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Biomonitoring for pollution assessment: A case study in Kasibeh Reserve in Al-Madain / East of Baghdad

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Abstract:
In the context of an ecological approach of assessing pollution in Reserve, biomonitoring renders a strategic method for estimating ecosystem health. Rapid bioassessment method using benthic macroinvertebrates as ecological indicators was successfully applied in Kasibeh Reserve in Al-Madain / East of Baghdad, surveyed for a period of three months for recording physicochemical variables of water and estimating the diversity of benthic and biotic indices. The spatial and temporal variability in macroinvertebrate communities and water quality showed noticeable ecological degradation. The taxonomic groups recorded included Oligochaeta, Nematoda, Mollusca and aquatic insects. The pollution index HFBI values ranged from 4.95 to 6.03 indicating very poor water quality conditions in the latter. The percentage EPT taxa and BMWP score showed distinct variation with highest biological monitoring working party score substantiated by the presence of pollution intolerant taxa. The present paper discusses the reasons for ecological degradation of the Kasibeh Reserve in Al-Madain and effectiveness as bioindicators in pollution monitoring studies.

Keywords: Biomonitoring, Macroinvertebrate, Reserve

Introduction

Kasibeh or Al-Madain Forest Reserve is a nature reserve located in the Al-Madaen District of the Baghdad Governorate, Iraq. It has an area of 157 dunums. It is affiliated with the Iraqi Ministry of Agriculture, Department of Forestry and Desertification. It was established to save Iraqi species and varieties from the danger of extinction, as the reserve contains farms to breed various animals, including reem deer, ostriches, turkeys, quails and others. In addition to nurseries for the cultivation of various plants and rare and perennial trees. The reserve was rehabilitated in cooperation with the FAO in 2018. In aquatic ecosystems, the biodiversity has received less attention during the last decades and these have been rigorously affected by anthropogenic pressures which resulted in gradual and alarming depletion of aquatic communities. The fundamental constraint for biodiversity conservation is the lack of knowledge about its high diversity and hotspot assessments in the tropics (Gerhardt, 2000; Sharma and Sarang, 2004). Biomonitoring has been widely used to assess the environmental impact of pollutant discharges with the use of biological variables to survey the environment properly (Sharma and Sharma, 2010).

Generally, biomonitoring programme involves the use of indicator species or indicator communities, and the presence or absence of these reflects environmental conditions. Bioassessment is a widely accepted technique for monitoring aquatic health in streams, lakes, and wetlands throughout the world. It is now recognized as an elementary tool for sustainable management of the world's freshwater resources (Sharma, *et al.* 2004; Reyam, *et al.* 2018). However, the fast degradation of these ecosystems brings forth the urgent need for biodiversity and demands its management surveys. Biological communities can serve as integrators of the dynamic physicochemical changes and are considered indicators of environmental conditions. The macroinvertebrate community characteristics such as diversity and richness are often used as indicators of the degree of pollution of bodies of water and gives an alternative way of physicochemical information Thus, biological monitoring using macroinvertebrates are based on the assumption that with increasing pollution, change will occur in the community assemblage of species present. Macroinvertebrates are often ubiquitous, can be extremely productive and abundant, and are good indicators of environmental conditions, toxic contamination and also perform important ecosystem functions. It is widely accepted that benthic

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macroinvertebrates play a major role in the evaluation of environmental quality of aquatic ecosystems and reflects the combined effects of various stresses influencing water quality in time and space a lot of works concerned with the diversity and distr ibution of aquatic macroinvertebrates were documented (Balachandran, *et al.* 2010) .

The spatial and temporal variation in diversity and distribution patterns of benthic macroinvertebrates was studied in in Kasibeh Reserve in Al-Madain / East of Baghdad The main objective of the present study was to use the diversity and abundance of macroinvertebrates and reliable macroinvertebrate based biotic indices (BMWP, HFBI and % Ephemeroptera taxa) as indicators of water quality and the spatial and temporal variation in physical and chemical water quality parameters to monitor the degree of pollution.

2. Experimental

2.1. Sampling

In this study, sampling was during three months , was data used geography Al-Madain Reserve Coordinates 33.1°N 44.583333°E, area 210 km² and Height 32 meters considered from the middle passes a middle lakeas PA were extracted from the World Database on Protected Areas (APHA, 1998). The sampling process took place in (May- June) 2022. Sampling was done along pre-existing transects macroinvertebrates . water samples were collected at 25 centimeters depth, the samples were classified according to transects. The samples were put in Ziplocs at room temperature.

2.2. Analysis of the samples or the analytical methods

Standard analysis of water quality parameters such as pH, water temperature, electrical conductivity, Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), nitrate, nitrite, phosphate were performed following the methodologies of APHA (2005).

Macroinvertebrates were sampled following the methodology of Rapid Bioassessment Protocol (Barbour *et al.*, 1999). Aquatic macroinvertebrates was collected from 10 meter reach of each station of it using D-frame dip net and kick net. A total of 10 jabs and 10 kicks were taken randomly from each site. Sorting was performed at the site itself and the collected sample was transferred into a white pan for a closer observation with a magnifying glass, and picked not less than 200 organisms using forceps and brushes, picked out as many different types as possible and then preserved in 95% Ethyl alcohol and brought to the laboratory for further taxonomic analysis. The collections of sediment benthic macroinvertebrates were done using a Van Veen grab following the standard methodology of APHA (2005). The sediment sample was sieved through 40 mm and 100 mm sieves and taken in large white trays.Small proportions of the sediment was taken in white trays and carefully checked under a microscope and watch glass to pick the stained organisms using fine brushes of varying sizes, forceps, needles . The group wise sorted sediment organisms were preserved in 70% ethanol and kept for further taxonomic resolution.

The collected samples were examined under a dissection or stereozoom microscope (4X and above) and identified using standard taxonomic keys. The identification of aquatic macroinvertebrates was done following the keys and manuals (Zheng, et al. 2010; Paula, *et al.* 2020). Statistical analysis of physicochemical parameters was per formed using SPSS 20. For macroinvertebrate community various diversity indices such as total species number , total number of individuals , Margalef's index , Shannon Wiener diversity Pielou's evenness index and Simpson index were estimated using PRIMER 6 software. Pollution tolerance index such as Hilsenhoff's family biotic index (8, Hilsenhoff, 1988) were calculated based on the family level tolerance value of all the macroinvertebrate taxa using its standard formula;

$$\mathbf{FBI} = \Sigma\, [(xi)\,(ti)] \,/\, n$$

Where xi =number of individuals within a taxon;

ti = tolerance value of a taxon and n = total number of organisms in the sample Biotic index such as percentage Ephemeroptera, Plecoptera and Trichoptera taxa (% EPT) and

Biological Monitoring Working Party (BMWP) score were estimated for all the samples for two years. Biological Monitoring Working Party (BMWP) score was calculated based on the standard scores attributed to different invertebrate families, according to their degree of intolerance against organic pollution (Armitage et al., 1993).

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3. Results and Discussion

The water temperature ranged from 25°C to 36°C during the study period, in the present investigation, pH of lake water remains acidic to alkaline ranged from 6.01 to 8.87, the maximum mean water pH observed at station 3 (7.53) during pre-monsoon may be due to the discharge of sewage and domestic wastes being dumped through the river which connects lake in its sites. The electrical conductivity ranged from 24 µS/cm to 69967 µS/cm during the study period was due to the intrusion of saline water, the mean conductivity values of water ranged from 136.08 µS/cm to 176.07 µS/cm. Similar observations agrees with the studies done in (Allén, 2003). Mean DO content during the study period varied from 1.18 mg/l to 4.97 mg/l whereas, clearly depicting the ecological integrity . In the present investigation BOD of water ranged from 2.14 mg/l to 39.95 mg/l . The maximum mean BOD were beyond the acceptable tolerance limit of 6 mg/l (CPCB, 2008). BOD above 8 mg/l in a water body is considered polluted, lowest BOD values (2.97 mg/l to 3.95 mg/l) indicated its good water quality conditions. COD varied from 14.92 mg/l to 86.10 mg/l . During the study period highest COD values similar highest COD values were reported in lake water of city in India according to (Reyam, *et al.* 2018).

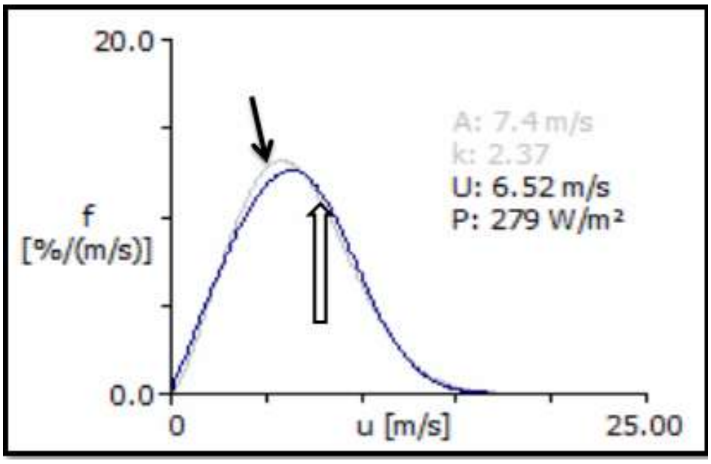

Fig. 1: Frequency at conductivity values and COD for 100 m height

Structure and Composition of Macroinvertebrates A total of 26 species were recorded during the study period under 22 orders, were recorded . The relative richness of macroinvertebrates was generally consistent ,the dominant types was Polycheates and Oligocheates. Similar findings of relatively high species richness of dipteran insects were reported in Kadinamkulam lake in (Scalenghe and Pantani, 2020 Latha and Thanga, 2010) , there was an equidistribution of macroinvertebrate fauna with abundance of pollution sensitive taxa of orders Ephemeroptera and Trichoptera. Here the dipteran taxa were very less owing to the good water quality conditions of this lake.

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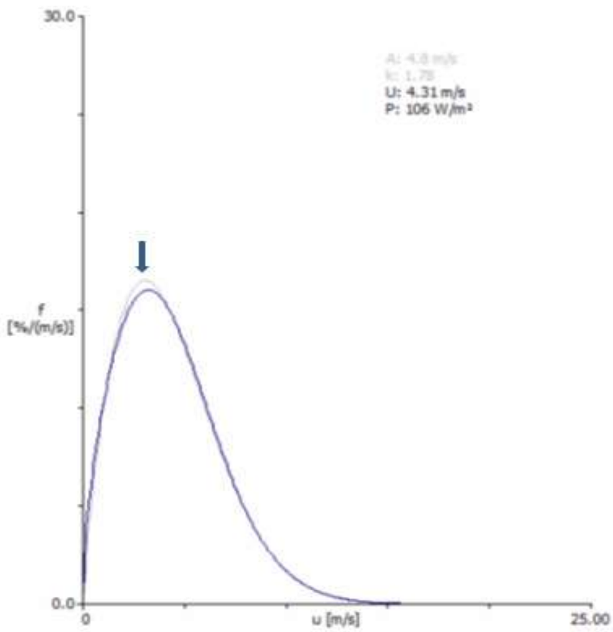

Fig. 2: Frequency at different factor for 100 m height in study sites

Many of the lentic habitats suppor t diverse macroinvertebrates communities which respond to habitat and water quality alterations thereby exhibit variations in community structure. On the other hand, many habitats, especially disturbed ones, are dominated by few species and are of less diverse due to one factor or other. The diversity of macroinvertebrates communities respond to changing habitats and water quality by variations in community structure according to (Sharma, *et al.*, 2004; Schneider, *et al.* 2015).

According 14 Shannon diversity showed highest value was found maximum during monsoon season. Margalef's species richness was found to be high during monsoon due to heavy organic pollution particularly eutrophication. Benthic Macroinvertebrate Hilsenhoff's Family Biotic Index for Evaluation of Pollution The spatial trend of Hilsenhoff's family based biotic

index is shown (Fig. 1). Family Biotic Index values were considerably high for all the three months indicating poor water quality conditions. This was due to deterioration of water quality as a result of industrial effluents, sewages, solid wastes, agricultural wastes and eutrophication. indicating excellent water quality conditions of the lake according to (WHO, 2013) .Abiotic index can able to separate polluted from relatively unpolluted water quality conditions. Biomonitoring for pollution assessment simply, BMWP score increases with an increase in abundance of pollution sensitive taxa. In the case of percentage occurrence of EPT taxa, EPT taxa were negligible present , lower percentage of EPT taxa (<1) along with dominance of tolerant taxa indicates severe environmental degradation (WHO, 2012) .

In the present study the biomonitoring based on macroinvertebrate community played a significant role in assessing the environmental status this study provided detailed evidence of severe degradation in water quality in Veli-Akkulam lake through a thorough evaluation of both physico-chemical and biological quality. Shannon and Simpson diversity of macroinvertebrate was rich in lake . The lowest diversity in lake was due to the abundance of pollution tolerant groups such as dipteran insects and Oligocheates Macroinvertebrate community in upstream region was dominated by Oligocheates sensitive EPT taxa was represented by the Philopotamidae, Polycentropodidae, Hydropsychidae, Odontoceridae and Leptoceridae.

4. Conclusion

We conclude from the foregoing that the Low values of DO and high values of BOD, COD, in upstream region significantly indicated severe eutrophic status of end lake due to the discharges of hospital wastes, sewages, agricultural wastes, sedimentation and eutrophication. The macroinvertebrate communities were occupied predominantly by highly tolerant Oligocheates and Polycheates. However, highest species diversity of macroinvertebrates in lake indicates better water quality conditions Moreover, macroinvertebrate indices of water quality such as BMWP score, percentage EPT (% EPT) and Hilsenhoff's family biotic index could remarkably distinguish the water quality conditions lakes thereby confirmed oligotrophic conditions and severely eutrophic status.

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