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Primary productivity and plankton diversity of Ana Sagar Lake in relation to fisheries potential

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Abstract
Plankton productivity was estimated in Ana Sagar lake, Ajmer from March 2021 to June 2021 on bi-weekly basis. GPP value ranged between 0.107 and 0.117 gC/m^3/h, NPP ranged between 0.62 and 0.68 gC/m^3/h and Community respiration ranged from 0.41 to 0.50 gC/m^3/h. Water temperature varied from 24.5 °C to 33.9 °C. pH ranged between 7.9 and 8.2. Variation in dissolved oxygen (DO) was from 7.53 to 8.73mgL^{-1}. This research highlights existing understanding on the potential of phytoplankton and zooplanktons as lake health indicators. Primary productivity was found to be high, owing mostly to sewage discharge, industrial effluents, and agricultural runoff from the surrounding metropolitan population. Its eutrophic state was also revealed by its high production and nutrient levels. The lake has a fairly rich fish fauna and so far 24 species representing 7 families have been recorded in the present investigation, of these, Indian major carps among the Cyprinidae family and tilapia (*Oreochromis niloticus*) belonging to cichlidae family was dominant in the catch.

Keywords: Fish biodiversity, Ana Sagar lake, primary productivity, eutrophication

1. Introduction
Rajasthan is India's largest state in terms of land size, as well as one of the diversification, where tradition and regal splendour collide in a riot of hues. Phytoplanktons are the principal producers in water bodies, influencing the structure and density of consumers as well as the water's properties. Furthermore, phytoplanktonic organisms are sensitive indicators because the structure and metabolism of phytoplankton change rapidly in response to environmental changes. Phytoplankton growth rate and variability are subject to cyclic changes may be seasonal called fluctuation and succession.

Phytoplanktons are an important component of any aquatic environment because they are primary producers promoting the growth of aquatic animals and create oxygen through the photosynthetic process (Kumar *et al.*, 2015) [9]. They are good indicators of water quality and water's ability to support heterotrophic organisms (Jakhar, P. 2013) [7]. Biological production may be used to assess trophic status and the potential for fishery resources in any aquatic body (Jhingaran, 1992) [8]. The density of phytoplankton in an aquatic environment is directly connected to its productivity (Narasimha, 2013) [10]. Phytoplankton plays an important part in the manufacture of organic substances in the lentic environment, on which all living creatures in the aquatic system rely as a source of sustenance. Some of them may pollute the environment by altering the quality of the water in which they grow. Even though they have no direct impact on fish output, they are reasonably excellent markers of biological productivity. In general, a fish's development is determined by the quality and amount of food available prominently phytoplankton and zooplankton diversity and its consumption by aquatic creatures. Any alteration in the quality and amount of food items will impact the fish or aquatic animal development. Several abiotic and biotic variables impact the qualitative and quantitative fluctuations of natural food components in a water body. Several researchers have researched the primary productivity of various water bodies in order to forecast their fish production potential and develop fisheries management regulations (Friedland *et al.*, 2012).

The productivity of reservoirs in the Rajasthan is higher than the national average because it is somewhat co-related to the higher temperature, however the productivity of minor water bodies in state is much lower. As a result, the State's Fisheries industry has enormous potential for development by complete utilization of unused water bodies by maintaining the natural productivity and plankton diversity.

The current research work is conducted to find out the primary productivity and plankton diversity in relation to fisheries production of lake Ana Sagar.

Attempt was made to assess the current water quality status and possibilities of fisheries development of lake Ana Sagar by following the conservative measures for future. The majority of such environmental problems are man-made, and so increased human activity in the catchment region of many aquatic systems has harmed the natural processes of these systems, jeopardising the existence and expansion of biotic communities (Bhatt *et al*., 2016 and Bhatt *et al*., 2018) [3, 4].

2. Materials and Methods

For the present study, four sampling station were selected in the Ana Sagar lake for collection and analysis at bi-weekly interval. Total 4 station selected for this work (Station A, B, C and D). Salient features of Ana Sagar lake are given below in Table 1.

2.1 Primary Productivity

Primary productivity was determined at each of the four locations using the light and dark bottle method. 250 ml glass stoppered black and white BOD bottles with glass stoppers were utilised for this purpose. The bottles were suspended about 15 cm below the surface of the water. The incubation time was set at three hours. The oxygen (O_2) concentration in the BOD bottles was determined using the standard Winkler's technique. The calculation was done as shown below

The calculation was done as shown below

Gross Oxygen Production (GOP) mg l^{-1}	= LB-DB
Net Oxygen Production (NOP) mg l^{-1}	= LB-IB
Community Respiration (CR) mg l^{-1}	= IB-DB

The values of gross and net primary productivity were calculated as follow

Gross Primary Productivity (GPP) g C m-3 h^{-1} = GOP/1.2 x 0.375 x h		
Net Primary Productivity (NPP) g C m-3 h^{-1} = NOP/1.2 x 0.375 x h		
Where,		
LB	=	Dissolved oxygen level in light bottle
DB	=	Dissolved oxygen level in dark bottle
IB	=	Dissolved oxygen level in initial bottle
H	=	Duration of incubation or exposure
1.2	=	A constant
0.375	=	A factor value (1 g of oxygen is equal to 0.375 g of carbon)

2.2 Plankton analysis

Plankton samples were gathered from the four experimental locations using a bolting silk cloth number 25 (mesh size 64) plankton net of 30 cm diameter, according to the conventional procedure (APHA, 2005) [2], for qualitative and quantitative measurement of zooplankton. The samples were collected fortnightly and kept in 5 ml sampling tubes. For subsequent qualitative and quantitative examination, the plankton samples were kept in 5% neutral formalin (zooplankton). A 1 ml subsample of plankton was obtained in the Sedgwick Rafter plankton counting cell using a broad mouth pipette (4mm) and counted under the microscope for quantitative analysis. The total number of plankton enumerated in each sample was multiplied by the dilution factor, and the resulting No l^{-1} for zooplankton was stated, APHA (2005) [2]. The qualitative analysis of zooplanktons were done following the standard methods of Edmondson (1965) [5], Needham and Needham (1962) [11] and Adoni (1985) [1]. The zooplankton was identified upto major groups such as Cladocera, Rotifera, Copepoda and Protozoa.

2.3 Study area

Lake Anasagar (26°27'-26°29' N and 74°36'-74°37' E) was formed by erecting a dam over the Luni River and was utilised for drinking water supply until recently. This is Ajmer's largest and most popular lake. King Anaji of the Chauhan dynasty erected it between 1135 and 1150 AD. Later, the Mughal kings added to the lake's beauty by building more structures. The Nagpahar and Taragarh hills form the lake's catchment area. The interrupted catchment area is roughly 45 percent, while the free catchment area is approximately 60 percent, and it includes 5 villages (4 complete and 1 partial) and a section of the city. The average annual rainfall in Ajmer is 500 mm. It has a total capacity of 2052 million litres and an average depth of 5 metres (Ranga 1995) [14]. Originally, it was a monsoon-fed, perennial, shallow freshwater lake that was built as an adaptation to climate variability (Panday *et al.*, 2013).

3. Results and Discussion

3.1 Primary Productivity

The results pertaining to gross and net primary productivities of the lake Ana Sagar during the study period (March 2021 to June 2021) are presented in Tables 2 to 5. In general, the GPP ranged between 0.103 to 0.115, 0.108 to 0.119 and 0.108 to 0.116 g C m-3 h^{-1} at station A, B, C and D, respectively. The average values of GPP were 0.108, 0.113, 0.1113 and 0.111 g C m-3 h^{-1}.

The statistical relationship of GPP was found positive with NPP, community respiration (CR) and total phytoplankton. The respective values of net primary productivity (NPP) at station A, B, C and D ranged from 0.06-0.068, 0.062-0.069, 0.061-0.071 and 0.062-0.068 g C m-3 h^{-1}. The average values of NPP were 0.064, 0.066, 0.0665 and 0.066 g C m-3 h^{-1}.

The statistical relationship of NPP was found positive with GPP and total phytoplankton. The respective values of CR at station A, B, C and D ranged from 0.035 to 0.052, 0.062 to 0.069, 0.038 to 0.052 and 0.041 to 0.051 g C m-3 h^{-1}. The corresponding average values of CR were 0.043, 0.044, 0.045 and 0.045 g C m-3 h^{-1}.

The GPP and NPP in present investigation were positively correlated with DO, nitrate and phosphate while CR was positively correlated with TZP and GPP.

3.2 Total Zooplankton

Planktons are one of the pioneer species in aquatic food web. Categorization was carried out by qualitative analysis of zooplankton following the standard methods. The zooplankton was identified upto major groups such as Cladocera, Rotifera, Copepoda and Protozoa.

During the present study four major groups of zooplankton from Ana Sagar lake were observed *viz*. Rotifera, Cladocera, Copepoda and Protozoa. Over all 26 genera of zooplankton were recorded in Anasagar lake during the present investigation (Table 7 to 16). Out of the total 26 genera, 7 were from Rotifera, 7 from Cladocera, 5 from Copepoa, and 7 belongs to Protozoa. A mean of 34.71 No L^{-1} of zooplankton was recorded in Anasagar lake during the study period (Table 16). The relative dominance of species among the categories at all station was recorded. Rotifera was dominated by *Keratella* sp., *Brachionus* sp. and Filin*ia* sp. The group Cladocera was dominated by *Moina* sp. and the group Copepoda by *Cyclops* sp. Whereas, *Arcella* sp. and *Phacus* sp. dominated the group Protozoa at station A, B, C and D.

3.3 Fish Fauna

During the present study, 24 fish species belonging to 7 families have been observed in Anasagar lake. Among these, three Indian major carps namely *Catla catla*, *Labeo rohita* and *Cirrihinus mrigala* were the dominant fish species among the Cyprinidae family and tilapia (*O. niloticus*) belonging to cichlidae family was dominant in the catch. Besides this, three exotic carps namely *Cyprinus carpio*, *Ctenopharyngodon idella* and *Hypophthalmichthys molitrix* were also found in the lake but not in significant number as compared to Indian major carps. Four minor species of Labeo and four species of Puntius were also present prominently among the other Cyprinids. Specimens of Siluridae, Notopteridae, Bagridae, Mastacembelidae and Channidae, were also found in the lake.

3.4 Fisheries yield potential

The average fish production of entire Anasagar lake (2015 – 2019) as reported by the Fisheries Department of Government of Rajasthan and fish contractor is about 218.358 ton/yr or 18196.56kg/month or 90.98 kg/ha/month. However, the potential fish production calculated on the basis of (Odum, 1971) using GPP (0.30 g C/m/hr).

FY (fish yield) = 1.2% [GPP (0.111 g C/m/hr) x average sunshine hour (8) x days
(365) x area (200) x Euphotic zone (1.92m) x 10000 (m/ha) /1000 (to convert in kg)]
= 1.2% [0.111 x 8 x 365 x 200 x 1.92 x 10000 / 1000]
=14,935.449 kg/yr
= 74.68 kg/ha/yr

3.5 Diversity indexes

3.5.1 Shannon-Wiener diversity index

The SWD index is perhaps most commonly used to established relationship of species diversity and pollution stress is calculated as under:

Diversity index (H) = - ∑ Pi ln Pi

	Major Group	N	N	Pi= n/N	Pi^2	ln Pi	Pi ln Pi
Diversity Index	Protozoa	7.42	34.63	0.214265	0.04591	-1.54054	-0.33008
	Rotifera	9.79	34.63	0.282703	0.079921	-1.26336	-0.35716
	Cladocera	8.88	34.63	0.256425	0.065754	-1.36092	-0.34897
	Copepoda	8.54	34.63	0.246607	0.060815	-1.39996	-0.34524
	Total(Σ)	34.63	138.52	1	0.252399	-5.56478	
	H= -(Σ Pi ln Pi)				1.38145		

Based on the present results the lake Anasagar lake can be categorized as moderately polluted lake.

3.5.2 Odum's species per thousand individuals:

During the present study, the Odum's Index was found between the range 0.214 to 0.282 which can be acclaimed in polluted water body. The Anasagar lake was found to have moderately low Odum's Index with higher representations of rotifers.

	Major Group	N	N	Pi= n/N	OI= Pi x 1000
Diversity Index	Protozoa	7.42	34.63	0.214265	214.27
	Rotifera	9.79	34.63	0.282703	282.73
	Cladocera	8.88	34.63	0.256425	256.42
	Copepoda	8.54	34.63	0.246607	246.61
	Total(Σ)	34.63	138.52	1	1000.00

Table 1: Salient features of Ana Sagar lake

Characteristics	Description
Geographic location	26°25'N-26°29'N(Latitude) 74°38'E-74°42'E (Longitude)
Location in Ajmer	North-West of Ajmer, Rajasthan
Lake type	Artificial lake, constructed by damming over Luni River
Lake water spread area	0.97 sq km to 1.87 sq km
Highest flood level	485.305 m above MSL (as revised in 2013)
Catchment area	53 sq km (gross), 20 sq km (intercepted by Lake Foysagar), 5 sq km
Topography of lake catchment area	Steep to gentle slope with low vegetal cover
Storage capacity of lake	5.68 Million Cum (at HFL)
Lake circumference	7.3 km (at HFL)
Source of water in lake	Rainfall runoff and overflow from Lake Foysagar through Bandi River
Depth	4.4 m
Overflow arrangements	Four overflow gates (size 1.2m X 1.8m)
Depth	4.4m
Overflow arrangements	Four overflow gates (size 1.2m X 1.8m)

Table 2: Primary productivity at station 'A' in Anasagar lake during March 2021 to June 2021

S.N.	Parameters	30 March	15 April	30 April	15 May	30 May	15 June	Mean	Max	Min	SD	CV%
1.	GPP(g C m^{-3} h^{-1})	0.112	0.115	0.107	0.103	0.106	0.108	0.11	0.12	0.10	0.004	3.99
2.	NPP(g C m^{-3} h^{-1})	0.06	0.067	0.068	0.068	0.064	0.061	0.06	0.07	0.06	0.004	5.50
3.	CR(g C m^{-3} h^{-1})	0.052	0.048	0.039	0.035	0.042	0.047	0.04	0.05	0.04	0.006	14.39

PP= Primary productivity, GPP= Gross primary productivity, NPP= Net primary productivity, CR= Community respiration

Table 3: Primary productivity at station 'B' in Anasagar lake during March 2021 to June 2021

S.N.	Parameters	30 March	15 April	30 April	15 May	30 May	15 June	Mean	Max	Min	SD	CV%
1.	GPP(g C m^{-3} h^{-1})	0.114	0.119	0.112	0.108	0.113	0.112	0.11	0.12	0.11	0.004	3.17
2.	NPP(g C m^{-3} h^{-1})	0.062	0.069	0.068	0.067	0.069	0.065	0.07	0.07	0.06	0.003	4.10
3.	CR(g C m^{-3} h^{-1})	0.052	0.050	0.044	0.041	0.044	0.037	0.04	0.05	0.04	0.006	12.48

PP= Primary productivity, GPP= Gross primary productivity, NPP= Net primary productivity, CR= Community respiration

Table 4: Primary productivity at station 'C' in Anasagar lake during March 2021 to June 2021

S.N.	Parameters	30 March	15 April	30 April	15 May	30 May	15 June	Mean	Max	Min	SD	CV%
1.	GPP(g C m^{-3} h^{-1})	0.113	0.116	0.109	0.108	0.109	0.113	0.11	0.12	0.11	0.003	2.82
2.	NPP(g C m^{-3} h^{-1})	0.061	0.065	0.067	0.066	0.071	0.069	0.07	0.07	0.06	0.003	5.19
3.	CR(g C m^{-3} h^{-1})	0.052	0.051	0.042	0.042	0.038	0.045	0.05	0.05	0.04	0.006	12.25

PP= Primary productivity, GPP= Gross primary productivity, NPP= Net primary productivity, CR= Community respiration

Table 5: Primary productivity at station 'D' in Anasagar lake during March 2021 to June 2021

S.N.	Parameters	30 March	15 April	30 April	15 May	30 May	15 June	Mean	Max	Min	SD	CV%
1.	GPP(g C m^{-3} h^{-1})	0.111	0.117	0.110	0.110	0.110	0.109	0.11	0.12	0.11	0.003	2.63
2.	NPP(g C m^{-3} h^{-1})	0.065	0.068	0.069	0.066	0.063	0.065	0.07	0.07	0.06	0.002	3.32
3.	CR(g C m^{-3} h^{-1})	0.046	0.049	0.041	0.044	0.047	0.044	0.05	0.05	0.04	0.003	6.17

PP = Primary productivity, GPP= Gross primary productivity, NPP= Net primary productivity, CR= Community respiration

Table 6: Average Primary productivity at station 'D' in Anasagar lake during March 2021 to June 2021

S.N.	Parameters	30 March	15 April	30 April	15 May	30 May	15 June	Mean	Max	Min	SD	CV%
1.	GPP(g C m^{-3} h^{-1})	0.113	0.117	0.110	0.107	0.110	0.111	0.11	0.12	0.11	0.003	3.04
2.	NPP(g C m^{-3} h^{-1})	0.062	0.067	0.068	0.067	0.067	0.065	0.07	0.07	0.06	0.002	3.32
3.	CR(g C m^{-3} h^{-1})	0.051	0.050	0.042	0.041	0.043	0.043	0.05	0.05	0.04	0.004	9.64
4.	Zooplankton (No l^{-1})	34.50	36.50	37.25	30.00	35.25	34.25	34.63	37.25	30.00	2.543	7.35

PP= Primary productivity, GPP= Gross primary productivity, NPP= Net primary productivity, CR= Community respiration

Table 7: Quantitative enumeration of zooplankton (No l^{-1}) at station A of Anasagar lake, Ajmer

ZP	Species	30 March	15 April	30 April	15 May	30 May	15 June	Mean	Max	Min	SD
Protozoa	*Arcella* sp.	1.00	2.00	3.00	1.00	2.00	3.00	2.00	3.00	1.00	0.89
	Paramecium sp.	2.00	1.00	2.00	1.00	1.00	1.00	1.33	2.00	1.00	0.52
	Amoeba sp.	0.00	1.00	2.00	1.00	1.00	0.00	0.83	2.00	0.00	0.75
	Diffugia sp.	1.00	0.00	1.00	0.00	1.00	0.00	0.50	1.00	0.00	0.55
	Oxytricha sp.	0.00	1.00	1.00	0.00	0.00	0.00	0.33	1.00	0.00	0.52
	Vorticella sp.	1.00	1.00	0.00	1.00	1.00	3.00	1.17	3.00	0.00	0.98
	Phacus Sp.	0.00	0.00	2.00	1.00	1.00	1.00	0.83	2.00	0.00	0.75
Rotifera	*Keratella* sp.	3.00	4.00	5.00	3.00	2.00	4.00	3.50	5.00	2.00	1.05
	Filinia sp.	2.00	3.00	2.00	3.00	3.00	2.00	2.50	3.00	2.00	0.55
	Branchionus sp.	4.00	2.00	3.00	4.00	3.00	3.00	3.17	4.00	2.00	0.75
	Notholca sp.	0.00	2.00	1.00	1.00	1.00	1.00	1.00	2.00	0.00	0.63
	Calurella sp.	1.00	2.00	0.00	1.00	1.00	1.00	1.00	2.00	0.00	0.63
	Trichocerca sp.	0.00	1.00	0.00	1.00	1.00	0.00	0.50	1.00	0.00	0.55
	Monostyla sp.	1.00	0.00	1.00	0.00	1.00	0.00	0.50	1.00	0.00	0.55
Cladocera	*Moina* sp.	4.00	5.00	3.00	2.00	3.00	2.00	3.17	5.00	2.00	1.17
	Ceriodaphnia sp.	1.00	1.00	0.00	0.00	0.00	0.00	0.33	1.00	0.00	0.52
	Chydrorus sp.	0.00	0.00	1.00	0.00	0.00	1.00	0.33	1.00	0.00	0.52
	Daphnia sp.	2.00	1.00	2.00	2.00	3.00	2.00	2.00	3.00	1.00	0.63
	Bosmina sp.	1.00	1.00	2.00	0.00	1.00	0.00	0.83	2.00	0.00	0.75
	Alona sp.	1.00	0.00	0.00	0.00	0.00	0.00	0.17	1.00	0.00	0.41
	Diaphanosoma sp.	1.00	3.00	3.00	3.00	2.00	3.00	2.50	3.00	1.00	0.84
Copepoda	*Cyclops* sp.	4.00	5.00	9.00	8.00	7.00	10.00	7.17	10.00	4.00	2.32
	Eucyclops sp.	0.00	0.00	0.00	1.00	0.00	0.00	0.17	1.00	0.00	0.41
	Mesocyclops sp.	1.00	0.00	0.00	0.00	0.00	0.00	0.17	1.00	0.00	0.41
	Halicyclops sp.	1.00	0.00	1.00	0.00	0.00	0.00	0.33	1.00	0.00	0.52
	Diaptomus sp.	1.00	1.00	2.00	1.00	3.00	2.00	1.67	3.00	1.00	0.82
	Total	33.00	37.00	46.00	35.00	38.00	39.00	38.00	46.00	33.00	4.47

Table 8: Quantitative enumeration of zooplankton (No l^{-1}) at station B of Anasagar lake, Ajmer

ZP	Species	30 March	15 April	30 April	15 May	30 May	15 June	Mean	Max	Min	SD
Protozoa	*Arcella* sp.	1.00	2.00	2.00	1.00	2.00	1.00	1.50	2.00	1.00	0.55
	Paramecium sp.	1.00	2.00	1.00	1.00	2.00	1.00	1.33	2.00	1.00	0.52
	Amoeba sp.	1.00	1.00	2.00	1.00	1.00	0.00	1.00	2.00	0.00	0.63
	Diffugia sp.	1.00	0.00	1.00	0.00	1.00	1.00	0.67	1.00	0.00	0.52
	Oxytricha sp.	0.00	1.00	1.00	1.00	0.00	0.00	0.50	1.00	0.00	0.55
	Vorticella sp.	1.00	2.00	1.00	1.00	0.00	3.00	1.33	3.00	0.00	1.03
	Phacus Sp.	1.00	0.00	2.00	1.00	2.00	1.00	1.17	2.00	0.00	0.75
Rotifera	*Keratella* sp.	2.00	1.00	2.00	2.00	2.00	2.00	1.83	2.00	1.00	0.41
	Filinia sp.	1.00	2.00	2.00	3.00	3.00	2.00	2.17	3.00	1.00	0.75
	Branchionus sp.	5.00	2.00	2.00	2.00	4.00	1.00	2.67	5.00	1.00	1.51
	Notholca sp.	1.00	2.00	1.00	1.00	1.00	1.00	1.17	2.00	1.00	0.41
	Calurella sp.	1.00	1.00	0.00	1.00	1.00	1.00	0.83	1.00	0.00	0.41
	Trichocerca sp.	0.00	1.00	1.00	1.00	1.00	0.00	0.67	1.00	0.00	0.52
	Monostyla sp.	1.00	0.00	1.00	0.00	1.00	1.00	0.67	1.00	0.00	0.52
Cladocera	*Moina* sp.	3.00	4.00	3.00	0.00	2.00	2.00	2.33	4.00	0.00	1.37
	Ceriodaphnia sp.	1.00	1.00	0.00	1.00	0.00	0.00	0.50	1.00	0.00	0.55
	Chydrorus sp.	3.00	0.00	0.00	0.00	0.00	0.00	0.50	3.00	0.00	1.22
	Daphnia sp.	2.00	1.00	2.00	2.00	2.00	2.00	1.83	2.00	1.00	0.41
	Bosmina sp.	1.00	1.00	2.00	0.00	1.00	0.00	0.83	2.00	0.00	0.75
	Alona sp.	1.00	1.00	0.00	1.00	0.00	1.00	0.67	1.00	0.00	0.52
	Diaphanosoma sp.	1.00	3.00	3.00	3.00	2.00	3.00	2.50	3.00	1.00	0.84
Copepoda	*Cyclops* sp.	5.00	4.00	4.00	6.00	7.00	9.00	5.83	9.00	4.00	1.94
	Eucyclops sp.	0.00	0.00	0.00	1.00	0.00	1.00	0.33	1.00	0.00	0.52
	Mesocyclops sp.	1.00	1.00	0.00	0.00	0.00	0.00	0.33	1.00	0.00	0.52
	Halicyclops sp.	1.00	0.00	1.00	0.00	0.00	0.00	0.33	1.00	0.00	0.52
	Diaptomus sp.	0.00	1.00	1.00	0.00	3.00	2.00	1.17	3.00	0.00	1.17
	Total	36.00	34.00	35.00	30.00	38.00	35.00	34.67	38.00	30.00	2.66

Table 9: Quantitative enumeration of zooplankton (No l^{-1}) at station C of Anasagar lake, Ajmer

ZP	Species	30 March	15 April	30 April	15 May	30 May	15 June	Mean	Max	Min	SD
Protozoa	*Arcella* sp.	2.00	2.00	1.00	1.00	1.00	2.00	1.50	2.00	1.00	0.55
	Paramecium sp.	0.00	2.00	1.00	1.00	1.00	1.00	1.00	2.00	0.00	0.63
	Amoeba sp.	1.00	1.00	1.00	0.00	1.00	0.00	0.67	1.00	0.00	0.52
	Diffugia sp.	1.00	1.00	1.00	0.00	1.00	1.00	0.83	1.00	0.00	0.41
	Oxytricha sp.	1.00	1.00	1.00	1.00	0.00	1.00	0.83	1.00	0.00	0.41
	Vorticella sp.	2.00	2.00	1.00	1.00	1.00	2.00	1.50	2.00	1.00	0.55
	Phacus Sp.	1.00	1.00	2.00	1.00	2.00	1.00	1.33	2.00	1.00	0.52
Rotifera	*Keratella* sp.	2.00	1.00	3.00	1.00	1.00	1.00	1.50	3.00	1.00	0.84
	Filinia sp.	1.00	2.00	2.00	2.00	2.00	1.00	1.67	2.00	1.00	0.52
	Branchionus sp.	4.00	3.00	2.00	1.00	3.00	1.00	2.33	4.00	1.00	1.21
	Notholca sp.	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00
	Calurella sp.	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00
	Trichocerca sp.	0.00	1.00	1.00	0.00	0.00	0.00	0.33	1.00	0.00	0.52
	Monostyla sp.	1.00	0.00	1.00	0.00	1.00	1.00	0.67	1.00	0.00	0.52
Cladocera	*Moina* sp.	4.00	3.00	2.00	0.00	1.00	3.00	2.17	4.00	0.00	1.47
	Ceriodaphnia sp.	1.00	1.00	1.00	1.00	0.00	0.00	0.67	1.00	0.00	0.52
	Chydrorus sp.	2.00	1.00	0.00	0.00	0.00	1.00	0.67	2.00	0.00	0.82
	Daphnia sp.	1.00	1.00	1.00	3.00	1.00	0.00	1.17	3.00	0.00	0.98
	Bosmina sp.	1.00	1.00	2.00	0.00	1.00	0.00	0.83	2.00	0.00	0.75
	Alona sp.	0.00	1.00	0.00	1.00	1.00	1.00	0.67	1.00	0.00	0.52
	Diaphanosoma sp.	1.00	2.00	3.00	2.00	2.00	3.00	2.17	3.00	1.00	0.75
Copepoda	*Cyclops* sp.	5.00	6.00	5.00	5.00	6.00	7.00	5.67	7.00	5.00	0.82
	Eucyclops sp.	0.00	1.00	1.00	1.00	1.00	1.00	0.83	1.00	0.00	0.41
	Mesocyclops sp.	0.00	1.00	0.00	1.00	0.00	0.00	0.33	1.00	0.00	0.52
	Halicyclops sp.	1.00	0.00	1.00	0.00	1.00	0.00	0.50	1.00	0.00	0.55
	Diaptomus sp.	0.00	1.00	1.00	1.00	2.00	1.00	1.00	2.00	0.00	0.63
	Total	34.00	38.00	36.00	26.00	32.00	31.00	32.83	38.00	26.00	4.22

Table 10: Quantitative enumeration of zooplankton (No l^{-1}) at station D of Anasagar lake, Ajmer

ZP	Species	30 March	15 April	30 April	15 May	30 May	15 June	Mean	Max	Min	SD
Protozoa	*Arcella* sp.	1.00	1.00	2.00	1.00	1.00	1.00	1.17	2.00	1.00	0.41
	Paramecium sp.	1.00	2.00	1.00	0.00	1.00	2.00	1.17	2.00	0.00	0.75
	Amoeba sp.	1.00	1.00	1.00	0.00	2.00	0.00	0.83	2.00	0.00	0.75
	Diffugia sp.	2.00	0.00	1.00	1.00	1.00	1.00	1.00	2.00	0.00	0.63
	Oxytricha sp.	1.00	1.00	1.00	1.00	0.00	1.00	0.83	1.00	0.00	0.41
	Vorticella sp.	2.00	1.00	1.00	1.00	1.00	2.00	1.33	2.00	1.00	0.52
	Phacus Sp.	1.00	1.00	2.00	1.00	1.00	1.00	1.17	2.00	1.00	0.41
Rotifera	*Keratella* sp.	2.00	1.00	1.00	1.00	1.00	2.00	1.33	2.00	1.00	0.52
	Filinia sp.	1.00	2.00	2.00	1.00	2.00	1.00	1.50	2.00	1.00	0.55
	Branchionus sp.	4.00	3.00	1.00	1.00	2.00	1.00	2.00	4.00	1.00	1.26
	Notholca sp.	1.00	2.00	1.00	1.00	0.00	2.00	1.17	2.00	0.00	0.75
	Calurella sp.	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00
	Trichocerca sp.	1.00	1.00	1.00	0.00	1.00	0.00	0.67	1.00	0.00	0.52
	Monostyla sp.	0.00	1.00	2.00	0.00	1.00	1.00	0.83	2.00	0.00	0.75
Cladocera	*Moina* sp.	4.00	3.00	3.00	1.00	1.00	2.00	2.33	4.00	1.00	1.21
	Ceriodaphnia sp.	0.00	2.00	0.00	1.00	1.00	0.00	0.67	2.00	0.00	0.82
	Chydrorus sp.	2.00	1.00	1.00	2.00	0.00	1.00	1.17	2.00	0.00	0.75
	Daphnia sp.	1.00	1.00	1.00	3.00	1.00	0.00	1.17	3.00	0.00	0.98
	Bosmina sp.	1.00	1.00	1.00	0.00	1.00	1.00	0.83	1.00	0.00	0.41
	Alona sp.	0.00	1.00	0.00	1.00	1.00	1.00	0.67	1.00	0.00	0.52
	Diaphanosoma sp.	1.00	2.00	2.00	3.00	3.00	2.00	2.17	3.00	1.00	0.75
Copepoda	*Cyclops* sp.	4.00	5.00	6.00	6.00	7.00	5.00	5.50	7.00	4.00	1.05
	Eucyclops sp.	0.00	1.00	0.00	1.00	1.00	1.00	0.67	1.00	0.00	0.52
	Mesocyclops sp.	1.00	1.00	0.00	0.00	0.00	2.00	0.67	2.00	0.00	0.82
	Halicyclops sp.	1.00	0.00	0.00	0.00	0.00	1.00	0.33	1.00	0.00	0.52
	Diaptomus sp.	1.00	1.00	1.00	1.00	2.00	1.00	1.17	2.00	1.00	0.41
	Total	35.00	37.00	33.00	29.00	33.00	33.00	33.33	37.00	29.00	2.66

Table 11: Average Quantitative enumeration of zooplankton (No l^{-1}) at station A, B, C and D of Anasagar lake, Ajmer

ZP	Species	A	B	C	D	Mean	Max	Min	SD	CV%
Protozoa	*Arcella* sp.	2.00	1.50	1.50	1.17	1.54	2.00	1.17	0.34	22.20
	Paramecium sp.	1.33	1.33	1.00	1.17	1.21	1.33	1.00	0.16	13.05
	Amoeba sp.	0.83	1.00	0.67	0.83	0.83	1.00	0.67	0.13	16.19
	Diffugia sp.	0.50	0.67	0.83	1.00	0.75	1.00	0.50	0.21	28.58
	Oxytricha sp.	0.33	0.50	0.83	0.83	0.62	0.83	0.33	0.25	40.07
	Vorticella sp.	1.17	1.33	1.50	1.33	1.33	1.50	1.17	0.13	10.11
	Phacus Sp.	0.83	1.17	1.33	1.17	1.13	1.33	0.83	0.21	18.72
Rotifera	*Keratella* sp.	3.50	1.83	1.50	1.33	2.04	3.50	1.33	1.00	48.79
	Filinia sp.	2.50	2.17	1.67	1.50	1.96	2.50	1.50	0.46	23.41
	Branchionus sp.	3.17	2.67	2.33	2.00	2.54	3.17	2.00	0.50	19.66
	Notholca sp.	1.00	1.17	1.00	1.17	1.09	1.17	1.00	0.10	9.05
	Calurella sp.	1.00	0.83	1.00	1.00	0.96	1.00	0.83	0.08	8.88
	Trichocerca sp.	0.50	0.67	0.33	0.67	0.54	0.67	0.33	0.16	30.00
	Monostyla sp.	0.50	0.67	0.67	0.83	0.67	0.83	0.50	0.13	20.19
Cladocera	*Moina* sp.	3.17	2.33	2.17	2.33	2.50	3.17	2.17	0.45	18.12
	Ceriodaphnia sp.	0.33	0.50	0.67	0.67	0.54	0.67	0.33	0.16	30.00
	Chydrorus sp.	0.33	0.50	0.67	1.17	0.67	1.17	0.33	0.36	54.32
	Daphnia sp.	2.00	1.83	1.17	1.17	1.54	2.00	1.17	0.44	28.25
	Bosmina sp.	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.00	0.00
	Alona sp.	0.17	0.67	0.67	0.67	0.55	0.67	0.17	0.25	45.87
	Diaphanosoma sp.	2.50	2.50	2.17	2.17	2.34	2.50	2.17	0.19	8.16
Copepoda	*Cyclops* sp.	7.17	5.83	5.67	5.50	6.04	7.17	5.50	0.76	12.64
	Eucyclops sp.	0.17	0.33	0.83	0.67	0.50	0.83	0.17	0.30	60.62
	Mesocyclops sp.	0.17	0.33	0.33	0.67	0.38	0.67	0.17	0.21	56.17
	Halicyclops sp.	0.33	0.33	0.50	0.33	0.37	0.50	0.33	0.08	22.82
	Diaptomus sp.	1.67	1.17	1.00	1.17	1.25	1.67	1.00	0.29	23.12
	Total	38.00	34.67	32.83	33.33	34.71	38.00	32.83	2.33	6.71

Table 12: Major groups of zooplankton (No l-1) at station A of Anasagar lake, Ajmer

Major Group	30 March	15 April	30 April	15 May	30 May	15 June	Mean	Max	Min	SD
Protozoa	5.00	6.00	11.00	5.00	7.00	8.00	7.00	11.00	5.00	2.28
Rotifera	11.00	14.00	12.00	13.00	12.00	11.00	12.17	14.00	11.00	1.17
Cladocera	10.00	11.00	10.00	7.00	9.00	7.00	9.00	11.00	7.00	1.67
Copepoda	7.00	6.00	12.00	10.00	10.00	12.00	9.50	12.00	6.00	2.51
Total	33.00	37.00	45.00	35.00	38.00	38.00	37.67	45.00	33.00	4.08

Table 13: Major groups of zooplankton (No l^{-1}) at station B of Anasagar lake, Ajmer

Major Group	30 March	15 April	30 April	15 May	30 May	15 June	Mean	Max	Min	SD
Protozoa	6.00	8.00	10.00	6.00	8.00	7.00	7.50	10.00	6.00	1.52
Rotifera	11.00	9.00	9.00	10.00	13.00	8.00	10.00	13.00	8.00	1.79
Cladocera	12.00	11.00	10.00	7.00	7.00	8.00	9.17	12.00	7.00	2.14
Copepoda	7.00	6.00	6.00	7.00	10.00	12.00	8.00	12.00	6.00	2.45
Total	36.00	34.00	35.00	30.00	38.00	35.00	34.67	38.00	30.00	2.66

Table 14: Major groups of zooplankton (No l-1) at station C of Anasagar lake, Ajmer

Major Group	30 March	15 April	30 April	15 May	30 May	15 June	Mean	Max	Min	SD
Protozoa	8.00	10.00	8.00	5.00	7.00	8.00	7.67	10.00	5.00	1.63
Rotifera	10.00	9.00	11.00	6.00	9.00	6.00	8.50	11.00	6.00	2.07
Cladocera	10.00	10.00	9.00	7.00	6.00	8.00	8.33	10.00	6.00	1.63
Copepoda	6.00	9.00	8.00	8.00	10.00	9.00	8.33	10.00	6.00	1.37
Total	34.00	38.00	36.00	26.00	32.00	31.00	32.83	38.00	26.00	4.22

Table 15: Major groups of zooplankton (No l^{-1}) at station D of Anasagar lake, Ajmer

Major Group	30 March	15 April	30 April	15 May	30 May	15 June	Mean	Max	Min	SD
Protozoa	9.00	7.00	9.00	5.00	7.00	8.00	7.50	9.00	5.00	1.52
Rotifera	10.00	11.00	9.00	5.00	8.00	8.00	8.50	11.00	5.00	2.07
Cladocera	9.00	11.00	8.00	11.00	8.00	7.00	9.00	11.00	7.00	1.67
Copepoda	7.00	8.00	7.00	8.00	10.00	10.00	8.33	10.00	7.00	1.37
Total	35.00	37.00	33.00	29.00	33.00	33.00	33.33	37.00	29.00	2.66

Table 16: Average of Major groups of zooplankton (No l^{-1}) at station A, B, C and D of Anasagar lake, Ajmer

Major Group	30 March	15 April	30 April	15 May	30 May	15 June	Mean	Max	Min	SD
Protozoa	7.00	7.75	9.50	5.25	7.25	7.75	7.42	9.50	5.25	1.38
Rotifera	10.50	10.75	10.25	8.50	10.50	8.25	9.79	10.75	8.25	1.11
Cladocera	10.25	10.75	9.25	8.00	7.50	7.50	8.88	10.75	7.50	1.42
Copepoda	6.75	7.25	8.25	8.25	10.00	10.75	8.54	10.75	6.75	1.55
Total	34.50	36.50	37.25	30.00	35.25	34.25	34.63	37.25	30.00	2.54

4. Conclusion

In any aquatic ecosystem biodiversity can affect both fauna and flora. Biodiversity contributes both directly and indirectly to human such as food for good health, security, social relationship, life and freedom of choices, etc. In last decade people interfere with the ecosystem and over-exploitation of natural resources its result that biodiversity decreases. But the losses in biodiversity and change in ecosystem service have adversely affected the well-being. The present study is relevant to fish and phytoplankton biodiversity with relationship to primary productivity of the Ana Sagar lake. This study explains that lake is in rich biodiversity of phytoplankton, fishes and need to be conserved in future.

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