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Variations in physico-Chemical Properties Affecting Zooplankton Diversity during Monsoon and Post- Monsoon Period of a Village Pond in Mohacha, Wazirpur, Sawai Madhopur, Rajasthan

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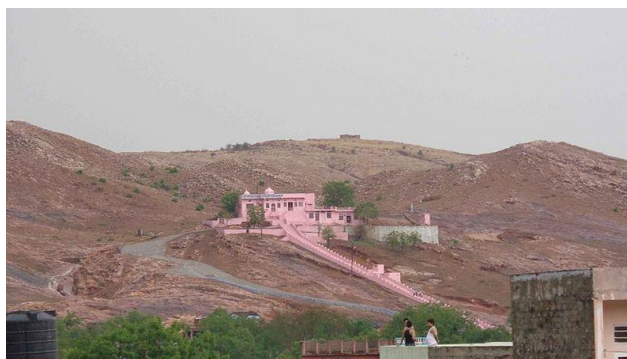
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ABSTRACT: Zooplankton are heterotrophic (sometimes detritivorous) plankton. Plankton are organisms drifting in oceans, seas, and bodies of fresh water. The word zooplankton is derived from the Greek *zoon*, meaning "animal", and *planktos* meaning "wanderer" or "drifter". Individual zooplankton are usually microscopic, but some (such as jellyfish) are larger and visible to the naked eye. Biodiversity monitoring is the first and a crucial step towards diagnosing pollution impacts on ecosystems and making conservation plans. Yet, bio-monitoring of ubiquitous micro-eukaryotes is extremely challenging, owing to many technical issues associated with micro-zooplankton such as microscopic size, fuzzy morphological features, and extremely high biodiversity. In the present paper we investigate variations in physico-chemical properties affecting zooplankton diversity during monsoon and post-monsoon period of a village pond in Mohacha, Wazirpur, Sawai Madhopur Rajasthan.

KEYWORDS: zooplankton, diversity, Mohacha, Wazirpur, Sawai Madhopur, Rajasthan

I. INTRODUCTION

The instability of environmental conditions is a typical feature of village pond in Mohacha, Wazirpur, Sawai Madhopur and the changes in abiotic factors are reflected in the biochemical activity of both vertebrates and invertebrates. These factors determine the rate of metabolic transformations, the efficacy of immune systems, and reaction patterns of bodies to stressors.



Sawai Madhopur

Zooplankton is one of the most important biotic elements that impact all functional aspects of aqueous ecosystems including food chains and trophic networks, energy flow, and the circulation of matter. They occupy a central position in food webs. The occurrence and distribution of plankton fauna depend on a number of factors such as climate change, habitat physicochemical properties, and biotic factors. Environmental factors are also important elements; for instance, water temperature impacts the growth and development of organisms and can influence their mortality.

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Different species show varied tolerances to increases or reductions in temperature ranges, and particularly sensitive individuals are eliminated by them. In addition, salinity in pond in Mohacha, Wazirpur, Sawai Madhopur has a significant impact on organisms, because it requires them to adjust the saline concentrations in their bodies to the surrounding environment. Changes in salinity are the direct cause of some species disappearing and others occurring. Environmental factors can also prompt organisms to migrate in order to avoid unfavorable environmental conditions, i.e., excessively high or low salinity. Variations in salinity can also contribute indirectly to food shortages and, consequently, they impact zooplankton abundance. Water pH can also have an impact on zooplankton; low pH causes reduced zooplankton abundance, as well as decreased biodiversity and the loss of some species, whereas alkaline conditions that accompany high primary production favors the growth and abundance of zooplankton. The availability of light determines the distribution of producers, and this indirectly impacts the diversity and distribution of animals. It also influences the vertical migration of plankton that require a specific intensity of light for many physiological processes.[1,2] Light also exerts an indirect impact on other physical factors such as temperature and water color. Oxygen dissolved in water, which is required for the survival of all aquatic organisms, is another important abiotic factor. Oxygen deficiencies can directly influence organism mortality. In addition, indirect influences are observed through predator-prey interactions since hypoxia influences mobile species to change their horizontal or vertical distribution. Many authors claim that the trophic status of a pond in Mohacha, Wazirpur, Sawai Madhopur, i.e., the availability of nutrients, significantly impacts the structure and abundance of zooplankton. When trophic conditions are modest, large, herbivorous forms (Calanoida copepods, large water fleas) dominate, while in fecund waters small detritivore forms and predatory organisms (Cyclopoida copepods, small water fleas, rotifers) occur abundantly. In this study determination of whether physicochemical properties such as water temperature, salinity, pH, and water

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transparency, particulate matter, oxygen concentration, nutrient concentrations, and chlorophyll a significantly impacted zooplankton occurrence.[3,4]

II. MATERIALS AND METHODS

The zooplankton was collected either with a Ruttner sampler or a 10 dm⁻³ bucket at shallow, coastal sites. The biological material (30 dm⁻³) was concentrated on an Apstein plankton mesh (with a 30 µm net size), fixed with Lugol solution, and preserved in 4% formalin. The zooplankton was examined microscopically and classified into one of three groups of planktonic animals: Rotifera, Cladocera, or Copepoda. The zooplankton structure was estimated using the dominance and stability indicators. Measurements of physicochemical environmental factors were taken simultaneously with plankton sampling during monsoon and post monsoon periods. Water transparency was determined with a Secchi disk and temperature, oxygen concentration, salinity, and pH were measured in situ with a HACH HQd Field Case oxygen probe (RUGGED) and a WTW Multi 350i probe. Particulate matter were determined with the direct weighing method. Chemical analyses were performed on unfiltered water samples to determine total phosphorus, orthophosphates, ammonium nitrogen, nitrate nitrogen, total nitrogen, and chlorophyll a. Pheophytin was determined in a laboratory as soon as possible after sampling. Ammonium nitrogen was determined spectrophotometrically with the indophenol method according to PN-C-04576-01:1976. Nitrate nitrogen (V) was measured colorimetrically with phenol disulphonic acid according to PN 73/C-04576/08-1973. The concentration of total nitrogen was determined as the sum of nitrate nitrogen and Kjeldahl's nitrogen measured with Kjeldahl's method. Total phosphorus and orthophosphates were determined with the method using ammonium molybdenate based on Standard Methods, whereas sampling and measurements of chlorophyll a were carried out according to ISO.[5,6] Samples for chlorophyll a determinations were kept cool and in the dark until they were moved to the laboratory (within 4 h), where the water samples were filtered and immediately elaborated using a mechanical grinder and anhydrous ethanol (99.8%) as the extraction solvent. The chlorophyll a concentration was measured using a spectrophotometer with an adjustment for pheopigments.

The results were processed with statistical methods using CANOCO version 4.52. Before statistical analyses, zooplankton abundance was log (x + 1) transformed to improve normality. All species and forms (*Keratella cochlearis* f. tecta) identified were included in the analyses. Nauplii and copepodites were excluded from the analyses since their identification to the species was impossible.[7,8]

Environmental variables were analyzed for redundancy using Pearson's correlation. If two variables were highly correlated ($r > 0.6$ or $r < -0.6$), the variable which showed the higher overall mean correlation was excluded from further analyses. Except for pH, O₂, chlorophyll a, and N-NH₄, the environmental variables were log-transformed or log + 1 transformed (TN and N-NO₃) to approximate normal distribution. Detrended Correspondence in Mohacha, Wazirpur, Sawai Madhopur Analysis (DCA) was used to determine if RDA (Redundancy Analysis) or Canonical Correspondence in Mohacha, Wazirpur, Sawai Madhopur Analysis (CCA) would be appropriate to evaluate associations between pond in Mohacha, Wazirpur, Sawai Madhopur water physicochemistry and zooplankton abundance. The DCA ordination gradient was in the range of 3–4 standard deviations (3.33 SD), which implied that both linear and unimodal methods were appropriate for the data. Thus, CCA was used to describe the relationships among the zooplankton species and the environmental variables selected for further analyses. The analyses were performed with focus scaling on inter-species distances (biplot scaling type). Environmental variables with variance inflation factors (VIF) <20 were selected for the following forward selection to avoid multicollinearity with other variables.[9,10]

The automatic forward selection procedure was used to select the contribution of environmental variables in the explanation of the species data set. This procedure computes the significance of a given variable and the stepwise cumulative variance explained with all the selected variables in the model. The statistical significance of eigen values and species-environment correlations for the axes generated by the CCA were tested with the Monte Carlo method based on 999 permutations including the unrestricted permutation. P values ≤0.05 were considered statistically significant.[11,12]

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III. DISCUSSION

During the period studied monsoon and post monsoon , the village pond in Mohacha, Wazirpur, Sawai Madhopur was characterized by extremely variable environmental conditions . The water temperature was typical of the months in which the samples were collected and did not drop below 10°C. Water transparency was low at up to 0.5 m, which is a characteristic phenomenon in pond in Mohacha, Wazirpur, Sawai Madhopur that are in village. Water pH oscillated from neutral to slightly alkaline. The particulate matter concentration in the water did not drop below 50 mg dm⁻³. Salinity, however, oscillated widely depending on the distance from sampling site . Oxygen conditions were good in the years studied, and high levels of nutrients and chlorophyll *a* were recorded. Pheophytin concentrations, which were lower than chlorophyll *a* concentration, indicated that conditions for zooplankton growth were good.[13,14]

Table 1. Average values of the physicochemical parameters of the pond in Mohacha, Wazirpur, Sawai Madhopur during monsoon and post monsoon were as follows (mean \pm std. dev. (range)).

	Monsoon (July)	Monsoon (August)	Post Monsoon(October)	Post Monsoon (November)
<i>T</i> [°C]	20.5 \pm 0.6 (19.7–22.1)	14.7 \pm 2.4 (14.0–18.9)	18.7 \pm 3.8 (10.9–20.7)	19.8 \pm 2.0 (16.0–20.5)
SDV [m]	0.45 \pm 0.04 (0.35–0.50)	0.35 \pm 0.08 (0.25–0.45)	0.35 \pm 0.06 (0.25–0.45)	0.27 \pm 0.03 (0.20–0.30)
pH [–]	8.72 \pm 0.18 (8.23–8.94)	8.67 \pm 0.35 (8.22–9.25)	8.64 \pm 0.13 (8.4–8.8)	7.69 \pm 0.40 (7.0–8.4)
Particulate matter [mg dm ⁻³]	58 \pm 12 (49–88)	56 \pm 19 (12–84)	78.57 \pm 22 (57–138)	95 \pm 16 (68–120)
Salinity [PSU]	2.9 \pm 0.7 (1.4–3.8)	3.43 \pm 1.90 (1.2–9.3)	4.1 \pm 0.4 (3.1–4.4)	3.5 \pm 0.6 (2.3–4.5)
Oxygen [mg dm ⁻³]	7.9 \pm 1.2 (6.8–11.4)	8.3 \pm 2.0 (7.6–13.2)	10.0 \pm 1.0 (8.7–12.9)	9.8 \pm 0.6 (8.4–10.6)
Chl <i>a</i> [μg dm ⁻³]	32.77 \pm 24.54 (13.11–101.57)	32.76 \pm 11.71 (26.21–68.80)	81.91 \pm 14.31 (38.23–102.39)	61.43 \pm 25.98 (36.86–141.98)
Pheophytin [μg dm ⁻³]	132.4 \pm 35.1 (29.29–167.14)	5.49 \pm 6.02 (0.00–20.79)	8.61 \pm 17.52 (0.00–92.82)	2.5 \pm 0.56 (0.00–24.46)
TP [μg dm ⁻³]	191 \pm 35 (163–261)	152 \pm 39 (91–213)	210 \pm 49 (104–284)	186.1 \pm 36.23 (130–260)
SPR [μg dm ⁻³]	24 \pm 10 (9–50)	16 \pm 7 (0–65)	14 \pm 10 (1–42)	14 \pm 12 (1–50)
TN [mg dm ⁻³]	0.63 \pm 0.11 (0.39–0.89)	1.25 \pm 0.25 (0.88–1.74)	1.71 \pm 0.27 (1.18–2.15)	1.62 \pm 0.24 (1.03–2.12)
N-NO ₃ [mg dm ⁻³]	0.01 \pm 0.006 (0.01–0.03)	0.07 \pm 0.02 (0.05–0.11)	0.04 \pm 0.016 (0.02–0.08)	0.03 \pm 0.013 (0.01–0.07)
N-NH ₄ [mg dm ⁻³]	0.02 \pm 0.01	0.02 \pm 0.01	0.03 \pm 0.007 (0.01–	0.03 \pm 0.014

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Monsoon (July)	Monsoon (August)	Post Monsoon(October)	Post Monsoon (November)
(0.005–0.045)	(0.012–0.064)	0.04)	(0.01–0.07)

The village pond in Mohacha, Wazirpur, Sawai Madhopur (study area) zooplankton included organisms from three taxonomic groups: Rotifera, Cladocera, and Copepoda. They were predominantly freshwater organisms that are highly tolerant of wide ranges of salinity. In total, 33 species were recorded, most of which belonged to Rotifera (17), followed by six Cladocera and ten copepod species. The species *K. cochlearis* was predominant in the qualitative structure of plankton fauna, while other commonly represented taxa -included *Brachionus angularis*, *Filinia longiseta*, *Polyarthra platyptera*, *Chydorus sphaericus*, *Diaphanosoma brachyurum*, *Acartia longiremis* and also *Eurytemora affinis*

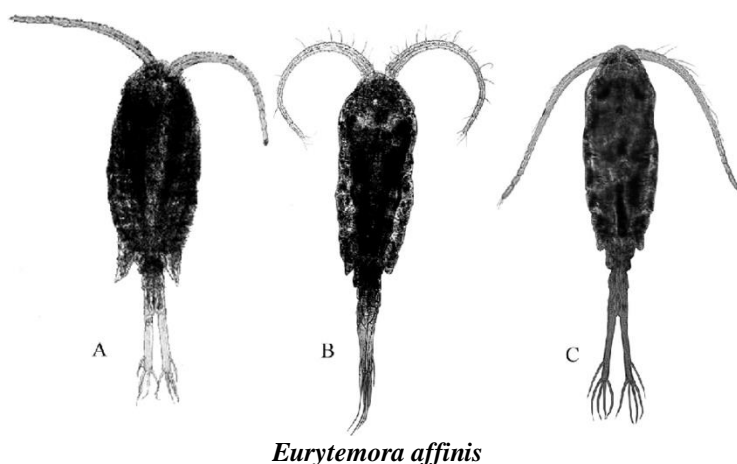


Table 2. Species composition, dominance and frequency of the zooplankton community in the study area (village pond Mohacha), Wazirpur, Sawai Madhopur over the experimental period.

		Dominance [%] ^a	Frequency [%] ^b
<i>Anureopsis fissa</i> (Gosse, 1851)	Anu fis	0.0	6.3
<i>Asplanchna priodonta</i> Gosse, 1850	Asp pri	0.2	40.6
<i>Brachionus angularis</i> Gosse, 1851	Bra ang	2.3	53.1
<i>Brachionus calyciflorus</i> Pallas, 1766	Bra cal	0.9	31.3
<i>Brachionus leydigii</i> Cohn, 1862	Bra ley	0.1	3.1
<i>Colurella colurus</i> Ehrenberg, 1830	Col col	0.0	6.3
<i>Euchlanis dilatata</i> Ehrenberg, 1832	Euc dil	0.0	6.3
<i>Filinia longiseta</i> Ehrenberg, 1834	Fil lon	12.2	62.5
<i>Keratella cochlearis f. tecta</i> (Gosse, 1886)	Ker cot	10.8	96.9
<i>Keratella cochlearis cochlearis</i> (Gosse, 1851)	Ker coc	54.1	93.8
<i>Keratella quadrata</i> (Müller, 1786)	Ker qua	0.2	31.3

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		Dominance [%] ^a	Frequency [%] ^b
<i>Polyarthra dolichoptera</i> Idelson, 1925	Pol dol	0.1	12.5
<i>Polyarthra platyptera</i> Ehrenberg, 1838	Pol pla	1.8	18.8
<i>Polyarthra vulgaris</i> (Carlin, 1943)	Pol vul	0.5	25.0
<i>Pompholyx sulcata</i> Hudson, 1885	Pom sul	0.2	21.9
<i>Synchaeta baltica</i> Ehrenberg, 1834	Syn bal	0.1	15.6
<i>Trichocerca pusilla</i> (Lauterborn, 1898)	Tri pus	0.5	34.4
<i>Trichocerca similis</i> (Wierzejski, 1893)	Tri sim	0.5	12.5
<i>Bosmina longirostris</i> (Müller, 1785)	Bos lon	0.0	15.6
<i>Ceriodaphnia quadrangula</i> (Müller, 1785)	Cer qua	0.2	21.9
<i>Chydorus sphaericus</i> (Müller, 1776)	Chy sph	4.4	34.4
<i>Diaphanosoma brachyurum</i> (Liévin, 1848)	Dia bra	3.2	81.3
<i>Leptodora kindtii</i> (Focke, 1844)	Lep kin	0.0	6.3
<i>Sida cristalina</i> (Müller, 1776)	Sid cri	0.0	9.4
<i>Acartia bifilosa</i> (Giesbrecht, 1881)	Aca bif	0.1	21.9
<i>Acartia longiremis</i> (Dana, 1846)	Aca lon	1.7	81.3
<i>Acartia tonsa</i> (Dana, 1846)	Aca ton	1.1	75.0
<i>Centropages hamatus</i> (Lilljeborg, 1853)	Cen ham	0.0	3.1
<i>Cyclops kolensis</i> Lindberg, 1956	Cyc kol	0.2	25.0
<i>Cyclops vicinus</i> Ulyanin, 1875	Cyc vic	0.3	21.9
<i>Eurytemora affinis</i> (Poppe, 1880)	Eur aff	2.7	71.9
<i>Eurytemora lacustris</i> (Poppe, 1887)	Eur lac	1.1	28.1
<i>Mesocyclops leuckarti</i> (Claus, 1857)	Mes leu	0.1	6.3
<i>Thermocyclops oithonoides</i> (Sars, 1863)	The oit	0.2	25.0

a

Dominance classes according to Kasprzak and Niedbała (1981): >10.0% eudominant species, 5.1–10.0% dominant species, 2.1–5.0% subdominant species, ≤1.0% sub-recedent species.

b

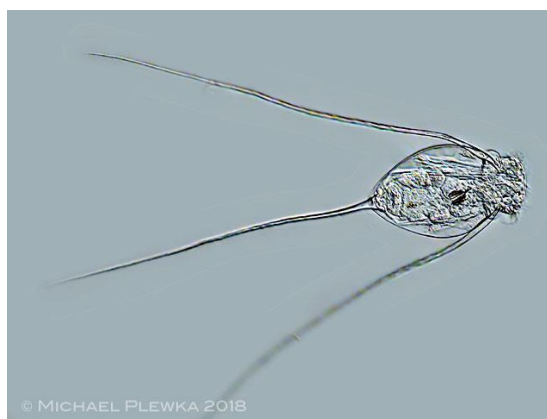
Frequency criterion according to Tischler (1949) as cited in Trojan (1980): 100–76% (absolutely constant species), 75–51% (constant species), 50–26% (accessoric species), 25–0% (random species).

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The quantitative analysis of the samples indicated that the total density of zooplankton in the village pond in Mohacha, Wazirpur, Sawai Madhopur ranged, on average, from 145 to 765 ind. dm^{-3} . Among rotifers, the most abundant was *K. cochlearis* with the highest density at the stations sampled of 6059 ind. dm^{-3} and *F. longiseta* at 835 ind. dm^{-3} .



F. longiseta

Among plankton crustaceans, high numbers were recorded for *Ch. sphaericus* (1533 ind. dm^{-3}) and *D. brachyurum* (433 ind. dm^{-3}), while among copepods *A. longiremis* (162 ind. dm^{-3}) and *E. affinis* (208 ind. dm^{-3}) were numerous.[15,16]



Ch. sphaericus

IV. DISCUSSION AND CONCLUSION

Variations in the physicochemical properties of water of study area in village brings about changes in the composition and abundance of aquatic organisms. Different environmental factors play important roles in the development and abundance of zooplankton. Plankton fauna are found across a wide range of environmental conditions, yet the presence of some species is limited by factors such as dissolved oxygen, pH, temperature, salinity, or other physical and/or chemical properties. In the study presented here, no distinct tendencies of zooplankton grouping depending on a given

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environmental parameter were observed. Some species showed a clear reaction to a given factor; *L. kindtii*, a water flea, was one of them with abundance increases at higher water temperatures.



Colurella colurus

This regularity was confirmed under laboratory conditions . These authors recorded growth rates that were comparable at 15°C, 17.5°C, and 20°C, but at higher temperatures (25°C) growth was distinctly faster. The close relation between the occurrence of *Leptodora* and water temperature. Other species did not show any correlation with this parameter, which is surprising since many authors have proved that the abundance and species diversity of zooplankton depend on temperature . An analogical situation was observed for salinity. There were no significant relations between this parameter and the abundance of zooplankton, which contrasts with data in the literature that emphasize the impact of salinity on plankton fauna in the village pond in Mohacha, Wazirpur, Sawai Madhopur. This could be explained by the specificity of the pond in Mohacha, Wazirpur, Sawai Madhopur studied, which is inhabited mainly by species with a high tolerance to wide salinity ranges.



Leptodora

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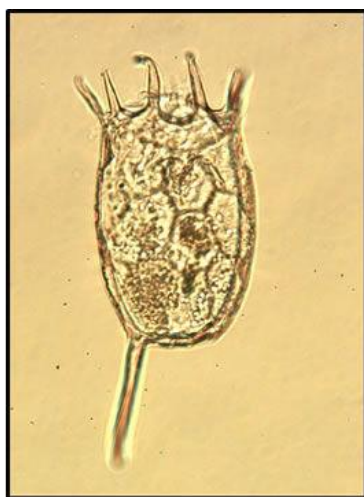
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In the present study, these were euryhaline rotifers of freshwater origin such as the genera *Brachionus* and *Trichocerca* and the species of *K. cochlearis*, *F. longiseta*, and *Pompholyx sulcata*. The copepods were represented by typically freshwater species, i.e., *E. affinis*, and marine species of *Acartia* genus – *A. tonsa* and *A. longiremis*. Water fleas were also found occasionally, because, as typically freshwater organisms, they do not tolerate high salinity. Interestingly, there was a negative correlation between the abundance of *A. fissa*, *B. leydigii*, and *S. baltica* and water pH. These organisms demonstrate a high degree of tolerance to pH changes ;therefore, this must have resulted from the impact of another factor, for instance, predatory pressure or strong water currents. Rotifers play a very important role in estuarine environments , and, in the present study, three dominant species comprised over 78% of the total numbers of zooplankton. Among them, only *F. longiseta* appears to have been affected mainly by ammonia concentrations, while influence of more than one of the measured environmental variables was noted with regard to the most abundant species of *K. cochlearis* (and its *tecta* form).[17,18]



A. tonsa



K. cochlearis

While analyzing the influence of physicochemical properties of village pond in Mohacha, Wazirpur, Sawai Madhopur it was observed that the samples could have stemmed from a diversity of environmental variables that were noted in study period.

Different living conditions for plankton organisms form annually, which means that the clusters found in the pond in Mohacha, Wazirpur, Sawai Madhopur do not have a fixed taxonomic “skeleton” and are formed and mixed depending on the abiotic factors in turn, shaped by the varied impact of factors associated with the proximity of the pond in Mohacha, Wazirpur, Sawai Madhopur. Thus, the present study demonstrated that physicochemical properties played a major role in creating zooplankton species structure and could also significantly impact entire zooplankton clusters.[19,20]

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