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ZOOPLANKTONIC DIVERSITY OF GUDA BISHNOIYAN POND, JODHPUR

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ABSTRACT:
Zooplanktons play key role in the food web by controlling phytoplankton production besides acting as bioindicator. The present study assessed the zooplanktons abundance and diversity of Guda Bishnoiyan pond near Jodhpur, by collecting monthly samples from three stations, A, B and C, filtering 50 lts of water, from June 2019 to March 2020 along with limnological parameters, free carbon dioxide, salinity and turbidity. Free carbon dioxide ranged from 0 to 5ppm, while salinity ranged from 0.14ppt to 6.62ppt, and turbidity ranged from 1.1 to 186 NTU during the study period. The study revealed the highest population of these organisms in month of June 2019 at all the three stations A, B, C being 222083 /lt, 63887/lt, and 68610/lt respectively. Lowest number was recorded in the month of October 2019 being 11.11 /lt and 46.66/lt at station A and B, while at station C it was recorded in July 2019 being 11.11/lt. Out of the four groups studied (rotifers, cladocera, copepodas, and ostracoda) twelve genus were found during the study period. Correlation analysis with limnological parameters showed that rotifer have positive correlation with all three limnological parameters. Copepods and ostracods showed nearly no correlation with free carbon dioxide and salinity, but ostracods showed negative correlation with turbidity. Cladocera showed negative correlation with all three limnological parameters. Rotifers were found to be a dominant group (pooled data of all three stations) during the study period and the order of dominance of the groups was found to be – rotifers (62.37%) > copepods(16.99%) > cladocera (13.02%) > ostracods (7.6%).Average value of Shannon - Wiener index , Simpson index, species richness index, species evenness and Simpson dominance index were found to be 0.95, 0.47, 0.65, 0.68, and 0.53 respectively (pooled data of all three stations), which indicate towards heavily polluted status of pond.

Keywords: Zooplankton, limnological parameters, diversity indices, Guda Bishnoiyan, Jodhpur.

INTRODUCTION:

Water is critical for survival on earth. It is nature's precious gift which is not only essential for the life of plants, animals and human beings but also for the regulation of the climate. The accelerated rate of industrialization and extensive, indiscriminate use of pesticides and chemical fertilizers are few factors responsible for inducing pollution in the aquatic environment. This deterioration in the quality of water is influencing the life in aquatic ecosystem. Not only aquatic organisms, humans are also being affected by contaminated water which leads to many diseases.

Zooplanktons, the tiny animals found drifting in water, are heterotrophic organisms constituting an essential part of the food chain which control the population of phytoplanktons. They are ecologically important and serves to be an integral components of pond ecosystem, as they help in transferring chemical energy from one trophic level to another.

Population of zooplanktons reflect the potential and nature of that aquatic ecosystem (Kumar *et al.*, 2010), besides giving an idea about pollution level because they work as good bioindicators. Distribution of these animals is also effected by many limnological parameters, like temperature, salinity, light penetration, water currents, etc.

Protozoa, Cladocera, Copepoda, Ostracoda are the major five classes that make up the zooplankton community. Rotifers are used as a bioindicator of eutrophication (Sharma and Tiwari, 2011) whereas prey and predator relationship is indicated by the presence of copepods.

Diversity index is a quantitative measure that reflects how many different types (such as species) there are in a dataset, and simultaneously takes into account how evenly the basic entities (such as individuals) are distributed among those types (https://www.quarrylifeaward.com). Diversity indices provide important information about rarity and commonness of species in a community. The ability to quantify diversity in this way is an important tool for biologists trying to understand community structure (Beals and Harrell 2000). Species evenness refers to how close in numbers each species in an environment is and richness simply quantifies how many different types the dataset of interest contains.

Keeping in view the above facts and significance of zooplankton, the present study was undertaken to assess the relation between limnological parameters on zooplankton distribution, and to find the diversity of their major groups at Guda Bishnoiyan pond near Jodhpur.

MATERIAL AND METHODS:

A. Study area- Jodhpur is 2nd largest city of state Rajasthan. It was named after its founder Rao Jodha and is also known as Suncity. It is situated in western part of Rajasthan about 300 km away from the border with Pakistan, covers 11.6% of total arid zone of Rajasthan. It lies between 26.28°N and 73.02° E, 231 m above sea level. Guda Bishnoiyan pond (Jodhpur) is about 25 km from Jodhpur and 2 km from Guda Bishnoiyan village. The pond (Fig 1) lies between latitude 26° 08' 09.8" N and longitude 73° 06' 13.8" E. This pond was declared Guda Bishnoiyan Conservation Reserve by forest department in 2011 and has an area of approximately 5.2 hac.

METHODOLOGY:

Zooplanktonic population of Guda Bishnoiyan pond was studied by taking monthly samples, between June 2019 to March 2020, in first week of each month between 8.00 to 11.00 AM. Samples were analyzed for limnological parameters, free carbon dioxide (Titrimetric method), salinity and turbidity (water analysis kit Systronics model No 371).

50 lt water samples were collected and filtered through zooplankton net and analyzed for the four groups – rotifera, cladocerans, copepods, and Ostracods. Zooplankton samples were preserved in 4% formalin, and analyzed under the trinocular microscope

20ml concentrate was made from the filtrate and counting was done taking five random replica using Sedgewick Rafter counting cell slide. Various genus were encountered in the groups studied. The results were analysed for various diversity indices like Shanon Weinner index (H'), Simpson index (D), Species richness index or

Menhinick index (d), Species evenness or Equitability index (E), and Simpson dominance index (SDI) .

1.. Shanon- Weiner W index (H'), (Shannon, and Wiener, 1949). was calculated using

$H' = - \sum p_i \ln p_i$

p_i is the proportion of individuals belonging to the *i*th species.

2.Simpson index (D) (Simpson 1949) was calculated using

$$D = \frac{\sum n (n-1)}{N (N-1)}$$

n = the total number of organisms of a particular species

N = the total number of organisms of all species

3. Species richness index or Menhinick index (d) (Menhinick 1964). was calculated using $d = s/\sqrt{N}$

Where 's' equals the number of different species represented in sample, and

N equals the total number of individual organisms in sample.

4. Species evenness or Equitability index (E) was calculated using

$$E = \frac{H'}{\ln *d}$$

Where H' is Shanon- Weiner W index

d is Species richness

5.Simpson dominance index (SDI) was calculated using SDI = 1-D

Where D is Simpson index (D),

6. Correlation analysis: The Pearson Correlation matrix(r) between limnological parameter and zooplanktons was done using Microsoft Excel, 2016.

Zooplanktons were identified using keys and standard monographs from APHA (22nd Ed), Edmonson (1959), Ward & Whipple (1954).

RESULT AND DISCUSSION

Samples were analyzed for limnological parameters, namely, free carbon dioxide, salinity, and turbidity, by taking monthly samples, between June 2019 to March 2020, in the first week of each month. During the whole study period, free carbon dioxide was absent at all the three stations except at stations A and B in June 2019. Salinity ranged from 0.14ppt to 6.62ppt, being highest in June 2019 at all three stations. It was lowest in October 2019 (0.14 ppt) at both stations A and C while it was lowest in September 2019 at station B (0.14 ppt).

Turbidity ranged from 1.1 to 186 NTU during the study period. It was highest in July 2019 at all the three stations being 186 NTU, 126NTU and 160NTU at station A, B, and C respectively. Lowest values were recorded at all the three stations in October 2019 being 1.1 NTU, 1.3 NTU and 1.7 NTU at station A, B, and C respectively.

The zooplanktonic study revealed the highest population of these organisms in month of June 2019 at all the three stations A, B, C being 222083 /lt, 63887/lt, and 68610/lt respectively. Lowest number was recorded in the month of October 2019 being 11.11 /lt and 46.66/lt at station A and B, while at station C it was recorded in July 2019 being 11.11/lt. Out of the four groups studied (rotifera, cladocera, copepodas, and ostracoda) twelve genus, were found during the study period, 3 belonging to rotifera (*Brachionus Keratella, Asplancha*), 4 to cladocera (*Daphnia, Cerodaphnia, Alona, Chydorus*), 2 to copepods (*Cyclops and Diaptomus*) and 3

belonging to ostracods (*Cypris, Eucypris, Cyclocypris*).

Rotifers were maximum in month of June 2019 (2386), cladocera were maximum in month of February 2020 (268) , copepodas were maximum in month of March 2020(432) and ostracoda were maximum in month of December 2019 (114), (calculated by taking pooled data of all three stations).

Rotifers were minimum in month of November 2019 (7), cladocera were minimum in month of September 2019 (7), copepodas were minimum in month of October 2019(10) and ostracoda were minimum in month of October 2019 (6), (calculated by taking pooled data of all three stations). Hence zooplankton population was found to be minimum in months of September, October and November 2019.

Correlation analysis with limnological parameters (calculated by taking pooled data of all three stations) showed that rotifera have positive correlation with all three limnological parameters. Copepods and ostracods showed nearly no correlation with free carbon dioxide and salinity, but ostracods showed negative correlation with turbidity. Cladocera showed negative correlation with all three limnological parameters. Total zooplankton individuals /lt showed positive correlation with free carbon dioxide, salinity and turbidity, being 0.99, 0.99, and 0.41 respectively. (Table I).

Rotifers were found to be a dominant group (pooled data of all three stations) during the study period and the order of dominance of the groups was found to be – rotifers (62.37%) > copepods (16.99%) > cladocera (13.02%) > ostracods (7.6%).

The zooplankton results were analyzed for various diversity indices like Shanon Weinner index (H'), Simpson index (D), Species richness index or Menhinick index (d), Species evenness or Equitability index (E), and Simpson dominance index (SDI). Average value of Shannon -Wiener index , Simpson index, species richness index, species evenness and Simpson dominance index were found to be 0.95, 0.47, 0.65, 0.68, and 0.53 respectively (pooled data of all three stations) Fig 1.

Shannon -Wiener index value was highest at station A in September 2019 (1.5) and was lowest at station A in June 2019 (0.09). Simpson index (D) was highest at station A in June 2019 (0.969) and was lowest at station A and C in October 2019 and July 2019, respectively. Species richness or Menhinick index (d) was highest at station A and station C (1.789) in October 2019 and July 2019, while was lowest at station A (0.1) in June 2019. Species evenness or Equitability index (E) was highest at station A and station C (0.961) in October 2019 and July 2019 was lowest at station A (0.069) in June 2019.Simpson dominance index (SDI) was highest at station A and station C (0.9) in October 2019 and July 2019. It was lowest at station A (0.03) in June 2019. Fig 2

Limnological parameters in relation to zooplanktonic population

Zooplankton due to their large density, shorter life span, drifting nature, high group or species diversity and different tolerance to the stress, they are being used as a indicator organisms for the physical, chemical and biological process in the aquatic ecosystem (Gajbhiye 2002). Among all the freshwater aquatic biota, zooplankton population is able to reflect the nature and potential of any aquatic systems (Kumar *et al.* 2010).The abundance of zooplanktons depends,

in gross, on the phytoplankton, aquatic microphytes and macrophytes (James *et al* 2003). Bhowmic (1968) reported that in summer zooplankton population increases due to higher concentration and increased photosynthetic activity of phytoplanktons. Malik and Panwar (2016) observed that growth of zooplanktons were maximum in summer and minimum in winter, the reason may be fluctuations in light intensity and temperature, in turn affecting the food supply of zooplanktons.

Free CO_2

The source of dissolved carbon dioxide in aqueous bodies is from air, from inflowing ground water, by decomposition of inorganic matter, by respiration of biota (Yashpal *et al* 2016). Maximum dissolved carbon dioxide levels in summer and minimum levels in winter which could be explained due to the decline in phytoplankton in summer (Bhattacharya *et al* 2002). The CO_2 values were recorded high in the months of summer season and absent in the south west monsoon season. Balakrishna *et al* (2013) observed during the summer season the metabolic rate is high due to increase in the temperature, which influence on the liberation of CO_2.

Bera *et al* (2014) found that zooplankton population showed notable positive correlation with free CO_2 (r = 0.344). Present study also Zooplankton population (zoo/lt) were positively correlated with free CO_2 (0.99) Table I.

Salinity

The salinity regulates survival, metabolism and distribution of organisms in freshwater ecosystem (Dhanasekaran *et al* 2017). It exerts different ecological and physiological effects depending on the interaction with other factors like temperature, oxygen and ionic compounds (Odum 1971). The higher salinity of water can reduce the diversity and density of plankton production (Horne and Goldman 1994). Dhanasekaran *et al* (2017) in their study found the mean values of salinity maximum during summer season In this study, the higher salinity recorded in summer (average of all three stations 5.9 ppt) was due to more evaporation of water because of higher temperature. Veerendra *et al* (2012) found that zooplankton may be directly correlated with the salinity. In present study zooplankton population was found to be highly correlated with salinity (0.99) Table I.

Turbidity

In monsoon months the flushing of water from the catchment area increases the turbulence and suspension of particles, whereas in winter the settlement of silt, clay and heavy suspended particles result in least turbidity in winter (Tidame and Shinde 2012). In present study same was observed. Thankhum and Meitei (2013), found no correlation between zooplankton population and turbidity but in present study it was found to be positively correlated (0.41) Table I.

Rotifera in relation to limnological parameters

About 1700 species of rotifers have been described from the different parts of the world and 500 species (only 330 species belonging to 63 genera and 25 families have so far been authenticated) was described from Indian water bodies (Arora and Mehra 2003) (Kiran *et al* 2007). In India, 21 species of *Brachionus* have been reported (Sharma 1987, Sharma 1992).

Rotifers are the most important soft-bodied metazoans (invertebrates) having a very short life cycle among the plankton (Jagadeeshappa and

Kumara 2013). Only 100 widely spread rotifer species are planktonic and their life cycles are influenced by temperature, food and photoperiod, (Dhanapathi 2000). Rotifers play a vital role in the trophic tiers of freshwater impoundments and serve as living capsule of nutrition (Kumar and Raghunathan 1999). Majagi and Vijaykumar (2009) observed that the number of rotifers increased in summer, which may be due to the higher population of bacteria and organic matter of dead and decaying vegetation. Sukand and Patil, (2004) in their study concluded that the dominance of rotifers in the reservoir was due to the continuous supply of food material which in turn indicates the eutrophic nature of the lake.

Krishna and Kumar (2017) found that rotifera showed highest number of species and genus *Brachionus* was dominant group among rotifer. Bharati *et al.*, (2014) reported that the abundance of rotifer species such as *Brachionus* indicates nutrient rich water body which may undergo the state of eutrophication.

Rotifers are regarded as bioindicators of water quality (Saksena *et al* 2006)(Sladecek 1983) and high rotifer density has been reported to be a characteristic of eutrophic lakes. Among the zooplankton, rotifers respond more quickly to the environmental changes and are used as indicator for a change in water quality (Gannon and Stemberger, 1978)

Presence of rotiferan species is an important aspect for monitoring pollution (Plasecki *et al* 2004). An increase in abundance of total rotifers may indicate advancing eutrophication and it can occur without a major change in species composition (Maiti 2012). *Brachionus calyciflorus, Keratella tropica* are pollution (eutrophy) indicator species (Maiti 2012), (Bilgrami 1991), (Plasecki *et al* 2004), (Gannon,and Stemberger, 1978). During the present study above genus have been found.

Vaidya (2017) in their study found that rotifers had a significant relationship with salinity (r = 0.447). and same was observed during present study (1.0). Bera *et al* 2014 observed that rotifer population was positively correlated with free CO_2 (r = 0.355) Present study also found that rotifer to be positively correlated with free CO_2 (0.98). Fouzia and Khan (2013) found that rotifers shows positive correlation with turbidity (0.318). Same was found in present study (0.46) Table I.

Copepoda in relation to limnological parameters

Freshwater copepods constitute one of the major zooplankton communities occurring in all types of water bodies. They serve as food to several fishes and play a major role in ecological pyramids (Kumar *et al* 2018).

Copepoda plays major roles in pond ecosystems. Benthic copepods eat organic detritus or the bacteria that grow in ponds and their mouth parts are adapted for scraping and biting (Battish, 1992). Thus copepods help to maintain the health of the aquatic system and serve as the most important food item in fresh water aquaculture (Shil *et. Al.,* 2013).

Sharmila and Shameem (2017) found the densities of copepoda were higher in summer season (556.29 org/lit) and lower in monsoon (505.12 org/lit.). Bera *et al* (2014) also found that occurrence of copepods were highest in the month of summer season. Yashpal *et al* (2016) found that copepods were present in every season but found to be maximum in summer and

moderately present in other seasons. Present study also found the same; copepods were high in summer March 2020.

Vaidya (2017) noticed that copepod had no relationship with salinity (r = 0.009) and same was observed in present study (0.04). In present study copepods were found to be have nearly no correlation with free CO_2 (0.03) and turbidity (0.1) Table I.

Cladocera in relation to limnological parameters

Cladocera is an order of small crustaceans commonly called water fleas. Around 620 species have been recognized so far, with many more undescribed species (Jagadeeshappa and kumara 2013).They are the most useful and nutritive group of crustaceans for higher members of fishes in the food chain (Kumar *et al* 2018). Bera *et al* (2014) found the population of cladocerans was maximum in number i.e. 249 Ind./L in the month of winter, and same was observed in present study.

Vaidya (2017) observed cladocerans had an inverse relationship with free CO_2 (r =.630), and salinity (r =.630) and same was observed in present study as cladocera showed negative correlation with all three limnological parameters in present study (cladocera – free CO_2= -0.15, cladocera –salinity = -0.19, cladocera – turbidity = - 0.20) Table I.

Ostracods in relation to limnological parameters

Kumar *et al* (2018) found that ostracods represented very low diversity and population density as compared to other groups of zooplankton. Fouzia and Khan (2013) found that ostracods showed negative correlation with turbidity (-0.058) and same was found in present study (-0.13). Ostracods were found to have no correlation with free CO_2 (0.06) and salinity (0.01) Table I.

Diversity indices

Shannon-Wiener diversity index varies from 0 to 5. According to this index, values less than 1 characterize heavily polluted condition, and values in the range of 1 to 2 are characteristics of moderate polluted condition while the value above 3 signifies stable environmental conditions (Stub *et al.*1970, Mason, 1988). Higher the value of H, Shannon -Wiener index higher is the diversity of the ecosystem (Kumar *et al* 2018). In present study average value of Shannon -Wiener index, was found to be 0.95, which characterize heavily polluted condition of the water body Fig 2. Generally, Simpson index ranges from 0 to 1. Mature and stable communities have high diversity value (0.6 to 0.9), while the communities under stress conditions, exhibiting low diversity, usually show close to zero value (Dash, 2003). Simpson diversity index is always higher where the community is dominated by less number of species and when the dominance is shared by large number of species (Whittaker, 1965). In the present study, Simpson index varied from 0.969 to 0.1 and average value was 0.47 indicating unstable community under stress condition Fig 2.

Species richness or Menhinick index d, attempts to estimate species richness but at the same time it is independent on the sample size. Richness simply quantifies how many different types the dataset of interest contains. Vincent *et al* (2012) reported that the higher values of species diversity index decrease species richness with

increasing trophic status. In present study it ranged from 0.1 to 1.789, and average for study period was 0.66, which indicate moderate diversity Fig 2.

Species evenness or Equitability index E, refers to how close in numbers each species in an environment is. Mathematically it is defined as a diversity index, a measure of biodiversity which quantifies how equal the community is numerically. In present study it ranged from 0.0699 to 0.961, and average for study period was 0.60, which indicate moderate evenness Fig 2.

The value of Simpson dominance Index SDI also ranges between 0 and 1, but now, the greater the value, the greater the sample diversity. In present study it ranged from 0.03 to 0.9, and average for study period was 0.48, which indicate moderate diversity Fig 2.

CONCLUSION:

The present study assessed the zooplankton abundance, diversity and their relationship with three limnological parameters namely, free carbon dioxide, salinity and turbidity of Guda Bishnoiyan pond near Jodhpur, by collecting monthly samples. The results indicate that zooplankton population remains high in summer compared to other period and they show positive correlation with free carbon dioxide, salinity and turbidity. Out of the four major groups of zooplankton studied (rotifera, cladocera, copepodas, and ostracoda), rotifera was found to be the dominant group and dominance of these indicates the eutrophic nature of the pond. Rotifers showed positive correlation with the all the three limnological parameters while other groups showed either negative or no correlation with limnological parameters. In present study average value of Shannon -Wiener index was found to be 0.95, which indicate heavy polluted condition of the water body.

Guda Bishnoiyan pond is a water body which is home to many migratory birds during winters, but high level of pollution may affect their visit in future. This can badly affect the ecotourism of this region. Hence, immediate measures must be taken to improve the status of this pond.

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Figure 1 Guda Bishnoiyan pond

Table I: Correlation result

Limnological Parameter/ Zooplankton	Free carbon dioxide (CO_2)	Salinity	Turbidity
Zooplankton /lt	0.99	0.99	0.41
Rotifera	0.98	1.0	0.46
Cladocera	-0.15	-0.19	-0.20
Copepoda	0.03	0.04	0.10
Ostracoda	0.06	0.01	-0.13

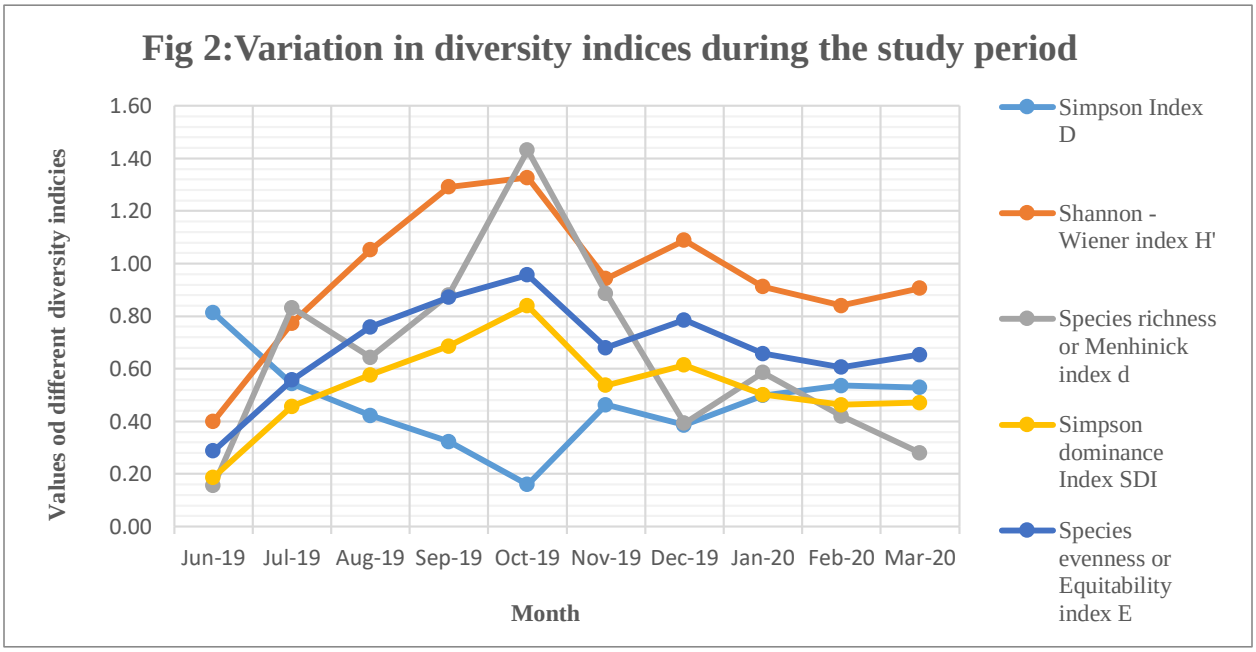
Fig 2:Variation in diversity indices during the study period
Values od different diversity indicies
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Jun-19
Jul-19
Aug-19
Sep-19
Oct-19
Nov-19
Dec-19
Jan-20
Feb-20
Mar-20
Month
Simpson Index D
Shannon - Wiener index H'
Species richness or Menhinick index d
Simpson dominance Index SDI
Species evenness or Equitability index E