

## SEASONAL CHANGES IN ZOOPLANKTON DIVERSITY AND SPECIES RICHNESS IN KOT DAM OF JHUNJHUNU DISTRICT, RAJASTHAN

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### ABSTRACT

Study was conducted at three sampling sites of Kot Dam located in Jhunjhunu district, Shekhawati region of Rajasthan from April 2021 to March 2023 to assess seasonal variation in species richness and diversity of zooplankton. During study, 58 zooplankton species were observed at all three sampling stations in Kot Dam. Of the 58 zooplankton species, the maximum number of species belonged to the Cladocera (21 species) followed by rotifers (15 species), protozoans and copepods, with eight species each. Minimum number of species was observed in the ostracod group (six species). At sampling station I, highest number of species (58 species in each season) was observed in summer 2021, monsoon 2021 and winter 2021-22 followed by summer 2022 (57), winter 2022-23 (56) and lowest number of species was observed during the monsoon 2022 (49). At sampling station II, the highest number of species was observed in summer 2021 and winter 2022-23 (56 species in each season) followed by winter 2021-22 (55), summer 2022 (54), monsoon 2021 (51) and lowest number of species was observed in monsoon 2022 (49). At sampling station III, maximum number of species was observed in winter 2022-23 (57) followed by summer 2021, winter 2021-22, summer 2022 (56 species in each season). Simpson diversity index ranged between 0.9743 to 0.9795 for sampling station I, 0.9736 to 0.9784 for sampling station II, and 0.9749 to 0.9785 for sampling station III, respectively. Shannon diversity index ranged from 3.75 to 3.963 for sampling station I, 3.739 to 3.91 for sampling station II, and 3.791 to 3.917 for sampling station III. Zooplankton is crucial biotic organisms of aquatic ecosystems and is an important component of food chains and webs.

**Keywords:** Zooplankton, Kot Dam, Cladocera, Season, Diversity, Ecosystem, Food chain, Food web.

### INTRODUCTION

Zooplankton are crucial biotic organisms that are significantly important in aquatic ecosystems (Arora and Mehra, 2003; Pawar, 2015). They serve as a vital connection in energy transfer between phytoplankton and higher aquatic animals, making them essential for maintaining ecological balance (Sinha and Islam, 2002; Kadam and Tiwari, 2012; Goswami and Mankodi, 2012; Manickam *et al.*, 2014). Studying zooplankton communities can be helpful in predicting long-term changes in lake ecosystems because these communities are highly sensitive to environmental fluctuations (Manickam *et al.*, 2014 & 2015). Anthropogenic impacts can significantly affect zooplankton communities (Madin *et al.*,

2001). Several studies have shown that zooplankton communities are sensitive to environmental fluctuations as well as changes in physicochemical parameters of water bodies (Ferrara *et al.*, 2002; Preston and Rusak, 2010; Jeppesen *et al.*, 2011; Kehayias *et al.*, 2014). In addition, human activities and changes in lakes and their surrounding areas can impact the zooplankton community (Dodson *et al.*, 2000). A qualitative and quantitative study of zooplankton is necessary for the assessing water conditions of a particular water bodies. Abundance of plankton in water is influenced by the physicochemical conditions of the environment as well as by factors such as light penetration, temperature, nutrition levels, herbivores and heterotrophic microbes (Reynolds, 1987; Lashkar and

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Gupta, 2009; Karuthapandi *et al.*, 2013; Nimbalkar *et al.*, 2013; Chishty and Choudhary, 2022a &b). Therefore, the present study was conducted to assess the seasonal variation in zooplankton diversity and species richness in Kot Dam, Jhunjhunu District, Rajasthan.

## MATERIAL AND METHODS

Kot Dam was constructed from 1923 to 1924 by Thakur Sarju Singh to fulfill the demand for water for drinking purposes and agricultural activities of Shekhawati region of Jhunjhunu district. Kot Dam is located at 27°39'2"N latitude and 75°25'10"E longitude. Height of Kot dam is up to 7.6 m (25 ft), and length is up to 80 m (260 ft). Water samples were collected on a seasonal basis for two years (April 2021 to March 2023) from three sampling stations, *viz.*, sampling station I (SS-I), station II (SS-II) and station III (SS-III) for the analysis of seasonal variation in zooplankton diversity and species richness.

Sampling procedure utilized specialized nets to obtain microscopic zooplankton at different depths in the water column. This analysis generally includes microscopic examination, taxonomic identification, and enumeration of individual organisms. Collection of plankton samples entails filtering a significant volume of water, generally 50 liters, through specialized plankton net. Upon collection, the plankton samples were promptly stored in a 4% formalin solution. This preservation approach enables the storage of samples for extended durations, allowing for comprehensive microscopic studies, species identification, and subsequent quantitative analysis of the planktonic population (Slotwinski *et al.*, 2014; Manickam *et al.*, 2018). Quantitative examination of zooplankton was conducted using a Sedgwick-Rafter plankton-counting chamber at Department of Zoology, Vidya Bhawan Rural Institute, Udaipur. Plankton identification was performed within 24 hours of sample collection. Plankton was identified using conventional field guides (Ward and Whipple, 1959; Sladeczek, 1973; Battish, 1992; APHA, 2012). Taxonomic identification and photography of plankton specimens were performed using a light microscope at 40×10 zoom. The Shannon and Simpson diversity indices of zooplankton were calculated using Past Software (Hammer *et al.*, 2001).

## RESULT AND DISCUSSION

During study, 58 zooplankton species were observed at all three sampling stations in the Kot Dam (Table 1). Of the 58 zooplankton species, the maximum number of species belonged to the Cladocera (21 species) group followed by rotifers (15 species), protozoans and copepods consisted eight species each. The minimum number of species was observed in the Ostracod group (six species) (Table 1). Species richness: At sampling station I, the highest number of species (58 species in each season) was observed in summer 2021, monsoon 2021 and winter 2021-22 followed by summer 2022 (57 species), winter 2022-23 (56) and the lowest number of species was observed during the

monsoon 2022 (49 species). At sampling station II, the highest number of species was observed in summer 2021 and winter 2022-23 (56 species in each season) followed by winter 2021-22 (55), summer 2022 (54) and monsoon 2021 (51), and lowest number of species was observed in monsoon 2022 (49). At sampling station III, maximum number of species was observed in winter 2022-23 (57) followed by summer 2021, winter 2021-22, summer 2022 (56 species in each season). Monsoon 2021 consisted of 54 zooplankton species and the lowest number of species was observed in the monsoon 2022 (54 species) (Table 2). Simpson diversity index: At sampling station I, highest value of Simpson diversity was observed in summer 2021 (0.9795) followed by winter 2022-23 (0.9793), summer 2022 (0.9787), winter 2021-22 (0.9786), monsoon 2021 (0.9756) and lowest value of Simpson diversity was observed in monsoon 2022 (0.9743). At sampling station II, highest value of Simpson diversity was observed in summer 2021 (0.9784) followed by winter 2022-23 (0.9783), winter 2021-22(0.9780), summer 2022 (0.9773), monsoon 2021 (0.9750) and lowest value of Simpson diversity was observed in monsoon 2022 (0.9736). At sampling station III, highest value of Simpson diversity was observed in winter 2022-23 (0.9785) followed by winter 2021-22 (0.9784), summer 2022 (0.9781), summer 2021 (0.9781) monsoon 2021 (0.9766) and lowest value of Simpson diversity was observed in monsoon 2022 (0.9749) (Table 2).

Shannon Diversity index: At the sampling station I, highest value of Shannon Diversity index was observed in summer 2021 (3.963) followed by winter 2022-23 (3.936), winter 2021-22 (3.926), summer 2022 (3.928), monsoon 2021(3.85) and lowest value of Simpson diversity was observed in monsoon 2022 (3.75). At the sampling station II, highest value of Shannon Diversity index was observed in summer 2021 (3.91) followed by winter 2022-23 (3.906), winter 2021-22 (3.893), summer 2022 (3.869), monsoon 2021 (3.785) and lowest value of Simpson diversity was observed in monsoon 2022 (3.739). At the sampling station III, highest value of Shannon Diversity index was observed in winter 2022-23 (3.917) followed by winter 2021-22 (3.912), summer 2022 (3.896), summer 2021 (3.894), monsoon 2021 (3.85) and lowest value of Simpson diversity was observed in monsoon 2022 (3.791) (Table 2). Dube *et al.* (2010) studied the community structure of zoo planktonic communities in the Kishore Sagar Tank, Rajasthan. They identified 36 species of zooplankton and classified them into seven groups, and the diversity of zooplankton exhibited immediate responses to alterations in the aquatic environment. Zooplankton is a reliable indicator of changes in water quality, trophic status, and pollution levels (Sharma, 1998). Dynamics of the plankton population, particularly the zooplankton community, largely determine fish populations (Madin *et al.*, 2001; Molinero *et al.*, 2020). Zooplankton plays a crucial role in aquatic ecosystems, affecting food chains, food webs, energy flow, and nutrient cycling (Lampert and

Sommer, 1997; Park and Shin, 2007). Direct and immediate response of zooplankton to several physical, chemical, and biological alterations in aquatic environments makes them a valuable indicator for assessing the impact of pollution and other disturbances on these ecosystems (Marques *et al.*, 2007).

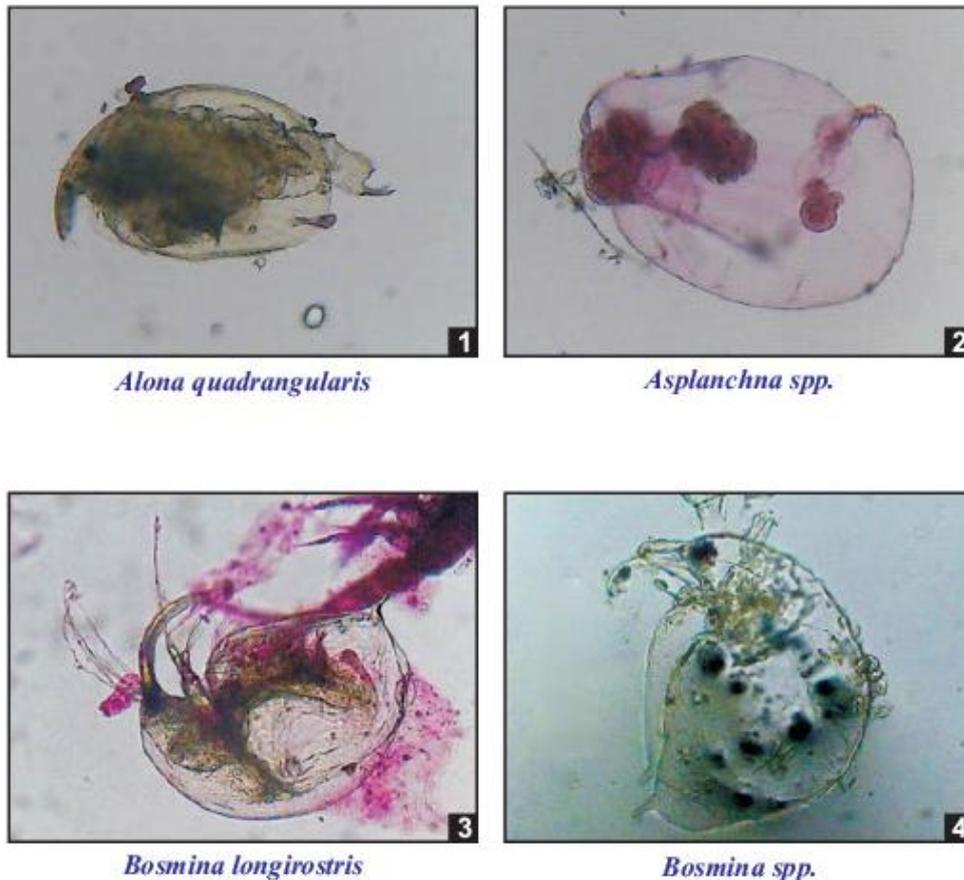
**Table 1.** List of Zooplankton species observed in various seasons of different sampling stations of Kot Dam.

S. no.	Group wise distribution of zooplankton in different seasons	Sampling Station I						Sampling Station II						Sampling Station III					
		S 2021	M 2021	W 2021-22	S 2022	M 2022	W 2022-23	S 2021	M 2021	W 2021-22	S 2022	M 2022	W 2022-23	S 2021	M 2021	W 2021-22	S 2022	M 2022	W 2022-23
<b>Group I: Protozoan</b>																			
1	<i>Astramoeba radiosa</i>	8	4	9	6	3	7	1	0	3	3	0	6	3	4	6	1	3	7
2	<i>Euglina spp.</i>	6	5	5	3	2	6	2	4	3	5	6	7	0	0	2	1	0	5
3	<i>Paramecium Aurelia</i>	7	3	8	9	7	10	8	6	8	6	5	9	10	8	12	10	6	8
4	<i>Paramecium bursaria</i>	3	2	2	2	0	3	5	5	7	4	1	6	8	2	10	6	0	8
5	<i>Paramecium spp.</i>	4	1	5	2	0	4	3	0	3	0	0	2	4	2	5	4	0	6
6	<i>Vorticella campanula</i>	5	3	4	3	3	4	0	3	3	2	2	2	2	2	5	4	3	5
7	<i>Vorticella microstoma</i>	3	3	5	4	3	4	4	2	0	5	5	7	5	2	7	3	4	5
8	<i>Vorticella spp.</i>	5	4	5	4	0	5	4	0	7	3	3	6	7	4	7	8	5	7
<b>Group II: Rotifers</b>																			
9	<i>Filinia opoliensis</i>	5	2	6	13	9	14	6	2	10	10	5	17	9	10	17	12	4	16
10	<i>Asplanchna spp.</i>	14	7	10	7	3	11	7	4	11	5	2	8	15	6	13	9	7	9
11	<i>Brachionus calyciflorus</i>	10	6	11	9	9	12	8	5	11	10	6	7	11	5	13	12	9	8
12	<i>Brachionus diversicornis</i>	10	3	14	12	5	11	7	5	8	6	5	8	13	7	9	10	11	12
13	<i>Brachionus havanaensis</i>	13	7	13	10	7	9	9	4	9	8	5	8	10	8	14	10	5	8
14	<i>Brachionus plicatilis</i>	12	11	14	6	7	7	12	9	12	12	10	11	9	8	10	7	4	9
15	<i>Brachionus quadridentatus</i>	10	7	7	8	2	10	13	4	15	8	7	10	14	8	13	8	7	9
16	<i>Brachionus spp.</i>	5	4	9	3	0	8	2	3	7	5	2	7	8	3	8	6	3	9
17	<i>Branchionus rubens</i>	8	2	9	5	4	6	6	4	9	7	3	8	10	6	8	7	6	10
18	<i>Keratella cochlearis</i>	8	6	11	9	4	13	4	0	8	6	1	8	7	3	11	11	3	13
19	<i>Keratella tropica</i>	3	1	8	5	0	8	7	5	10	4	3	7	9	7	13	10	9	13
20	<i>Lecane papuana</i>	6	3	11	8	7	8	5	1	5	6	7	6	10	4	14	5	0	7
21	<i>Lecane spp.</i>	7	1	8	7	4	13	7	6	7	9	9	13	11	7	8	14	9	19
22	<i>Monostyla bulla</i>	10	7	9	6	8	9	9	6	9	12	5	14	13	10	11	15	7	19
23	<i>Tricocerca longiseta</i>	7	4	7	14	7	12	12	11	17	12	9	12	4	4	5	8	7	7
<b>Group III: Copepods</b>																			
24	<i>Cyclops leuckarti</i>	8	7	10	10	9	11	7	4	7	8	7	7	8	4	10	10	7	12
25	<i>Cyclops spp.</i>	9	10	11	8	8	11	10	8	13	13	13	20	14	9	12	8	5	9
26	<i>Diaptomus spp.</i>	8	5	13	14	8	18	8	11	11	10	6	17	19	9	21	20	15	22
27	<i>Mesocyclops leuckartii</i>	12	11	15	9	4	11	13	9	15	7	8	14	12	3	15	11	8	16
28	<i>Mesocyclops spp.</i>	10	8	14	4	2	6	8	0	9	9	5	10	6	2	10	10	5	17
29	<i>Nauplii</i>	12	9	15	7	4	11	10	7	5	8	1	7	13	9	8	7	8	14
30	<i>Paracyclops spp.</i>	7	5	9	9	8	15	12	8	14	13	13	15	3	0	9	9	5	10
31	<i>Thermocyclops spp.</i>	12	10	13	9	7	14	11	5	16	8	2	14	9	4	15	11	3	16
<b>Group IV: Cladocera</b>																			
32	<i>Alona quadrangularis</i>	9	7	9	10	9	13	8	8	9	11	4	10	12	8	17	6	6	13
33	<i>Bosmina fatalis</i>	10	6	12	8	1	13	11	10	13	5	0	6	11	4	16	8	2	14
34	<i>Bosmina longirostris</i>	15	18	16	17	7	15	13	12	14	10	7	9	18	16	22	16	9	18
35	<i>Bosmina spp.</i>	14	12	13	12	11	11	12	8	13	12	11	15	13	12	16	12	7	16
36	<i>Bosminopsis deitersi</i>	18	14	20	11	4	16	10	7	14	10	8	14	17	9	22	15	6	18
37	<i>Ceriodaphnia reticulata</i>	19	14	23	13	7	13	11	12	18	9	6	11	15	11	21	19	3	23
38	<i>Ceriodaphnia spp.</i>	14	4	13	17	4	15	13	6	16	6	0	12	19	8	18	15	11	14
39	<i>Chydorus sphaericus</i>	8	1	15	10	3	17	11	9	12	12	9	15	11	10	14	14	16	18
40	<i>Chydorus spp.</i>	9	7	14	8	5	7	15	7	15	7	5	9	6	7	10	9	1	7
41	<i>Daphnia dubia</i>	10	11	11	6	0	8	12	7	20	10	6	16	9	7	9	10	6	17
42	<i>Daphnia longiremia</i>	12	7	11	10	6	9	10	5	9	6	5	10	12	7	11	9	6	11
43	<i>Daphnia lumholtzi</i>	17	13	18	13	12	15	13	12	15	12	9	12	17	13	18	16	3	15
44	<i>Daphnia magna</i>	18	12	22	12	8	11	15	10	16	13	9	18	11	11	18	11	4	16
45	<i>Daphnia pulex</i>	11	13	20	10	7	13	14	12	13	12	7	16	15	13	16	12	11	14
46	<i>Daphnia spp.</i>	9	6	11	11	12	16	18	12	20	15	6	18	15	12	16	14	14	21
47	<i>Diaphanosoma excisum</i>	11	11	14	15	6	15	15	14	21	19	3	20	16	7	11	18	11	19
48	<i>Diaphanosoma sarsi</i>	12	6	15	11	9	10	14	4	13	15	11	14	14	6	19	14	13	15
49	<i>Eubosmina spp.</i>	13	9	17	15	2	12	8	1	12	14	16	18	17	8	20	15	8	15
50	<i>Eubosmina tubicon</i>	9	6	11	9	7	10	6	7	8	4	7	6	7	6	7	9	9	13
51	<i>Moina macrocopa</i>	10	6	16	4	5	9	12	8	17	6	6	13	6	7	8	4	7	6
52	<i>Pleuroxus trigonellus</i>	9	8	12	11	9	15	11	7	12	9	9	9	13	9	13	11	9	7

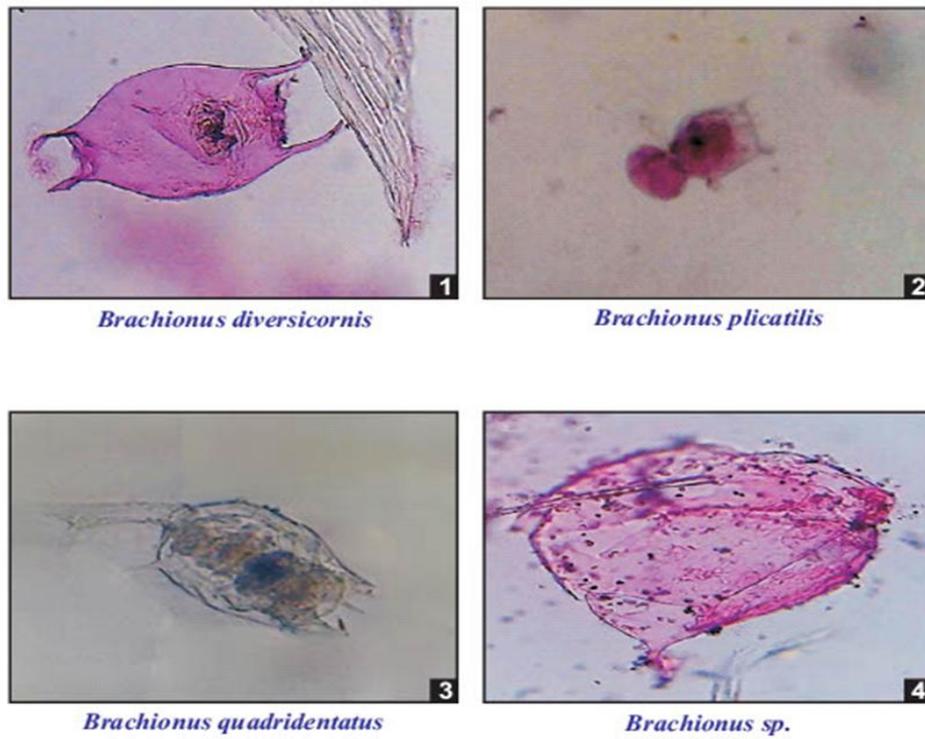
Group V: Ostracods																			
53	<i>Cyclocypria spp.</i>	6	2	3	5	1	2	5	4	4	2	0	0	4	2	0	6	1	4
54	<i>Cypretta fontinalis</i>	7	2	3	5	1	5	4	1	6	0	0	1	4	5	2	3	3	0
55	<i>Cypris spp.</i>	3	1	1	5	0	2	3	2	2	1	0	1	1	0	3	1	0	4
56	<i>Eucypris</i>	6	2	2	3	1	3	3	1	1	1	0	9	0	1	3	1	2	1
57	<i>Heterocypris</i>	3	2	2	1	0	0	0	0	0	0	1	0	1	0	0	0	0	1
58	<i>Stenocypris spp.</i>	2	1	1	0	0	0	3	0	0	0	0	2	1	1	2	0	0	1

**Table 2.** Seasonal variation in composition of Zooplankton species richness and diversity indices of different sampling stations of Kot Dam (SS- Sampling station).

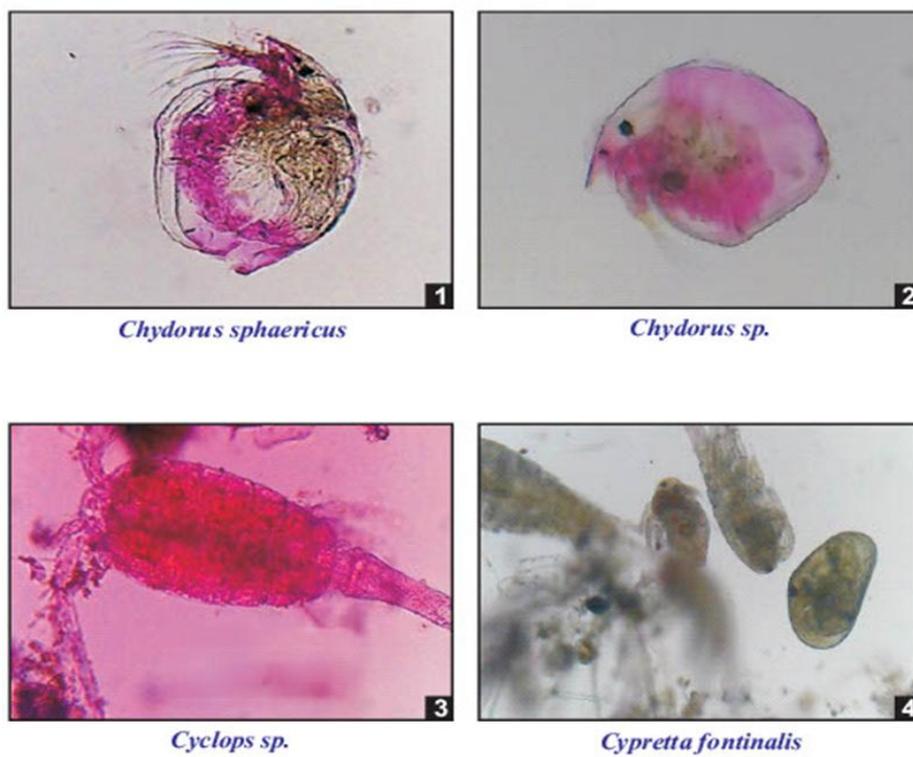
S.No.	Species Richness and Diversity indices	Sampling Station	Different Season					
			S 2021	M 2021	W 2021-22	S 2022	M 2022	W 2022-23
1	Species Richness	SS I	58	58	58	57	49	56
		SS II	56	51	55	54	49	56
		SS III	56	54	56	56	51	57
2	Simpson Diversity index	SS I	0.9795	0.9756	0.9786	0.9787	0.9743	0.9793
		SS II	0.9784	0.975	0.978	0.9773	0.9736	0.9783
		SS III	0.9781	0.9766	0.9784	0.9781	0.9749	0.9785
3	Shannon Diversity index	SS I	3.963	3.85	3.926	3.928	3.75	3.936
		SS II	3.91	3.785	3.893	3.869	3.739	3.906
		SS III	3.894	3.85	3.912	3.896	3.791	3.917



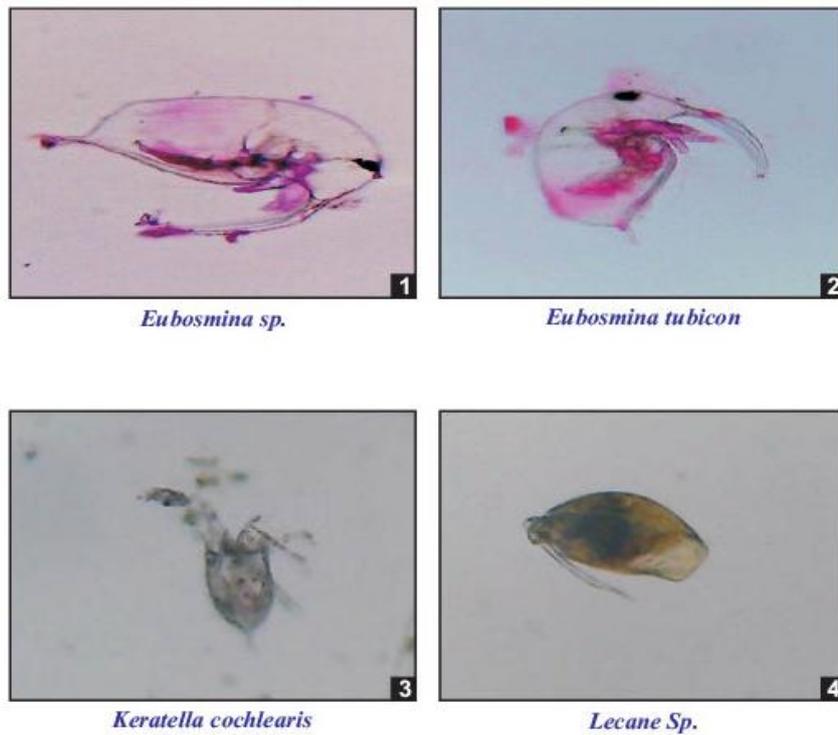
**Figure A. 1.** 1. *Alona quadrangularis*, 2. *Asplanchna* spp., 3. *Bosmina longirostris*, 4. *Bosmina* spp.



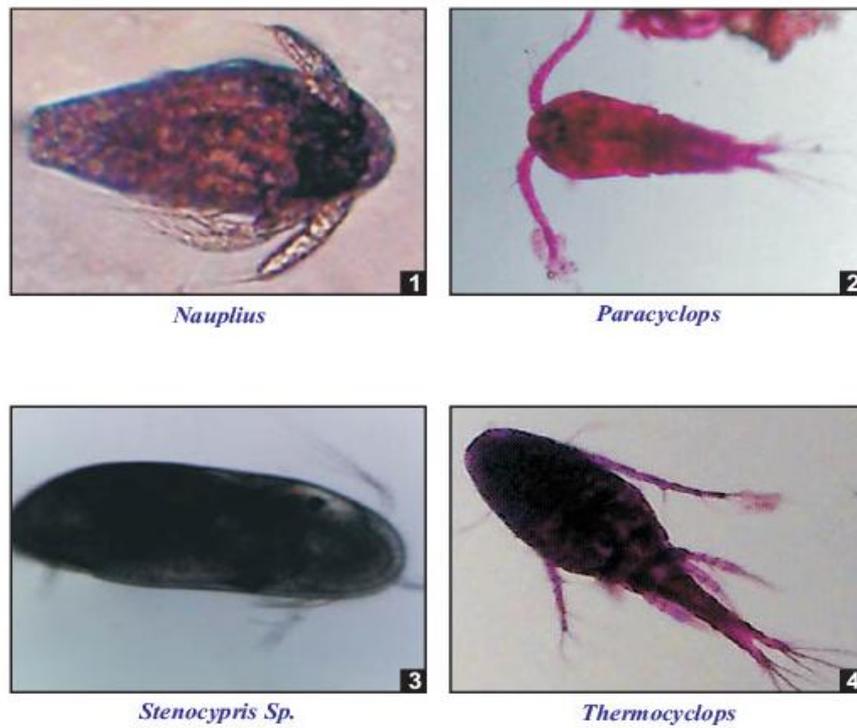
**Figure B:** 1. *Brachionus diversicornis*, 2. *Brachionus plicatilis*, 3. *Branchionus quadridentatus*, 4. *Branchionus spp.*



**Figure C** 1. *Chydorus sphaericus*, 2. *Chydorus spp.*, 3. *Cyclops spp.*, 4. *Cyprretta fontinalis*.



**Figure D:** 1. *Eubosmina sp.*, 2. *Eubosmina tubicon*, 3. *Keratella cochlearis*, 4. *Lecane spp.*



**Figure E.** 1. *Nauplius*, 2. *Paracyclops*, 3. *Stenocypris Sp.*, 4. *Thermocyclops*.

## CONCLUSION

Therefore, present study provides a seasonal detailed account of zooplankton diversity in the different seasons of the Kot Dam. In the present study, the overall species richness and diversity of zooplankton were observed to be at their lowest during the monsoon season. This phenomenon is attributed to alterations in the physicochemical parameters and properties of water, such as increased turbidity, reduced light intensity, cloudy weather, and precipitation. Similar observations have been reported in various studies (Watkar and Barbate, 2013; Bhavan *et al.*, 2015; Manickam *et al.*, 2014, 2015, 2018).

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## CONFLICT OF INTERESTS

The authors declare no conflict of interest

## ETHICS APPROVAL

Not applicable

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## AI TOOL DECLARATION

The authors declares that no AI and related tools are used to write the scientific content of this manuscript.

## DATA AVAILABILITY

Data will be available on request

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