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ZOOPLANKTON DYNAMICS AND DIVERSITY IN WATER OF ABANDONED POND ECOSYSTEMS DURING PRE-COVID-19 AND POST-COVID-19 PERIOD

BUSHRA NASEER[1]*AND SHAILENDRA KUMAR SINHA[2]
[1,2]Department of Zoology, Binod Bihari Mahto Koyalanchal University,
Dhanbad - 826004, Jharkhand
e-mail: bushrannaseer@gmail.com

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***Corresponding author**

ABSTRACT

Zooplankton community of two abandoned ponds have been analysed and compared between pre-COVID-19 and post-COVID-19. Results showed that the water quality improved during the post-COVID-19 period as compared to the pre-COVID-19 period (PRC91/POC19) in terms of physicochemical parameters with the annual average values for pond 1 as DO (in mg/L) 4.6/4.94, pH 6.58/7.18, TDS (in mg/L) 1103.25/592.91, PO43- (in mg/L) 0.69/0.61; and for Pond 2 as DO (in mg/L) 4.45/5.46, pH 7.55/7.71, TDS (in mg/L) 920.91/381.58, PO43- (in mg/L) 0.41/0.29. Zooplankton community was found less diversified in the POC19 but stable. Zooplankton population showed rotifers as the dominant group during both the periods.

INTRODUCTION

Ponds, a freshwater ecosystems, play an important role in pollution monitoring (Hill *et al*., 2021). Ponds ecosystems are crucial for preserving biodiversity, maintaining ecological balance, and delivering basic ecosystem functions. A number of aquatic organisms ranging from microscopic to macroscopic in nature thrive in these habitats- including the zooplankton. They are sensitive to environmental changes and serve as a fundamental link in the aquatic food chain. In order to evaluate the health of freshwater ecosystems, one must have a thorough understanding of the dynamics and diversity of zooplankton communities in ponds (Xiong *et al*., 2020). To throw light on the effects of the global pandemic on these delicate aquatic systems, the current study examines zooplankton dynamics and diversity in neglected waters of abandoned pond ecosystems during the pre-COVID-19 (PRC19) and post-COVID-19 (POC19) periods. The importance of zooplankton variety in preserving water quality and supporting the larger aquatic food chain has been highlighted in recent studies (Kar and Kar, 2016; Singh *et al*., 2021; Patel and Laharia, 2021).

A rare opportunity to study the effects of lessened anthropogenic stress on freshwater ecosystems was made possible by the Covid19 pandemic, which first surfaced in late 2019 and was followed by global lockdowns and reduced human activity in early 2020 (Bates *et al*., 2021). Zooplankton group members, which include rotifers, cladocerans, and copepods, are extremely sensitive to changes in their environment. Changes in zooplankton community and diversity may have a ripple effect on the aquatic environment as a whole. So studying the zooplankton in deserted pond ecosystems can help us in understanding how resilient freshwater environments are. It has been demonstrated in earlier research findings that zooplankton community can react quickly to alterations in environmental factors such as water quality, temperature, and nutrition levels (Zhou *et al*., 2020; Wang *et al*., 2022). However, little is known about how pond ecosystems respond to sudden drops in anthropogenic pressure, like those experienced during the CO19 pandemic. Attempts have been made through this communication to explore the impact of cessation of anthropogenic activity on zooplanktonic community

MATERIALS AND METHODS

Study Area

Present investigation was conducted at two different ponds that are not managed for any commercial use rather have become repository of waste disposal (Table 1). The ponds under investigation are located in Govindpur block namely Rejali pond (P-1; 23°49'45.45"N and 86°31'15.00''E) and Balliapur Block named as Bhokta pond (P-2 23°45'39.15"N and 86°30'29.62"E.), in Dhanbad district.

During the CO19 complete lockdown period, waste disposal in ponds was stopped except comparatively lesser amount of domestic sewage.

Sample collection and analysis

Monthly surface water samples were collected from the P1 and P2 from February 2019 to January 2020 (PRC19) and July

2020 to June 2021 (POC19) for limnobiotic analysis. Five samples were taken and their average was calculated for the final result. The range and annual mean values of these parameters are mentioned in Table 2. Temperature of the water (WT) was measured at the sampling location with the help of a centigrade thermometer (0 to 100 °C scale). Sechhi disc was employed to determine the transparency (TSPCY) of the water of the pond. At the sampling location, the Labtronics Water and Soil Analysis Kit, model LT-62, was used to assess the pH and Total Dissolved Solids (TDS). According to APHA, 2005, the standardized procedures were used to determine dissolved oxygen (DO) and biochemical oxygen demand (BOD). Apart from these, other parameters like chemical oxygen demand (COD), nitrate (NO_3-), phosphate PO_4^{3-}, and chloride Cl^- have been analysed by applying standard methods as given in APHA, 2005.

Plankton net made of bolting silk cloth possessing mesh size of 25μm was used to filter 100 litres of water or collect the zooplankton samples, subsequently the samples were preserved in 70% alcohol. Then collected zooplankton samples were examined and identified with the help of standard literature (Prescott, 1962; Needham and Needham, 1966; Adoni *et al.*, 1985; Agarker *et al.*, 1994; APHA, 2005). Following indices were calculated using different formulae as under

Shannon-Wiener diversity index

$$H' = \sum_{n=1}^{s} \text{Piln ni/N}$$

where S is the number of taxa, N is the total number of individuals across all species, Pi is the proportion of the total number of individuals, H' is the diversity index, and ni is the number of individuals of each species..

Evenness Index

$$E = \frac{H'}{H' \max}$$

where E is the evenness index, H' max is ln S, and H' is the diversity index.

Simpson's Diversity Index

$$D = 1 - \frac{\sum_{i=1}^{s} (n_i(n_i - 1)}{N - (N - 1)}$$

Where D is the Simpson's Diversity Index, ni is the number of individuals of the i-th species, N is the total number of individuals in the sample, and S is the total number of species in the sample.

RESULTS AND DISCUSSION

Temporal variations in the abiotic parameters

To understand how physicochemical parameters affect aquatic variety, it is crucial to monitor these elements in the aquatic environment (Das, Pal, and Keshri, 2015).

The range of water temperature was recorded between 16°C-36 °C and 16 °C-34 °C in case of P1 during the PRC19 and POC19 respectively, the same was recorded as 15 °C-36°C and 16°C-34°C in the medium of P2. Diverse planktonic organisms have been recorded to survive well in water with a temperature range of 13.5°C to 32°C (Kamat and Sima, 2000; Gaikwad, Ingle and Thorat, 2008). It has been reported that a 1°C rise in water temperature causes an increase in ion mobility and solubility, which causes conductivity to increase by 2-4% (Miller, Bradford, and Peters, 1988).

During the study period, the pH values of the pond ranged from 5.9, which is acidic to 7.1, which is slightly alkaline in P1 during PRC19 while pH was recorded within the range of 6.1-8.2 during the POC19 in the same pond water. In P2 the value of pH was recorded as 7.2-8.1 and 7.3-8, during the PRC19 and POC19 thereby representing slightly better conditions of water in terms of pH in case of P2.

Transparency measured between 15 cm and 19.5 cm, and 14 cm to 19.1 cm in P1 and P2, respectively, during the PRC19 period. On the other hand, the transparency during POC19 from P1 and P2 were recorded within the range of 15 cm to 18 cm; and 17.3 cm to 22.5 cm, respectively. The mean transparency values from P1 and P2 recorded during the PRC19 and POC19 periods were 17.03 cm, and 16.6 cm; and 17.4 cm, and 19.55 cm. Turbidity, plankton growth, cloudiness, rainfall, as well as the position and visibility of the Sun in the sky, all have an impact on the transparency of water (Jobling, Struthers and Rissik, 2010).

DO has widely been proposed as the primary indicator of health of an aquatic body. It has been regarded as a blatant sign of quality assessment. The environment of an aquatic body has a complete impact on DO. DO concentration and water body temperature have the exact opposite relationship. In P1, and P2 the annual mean DO values during the PRC19 and POC19 were 4.6 mg/L and 4.94 mg/L; 4.45 mg/L, and 5.46 mg/L, respectively.

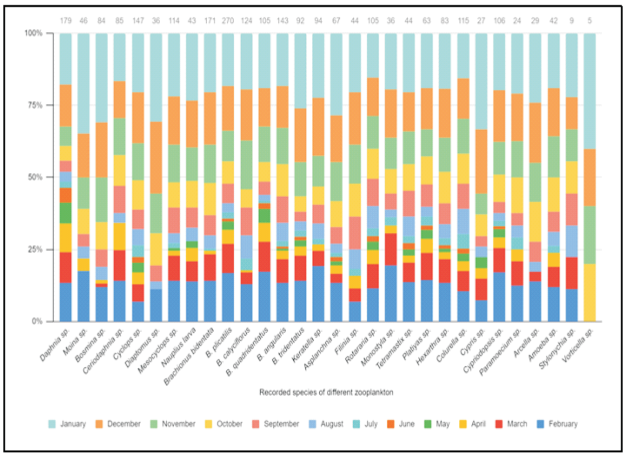
The TDS estimation can also be used to determine water quality because it takes into consideration a variety of dissolved materials, both organic and inorganic, that are present in water (Jayakumar, *et al.*, 2009). TDS values recorded during the investigation period were in the following order: P1>P2 during both periods of PRC19 and POC19. Even the twelve month mean values of TDS in P1 went down from 1103.25 to 592.91 and the same went for P2 as the value got down from 920.91 to 381.58; during the PRC19 and POC19.

In the natural waterways, the chloride anion is frequently present. High Chloride ion concentrations in natural ponds are regarded as pollution indicators (Prakash, 2004). Chloride ion concentration is often higher in organic wastes, hence the presence of a lot of it in natural water paints a clear image of sewage pollution. P1 samples of water had a chloride level that ranged from 14-65 mg/L and 7-65 in PRC19 and POC19, respectively. The P2 samples chloride concentrations ranged from 9-52 mg/L, and 3-57 mg/L in the same period of study as in P1; and the overall values decreased in both the ponds again presenting an improved conditions of the ponds in terms of organic pollution due to high chloride concentrations.One of the main macronutrients, the phosphates, plays an important part in biological productivity and subsequently leading to the eutrophication of the water body (Chislock *et*

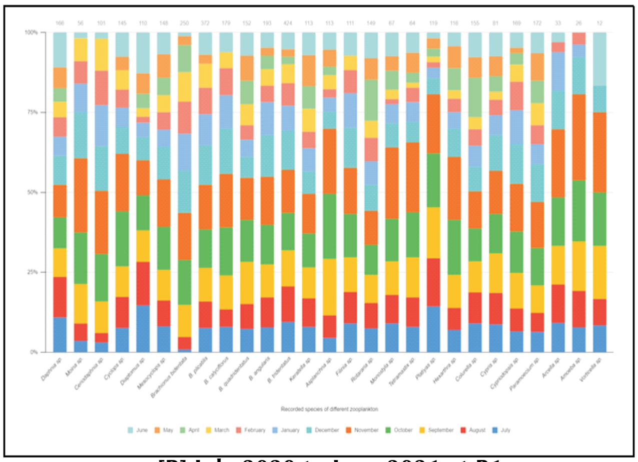
Table 1: Major source of effluents reported during the study period in the abandoned ponds.

Ponds	Effluent sources
P1	Waste dumps from local surrounding market area, sewage waste arising from local residential area, sewage effluent from locally spread market area through drains, surface run-off.
P2	Disposal of solid waste, use of soap and detergents for bathing and washing clothes, and the discharge of sewage water.

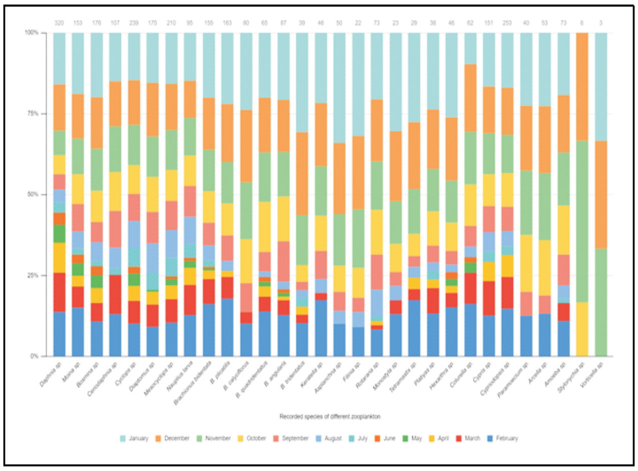
During the CO19 complete lockdown period, waste disposal in ponds was stopped except comparatively lesser amount of domestic sewage.



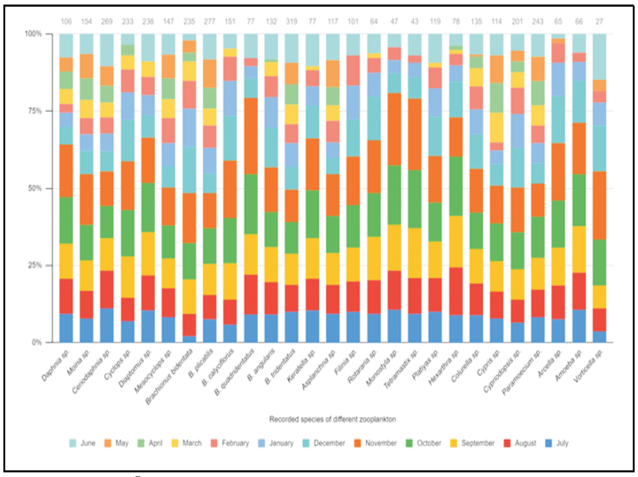
[A] February 2019 to January 2020 at P1



[B] July 2020 to June 2021 at P1



[C] From February 2019 to January 2020 at P2



[D] From July 2020 to June 2021 at P2

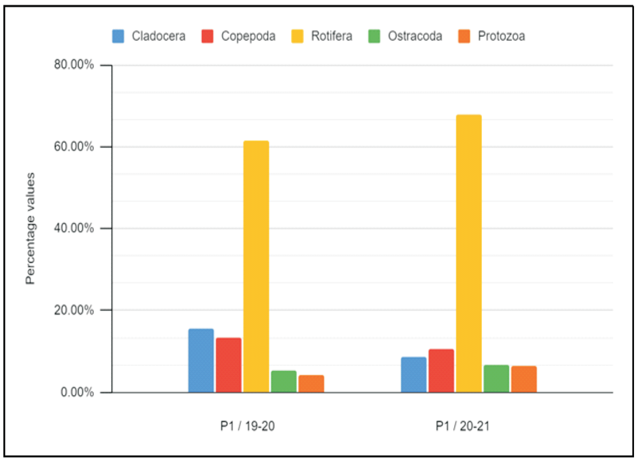
Fig: 1. Monthly abundance of zooplankton species during the time period along with their 12 months summation.

al., 2013). Though the annual mean value of phosphate concentration dropped (from 0.69 mg/L to 0.61 mg/L) during the POC19 period in case of water samples collected from the P1, it still remained relatively high. While in case of P2, condition was better during the POC19 period and the annual mean value reported was 0.29 mg/L. These relatively lower levels may have been brought about by the aquatic vegetation's use of the phosphate and also because of a definite decrease in anthropogenic activity near the pond. Phosphate concentrations in P1 were somewhat greater, which may have been caused by a low dissolved oxygen event and maximum sewage (domestic/residential) effluent outflow. As a result of surface runoff, agricultural fertilisers from nearby catchment regions might had also used to increase the phosphate concentration in the ponds. The ponds under study had a range of nitrate concentrations. The average nitrate values increased (0.19 mg/L) in the POC19 in P1 as compared to the PRC19 (0.14 mg/L) values which might be as a result of continued domestic sewage discharge in the pond. Condition has been observed as good in case of P2 where the nitrate values decreased (from 0.58 mg/L to 0.44 mg/L) in POC19 that is a clear interpretation of better water quality due to decreased anthropogenic activities in this particular pond as also studied by Kannel *et al*. (2007) and Yadav and Goyal, (2022).

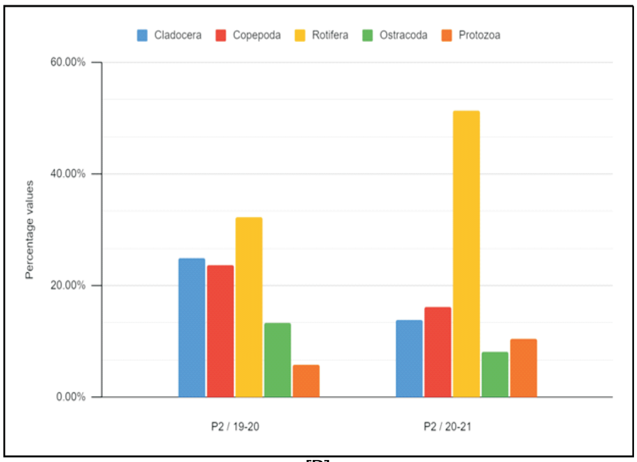
The biochemical oxygen demand (BOD) is an important factor to be taken into account while carrying out the study on water bodies receiving organic pollutant load as it is a reliable parameter of organic pollution. It is an established fact that high organic pollutant is denoted by high BOD values. The BOD value from the P1 ranged from 4.6 mg/L to 8 mg/L during the PRC19 period; while the same ranged from 0.03 mg/L to 5.09 mg/L during the POC19 period. BOD values those from

Table 2: Temporal variation in different abiotic parameters during the study periods.

Physicochemical Parameters	P1 PRC19 Range	Annual mean	St. Dev.	POC19 Range mean	Annual	St. Dev.	P2 PRC19 Range mean	Annual	St. Dev.	POC19 Range mean	Annual	St. Dev.
BOD (in mg/L)	4.6-8	6.25	1.29	0.03-5.09	2.08	1.22	1.7- 7.2	5.13	1.88	0.11-5.03	1.93	1.76
DO (in mg/L)	1.5- 8.6	4.6	1.88	0.9-8.1	4.94	2.2	1.6- 7.8	4.45	2.006	2.2-7.9	5.46	1.61
pH	5.9-7.1	6.58	0.304	6.1-8.2	7.18	0.69	7.2-8.1	7.55	0.235	7.3-8	7.71	0.19
TDS (in mg/L)	970-1250	1103.25	146.35	495-795	592.91	95.39	798-1071	920.91	143.86	282-450	381.58	53.17
TSPCY (in cm)	15-19.5	17.03	1.69	15-18	16.6	6.05	14-19.1	17.4	1.56	17.3-22.5	19.55	5.98
WT (in °C)	16-36	25.58	6.84	16-34	24.83	6.05	15-36	25.66	6.86	16-34	24.83	5.98
NO3- (in mg/L)	0.10-0.19	0.14	0.026	0.1-0.75	0.19	0.17	0.10-0.99	0.58	0.41	0.01-0.87	0.44	0.25
PO43- (in mg/L)	0.43-1.05	0.69	0.226	0.3-1.07	0.61	0.21	0.19-0.92	0.41	0.22	0.18-0.5	0.29	0.11
Cl- (in mg/L)	14-65	36.91	15.84	Jul-65	37.5	19.6	Sep-52	28.83	12.52	Mar-57	26.5	16.97
COD (mg/L)	36-76	56.58	15.64	1.1-22	16.09	5.877	15-68	48.16	19.26	Jan-58	10.08	18.58



[A]



[B]

Fig. 2 [A] / [B]: Variation in percentage composition of different zooplankton groups during PRC19 and POC19 at different abandoned pond ecosystems.

the P2 recorded to be ranging from 1.7 mg/L to 7.2 mg/L during PRC19, and 0.11 mg/L to 5.03 mg/L during the POC19. During the current work period, in both of the pond water, the value of the measured COD dropped drastically during the POC19 (P1 = 16.09 mg/L, and P2 = 10.08 mg/L) period as compared to the PRC19 (P1 = 56.58 mg/L, and P2 = 48.16 mg/L) period; in terms of annual average concentration. This indicates a better water quality as also supported by Wang *et al*. (2020); that improved water quality is the result of fewer organic materials consuming oxygen during decomposition, as indicated by lower COD readings.

Temporal abundance of zooplankton

Plankton are very sensitive to change because their species replacement occurs when the conditions in the aquatic ecosystem change, and they display the current status of several ecological and biological aspects of the aquatic environment (Puroshottama *et al*., 2011). It has been suggested that a water body's zooplankton community serves as a good indicator of its nutrient and pollution status (Ogbeibu, Ezemonye and Uyigue, 2001; Imoobe and Adeyinka, 2010). Each zooplankton species was found in varying numbers and locations in each pond (Figure: 1, Table 3, and Table 4) during

Table 3: Temporal and annual variations in different counts of zooplankton population in P1.

PRC19	Total count	Average count	St. dev.	POC19	Total count	Average count	St. dev.
Feb	345	11.5	9.1	Jul	292	10.81	8.49
Mar	195	6.5	6.29	Aug	328	12.14	9.46
Apr	99	3.3	3.93	Sep	413	15.29	9.96
May	51	1.7	2.87	Oct	500	18.51	11.23
Jun	27	0.9	1.75	Nov	574	21.25	12.24
Jul	53	1.7	1.91	Dec	398	14.74	12.43
Aug	118	3.93	3.07	Jan	298	11.03	9.3
Sep	174	5.8	4.36	Feb	239	8.85	8.3
Oct	227	7.56	5.04	Mar	210	7.77	7.29
Nov	305	10.16	6.86	Apr	158	5.85	6.27
Dec	415	13.83	9.3	May	158	5.85	4.56
Jan	523	17.43	10.66	Jun	228	8.44	6.39

Count is mentioned in U/L.

Table 4: Temporal and annual variations in different counts of zooplankton population in P2.

PRC19	Total count	Average count	St. dev.	POC19	Total count	Average count	St. dev.
Feb	387	12.9	10.9	Jul	321	11.88	7.7
Mar	219	7.3	8.87	Aug	371	13.74	7.36
Apr	115	3.83	6.35	Sep	436	16.14	8.64
May	53	1.76	3.83	Oct	503	18.62	9.3
Jun	34	1.72	2.5	Nov	553	20.48	9.33
Jul	76	2.62	3.95	Dec	368	13.62	8.39
Aug	157	5.41	5.79	Jan	298	11.03	7.75
Sep	233	8.03	6.28	Feb	242	8.96	6.45
Oct	308	10.26	6.92	Mar	175	6.48	6.12
Nov	393	13.1	8.31	Apr	148	5.48	6.77
Dec	493	16.43	11.17	May	150	5.55	7.72
Jan	564	36.38	12.79	Jun	270	10	7.62

Count is mentioned in U/L.

Table 5: Analysis of variance (ANOVA) for comparing the total population of zooplankton during PRC19 and POC19 from P1.

Anova: Single Factor						
SUMMARY						
Groups	Count	Sum	Average	Variance		
Cladocera	2	717	358.5	2520.5		
Copepoda	2	743	371.5	1984.5		
Rotifera	2	4132	2066	520200		
Ostracoda	2	383	191.5	6844.5		
Protozoa	2	352	176	8978		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	5201985	4	1300496	12.029	0.008	5.192
Within Groups	540527.5	5	108105.5			
Total	5742512	9				

Table 6: Analysis of variance (ANOVA) for comparing the total population of zooplankton during PRC19 and POC19 from P2.

Anova: Single Factor						
SUMMARY						
Groups	Count	Sum	Average	Variance		
Cladocera	2	1285	642.5	25764.5		
Copepoda	2	1337	668.5	5100.5		
Rotifera	2	2950	1475	494018		
Ostracoda	2	719	359.5	3960.5		
Protozoa	2	576	288	25538		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	1779447	4	444861.7	4.012	0.079	5.192
Within Groups	554381.5	5	110876.3			
Total	2333828	9				

the two (PRC19 and POC19) years time period. The two ponds under study had a total of thirty different zooplankton species during PRC19, which belonged to five groups as also recorded by (Naseer and Sinha, 2021); Cladocera (4 species), Copepoda (4 species), Rotifera (15 species), Ostracoda (2 species), and Protozoa (5 species); while 27 species of zooplankton were recorded during POC19 which excluded the occurrence of *Bosmina* sp, Nauplius larva, and *Stylonychia* sp.

Total number of zooplankton reported from P1 and P2 during PRC19 was 2532 and 3021, respectively, and this number increased significantly as 3795 and 3835 for P1 and P2, during

Table 7: Annual mean values in different biodiversity indices of water samples from P1 and P2 during the study period

	P1		P2	
PRC19	Average	St.dev.	Average	St.dev.
Simpson_1-D	0.95	0.05	0.91	0.05
Shannon_H	3.04	0.26	2.83	0.29
Evenness_e^H/S	0.85	0.07	0.77	0.07
POC19	Average	St.dev.	Average	St.dev.
Simpson_1-D	0.94	0.01	0.94	0.01
Shannon_H	3.03	0.11	3.01	0.12
Evenness_e^H/S	0.83	0.06	0.86	0.06

the POC19. The ANOVA (conducted by using the PAST 4.0) findings from P1 (Table 5) show significant difference in zooplankton populations between the classes PRC19 and POC19 (p = 0.008). Also, the F-value exceeds the necessary F crit value, further supporting the rejection of the null hypothesis. ANOVA was performed for water samples from P2 (Table 6) and the results showed that the total zooplankton population from PRC19 and POC19 did not have significant differences among the group means. The p-value (0.079) is greater than the typical significance level of 0.05 and the F-statistic (4.012) is less than the critical value (5.192) at the 0.05 significance level further supporting the lack of significant differences.

However, with a decrease in percentage contribution from PRC19 to POC19, Rotifers remained the dominant one during both of the study periods (Figure 2) also reported by Mallik & Sinha, 2016; as the rotifers being the dominant group during the study. The trend of occurrence of different zooplankton groups during PRC19 is Rotifera > Cladocera > Copepoda > Ostracoda > Protozoa and POC19 is Rotifera > Copepoda > Cladocera > Ostracoda > Protozoa in case of P1. While the trend of abundance of these groups in P2 during PRC19 goes as Rotifera > Cladocera > Copepoda > Ostracoda > Protozoa while in POC19, it is Rotifera > Copepoda > Cladocera > Protozoa > Ostracoda.

And among the Rotifers *Brachionus. plicatilis* appeared to be the most abundant one in P1 during PRC19 and *Monostyla* sp. emerging as the least abundant one; the B. tridentatus was discovered to be the most dominant zooplankton species in the POC19 period while *Tetramastix* sp. was counted as the least in number. In water samples collected from P2 the B. plicatilis has been reported to occur as the most abundant one and Filinia sp. represented the least countable zooplankton species in the PRC19; the *Brachionus. plicatilis* was replaced by the *B. tridentatus* in terms of the most frequently occurring species while *Tetramastix* sp. has been recorded as the least in number in the study period of POC19. And species from genera of *Brachionus* (Kostopoulou, Carmona and Divanach, 2012; Phan *et al.*, 2021), *Filinia* (Paul and Kumari, 2020), Monostyla (Oh *et al.*, 2017) have been reported as bioindicator species representing the water quality.

There are a number of factors supporting the dominant distribution of rotifers in ponds. In general, rotifers consume bacteria, tiny algae, and detritus and are able to filter 1,000 times their own body volume in a single hour (Bronmark and Hansson, 1998). The numerical abundance of rotifers in aquatic environments has been attributed, in addition to the availability of food, to their parthenogenetic reproductive pattern, their status as S-strategist organisms with short life cycles under favourable conditions, and a wide tolerance to environmental fluctuation (Herzig, 1983; Wetzel, 2001; Neves *et al.*, 2003).

In order to determine whether there were any significant differences between the observed Rotifer populations during the PRC19 and POC19 period in the water samples of zooplankton from P1 and P2, a Mann-Whitney U test or Wilcoxon rank-sum test was performed (Figure: 3). And the results thus calculated showed that the p-value is less than the threshold significance level value (α) of 0.05 in both the cases of P1 (0.015) and P2 (0.007) which suggests that the rotifer species are statistically and significantly different.

Temporal diversity of zooplankton during the PRC19 and POC19 periods

Diversity in P1

According to Sibel (2006), the Shannon-Weaver diversity index is a valid and helpful metric for assessing the seasonal variation of zooplankton and water quality in an aquatic body. A high Shannon index value indicates a higher species variety. The Simpson Index value has a value range from 0 to 1, with a higher number indicating greater sample variety (Simpson, 1949). Simpson's diversity index measures the probability that two individuals randomly selected from the community belong to different species. Higher values indicate lower diversity, as it suggests that a few species dominate the ecosystem. In this case (P1), during the PRC19 period the value was calculated as 0.95 which represents slightly higher diversity of zooplankton species in P1 than the POC19 period (0.94). As higher values of Shannon's diversity index is an indication that the community has higher diversity, the PRC19 period had slightly higher diversity holding the average index value of 3.04 compared to the POC19 period *i.e.* 3.03. Evenness index represents how evenly the species are distributed in a community and the values closer to 1 indicate more even distribution. During the PRC19 period, higher (0.85) evenness values were observed compared to the POC19 period (0.83). Though the differences between the PRC19 and POC19 periods are relatively small, the PRC19 period shows slightly higher zooplankton diversity, and evenness compared to the POC19 period.

Diversity in P2

The POC19 period had slightly higher (0.94) dominance compared to PRC19 period (0.91), indicating a slightly less diverse ecosystem including that POC19 (3.01) also had a higher Shannon index value compared to PRC19 period (2.83), suggesting a higher species diversity of zooplankton community in the POC19 period. As evenness reflects how evenly species are distributed in the ecosystem, its values were recorded in the POC19 period as 0.86 that is slightly higher as compared to the PRC19 period (0.77); indicating a more even distribution of zooplankton species in the P1. Overall, the POC19 period shows slight but higher species diversity, dominance, and evenness compared to the PRC19 period. However, the differences between the two are relatively small, suggesting that during both the periods relatively healthy ecological conditions.

CONCLUSION

This study reveals significant temporal fluctuations in key abiotic

Table 8: Mann-Whitney U test to compare the total population of Rotifers during the PRC19 and POC19 periods.

P1		P2	
PRC19	POC19	PRC19	POC19
N: 15	N: 15	N: 15	N: 15
Mean rank: 5.78	Mean rank: 9.71	Mean rank: 5.6	Mean rank: 9.9
Mann-Whitn U : 53.5		Mann-Whitn U : 48	
z : 2.42	p (same med.): 0.015	z : 2.65	p (same med.): 0.007
Monte Carlo permutation:	p (same med.): 0.013	Monte Carlo permutation:	p (same med.): 0.005

parameters in aquatic ecosystems (P1 and P2), such as temperature, pH, transparency, dissolved oxygen, TDS, chloride, phosphate, nitrate, BOD, and COD. These parameters serve as vital indicators of water quality and environmental well-being. The findings demonstrate variations between the pre-COVID-19 (PRC19) and post-COVID-19 (POC19) periods, with POC19 indicating improved water quality, reduced organic pollution, and enhanced transparency. The study also highlights changes in zooplankton, with rotifers dominating and bioindicator species present. This research underscores the dynamic nature of aquatic ecosystems and the importance of ongoing monitoring for ecological assessment.

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