



## Diversity of aquatic insects in relation to physico-chemical parameters of two fresh water bodies of Balrampur District (U.P.), India

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### Abstract

Present investigation has made an attempt to assess the physico-chemical status of water of two natural perennial fishery ponds of Balrampur district of Uttar Pradesh, India and also established the variations in the diversity of aquatic insects of the study areas. The physico-chemical parameters values obtained are in the range of international standards values as well as other scientist works. The diversity of insect fauna of these two freshwater bodies was represented by 32 genera belonging to 20 families and 6 orders. Among the aquatic insects collected from both fresh water bodies, the order Hemiptera (15 genera) was dominant and followed by order Odonata (7 genera), Ephemeroptera (3 genera), Diptera (3 genera), Coleoptera (2 genera) and Trichoptera (2 genera).

**Keywords:** biodiversity, insect fauna, biomonitoring, limnology

### Introduction

Biodiversity is the 'foundation of human life' on earth because each organism plays an important role and helps in producing more product+ve and stable ecosystem which has the ability to survive in stress conditions [1]. Environmental conditions play a key role in defining the function and distribution of organisms, in combination with other factors. Environmental changes have had enormous impacts on biodiversity patterns in the past and will remain one of the major drivers of biodiversity patterns in the future [2]. Aquatic ecosystem is helpful in maintaining the biodiversity. The biodiversity has different values [3] and explored at three levels *namely*: ecosystem diversity, species diversity and genetic diversity. The genetic diversity acts as a buffer for biodiversity [4]. The biodiversity helps to maintain the ecological balance. There is a necessity of ecological balance for widespread biodiversity [5]. The climate change has a huge impact on biodiversity [2] and farmers' practices [6]. Numbers of studies have been carried out on Physico-chemical condition, biodiversity of fish fauna and macrophytes of freshwater lentic and lotic bodies of U.P. including Prakash *et al.*, [7, 8, 9, 10, 11, 12, 13, 14, 15, 16].

Arthropoda represent the largest animal phylum and its members are known to show diverse biology, habits and habitat. Most of them are hardy, a character responsible for their occurrence and survival in a wide range of conditions which may not be tenable for many other animal groups. Class Insecta is the largest class of animals, belong to this phylum. This class comprises both useful and harmful insects. The later include aphids [17]. They occupy all the three habitats *viz.* air, water and land. Aquatic insects complete their life cycles in water bodies and are found in or on the surface of the lentic or lotic water. They play important role in ecosystem functioning by virtue of their abundance, taxonomic diversity and trophic significance. Aquatic insects make up 3-5% of all insect species; they are taxonomically diverse and play a critical role in stability and

maintenance of ecosystem, especially in nutrient dynamics. Aquatic insects are considered as a very good indicator of water quality and human impact on the freshwater ecosystem because of their wide range of environmental disturbance tolerant [18].

These aquatic 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. 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 [19].

The presence or absence of aquatic insects can indicate whether a particular ecosystem is healthy or polluted. The changes in the physico-chemical properties of water can adversely affect the diversity, distribution and composition of aquatic insects [20]. 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 [21]. Thus, the present study documents the diversity of aquatic insects in some freshwater bodies of Balrampur district of U.P. and also emphasizes the impacts of pollution.

### Study Areas

The selected Tulsidas Talab (photo 1) and Mavalal Talab (photo 2) are located in Balrampur district of Uttar Pradesh (maps 1 and 2). These study areas (image1) were small perennial lentic fresh water bodies, situated at a distance of 831.6m and 596.3 m to the east and north-east of M.L.K. P.G. College Balrampur campus. The maximum area and depth occupied by the Tulsidas Talab during rainy season was 0.9 ha and 250.0 cm respectively. It has a saucer shaped

basin with gentle slopes from its margins. Three sides of the pond are surrounded by agricultural land. The maximum area and depth occupied by Mavalal Talab was 0.5 ha and 210.0 cm respectively. It is surrounded by buildings and

located in the densely populated area. The margin of the pond is infested by *Eichhornia crassipes* and the organic deposition causes sedimentation of the pond.

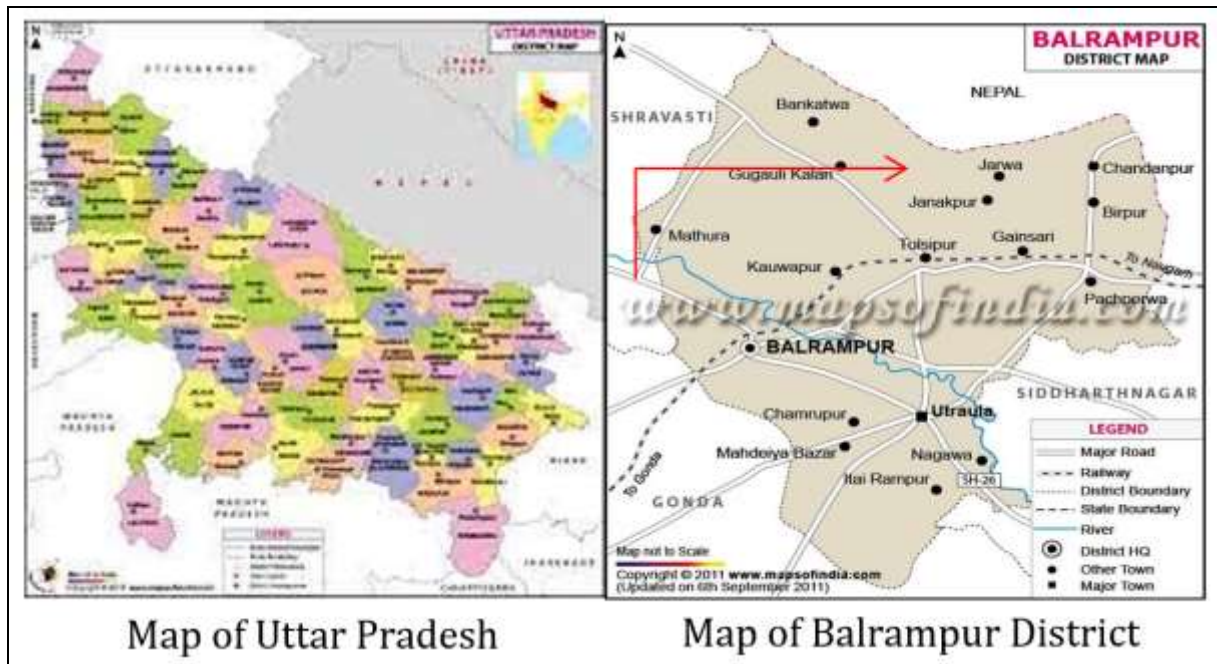


Image 1: Satellite map of Balrampur showing study areas



Photo 1: Tulsidas Talab in Balrampur (U.P.)



Photo 2: Mavalal Talab in Balrampur (U.P.)

## Materials and Methods

Physico-chemical parameters such as water temperature and pH of water sample were analyzed by using a mercury bulb thermometer and pH meter respectively. Dissolved oxygen (DO), Free carbon di-oxide (CO<sub>2</sub>), Total alkalinity (TA), Total hardness (TH), Total dissolved solids (TDS), BOD, Chloride and nitrates of water samples were analyzed by following standard titrimetric methods [22].

Aquatic insects were collected using dipnet (0.3 x 0.3m) having mesh size 500 $\mu$  for a period of one year from April 2019 to March 2020. A random sampling of a 50m reach was taken for collecting insect samples. A total of 10 dippings or 10 kicking was carried out along the length of

the sampling reach. The collected material was washed by running water through the nets two or three times to detach the insects/larvae adhered in the nets. The samples were then transferred to white trays in small quantities for handpicking aquatic insects using forceps and fine brushes. The handpicked samples were then preserved in 95% ethyl alcohol and brought to the laboratory for further analysis. Before preserving natural colour of insects were noted. The collected samples were examined under a dissecting microscope and identified with the help of standard taxonomic keys and literature including [23, 24]. The family level identification was done according to proper insect manual.

## Results and Discussion

**Table 1:** Water Quality Parameters of Two water bodies and Comparison of results with other standard values

S.N.	Water Parameters	Study area (Talab)		Standard value		
		Mavalal Talab	Tulsidas Talab	WHO (2009)	BIS (1991)	FEPA (1991)
1.	Temperature ( $^{\circ}$ C)	15.4-31.5	15.8-31.8	<35.0	-	27
2.	pH	7.8-9.0	8.2-9.0	6.5-9.2	6.5-8.5	6-9
3.	DO (mg/l)	4.0-4.8	4.1-4.9	6	6.0	8-10
4.	FCO <sub>2</sub> (mg/l)	4.4-10.2	3.32-6.14	-	-	-
5.	TA (mg/l)	64.0-135.0	85.0-174.0	200	50-200	-
6.	TH (mg/l)	110.0-135.0	145-170.0	100-500	300	-
7.	TDS (mg/l)	115.0-120.0	126.0-132.0	1000	500	-
8.	BOD (mg/l)	2.8-7.4	2.4-5.4	6	5	10
9.	COD (mg/l)	11.2-12.8	11.4-12.0	10	-	-
10.	Chloride (mg/l)	37.80-40.20	37.70-42.10	250	250	-
11.	Nitrate (mg/l)	1.10- 2.08	1.20-1.34	50	45	20

Temperature is one of the most important basic environmental factors for all aquatic organisms which effects chemical and biological reaction in water [25]. The changes in temperature affect the metabolism and physiology of aquatic organisms. In the present study, authors recorded a varied temperature in both the ponds from 15.4-31.8 $^{\circ}$ C which come under the standards [26, 27].

The pH is a measure of hydrogen ion concentration and it indicates the acid base balance of the water. In the present study, the pH values of both ponds varied from 7.8 – 9.0 which showed the favourable condition of pond productivity. These values are also within the international standards [26, 27, 28].

Dissolved oxygen plays a vital role in the growth, survival, behavior and physiology of aquatic organisms. The optimum concentration of DO in pond water is 6.0-9.0mg/L [25]. In the present study, DO obtained were in the range of 4.0 -4.9 mg/L and these values lower the standards [26, 27, 28].

Free carbon dioxide in a water body is generally derived from the atmospheric sources, biotic respiration and decomposition of organic matter by saprophytes. In the present study, the FCO<sub>2</sub> of both the ponds was ranged between 3.32 and 10.2 mg/L. The present finding is similar to that of Kumar *et al.* [29]. The alkalinity is a measure of buffering capacity of water and is important for aquatic life. It equilibrates the pH changes that occur naturally as a result of photosynthetic activity of phytoplankton [30]. In the present study, total alkalinity of both ponds varied from 64.0 - 174.0 mg/L which come under the standards [26, 28].

Total hardness is defined as the sum of calcium and magnesium concentration in aquatic bodies which are present in the combination of carbohydrates and bicarbonates which causes temporary hardness. The

hardness in the present water bodies varied between 110.0 and 170.0 mg/L which are within the range [26, 28].

A total dissolved solid (TDS) is the direct measure of all the dissolved substances (both inorganic and organic) in the water bodies. In the present study, TDS values obtained ranged from 115.0 – 132.0 mg/L. The values obtained are within the range of standards [26, 27].

Biochemical oxygen demand (BOD) is the amount of oxygen taken up by micro-organism for the decomposition of organic waste materials in water [31]. In the present study, the value of BOD of both ponds ranged between 2.4- 7.4. These values are within the range of [27]. Authors recorded COD range from 11.2- 12.8 mg/L and these values slightly higher the standard value of [26]. [25] reported the optimum level of COD<50.0mg/L for fresh water aquaculture.

Chloride is one of the major inorganic anion and is a common constituent of all natural water but are generally non harmful [32]. In the present study chloride obtained from both water bodies was in the range of 37.70-42.10 mg/L which come under the standards [26, 28].

Nitrate is essential nutrient for photosynthetic autotroph and its presence in any aquatic ecosystem depends on the activity of nitrifying bacteria. Authors obtained nitrate value in the range of 1.10- 2.08 mg/L. These values come under the standards [26, 27, 28].

Thus, in the present study authors recorded the values of different physico-chemical parameters in the range of standards values as well as other scientific works. A better fish production can be done if managed these water bodies scientifically. Since these ponds in their present state hold only Indian major carps so it is desirable that fast growing compatible fish species *i.e.* exotic carp (silver carp, common carp and grass carp) be stocked in this pond for optimum

utilization of available food resources of the pond. The present study indicated that both fresh water bodies are rich in aquatic insects (Table 2). The diversity of insect fauna of these two freshwater bodies was represented by 32 genera belonging to 20 families and 6 orders. Among the aquatic insects collected from both fresh water bodies, the order Hemiptera (15 genera) was dominant and followed by order Odonta (7 genera), Ephemeroptera (3 genera), Diptera (3 genera), Coleoptera (2 genera) and Trichoptera (2 genera).

**Table 2:** Distribution of different species of aquatic insects in two pond ecosystems

S.N.	Species	Mavalal Talab	Tulsidas Talab
Order: Diptera			
1.	<i>Anophiles species</i> (Anophilinae)	++	+
2.	<i>Culex species</i> (Culicidae)	++	+
3.	<i>Tanytarsuslarvae</i> (Chironomidae)	++	-
Order: Coleoptera			
4.	<i>Dineutusspecies</i> (Gyrinidae)	++	+
5.	<i>Laccophilusspecies</i> (Dytiscidae)	++	+
Order: Hemiptera			
6.	<i>Anisops species</i> (Notonectidae)	++	+
7.	<i>Enithares species</i> (Notonectidae)	++	-
8.	<i>Gerrisspecies</i> (Gerridae)	++	+
9.	<i>Aquarius species</i> (Gerridae)	++	-
10.	<i>Hebrus species</i> (Hebridae)	+	-
11.	<i>Hydrometrasspecies</i> (Hydrometridae)	+	+
12.	<i>Mesoveliasspecies</i> (Mesoveliidae)	++	+
13.	<i>Micronectasspecies</i> (Corixidae)	++	-
14.	<i>Neopleasspecies</i> (Pleidae)	+	-
15.	<i>Paraplea species</i> (Pleidae)	++	+
16.	<i>Plea species</i> (Pleidae)	+	-
17.	<i>Ranatra species</i> (Nepidae)	++	+
18.	<i>Laccotrephes species</i> (Nepidae)	+	-
19.	<i>Belostoma species</i> (Belostomatidae)	++	-
20.	<i>Leptocerusspecies</i> (Belostomatidae)	+	+
Order: Ephemeroptera			
21.	<i>Baetis species</i> (Baetidae)	++	-
22.	<i>Cloeon species</i> (Baetidae)	+++	++
23.	<i>Caenis species</i> (Caenidae)	+	+
Order: Odonata			
24.	<i>Acisoma species</i> (Libellulidae)	+++	++
25.	<i>Brachythemis species</i> (Libellulidae)	++	+
26.	<i>Crocothenies species</i> (Libellulidae)	++	-
27.	<i>Pantallaspecies</i> (Libellulidae)	++	+
28.	<i>Ischnurasspecies</i> (Coenagrionidae)	+++	++
29.	<i>Ceriagrion species</i> (Coenagrionidae)	++	+
30.	<i>Pseudagrion species</i> (Coenagrionidae)	+	-
Order: Trichoptera			
31.	<i>Hydropsyche species</i> (Hydropsychidae)	+++	++
32.	<i>Polycentropusspecies</i> (Polycentropodidae)	+	-

Among the collected aquatic insects the order Hemiptera was diverse in number of genera. It was represented by 9 families viz., Pleidae (3 genera), Notonectidae (2 genera), Gerridae (2 genera), Nepidae (2 genera), Belostomatidae (2 genera) and rest of the families viz., Hebridae, Hydrometridae, Mesoveliidae and Corixidae represented by only one genus. Of these, Pleidae, Belostomatidae and Nepidae were the most common family among Hemiptera in both the ponds. Water strider, *Aquarius species*, Marsh treader, *Hydrometra species* and *Gerris species* were found on the surface of the water bodies.

The Order Diptera was represented by three families viz., Anophilinae, Culicidae and Chironomidae and each family was represented by only one genus. Midge larvae of *Tanytarsus* were in enormous number in the marginal polluted area of Tulsidas talab where oxygen is often depleted. Most of the Dipterans inhabited in the marginal polluted zone of both water bodies with wide range of tolerance.

Ephemeroptera was one of the intolerant and sensitive group and was represented by two families viz., Baetidae (2 genera) and Caenidae (1 genus), which are indicator of water quality ecosystem health. The Order Coleoptera was contributed by the two families viz., Gyrinidae and Dytiscidae each family represented with only one genus. Insect order Odonta was represented by two families viz., Libellulidae (4 genera) and Coenagrionidae (3 genera). The Order Trichoptera or caddis flies was represented by two families viz., Hydropsychidae and Polycentropodidae and each family was represented by only one genus.

The mayflies, *Cloeon species*, larvae of Caddisflies, *Hydropsyche species*, Dragonflies, member of Libellulidae family and Damselflies, member of Coenagrionidae family were found in large numbers in both water bodies. These insects lived among submerged plants or on the bottom of the pond. These insects have gills and do not come to the surface for air.

In the present study pollution sensitive groups (Ephemeroptera and Trichoptera) were represented by *Baetis*, *Cloeon*, *Caenis*, *Hydropsyche* and *Polycentropus* which indicate the pond's health. The biodiversity of aquatic insect communities in a given pond ecosystem reflect the environmental conditions. The sensitive species inhabiting the habitats of the adverse environmental conditions are gradually eliminated and the tolerant species establish their colonies and grow in abundance.

The structure and composition of biotic community is well reflected with altering water quality and are also shown in their distribution, diversity and abundance pattern of species. Most aquatic habitats with acceptable water quality and substrate conditions support diverse macro invertebrate community. Such community responds to changing habitats and community structure such as invertebrate abundance and composition. Present study reveals greater diversity and abundance of insects in Mavalal Talab compared with Tulsidas Talab. The results of the study revealed greater diversity of aquatic insects in Mavalal Talab with a possibility of pollution in lower reaches and suggest effectively for stringent biomonitoring programmes.

There is less information on the abundance and diversity of aquatic insects in freshwater bodies of eastern Uttar Pradesh. 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.

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