



Studies on seasonal and spatial variation of zooplankton community in freshwater Parasдох Reservoir, Betul district (M.P.) India

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Abstract

The present study was conducted from March 2023 to February, 2024 to understand the seasonal and spatial variation of zooplankton community of Parasдох reservoir. The study provide new insights into reservoir ecology, water quality and valuable information about seasonal changes affected zooplankton community. During the study period, total 110 zooplankton species were recorded in this reservoir at three stations in which 46 species of Rotifera, 27 species of Cladocera, 9 species of Copepoda, 24 species of Protozoa, 4 species of Ostracoda were observed.

Result of the study shows that the water quality of the reservoir is fairly good except at few places which may be due to some seasonal variations and localised anthropogenic impacts. The Reservoir is rich in wide varieties of zooplankton community and suitable for fish culture practices.

Keywords: Parasдох reservoir, zooplankton community, pollution, fish culture, water quality, seasonal variation, spatial variation

Introduction

Zooplankton are microscopic, free floating, diverse and heterotrophic organisms found more or less in all water bodies. Zooplankton are essential to the functioning of aquatic ecosystem as the most crucial link in the energy transfer between phytoplankton and higher aquatic animals like fish. The functioning of an aquatic ecosystem's food chain, food web, energy flow and nutrient cycling are influenced by zooplankton. Due to their high density they serve as the indicators of the physical, chemical and biological processes occurring in aquatic system. Zooplankton community is composed of both primary consumers and secondary consumers which feed on other zooplankton.

Zooplankton are cosmopolitan in distribution and found in all types of water body, including polluted, municipal and industrial waste water. Zooplankton can survive under a wide range of environmental condition. Zooplankton populations are the excellent indicators of the stability of the food chain. Fish production in a waterbody are directly or indirectly dependent on the abundance of plankton.

Zooplankton diversity and density refers to variety within community and their diversity is one of the most important ecological parameters. They do not only form an integral part of the lentic community but also contribute significantly the biological productivity of the freshwater ecosystem.

Zooplankton is a good indicator of the changes in water quality because they are strongly affected by environmental conditions and respond quickly to changes in water quality. Zooplankton plays an important role in the early detection and monitoring the pollution of water as they act as the biological indicator. They are also indicating the trophic status of a water body and some of them are bioindicator of organic and inorganic pollution. Zooplankton are classified in various groups *viz.* Rotifera, Cladocera, Copepoda,

Ostracoda and Protozoa. The domination of zooplankton in sssshallow water bodies vary according to the degree of organic pollution. Hence zooplankton can speak to situation of waterbody health.

Now a day's pollution of water bodies is increasing rapidly due to exponential growth of population, industrial proliferation, unplanned urbanization, increasing living standard and wide share of human activities. The population explosion along with urbanization and industrialization has not only resulted in deterioration of water quality but also on biodiversity of many aquatic resources thereby impacting the livelihood generation and economic prosperity all over the world. The water pollution therefore is clearly one of the most critical challenges that create a problem of disease, environmental degradation and economic stagnation apart from biodiversity loss (Pani Subrata, 2007).

The life and its stability in aquatic environment are governed by many physico-chemical and biological characteristics of a water body. Physico-chemical parameters of water is important measure to know the quality of water before it is used for drinking, domestic, agricultural or industrial or any other purpose. Apart from conventional physico-chemical analysis, biological assessment through analysis of planktonic communities, fishes etc are being used nowadays to determine the overall ecological condition of an aquatic environment.

Presence of biological components like zooplankton plays an important role on fish production. From the hydro biological point of view the role of phytoplankton and zooplankton biomass plays a significant role in reflecting the true quality of water. Fishes have narrow range of tolerance and play significant role, because of top most actuality in the water ecosystem or they occupy top position of food chain.

Water quality assessment is very important, as the majority of the water used in urban cities comes from surface water.

It is the measure of how suitable the water is from a biological, chemical and physical perspective. Water quality can be impacted negatively by both natural and human causes (Misra, et al. 2005) [4]. Physico-chemical parameters like pH, Dissolve Oxygen, hardness, nitrates phosphates have direct impact on water quality of any aquatic system. The changes in different parameters have a strong relationship with the external influences, anthropogenic activities, nutrient loading etc. These physico-chemical parameters have a deep and significant relationship with biological parameters, as well as the biodiversity of an aquatic eco-system.

Thus the assessment of water quality through physico-chemical and biological analysis especially of zooplankton community in Parasдох Reservoir in Betul District of Madhya Pradesh was done during the period 2023 to 2024 for understanding the changes in characteristics of the reservoir water as it can reflect directly on the fish community of the reservoir system. The effects of pollution stress manifest themselves in several ways in ambient biotic community viz. change in the pattern of distribution, elimination of species, dominance of tolerant species, change in diversity and morphological and physiological changes (Dixit and Pani, 2014) [3].

Material and methods

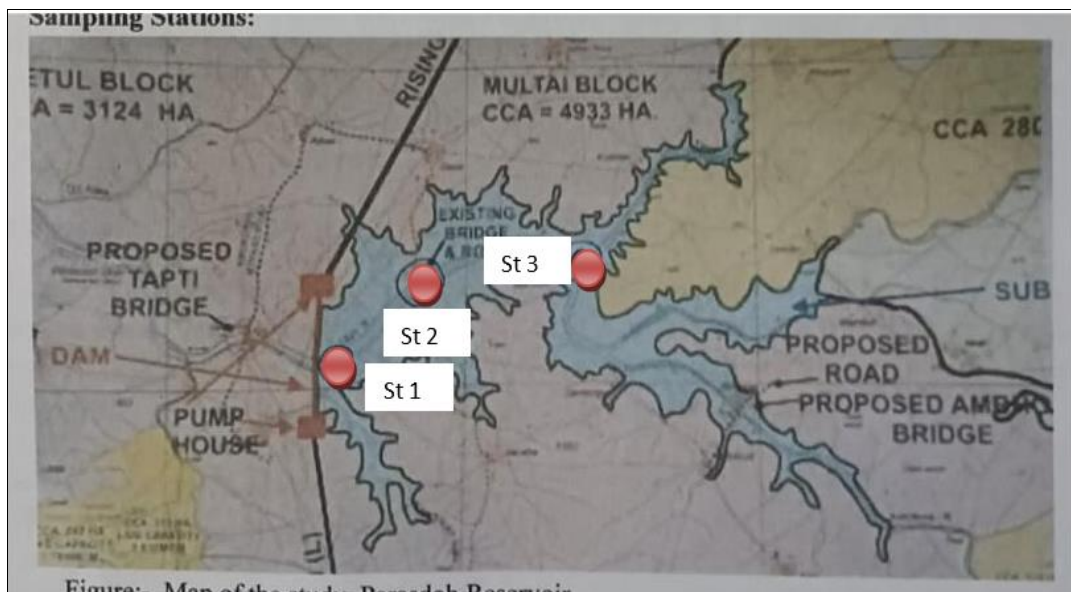
The present study was designed to assess the cumulative impact of various anthropogenic activities on the water

quality of the reservoir with respect to its use for enhancement of fish production. For this an extensive field survey was conducted in the catchment of the reservoir including the inflow and out flow channels of the water body. After a meticulous survey, three sampling stations were finalized for collection of water samples so as to have a representation of the existing water quality with respect to various anthropogenic activities being performed in the catchment area of the reservoir.

Description of Study area

Parasдох reservoir is a major perennial reservoir which is located near Pachdhar village in Prabhat Pattan Block, Tal Multai in Betul District of Madhya Pradesh (Map-1). The dam has a catchment area of 588.50 sq.km. Length of the Dam is 1612 m and the maximum height of the reservoir from the lowest river bed 27 m that is linked with Tapti River. The gross water storage capacity of the dam is 72.73 m. The dam water plays an important role for drinking, irrigation and fish production. The average water area of 594.95 hectare is used for fish production in the reservoir. The annual rainfall in Multai is 1024.89 mm. The maximum rainfall is 1574.80 mm. and the minimum rainfall is 440.94 mm.

For the present investigation water samples were collected from the identified sampling sites (Map-1) at seasonal intervals during the period March 2023 to February, 2024.



Map 1: Parasдох Reservoir with sampling stations.

Composite samples were collected from the surface of the three identified sampling stations of the reservoir. Collection, preservation and analysis of the water samples for various physico-chemical parameters were done following the standard methods described in APHA (2017) [1]. After collection of the samples the bottles were tightly capped and were immediately transported to the laboratory to avoid any unpredictable changes in the physico-chemical characteristics. Suitable preservation techniques were adopted as per the standard methods. The parameters like temperature, TDS, conductivity, Dissolved Oxygen were analyzed on the field while rest of the parameters including

enumeration of zooplankton were done in the laboratory as per the methods described in APHA (2017) [1].

Result

The results obtained for various Physico-chemical parameters are discussed below.

Physico-chemical Characteristics of Parasдох Reservoir during 2023-2024

Seasonal variations in different physico-chemical parameters at various stations of Parasдох reservoir for the period 2023-2024 is depicted in Table 2 (mean values).

Table 1: Physico-chemical analysis during different seasons in Parasдох reservoir during 2023 to 2024 (mean values)

Parameters	Summer			Monsoon			Post monsoon			Winter		
	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3
Air Temperature (°C)	36	36.5	37	34.2	32.8	33.2	29	27	29	26	24	19
Water Temperature (°C)	29	30	31	30.5	30.8	29.4	31.9	31.8	31.6	22.4	21.4	19.4
Sacchi Transparency (Cm)	108	91.5	74.5	108.8	98.8	92.3	78.75	81.25	91.25	154	150.5	131
pH	8.2	8.3	8.2	8.1	8.3	9.4	7.2	7.75	7.91	6.98	7.23	7.54
Electrical conductivity (mS/cm)	305	262	288	315	327	311	150.9	151.4	167.2	105.9	106.7	106.2
Total dissolved Solids (mg/l)	150	137	149	224	231	229	102	110	128	290	328	352
Dissolved Oxygen (mg/l)	7.8	7	7.6	7.2	7.6	8	7.8	8	8.2	7.4	7.6	7.8
Total Alkalinity (mg/l)	130	132	124	138	146	140	84	84	98	70	64	94
Total Hardness (mg/l)	166	148	168	172	168	158	142	138	172	260	232	206
Chloride (mg/l)	10.99	12.99	14.99	28	32	26	18.99	19.99	20.99	23.99	18.99	22.99
Nitrate (mg/l)	0.09	0.03	0.07	0.09	0.11	0.01	0.01	0.02	0.01	1.5	1.2	1.1
Ortho-phosphate (mg/l)	1.0	5.48	15.55	8.24	10.4	9.92	0.06	0.07	0.07	1.4	0.5	0.8

The water quality of a Reservoir is determined by assessing three classes of attributes: biological, chemical, and physical. There are standards of water quality set for each of these three classes of attributes. Some attributes are considered of primary importance to the quality of drinking water, while others are of secondary importance as well as for understanding the biodiversity of the Reservoir ecosystem (Bhateria and Jain, 2016)^[2].

Physical attributes of the water can be important indicators of water quality. Apart from this assessment of physical attribute, the chemical attribute includes measures of many elements and molecules dissolved or suspended in the water. Chemical measures can be used to directly detect pollutants such as nitrate, phosphate and other active nutrients. Chemical measures can also be used to detect imbalances within the ecosystem. Such imbalances may indicate the presence of certain pollutants. Since the chemical quality of water is important to the health of humans as well as the plants and animals that live in and around streams, it is necessary to assess the chemical attributes of water along with physical and biological attributes.

Considering the importance of these attributes, the physico-chemical, biological characteristics of the Parasдох Reservoir have been analyzed during the period 2023-2024 as stated above to determine the environmental impact of various natural and anthropogenic variables on aquatic resources of the reservoir.

Biological Characteristics of Parasдох Reservoir during 2023-2024

Zooplankton biodiversity is considered to be one of the important ecological indicators of aquatic environment under assessment of biological characteristics of an aquatic water body. Biodiversity of zooplankton is essential to keep our ecosystem healthy because each species plays a specific role (recycling of nutrients, food for another and maintaining of soil fertility) in the ecosystem and some species may allow natural ecosystem to function in a healthy manner. Zooplankton communities are highly sensitive to environmental fluctuations. Changes in zooplankton abundance, species diversity and community composition can indicate the change or disturbance of the environment. A change in the physico-chemical conditions in aquatic

systems brings a corresponding change in the relative composition and abundance of organisms thriving in the water; therefore, they can be used as a tool in monitoring aquatic ecosystems, hence, zooplankton have been considered as ecologically important organism. Thus the study of zooplankton is necessary to evaluate the fresh water reservoir in respect to their ecological and fishery status. The seasonal fluctuations of zooplankton populations can be expressed by various quantitative parameters such as population densities, biomass and biochemical compounds. The distribution of zooplankton community depends on a complex of factors such as change of climatic conditions, physical and chemical parameters and vegetation cover.

Zooplankton Community

Zooplankton Community Structure of Parasдох Reservoir during 2023-2024 included five groups viz. Rotifera, Cladocera, Copepoda, Ostracoda and Protozoa. Total 110 species of various groups of zooplankton species were recorded in the reservoir during 2023-2024 in which Rotifera is represented by 46 species while Cladocera, Copepoda, Protozoa and Ostracoda were represented by 27, 9, 24 and 4 species respectively.

Variation in community structure of different categories of zooplankton community is depicted in Table-3. The dominance of zooplankton community interns of presence is as under:

Rotifera > Protozoa > Cladocera > Copepoda > Ostracoda

Seasonal and spatial variation of zooplankton community in Parasдох reservoir

Seasonal and spatial variation of different groups of zooplankton community is Parasдох Reservoir

Spatial Variation of various groups of zooplankton community during different seasons of 2023-2024 is discussed below.

Rotifera

During 2023-2024 the Rotifera community in Parasдох Reservoir was represented by 46 species (Table-3 & Fig-2). Maximum number of species of this community was recorded at station-3 during monsoon season.

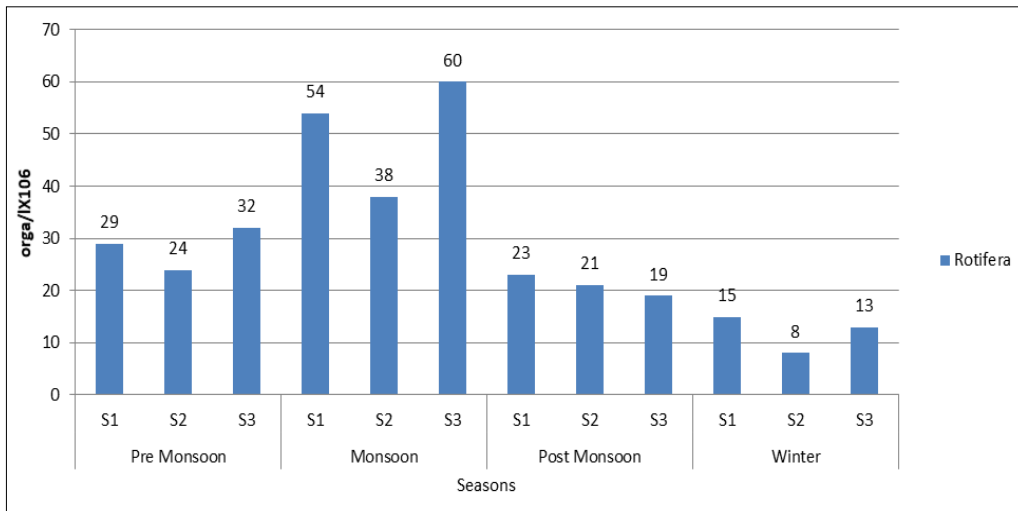


Fig 2: Variation in Rotifera community in different seasons in Parasдох Dam during during 2023-2024

Cladocera

The Cladocera community in Parasдох Reservoir was represented by 27 species (Table-3 & Figure-3). Maximum number of species of this community was recorded at station-1 during monsoon season.

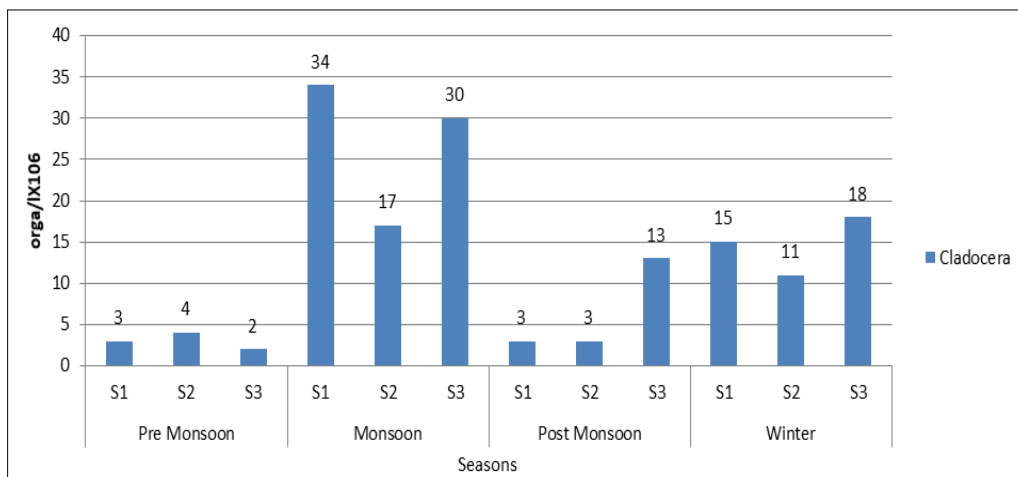


Fig 3: Variation in Cladoceran community in different seasons in Parasдох Dam during 2023-2024

Copepoda

The Copepoda community in Parasдох Reservoir was represented by 9 species (Table-3 & Figure-4). Maximum number of species of this community was recorded at station-2 during monsoon & winter seasons (Fig-4).

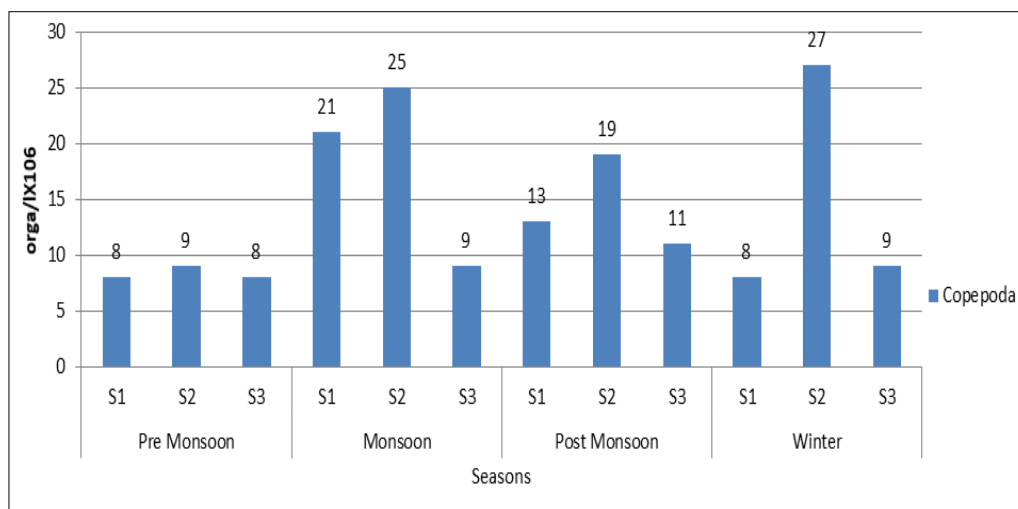


Fig 4: Variation in Copepoda community in different seasons in Parasдох Dam during 2023-2024

Protozoa

The Protozoa community in Parasдох Reservoir was represented by 24 species (Table-3 & Fig-5). Maximum number of species of this community was recorded at station- 2& 3 during pre-monsoon and post-monsoon seasons.

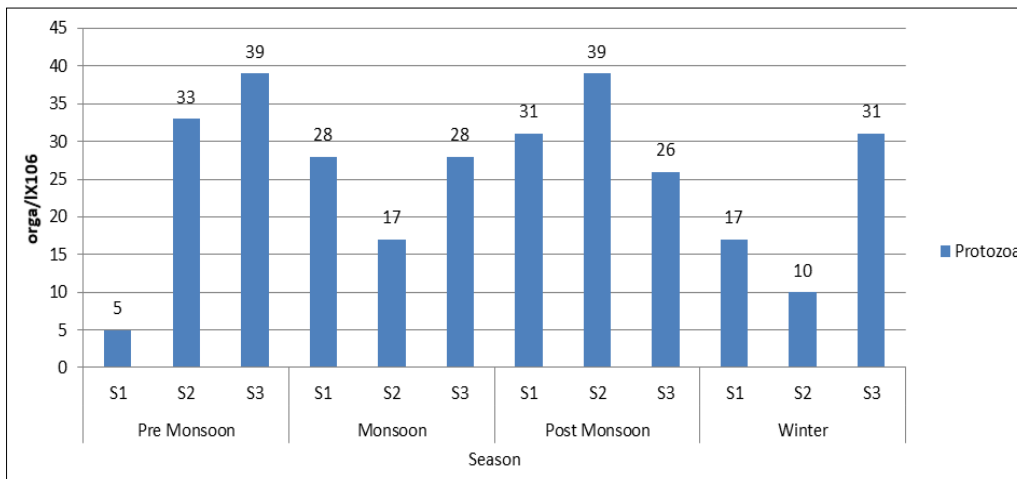


Fig 5: Variation in Protozoan community in different seasons in Parasдох Dam during 2023-2024

Ostracoda

The Ostracoda community in Parasдох Reservoir was represented by 4 species (Table-3 & Fig-6). Maximum number of species of this community was recorded at station-1 during monsoon season.

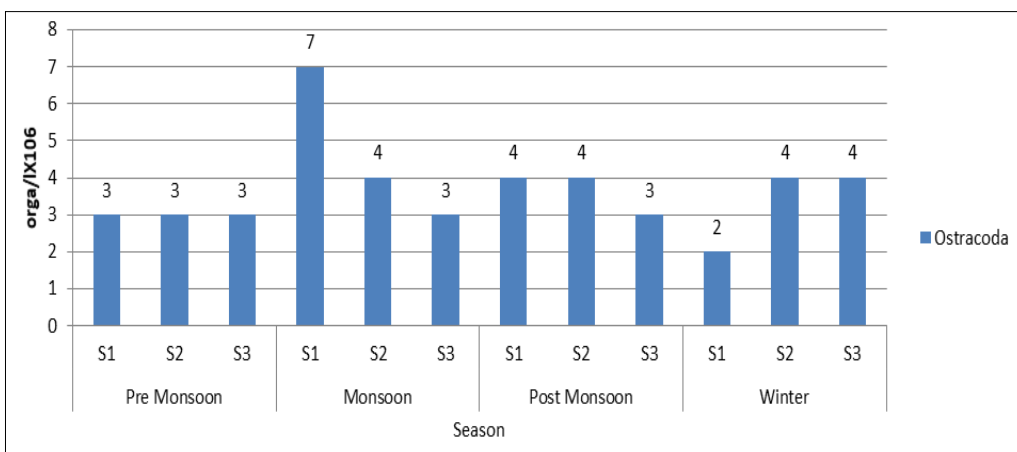


Fig 6: Variation in Ostracodan community in different seasons in Parasдох Dam during 2023-2024

Percent variation of zooplankton community structure at Parasдох Reservoir during 2023-2024

Variation in percent contribution (average values) in density of various groups of zooplankton species in Parasдох Reservoir during 2023-2024 is shown in Fig-7. Out of five groups Rotifera represented maximum species (34%) followed by Protozoa (30%), Copepoda (17%), Cladocera (15%) while Ostracoda contributed (4%) only (Fig-7).

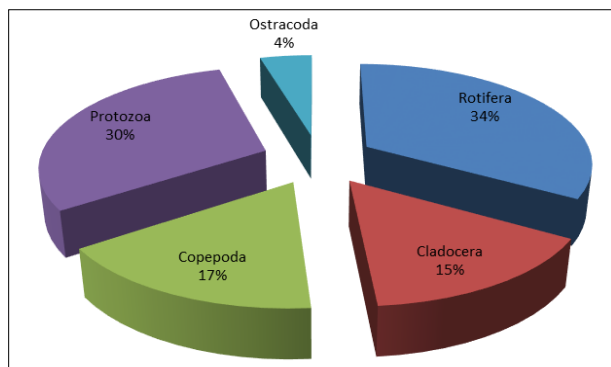


Fig 7: Variation in percent contribution (average values) of various groups of zooplankton community in Parasдох Dam during 2022-2023

Seasonal variation of various groups of zooplankton community in Parasдох reservoir during 2023-2024.

Seasonal variation in percent contribution (average values) of various groups of zooplankton community at different stations in Parasдох Reservoir during 2023-2024 is shown in Fig-8 to 11.

Pre monsoon Season

Percent contribution (average values) of various groups of zooplankton community at different stations in Parasдох Reservoir during Pre monsoon Season of 2023-2024 is shown in Fig-8. During pre-monsoon season, maximum density of rotifera community was recorded at station -3

(38%), maximum density of Cladocera was recorded at station -2 (45%), maximum density of Copepoda was recorded at station -2(42 %), maximum density of Protozoa

community was recorded at station -3 (47%) and maximum density of Ostracoda community was recorded at station -1 (34%).

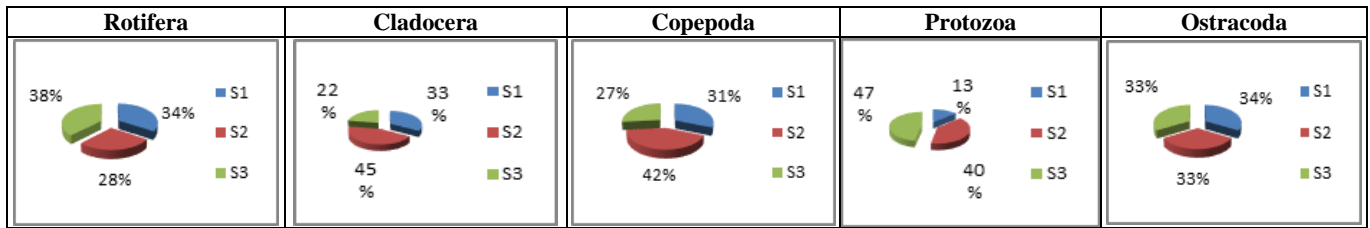


Fig 8: Percent contribution (average values) of various groups of zooplankon community at different stations in Parasдох Reservoir during Pre monsoon Season of 2023-2024

Monsoon Season

Percent contribution (average values) of various groups of zooplankon community at different stations in Parasдох Reservoir during monsoon Season of 2023-2024 is shown in Fig-9. During monsoon season, maximum density of Rotifera community was recorded at station -3 (39%),

maximum density of Cladocera community was recorded at station -1 (34), maximum density of Copepoda community was recorded at station - 2 (44 %), maximum density of Protozoa community was recorded at station -1 (39%), and maximum density of Ostracoda community was recorded at station -1 (50%).

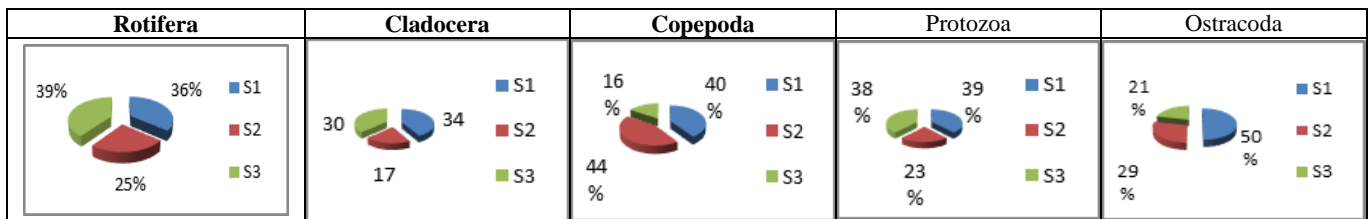


Fig 9: Percent contribution (average values) of various groups of zooplankon community at different stations in Parasдох Reservoir during monsoon Season of 2023-2024

Post Monsoon

Percent contribution (average values) of various groups of zooplankon community at different stations in Parasдох Reservoir during post monsoon season of 2023-2024 is shown in Fig-10. During post monsoon season, maximum density of Rotifera community was recorded at station -1

(37%), maximum density of Cladocera community was recorded at station -3 (68%), maximum density of Copepoda community was recorded at station - 2 (46 %), maximum density of Protozoa community was recorded at station -2 (41%), and maximum density of Ostracoda community was recorded at station -1 (37%).

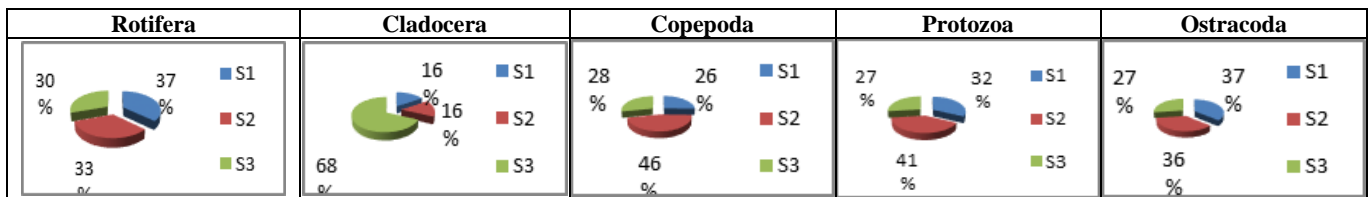


Fig 10: Percent contribution (average values) of various groups of zooplankon community at different stations in Parasдох Reservoir during post monsoon Season of 2023-2024

Winter season

Percent contribution (average values) of various groups of zooplankon community at different stations in Parasдох Reservoir during winter season of 2023-2024 is shown in Fig-11. During winter season, maximum density of Rotifera community was recorded at station -1 (42%), maximum

density of Cladocera community was recorded at station -3 (41%), maximum density of Copepoda community was recorded at station - 2 (42 %), maximum density of Protozoan community was recorded at station -3 (54%), and maximum density of Ostracoda community was recorded at station -2 as well as at station -3 (40%).

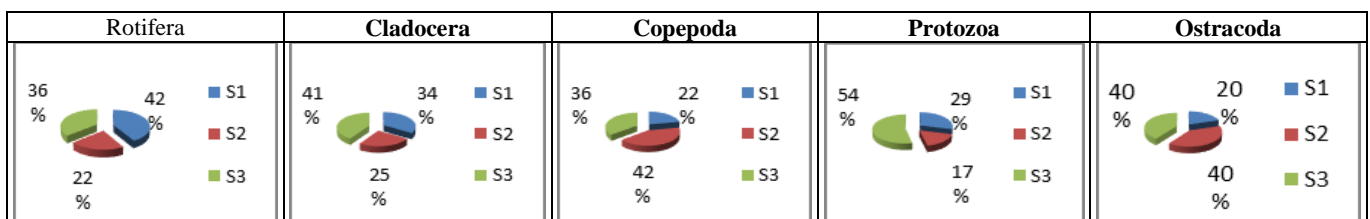


Fig 11: Percent contribution (average values) of various groups of zooplankon community at different stations in Parasдох Reservoir during winter Season of 2023-2024

Discussion

There has been a greater evidence of progressive deterioration of the water quality not only in India but also all over the world (Pani and Misra, 2005) ^[4, 6]. While the natural factors like dust, storm, runoffs and weathering of minerals are slow process in causing eutrophication but modern civilization, industrialization and increase the intensity of pollution which culminated to fast degradation of our fresh resources (Pandey *et al*, 2010) ^[5]. With the increase in human population and their activities the self-purification power of water resources has diminished, leading to severe problems. In urban areas the situation is still worse where the water body is subject to much greater human pressure including direct discharge of sewage and industrial waste, which often contains heavy metals (Pani, and Mishra, 2000) ^[8].

In India River and lake pollution is very severe and critical problem due to huge amount of pollutants discharged by urban activities. Thus, water pollution needs serious immediate action and continuous monitoring of pollution level in order to prevent the water because of its importance in maintaining the human health, plants and agriculture. Without fresh water sustainable development will not be possible. Water quality assessment is very important, as the majority of the water used in urban cities comes from surface water. It is the measure of how suitable the water is from biological, chemical and physical perspectives. Water quality can be impacted negatively by both natural and human causes. Physico-chemical parameters like pH, Dissolve oxygen, hardness, nitrates phosphates have direct impact on water quality of any aquatic system.

Nutrients are essential for plant growth and development. Many nutrients are found in wastewater and fertilizers, and these can cause excess weed and algae growth if large concentrations end up in water. This can contaminate drinking water and clog filters. Nutrient over-enrichment can cause a range of economic and non-economic impacts, including eutrophication and associated anoxia and hypoxia, loss of sea grass beds and corals, loss of fishery resources, changes in ecological structure, loss of biotic diversity, and impairment of aesthetic enjoyment (Pani, 2017) ^[9].

Most of the water samples contain significant amount of nitrate and ortho phosphate that provides nutrition for the growth and multiplication of microorganisms. Thus, by detailed analysis of the data obtained during the study period 2023-2024, it can be concluded that the quality of water of Parasдох reservoir in general observed to be good except at few intervals wherein little sign of pollution was observed. Based on the observed the reservoir water may be placed under class - C of Central Pollution Control Board (CPCB, New Delhi) designated for best uses of water for irrigation and drinking water after conventional treatment.

Conclusion

During present investigation, presence of few pollution tolerant zooplankton species shows that water at some places of Parasдох reservoir is polluted. Zooplankton demonstrates an integrated effect of pollution and community response is sensitive to organic loading, substrate alterations, toxic pollution etc (Pani, 2007). Considering this zooplankton community of Parasдох

Reservoir was also analyzed along with physicochemical observations to obtain a realistic picture of water quality the reservoir. As part of this study qualitative and quantitative distribution of various zooplankton communities belonging to different families recorded was done in Parasдох Reservoir during the period 2023-2024 which is depicted in Table - 3 to 8 & Fig- 8 to 11.

The present investigation concludes that the water quality of Parasдох reservoir is mildly deteriorated especially near station-2 which receives discharge of raw water from the nearby settlements. The concentration of ortho phosphate, Nitrate-nitrogen and Chloride reveal sign of organic pollution from the adjoining inlets at some intervals. Similarly high concentrations of inorganic constituents like total hardness, total alkalinity, etc also indicate deteriorating water quality of the reservoir.

While observing the distribution of different groups of zooplankton community *viz.* Rotifera, Cladocera, Copepda, Protozoa and Ostracods, during the period 2023-2024, a distinct variation in terms of species composition with respect to temporal and spatial variations were observed (Fig-8 to -11). This may be due to variations in nutrient enrichment at different stations and availability of water as the water balance of the reservoir is highly variable due to its multipurpose uses, irrigation being one of the major purpose. However the reservoir is very rich in biodiversity especially with zooplankton community and can serve as one of the best water body for optimum fish production.

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