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Diversity and distribution of zooplankton in river Ghaggar of Punjab with special reference to pollution bioindicators

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ABSTRACT

The present study reveals the diversity, abundance and composition of zooplankton in ghagger river. The objective of the study is to determine pollution bioindicators zooplankton diversity in River Ghaggar. A total of 27 genera of zooplankton population were recorded and categorized into 4 different groups, i.e. Protozoa, Rotifera, Copepoda and Cladobcera at the sites S1(Devigarh, Patiala) from 2017 to 2019. Among these Copepoda and Rotifera were the dominant groups. Of all the seasons, summer season depicted the highest density of zooplankton at this particular site and lowest diversity during monsoon season. The diversity indices were observed to be S1 sites indicating that the River is moderately polluted as the values of Shannon-Weaver diversity index for zooplankton are above two in different seasons. The present study revealed that the water of River Ghaggar is contaminated by sewage and other organic pollution.

Key words: *Ghagger river, Zooplankton, Pollution bio indicators, Shannon-weaver diversity index, Simpson diversity index, Seasonal variations.*

Introduction

Ghaggar, one of the major rivers of northern India originating in outer Himalayas and flowing through the state of Punjab, Haryana, and Rajasthan, is put to multiple uses. Along its course of 464 km, it receives discharge from various cities and run off from agricultural area. Zooplankton being heterotrophic organisms and foremost link in food chain play a pivotal role in aquatic ecosystems by cycling of organic materials, energy transfer in the food web and energy transfer from primary producer to secondary consumer (Steinberg and Robert, 2009). Apart from this, certain species of zooplankton have the ability of indicating the deterioration in the quality of water caused by pollution or eutrophication (Mahajan, 1981). The survival and growth of fishes are directly related to zooplankton due to the fact that they feed on them and also serve as base of food chains and food webs in all aquatic ecosystems (Miah *et al.*, 2013, Shivashankar and Venkataramana, 2013). The ability of zooplankton to react rapidly to the changes in environmental conditions as well as physical and chemical conditions of water body makes them a good indicator of changes occurring in water quality, thus helping in understanding the status of water pollution (Contreras *et al.*, 2009). Numerous factors like physico-chemical properties of habitat, biotic factors and climate change affect the occurrence and distri-

bution of plankton fauna (Richardson 2008; Rajagopal *et al.,* 2010; Ahmad *et al.,* 2011; Alexander 2012). Environmental factors like water temperature serve as an essential element, affecting the growth and development of organisms, thus controlling their death rate (Hall and Burns, 2001; Andrulewicz *et al.,* 2008, Tunowski, 2009). Another environmental factor like salinity, significantly affects the organisms as they have to adjust the saline concentration in their bodies as per the external environment (Lawrence *et al.,* 2004; Ojaveer *et al.,* 2010). In semi-enclosed water bodies, factors like warming of surface waters and freshwater input are very important in the process of stratification (Rabalais *et al.,* 2002). These environmental parameters ultimately affect the composition and density of zooplankton by affecting their breeding (Greenwood *et al.,* 2001). The present study was conducted to assess the diversity and distribution of zooplankton in Ropar wetland (Ramsar site) Punjab, India.

Materials and Methods

Study Area

In the present study, the Ghaggar River was selected to evaluate the pollution on the basis of zooplankton diversity. The selected study area is near village Devigarh, Patiala. Latitude and Longitude 30.3398°N, 76.3869°E. The Ghaggar River originates from the Shivalik Hills of Himachal Pradesh. It runs along the foot of the Shivaliks and flows through Haryana and Punjab to Rajasthan and then disappear itself in the sands of the Thar Desert.

Collection, Preservation and Identification of Zooplankton Samples

The zooplankton samples were collected during early morning be-tween 6.00 to 8.00 AM, at first week of the month. A nylon bolting cloth plankton net was used having a mesh size of 24 mesh/mm^2 for collection of plankton samples. One hundred litters of water were sieved every time through the zooplankton net. Samples were collected and preserved in plastic sample bottles containing (5%) neutralized formalin solution and kept in the laboratory for identification and further analysis as per Trivedy and Goel (1986) and APHA (2012). In the laboratory, plankton slides were prepared for identification. Using binocular and light microscope, identification and counting of zooplankton was done. To determine the density, Sedgwick Rafter Counting Chamber (Welch 1948) was used in the laboratory. The planktons were identified to genus level as per the guidelines given by Needham and Needham (1966), Kodakar (1992), Edmondson (1992), Gupta (2012), APHA (2012), Gupta (2012).

Data Analysis

Statistical analysis of the data were made in Microsoft Excel and PAST software. The statistical calculations like, statistical mean, standard deviation (S.D.) was determined.

Determination of Diversity Indices

The percentage occurrence and relative numerical abundance of zooplankton were subjected to diversity analysis using different indices like Shannon Diversity Index "H" (Shannon and Weiner, 1963), Pielou Evenness Index "J" (Pielou, 1969) and Simpson Diversity Index "D" (Simpson, 1949).

Results and Discussion

Zooplankton, as crucial biotic strand of aquatic ecosystems, has a tremendous influence on all its essential components like, food chain, food web, energy flow and trophic networks. Aquatic environments have varied abundance and composition of zooplanktons, which renders ecological importance to their biomass and makes it a viable tool for assessing global warming, pollution, eutrophication and other environmental problems. Zooplanktons play decisive role in transferring energy inside food web, from primary producers to secondary consumers and recycling of nutrients. The present study was carried out for a period of 2 years from 2017 to 2019 to check the distribution, assemblage structure and seasonal variations of zooplankton diversity of Ghaggar river . During the present study, 27 genera of zooplankton population were recorded and these were categorized into 4 different groups, i.e. Rotifera, Cladocera, Copepoda and protozoa at all the sites. Among these 27 genera, Rotifera consists of 14 genera, Cladocerans 3 and Copepods7 genera and Protozoan with 3 genus only the site. Our results are in soundness with Negi and Negi (2010) who examinedin his results that zooplankton diversity of Hinval freshwater stream of Shivpuri of Garhwal region (Uttarakhand) and reported a total of 16 genera among which rotifers constituted the major zooplanktonic diversity (7 genera) followed

by Protozoans (4 genera),

Cladocerans (4 genera) and Nemata (1 genus). Similar study on zooplankton diversity of Julur Nalgonda district revealed 26 genera of zooplankton, out of which 8 genera were of Rotifers, 5 of Copepods, 12 of Cladocera and 1 of Ostracods (Ankathi and Piska, 2009). Another study on zooplankton diversity of a tropical wetland system reported 36 genera of zooplankton, categorized into 6 groups, Rhizopoda, Cladocera, Rotifera, Ciliophora, Copepoda and others

Contain Zooflagellates, Ostracoda, Callanoids and Herpacticoids (Nirmal Kumar *et al.,* 2011). The zooplankton diversity of Ambadi reservoir, Talika Kinwat, Maharashtra resulted 17 species of zooplankton. These included 6 species of rotifers, 4 species of copepods, 6 species of cladocerans and 1 species of ostracods (Kamble and Mudkhede, 2013). Our results are also parallel to Brraich and Kaur (2015) who recorded 17 genera of zooplankton in Nangal wetland, classified into 5 different groups, Protozoa (6 genera), Rotifera (6 genera), Cladocera (2 genera), Copepoda (2 genera) and Ostracoda (1 genera). Protozoa and Rotifera were the dominant groups among zooplankton community, both having 6 genera, constituting 70.59% of the total zooplankton population. One more study on Bhimtal Lake situated in Uttarakhand, India showed the presence of 29 species of zooplankton including 16 species of Rotifera, 8 species of Cladocera and 5 species of Copepoda. Rotifera group was the most dominant among all the three groups (Panwar and Malik, 2016). An assessment of diversity status of

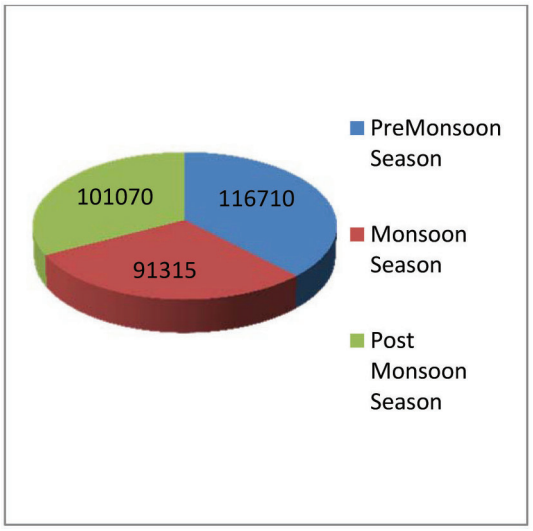

Fig. 2. Seasonal Variation In Zooplankton Diversity.

zooplankton in Jal Ghar Bhiwani, Haryana India recorded a total of 13 species of zooplankton belonging to 13 genera, 9 families, 5 orders and 4 classes and Rotifers were the dominant group (Kumar and Kumari, 2017). The present study is also in accordance with Sharma and Kumari (2018) who assessed the zooplankton diversity of sacred Lake Prashar, Himachal Pradesh, India and divided it into five groups which constituted Rotifera (38%) followed by Cladocera (26%), Protozoa (25%), Copepoda (6%) and Ostrocoda (5%) and among these, particularly Rotifera and Cladocera were the dominant groups throughout the study period.

During the present study of river Ghaggar, we fround that density of zooplankton population varied in different seasons and is maximum during Pre Monsoon season and least abundant in monsoon season. The total number of zooplankton present in river ghaggar at S1 in seasons, Pre monsoon, Monsoon, Post monsoon is 116710,91315 and 101070 respectively. The highest abundance of zooplankton population during the Pre monsoon seasons could be due to the water quality, decaying vegetation and increased levels of organic matter in the sediment along with high temperature. It may also be due to the high phytoplankton density during this period as they are the prime food for zooplankton in water bodies. During the monsoon season, the reason behind the small amount of zooplankton population was due to the dilution of water with rain water and high level of turbidity. Consequently, zooplanktons are foremost indicators of pollution status, water quality, climate change and productivity of aquatic ecosystems. The S1 site is observed to have maximum diversity of zooplankton, Our results are compatible with Kar & Kar (2016) who observe that zooplankton diversity of a freshwater pond in a Cachar district of Assam, India have higher population density of zooplankton during winter season and lower during the summer season. The minimum density of zooplankton was observed in the monsoon season, whereas maximum peak density was recorded in pre and post monsoon seasons but the former peak was higher than pre monsoon in some lentic water bodies of Karwar (Vasanthkumar *et al.,* 2015). The low population density of zooplankton during monsoon season may be attributed to the dilution factor by rain and high water level (Akbulut, 2004; Mulani *et al.,* 2009; Rogozin, 2000; Tasevska *et al.,* 2010). The present study recorded the higher population of rotifers and

Table. Seasonal Variations in Zooplankton Diversity Indices at S1 Site of Ghaggar River in Punjab.

Indices	Pre Monsoon Season	Monsoon Season	Post Monsoon Season
Taxa_S	27	27	27
Individuals	14578	12622	11908
Simpson_1-D	0.9372	0.9348	0.9341
Shannon_H	2.875	2.826	2.807
Evenness_e^H/S	0.6565	0.625	0.6136

is further affirmed by number of workers, which might be due to hypereutrophical conditions of the water body at high temperature and low water level (Abbas and Talib, 2018; Jayabhaye and Madlapur 2006; Tyor *et al.,* 2014; Manickam *et al*., 2018).

Species Diversity

It is the simplest evaluation of biodiversity in an area or account of the number of different species in a given examine area. It was determined by using the Shannon- Weaver Index. It is a measure for certify the gross health of various biological habitat. (Shannon-Weaver index, Simpson's index and species evenness index for zooplankton population in different seasons ranges from 2.875 to 2.807, 0.9372 to0.9341 and 0.6565 to 0.6136. Shannon-Weaver is the most preferred index among the other diversity indices. The values above 3.0 indicate that the structure of habitat is stable and balanced and the values under 1.0 indicate that there is pollution and degradation of habitat structure. The Shannon-Weaver Diversity Index, commonly used to assess the impact of pollution is based upon the plankton diversity. Our results are in conformity with Ansari and Khan (2014); Pradhan (2014) and Tyor *et al.,* (2014). The values of Shannon-Weaver diversity index for zooplankton were found to be below three and our results are as per Brraich and Kaur (2015) thus, indicating that the water body was moderately polluted.

Species Evenness

It is a diversity index, a measure of biodiversity which quantifies how equal the populations are numerically. The values ranged between 0-1. The less variation in population between species, the higher evenness will be. It is a measure of the relative abundance of the different species making up the rich an area. Variation among the values was less during the present investigation. Higher values were found during the pre monsoon season (0.6565) Minimum values are found in post monsoon (0.6136) Similar calculations have been calculated by Ansari and Khan (2014) and Tyor *et al.* (2014).

Conclusion

It is concluded from this study that the zooplankton population of Ghagger River at S1 is Moderately polluted. It contain 27 genera of zooplankton with proliferate number. The recorded genera were classified into four clasei.e. Rotifera, Cladocera, Copepoda,protozoa Rotifera is the dominant group among all zooplankton community. Zooplankton populations become one of the necessities to evaluate freshwater river with respect to their ecological and fisheries status. It would also give a preliminary knowledge of the diversity and productivity of the wetland. This, in turn, helps in planning, exploitation, antipollution or water conservation strategies. By using various indices Species diversity indices of the zooplankton groups were also calculated where the Shannon -Weaver Index ranged between 0.943 - 2.754 and Species Evenness ranged between 0.6565 - 0.6136. it is concluded that S1 site is Moderately polluted .Among all the three seasons of the year pre monsoon season show much abundance of zooplankton that give us indication of pollution in that particular period of year.

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