International Journal of Zoology Studies
ISSN: 2455-7269
Impact Factor: RJIF 5.14
www.zoologyjournals.com
Volume 2; Issue 5; September 2017; Page No. 175-181

Study on seasonal density of zooplanktons in Ken River of Panna district (M.P.)

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Abstract
Seasonal density of Zooplankton in the Ken River was studied July 2013 to June 2014. Zooplankton forms the microscopic and free floating animals that play an important role in aquatic food chain as they are largely consumed by fishes particularly their larvae and other higher organisms in food chain. They feed on phytoplankton and facilitate the conversion of plant material into animal tissue. They play a major role to study the faunal diversity and in energy transfer to the next higher trophic levels and are also good indicator of water quality. They are strongly affected by environmental conditions and responds quickly to change in environmental quality. Hence, qualitative and quantitative study of zooplanktons is of great importance.

Keywords: zooplankton, ken river, seasonal density, trophic status

Introduction
Plankton is the natural food of many species of fishes especially zooplankton constitute important food item of many omnivorous and carnivorous fishes, the larvae of carps feed mostly of zooplankton because zooplankton provides the necessary amount of protein for the rapid growth. The zooplankton forms the principal source of food for fish within the water body. Zooplankton contributes about 82% of the food items of *Anabas testudineus* (Shafi and Mustafa, 1976), 32% of *Notopterus notopterus* (Mustafa and Ahmed, 1979), 47.06% of *Catlacatla* and 6.37% of *Labeo rohita* (Ali and Islam, 1981) and 30% of *Mystus vittatus* (Bhuiyan and Haque, 1984). Bhuiyan and Islam (1988) reported that the main food items of *Xenentodon cancila* was zooplankton. Zooplankton also plays a very important role in the food chain as they are in the second trophic level as primary consumer and also as contributors to the next trophic level. Both the qualitative and quantitative abundance of plankton in any water body are of great importance for aquaculture, as they differ from location to location and within similar ecological conditions (Boyd, 1982).

Study Area
The Ken river is one of the major river of Bundelkhand region of Central India. It flows through two states Madhya Pradesh and Uttar Pradesh. It is a tributary of Yamuna river. The Ken river originates near village, Ahirgawan on the north-west slopes of Kaimur Range in Katni district of M.P. and travels a distance of 427 Km. before merging with Yamuna at village, Chilla of Fatehpur in U.P. at 25°46'N and 80°31'E. It is one of the sixteen perennial rivers of Madhya Pradesh. It flows about 55 Km. through Panna National Park from South to North. Hence it is a source of drinking water for wild animals of Panna National Park.

Material and Methods
For this study there are four sampling station were selected on the basis of utilization of water for different purpose such as bathing, irrigation, washing, Animal drinking and depth of the river. These sampling station are Tighara Bridge near Tighra village (A), Panda wan Bridge near Pandawan village (B), Madala Bridge near Madala village (C) and Raneh Fall near Ken Gharial Sanctuary (D)
One hundred liters of water sample from selected stations of the Ken river was filtered through plankton net (0.1 mm mesh size) and allowed to settle down for 24-48 hours. For plankton study, the samples were collected monthly, early in the morning (8.00 am to 9.30 am). The samples were preserved in 4% formalin solution in 50 ml bottle. The plankton count was made by Sedgwick rafter counting cell under the microscope.
Identification of phytoplankton and zooplankton species was performed using keys and monographs of Adoni (1985) [1], Michael (1973) [10], Krishnaswamy (1973), Santhanam *et al.* (1989), Smith (1950), Pennak (1978), Welch (1948), Tonapi (1980), APHA (1998), Desikachary (1959), Edmondson (1959), Agarkar (1975), Prescott (1982). Counting of the individual plankton was done by "Lak Keys" dropping method (1935) using the formula:

$$\text{Plankton units/l} = \frac{N \times C \times 10}{Y}$$

Where
N = Number of plankton counted in 0.1 ml concentrate.
C= Total volume of concentrate in ml.
Y= Total volume of water filtered for sample in liters.

Result and Discussion
Monthly sampling of zooplankton was recorded at four stations of Ken river of Panna landscape during July 2013 to

June 2014. The density of each zooplanktonic species was recorded at different stations during all seasons of the study period and represented in Table 1 to 3. In present study, in all 36 species of zooplankton were recorded. Among 36 species, 7 species were represented by Protozoa, 14 species to Rotifera, 6 species to Copepoda, 7 species to Cladocera and 2 species to Ostracoda.

Seasonal density of Zooplankton

The average density of different members of zooplankton observed at four stations of Ken river at Panna landscape during three seasons of study period are represented in Tables 1 to 3.

i) Rainy Season (July 2013 to October 2013)

The average density of different species of zooplankton observed during rainy season of study year is represented in Tables 1.

Among the 7 species of Protozoa, the minimum density was recorded for *Actinophrys sp*. (3.50 org/l) and maximum density for *Epistylisanastica* (12.50 org/l) during rainy season of study period respectively. *Euglena sp*. (7.50 org/l) and *Euglepha sp.* and *Holophrya sp*. (each 6.75 org/l) during of study period also showed appreciable density. The total density of this group was recorded as 37 org/l at station A, 45 org/l at station B, 64 org/l at station C and 45 org/l at station D with an average density of 47.75 org/l during of study period respectively. The maximum density of Protozoa was recorded at station C and minimum at station A during study year.

The minimum and maximum average density of different members of Rotifera fluctuated between 3.50 org/l to 15.75 org/l during of study period. The minimum density was observed for *Lecaneovalies* and maximum for *Rotaria sp*. during study year. Some members of Rotifera also showed higher density in comparison to other members of the group as *Porella sp*. (13.50 org/l), *Notholca sp.* (11.75 org/l and *Tricocerca sp.* (10.50 org/l) during study year. The total density of this group was recorded as 87 org/l, 109 org/l, 161 org/l and 114 org/l at stations A, B, C and D respectively with an average density of 117.75 org/l during of study period. The minimum density of this group was recorded at station A and maximum at station C during study year.

Freshwater copepods occur in all types of water bodies. They serve as food to several fishes and play a major role in ecological pyramids. Among the members of Copepoda, *Nauplii* showed the maximum density of 49.0 org/l during of study period respectively. The minimum density was represented by *Mesocyclops sp*. (11.50 org/l) during study year. Some members of this group also showed better density as *Diaptomus sp*. (33.0 org/l) and Cyclops sp. (30.50 org/l) during study year. The total density of this group fluctuated between 143 org/l (station A) to 192 org/l (station C) with an average total density of 162.25 org/l during of study period.

Cladocerans are popularly called as 'water flea' prefers to live in deep water and constitute a major item of food for fish. Among the members of Cladocera, the minimum density was represented by *Daphnia carinata* (11.75 org/l) and maximum density by *Moina brachiata* (27.75 org/l) during study year. Some members of this group also showed better density as *Daphnia pulex* (18.0 org/l), *Mono daphnia sp*. (16.0 org/l) during of study period respectively. The total density of this group was recorded as 97 org/l at station A, 110 org/l at station B, 133 org/l at station C, 114 org/l at station D with an average density of 113.50 org/l during of study period respectively. The minimum density was observed at station A and maximum at station C during rainy season of study year.

Among the two members of Ostracods the minimum density was observed for *Gastrocypris sp*. (13.25 org/l) and maximum density for *Cypris sp*. (14.75 org/l) during of study period. The total density of this group fluctuated between 21 org/l (station A) to 40 org/l (station C) with an average density of 28.0 org/l during of study period.

Among the different groups of zooplankton, Copepoda showed their dominance with an average total density of 162.25 org/l followed by Rotifera (117.75 org/l), Cladocera (113.50 org/l), Protozoa (47.75 org/l) and Ostracoda (28.0 org/l) during study year.

The total density of zooplankton varied between 385 org/l (station A) to 590 org/l (station C) with an average total density of 469.25 org/l during of study period.

ii) Winter season (Nov. 2013 to Feb. 2014)

Zooplankton density observed in Ken river at Panna landscape during winter season of study year are represented in Tables 2.

Among the 7 species of Protozoa, the maximum density was recorded for *Epistylisanastica* (17.25 org/l) and minimum density for *Amoeba sp*. (8.0 org/l) during winter season of study period respectively. Some other members of this group also showed better density as *Euglena sp*. (13.0 org/l), *Euglepha sp.* (11.50 org/l) and *Holophrya sp*. (10.75 org/l) during study year. The total density of this group was recorded as 67 org/l at station A, 75 org/l at station B, 94 org/l at station C and 79 org/l at station D with an average total density of 78.75 org/l during of study period respectively. The minimum density of Protozoa was recorded at station A and maximum at station C during study year.

The average density of different members of Rotifera fluctuated between 7.75 org/l to 19.0 org/l during study year. The minimum density was recorded for *Lecaneovalis* and maximum density for *Rotariasp*. during study year. Some species of this group also showed noticeable density as *Porella* sp. (17.25 org/l), *Notholca* sp. (16.0 org/l) and *Trichocerca* sp. (15.50 org/l) during of study period. The minimum density of this group was recorded at station A and maximum at station C during study year. The total density of this group was recorded as 146 org/l at station A, 165 org/l at station B, 218 org/l at station C and 168 org/l at station D with an average total density of 174.25 org/l during winter season of study period respectively.

Among 6 species of Copepoda, *Nauplii* exhibited the higher density of 49.25 org/l, followed by *Diaptomus sp. (34.25 org/l), Cyclops sp. (30.50 org/l), Heliodiaptomussp. (25.00 org/l), Gammarus sp*. (18.25 org/l) and *Mesocyclops* sp. (14.75 org/l) during of study period. The total density of this group was recorded as 155 org/l at station A, 166 org/l at station B, 200 org/l at station C and 167 org/l at station D during of study period respectively. The average total density of this group was recorded as 172.0 org/l during of study period.

Among Cladocera, the maximum density was recorded for

Moina brachiata (30.50 org/l) and minimum density for *Daphnia carinata* (15.50 org/l) during study year. *Mono daphnia sp*. (20.0 org/l) and *Bosminacoregoni* (19.50 org/l) during study year also showed appreciable density. The total density of this group varied between 122 org/l (station A) to 158 org/l (station C) with an average total density of 139.0 org/l during study year.

Among the members of Ostracoda the minimum density was recorded for *Gastro cypris sp* (11.75 org/l) and maximum density for *Cypris sp*. (12.25 org/l) during of study period respectively. The total density of this group varied between 14 org/l (station A) to 35 org/l (station C) with an average total density of 24.0 org/l during study year.

Among the different groups of zooplankton, Rotifera showed their dominance with maximum density of 174.25 org/l, followed by Copepoda (172.0 org/l), Cladocera (139.0 org/l), Protozoa (78.75 org/l) and Ostracoda (24.0 org/l) during winter season of study period respectively.

The total density of zooplankton was recorded as 504 org/l at station A, 565 org/l at station B, 705 org/l at station C and 578org/l at station D with an average total density of 588.0 org/l during winter season of study period respectively.

iii) Summer season (March 2014 to June 2014)

The density of different members of zooplankton, recorded during summer season of study year in Ken river at Panna landscape are represented in Tables 3.

The density of Protozoa varied between 2.0 org/l to 11.50 org/l during of study period. The minimum density was recorded for *Amoeba sp*. and maximum density for *Epistylisanastica* during study year. *Paramecim sp*. (10.0 org/l) and *Euglena sp*. (7.50 org/l) also showed better density during study year. The maximum density of Protozoa was recorded at station C and minimum density at station A during study year. The total density of Protozoa was observed as 32 org/l at station A, 40 org/l at station B, 52 org/l at station C and 45 org/l at station D with an average total density of 42.25 org/l during of study period respectively.

Among the 14 species of Rotifera, the minimum and maximum density was fluctuated between 7.75 org/l to 19.75 org/l during of study period. The minimum density was recorded for *Lecaneovalis* and maximum density for *Rotaria sp*. during study year. Some members of this group also showed appreciable density as *Porella* sp. (17.25 org/l), *Trichocereasp*. (16.50 org/l) and *Notholcasp*. (16.0 org/l) during of study period. The total density of this group varied between 144 org/l (station A) to 218 org/l (station C) with an average total density of 175.0 org/l during of study period.

The species of Copepoda have shown the density in the range of 18.00 org/l to 53.50 org/l during of study period. The minimum density was recorded for *Mesocylops sp*. and maximum density for *Nauplii* during study year. Some species of this group also showed better density as *Diaptomus sp*. (39.00 org/l), *Cyclops sp.* (34.75 org/l) and *Heliodiaptomus* sp. (29.50 org/l) during study year. The total density of this group fluctuated between 181 org/l to 255 org/l with an average total density of 197.0 org/l during of study period. The minimum density of this group was recorded at station A and maximum density at station C during study year.

Among the 7 members of Cladocera, the minimum and maximum density varied between 10.75 org/l (*Ceriodaphniasp*.) to 25.25 org/l (*Moina brachiata*) during of study period. Some members of this group also showed better density as *Daphnia pulex* (16.50 org/l), *Mono daphania sp*. (15.25 org/l) and *Bosminacoregoni* (15.0 org/l) during of study period. The total density of this group fluctuated between 88 org/l (station A) to 125 org/l (station C) with an average density of 105.75 org/l during of study period.

Among 2 members of Ostracoda, the maximum density was recorded for *Cypris sp*. (17.50 org/l) and minimum for *Gastrocypris sp*. (17.0 org/l) during of study period respectely. The total density of this group varied between 26.0 org/l (station A) to 45 org/l (station C) with an average density of 34.50 org/l during of study period.

Among the different groups of zooplankton, Copepoda showed the maximum density of 197.00 org/l followed by Rotifera (175.0 org/l), Cladocera (105.75 org/l), Protozoa (42.25 org/l) and Ostracoda (34.50 org/l) during of study period.

The total density of zooplankton was recorded as 471org/l at station A, 527 org/l at station B, 665 org/l at station C and 555org/l at station D with an average total density of 554.5 org/l during of study period respectively.

Table 1: Density of zooplankton population (org/l) at four sampling stations of Ken river at Panna Landscape during rainy season (July 2013 to Oct. 2013).

S. No.	Name of species	Station				Average
		A	B	C	D	
Group -Protozoa						
1	*Actinophrys sp.*	3	5	4	2	3.50
2	*Amoeba sp.*	5	3	6	3	4.25
3	*Epistylisanastica*	10	12	15	13	12.50
4	*Euglena sp.*	4	7	10	9	7.50
5	*Euglepha sp.*	6	5	9	7	6.75
6	*Holophrya sp.*	5	7	11	4	6.75
7	*Paramecium sp.*	4	6	9	7	6.50
	Total	37	45	64	45	47.75
Group-Rotifera						
1	*Asplanchnabrightwelli*	7	4	9	6	6.50
2	*Brachionusangularis*	4	9	11	5	7.25
3	*Brachionusbidentata*	5	6	10	7	7.00
4	*Brachionuscaudatus*	2	5	11	4	5.50

5	*Brachionus falcatus*	4	7	9	5	6.25
6	*Brachionus patulus*	3	8	12	9	8.00
7	*Euchlaneis sp.*	4	5	9	7	6.25
8	*Filiniaterminalis*	7	8	14	13	10.50
9	*Keratella sp.*	5	4	7	6	5.50
10	*Lecaneovalis*	3	5	4	2	3.50
11	*Notholca sp.*	9	10	15	13	11.75
12	*Porella sp.*	11	14	17	12	13.50
13	*Rotaria sp.*	16	13	19	15	15.75
14	*Trichocerca sp.*	7	11	14	10	10.50
	Total	87	109	161	114	117.75
Group-Copepoda						
1	*Cyclops sp.*	27	29	35	31	30.50
2	*Diaptomus sp.*	32	36	39	25	33.00
3	*Gammarus sp.*	15	17	18	14	16.00
4	*Heliodiaptomus sp.*	18	21	27	23	22.25
5	*Mesocyclops sp.*	10	12	14	10	11.50
6	*Nauplii*	41	45	59	51	49.00
	Total	143	160	192	154	162.25
Group-Cladocera						
1	*Alona sp.*	11	12	14	13	12.50
2	*Bosminacoregoni*	13	15	19	15	15.50
3	*Ceriodaphnia sp.*	10	12	15	11	12.00
4	*Daphnia carinata*	7	11	14	15	11.75
5	*Daphnia pulex*	14	19	21	18	18.00
6	*Moina brachiata*	25	27	32	27	27.75
7	*Monodaphnia sp.*	17	14	18	15	16.00
	Total	97	110	133	114	113.50
Group-Ostracoda						
1	*Cypris sp.*	15	12	19	13	14.75
2	*Gastrocypris sp.*	6	11	21	15	13.25
	Total	21	23	40	28	28.00
	Grand Total	385	447	590	455	469.25

Table 2: Density of zooplankton population (org/l) at four sampling stations of Ken river at Panna Landscape during winter season (Nov. 2013 to Feb. 2014).

S. No.	Name of species	Station				Average
		A	B	C	D	
Group -Protozoa						
1	*Actinophrys sp.*	7	11	9	6	8.25
2	*Amoeba sp.*	9	7	10	6	8.00
3	*Epistylisanastica*	14	15	18	22	17.25
4	*Euglena sp.*	10	13	16	13	13.00
5	*Euglepha sp.*	11	9	13	13	11.50
6	*Holophrya sp.*	9	11	16	7	10.75
7	*Paramecium sp.*	7	9	12	12	10.00
	Total	67	75	94	79	78.75
Group-Rotifera						
1	*Asplanchnabrightwelli*	12	7	14	10	10.75
2	*Brachionusangularis*	8	13	15	10	11.50
3	*Brachionusbidentata*	9	10	13	11	10.75
4	*Brachionuscaudatus*	6	9	17	8	10.00
5	*Brachionusfalcatus*	8	11	12	9	10.00
6	*Brachionuspatulus*	8	13	18	11	12.50
7	*Euchlaneis sp.*	8	8	12	9	9.25
8	*Filiniaterminalis*	12	13	18	16	14.75
9	*Keratella sp.*	8	7	11	11	9.25
10	*Lecaneovalis*	6	10	9	6	7.75
11	*Notholca sp.*	15	12	19	18	16.00
12	*Porella sp.*	14	18	21	16	17.25
13	*Rotaria sp.*	21	17	21	17	19.00
14	*Trichocerca sp.*	11	17	18	16	15.50
	Total	146	165	218	168	174.25

Group-Copepoda						
1	*Cyclops sp.*	28	31	34	29	30.50
2	*Diaptomus sp.*	32	37	41	27	34.25
3	*Gammarus sp.*	18	20	18	17	18.25
4	*Heliodiaptomus sp.*	18	22	30	30	25.00
5	*Mesocyclops sp.*	15	16	15	13	14.75
6	*Nauplii*	44	40	62	51	49.25
	Total	155	166	200	167	172.00
Group-Cladocera						
1	*Alona sp.*	13	15	19	18	16.25
2	*Bosminacoregoni*	18	19	23	18	19.50
3	*Ceriodaphnia sp.*	15	17	18	15	16.25
4	*Daphnia carinata*	12	14	18	18	15.50
5	*Daphnia pulex*	16	22	24	22	21.00
6	*Moina brachiata*	29	30	34	29	30.50
7	*Monodaphnia sp.*	19	18	22	21	20.00
	Total	122	135	158	141	139.00
Group-Ostracoda						
1	*Cypris sp.*	11	11	17	10	12.25
2	*Gastrocypris sp.*	3	13	18	13	11.75
	Total	14	24	35	23	24.00
	Grand Total	504	565	705	578	588.00

Table 3: Density of zooplankton population (org/l) at four sampling stations of Ken river at Panna Landscape during summer season (March 2014 to June 2014).

S.No.	Name of species	Station				Average
		A	B	C	D	
Group -Protozoa						
1	*Actinophrys sp.*	2	4	2	1	2.25
2	*Amoeba sp.*	2	2	3	1	2.00
3	*Epistylisanastica*	9	8	14	15	11.50
4	*Euglena sp.*	6	8	7	9	7.50
5	*Euglepha sp.*	3	4	5	7	4.75
6	*Holophrya sp.*	3	5	9	0	4.25
7	*Paramecium sp.*	7	9	12	12	10.00
	Total	32	40	52	45	42.25
Group-Rotifera						
1	*Asplanchnabrightwelli*	12	9	16	9	11.50
2	*Brachionusangularis*	7	11	16	8	10.50
3	*Brachionusbidentata*	8	10	13	12	10.75
4	*Brachionuscaudatus*	7	7	15	9	9.50
5	*Brachionusfalcatus*	9	14	14	6	10.75
6	*Brachionuspatulus*	7	13	16	13	12.25
7	*Euchlaneis sp.*	6	8	11	7	8.00
8	*Filiniaterminalis*	12	14	17	19	15.50
9	*Keratella sp.*	5	8	11	12	9.00
10	*Lecaneovalis*	5	10	8	8	7.75
11	*Notholca sp.*	16	9	20	19	16.00
12	*Porella sp.*	15	18	20	16	17.25
13	*Rotaria sp.*	21	20	23	15	19.75
14	*Trichocerca sp.*	14	18	18	16	16.50
	Total	144	169	218	169	175.00
Group-Copepoda						
1	*Cyclops sp.*	31	34	39	35	34.75
2	*Diaptomus sp.*	38	41	45	32	39.00
3	*Gammarus sp.*	22	23	24	20	22.25
4	*Heliodiaptomus sp.*	24	27	34	33	29.50
5	*Mesocyclops sp.*	18	19	18	17	18.00
6	*Nauplii*	48	44	65	57	53.50
	Total	181	188	255	194	197.00
Group-Cladocera						
1	*Alona sp.*	9	11	13	14	11.75
2	*Bosminacoregoni*	13	13	19	15	15.00

3	*Ceriodaphnia sp.*	11	11	12	9	10.75
4	*Daphnia carinata*	7	10	13	15	11.25
5	*Daphnia pulex*	12	16	21	17	16.50
6	*Moina brachiata*	23	24	28	26	25.25
7	*Monodaphnia sp.*	13	12	19	17	15.25
	Total	88	97	125	113	105.75
Group-Ostracoda						
1	*Cypris sp.*	17	17	21	15	17.50
2	*Gastrocypris sp.*	9	16	24	19	17.00
	Total	26	33	45	34	34.50
	Grand Total	471	527	665	555	554.5

Annual density of Zooplankton

Annual density of zooplankton has been computed from the basic data and represented in Table 4. Copepoda showed their dominance with density of 177.08 org/l during of study period respectively. Next in order was Rotifera with density of 155.67 org/l followed by Cladocera with density of 119.42 org/l, Protozoa with density of 56.25 org/l and Ostracoda with density 29.00 org/l during of study period respectively. The percentage contribution of these groups was recorded as 32.95% for Copepoda, followed by Rotifera (28.97%), Cladocera (22.22%), Protozoa (10.47%) and Ostracoda (5.40%) during of study period respectively.

Table 4: Average annual density (org/l) of different taxonomic groups of zooplankton and their percentage contribution observed during study period (July 2013 to June 2014).

S. No.	Taxonomic group	First year (July 2013 to June 2014)				
		Rainy season	Winter Season	Summer Season	Mean annual density	%
1	Protozoa	47.75	78.75	42.25	56.25	10.47
2	Rotifera	117.75	174.25	175.0	155.67	28.97
3	Copepoda	162.25	172.0	197.0	177.08	32.95
4	Cladocera	113.50	139.0	105.75	119.42	22.22
5	Ostracoda	28.0	24.0	34.50	29.00	5.40
	Total 05	469.25	588.0	554.50	537.42	100.00

Conclusion

In present study, in all 36 species of zooplankton were recorded from Ken River of Panna District, Madhya Pradesh. Among 36 species, 7 species were represented by Protozoa, 14 species to Rotifera, 6 species to Copepoda, 7 species to Cladocera and 2 species to Ostracoda. The percentage contribution of these groups was recorded as 32.95% for Copepoda, followed by Rotifera (28.97%), Cladocera (22.22%), Protozoa (10.47%) and Ostracoda (5.40%) during of study period respectively.

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