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Impact of physicochemical factors on zooplankton species of Papara Dam, Satna (M.P.)

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Abstract

Present investigation has been conducted on Papara dam, Satna of Madhya Pradesh with special reference to its zooplankton in relation physico-chemical characteristics. A total of 13 species of protozoa, 03 species of Porifera, 02 species of Coelenterata, 01 species of Platyhelminthes, 17 species of Rotifera, 04 species of Ostracoda, 10 species of Copepoda, 14 species of Cladocera, in all 64 species of zooplankton were identified from Papara Dam in the year 2012-2013. The investigation on physicochemical characteristics at different sites revealed its alkaline nature, suitable for aquaculture practices. Significant site variations have been recorded due to the interference of sewage and agricultural wastes. Among all the zooplankton groups, Rotifera recorded dominance. Maximum diversity of zooplankton population was recorded at macrophytic sites. Later on there was a sudden fall in the month of February and again zooplankton population increased progressively in the following months and reached to the highest value in the month of June.

Keywords: Water chemistry, zooplankton population, Papara dam

1. Introduction

Aquatic ecosystem is the most diverse ecosystem in the world. The first life originated in the water and first organisms were also aquatic where water was the principal external as well as internal medium for organism. Limnology has come a long way since the time (Forel and Leman, 1982) [1] in understanding the dynamic of a lentic water bodies subsequently. Limnology was studied with reference to the organism especially plankton (Hensen, 1887 and Fritsch, 1907) [2, 3]. Zooplanktons are important in an environmental impact study. They are extremely responsive to change in the environment and thus indicate environmental changes and fluctuations that may occur. Zooplankton acts as a biological indicator of water pollution.

The biodiversity and distribution of zooplankton in aquatic ecosystem depend mainly on the physicochemical properties of water. Pollution of water bodies by different sources results in drastic change in zooplankton populations, and thereby affects the production potential of the ecosystem. Zooplankton communities are highly sensitive to environmental variation. Hence, they are effective tools in environmental biomonitoring of an aquatic system. Changes in the zooplankton species composition have been used as indication of increased eutrophication of fresh waters (Wanganeo and Wanganeo, 2006) [4]. Some species flourish in highly eutrophic waters while others are very sensitive to organic or chemical wastes (El-Enany, 2009) [5]. In India, several important contributions on zooplankton and their diversity, density, ecological importance has been made in different parts of the country such as Ganapati (1949) [6]; Wanganeo and Wanganeo (2006) [4]; Ramachandra *et al.*, (2006) [7]; Dhanapathi (2000) [8]; Sharma (2009) [9] and Kumar *et al.*, (2011) [10].

Thus, the present work aimed to assess the biodiversity of Zooplankton and their Relation to the physico-chemical parameters of Papara dam which is mainly used for irrigation purposes, commercial fishing practices and recreation.

2. Materials and Methods

Physico-chemical analysis of water samples were carried out following the standard methods as described by Adoni (1985) [11] and APHA (2005) [12]. For enumeration of zooplankton population surface water samples (100 liters) were filtered with the help of plankton net made of bolting silk of mesh size of 20 µm and concentrated samples were preserved with 5% formaldehyde solution in 100 ml plastic vials. The concentrated samples were examined under the inverted microscope (Metzer made) and identification of plankton was done following the taxonomic references of Needham and Needham (1962) [13], Sharma (1999) [14] and Dhanapathi (2003) [15].

Geographical distribution of plankton plays an important role in the aquatic ecosystem. For the convenience of the description of the Dam, the planktonological biomass with special reference to zooplankton, it is essential to give the geographical status of Papara Dam, Satna (M.P.). The district Satna of M.P. is located on the South West part of Madhya Pradesh. It is an important district of ex-Vindhya Pradesh state and part of Baghelkhand rule of second century A.D. Satna district is a pilgrim and an industrial place and area rich in Limestone, Bauxite, White clay, Geru, Ramraj and Flagstones. It is also famous for its religious places of Chitrakoot. The district Satna is the central part of Vindhya region which is surrounded by the boundaries of Rewa and Satna on the North, Bilaspur district on the South and Jabalpur on the West side. Satna district comprises of five tehsils namely Raghuraj Nagar, Rampur Baghelan, Nagod, Amarpatan and Maihar.

The underlying rock is stratified sandstone exposed on hill slopes and plateau. Soil type is almost sandy loam and is poor in depth due to soil erosion. The climate of district determined by a subtropical standard is mild and healthy. The Satna district is located in the nitron of Subtropical Indian Continent and are characterized by monsoon type of climate. Rainfall and temperature exhibit well marked variations with season to season. Author has confined his research work to the Papara Dam, Satna the site of research work. For the convenience of the description of Dam, it is essential to give the geographical status of the area.

3. Results and Discussion

3.1 Physicochemical analysis

Physico-chemical analysis of Papara dam are given in Table 1. Significant variations in the physicochemical properties of Papara dam at different sites have been recorded which is due to the various pollution loads from the incoming channels.

Table 1: Physico-chemical characteristics of Papara Dam during 2012-2013.

S. No.	Parameters	S_1		S_2		S_3		S_4		S_5	
		Max.	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**
1.	Air temp. (°C)	38.8	20.4	41.6	23.6	40.2	22.2	41.8	31.2	41.4	21.0
2.	Water temp. (°C)	36.6	17.4	38.8	22.0	38.0	20.8	38.0	20.0	36.6	19.4
4.	pH (units)	8.5	7.4	8.4	7.4	9.3	6.8	10.6	6.0	8.2	4.9
	Turbidity (NTU)	288	12	286	16	572	52	660	57	278	28
5.	Total alkalinity (mg/l)	166	88	138	96	300	108	316	76	280	70
6.	Total hardness	92	80	98	70	172	76	142	38	122	22
7.	Dissolved oxygen(mg/l)	8.6	5.2	9.6	5.4	7.4	3.0	8.0	1.6	8.8	4.4
8.	BOD (mg/l)	37	8.0	38	8.0	476	78.0	1400	82.0	120	10.0
9.	COD (mg/l)	40	20	60	22	582	112	1632	142	152	24

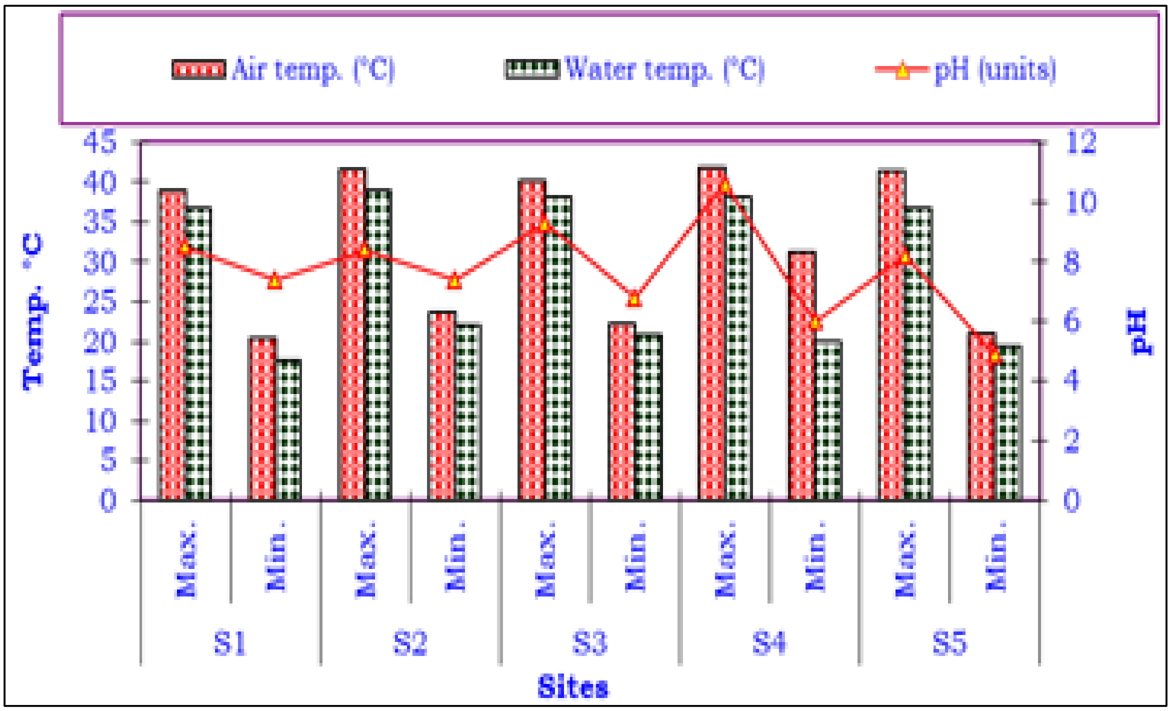

Fig 1: Physico-chemical characteristics of Papara Dam during 2012-2013.

The temperature of both air and water is an important factor influencing all aquatic flora and fauna and chemical solutes. Nearby Papara dam air temperature ranged between 17.4 to 38.8°C. Minimum air temperature was recorded at S_1 and maximum at S_2 sampling site. Temperature of atomos ranged between 20.4 to 41.8°C. Higher air temperature as compared to surface water temperature has also been noticed by Ayoade *et al.* (2006) [16] and Wanganeo *et al.* (2011) [17].

pH value in Papara dam ranged between 6.0 to 10.6 units indicating its alkaline nature (Table 1). Low pH of 6.0 units recorded at S_4 sampling site was due to the higher decomposition rates of vegetation as well as mixing of sewage waters. The magnitude of daily and seasonal variation in pH at different locations of water body depends on the buffering capacity, alkalinity of water and rates of photosynthesis (Boyd and Tucker, 1998) [18].

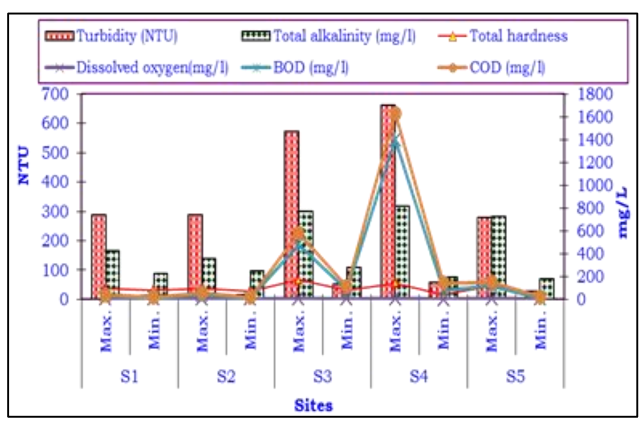

Fig 2: Physico-chemical characteristics of Papara Dam during 2012-2013.

Turbidity values ranged between 12 NTU to 660 NTU and recorded minimum value at S_1 and maximum at S_4 during the sampling stations, respectively (Table 1 and Graph 1). The type and concentration of suspended particles such as silt, clay, fine particles of organic and inorganic matter, soluble organic compounds, plankton and other microscopic organisms control the transparency of the water (Chapman, 1992) [20] reported transparency value of body which also confirmed by Kumar *et al.* (2012) [21].

Total alkalinity in surface waters of Papara dam ranged between 70 to 316 mg/l (Table 1 and Graph 2). Maximum total alkalinity was docume nted at S_4 sampling site. Due to the growth of algal population and aquatic vegetation, photosynthetic activity also increases which increases total alkalinity (Vijayarghavan, 1971) [21].

In overall study it was observed that highest value of total hardness was recorded in the S_3 sampling site and the lowest value was recorded in the sampling station S_5. Maximum hardness values at shallow sites have been recorded due to the low water level and high rates of evaporation (Krishnamoorthi, 2011) [22].

Dissolved oxygen in Papara dam ranged between 1.6 to 9.6 mg/l (Table 1 and Graph 2). Higher dissolved oxygen value was documented at S_2 sampling site which is attributed to higher photosynthetic activity by submerged aquatic vegetation especially *Vallisneria* sp. and filamentous algae. Besides this, turbulence caused by boating activity also leads to increase in dissolve oxygen. Whereas, low dissolved oxygen recorded during sampling site at S_4. Low dissolved oxygen nearby polluted sites of some water bodies of Bhopal has also been reported by Bhatnagar (1982) [23].

During the course of study it was observed that lowest value of BOD was recorded in the sampling site S_1 and S_2 and highest BOD was recorded in the sampling site S_4.

COD ranges from 20 mg/l to 1632 mg/l. During the study maximum value was observed in S_4 sampling site and minimum was observed in sampling site S_1. Most applications of COD determine the amount of organic pollutants found in surface water, making COD a useful measure of water quality (Clair, 2003) [24].

3.2 Biological analysis

It was collected in the month of October, November 2012 and January, February and March 2013. Their maximum number was 18/L at station 'S_2'. *Planaria* was observed only once in station in the month of June 2012. Some other forms which were occasionally encountered like *Nois*, *Stylaria*, *Monohysteria*, *Loxodes*, *Setenter*, *Colpidium*, *Bursaria*, *Diltiugia*, *Brachionus*, *Keratella*, *Platyias*, *Philodina*, *Rotaria*, *Filinia*, *Asplanchna*, *Polzarthra*, *Sinartherim*, *Chonochilus*, *Aphalodelba* and *Cymbella*. Species were far less in number.

Table 2: The details of comparative qualitative occurrence of Zooplankton diversity at five study sites of Papara Dam during 2012-2013

S. No.	Zooplankton & Classification	Sampling sites				
		S_1	S_2	S_3	S_4	S_5
1	2	3	4	5	6	7
Protozoa						
1.	*Arcella vulgaris*	1-6	1-6	1-6	1-6	1-6
2.	*Difflugia corona*	1-6	5-6	1-6	5-6	5-6
3.	*Thecomoeba* sps.	1-6	1-6	4-6	1-6	1-6
4.	*Dinamoeba* sps.	1-6	1-6	4-6	4-6	4-6
5.	*Stentor* sps.	5-6	5-6	5-6	5-6	4-6
6.	*Nebalia* sps.	5-6	4-6	4-6	4-6	-
7.	*Vorticella nebulifera*	3-5	1-6	6	4-6	1-6
8.	*V. convallaria*	5-6	5-6	5-6	5-6	4-6
9.	*V. companula*	5-6	5-6	5-6	5-6	4-6
10.	*V. patellina*	2-4	1-6	3	4-5	5-6
11.	*Euglena viridis*	1-6	1-6	4-6	1-6	1-6
12.	*E. gracilis*	3-5	1-6	6	4-6	1-6
13.	*Paramaecium caudatum*	1-6	5-6	1-6	5-6	5-6
Porifera						
1.	*Spongilla* sp.	1-6	1-6	4-6	1-6	1-6
2.	*Heliclona* sp.	4-6	1-5	3-5	4-6	-
3.	*Ephydatia* sp.	1-6	3-6	4-6	1-6	5-6
Coelenterata						
1.	*Hydra viridis*	4-6	1-6	1-6	1-6	1-6
2.	*H. fusca*	3-6	4	3-6	-	4-6
Platyhelminthes						
1.	*Planaria dorotocephala*	1-6	5-6	1-6	5-6	5-6
Rotifera						
1.	*Anuraeopsis fissa*	2-6	4	5-6	1-6	-
2.	*Asplanchna brightwelli*	5-6	4-6	5-6	5-6	5-6
3.	*Asplanchnopus multiceps*	4	1-6	3-6	6	1-6
4.	*Brachionus angularis*	1-6	2-6	-	4	4-6
5.	*B. caudatus*	4-6	4-6	5-6	5-6	5-6
6.	*B. havanaesis*	1-6	5-6	6	1-6	1-6
7.	*Chromogaster ovalis*	5	4	4	4	4
8.	*Epiphanes clavulata*	1-4	3-6	-	4-6	2-5

9.	*Keratella cochlearis*	1-6	3	4-6	2-6	-
10.	*K. tropica*	4-6	1-6	1-6	1-6	1-6
11.	*Monostyla bulla*	-	1-3	-	-	-
12.	*Notholca acuminate*	2-6	1-6	4-6	3	-
13.	*Platyias quadricornis*	1-6	2-6	5-6	4	1-6
14.	*Polyarthra vulgaris*	5-6	1-6	3-6	5	2-6
15.	*Scaridium longicaudum*	1-6	4	2-6	4	1-6
16.	*Synchaeta pectinata*	3-6	4-6	1-6	1-6	2-6
17.	*Trichocerca similis*	1-6	5	2-6	4	1-6
Ostracoda						
1.	*Cypris* sps.	1-6	1-6	1-6	1-6	1-6
2.	*Stenocypris* sps.	1-6	1-6	1-6	1-6	1-6
3.	*Heterocypris* sps.	4-6	5-6	5-6	4-6	5-6
4.	*Nauplius* stage	1-6	1-6	1-6	1-6	1-6
Copepoda Cyclopoida						
1.	*Cyclops* sps.	1-6	1-6	1-6	1-6	1-6
2.	*Microcyclops* sps.	1-6	1-6	1-6	1-6	1-6
3.	*Mesocyclops* sps.	1-6	1-6	4-6	1-6	4-6
4.	*Macrocyclops* sps.	5-6	1-6	5-6	4-6	4-6
5.	*Eucyclops* sps.	5-6	1-6	5-6	5-6	5-6
Cyclopoida						
1.	*Allodiaptomus* sps.	5-6	5-6	5-6	5-6	5-6
2.	*Heliodiaptomus* sps.	5-6	5-6	5-6	5-6	5-6
3.	*Neodiaptomus* sps.	5-6	1-6	5-6	4-6	5-6
4.	*Diaptomus* sps.	2-6	4	-	1-3	1-6
Harpacticoida						
1.	*Cletocampus* sps.	3	-	5-6	5-6	1-6
Cladocera						
1.	*Daphnia pulex*	5-6	1-5	1-6	1-6	4-6
2.	*Daphnia carinata*	-	4	4	4	4
3.	*Daphina lumholtizi*	1-6	-	4	-	4
4.	*Ceriodaphnia* sps.	1-6	1-6	1-6	1-6	1-6
5.	*Simocephalus* sps.	1-6	1-6	1-6	1-6	1-6
6.	*Moina* sps.	5-6	4-6	1-6	5-6	5-6
7.	*Macrothrix rosea*	5-6	5-6	5-6	5-6	5-6
8.	*Macrothrix* sps.	5-6	1-6	1-6	4-6	4-6
9.	*Diaphanosoma* sps.	5-6	4-6	5-6	4-6	5-6
10.	*Diaphanosoma brachyurum*	5-6	1-6	4-6	4-6	4-6
11.	*Leydigia* sps.	5-6	4-6	5-6	4-6	5-6
12.	*Alona* sps.	1-6	4-6	5-6	5-6	5-6
13.	*Alonella* sps.	5-6	5-6	5-6	5-6	5-6
14.	*Scapholeberis* sps.	1-4	4	-	1-4	1-3

The most dominant zooplankton species were *Diaphanosoma brachyaurum, Simocephalus* sps., *Cyclops* sps., *Arcella* sps., *Thecomoeba* sps., *Cypris* sps. and *Stenocypris* sps. Zooplankton densities have gradually increased from 224.9 org/l in October to 1833.1 org/l in March at S_2. A similar pattern was observed in all other stations. The density was less when compared to the phytoplankton population.

Nautiyal (1986) [25] have reported only 15% of zooplankton from river Bhagirathi. Govind (1969) [26] reported dominant cyclopoid population from Tungbhadra reservoir and Aliyar reservoir.

A total of 13 species of protozoa, 03 species of Porifera, 02 species of Coelenterata, 01 species of Platyhelminthes, 17 species of Rotifera, 04 species of Ostracoda, 10 species of Copepoda, 14 species of Cladocera, in all 64 species of zooplankton were identified from Papara Dam in the year 2012-2013.

The production of zooplankton expressed as average numerical values, varied from 09 units/L and 426 units/L in the investigated period. The maximum production was recorded in the month of June while the minimum was in the month of August.

The total number of zooplankton showed a remarkable trend of seasonal fluctuations. Two peaks were observed during the period of study, one of higher magnitude in the month of June and the other of lower magnitude in the month of December. Minimum number was recorded in the month of August. From August onwards they increased progressively upto December. Later on there was a sudden fall in the month of February and again zooplankton population increased progressively in the following months and reached to the highest value in the month of June.

In the present study, a positive impact of temperature on the growth of zooplankton population has been noticed. Temperature has been considered as one of the primary factors to cause the abundance of zooplankton in freshwaters particularly in shallow waters where bottom exhibit considerable variations in temperature, especially with the progression of the warm season (Ahangar *et al.*, 2012) [27]. Tripathi *et al.* (2006) [28] and Yamaguchi and Bell (2007) [29] also reported highest zooplankton population in summer season.

This study revealed that physicochemical fluctuations was negative impact on the zooplankton species richness and abundance, thus, the need for the government to establish catchment management agency in order to curtail the menace that disrupt the aquatic ecosystem.

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