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Diversity of zooplankton and their seasonal variation of diversity in the Nandeshwer Dam, Udaipur, Rajasthan (India)

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Abstract
Aquatic systems play important role in landscapes as they are habitats for different biodiversity (lower to higher level organisms) which has an important role in food chain or food webs. These zooplankton are serving as a food for other higher organisms. Zooplankton transfer the energy from primary level to higher level. A total 31 species of zooplankton notice in the Nandashwer dam protozoa (10 genera), Cladocera (10 genera), Copepoda (3 genera), Ostracoda (3 genera) and Rotifera (7 genera). Dominant zooplankton were Cladoceran > Rotifera > Protozoa > Copepoda > Ostracoda.

Keywords: Zooplankton, biodiversity, Nandeshwer dam, Udaipur lake

Introduction
Zooplankton plays a pivotal role in aquatic food web because they are important food for fish and invertebrate predators. In term of biomass and productivity the dominant groups of zooplankton in most natural waters are crustacean and rotifer. Zooplankton are susceptible to variation in a wide number of environment factors including; water, temperature, light, pH, oxygen, salinity, food availability (algae, bacteria, etc.) and predation by fish and invertebrates. The population of zooplankton is a function of availability of suitable food for aquatic organisms. Zooplankton communities are typically diverse (more than 20 species) and occur in almost all lakes and ponds. Zooplankton may be used as indicators of the tropic status of water bodies. Biological production in any aquatic body gives direct correlation with its physico-chemical status which can be used as tropic status and fisheries resources potential [4]. The measurement of planktonic productivity helps to understand various trophic levels and resources as essential inputs for proper management of lake. Some notable studies on zooplankton diversities have been made [7, 5].

Materials and Methods
The present study was carried out during July, 2015 to July, 2016 with a view to investigate the zooplankton of Nandeshwer dam for assessing aquacultural possibilities with reference to prevailing limnological conditions. Nandeshwer dam is situated in the Udaipur district of Rajasthan. It is 13 km away from the Udipur city. Nandeshwer dam is located at latitudes 24°31'30"N and 73°38'00"E longitude. Water of dam is extensively used by people living in the vicinity of dam. The over flow of this dam goes to Pichhola lake of Udaipur especially during monsoon.

Zooplankton samples were collected along with the sampling of water. For the sample collection, an appropriate quantity of water sample (*i.e.* 50 litres from surface) was filtered through bolting silk No.16 and zooplankton obtained were preserved in 4% neutralized formaline. For quantitative analysis of plankton, one ml subsample was taken in Sedgwick Rafter plankton counting cell with the help of plankton pipette and counted under C.Z. inverted microscope. The total number of plankton counted in each sample were multiplied with dilution factor and results were expressed as No.l^{-1} and Cell ml^{-1}, respectively for zooplankton [1]. The qualitative analysis of zooplankton was done following the standard methods [3, 9]. The identification of zooplankton was also identified up to major groups such as Cladocerans, Rotifers and Copepods.

Table 1: Check list of zooplankton found in Nandeshwer dam, Udaipur

	Zooplankton
Protozoa	*Moina*
Acrcella discoida	*Scapholeberis kingi*
Amoeba	***Copepoda***
Astramoeba radiosa	*Diaptomus sp.*
Centropyxis ecornis	*Eucyclops sp.*
Difflugia	*Mesocyclops sp.*
Euglena acur	**Ostracoda**
Paramecium sp.	*Cyclocypria sp.*
trinema sp	*Cypris*
Cladocera	*Heterocypris*
Alona sp.	**Rotifera**
Alonella sp.	*Asplanchna*
Bosmina longirostris	*B. falcatus*
Ceridaphnia reticulate	*Brachionus calyciflorus*
Ceriodaphnia sp.	*Filina sp.*
Chydorus avails	*K. cochleares*
Chydorus sp.	*Monostyla sp.*
Daphnia sp.	*Tricocerca sp.*

Results and discussion

Qualitative and quantitative analyses was carried out in the Nandeshwer dam and found mainly 5 groups of zooplankton (Parotozoa, Cladocera, Copepoda, Ostracoda and Rotifera) (Tables 1.1).

The total zooplanktonic density of the Nandeshwer dam in surface water varied between 11.33 to 92.67 No. l^{-1} during study period. At the three sampling stations of surface water, however, total zooplankton ranged from 10.00 to 84.00, 14.00 to 100.00 and 10.00 to 102.00 No. l^{-1} at stations 'A', 'B' and 'C', respectively. Corresponding annual average total zooplankton values were 48.08, 57.76 and 55.36 No. l^{-1} at different stations of water.

In surface water 8 forms of protozoa were observed. These, zooplankton ranged from 2.00 to 16.00, 0.00 to 22.00 and 0.00 to 24.00 No.l^{-1} at stations 'A', 'B' and 'C', respectively. Corresponding annual average values were 7.68, 10.40 and 10.24 No. l^{-1}. In surface water the most dominant species were recorded at station 'B', followed by 'C' and 'A'. The dominant forms were *Acrcella, Amoeba, Astramoeba radiosa, Centropyxis ecornis, Difflugia, Euglena acur, Paramecium sp* and *trinema sp.*

In surface water 10 forms of cladocera were observed. These, zooplankton ranged from 0.00 to 64.00, 0.00 to 46.00 and 0.00 to 44.00 No.l^{-1} at stations 'A', 'B' and 'C', respectively. Corresponding annual average values were 18.64, 21.12 and 19.52 No.l^{-1}. The most dominant species were recorded at stations 'B', followed by 'C' and 'A'. The dominant forms had been *Alona sp., Alonella sp., Bosmina longirostris, Ceridaphnia reticulate, Ceriodaphnia sp., Chydorus avails, Chydorus sp., Daphnia sp, Moina* and *Scapholeberis kingi.*

In surface water 3 forms of copepods were observed these, zooplankton ranged from 0.00 to 18.00, 0.00 to 24.00 and 0.00 to 24.00 No.l^{-1} in stations 'A', 'B' and 'C', respectively. Corresponding annual average values were 6.56, 7.52 and 8.16 No.l^{-1}. The most dominant species were recorded at station 'B', followed by 'C' and 'A'. The dominant forms were *Diaptomus sp., Eucyclops sp.* and *Mesocyclops sp.*

In surface water 3 forms of ostracoda were observed these organisms ranged from 0.00 to 14.00, 0.00 to 18.00 and 0.00 to 20.00 No.l^{-1} at stations 'A', 'B' and 'C', respectively. The annual average for ostracoda were 4.24, 5.60 and 5.20 No.l^{-1}. The most dominant species were recorded at station 'B', followed by 'C' and 'A'. The dominant forms comprised of *Cyclocypria sp., Cypris* and *Heterocypris*.

In surface water 3 forms of ostracoda were observed. Here the value ranged from 0.00 to 12.00, 0.00 to 10.00 and 0.00 to 12.00 No.l^{-1} at station 'A', 'B' and 'C', respectively. Corresponding the annual average values were 1.92, 2.40 and 2.40 No.l^{-1}. The most dominant species were recorded at station 'C', followed by 'B' and 'A'. The dominant forms of *Cyclocypria sp., Cypris* and *Heterocypris*.

In surface water 7 forms of rotifera were observed these, zooplankton ranged from 0.00 to 26.00, 0.00 to 28.00 and 0.00 to 30.00 No.l^{-1} in station 'A', 'B and 'C', respectively. The corresponding the annual average values were 10.96, 13.21 and 12.24 No.l^{-1}. Dominance of species were recorded at stations 'B', followed by 'C' and 'A'. Here these dominant forms comprised of *Asplanchna, B. falcatus, Brachionus calyciflorus, Filina sp., K. cochleares, Monostyla sp.*and *Tricocerca sp.*

The observations on zooplankton had positive significant relationship with air temperature, pH, depth of visibility, carbonate alkalinity, bicarbonate alkalinity, total alkalinity, total dissolved solid, nitrate-nitrogen and orthophosphate. While sub-surface water had positive significant relationship with air temperature, pH, depth of visibility, carbonate alkalinity, bicarbonate alkalinity, total alkalinity, total dissolved solid and nitrate-nitrogen.

During study of seasonal variations zooplankton cladocerans were recorded maximum in all season and ostrocoda was absent in winter season in surface water and sub-surface of station A and station B as shown in Table 1.2-1.4 respectively [10]. Five genera of rotifers, three genera of cladocerans and ostracods and two genera each in respect of protozoans and copepods in Virla reservoir, Madhya Pradesh. While analyzing seasonal dynamics of rotifers in relation to physicochemical conditions of lotic water body [2] made similar observations in increased densities of zooplankton in summers and reduced densities in winters. In summer season the absence of inflow of the water brings stability to the water body. The availability of food is more due to production of organic matter and its decomposition [6]. In the study of seasonal variation and Zooplankton diversity in Thigra Reservoir Gwalior (M.P.) it was total 20 species were recorded during the study, 10 belonged to rotifera, 4 each to copepodand, cladocera and 2 to protozoa. Rotifera was the most dominant group throughout the study period. Seasonal variations wereobserved in the distribution of zooplanktons. Seasonally, the number was highest during summer. 23 species of zooplankton were noticed in Daya reservoir [11]. The average density of zooplankton as reported by Shekhawat [12] was 15 Nos/l. [8] observed the 27 species of zooplankton in Goverdhan sagar.

Table 2: Seasonal distribution of zooplankton (No./l) groups in Nandeshwer dam of Surface water, Station A

Groups	**Winter**	**Summer**	**Monsoon**
1.Protozoa	38.00	106.00	48.00
2. Cladocera	324.00	134.00	8.00
3. Copepoda	24.00	108.00	32.00
4. Ostracoda	0.00	58.00	48.00
5. Rotifera	8.00	158.00	108.00

Table 3: Seasonal distribution of zooplankton (No./l) groups in Nandeshwer dam of Surface water, Station B

Groups	Winter	Summer	Monsoon
1.Protozoa	46.00	140.00	74.00
2. Cladocera	330.00	190.00	8.00
3. Copepoda	28.00	116.00	44.00
4. Ostracoda	0.00	84.00	56.00
5. Rotifera	8.00	194.00	126.00

Table 4: Seasonal distribution of zooplankton (No./l) groups in Nandeshwer dam of Surface water, Station C

Groups	Winter	Summer	Monsoon
1.Protozoa	97.00	140.00	68.00
2. Cladocera	48.00	174.00	8.00
3. Copepoda	306.00	124.00	34.00
4. Ostracoda	46.00	80.00	50.00
5. Rotifera	0.00	188.00	112.00

Conclusion

The density and quality of zooplankton observed during study period indicated the moderate productivity of this reservoir. Showed the dominance over zooplankton population. The positive significant correlation of zooplankton with total phytoplankton again suggests the grazing action of former on latter. Phytoplankton and zooplankton populations were represent by 35 and 31 genera, respectively, which shows a fairly good planktonic diversity.

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