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AQUATIC INSECTS AS INDICATORS OF WATER QUALITY: A REVIEW STUDY ON SEASONAL DISTRIBUTION AND BIOMONITORING INSIGHTS FROM AMBAZARI, ZILPI AND GOREWADA LAKE IN DISTRICT, NAGPUR DISTRICT, MS, INDIA

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Abstract
Aquatic insects playa pivotal role in freshwater ecosystems. The present study will assess the data on diversity, distribution and the physicochemical parameters across different seasons of aquatic insects in Ambazari, Zilpi and Gorewada Lake under Nagpur District. The Lentic ecosystems are increasingly threatened by anthropogenic activities, including pollution, habitat destruction, and climate change and socioeconomic development ultimately pollutant discharge increases from industry, agriculture and domesticity. Biomonitoring which utilizes biological indicators to assess ecosystem health, has gained prominence as an effective method for evaluating aquatic environments. Traditional water quality assessment methods, such as chemical and physical analysis, provide only an exposure to conditions and may not reflect long-term ecosystem changes. Because of their sensitivity to environmental changes, diverse ecological roles, aquatic insects are particularly valuable bioindicators. In contrast, biomonitoring using aquatic insects offers a more comprehensive approach to assessing ecosystem health by integrating biological responses over time. This review study will explore the role of aquatic insects in biomonitoring lentic ecosystems, the methodologies employed, and the challenges associated with their use. The study highlights various indices, including Pearson's correlation, Biotic Indices (BMWP and ASPT), Water Quality Index and Comprehensive Pollution Index (CPI) which utilize insect diversity and abundance to infer water quality.

Keywords: Aquatic insects, Biomonitoring, Bioindicators, Pearson's correlation, Water quality assessment, EPT index.

I. Introduction:

Aquatic insects hold on to the freshwater ecosystem, functioning properly. As bottom dwellers, they consume detritus, organic matter, debris, and humus, aiding in nutrient decomposition and recycling, which are very important for the productivity of these ecosystems. Aquatic insects are among the most prolific animals on earth and form one of the essential components of an aquatic ecosystem. They constitute about 60% of the total aquatic fauna inhabiting freshwater habitats and are therefore regarded as the most diverse group (Balian *et al.*, 2008). They are cosmopolitan insects in distribution and grouped in 13 taxonomic orders, of which Ephemeroptera, Odonata, Plecoptera,

Trichoptera, and Megaloptera are exclusively restricted to freshwater with aquatic larval stages. Whereas the remaining eight orders are Collembola, Hemiptera, Diptera, Coleoptera, Hymenoptera, Lepidoptera, Neuroptera, and Orthoptera are belong to the terrestrial as well as aquatic or semi-aquatic insect group (Barman, 2015). Even there are seasonal variations in physico-chemical parameters and the diversity of insect population (Tijare *et al*., 2015; Dorlikar, 2018). This review focuses on the seasonal distribution of aquatic insects in Ambazari, Zilpi, and Gorewada Lakes, offering insights into their potential as bioindicators of aquatic ecosystem health.

II. Study Area

Nagpur district in Maharashtra is home to several lakes that support rich biodiversity. Ambazari Lake, located on the southwest border of Nagpur, is subject to high pollution due to industrial and domestic waste. Zilpi Lake, or Bhivkund Lake located at Mohgaon in the western agriculture zone a semi-rural freshwater body, experiences moderate anthropogenic impact. Gorewada Lake, a protected reservoir, located the northwestern forest zone remains relatively pristine. The study of these lakes provides a comparative understanding of aquatic insect distribution under varying ecological conditions.

III. Ecological Role of Aquatic Insects:

Aquatic insects perform several ecological roles as decomposers, predators, prey and bioindicators. As a decomposers,aquatic insects play an important role in the decomposition and assimilation of nutrients from organic matter. Few aquatic insects feed upon mosquito and mayfly larvae, midges which otherwise act as vectors of various diseases (Lee, 1967; Nilsson and Soderstrom, 1988 and Aditya *et al*., 2006). Terrestrial and freshwater predators feed upon aquatic insects, which contribute to energy flow in the community (Nair *et al*., 2015). Freshwater insects are the best candidates for assessing the pollution status of any water body.

IV. Methodology

This review synthesizes findings from existing literature and field studies conducted between 2009 and 2024. The methodology includes:

- Collection and identification of aquatic insects using standard entomological methods.
- Evaluation of aquatic insect diversity and water quality parameters across different seasons, including pre-monsoon, monsoon, and post-monsoon.
- Statistical analysis of diversity indices (Shannon-Wiener, Simpson's index) and their correlation with physicochemical parameters.
- Estimations of water quality can be analyzed by the Water Quality Index (WQI) tool (APHA,2022) for physicochemical parameters (Clescerl et al, 1998).
- Aquatic environmental factors can be estimated by various methods such as Pearson's Correlation Coefficient (r), Biomonitoring Working Party (BMWP) Score and Average Score per Taxon (ASPT),Canonical Correspondence Analysis (CCA), Comprehensive Pollution Index (CPI) and EPT Index.

V. **Literature Review**: Minza Mumtaz *et al.,*(2024)Investigate the variations in physicochemical characteristics and metal content and calculation of the Water Quality Indices (WQI) to assess the groundwater status of seven districts (Central, East, West, South, Malir, Korangi, and Kemari) of Karachi City, Pakistan. Rathod (2022)observed 7 types of aquatic insects which belong to 6 families, Dytiscidae, Aeshnidae, Notonectidae, Neptidae, Hydrophilidae, Gerridae and three orders underColeoptera, Odonta andHemiptera. He concluded that aquatic insects are more important for the aquatic environment and maintaining water balance. Aquatic insects also keep the water temperature, humidity in Vasant Sagar Reservoir. Pusad. Dist. Yavatamal. The study by Zade and Kulkarni (2020) aimed to document species richness and relative abundance of aquatic insects in the Ramala Reservoir, located in Chandrapur city, Maharashtra. Their findings estimated a total of 16 insect species belonging to 14 families and 4 orders inhabiting the reservoir and its surroundings. Conducted between June 2017 and April 2018, the study covered three seasons, revealing noticeable seasonal fluctuations in insect populations. Babasola and Emmanuel, (2019)found accumulation of chironomids in the pollutedwater body which indicates that they are tolerant to polluted water. Dorlikar(2018) reported eight species of order Heteroptera, and the Physico-chemical characteristics of the Gorewada reservoir suggested that Dissolved oxygen (DO) showed a significant positive correlation and transparency showed a negative correlation with the density of Heteroptera. Two seasonal surveys (post-monsoon and winter) were conducted to assess the pollution status of two ponds by analysing the aquatic insect community and the physicochemical properties of the water. As a result, 29 species from 17 families and 5 orders were recorded in one pond, while the other pond had 17 species from 8 families and 3 orders in Cachar district,Assam by Dalal and Gupta (2016).Pearson's Correlation Coefficient was used to identify significant correlations between the diversity and density of aquatic insects and various water variables. The Biological Monitoring Working Party (BMWP) score and the Average Score Per Taxon (ASPT) were calculated to assess the water quality status of the system. Canonical Correspondence Analysis (CCA) was applied to determine the relationship between environmental variables and the structure of the aquatic insect community. Additionally, the impact of environmental variables on aquatic insect diversity was analysed and discussed by Barman and Gupta(2015). In the study of Majumdar *et al.* (2013), a total of 31 species of aquatic insects were recorded from three different freshwater lakes, and the number of aquatic insect species and their abundance varied among the lakes. Jumbe and Nandini(2009) analysedheavy metals, including Cd, Co, Cu, Cr, Mn, Pb, Ni, and Zn, in lake bed sediments based on various criteria. The Sediment Geo-accumulation Index indicated moderate pollution levels for Co, Cu, and Pb. Additionally, the Pollution Load Index (PLI) for heavy metals in the lakes ranked them in the following order: Ni > Pb > Cd > Cu > Cr > Co > Zn > Mn in urban lakes of Bangalore.

VI. Conclusion and Recommendations

These freshwater resources are shrinking day by day due to continuous anthropogenic stress in the form of an influx of maximum use of fertilizers, pesticides in the agricultural fields, sewage from the nearby villages, large amounts of aquatic vegetation, and encroachment of land for expansion of the agricultural field in the selected study site. Moreover, pollution and overexploitation have also affected the quality of potable water by making it unfit for domestic use. Even there are seasonal variations in physico-chemical parameters and the diversity of insect population (Tijare *et al*., 2015; Dorlikar, 2018). Various biotic community indices are utilized to assess the status of freshwater bodies (Shafie, 2017; Biju Kumar *et al.,* 2012). The population of aquatic insects even fluctuates season-wise and is affected by several environmental factors, where different aquatic insects indicate the status of water quality, hence, they are also considered as bioindicators or biomonitors (Dorlikar, 2018; Zade *et al*., 2020). The abundance and distribution of aquatic insect species show seasonal variations due to biotic and abiotic factors. In Nagpur district, some of the lentic ecosystems show the contamination of surface water, which is a significant environmental concern and constitutes a high risk to both water and aquatic ecosystems (Puri *et al*., 2011). The study reinforces the importance of aquatic insects in water quality evaluation and highlights the varying pollution levels across the three lakes. Conservation measures, such as reducing industrial effluents, promoting ecological restoration, and implementing continuous biomonitoring programs, are recommended to safeguard freshwater ecosystems in the Nagpur district.Continued research and monitoring efforts are needed for conservation.Collaboration among scientists, policymakers, and communities is essential.

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