ISSN: 2347-5129
(ICV-Poland) Impact Value: 5.62
(GIF) Impact Factor: 0.549
IJFAS 2016; 4(6): 271-275

www.fisheriesjournal.com
Received: 08-09-2016
Accepted: 09-10-2016

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Biodiversity of aquatic insect population in three permanent ponds of Guwahati, Assam, India

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Abstract
The present study deals with the aquatic insects survey conducted from February 2016-May 2016 in three permanent ponds of Guwahati city, Assam. This study enumerated 25 different species belonging to 6 orders and 13 family. Order Hemiptera represent the highest number of species (15 species) followed by Coleoptera (4 species) and other orders such as Odonata (2 species), Hymenoptera (1 species), Ephemeroptera (1 species), and Diptera (2 species). In the present study order Hemiptera was found most diverse and relatively abundant in the pond. Overall species abundance and richness revealed that insect order Hemiptera were the most dominant and that of Hymenoptera was the least dominant in the three pond system. In this study, Coleoptera was the second dominant order and Ephemeroptera and Hymenoptera was the least dominant order which suggested that the study area of Guwahati city is less polluted and rich in aquatic vegetation. The Shannon-Weiner diversity index for aquatic insect remained above 3.0 indicating the good quality of the water. The values of Shannon diversity index at three pond system Jorpukhuri, Dighalipukhuri and Silpukhuri is 2.4894, 2.0886 and 1.4678 respectively. The Simpson values for richness and evenness of the three pond Jorpukhuri, Dighalipukhuri and Silpukhuri is 0.906, 0.9 and 0.82 respectively.

Keywords: Aquatic insects, permanent ponds, physico-chemical properties, diversity, distribution

1. Introduction
Fresh water ecosystems are colonized by a diverse array of aquatic organisms [1]. Aquatic insects, a group of Arthropods, live their life cycle in water bodies and are found in or on the surface of the lentic or lotic waters. There are 8 major order of insect that spend at least a part of their life cycle in the fresh water ecosystem. Aquatic insects are considered as a very good indicator of water quality because of their wide range of environmental disturbance tolerant levels [2]. Some of these aquatic insect may be beneficial to human beings, while few others may be quite harmful [3]. These insects form an important component of the food chain and energy flow pathways and comprise of a high proportion of biomass in fresh water ecosystems [4]. At the larval stage, they constitute the principal nutritive fauna of fish and are known to play a significant role in the processing and cycling of nutrients as they belong to several feeding groups such as filter feeders, deposit collectors and predators [5]. Aquatic insects are used for assessing water quality and provide information to environmental managers and decisions makers to take accurate and justifiable actions in regard to the state and quality of water bodies [2]. Besides of their importance as bio-monitors, bio- indicators, predators, and as bio-control agents, conservationist are far from the listing of all the species under threat. Not many aquatic insects have been listed as threatened or endangered, because entomologist has just begun to study their distribution and population numbers in recent years. Many group of aquatic insects are very susceptible to pollution or alteration of their habitat [6].
The presence or absence of aquatic insects can indicate whether a particular system is healthy or polluted. The changes in the physico-chemical properties of water can adversely affect the diversity, distribution and composition of aquatic insects [7]. In general, much attention has been given in the large water bodies, while in the small ones especially the ponds remains neglected which serve as repositories to the local biodiversity. Ponds often constitute biodiversity "hot spot" within a region or a landscape, challenging conventional applications of species area models in practical nature conservation [8].

2. Materials and Methods

2.1 Study Area

The field work is carried out on the three permanent ponds selected in Guwahati city, Assam. The pond ecosystems taken under study are Jorpukhuri, Dighalipukhuri and Silpukhuri (Figure 1). Jorpukhuri is located in Latasil area on the eastern side of the Ugratara temple. Dighalipukhuri, located at the heart of Guwahati city, is a man-made pond that is rectangular in shape and about half a mile in length. The latitude 26.11 and longitude 91.83 are the geo coordinate of Dighalipukhuri. Silpukhuri is a round deep man-made tank with concrete wall all around the pond.

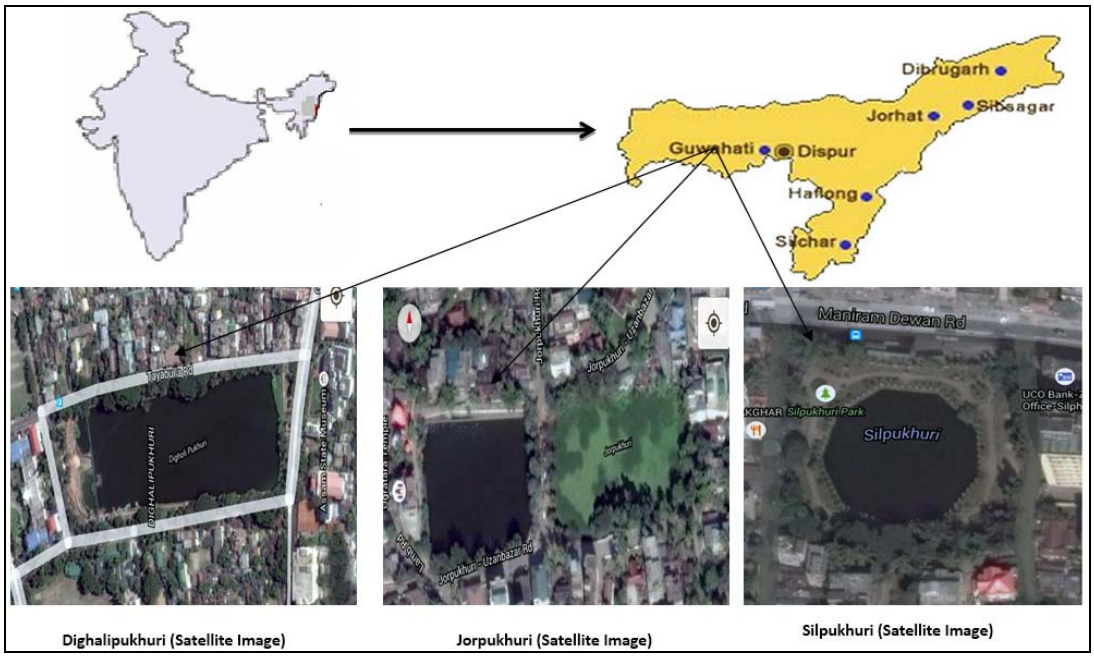


Fig 1: Map of Assam showing the satellite image of the three ponds under study of Guwahati

2.2 Sampling Method

The present study is based on the studies carried out for a period of four months from February, 2016 to May, 2016 (pre- monsoon). Insects and water samples were brought to the laboratory, Zoology Department, Handique Girls' College. For sampling the three ponds area is arbitrarily divided into five zones namely North, South, East, West and Central zone. Insect samples were collected using hand operated nets from the above mentioned zones.

2.3 Physico-Chemical Parameters of Water

Physico-chemical parameters such as air temperature (AT), water temperature (WT) and p^H of water sample were analyzed by using a mercury bulb thermometer, pH meter (Model: Digital p^H meter) respectively. Dissolved oxygen (DO), Free carbon di-oxide(CO_2), Total alkalinity (TA), Calcium, Magnesium, Total hardness, Salinity, Chloride of water sample were analyzed by standard titrimetric methods (APHA, 2005).

2.4 Statistical Analysis

Species diversity indices of the collected aquatic insects such as Shannon- Weiner, Simpsons, Evenness were computed to understand the biotic community of each study area.

3. Results

3.1 Analysis of Physico-chemical parameters: The physico-chemical parameters of the three pond ecosystem namely, Jorpukhuri, Dighalipukhuri and Silpukhuri are summarized in Table 1.

Table 1: Water analysis result of the three pond ecosystem under study

Study area	AT (˚C)	WT (˚C)	pH	DO (mg L^{-1})	FCO_2 (mg L^{-1})	TA (mg L^{-1})	Mg (mg/ml)	Ca (mg/ml)	Cl_2 (mg/ml)	Salinity (mg/l)	Hardness (mg/l)
Dighalipukhuri	33.25	29.75	9.44	13.13	Nil	27.3	2.42	64.36	37.7	20.41	74.3
Jorpukhuri	33	29.5	8.02	12.63	8.6	39	5.40	101.43	61.9	33.5	123.6
Silpukhuri	33.5	29.9	8.15	10.33	5	27.6	2.48	65.1	28	15.37	75.3

(AT-Atmospheric temperature, WT-Water temperature, D.O-Dissolved Oxygen, FCO_2-Free Carbon Dioxide, TA-Total Alkalinity)

3.2 Aquatic insects

A total of 25 aquatic insect species were identified which comprised of 6 order and 13 families. In this study, 6 families of order Hemiptera with 15 genera, 2 families of Coleoptera with 4 genera, 2 families of order Odonata with 2 genera, 1 family of order Diptera with 2 genera, 1 family of order Ephemeroptera with 1 genera, 1 family of order Hymenoptera with 1 genera were recorded during the study period of February- May, 2016 (Table 2). Hemiptera were recorded in highest number. The order Hemiptera composed of 60%, Coleoptera composed of 16%, Odonata composed of 8%, Diptera composed of 8%, Ephemeroptera composed of 4% and Hymenoptera composed of 4% each of the total recorded aquatic insect species (Fig. 1).

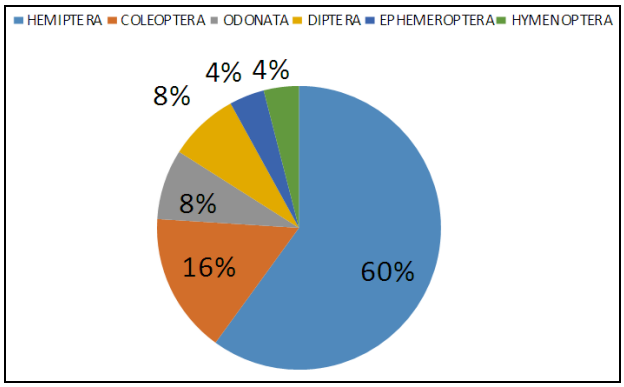


Fig 2: Percentage of different orders of aquatic insect in the three permanent pond ecosystem under study.

Table 2: Distribution of different species of aquatic insect in the three pond ecosystem

Sl. No	Order	Species	Spring (Feb-April)	Pre-Monsoon (May)
1.	Diptera	*Aedes aegypti*	+	
2.		*Culex species*		+
3.	Ephemeroptera	*Betis species*	+	
4.	Coleoptera	*Dineutus spinosus*		+
5.		*Laccophilus species*	+	+
6.		*Laccophilus species*		+
7.		*Laccophilus indicus*		+
8.	Hemiptera	*Gerris gracilicornis*		+
9.		*Gerris species*	+	+
10.		*Hydrometra greeni*		+
11.		*Plea liturata*	+	
12.		*Gerris gibbifer*	+	
13.		*Enithares species*	+	
14.		*Enithares species*	+	
15.		*Limnogonis nitidus*	+	
16.		*Nychia marshalli*	+	
17.		*Mesovelia mulsanti*		+
18.		*Micronecta scutelaris*	+	
19.		*Neogerris parvula nymph*	+	+
20.		*Neogerris parvula adult*	+	+
21.		*Neogerris species*	+	
22.		*Neoplea striola*		+
23.	Odonata	*Pantala flavescens*		+
24.		*Ischnura senegalensis*		+
25.	Hymenoptera	*Polyrhachis sokolova*		+

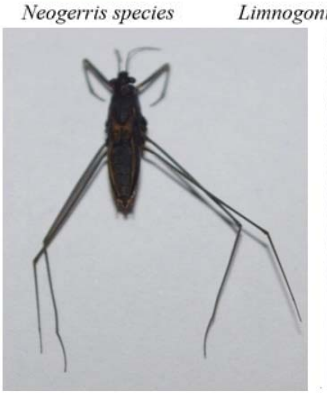
3.3 Species richness, evenness and diversity

The Shannon and Wiener diversity index were highest at Jorpukhuri (2.4894) and lowest at Silpukhuri (1.4678) respectively while in the Dighali pukhuri it is 2.0886. The Simpson Diversity Index for richness and evenness is highest in the Jor pukhuri (0.906) followed by Dighalipukhuri (0.9) and Silpukhuri (0.82). The similarity and dissimilarity of aquatic insects between Dighalipukhuri and Jor pukhuri is 0.38% and 0.62% respectively followed by Dighalipukhuri and Silpukhuri (0.42% and 0.58%) while the similarity and dissimilarity between Silpukhuri and Jorpukhuri is 0.36% and 0.64% respectively.

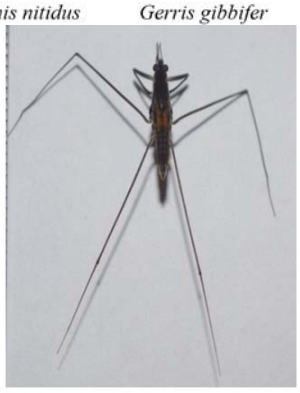
Neogerris species

Limnogonis nitidus

Gerris gibbifer



Gerris gracilicornis



Gerris species

Nychia marshalli

Micronecta scutelaris

Enithares species

4. Discussion

The study of population of the aquatic insect in the three perennial ponds revealed the fact that the aquatic insect population is regulated and governed by both abiotic and biotic factors. Abiotic factors such as water temperature, air temperature, dissolved oxygen, p^H, free carbon dioxide, alkalinity, hardness of water, salinity, chloride, magnesium, and calcium may be responsible for the prevailing population level of aquatic insect in the three pond ecosystem under study.

Many aquatic insects are sensitive to changes in water temperature. Water bodies will naturally show changes in temperature seasonally and daily relative to the atmosphere temperature [9]. In the present investigation the minimum water temperature was recorded during February (22 ˚C) and maximum was recorded in the month of May (32 ˚C). In the present study the p^H values ranged from 7.84 to 9.44 in all the three aquatic bodies. Dissolved oxygen (DO) is essential to all forms of aquatic life including the organisms; in general, the concentration of dissolved oxygen will be the result of biological activity. In the present investigation the dissolved oxygen in Dighali pukhuri, Jorpukhuri, and Silpukhuri area is 13.13 mg/l, 12.63 mg/l and 10.33 mg/l respectively. The DO is low in Silpukhuri than other two ponds which may be due to the polluted water and due to eutrophication. In the present investigation carbon dioxide in Jorpukhuri and Silpukhuri is 8.6 mg/l and 5 mg/l respectively whereas in Dighali pukhuri the presence of carbon dioxide was not detected during the study period. Total hardness of the experimental sites under study is found to be 74.3, 123.6, 75.3 for Dighalipukhuri, Jorpukhuri and Silpukhuri respectively. The Calcium concentration ranges between 64.36-101.43 mg/L and the magnesium concentration ranged from 2.42-5.46 mg/L in all the water bodies under study. The concentration of Chloride in the three bodies are 37.7, 61.9, 28 mg/ml in Dighalipukhuri, Jorpukhuri and Silpukhuri respectively.

In the present investigation a total of 25 species have been recording belonging to 6 orders (Hemiptera, Coleoptera, Diptera, Odonata, Ephemeroptera and Hymenoptera). Order Hemiptera represent the highest number of species (15 species) followed by Coleoptera (4 species) and other orders such as Odonata (2 species), Hymenoptera (1species), Ephemeroptera (1 species), and Diptera (2 species) Table 2.

The major aquatic insect taxa Plecoptera and Tricoptera were completely absent in the studied area. In contrast, insect of the order hemiptera, diptera, odonata and coleoptera showed high species richness and abundance. These results are similar to that of the perennial Loktak lake of Manipur of northeastern part of India [10]. In the present study order hemiptera was found most diverse and relatively abundant in the pond. 73 insect species associated with macrophyte from fresh water wetland of West Bengal has been recorded [11]. Overall species abundance and richness revealed that insect order hemiptera were the most dominant and that of hymenoptera was the least dominant in the three pond system. In this study, coleoptera was the second dominant order and ephemeroptera and hymenoptera was the least dominant order which suggested that the study area of Guwahati city is less polluted and rich in aquatic vegetation. However, in West Bengal some researchers found insects of odonata and coleoptera to be the most common [12]. It was found that the number of species was recorded highest (15) followed by order coleopteran (4). Deepa and Rao have recorded 8 hemipteran from Pocharam lake, Andhra Pradesh [13]. Bhattacharya described eight species in association with *Eichhornia crassipes* in some freshwater wetlands of West Bengal; Khan has recorded eight species from two man-made lakes of Kolkata; Hazarika and Goswami, recorded 14 species from two pond ecosystems in Gauhati University, Assam; while Das and Gupta have recorded 12 species of Hemiptera from rain pools and 10 species of hemiptera from agricultural fields in Cachar district, Assam [11, 14-16]. Similarly, Das and Gupta also have recorded 14 species of hemiptera from a temple pond in Cachar district, Assam [17]. The number of recorded species in the present study signifies the rich diversity of aquatic insects in the only Dighalipukhuri, Silpukhuri and Jorpukhuri of Guwahati city, Assam.

The Shannon-Weiner diversity index for aquatic insect remained above 3.0 indicating the good quality of the water. The values of Shannon diversity index at three pond system Jorpukhuri, Dighalipukhuri and Silpukhuri is 2.4894, 2.0886 and 1.4678 respectively. The Simpson values for richness and evenness of the three pond Jorpukhuri, Dighalipukhuri and Silpukhuri is 0.906, 0.9 and 0.82 respectively. The similarity of aquatic insect species is highest in between the Dighalipukhuri and Silpukhuri (0.42%) and the dissimilarity of the aquatic insect species is highest in between the Jorpukhuri and Silpukhuri (0.64%).

Occurrence of more diverse and abundant insects in the three pond ecosystems suggest the presence of luxuriant aquatic

vegetation. Another possible cause of insects abundance and richness in Jorpukhuri and Dighali pukhuri may be larger size and greater depth than Silpukhuri. A significance difference in density and diversity of the aquatic insects between the three sampling sites under study may be attributed to the significant difference in physico-chemical parameters of the water bodies.

Aquatic insects are probably best known for their ability to indicate about the water quality in a particular environment. In the process of biological monitoring, healthy aquatic environments have a lot of different sensitive kinds, while the polluted environments have only a few kinds of aquatic insects. In the three pond, population included, *Hydrometra, Culex, Aedes, Dineutus, Gerris, Enithares, Ischnura, Laccophilus, Mesovelia, Micronecta, Neogerris, Nychia, Pantala, Plea* and *Polyrhachis* species. In this study, a total of 25 species was recorded from three different pond ecosystem and the number of aquatic insect species and their abundance varied among the ponds. Dominance of hemipteran and coleopteran insect suggested that the pond ecosystem of Guwahati city is relatively less polluted. This study revealed that the Pond Jorpukhuri is a rich aquatic system although encountering anthropogenic disturbances. Based on the Shannon Wiener index it was found that Jorpukhuri have the rich diversity of aquatic insects. There is scanty information on the abundance and diversity of aquatic insects in freshwater bodies in Assam. Therefore, it is imperative to make continuous investigation, census and research activities on the taxonomy and diversity of aquatic insects, so that knowledge regarding this important group can be utilized by future researchers as baseline data for further research and conservation planning.

5. Acknowledgement: The authors are grateful to Department of Zoology and Institutional Biotech Hub (DBT), Handique Girls' College for supporting with lab and space facilities in completing this project work.

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