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Analysis of the distribution and diversity of aquatic insects in Lingan Kerur Lake in Degloor, Maharashtra

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Abstract
A study on biodiversity and abundance of aquatic insects in Lingan Kerur Lake of Degloor Taluka was carried out from February 2023 to November 2023. The study included systematic sampling of aquatic insects at 4 different stations throughout the Lingan Kerur lake using standard entomological procedures. Specimens were collected, identified, and classified into different taxa. A total of 8 species belonging to 8 families and 4 orders were recorded in 4 study stations of Lingan Kerur Lake during the study period. At order level, Diptera showed maximum relative abundance (56.78%) followed by Odonata (20.93%) in Lingan Kerur Lake. The Calculated status of different species of aquatic insects in lake revealed that *Culex* sp. and *Chironomidae* sp. from the order Diptera, were dominant. The highest Shannon diversity index (1.96) and evenness values (0.94) were recorded in station 4 while lowest Shannon diversity index (1.45) and evenness (0.84) were recorded in station 3 and station 2 respectively. This indicated that station 4 has more diversity and less domination by one or a few species than the other survey stations. Based on this research, it was found that Lingan Kerur Lake has moderate diversity of aquatic insects and it highlights the critical necessity for conservation activities to preserve biodiversity of aquatic insects in Lingan Kerur Lake.

Keywords: Biodiversity indices, aquatic insects, water quality, diversity, bioindicator

1. Introduction
All living things including plants, microorganisms, animals, and fungi are considered to be part of biodiversity. According to scientific estimation, roughly 8.7 million plant and animal species are thought to exist. As of right now, only about 1.75 million distinct species have been recognized and described. The majority of which are insects that constitutes approximately 950,000 distinct species (Melissa McDaniel, 2023) [6]. Though aquatic insect makes up only 3–5% of all insect species (Daly, 1998) [3]. A dynamic ecosystem depends significantly on freshwater bodies, including both lotic and lentic bodies. In freshwater environments, such as ponds, reservoirs, streams, groundwater, and dams, aquatic insects add aesthetic value and are therefore valuable for recreational purposes. Aquatic insects are a sensitive to a variety of anthropogenic influences. Many of these insects are highly sensitive to water quality. (Parikh *et al*., 2021) [8] In fact, the diversity of species present in an ecosystem can serve as an indicator of the stream's health, and scientists can use biodiversity index to assess stream quality. Stoneflies, for example, are known to have a low tolerance for poor water quality, therefore their presence suggests a healthy stream. (DeWalt & Ower, 2019) [4].
The aquatic insect species known as Ephemeroptera, Plecoptera, and Diptera (EP&D) can only survive in streams with lower levels of pollution, cold temperatures, and adequate oxygen. They are highly sensitive to changes in water quality. (Chowdhury *et al*., 2023a) [1].
A prominent freshwater lake called Lingan Kerur Lake which is a naturally formed lake situated near the Lingan Kerur town of Degloor. This lake is extremely ecologically significant for the nearby community and the surrounding area. The significance of the lake is derived from its various attributes such as its role in sustaining biodiversity and offering a range of ecosystem services. According to the literature review, this is the first study on the quantitative assessment of aquatic insect diversity in this naturally-made freshwater lake. Despite its significant ecological value, Lingan Kerur Lake has not received extensive research on the aquatic insect.

The unavailability of data on the diversity, taxonomy, and ecological roles of aquatic insects in Lingan Kerur Lake highlights the critical need for a fundamental investigation. This study issue statement aims to fill this essential gap and serve as the foundation for understanding the biodiversity of aquatic insects within this specific lake. The objectives of this research include, Documentation of the diversity of aquatic insects in Lingan Kerur Lake, identification and classification of the various aquatic insects present in the given Lake.

2. Materials and Methods

2.1 Study area

Lingan Kerur Lake is a naturally formed freshwater lake of Maharashtra, located in the outskirts of Degloor city (18°30'47.2" to 18°31'20.8" N and 77°33'37.0" to 77°34'17.5" E). The average depth of water during the monsoon period is approximately 3 meter and during the non-monsoon period it's 0.5 meter. The catchment run-off is the primary source of water in the lake, which has intermittent water permeance. The coordination of study sites is provided in (Table 2).

Table 1: The coordinates of study sites

Sr. No.	Station Number	Coordinates
1	Station 1	18°31'19.3"N 77°34'07.7"E
2	Station 2	18°30'59.3"N 77°34'08.2"E
3	Station 3	18°31'00.1"N 77°33'47.6"E
4	Station 4	18°31'15.1"N 77°33'43.9"E

Fig 1: Different Study Stations in Lingan Kerur Lake

2.2 Sampling and Identification of Aquatic insects

The survey for collection of aquatic insects was conducted from February 2023 to November 2023. Aquatic insects were randomly collected at 15 days intervals between 8:00 am to 10:00 am local time. The insects were randomly collected from four corners of the Lingan Kerur Lake using D-frame dipnet having (30 cm × 30 cm frame, having mesh size of 500 µ). A total 10 dipping events were performed and the gathered samples from the given location were combined to create a single sample. For the collection of adult flying insects, a net of 12-inch diameter was used.

Collected insects were immediately sorted and preserved in a 70% ethanol solution for the identification purpose, only one or two specimens of each kind where used and remaining specimens were then counted and returned to their original sampling location.

The collected aquatic insects were identified using standard keys (Miller KB, 2016) [7] (Khan, 2001) [5] (In Merritt, 2019).

In the present study the data were analysed for diversity using the Shannon – Wiener's formula (Shannon, 1949) [11]: Simpson index (SIMPSON, 1949) [12]; the evenness index equitability (J') was computed using the following formula of Pielou (Pielou EC., 1966) [9].

3. Results

A total of 664 aquatic insects, representing 8 genera categorized under 8 families and 4 orders, were recorded from four different sampling stations in Lingan Kerur Lake. The aquatic insects of Station 1 constitute a total of 159 individuals belonging to 7 genera, classified into 7 families and 4 orders. Station 2 comprises a minimum of 133 individuals belonging to 7 genera, classified into 7 families and 4 orders. Station 3 constitutes a total of 160 individuals belonging to 5 genera categorized under 5 families and 3 orders. Station 4 constitutes a maximum of 212 individuals belonging to 8 genera categorized under 8 families and 4 orders.

1. Abundance and Diversity

Aquatic insects belonging to the order Diptera (56.78%) and Odonata (20.93%) showed a higher abundance of different insect groups followed by those belonging to Hemiptera (16.72%) and coleoptera (5.57%) however species richness of different insect groups did not follow the same pattern. The species richness of aquatic insects belonging to order Hemiptera (37.5%) dominated the collection followed by Odonata (25%), Diptera (25%) and Coleoptera (12.5%). The Calculated Shannon-wiener diversity index revealed the maximum diversity of (1.96) occurred in station 4 and minimum diversity of (1.45). This variation in diversity is due to differences in species richness and evenness between survey stations.

The calculated Simpson diversity indices revealed maximum diversity (0.852) and least dominance (0.148) of aquatic insects occurred in station 4 and Minimum diversity (0.742) and maximum dominance (0.258) occurred in station 3. This indicates that station 4 has more diversity and less domination by one or a few species than the other survey stations.

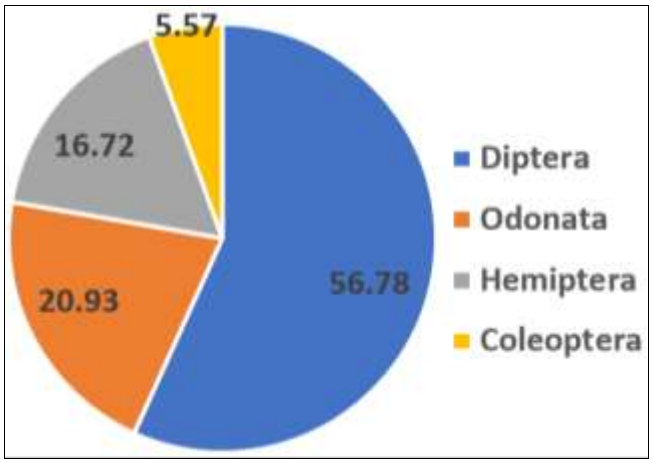

Fig 2: Diversity of aquatic insects in Lingan Kerur Lake

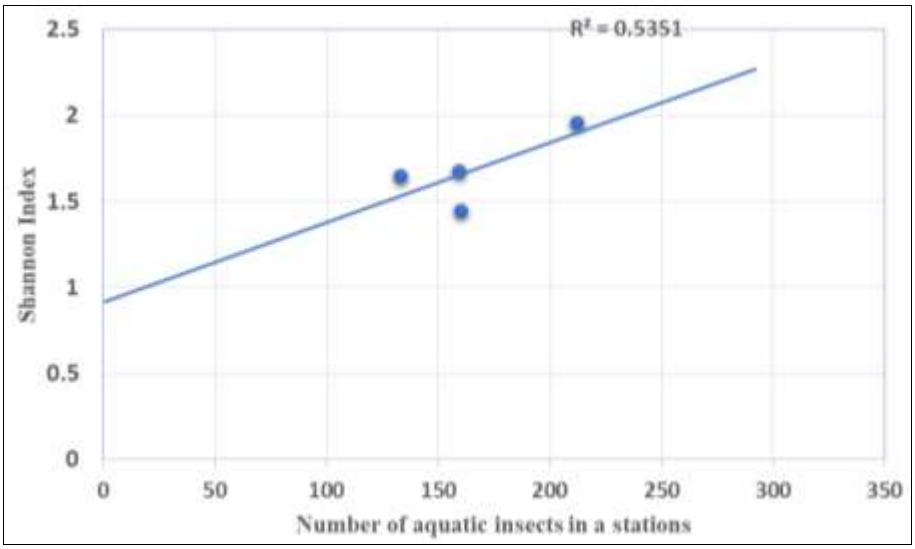

Fig 3: Correlation of diversity index and aquatic insect

Table 2: Table shows insect diversities in Lingan Kerur lake stations

Insect Diversities in Lingan Kerur Lake	Stations				
	Stations 1	Stations 2	Stations 3	Stations 4	Total
No. of individuals	159	133	160	212	664
Shannon-Wiener Index (H')	1.68	1.65	1.45	1.96	1.78
Simpson Dominance Index (D)	0.222	0.227	0.258	0.148	0.201
Simpson Diversity Index (1-D)	0.778	0.773	0.742	0.852	0.799
Evenness Index (J')	0.86	0.84	0.90	0.94	0.86
Average Population size	22.7	19	32	26.8	83

2. Relation between number of insects and diversity

The pearson correlation coefficient (r=0.7315 and p=0.26) results revealed a statistically non-significant large positive relation between the total number of individuals counted in different stations (X) and the Shannon diversity index(Y). (Fig 1.)

3. Species relative abundance and evenness

In the present study, total 8 species are found in Lingan Kerur Lake, *Culex* sp. has the maximum relative abundance of (30.58%) followed by *Chironomidae* sp. (26.20%), *Onychogomphus* sp. (11.29%), *Ranatra* sp (11.15%), *Lestes* sp. (9.64%), *Ciliatus* sp. (5.57%), *Aquarius* sp. (4.37%) and *Lethocerus* sp. (1.20%) respectively. The calculated evenness revealed that station 4 has maximum evenness of (0.94) and Station 2 has the lowest evenness (0.84). This indicates that station 2 is dominated by one or few species than the other survey stations.

Table 3: Table shows classification of aquatic insects and number of insects

Classification of aquatic insects		Number of insects				
Order/Family	Biological name	Station 1	Station 2	Station 3	Station 4	Relative Abundance
Diptera						
Culicidae	*Culex* sp.	53	43	58	49	30.58%
Chironomidae	*Chironomidae* sp.	47	41	49	37	26.20%
Coleoptera						
Dytiscidae	*Ciliatus* sp.	11	07	-	19	5.57%
Hemiptera						
Belostomatidae	*Lethocerus* sp.	-	-	-	8	1.20%
Gerridae	*Aquarius* sp.	09	06	-	14	4.37%
Nepidae	*Ranatra* sp.	15	09	21	29	11.15%
Odonata						
Gomphidae	*Onychogomphus* sp.	13	19	18	25	11.29%
Lestidae	*Lestes* sp.	11	08	14	31	9.64%
--	Total species	07	07	05	08	8
--	Total individuals	159	133	160	212	100%

4. Discussions

In the present study, the high abundance of order Diptera and order Odonata indicate favourable environmental conditions, as the insects belonging to order Diptera are sensitive to the water quality (Chowdhury *et al*., 2023b) [2]. Their prevalence in Lingan Kerur lake could suggest a relatively less polluted and ecologically balanced ecosystem in Lingan Kerur Lake. Dragonflies belongs to order Odonata are regarded to be trusted ecological indicator in aquatic habitats. They are sensitive to habitat disturbance in lakes and dams. (Shafie *et al*., 2017) [10]. In the present study Chironomids were abundant (26.20%) that could suggest that their presence

could suggest moderate healthy ecosystem. As per previous research the prevalence of pollution-tolerant species of aquatic insects *Chironomus species* at Lingan Kerur Lake represents lake having poor water quality. Variations in diversity indices across 4 different stations could be related to changes in habitat characteristics and water quality of Lingan Kerur Lake.

In the present study, the calculated diversity indices could suggest distinct patterns, especially in Station 4 (Shannon Index of 1.96, Simpson diversity Index of 0.852) could indicate comparatively healthier ecosystem with balanced interactions among species than the remaining survey stations. The overall Shannon diversity index (H') recorded at Lingan Kerur Lake was 1.78. In the aquatic ecosystem Shannon diversity index of less than 1 indicates highly polluted water, whereas Shannon diversity index of 1-3 suggests moderate pollution, and more than 4 indicates clean and unpolluted water (Wilhm JL, 1968) [14].

An Evenness value of 1 indicates equal distribution of individuals (Turkmen G, 2010) [13].

The high evenness of aquatic insects in Station 4 (0.94) could indicate that station 4 had equal distribution of individuals than the other survey stations but evenness of station 1 (0.86), Station 2 (0.84) and Station 3 (0.90) could indicate that these stations are dominated by one or few species. The overall evenness (J') was recorded at Lingan Kerur Lake was (0.86) which could suggest nearly equal distribution of individuals.

The results of the Pearson correlation coefficient (r=0.7315 and p=0.26) showed a statistically non-significant large positive relationship between the Shannon diversity index and the total number of individuals counted in various stations. Based on this, it could suggest that those two factors do not have a significant relationship. Recognizing the patterns of distribution of aquatic insects can help to guide future conservation plans for entomofauna of Lingan Kerur Lake.

5. Conclusion

The current research provides baseline data on the diversity and distribution of aquatic insects in the Lingan Kerur Lake in Degloor. The higher prevalence pollution-tolerant *Chironomus* sp. in Lingan Kerur Lake indicated moderate pollution. The variations in diversity indices across 4 different stations could be related to changes in habitat characteristics and water quality of Lingan Kerur Lake. Throughout the whole study period, there was no existence of orders that are sensitive to pollution, indicates poor water quality. The research highlights the value of aquatic insects in evaluating the condition of water bodies This study recommends that this freshwater lentic body be immediately protected in order to support long-term conservation and biomonitoring programmes.

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