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Distribution of zooplankton in river Narmada at Hoshangabad, Madhya Pradesh India

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Abstract
The present paper deals with the Zooplankton composition, seasonal fluctuation and diversity indicies in river Narmada, Hoshangabad from Nov. 2010-Oct. 2012. The Zooplankton composition of river Narmada at three sampling stations were composed of 38 species belonging to 5 groups viz. Rotifer, Cladocera, Copepod, Protozoa and Ostracoda. The Zoolankton community was dominated by Rotifers (40%) followed by cladocera (29%), copepoda (18%), protozoa (8%) and ostracoda (5%). Several types of indices such as dominance index (simpson, 1949) varied from 0.94 to 0.96 while shannon's diversity index 3.18 to 3.46 and dominance -D varied from 0.04 to 0.06 of river Narmada were calculated. The dominance of Brachionus indicates the level of organic matter in the river.

Keywords: narmada river, zooplankton, diversity indices, brachinonus species

Introduction
Water is among the prime necessities of life required for growth and daily activities of all living organism in the globe. The river Narmada Valley is one of the major hot spot for aquabiodiversity in India. Biodiversity conservation and management are worldwide concern (Ramesh *et al.*, 2010) [1], where determining the diversity levels of indicator groups of ecosystem should permit the prediction of other taxa to be present i.e. the importance and appropriateness of using the invertebrate groups as indicator (Oliver and Beattie, 1993) [2] and (Pearson, 1994) [3]. The use of indicator taxa in conservation efforts from pollution control to biodiversity has been the focus of attention (Landers *et al.*, 1988) [4]. Biodiversity describes the variety of biological organisms in a given habitat, area or ecosystem. It includes several components involving variation in species, ecosystem and genetics. Biodiversity is essential stabilization of ecosystem, protection of overall environment quality for understanding intrinsic worth of all species on the earth (Nelson 2006) [5].
Zooplanktons are microscopic free swimming heterogeneous assemblage of minute flowing animal forms found in aquatic systems are represented by wide array of taxonomic groups (Protozoans, Rotifera, Cladocera, Ostracoda and Copepoda). Zooplankton communities have been investigated in numerous reservoirs, lakes, and shallow water bodies (Abbasi *et al.*, 1996) [6] and Sugunan (1980) [7]. The dominance of zooplankton in shallow water bodies by rotifers, cladocera or copepods varies according to the degree of organic pollution Moitra and Bhowmik (1968) [8], Verma and Munshi (1987) [9]. The survival strategies of the zooplankton have been reported in a few studies and examined in some detail recently by Khatavkar *et al.*, (1989) [10]. Due to their higher density, shorter life span, drifting nature, high group or species diversity, different tolerance to the stress and often respond quickly to environmental change and water quality. Zooplanktons form an important link in the transformation of energy from producers to consumers Shastree *et al.*, (1991) [11].
Thus, in order to find out the status of a fresh water body it is necessary to evaluate the seasonal diversity and abundance of zooplankton. The present study is an effort to study the diversity and seasonal abundance of zooplankton in a river Narmada, Hoshangabad (M.P).

Material and Methods
Study area
The present study was carried out for two years from Nov.2010- Oct.2012 due to which include all four seasons. Different species reproduce in different season hence, we choose whole year for study. The Narmada river is one of the biggest west flowing river of the penninsula originated from Amarkantak (located at 22^0 40 ′0″ N 81^0 45 ′0″ E) in the district of Shahdol in Madhya Pradesh, the river travels a total distance of 1,312 kms before meeting Arabian sea (located at $21^0$39′3.77″ N 72^0 48′42.8″ E) in the gulf of Cambay in Gujarat out of which 1077 km in the state of Madhya Pradesh. The study is conducted at Hoshangabad stretch. Hoshangabad city is famous for its ghats and is located at latitude of $22^0$23′40″ and longitude of 77^0 58′ 30″. For study purposes, three sampling stations one near Sethanighat and another two Upstream and Downstream were selected.

Sampling method
Collection and preservation of Zooplankton was done at the study sites while method of identification of zooplankton was applied in the laboratory. Samples were collected seasonally from three sampling stations during the study period. For qualitative and quantitative studies of zooplankton, 10 lits. Of surface water were passed through a No. 25 bolting silk cloth net of mesh size 63µm and concentrated to 100ml and were

preserved by adding 2ml of 4% formalin simultaneously. The samples were observed and identified under microscope using keys and monographs of Edmondson (1959) [12], Pennak, (1978) [13], Battish, (1992) [14], Dhanapathi, (2000) [15] and Adoni, (1985) [16]. Zooplanktons were counted with the help of Sedgwick Rafter cell method. 10ml of concentrated sample was used for the identification of different groups of zooplankton like Rotifera, Copepoda, Cladocera, Protozoa and Ostracoda. For their numerical estimation, the organisms were observed under light microscope using "Sedgwick Rafter Cell" as per procedure given in standard methods APHA, (1991) [17]. Average 5 to 10 counts for each sample were taken and results were expressed in number of organisms/litre. The results have been expressed as ind./l (Wanganeo and Wanganeo, 2006) [18].

Result & Discussion

During the entire study of Narmada river, a total of 38 species of zooplankton, belonging to groups Rotifera (15 species), Cladocera (11 species), Copepoda (7 species), Protozoa (3 species) and Ostracoda (2 species) was registered from all the study sites (Table 1). The overall dominance pattern across the various sites of the river in terms of percentage contribution has been depicted in (Fig 1):

Rotifera (40%) >Cladocera (29%) >Copepoda (18%) >Protozoa (8%) >Ostracoda (5%)

Table 1: Diversity of different groups of zooplankton

Groups	Narmada river
Rotifera	15
Cladocera	11
Copepoda	7
Ostracoda	2
Protozoa	3
Total	38

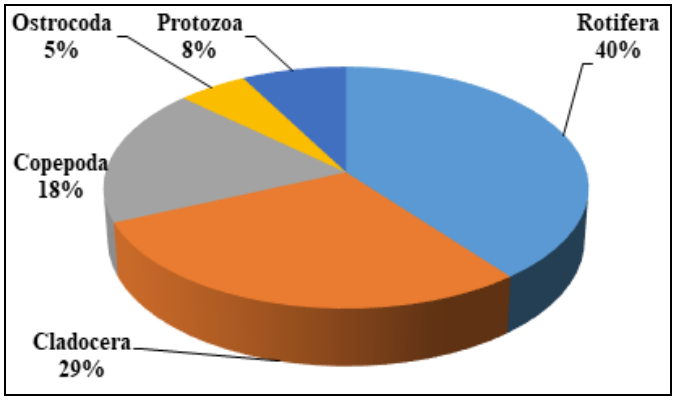

Fig 1

During the two years (2010-2012) of present investigation of zooplankton diversity in the Narmada river, site II recorded relatively maximum number of species (32) followed by site I (30 species), which in turn was followed by site III documenting 27 species (Table 2).

Table 2: Station Variation of Diversity of Zooplankton

	Narmada River		
	Site I	Site II	Site III
Rotifera	11	12	10
Cladocera	9	10	9
Copepoda	6	5	4
Ostracoda	2	2	2
Protozoa	2	3	2
Total	30	32	27

During the present investigation carried on zooplankton dynamics for 8 seasons from (winter 2010 to post monsoon 2012), a total of 38 species were recorded in Narmada River. The study revealed that cumulative seasonal diversity ranged from 27 to 35 species with a total mean value of 32. A major peak of 34 species was recorded in the summer season of first year while in second year it was during monsoon season. The second highest peak of 34 species was also registered in the summer season in the second year. This diversity in species was contributed by Rotifera in the summer seasons to the tune of (38 % and 40 %) during first year summer and second year monsoon peaks, respectively.

Rotifera

The Rotifera shows a wide range of zooplankton. In Narmada River, Rotifera was the most dominant group among all the identified groups. Rotifera shows the maximum diversity in summer season at site I with 525 ind./l and minimum was observed in monsoon season at site I with 35ind./l. Maximum diversity may be due to the production and decomposition of organic matter Majagi and Vijaykumar (2009) [19] and minimum may be due to the rainfall and heavy floods, poor water quality and less food availability.

Cladocera

Cladocera plays an important role in the integrity and stability of aquatic ecosystems and also serve as important fish diet Dodson and Hanazato (1995) [20]. Cladocera group identified from River Narmada were representing (11) species. Maximum diversity of Cladocera were recorded in summer season at site II with 285 ind. /l and minimum were recorded in winter season at site III with 40 ind./l. The highest diversity may be due to the availability of food and nutrients. The density and biomass of the Cladocerans was determined by the food supply (Wright 1995, Sharma and Mankodi 2011) [21, 22]. The lowest diversity may be due to the low temperature and low water level.

Copepoda

The living Copepods constitute an important link in aquatic food web. They serve as food to several fishes and play an important role in the energy transformation at various tropic levels. During the investigation (07) species of group Copepoda were recorded, maximum. Copepod species were identified during the summer season at SII (upstream) with 220 Ind. /l which may be due to the enrichment of nutrients.

The minimum. Copepod species were recorded during the post monsoon season at site I (near Sethanighat with 40 Ind. /l, which may be due to low population of phytoplankton.

Ostracoda

Ostrocoda commonly known as "Seed shrimps". Ostracoda were found in all fresh water bodies. Ostracoda group were recorded with only 2 species, maximum diversity of ostracoda species were identified in the summer season at site II (Upstream) with 110 Ind./l, which may be due to high temperature which is favorable for the growth of ostracod species and minimum diversity of ostracod population were recorded in the winter season at site I and II which may be due to low water level and low water temperature. Sunkad and Patil (2004) [23] also recorded maximum ostracod population in summer season in fort Lake Belgeum.

Protozoa

Protozoa act as bio-indicators for pollution. Environmental bio-monitoring has been recognized since long particularly in water purification plants and activated sludge process (Kolwitz *et al.*,) [24]. The protozoa population in the Narmada river contributed only 8% of total Zooplankton during Nov-10-Oct 2012 were representing 3 species, while maximum protozoa species were identified during summer season at site II with (85 ind./l)and minimum protozoa species were recorded in post monsoon season at site I with (5ind./l).

Dominant and abundant Genera of Zooplankton in river Narmada.

During the present study, among the Rotifera community the most abundant genera is represented by *Brachionus species*. The species has cosmopolitan distribution and it was represented by five species viz., *Brachionus calyciflorus, Brachionus havanaensis falcatus, Brachionus quadridentata and Brachionus scliifere.* Mageed (2008) [25] and Uzma (2009) [26] started that presence of more than five species of *Brachionus* reflects eutrophication of water bodies. The dominance of *Brachionus* is an indication that the water body under study is eutrophic and their abundance was due to the presence of high levels of organic matter in the river (Matsumura, *et al.*, 1990) [27]. According to the observation the *Brachionus* species are very common in temperate and tropical waters (Hutchinson, 1967) [28], indicates alkaline nature of water. According to several authors, the permanent dominancy of Rotifer species such as *Brachionus* can be consider as a biological indicator of more eutrophic waters (Maemets, 1983, Nogueira., 2001 and Dirican *et al.*, 2009) [29, 30, 31].

The Cladocera were second identified group in order of dominance with abundance of *Daphnia plexus* species. D*aphnia* is associated with clear lake healthy support fish population (Mazumdar, 1994) [32]. Low population of *Moina* was observed in the present study same was reported by Choubey (1992) [33] from Gandhi Sagar reservoir.

The Copepoda group observed as third dominant group. Copepoda during the entire period was mainly represented by *Cyclops* sp.and *nauplii larvae*. Joshi (1987) [34] reported dominant population of Copepoda (Cyclops sp.) throughout the year from Sagar Lake. *Cyclops* is srictly pollution sensitive taxa (Bhatnagar *et al.*, 2013, Bhatti and Rana 1987, Wolfram *et al.*, 2002) [35, 36, 37]. Protozoa was observed in minor quantities.

Table 3: Identification of Zooplankton Population (Ind./l) in Narmada river during 2010-2012.

Rotifera	SI	SII	SII
Brachionus calyciflorus	+	+	+
Brachionus havanaensis	+	+	+
Brachionus falcatus	+	+	+
Brachionus quadridentata	+	_	_
Brachionus scliiferi	+	+	+
Calciflorus sp.	+	+	_
Cephalodella auriculata	_	+	+
Keratella cochlearis	+	+	_
Keratella earlinae	+	_	+
Keratella valga	_	+	+
Keratella tropica	+	+	_
Lepodella patella	+	_	+
Monostyla bulla	+	+	+
Monostyla lunaris	_	+	+
Philinia longisita	+	+	_
Copepoda			
Cyclops bicuspidatus	_	+	+
Cyclops scutifer	_	_	_
Cyclops varicans rubellus	+	+	+
Cyclops vernalis	_	_	+
Cyclops viridis	+	+	+
Diaptomus minutus	+	+	+
Eucyclops prionophorus	+	+	
Ostrocoda			
Cyprella intonsa	+	+	+
Cypridopsis Helvetica	+	+	+
Protozoa			
Coleps	_	+	+
Gamanuras pulex	+	+	_
Polyacanthus patulus	_	+	+
Cladocera			
Allona sp.	_	+	+
Allonella sp.	+	_	+
Bosmina longirostris	+	+	+
Ceriodaphnia sp.	_	+	+
Chydorus sp.	+	+	+
Daphnia pulex	+	_	+
D.similis	_	+	
Leydigia sp.	+	+	+
Macrothrix sp.			
Moina sp.	+	+	+
Sida sp.	+	+	+

The Dominance value fluctuated from lowest of 0.04 to highest of 0.06 during the two years of study period. Highest value showed at site I (0.06) and lowest at site II and site III (0.04). The value of Dominance index is always higher where the community is dominated by a fewer number of species and when the dominance is shared by a large number of species (Whittaker, 1967) [38]. Present observation was also supported by (Basu *et al.*, 2013, Kumar *et al.*, 2015, Suresh *et al.*, 2009) [39, 40, 41].

Shannon-Weaver index shows diversity in zooplankton communities, it has specific importance to determine the seasonal fluctuations of zooplankton. Diversity indices are good indicators of pollution in aquatic ecosystem (Mason, 1988) [42]. While study Shannon's diversity (Shannon and

Weiner) [43] varied from 3.46-3.18 while as maximum 3.46 were recorded at site III and minimum at site I (3.18). Similar results were observed in Chambal River (Kumar *et al.*, 2015). The higher values of Shannon's index (H') the greater is planktonic diversity.

Table 4: Zooplankton indices of Narmada River.

Narmada river	First year			Second year		
	site 1	site 2	site 3	site 1	site 2	site 3
Taxa_S	38	35	38	36	36	38
Individuals	2100	1960	1330	1880	2280	1275
Dominance_D	0.06	0.04	0.04	0.04	0.04	0.04
Shannon_H	3.18	3.31	3.45	3.32	3.37	3.46

Conclusion

The relative taxonomic report summarizes to reveal the studies during 2010-12 works on zooplanktons of river Narmada. This report provides knowledge of diversity of various species for further detailed study. Conservation of biodiversity is necessary for healthy environment so we can use bio indicator species in place of chemical for pollution assessment as well as anthropogenic activities. Hence there is an urgent need to create awareness among local peoples on the importance of riverine habitat as well as its fauna and the need to conserve them for future generations.

In river Narmada the biological heterogenecity loss driven by local, regional, global and climatic factors which is a major threat to the future of our generation directly or indirectly. River water is less satisfactory for drinking purposes with an increasing awareness in the field of water pollution and desire of river maintenance at their highest quality level is required. Strict environment compliance is required to check the pollution load.

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