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Aquatic Insect Diversity And Its Impact On The Physical And Chemical Conditions Of Upper Lake During The Monsoon Season

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***Abstract*:** There were a total of 24 species identified during the 2022 Pre-monsoon season in the Upper Lake Bhopal insect fauna, according to the current investigation. These 24 aquatic bug species were divided into 6 orders and 21 families. The lake's site with the most vegetation contained a maximum of 23 species of aquatic insects, whereas the lake's site with the least vegetation contained 9 species. The insect fauna from the order Hemiptera dominated over Diptera.

Keywords: **Aquatic insects, Upper Lake, Pre-monsoon, Diversity.**

I. Introduction:

Insects that spend a portion of their life cycle in water are said to be aquatic. A third of all animals on the earth, or over 751,000 recognised species, are insects, which live on land and in water.[1] They can survive in every climatic state and can resist extreme and harsh environments.[2] That live in water are crucial to ecological systems. Since aquatic insects are the main bio-indicators of fresh water bodies, their presence or absence can indicate whether the water body is healthy or polluted because they are affected by the physico-chemical and biological characteristics of the water and act as a food source for fish and other invertebrates as well as a carrier of pathogens that can infect both humans and animals.[3] Aquatic insects support colonies of higher organisms like fish, frogs, and other creatures through their feeding strategies, which help improve the river's nutrient cycling. [4] These play a key role in the aquatic ecosystem's natural food chain and are involved in nutrient recycling. These also work as trustworthy indicators of the ecological properties of water.[5] Among benthic macro invertebrate, aquatic insects have most character in fresh water ecosystem. Some insect species only spend the first half of their life cycles in water.[6] India has over 108276 insect species, making it a country with a high biodiversity of insects.[7] Therefore, because of overuse and contamination, fresh water is today a scarce resource. India's water resources are in critical condition as a result of unplanned urbanisation and industrialization.[8] More than 500 species of water insects live in the inland wetlands of India, primarily the Ephemeroptera (mayflies), Odonata (dragonflies), and Trichoptera (caddisflies).[9] In terms of freshwater mega biodiversity, the Indian subcontinent is one of the world's mega biodiversity countries, ranking eighth overall. The aquatic insect diversity of Upper Lake Bhopal during the monsoon season has been measured in the current study.

II. Materials and Methods:

2.1. Study Area:

Formerly called Upper Lake, Bhojtal is a sizable lake located on the western side of Bhopal, the capital of Madhya Pradesh. It provides around 30 million imperial gallons (140,000 m3) of water each day to almost 40% of the city's population, making it a significant supply of drinking water. Bhojtal is located in the western portion of Bhopal City and is bordered to the south by the Van Vihar National Park, to the east and north by populated areas, and to the west by agricultural fields. It has an area of 31 km², and drains a catchment or watershed of 361 km². The Upper Lake's catchment is primarily rural, with some urbanized areas near its eastern end.

Table 1 lists the site codes and names of the sample stations in Bhopal.

s.no	Name of sampling station	Site code
01	View point (Boat club)	S I (S1)
02	Khanu gaon	S II (S2)
03	Van Vihar	S III (S3)

Table 2. displays the study area's descriptive characteristics.

S.no	Features	Bada Talab/ Upper Lake/ Big Pond
1	Period of formation	(1005-1055)
2	Coordinates	23.2532° N,77.3382°E
4	Catchment area	361.km2
5	Maximum length	31 km
6	Maximum width	5 km
7	Surface area	31 km2
8	Source of water	Khanu gaon, View point, Van vihar

2.2. Sampling Site:

The current investigation was conducted in August and September of 2022. Water samples was collected from three different points of Upper Lake Bhopal i.e. View Point (Boat Club), Khanu Gaon and Van Vihar. The field measurements of the water quality parameters included pH, electric conductivity total dissolved solids, dissolved oxygen. Air temperature and water temperature were recorded at the site itself. However, laboratory measurements were made of variables such chlorides, alkalinity, and hardness. Standard techniques are used to test all other parameters, including electrical conductivity, total dissolved solids, BOD, and COD (APHA, AWWA, WEF, 1998). Using the titration method, alkalinity, total hardness, chloride, and calcium and magnesium ions were measured. The spectrophotometer method is used to evaluate irons, nitrate, and sulphate (APHA 1998). For the collection of aquatic insect's different types of nets and sieves were used. The flying bug species were collected using an aerial net. Aquatic D-hand nets with dimensions of 30 30 cm frame, 250 m, and 20 m mesh were used to collect samples of aquatic insects. Forceps and a brush were used to filter the entire sample to remove the insects, which were then stored in 70% ethyl alcohol. The collected species were recognized using various identification keys, including Pennak (1978), Bal and Basu (1994), Subramanian (2005), and Mccafferty. The sampling stations are mentioned below in Table 1 and figure 2.

Site 1- View point

Site 3- Van Vihar

Fig. 1: Sample Collection sites (Source: Google earth)

2.3Physico-chemical Parameters of Water

A) Water Temperature (^{0}C)

Temperature has a more profound direct and indirect influence on all life processes than any other factor. A centigrade mercury thermometer with a range of 0 to 110°C was used to record the seasonal and spatial temperature fluctuations on the each sample site on the first day of each month.

S1, S2, and S3 were each measured at the same depth for temperature.

B) Air Temperature (^{0}C)

It has a significant role in regulating biogeochemical processes. During the research period, the air temperature fluctuates between 32 and 35 degrees Celsius. Spatial fluctuations in air temperature experienced during a particular season might be due to the timing of collection and the influence of weather, which quite fluctuate diurnally and seasonally in the Lakes.

C) Total Hardness

EDTA titration was used to calculate total hardness. Ethylene Diamine Tetra Acetic Acid (EDTA) and its sodium salts yield the soluble chemical when added to a solution of certain metal cations. A tiny amount of dye, such as Eriochrome Black T indicator, is used to signal this action (APHA, 2012). The following formula is used to determine the hardness.

Total Hardness (*mg / l*)
= *ml EDTA Used x* 1000 / *Volume of sample* (*ml*) *taken*

The hardness is measured in milligrams of CaCO3 per liter.

D) pH

The pH scale is used to measure the amount of hydrogen ions in water. Which also determines how acidic or alkaline the water is. Using a pH meter, a scientist can determine the acidity or alkalinity of water-based solutions by measuring the activity of hydrogen ions in the solution. Here, the electrometric method—a digital pH meter—was used to measure the water's pH. Since pH might fluctuate over time due to a variety of interactions and reactions that may occur within the water sample, including hydrolysis processes,

absorption loss of certain gases, oxidation or reduction events, etc., the pH was determined immediately following the collection of water samples from sites.

By submerging an electrode in water, the ionic strength of hydrogen ions can be determined.

E) Dissolved Oxygen (DO)

The amount of free, non-compound oxygen found in liquids, such as water, is called "dissolved oxygen." It is important parameter in assessing water quality because of its influence on the organisms living in water bodies. Winkle's approach was used to calculate the amount of dissolved oxygen in water. After collecting the water in a glass topping bottle, manganese solution (MnSO4) was added to repair the dissolved oxygen. The following formula is used to determine the dissolved oxygen.

$$Dissolved\ oxygen\ (mg \setminus l) = X \times N \times 8\ x\ 1000 / Y$$

Where,

X- Sodium thiosulfate volume (ml) Y: Sample volume (ml)

N- sodium thiosulfate normalcy (0.25 N).

The unit of measurement for dissolved oxygen is mg/l.

F) Alkalinity

Methyl orange and phenolphthalein solution were used as indicators in the titration method with a strong acid, such as hydrochloric, to measure total alkalinity. The presence of hydroxyl ions in the sample was a result of the solutes being hydrolyzed when standard acid was added. Here, the total alkalinity is first determined, and then the phenolphthalein alkalinity (APHA, 2012).

The total alkalinity is calculated by following formula.

$$Total\ alkalinity\ (mg / l)$$

$$= Ax\ N\ x50x1000 \setminus volume\ of\ sample\ (ml)$$

Where

A= ml of titrant utilized N=Titrant Normality

The mg equivalent of CaCo3/l is used to represent the total alkalinity.

III. Results and Discussion

The quality of the water parameters of all sites of Bhopal during the study period are depicted in Table 3 and the aquatic insect species recorded are shown in Table 4.

Table 3: Water quality parameters of all sites of Bhopal during monsoon season.

S.No.	Parameters	Site 1	Site 2	Site 3
1.	Air temperature °C/°F	32/89.6	35/95	33/91.4
2.	Water temperature °C/°F	20/69.26	22.4/72.32	22.4/72.32
3.	Total hardness mgl-1	54.6	56	48
4.	pH	6.1	6.88	7.07
5.	DO mgl-1	7.6	4.8	4.6

6.	Alkalinity mgl-1	50	56	52

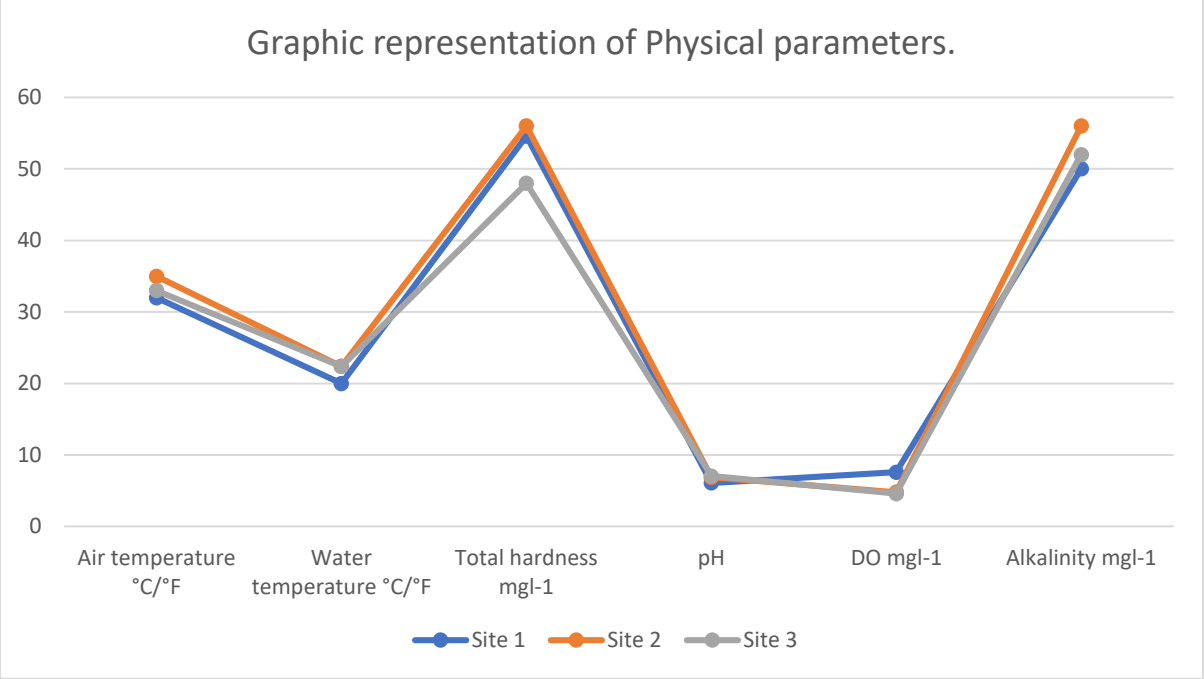

Fig.03: Physical parameter variations at three sites of Upper Lake.

Table 4: List of bug species found at Upper Lake Bhopal during the 2022 monsoon season.

S. No	Taxa	Common name	Site 1 Vegetation rich	Site 2 Disturbed site	*Site 3* Disturbed site
Order: Ephemeroptera					
Family: Leptophlebiidae					
1	*Leptophlebia*	Black and blue quills	+	-	-
Family: Siphlonuridae					
2	*Ameletus*	Brown dun	+	-	-
Order: Odonata					
Family: Coenagrionidaes					
3	*Enallagma*	Bluets	+	+	+
4	*Ischnuraaurora* Brauer, 1865	Golden dartlet	+	+	+
Family: Libellulidae					
5	*Libellula quadrimaculata* Linnaeus, 1758	Four-spotted chaser	+	+	+
Family: Petaluridae					
6	*Tachopteryx* sp.		+	-	+
Order: Coleoptera					
Family:Hydrophilidae					
7	*Tropisternus lateralis* Fabricus, 1775		+	-	-

Family: Notoridae					
8	*Hydrocanthus* sp.	Burrowing water beetle	+	-	-
Order: Lepidoptera					
Family: Pyralidae					
9	*Ostrinia* sp.		+	-	-
Order : Diptera					
Family : Syrphidae					
10	*Eristalis* sp.	Rat tailed maggots	+	-	-
Family: Chironomidae					
11	*Chironomus* sp.		-	+	+
12	*Ephydra* sp.		-	+	-
Family :Stratiomyidae					
13	*Euparyphus* sp.		-	-	+
Family: Psychodidae					
14	19	*Telmatoscopus* sp.		-	+
Order: Hemiptera					
Family: Belostomidae					
15	*Diplonychus indicus* Venkatesan & Rao, 1980	water bug	+	-	-
Family :Stratiomyidae					
16	*Lethocerus indicus* Lepeletier & Serville, 1825	Gaint water bug	-	-	+
Family: Corixidae					
17	*Sigara alternata* Say, 1825	Water boatman	+	+	+
Family : Gerridae					
18	*Aquarius remigis* Say,1832	Common water strider	+	-	-
Family: Hydrometridae					
19	*Hydrometra martini* Kirkaldy, 1900	Marsh Treader Bug	+	-	-
Family : Veliidae					
20	*Microvelia*sp.	Common pond skater	+	+	+
Family: Naucoridae					
21	*Pelocoris* sp.	Creeping water bugs	+	-	-
Family :Notonectidae					
22	*Notonecta undulate* Say, 1832	Grouse winged backswimmer	-	-	+
Family: Nepiidae					
23	*Nepa* sp.	Water scorpions	+	-	+
24	*Ranatra* sp.	Water stick insects	+	+	+

For this study, a total of 24 aquatic insect species from 6 orders and 21 families were identified from the upper Lake Bhopal's three sampling sites. The water body's first location, where the most of the macrophytes were present, was where the vast bulk of aquatic insects species (20) was found. There was a total of 11 and 12 species documented from sites 2 and 3, respectively. The water body's overall species variety showed that The most common insects were those belonging to the Hemipteran order and those from the order Lepidoptera were the least prevalent.

Fig. 4 displays the reported percentage of bug species from different orders.The diversity of Just 5% and 9% of aquatic insect taxa were found in the orders Lepidoptera and Ephemeoptera, respectively. However, with percentage compositions of 38% and 24%, respectively, the species from the orders Hemiptera and Diptera were determined to be dominating over the study period. Beetles of the Hydrophilidae family live in shallower areas of bodies of water that are rich in macrophytes and typically eat detritus, algae, and dead plant material (Khan and Ghosh,2001). The Upper Lake Bhopal insect diversity has been discovered to be impacted by pH site variation, with site 3 revealing the highest number of aquatic insects (20 in number) and a high pH, while sites 1and 2 exhibited limited insect diversity and a relatively low pH. Anthropogenic activities disrupted sites 2 and 3, which is why there was little insect diversity there.

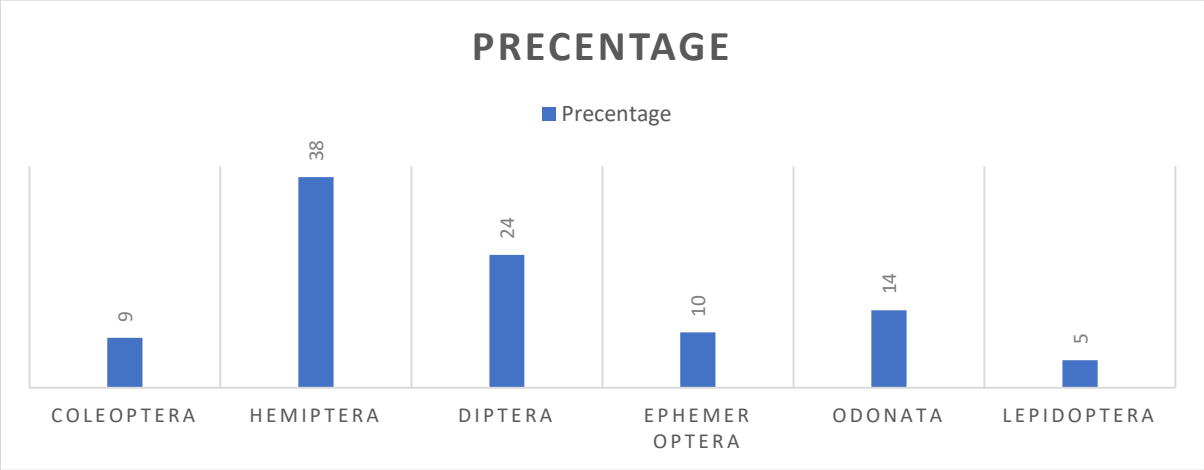

Fig.04: Percentage of species of insect orders in Upper Lake Bhopal.

IV. .Conclusion:

Insect species from the order Hemiptera were predominate throughout the study period, and the current study demonstrated that the insects were more diversified close to the vegetation-rich section of the water body. An abundance of hemipteran-related insect species was found in the area with high macrophyte density, demonstrating this group's reliance on macrophytes for food, shelter, and breeding. The next subdominant group belonged to Diptera. They were primarily discovered close to aquatic vegetation-covered lake substrates, demonstrating their need on dissolved/decomposed organic material and macrophyte exudates. The prevalence of these insects supports the eutrophic state of water body.

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