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Limnological studies of Amara Pond (Raipur Karchuliyan) Rewa (M.P.) with special reference to zooplankton population

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Abstract
Present investigation has been conducted on Amara pond (Raipur Karchuliyan) Rewa of Madhya Pradesh with special reference to its zooplankton diversity in relation physico-chemical characteristics. A total of 14 species of protozoa, 02 species of Porifera, 02 species of Coelenterata, 01 species of Platyhelminthes, 23 species of Rotifera, 05 species of Ostracoda, 02 species of Copepoda, 01 species of Harpacticoida, 5 species of Cladocera, in all 55 species of zooplankton were identified from pond in the year 2014-2015. 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 during summer season.

Keywords: Water chemistry, zooplankton population, Amara pond

1. Introduction
Zooplankton study is important as it could provide ways to predict the productivity of fresh water aquatic system (Borgmann *et al.*, 1984; Morgan *et al.*, 1978) [1-2]. In deciphering trophic status and bio-monitoring of aquatic habitats, zooplankters play a vital role (Krishnamoorthi *et al.*, 2011) [3]. 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 Amara pond 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], Edmondson (1992) [14], Reddy (1994) [15], Sharma (1999) [16] and Dhanapathi (2003) [17].
Geographical distribution of plankton and fish fauna plays an important role in the aquatic ecosystem. For the convenience of the description of the pond, the planktonological biomass, it is essential to give the geographical status of Amara Pond (Raipur Karchuliyan), Rewa (M.P.). The district Rewa 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. Rewa district is a pilgrim and an industrial place and area rich in Limestone, Bauxite, White clay, Geru, Ramaraj and Flagstones. It is also famous for its religious places of Dist. The district Rewa is the central part of Vindhya region which is commissionary head quarter, situated at 24^0 32' N latitude and 81^0 18' E longitude. It is 365.7 above the mean sea level. surrounded by the boundaries of Satna on the West, Sidhi district on the South, Allahabad on the North and Mirjapur on the East side.
During the present investigation author has selected four study sites for Physico-chemical nature of water and Zooplankton of this Amara Pond (Raipur Karchuliyan) Rewa region in particular. This historic geographical region provides a unique environment. So far no work on these aspects was attempted and hence the present problem was undertaken. For the convenient of the study 4 research sites S_1-S_4 was established about 1/2 km. of distance each at ecologically significant areas.

3. Results and Discussion

Physicochemical analysis

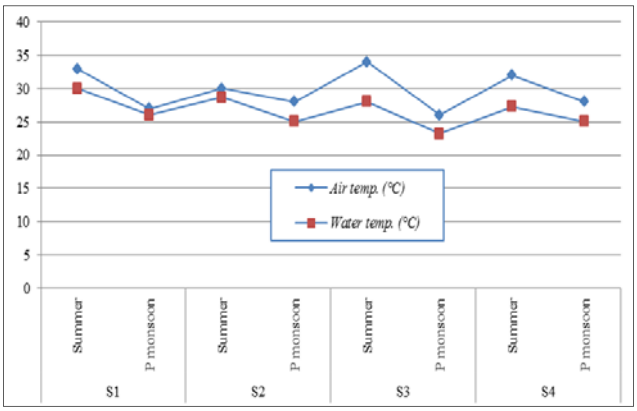

Fig 1: Graphics analysis of seasonal variation temperature (°C)

Physico-chemical analysis Physico-chemical characteristics of Amara pond are given in Table 2. Significant variations in the physicochemical properties of Amara pond at different sites have been recorded which is due to the various pollution loads from the incoming channels. The temperature of both air and water is an important factor influencing all aquatic flora and fauna and chemical solutes. Nearby Amara pond air temperature ranged between 26 to 34°C. Minimum air temperature was recorded at S_3 during post monsoon season and maximum at S_3 during summer period. Water temperature ranged between 23.2 to 30°C. Air temperature recorded higher values as compared to the water temperature which is mainly governed by the local climatic conditions of the aquatic system. Higher air temperature as compared to surface water temperature has also been noticed by Ayoade *et al.* (2006) [18] and Wanganeo *et al.* (2011) [19]. Transparency values ranged between 37 cm to 56 cm and recorded minimum value at S_4 and maximum at S_1 during post monsoon, 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 Wanganeo *et al.* (2011) [19] and Kumar *et al.* (2012) [21].

pH value in Amara pond ranged between 7 to 8.5 units indicating its alkaline nature (Table 1). Low pH of 7 units recorded at S_4 during summer season 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) [22]. The alkaline pH range (7 to 8.5) of Amara pond indicates productive nature which is favorable for good growth and survival of fishes (Adhikari, 2003) [23] and also supports growth of zooplankton population (Wanganeo and Wanganeo, 2006) [4].

TDS ranged between 201 to 543 ppm in Amara pond (Table 1). Higher TDS values recorded at S_4 indicate regular interference from respective catchment area. Whereas, comparatively low TDS values recorded at S_3 indicate of Amara pond. Comparatively low TDS values recorded at sites 1, 2 and 3 also indicate good quality of water (Kumbhar *et al.*, 2008) [24].

The specific conductivity in Amara pond varied between 302 to 780 µs/cm (Table 1). The high conductivity value of 780 µs/cm recorded at confluence site during summer season could be attributed to the high amount of dissolved solid and salt ions coming from domestic raw waters. The specific conductivity value of site 2 recorded 577 µs/cm during summer season and 541 µs/cm during post monsoon season signify high amount of anthropogenic pressure (Table 1). These results coincide with work of Wanganeo *et al.* (2011) [19] who reported variation in specific conductivity at different sites of a water body.

Dissolved oxygen in Amara pond ranged between 3.7 to 8.3 mg/l (Table 1 and Graph 2). Higher dissolved oxygen value was documented at S_3 during post monsoon 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 summer season at S_2. Low dissolved oxygen nearby polluted sites of some water bodies of Bhopal has also been reported by Bhatnagar (1982) [25].

Table 1: Physico-chemical characteristics of Amara pond during 2014-2015.

S. No.	Parameters	S_1		S_2		S_3		S_4	
		Summer	P monsoon	Summer	P monsoon	Summer	P monsoon	Summer	P monsoon
1.	Air temp. (°C)	33	27	30	28	34	26	32	28
2.	Water temp. (°C)	30	26	28.7	25.1	28	23.2	27.3	25.1
3.	Secchi transparency (cm.)	51	56	49	54	48	53	43	37
4.	pH (units)	8.0	8.3	7.3	7.6	8.2	8.5	7	7.2
5.	TDS (ppm)	258	207	314	268	252	201	543	517
6.	Conductivity (µs/cm)	342	302	577	541	377	340	780	741
7.	Dissolved oxygen(mg/l)	7.3	6.3	3.7	4.6	5.1	8.3	4.2	5.7
8.	Total alkalinity (mg/l)	141	123	136	143	144	152	136	147
9.	Chloride (mg/l)	47	38.5	48.5	60	50.4	43.4	75.9	66.8
10.	Total hardness (mg/l)	220	207	250	238	274	254	277	260
11.	Calcium hardness (mg/l)	123	93	134	116	160	140	164	156

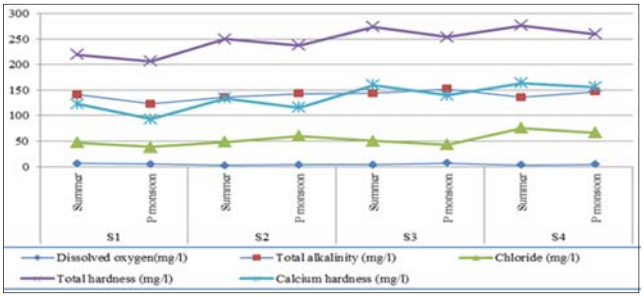

Fig 2: Graphics analysis of seasonal variation.

Total alkalinity in surface waters of Amara pond ranged between 123 to 152 mg/l (Table 1 and Graph 2). Maximum total alkalinity was documented at S_3 during post monsoon season. Due to the growth of algal population and aquatic vegetation, photosynthetic activity also increases which increases total alkalinity (Vijayarghavan, 1971) [26].

Chloride varied between 38.5 to 75.9 mg/l in Amara pond (Table 1 and Graph 2). Maximum chloride value (75.9 mg/l) recorded at S_4 during summer season which depicted higher pollution level and eutrophic condition of the site due to the domestic polluted waters with high salinity. While minimum chloride (38.5 mg/l) was recorded at S_1 during post monsoon season. Further, similar ranges of chloride concentrations have also been reported by various authors in Indian water bodies (Wanganeo *et al*., 2011) [19].

A range between 207 to 277 mg/l of total hardness was documented in Amara pond (Table 1 and Graph 2). Maximum total hardness (277 mg/l) was recorded at S_4 during summer season and minimum 207 mg/l at S_1 during post monsoon season. Maximum hardness values at shallow sites have been recorded due to the low water level and high rates of evaporation (Krishnamoorthi, 2011) [3].

Calcium hardness recorded maximum value of 164 mg/l at S_4 during summer season (Table 1 and Graph 2) due to anthropogenic pressure and some amount of calcium also contributed by rocks. Composed by calcium concentration (160 mg/l during summer and 140 mg/l during post monsoon season) was also documented at S_3. Increase in calcium due to the decomposition of plants has been reported by Purohit (1989) [27] in some Indian freshwater bodies.

Biological analysis

It was collected in the month of October, November 2014 and January, February and March 2015. Their maximum number was 18/L at station 'S_2'. Planaria was observed only once in station in the month of June 2014. 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 four study Sites of Amara Pond (Raipur Karchuliyan), Rewa (M.P.) during 2014-2015.

S. No.	Zooplankton & Classification	Sampling sites			
		S_1	S_2	S_3	S_4
	Protozoa				
1.	*Arcella vulgaris*	1-6	1-6	1-6	1-6
2.	*Amoeba proteus*	5-5	5-6	5-4	5-6
3.	*Difflugia corona*	1-6	5-6	1-6	5-6
4.	*Euglena viridis*	1-6	1-6	4-6	1-6
5.	*E. gracilis*	3-5	1-6	6	4-6
6.	*E. acathophola*	1-6	1-6	4-6	1-6
7.	*Vorticella vaginicola*	1-6	1-6	4-6	4-6
8.	*V. pyxicola*	5-6	5-6	5-6	5-6
9.	*V. nebulifera*	3-5	1-6	6	4-6
10.	*V. convallaria*	5-6	5-6	5-6	5-6
11.	*V. companula*	5-6	5-6	5-6	5-6
12.	*V. patellina*	2-4	1-6	3	4-5
13.	*Paramaecium caudatum*	1-6	5-6	1-6	5-6
14.	*P. bursaria*	2-3	1-4	3-2	4-5
	Porifera				
1.	*Heliclona* sp.	4-6	1-5	3-5	4-6
2.	*Ephydatia* sp.	1-6	3-6	4-6	1-6
	Coelenterata				
1.	*Hydra viridis*	4-6	1-6	1-6	1-6
2.	*H. fusca*	3-6	4	3-6	-
	Platyhelminthes				
1.	*Planaria dorotocephala*	1-6	5-6	1-6	5-6
	Rotifera				
1.	*Anuraeopsis fissa*	2-6	4	5-6	1-6
2.	*Asplanchna brightwelli*	5-6	4-6	5-6	5-6
3.	*Asplanchnopus multiceps*	4	1-6	3-6	6
4.	*Brachionus angularis*	1-6	2-6	-	4
5.	*B. caudatus*	4-6	4-6	5-6	5-6
6.	*B. havanaesis*	1-6	5-6	6	1-6
7.	*B. faricula*	1-5	2-4	3-	4-1

8.	*B. rotifer*	2-6	4-4	5-2	5-5
9.	*B. calfertus*	1-2	5-3	4-5	1-6
10.	*Chromogaster ovalis*	5	4	4	4
11.	*Epiphanes clavulata*	1-4	3-6	-	4-6
12.	*Gostropus* sps.	4-5	3-6	2-6	1-6
13.	*Keratella cochlearis*	1-6	3	4-6	2-6
14.	*K. tropica*	4-6	1-6	1-6	1-6
15.	*Monostyla bulla*	-	1-3	-	-
16.	*Monogonot rotifer*	4-5	4-5	3-6	2-6
17.	*Notholca acuminate*	2-6	1-6	4-6	3
18.	*Platyias quadricornis*	1-6	2-6	5-6	4
19.	*Polyarthra vulgaris*	5-6	1-6	3-6	5
20.	*Rotaria* sps.	2-5	1-6	4-6	3-4
21.	*Scaridium longicaudum*	1-6	4	2-6	4
22.	*Synchaeta pectinata*	3-6	4-6	1-6	1-6
23.	*Trichocerca similis*	1-6	5	2-6	4
	Ostracoda				
1.	*Cypris* sps.	1-6	1-6	1-6	1-6
2.	*Stenocypris* sps.	1-6	1-6	1-6	1-6
3.	*Heterocypris* sps.	4-6	5-6	5-6	4-6
4.	*Nauplius stage*	1-6	1-6	1-6	1-6
	Copepoda Cyclopoida				
1.	*Cyclops* sps.	1-6	1-6	1-6	1-6
2.	*Microcyclops* sps.	1-6	1-6	1-6	1-6
3.	*Mesocyclops* sps.	1-6	1-6	4-6	1-6
4.	*Macrocyclops* sps.	5-6	1-6	5-6	4-6
5.	*Eucyclops* sps.	5-6	1-6	5-6	5-6
	Cyclopoida				
1.	*Allodiaptomus* sps.	5-6	5-6	5-6	5-6
2.	*Diaptomus* sps.	2-6	4	-	1-3
	Harpacticoida				
1.	*Cletocampus* sps.	3	-	5-6	5-6
	Cladocera				
1.	*Daphnia pulex*	5-6	1-5	1-6	1-6
2.	*Daphnia carinata*	-	4	4	4
3.	*Moina* sps.	5-6	4-6	1-6	5-6
4.	*Alona* sps.	1-6	4-6	5-6	5-6
5.	*Alonella* sps.	5-6	5-6	5-6	5-6

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) [28] have reported only 15% of zooplankton from river Bhagirathi. Govind (1969) [29] reported dominant cyclopoid population from Tungbhadra reservoir and Aliyar reservoir.

A total of 14 species of protozoa, 02 species of Porifera, 02 species of Coelenterata, 01 species of Platyhelminthes, 23 species of Rotifera, 05 species of Ostracoda, 2 species of Copepoda, 1 species of Harpacticoida, 5 species of Cladocera, in all 55 species of zooplankton were identified from pond in the year 2014-2015.

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) [30]. Tripathi and Tiwari (2006) [31] also reported highest zooplankton population in summer season.

Hence, study of zooplankton population in this water body has great importance as they also used to estimate the fishery potential of any aquatic body. Also, the occurrence and abundance of zooplankton may be regarded as a major indicator of the entire environmental status of any water body.

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