46′264″E) situated in the south of Silchar town, Barak Valley, Assam has 1500 fishery ponds and 12 seasonal lakes. (Fig.1). Although the wetland is resourceful with variety of macrophytes, trees and fishes it is in a derelict or near derelict state due to high rates of siltation, infestation of weeds, unscientific fishing activities, and use of pesticides in the surrounding tea gardens and agricultural fields [4] which led to a loss of 73% wetland area of Chatla floodplain [5]. All these factors can affect the communities of aquatic organisms leading to loss of diversity and species extinction [6]. Since, fluctuations in aquatic insect community can give quick information of their surrounding water quality and are commonly used as tools for marking an integrated assessment of water quality, investigation on water quality of two fishery ponds of Chatla wetland with special reference to aquatic insects was carried out.

MATERIALS AND METHODS

The topography of the Chatla floodplain is fenland type with small hillocks strewn among large stretches of lowland. Pond 1 is a fish pond and is relatively undisturbed. Pond 2 is a fishery cum community pond. Water and insect samples were collected in replicates from both the sites during 2009-2010. Physico-chemical parameters such as Air temperature (AT), Water temperature (WT), Transparency, pH, Electrical Conductivity (EC), Dissolved oxygen (DO), Free CO_2, Total alkalinity (TA), Nitrate (NO_3^-) and Phosphate (PO_4^{3-}), Nitrite (NO_2^-), and Ammonium (NH_4^+) content of water were analyzed by standard methods [7,10]. The aquatic insects were collected by kick method whereby the vegetation was disturbed and the

circular net (mesh size 60µm) was dragged around the vegetation for one minute[11-12]. They were immediately sorted, preserved in 70% ethyl alcohol and were later identified using Dewinter advanced stereo zoom microscope with the help of standard keys[13-19]. A number of identified insects were confirmed in the entomological laboratory of Zoological Survey of India. Statistical analyses were done by MS EXCEL 2007; SPSS 15.0 for Windows, Shannon Wiener Index of Diversity (H'), Evenness Index (J') and Berger–Parker Index of Dominance (d) were calculated by Biodiversity professional version 2 for windows.

RESULTS AND DISCUSSION

Different physico-chemical parameters (AT, WT, Transparency, pH, EC, DO, Free CO_2,TA, PO_4^{3-}, NO_3^-, NO_2^-, NH_4^+) in pond 1 and 2 during Post monsoon 2009 to Monsoon 2010 and their mean concentrations are shown in Table 1. Table 2 showed the distribution of aquatic insects in pond 1 and 2. The significant correlations that exist among environmental variables, diversity and density of insect are shown in Table 3. Fig.2 showed the relative abundance of aquatic insect orders recorded from pond 1 and pond 2 during the study period. Relative abundance of aquatic insect families and aquatic insect species in pond 1 and 2 are shown in the Fig.3 and Fig.4 respectively. Pattern of variation in the levels of Shannon – Weiner Diversity index (H') and Evenness index (J') and Berger-Parker index of Dominance (d) are shown in the Fig.5.The study revealed that in pond 1 and 2 both air and water temperature did not show much variation. In pond 1 DO, EC, NH_4 and NO_3^- concentration were slightly higher than that of pond 2 while other parameters such as Transparency, Free CO_2, TA, pH, and PO_4^{3-} concentration were recorded to be higher in pond 2. The solubility and availability of nutrients is affected by oxygen content of water and therefore the productivity of aquatic ecosystems [18]. The range of DO recorded in the present study is similar to the DO concentration reported in a previous study in the same area[21]. In pond 1 correlation coefficient analyses revealed a significant negative relationship of WT with pH and DO. Classical negative relationship of WT with DO was also recorded in a previous study on Chatla floodplain [22] which is attributed to the fact that in lower temperature oxygen carrying capacity of water increases[23]. Negative relationship of DO with Rainfall might be an indication that surface runoff transported sewage, fertilizer etc. into the pond which have lowered DO value by bacterial respiration [22]. EC was found to be higher in pond 1 (4.59ms/ppt ± 2.93) compared to pond 2 (3.24ms/

Table 1: Physico-chemical properties of water of Pond 1 and Pond 2

	Study Sites			
	Pond 1		Pond 2	
Parameters	**Range**	**Mean±Std dev.**	**Range**	**Mean±Std dev.**
AT(^{0}C)	22.6-29.83	25.93±0.75	22.6-29.3	25.09 ± 0.88
WT(^{0}C)	23.37-31.5	26.13±1.40	23-30.5	26.83 ± 0.75
Rainfall(cm)	0-1484.7	551.98±590.2	0-1484.7	551.98±590.2
pH	5.24-6.88	6.27 ± 0.31	6.38 – 7.8	7.15 ± 0.52
EC (ms/ppt)	0.10-3.57	4.59 ± 2.93	0.09-7.82	3.24 ± 0.20
Transparency (cm)	0-33.67	14.79 ± 1.60	13.08-24.83	17.19 ± 2.77
DO (mg l^{-1})	5.91-10.43	8.84 ± 0.86	6.77-9.18	7.83 ± 0.72
Free CO_2(mg l^{-1})	2.31-11.65	8.28 ± 0.57	8.42-35.60	16.15 ± 1.60
TA(mg l^{-1})	11-30.53	19.93 ± 2.26	10.43-52.37	26.89 ± 3.49
PO_4^{3-} (mg l^{-1})	0.32-1.88	0.86 ± 0.27	0.40-2.16	1.25± 0.72
NO_3^- (mg l^{-1})	0.14-1.01	0.53 ± 0.23	0.13-0.66	0.46 ± 0.19
NO_2^-(mg l^{-1})	0.007-0.02	0.01 ± 0.01	0.01-0.08	0.03± 0.03
NH_4^+	0.08-0.48	0.30 ± 0.13	0.07-0.33	0.17 ± 0.09

ppt ± 0.20) where it showed significant positive correlation with TA and NO_3^{-}. The range of NO_3^{-} between 0.1 - 3.0 mgl^{-1} is considered favorable for fish productivity[25]. In both the ponds, NO_3^{-} concentration was found within the said range indicating their suitability for fish production. In pond 2 EC showed significant positive correlation with TA, Free CO_2, and DO. Higher free CO_2 accompanied by higher TA and higher pH in pond 2 could be due to external application of lime. It is known that addition of lime increases fish production in soft (low total hardness) waters by stabilizing the pH of bottom mud and increasing the availability of Phosphorus and Carbon dioxide for

Table 2: Distribution of aquatic insect species in Ponds 1 and 2 of Chatla floodplain during study period

Order	Family	Sp. Name	Pond 1	Pond 2
Hemiptera	Gerridae	*Gerris lepcha* Distant	+	+
		Limnogonus nitidus Mayr	+	+
		Neogerris parvula Stål	+	-
	Mesoveliidae	*Mesovelia vittigera* Horvath	+	+
	Notonectidae	*Enithares fusca* Brooks	+	+
		Anisops barbata Brooks	+	+
Odonata	Coenagrionidae	*Enallagma sp.*	+	+
Diptera	Culicidae	*Culex sp.*	-	+

Table 3: Significant Correlations among environmental variables, diversity and density of aquatic insects for pond 1 and pond 2

Parameters	Pond 1	Pond 2
WT Vs pH	-.956(*)	-
WT Vs DO	-.989(*)	-
pH Vs DO	.989(*)	-
pH Vs Rainfall	-.987(*)	-
EC Vs DO	-	.995(**)
EC Vs Free CO_2	-	.954(*)
EC Vs TA	.970(*)	.973(*)
EC Vs NO_3^-	.983(*)	-
DO Vs Rainfall	-.961(*)	-
DO Vs TA	-	.977(*)
Free CO_2 Vs Insect Density	-	.993(**)
TA Vs NO_3^-	.997(**)	-
NO_3^- Vs Rainfall	-	-.993(**)
NO_2^- Vs NH_4^+	-	.967(*)
NO_2^- Vs Rainfall	-	.960(*)
PO_4^{3-} Vs NO_2^-	.955(*)	-
PO_4^{3-} Vs Insect density	-.984(*)	-
NO_2^- Vs Insect density	-.963(*)	-
Transparency Vs Diversity of insects	-	.977(*)

* Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed).

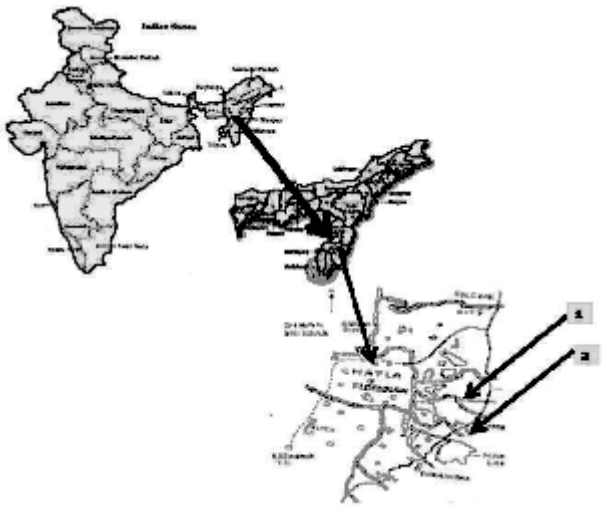

Fig. 1: Location of the two Ponds , 1 and 2 in the floodplain of Chatla Wetland

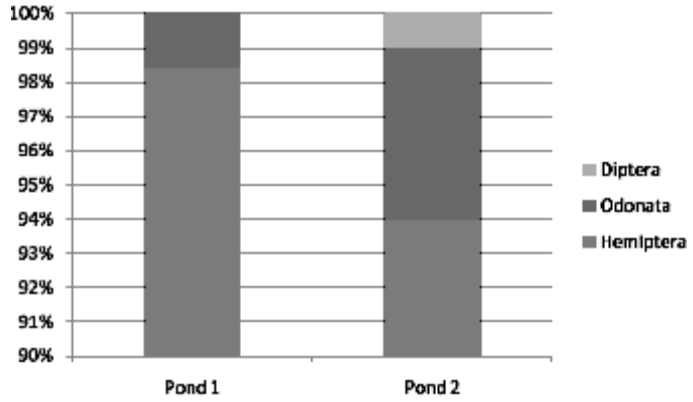

Fig. 2: Relative abundance of insect orders in Pond 1 and Pond 2

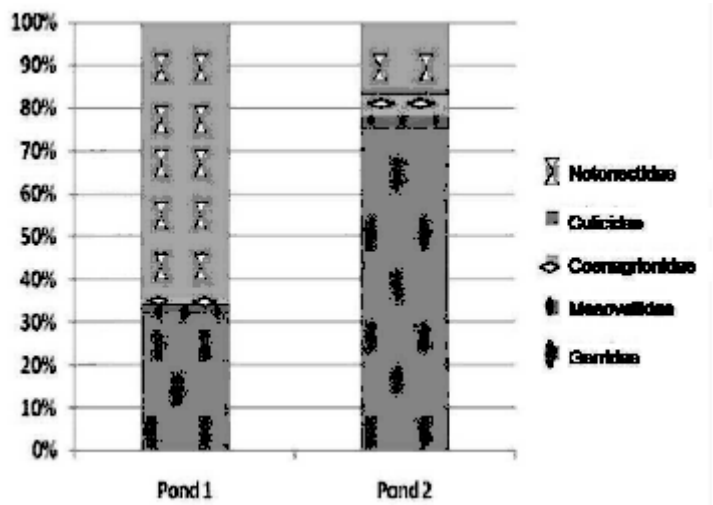

Fig. 3: Relative abundance of aquatic insect families in Pond 1 and Pond 2

photosynthesis. The overall effect of liming is to increase phytoplankton production which results in increased fish production[26]. Another reason might be that in heavily stocked fish ponds, Carbon dioxide (CO_2) concentration can become high as a result of respiration. High CO_2 concentrations are almost always accompanied by low DO concentrations (high respiration). Acidity of rain water has impact on the pH of natural water bodies. As rain falls to the earth, each droplet becomes saturated with CO_2 and pH is lowered[27]. This explained the negative relationship of Rainfall with pH in pond 1. However in pond 2 no such relationship could be found due to application of lime. In pond 1 DO has shown significant positive correlation with pH , such type of positive correlation in between DO and pH have been recorded from the study of Asa lake Ilorin , Nigeria[28] where DO distribution followed a similar annual cycle with the pH. In pond 2 DO has shown a positive significant correlation with TA. These alkalinity relationships are extremely important in water

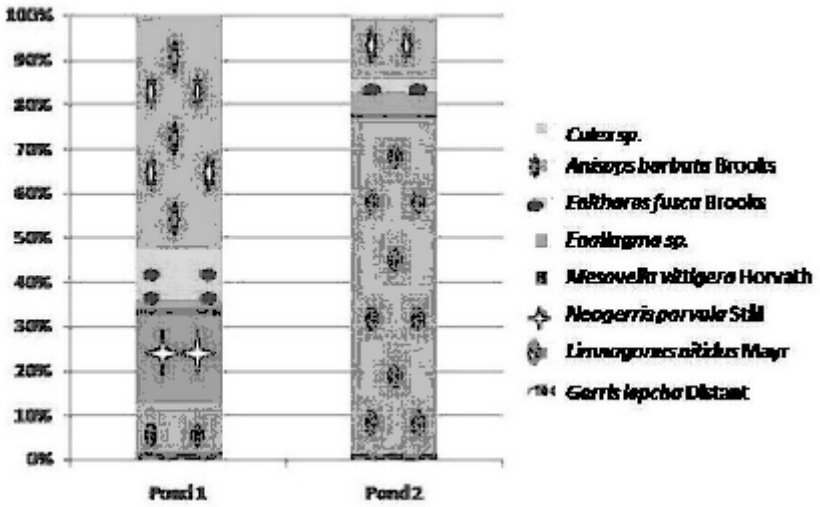

Fig. 4: Relative abundance of aquatic insect species in Pond 1 and Pond 2

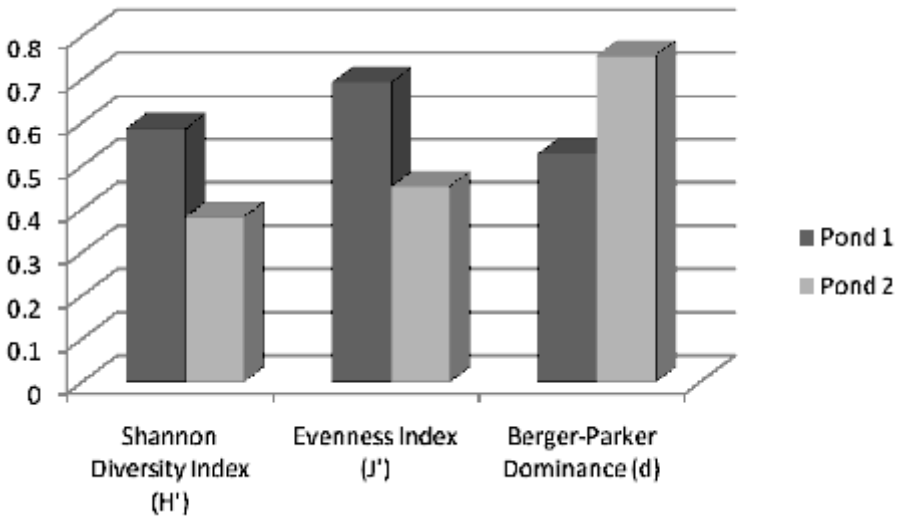

Fig. 5: Pattern of variation in the levels of Shannon diversity index, Evenness index and Berger-Parker dominance of different insect species in both the Ponds

chemistry, since the most prominent water problems are deposits and corrosion, and these are closely related to the instability of each specific water caused by the tendency of $CaCO_3$ to dissolve in or precipitate from it [29]. Range of PO_4^{3-} (0.86 ± 0.27 in pond 1 and 1.25 ± 0.72 in pond 2) recorded in the present study is supported by the previous study in a marsh of the same floodplain[30]. Relatively high concentration of PO_4^{3-} in pond 2 might be due to its use as community pond where PO_4^{3-} is contributed by household activities such as washing, bathing etc. In pond 1 PO_4^{3-} has shown significant positive correlation with NO_3^-. Actually large concentration of PO_4^{3-} and NO_3^- reported together from a water body indicate that water is eutrophic in nature[31] but as the water of this pond showed low concentration of both ,it indicates the water is not eutrophicated. Rainfall showed significant negative relationship with NO_3^- and positive correlation with NO_2^- in pond 2. A previous study conducted in the same study area also reported relatively high concentration of NO_3^- during dry months [32]. A positive correlation between NO_2^- and NH_4^+ is supported by the fact that the most possible way of Nitrate entry in an aquatic system is through oxidation of Ammonia form of Nitrogen to NO_2^- and to NO_3^- consequently [31].

Aquatic insect community of pond 1 was represented by two orders- Hemiptera, Odonata; four families- Gerridae, Notonectidae, Mesoveliidae (Hemiptera), Coenagrionidae (Odonata) and seven species. Pond 2 was represented by three orders Hemiptera, Odonata, Diptera; five families- Notonectidae, Gerridae, Mesoveliidae (Hemiptera), Coenagrionidae (Odonata); Culicidae (Diptera) and seven species (Table 2). In both the ponds order Hemiptera was the most prominent order, having 98% relative abundance in pond 1 and 94% in pond 2. The most abundant family in Pond 1 is Notonectidae (64%), followed by Gerridae (32%), Mesoveliidae (2%), and Coenagrionidae (2%). In Pond 2 the relative abundance of Gerridae was highest (76%) followed by Notonectidae (16%), Coenagrionidae (5%), Mesoveliidae (2%) and Culicidae (1%) (Fig.2 and 3). The aquatic insect species found common in both the ponds were *Gerris lepcha* Distant, *Limnogonus nitidus* Mayr, *Enithares fusca* Brooks, *Mesovelia vittigera* Horvath, *Enallagma sp*. and *Anisops barbata* Brooks. In addition to these species *Neogerris parvula* Stål was recorded in pond 1 and *Culex sp*. in pond 2 (Fig.4). Values of Shannon –Weiner Diversity index (H') and Evenness index (J') were found higher in pond 1 than that of Pond 2 while Berger-Parker index of Dominance (d) value was found higher in pond 2 (Fig. 5). However the H' values were found to be less than 1 in both the ponds indicating polluted nature of water[35]. In pond 1 insect density has shown negative correlations with PO_4^{3-} and NO_2^-. This might be due to the reason that increased pollution level with high concentration of PO_4^{3-} and NO_2^-.might have disturbed the colonization as many species of aquatic insects are very susceptible to pollution or alteration of their habitat [33]. In pond 2 density of aquatic insects showed positive correlation with Free CO_2 which might be due to increased respiration by more number of insects. Rainfall [34] has shown no significant relationship with diversity or density of aquatic insects in both the ponds. The diversity of aquatic insects showed positive correlation with Transparency. Such kind of positive correlation was reported from lake Victoria[37]. From the study, it can be said that different physico chemical parameters of water quality are inter related and these factors influence diversity, density and distribution of aquatic insects in a particular water body.

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