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Study of aquatic insects, their role in improving biodiversity and balancing the food web of a freshwater ecosystem at Karadkhed Dam in Nanded, Maharashtra

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Abstract
Fresh water ecosystem plays very crucial role in ecology and it maintain ecological balance of flora and fauna on the earth. Aquatic insects are among the most diverse groups of animals of especially in the fresh water ecosystem. Aquatic and terrestrial food chains both include aquatic insects as essential components. Due to their involvement in the energy and nutrient cycling through food chains and webs as well as their role in water purification, aquatic insects serve as the link between the aquatic and terrestrial ecology. The water quality Acts as a limiting factor for biotic components in an aquatic ecosystem. The aquatic biodiversity gets affected by several factors such as industrial pollution or anthropogenic activities. Present investigation is an attempt to document abundance and diversity of aquatic insects and the role of aquatic insects in the food web of a fresh water karadkhed dam, Nanded, Maharashtra. The study was carried out during 2021 to 2022, including the three seasons.

Keywords: Aquatic insects, freshwater, biodiversity, food web

Introduction
Freshwater bodies including both lotic and lentic bodies are very essential for the existence of dynamic ecosystem. Aquatic insects have recreational value because they enhance the attractiveness of any freshwater body of water, including ponds, reservoirs, and dams. There are various kinds of aquatic insects as almost every type of freshwater environment habitat from puddles to river to lakes, including both lentic and lotic habitats, can belong to various species of aquatic insects. Due of their high abundance, fast birth rate with short generation times, massive biomass, and quick colonisation of freshwater habitat, aquatic insects are regarded as model organism in studies of the structure and function of the freshwater environment. Thus, insects have a wide range of environmental disturbance tolerance levels, making them excellent indicators of water quality (Ikomi, 2009) [6].
Inland fresh water resources have come under growing scrutiny recently since they are impacted by a variety of human activities in various ways. It is made up of artificial lakes, which are one type of water resource and a component of the watersheds, a yet more complex system. Any human activity in the entire watershed will inevitably have an impact on the reservoir's and downstream areas' water quality. In general, faster reservoir silting is caused by deforestation, grazing, and other forms of removal of vegetation in the watershed. The change in the biota, the qualities of the soil, and the physio-chemical condition of the reservoir are all impacted in addition to the water quality.

Aquatic insect communities: As the most diverse and frequently the most abundant group of macro invertebrates that live on aquatic habitats, insects have effectively invaded almost all aquatic environments. Even though there are various habitats, the majority of aquatic insects are located in either lotic or lentic habitats. Lentic habitats, such as reservoirs, lakes, ponds, and different kinds of wetlands, provide a wide range of aquatic habitats that have been utilised by a variety of insects. Compared to profoundly sediments, littoral sections of reservoirs, ponds, and lakes are often better oxygenated, physically more complex, and provide more abundant and diverse Food supplies.

All of these elements contribute to a wide variety of insects and highly intricate trophic relationships. Following are some insect's orders along with examples showing association of some aquatic insect's development stages with freshwater habitats.

Table 1: Some aquatic insects' orders and their development stages association with fresh water habitat.

Sr. N	Nature of a developing stage	Order	Examples
1.	Strictly aquatic in their immature stages	Ephemeroptera	mayflies
	Strictly aquatic in their immature stages	Odonata	dragonflies & damselflies
	Strictly aquatic in their immature stages	Plecoptera	stoneflies
	Strictly aquatic in their immature stages	Trichoptera	caddisflies
	Strictly aquatic in their immature stages	Megaloptera	fishflies & alderflies
2.	Partially aquatic in their immature stages	Collembola	Semi-aquatic springtails
	Partially aquatic in their immature stages	Neuroptera	spongillaflies
	Partially aquatic in their immature stages	Heteroptera	Aquatic & semi aquatic flies
	Partially aquatic in their immature stages	Coleoptera	water beetles
	Partially aquatic in their immature stages	Diptera	aquatic flies and midges
	Partially aquatic in their immature stages	Lepidoptera	aquatic caterpillars
3.	Adult & larval stages that are aquatic	Coleoptera	water beetles
	Adult & larval stages that are aquatic	Heteroptera	Aquatic & semi aquatic flies

Role of aquatic insects in improving biodiversity and balancing the food web of a freshwater ecosystem is as given below

Trophic interactions

In aquatic eco-systems, insects play a key role in transferring energy from microbial to vertebrate populations as well as between aquatic and terrestrial ecosystems. In order to comprehend these connections and integrate organic matter digestion with social interactions, food web studies have been used. A food web study has two objectives: to identify the sources of organic matter for the various consumers and to clarify the trophic structure of the web. In most aquatic ecosystems, either three or four trophic levels are present including: 1. Primary producers and detritus; 2. Primary consumers, including detritivores (shredders and collectors) and grazers (scrapers); 3. Secondary consumers (predators); and 4. Tertiary consumers (vertebrate predators which consume invertebrate predators). Since aquatic insects are abundant, diverse, and play a significant part in the food web of the eco-systems they live in, their ecology has been studied from a variety of angles. They act as prey for almost all vertebrate and invertebrate predators in aquatic food webs, and many also act as predators. There is a wealth of knowledge about how insects react to various environmental influences, including those that work at the landscape level. As a result, in freshwater systems, insect responses are frequently utilised as indicators of water quality conditions.

Ecosystem Health

The absence of aquatic insects in standing or fresh water, or the presence of dead or dying

Ones, is usually an indicator of the health of the water. Many aquatic insect species are extremely vulnerable to pollution and other environmental hazards. Aquatic insects play a variety of responsibilities in maintaining a healthy freshwater habitat. Some thin the algae, allowing the water to produce more oxygen. Others assist in decomposing fallen, dead leaves. Some help maintain the water clear by filtering it. For various degrees of disruption in a water body, members of the aquatic insect families Chironomidae (Diptera), Lesticidae and Libellulidae, Aeschnidae (Odonata), Gyrinidae, (Coleoptera), Gerridae and Belostomatidae, (Hemiptera), are regarded as indicators of pollution. A number of research conducted by freshwater scientists domestically and abroad concurred that the structure of the aquatic insect community accurately reflects the current environmental situation of the aquatic environment in which they live (Buss, 2004) [2]. The presence of midge larvae, water boatman, and backswimmers (pollution-tolerant) in water bodies is evidence that the water is contaminated, while the presence of nymphs of dragonflies, damselflies, and dobsonflies indicates that the water is moderately polluted (De Moor, 2003) [4].

Control of noxious weeds

Numerous noxious, invasive weed species have caused issues in various parts of the world where they outcompete local species, obstruct normally navigable waters and water intake infrastructure, and exclude food-fish species. An example is the successful management of the invasive common water hyacinth (Eichhornia crassipes) by two imported weevil species (Coleoptera: Curculionidae) and one imported moth species. It is possible to conduct research to find aquatic insect species that could help control or eradicate weeds.

Ecological role of adult aquatic insects

As a result of their trophic relevance, taxonomic diversity, and numerical abundance, aquatic insects play a variety of roles in the functioning of ecosystems. (Abhijna, 2013) [1]

Most of research have shown that 1 to 57% of the biomass produced by immature aquatic insects comes from the aquatic system in the form of adult insects (Dalal, 2016) [3]

Material and Methods

Description of the study area

Karadkhed Dam, is an earth fill dam on Local River near Degloor, Nanded district in state of Maharashtra in India. This dam's water is used for both residential usage and fish farming. It supports a vast range of plant and animal species and contributes significantly to nature preservation. It is a recreational area that draws locals in search of happiness, mental peace, and fresh air. For the purpose of examining insect biodiversity, three sampling locations were chosen. The research was conducted for a year from 2021 to 2022. The time for collection of insects was on early morning hours and late noon hour's collection since insect's cling to small roots and leaves of aquatic plants such as Vallisneria, Chara, Hydrilla during these hours and minimum disturbance of man-made activities was found at noon. Aquatic insects in the open were captured with a hand net and taken to a lab for additional examination and classification.

Insects that were Insect attached to the vegetation were handpicked and collected. Out of the three sampling locations, one is heavily covered with floating and submerged plants, where the most insects were found. The other two sampling locations having sparse vegetation and area of live-stock washing, fishing have comparatively less variety of fauna and therefore aquatic insects too. Identification of insects was done using different standard literatures and keys given by (Gulati, 2012) [5] (Tonapi, 1959) [9].

Results and Discussion

The biodiversity and population dynamics of aquatic insects of karadkhed dam were studied for a year, from 2021 to 2022. The list of species collected is given in the table 1.

Total 11 species of aquatic insect belonging 11 families and four orders were found in the study. It has been observed that abundance and biodiversity if insects were governed by many biotic and abiotic factors. There were two population density peaks throughout the year, the first occurring in the summer and the second in the winter. The most important factor is temperature which was a significant element that impacts the seasonal cycle and insect population in aquatic ecosystems. Numerous environmental conditions have a significant impact on the biotic community's population density in aquatic ecosystems. One of the physical components with the greatest impact is temperature. The summer time insect population peak must be tied to the temperature, which is connected to the availability of food. Regarding aquatic insects, similar seasonal population dynamics were seen by (Khanna, 2001) [7].

It was observed that most of the insects were found on the roots and leaves of aquatic plants.

During the study period, seasonal variations in insect population were clearly seen. Four major orders of aquatic insects were found *viz*. Diptera, Coleoptera, Odonata and Hemiptera.

Two species of the order Diptera, which comprises the three species of mosquitoes Culex, Ades, and Anopheles, as well as chironomous (midge) larvae, were found. Chironomids are always present throughout the aquatic ecosystem. These are a crucial source of food for fish and insects. The ecological diversity of dipterans is their most significant characteristic. Chironomids are indicators of water quality and can tolerate moderate pollution. There are more than 500 species of Odonata occurring in India (Prasad. M. and Vaeshney, 1995) [8]

Two species of the order Odonata, which comprises the two species of flies- dragon fly and damsel fly were found that are predators. Only one species of Order-Coleoptera of family Dytiscidae that was diving beetle which feeds on tadpole.

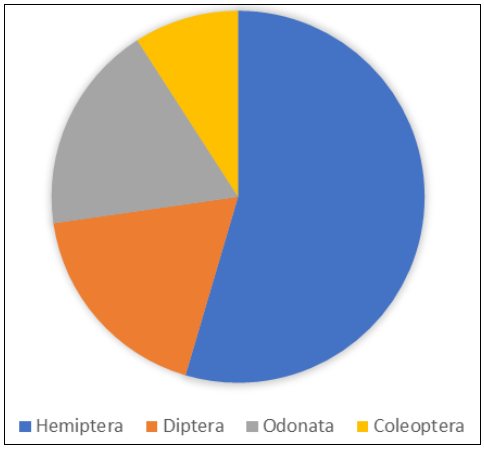

Fig 1: Diversity of Aquatic insects in Karadkhed dam, Degloor

Beetles are less relevant than aquatic Hemiptera in terms of limnology, despite having a far better understanding of their ecology. As they consume tadpoles, other insects, worms, and mosquito larvae, they are also significant commercially. Some of the bugs are scavengers that contribute to maintaining and extending the healthy character of freshwater bodies. Total 6 different species of aquatic bugs belonging to 6 families were found during this study. Thus, the order Hemiptera contained the greatest number of species. Hemiptera topped all other orders in terms of diversity and abundance.

Table 2: Diversity of aquatic insects of karadkhed dam and their feeding habit.

Sr. N	Family	Scientific name	Common name	Feeding habits
Order- Diptera – (Partially aquatic in their immature stages)				
1	Chironomidae	*Chironomous sps.*	Midge	Detritus and waste feeders. Good indicators of water quality/
2	Culicidae	*Culex sps. Aedes sps. Anopheles sps.*	Mosquito	Male feeds on nectars and plant sap. Female feeds On blood meal.
Order- Odonata – (Strictly aquatic in their immature stages)				
3	Gomphidae	*Onychogomphous*	Dragon fly	Predator
4	Lestidae	*Lestes*	Demsel fly	Predator
Order-Hemiptera (True bugs)				
5	Belostomidae	*Belostoma fluminea*	Giant water bugs	Predator, feed on aquatic crustaceans, small fishes.
6	Corixidae	*Sigara sps.*	Water boatman	Feed on small aquatic insects
7	Gerridae	*Aquarius remigis*	Water striders	Predators, feed on mosquito larvae, aquatic insect
8	Nepidae Sub family: Ranatrinae	*Ranatra brevicollis*	Water scorpions	Predators, feed on aquatic insects
9	Nepidae Sub family: Nepinae	*Nepa cinera*	Water scorpions	Predators, feed on aquatic insects
10	Notonectidae	*Notonecta sps.*	Back swimmers	Predators, feed on aquatic crustaceans, small fishes
Order-Coleoptera – (Both adult and larval stages are aquatic)				
11	Dytiscidae	*Cybister sps.*	Diving beetle	Predators, feed on tadpole

Table 2 lists all the species in this order along with their typical feeding habits. They are almost all predators. Some of them also consume tiny fish and tadpoles as food. The feeding habits of aquatic helipterums make them economically significant.

Conclusion

In aquatic eco-systems, insects play a key role in the energy transfer from microbial to vertebrate populations as well as between aquatic and terrestrial eco-systems.

Many aquatic insect species are extremely vulnerable to pollution and other environmental hazards. Aquatic environments, which contain a number of biotic and abiotic elements, are associated to insect abundance and diversity. The freshwater biome is enriched with a variety of animals, and plants can flourish there. The presence of 11 representative species from the four major orders of aquatic insects suggests that the habitat around Karadkhed dam is in a moderate state. Furthermore, it is crucial to understand that the freshwater biomes are under severe threat from pollution and climate change, both of which require attention

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