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Studies on Zooplankton Diversity of Manar Reservoir with Selected Physico-Chemical Parameters, Maharashtra

Bhosle Shivam A.[1,*], Shivanikar Sudhir V.[2], Shiurkar Janhavi R.[3]

Abstract

Freshwater reservoirs in India are increasingly exposed to anthropogenic pressures, such as agricultural runoff, domestic sewage discharge, and water level fluctuations, which significantly influence nutrient dynamics and aquatic ecosystem stability. Biomonitoring using plankton communities provides an effective approach for evaluating ecological health, as these organisms respond rapidly to changes in physico-chemical conditions. The present investigation was carried out to assess the environmental status and trophic condition of Manar Reservoir, located near Barul village in Nanded district, Maharashtra, through zooplankton-based biomonitoring integrated with selected water quality parameters. Four sampling stations representing distinct hydrological zones from the river inflow region to the main storage area of the reservoir were selected for systematic study. Water and Zooplankton samples were collected twice monthly from January to December 2024. Physico-chemical parameters including temperature, pH, dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), phosphate, sulphate, and nitrite–nitrogen were analyzed using standard methods. Zooplankton were collected using a standard plankton net, preserved when required, and identified under a research microscope based on morphological characteristics. The results indicated that the analyzed physico-chemical parameters remained within permissible limits throughout the study period, reflecting favorable environmental conditions. Seasonal variation was observed in Zooplankton diversity and abundance, with comparatively higher productivity during winter months. The absence of excessive organic and chemical pollution suggests that the reservoir is relatively free from significant ecological stress. Overall, the study demonstrates that Manar Reservoir maintains a stable Zooplankton community and good water quality. The findings provide valuable baseline data for long-term ecological monitoring and contribute to the sustainable management of this important freshwater resource.

Keywords: Bio-monitoring, diversity, freshwater evaluation, Zooplankton, physico-chemical

***Author for Correspondence**
Bhosle Shivam A.
E-mail: shivambhosle18@gmail.com

[1]Research Student, Department of Environmental Science, Netaji Subhashchandra Bose Senior College, Nanded, Maharashtra, India
[2]Principal (Former), Department of Environmental Science, Netaji Subhashchandra Bose Senior College, Nanded, Maharashtra, India
[3]Assistant Professor, Department of Environmental Science, Netaji Subhashchandra Bose Senior College, Nanded, Maharashtra, India

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INTRODUCTION

Zooplankton forms an integral component of aquatic food webs and contributes significantly to energy transfer and nutrient cycling. Due to their rapid response to environmental changes and sensitivity to physicochemical variations, they are widely recognized as reliable bio-indicators for assessing water quality and ecological status of freshwater bodies [1]. Their diversity, abundance, and seasonal distribution reflect the trophic condition and environmental health of reservoirs.

Plankton plays a crucial role in aquatic food webs, where Phytoplankton act as primary producers and Zooplankton function as primary consumers, transferring energy to higher trophic

levels. Their diversity and abundance reflect the trophic status and environmental condition of freshwater bodies [2]. Therefore, plankton-based biomonitoring is widely used to evaluate water quality and reservoir productivity. The present study aims to assess the ecological status of Manar Reservoir using plankton diversity and selected physico-chemical parameters to provide baseline information for its sustainable management.

STUDY AREA AND SAMPLING SITES

Manar Reservoir (Figure 1) is located near Barul village in Nanded district, Maharashtra, approximately 50 km from Nanded city. It is an important freshwater system used for drinking water supply, irrigation and fisheries. The reservoir supports diverse aquatic life and plays a significant role in regional ecological balance.

The reservoir was influenced by seasonal variations and anthropogenic activities from surrounding agricultural and residential areas, which may affect water quality and biological productivity, due to its ecological and socio-economic importance. The Manar Reservoir was selected for the present study to evaluate Zooplankton diversity and environmental conditions through biomonitoring.

Nearly four water sampling stations were established at different locations with well composite, content of water within the reservoir to represent distinct hydrological conditions and varying degrees of anthropogenic influence. Generally, we observed very little agricultural and domestic matter which influences this water body. These sampling sites were designated as S_1, S_2, S_3 and S_4, extending from the point of river inflow to the main storage zone of the reservoir. The selected sites covered the gradient from the entry region of incoming water to the deeper and wider storage areas of the dam. The exact locations and distribution of these sampling stations are illustrated in Figure 2. Water sampling was conducted twice monthly throughout, i.e., January to December 2024 to monitor seasonal variations and plankton dynamics in this freshwater reservoir, we have calculated the average values of noted results and mentioned precisely in this study.

Several key physico-chemical parameters were examined to evaluate water quality and its influence on Zooplankton productivity in the reservoir ecosystem [3]. The parameters analyzed included water temperature measured using a micro-thermometer, pH determined with a digital pH meter, dissolved oxygen estimated by Winkler's method, biochemical oxygen demand (BOD) measured over a five-day incubation period, and chemical oxygen demand (COD) assessed using the reflux method. In addition, nutrient parameters, such as phosphate, Sulphate and nitrite-nitrogen, were quantified using a digital spectrophotometer.

Water samples were collected regularly throughout the study period from January to December 2024 and transported to the laboratory for detailed analysis following standard procedures. Based on the physico-chemical characteristics and biological examination, various Zooplankton species present in the reservoir were identified. The data obtained were used to evaluate Zooplankton productivity and to draw conclusions regarding the ecological status and environmental condition of the reservoir. Sampling Site of Manar Dam given in Table 1 & in Figure 3 display Board at the dam site showing details.

Figure 1. A view showing large water storage in Manar Dam.

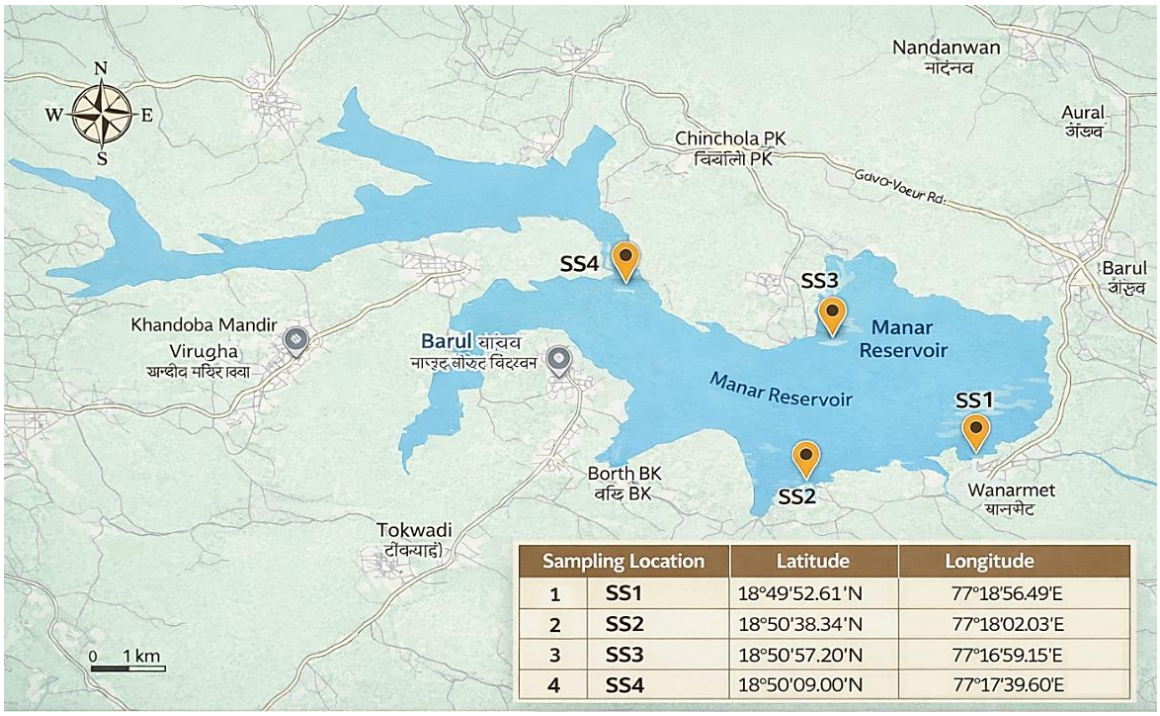

Figure 2. Google map visuals of Manar reservoir with selected four different water sampling sites.

Table 1. Sampling site of Manar Dam.

S.N.	Sampling site (SS)	Latitude	Longitude
1.	(SS_1)	18°49'52.61"N	77°18'56.49"E
2.	(SS_2)	18°50'38.34"N	77°18'2.03"E
3.	(SS_3)	18°50'57.20"N	77°16'59.15"E
4.	(SS_4)	18°50'09.00"N	77°17'39.60"E

Note: SS = Sampling Site.

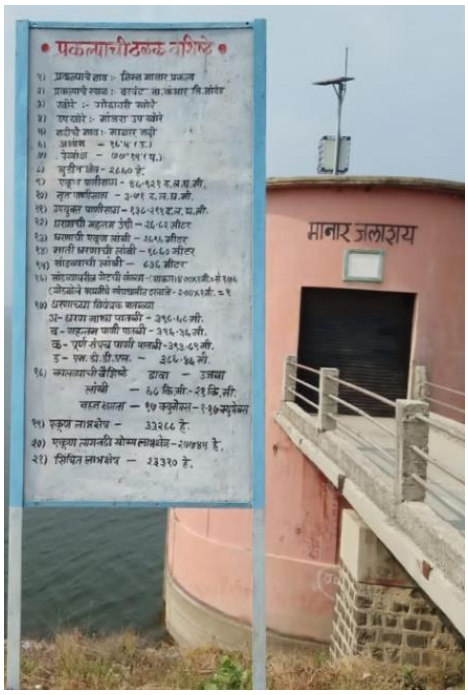

Figure 3. Display Board at the dam site showing details.

MATERIAL AND METHODOLOGY

Water samples were collected in clean, sterilized glass and plastic containers following standard sampling protocols to avoid contamination. Physico-chemical parameters, such as temperature and pH, were measured at the sampling site, while the remaining parameters were analyzed in the laboratory using standard procedures.

Zooplankton samples were collected regularly from the selected stations using a standard plankton net as shown in Figure 4 by filtering reservoir water from a depth range of approximately 15 to 60 cm below the surface. The samples collected were transferred carefully into labeled containers and transported to the laboratory for further examination. Fresh samples were analyzed immediately, while a portion of the samples were preserved in formalin for detailed identification and future reference.

Figure 4. Collection of water samples with the help of Plankton net.

In the laboratory, Zooplankton organisms were concentrated by sedimentation and examined under a research microscope using appropriate magnification. Identification was carried out based on morphological characteristics, such as body shape, size, appendages and structural features, following standard taxonomic keys. Necessary laboratory equipment, glassware, and microscopic techniques were used to ensure accurate identification. The observed Zooplankton species, their distribution were recorded systematically and used to assess the ecological condition of the reservoir.

RESULTS AND DISCUSSION

Munde and More (2020) [4] studied the diversity and seasonal variation of Zooplankton in Sukhana Dam, Aurangabad, Maharashtra, to evaluate its ecological condition. The study was carried out from July 2008 to June 2009. A total of 29 Zooplankton species belonging to four groups – Cladocera, Copepoda, Rotifera and Ostracoda – were recorded, with Copepoda as the dominant group followed by Cladocera and Rotifera. The study reported maximum Zooplankton density during summer and minimum during the monsoon, indicating strong seasonal influence on plankton distribution due to temperature, nutrient availability and dilution effects. Zooplankton abundance was closely associated with environmental conditions and food availability, particularly Phytoplankton productivity.

Investigation work carried out for plankton diversity and water quality of Azhagankulam Pond, Tamil Nadu. The study recorded 24 plankton species, including Zooplankton and Phytoplankton groups, with Brachionus (Rotifers), Calanus (Copepods), Daphnia (Cladocerans), and Spirulina as dominant forms. Seasonal variation in plankton diversity was observed, with higher abundance during December and

lowest in March, influenced by environmental factors such as temperature, salinity, and nutrient availability. The presence of eutrophic conditions indicated nutrient enrichment affecting freshwater biodiversity [5].

A study by Bhatnagar et al. (2013) [6] assessed the water quality of the Yamuna River using physico-chemical parameters, Plankton and Macro Zoo benthos as Bio-indicators. The study reported increased pollution due to sewage and industrial discharge, resulting in decreased species diversity and abundance of Phytoplankton, Zooplankton and benthic organisms. Dominance of tolerant species, such as Navicula, Brachionus, and Tubifex, indicated stressed and polluted conditions.

A systematic study was conducted on Raja Bandh Pond, Jharkhand. The study was carried out from July 2018 to June 2019. They recorded 14 species of Zooplankton belonging to four major groups – Rotifera, Cladocera, Copepoda and Ostracoda – with Rotifera being the dominant group, indicating environmental stress and possible organic pollution. The presence of pollution indicator species, like Brachionus, further suggested organic enrichment and deteriorating water quality [7].

Kharbyngar et al. (2024) [8], from Sankardev College, investigated the diversity and abundance of Phytoplankton and Zooplankton in freshwater ecosystems of Meghalaya, particularly at two places which are Ri-Bhoi and East Khasi Hills districts during 2023–2024. The study recorded diverse plankton groups including green algae, blue–green algae, diatoms, desmids, protozoa, rotifers and crustaceans with Phytoplankton showing higher abundance than zooplankton. Greater plankton diversity was observed in Ri-Bhoi compared to East Khasi Hills, and dominant species, such as Microcystis and Bosmina, were identified.

Phonmat et al. (2025) [9] investigated Phytoplankton and Zooplankton assemblages across 50 lentic water bodies in Thailand to evaluate the influence of trophic gradients and environmental factors on plankton distribution. Field sampling was conducted at 264 points in April and May 2024. The study reported that Phytoplankton density increased in eutrophic and hypereutrophic conditions, with Cyanophyta dominating nutrient-rich waters, while Dinophyta was more abundant in oligotrophic systems. Zooplankton composition also varied with trophic status, with Rotifers dominating eutrophic waters and Copepoda prevailing in oligotrophic conditions.

The study conducted on the Kangsabati River, West Bengal, evaluated water quality using the Water Quality Index (WQI) and Zooplankton diversity to assess ecosystem health and pollution status. A total of 57 Zooplankton species were recorded, with Copepods, Rotifers and Cladocerans dominating the community, indicating their ecological importance in freshwater ecosystems as well as food chain pattern [10].

The WQI values ranged from very poor to unfit for consumption, reflecting significant anthropogenic impacts such as sewage discharge, agricultural runoff, and industrial effluents. Strong correlations were observed between plankton density and physicochemical parameters, such as dissolved oxygen, biological oxygen demand, total dissolved solids, and nutrient concentrations, highlighting the influence of environmental factors on Zooplankton distribution. Multivariate statistical tools, like PCA and cluster analysis, are effective for identifying key environmental drivers affecting aquatic ecosystems.

Tang et al. (2024) [11] investigated the plankton community structure and its relationship with environmental factors in the midstream of the Jialing River, China, in the summer of 2022. The study recorded 149 Phytoplankton species and 48 Zooplankton species, with diatoms, cyanobacteria and green algae dominating the Phytoplankton community, while rotifers and protozoa dominated zooplankton. Diversity indices indicated moderate pollution levels and redundancy analysis revealed that water temperature, pH, electrical conductivity, transparency, and total phosphorus were key factors influenced plankton distribution. The study also highlighted the effectiveness of traditional biomanipulation through piscivorous fish in controlling Phytoplankton density and improving aquatic ecosystem management.

Investigations carried out on Phytoplankton and Zooplankton communities in relation to ecological status under the Water Framework Directive in regulated lowland water courses. Six sampling campaigns were carried out in the upstream part of the Scheldt catchment at stations monitored in the WFD context. The study found that nutrient concentrations, especially nitrogen and phosphorus, significantly influenced plankton composition, biomass and diversity. Diatoms dominated nutrient-rich waters, while rotifers indicated eutrophic and degraded ecological conditions. Plankton distribution showed strong correlation with physicochemical parameters such as dissolved oxygen and temperature [12].

Kozak and Gołdyn (2014) [13] investigated the variation in Phytoplankton and Zooplankton communities in Lake Uzarzewskie, Poland, during restoration aimed at improving water quality in 2010–2012. A total of 161 Phytoplankton taxa were identified, with Chlorophyceae dominant in terms of taxa, while cyanobacteria dominated in abundance, especially during summer and autumn. Zooplankton was mainly represented by rotifers, indicating the hypertrophic condition of the lake. Restoration measures, such as phosphorus inactivation and hypolimnetic oxygenation, contributed to gradual improvement in water quality, reflected by increased Shannon–Weaver diversity index values. Significant correlations were observed between plankton abundance and physicochemical parameters such as temperature, oxygen, nutrients, and pH.

Panikkar et al. (2024) [14] assessed the plankton diversity and physicochemical characteristics of the Karapuzha Reservoir to evaluate ecosystem health and fish production potential availability. Sampling conducted month-wise for a period of one year, i.e., April 2009 to March 2010. The study recorded 36 genera of Phytoplankton and 11 genera of Zooplankton, with Chlorophyceae dominating the Phytoplankton community and Rotifers representing major Zooplankton groups. Diversity indices revealed moderate pollution status of the reservoir, highlighting the influence of physicochemical factors on aquatic productivity and sustainability.

The researchers investigated some lentic Water Bodies of East Champaran, Bihar viz. Turkaulia Lake, Motijheel Lake, Kararia Lake and Suraha Lake. The relationship between Phytoplankton and Zooplankton in these four lentic water bodies and observed a close association between their population dynamics. Rotifers dominated the Zooplankton community and seasonal variations showed maximum Phytoplankton density during the rainy season and minimum during winter. The study suggested that Zooplankton grazing, nutrient availability and physico-chemical parameters, such as pH, temperature, and alkalinity, influenced the plankton abundance and interactions in an aquatic body [15]. Details of observed values of different parameters are well indicated in Table 2.

Table 2. Physicochemical parameter analyzed and the average values during January to December 2024 at selected four sampling sites of Manar Reservoir.

Parameters	Sampling site				Mean ± standard deviation
	S1	S2	S3	S4	
Temperature	24.1	23.6	24.3	23.8	24 ± 3.134
pH	7.9	7.8	7.8	7.5	7.76 ± 0.214
DO (mg/L)	3.97	3.96	4.06	3.89	3.97 ± 0.350
BOD (mg/L)	6.19	6.29	6.16	6.24	6.22 ± 0.296
COD (mg/L)	0.86	0.92	0.98	0.93	0.92 ± 0.186
Sulphate (mg/L)	20.2	21.0	21.3	20.9	20.8 ± 1.245
Phosphate (mg/L)	0.893	0.915	1.086	0.923	0.954 ± 0.052
Nitrite–Nitrogen (mg/L)	0.459	0.462	0.469	0.463	0.463 ± 0.018

During Findings We Observed, Identified and Investigated Zooplankton as Shown Below

Daphnia

Among Zooplankton Daphnia (Figure 5) is crustacean, Daphnia was predominantly observed during winter and post-monsoon seasons in the reservoir, corresponding with higher dissolved oxygen, lower

BOD and moderate nutrient concentrations. The abundance of Daphnia indicates favourable water quality and efficient grazing on Phytoplankton, particularly diatoms and green algae. Its presence reflects stable ecological conditions and highlights its role in maintaining trophic balance within the reservoir.

Figure 5. Daphnia.

Cyclops

Cyclops (Figure 6) is a common freshwater Zooplankton species and exhibited wide distribution across all seasons, with increased density during summer and monsoon months. The species showed tolerance to moderate organic load and fluctuating dissolved oxygen levels, as reflected by the seasonal BOD variations. The adaptability of Cyclops suggests its importance as a key intermediate consumer linking Phytoplankton and higher trophic levels.

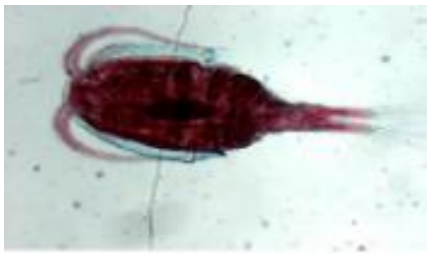

Figure 6. Cyclops.

Brachionus

This Zooplankton mostly found in water bodies, Brachionus (Figure 7) was abundant during summer months, coinciding with higher phosphate and nitrite–nitrogen concentrations. Its dominance during nutrient-rich periods indicates eutrophic tendencies and enhanced primary productivity. The presence of Brachionus serves as an indicator of organic enrichment and increased microbial activity within the reservoir ecosystem.

Figure 7. Brachionus.

Zoea

Zoea (Figure 8) stages were recorded sporadically, mainly during post-monsoon periods, when water stability and dissolved oxygen levels were comparatively high. Their occurrence suggests favourable breeding conditions and availability of food resources. The presence of Zoea larvae reflects connectivity with inflow regions and contributes to understanding recruitment patterns within the reservoir.

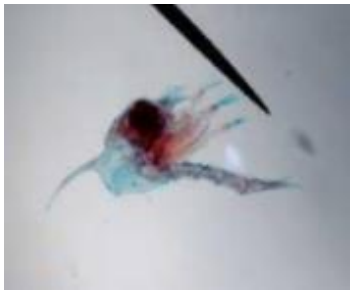

Figure 8. Zoea.

Keratella

Keratella (Figure 9) was commonly encountered during winter and early summer, showing preference for well-oxygenated waters with low BOD. Its distribution suggests moderate nutrient conditions and ecological stability. The consistent occurrence of Keratella highlights its sensitivity to environmental changes and its usefulness as a bio-indicator species.

Figure 9. Keratella.

Moina (Monia)

Moina (Figure 10) was observed predominantly during summer and monsoon seasons, coinciding with higher temperature and nutrient availability. The species thrives under moderately eutrophic conditions and contributes significantly to Zooplankton biomass and significant role in food chain ecosystem. Its abundance reflects enhanced Phytoplankton availability and supports secondary productivity in the reservoir.

Figure 10. Moina.

Bosmina

Bosmina (Figure 11) showed higher abundance during winter and post-monsoon periods in our findings, it is corresponding with high dissolved oxygen and reduced organic load. Its presence indicates favourable grazing conditions and relatively clean water. Bosmina plays a vital role in energy transfer from Phytoplankton to higher trophic levels thus having vital role in freshwater aquatic productivity.

Figure 11. Bosmina.

Nauplius

This type of plankton as Nauplius (Figure 12) stages were observed throughout the study period, with increased occurrence during monsoon and post-monsoon seasons. Their presence reflects active reproductive cycles of copepods under favourable environmental conditions. The abundance of Nauplius indicates healthy Zooplankton regeneration and dynamic population turnover in Manar Reservoir.

Figure 12. Nauplius.

Alona

Alona (Figure 13) was predominantly recorded during winter months, when water temperature was found lower and dissolved oxygen was higher. The species prefers stable environments with moderate nutrient levels and contributes to benthos–pelagic energy flow. Its occurrence signifies ecological stability and balanced nutrient conditions in the reservoir; hence it is considered positive role in food chain ecosystem.

Figure 13. Alona.

Rotifers

These are common Zooplankton as Rotifers (Figure 14) formed a significant component of the Zooplankton community and were present throughout all seasons in the reservoir. Their highest density generally was recorded during summer, coinciding with elevated nutrients and Phytoplankton abundance. Rotifers respond rapidly to environmental changes, making them effective indicators of trophic status and water quality fluctuations. Thus, a large number its presence indicated the healthy aquatic water body for food.

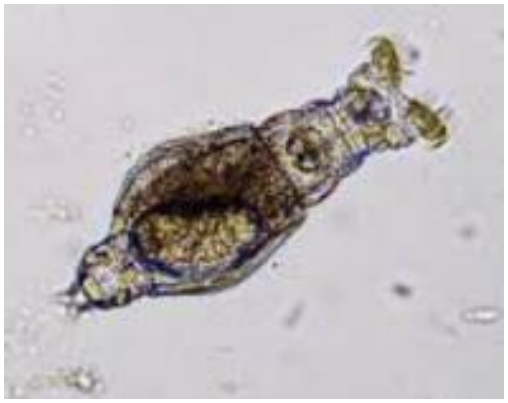

Figure 14. Rotifers.

CONCLUSION

Based on observations recorded from the four selected sampling sites, the analyzed values of biochemical oxygen demand (BOD) and chemical oxygen demand (COD) were found to remain within acceptable limits throughout the study period of Manar reservoir. These results indicated favorable environmental conditions for the growth and survival of Zooplankton communities. The absence of elevated levels of organic and chemical pollutants suggests that the reservoir water maintains good ecological quality. A comparative assessment of the measured physico-chemical parameters revealed no excessive accumulation of harmful substances, indicating that Manar Reservoir is relatively free from significant pollution stress. The detailed values of these parameters are presented in Table 1. Actually, the surroundings of this Manar sites have no industries, factories associated, hence generally we found clean water of Manar reservoir and its periphery.

Manar Reservoir supports a diverse population of aquatic (organisms) plankton that especially of zooplankton. A rich diversity of plankton, Phytoplankton and Zooplankton was observed as per the early history of this reservoir too. This included a well-established Zooplankton community, reflecting a stable and productive freshwater ecosystem. Zooplankton plays a crucial role in maintaining ecological balance by linking primary producers to higher trophic levels, thereby contributing to aquatic food web stability.

The observed, identified Zooplankton diversity and its distribution highlighted the ecological importance of the reservoir, its value in supporting fisheries and other socio-economic activities. The physico-chemical data analyzed and recorded from the present investigation provide important baseline information for future studies on Zooplankton ecology, biomonitoring and environmental assessment. Seasonal fluctuations in Zooplankton abundance were closely associated with variations in environmental conditions, emphasizing their significance as reliable indicators of reservoir health, hence we strongly observed this water body ecologically fruitful for all systems.

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