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Monitoring Water Quality Using Zooplankton Organisms As Bioindicators In The Well Water Of Nagpur City (M.H.) India

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Abstract :
The existence of zooplanktons and their population was investigated with reference to water quality from June 2016 to September 2016. Water samples were collected from one sampling station from each zone as such ten zones of Nagpur city were evaluated for the present study. Zooplanktons were sampled using plankton net. By qualitative and quantitative analysis of the zooplankton community, bioindicator species were selected for evaluation of water quality. The results revealed that zooplanktons are present in all wells of eight zones except the wells of Lakadganj and Satranjipura Zones. Statistical analysis using one way ANOVA (F-test) for difference of species in month wise and area wise correlation and comparing the distribution of zooplanktons were significantly higher ($p<0.05$) in eight zones than Lakadganj and Satranjipura Zones. Protozoans were present in the range of 9% -100% (r=0.763), Copepods were 8% - 100% (r=0.830), Ostracoda 46% - 67% (r=0.806), Rotiferans were 20% - 100% (r=0.826) quantitatively. Qualitatively *Arcella hemisphaerica, Nassula, Malacophryx, Centropyxis, Euplotes patella, Nassula ornata, Tetrahymena pyriformis* of protozoa, *Cyclops* and *nauplius* of copepoda, *Cypris* of ostracoda and *Brachionus calyciflorus, angularis, bidentata, plicatilis, forficula, caudatus species, Keratella tropicana, quadrata species, Filinia longiseta, Asplanchna priodanata, Rotaria sp, Lecane species, budapestinensis species of Rotifera were observed in the samples.* The presence of zooplanktons (r=0.96) and their number varied from place to place depending upon the condition of water reservoir. The findings of the present study will helpful to improve management plans for well water quality control authorities of the city.
Keywords : Zones of Nagpur City, Bioindicators, Zooplankton, water Quality.

Introduction :

Before 1936, dugwells, rivers and ponds were the main source of drinking water to the city population. Water works department, Nagpur Municipal Corporation, Nagpur, besides the surface water sources, they have constructed open wells in various localities. Field investigations revealed that many public wells are deliberately misused for dumping garbage. Consequently these dependable sources get polluted. These pollutants may be biological or physicochemical.

Zooplanktons are microscopic organisms that are suspended in water. These include many kinds of Protozoans, microcrustaceans and other microinvertebrates that are planktonic in water bodies (omudu & odeh, 2006). They are globally recognized as pollution indicators organisms in the aquatic environment (yakubu et al., 2000)

Water of good drinking quality is of basic importance to human physiology and man's continued existence depends very much on its availability (Lamikarna, 1999: FAO, 1997). The provision of potable water to the population is necessary to prevent health hazards (Nikoladze and Akastal, 1989; Lemo 2002). A good knowledge of the qualities of raw water is necessary so as to guide its suitability for use (omezuruike et al. 2008).

This study is therefore is an attempt to examine the quality of well water with the help of zooplankton analysis as they are the bioindicators of pollution, as well as to find out the possible reasons for this pollution of the water reservoirs.

Material and Methods :

Study Area

The water samples were collected from the wells of ten zones of the Nagpur city. Nagpur district is one of the nine districts of Vidarbha region of Maharashtra. It is situated on the eastern part of the state abutting Chindwada district of Madhya Pradesh in North. It is bounded by Wardha and Amravati district in the west, Bhandara district in the east and Chandrapur district in the south. It lies between north latitudes 20°35' and 21°44' and east latitudes 78°15' and 79°40'and falls in survey on India to toposheets 55 k. The district has a geographical area of 9892 sq km (Murthy and Sahoo, 1999).

Water supply service area is statutory limit of Nagpur Municipal Corporation. The total service area within the city is 217sq.km of which is about 7sq.km. area is under catchment of lakes at periphery of city. The city is divided in to ten administrative zones – Dharampeth, LaxmiNagar, Hanuman Nagar, Dhantoli, NeharuNagar, Gandhibagh, Satranjipura, Lakhadganj, AshiNagar, Mangalwari. (source : NMC, water audit and leak detection report march -2004) (Fig. 1)

Figure. 1 : Location Map of Study Area

Sample Analysis :

Water samples were collected between 6.00 am to 9.00 am in June, July and August and September (monsoon season) from three well of the each zone of Nagpur city for the analysis of zooplankton. Thus total 30 sampling points were selected for the convenience of sampling during the study period.

Zooplankton Sampling :

Zooplankton samples were collected by passing water through plankton net of mesh size 50µm 50 litres of water is passed through the plankton net and the final concentration of plankton sample is 25ml to this 5ml of 4% formalin is added which acts as fixative as well as preservative.

Identification and counting of zooplankton :

From the pressured sample 1 ml of the sample was taken on the slide with the help of dropper and observed under the microscope. The following are the specific volumes for identification of different groups of zooplankton - Protozoa, Ostracoda, Copepoda, Cladocera, Rotifera number of plankton in the S-R cell was derived from the following formula APHA (1976)

$$\text{Number of Species/ Litre} = \frac{CX\ 1000\ mm^3}{L \times D \times W \times S}$$

Where,

C = Number of organisms counted

L = Length of each stripe (S-R cell length) in mm

D = Depth of each stripe in mm

W = Width of each stripe in mm

S = Number of stripe

Statistical Analysis :

With the help of statistical (F-test) one way ANOVA for difference of species in month wise and area wise correlation. (Sukhatme B.V. 1984, Goon A. M. 2008)

Results and Discussion :

The identified zooplankton population in the present study were under five groups including protozoa, ostracoda, copepoda, cladocera and rotifera. A total eleven zooplankton genera under five groups were recorded from the study area. Among the identified zooplankton the group rotifer was dominant with five genus followed by copepdoda (2 genus), protozoa (7 genus), ostracoda (1 genus) also found. The composition of zooplankton in the month of June – September is given in the table 1. The month wise qualitative composition is given in the table 2,5,8,11 (June, July, August and September). The area wise and month wise correlation of protozoa, ostracoda, copepoda and rotifera in June, July, August and September is given in the table 3,6,9,12 - area wise and 4,7,10,13 - month wise. The area wise and month wise graph represents in the fig. 6 and 7.

The use of zooplankton community structure as an indicator of the wellbeing of well waters. The zooplankton community structure in all ten Zones of Nagpur city were Rotifera>copepoda> protozoa.

In the present study the greatest diversity was observed among rotifera with 14 species followed by protozoa and copepoda.

Largely available zooplanktons were represented by the members of group rotifera in the month of July in the Lakadganj, Hanumannagar and Aashinagar zone and in the month of August in Nehrunagar and Aashinagar zone. This diversity increases from 27% to 100% in Hanumannagar zone. A noticeable change been observed in the Dharampeth zone i.e. in the month of June. The water is free from zooplankton but in the month of July the population of copepods and in the month of August the population of protozoan was observed up to the 100%. The total population in the month of July was 600/50ml and again in the month of August was 900/50ml. These figures are statistically mentioned as cyclic correlation in all the areas for protozoa and copepoda and in decreasing manner for ostracoda in all areas. It is also seen that for the first four areas correlation is increasing in nature and there is no correlation in Lakadganj and Satranjipura zones. Further it is highly increased and then again it is highly decreased for Rotiferans. It is concluded that protozoa, ostracoda, copepoda and rotifera are

positively correlated in all the months. It is seen that protozoa and ostracoda are highly positive correlated with each other and rotifera and copepod are positive correlated in all the months. It is also seen that copepoda are positive correlated with ostracoda and protozoa and highly positive correlated with rotifer.

Table 1 : Composition of zooplankton in the month of June – September

Sr. No.	MONTH / WELLS ⇩	No. Of Zooplanktons			Protozoa			Ostracoda			Copepada			Rotifera		
	ZONE - LAXMINAGAR															
	⟹	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1	June	5 (1500)	15 (4500)	20 (6000)	-	7 (47%)	1 (5%)	-	1 (7%)	1 (5%)	3 (60%)	4 (27%)	7 (35%)	1 (40%)	3 (20%)	11 (55%)
2	July	13 (3900)	13 (3900)	18 (5400)	-	5 (39%)	3 (17%)	-	1 (8%)	2 (12%)	4 (31%)	3 (13%)	3 (17%)	9 (69%)	4 (31%)	10 (62%)
3	August	7 (2100)	10 (3000)	12 (3600)	-	-	4 (34%)	-	2 (20%)	1 (19%)	4 (57%)	4 (40%)	2 (17%)	3 (43%)	4 (40%)	5 (42%)
4	September	1 (300)	5 (1500)	7 (2100)	-	3 (60%)	2 (29%)	-	1 (20%)	2 (29%)	1 (100%)	1 (20%)	2 (29%)	-	-	1 (15%)
	ZONE - DHARAMPETH															
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1	June	-	2 (600)	2 (600)	-	-	-	-	1 (50%)	-	-	1 (50%)	2 (100%)	-	-	-
2	July	2 (600)	2 (600)	3 (900)	-	2 (100%)	1 (34%)	-	-	-	2 (100%)	-	2 (67%)	-	-	-
3	August	3 (900)	2 (600)	2 (600)	3 (100%)	1 (50%)	-	-	-	-	-	1 (50%)	1 (50%)	-	-	1 (50%)
4	September	4 (1200)	4 (1200)	2 (600)	1 (25%)	2 (50%)	1 (50%)	3 (75%)	-	-	-	2 (50%)	1 (50%)	-	-	-
	ZONE - HANUMANNAGAR															
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1	June	11 (3300)	2 (600)	5 (1500)	-	-	-	-	-	-	8 (73%)	2 (100%)	1 (20%)	3 (27%)	-	4 (80%)
2	July	3 (900)	4 (1200)	2 (600)	-	-	-	-	-	-	-	2 (50%)	2 (100%)	3 (100%)	2 (50%)	-
3	August	11 (3300)	9 (2700)	4 (1200)	1 (9%)	1 (12%)	-	-	-	-	7 (64%)	6 (67%)	2 (50%)	3 (27%)	2 (23%)	2 (50%)
4	September	1 (300)	2 (600)	1 (300)	-	-	-	-	-	-	1 (100%)	2 (100%)	-	-	-	1 (100%)
	ZONE - DHANTOLI															
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1	June	21 (6300)	-	25 (7500)	13 (62%)	-	20 (80%)	-	-	-	-	-	-	8 (38%)	-	2 (4%)
2	July	2 (600)	1 (300)	12 (3600)	2 (100%)	1 (100%)	5 (42%)	-	-	-	-	-	-	-	-	3 (8%)
3	August	2 (600)	2 (600)	7 (2100)	1 (50%)	1 (50%)	4 (57%)	-	-	-	-	-	-	1 (50%)	1 (50%)	1 (3%)
4	September	1 (300)	1 (300)	5 (1500)	-	-	3 (60%)	-	-	-	1 (100%)	1 (100%)	1 (20%)	-	-	1(20%)
	ZONE - GANDHIBAGH															
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1	June	2 (600)	7 (2100)	7 (2100)	-	-	2(28.50%)	-	2(28.50%)	2(28.50%)	2 (100%)	2(28.50%)	-	-	3 (43%)	3 (43%)
2	July	5 (1500)	7 (2100)	6 (1800)	-	2(28.50%)	2(33.33%)	-	-	2(33.33%)	4 (80%)	3 (43%)	-	1 (20%)	2(28.50%)	2(33.33%)
3	August	1 (300)	2 (600)	1 (300)	-	1 (50%)	-	-	-	-	1 (100%)	-	1 (100%)	-	1 (50%)	-
4	September	1 (300)	1 (300)	1 (300)	-	1 (100%)	-	-	-	-	1 (100%)	-	-	-	-	1 (100%)
	ZONE - LAKADGANJ															
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1	June	-	-	1 (300)	-	-	-	-	-	-	-	-	-	-	-	1 (100%)
2	July	1 (300)	2 (600)	1 (300)	-	-	-	-	-	-	-	-	1 (100%)	1 (100%)	2 (100%)	-
3	August	-	-	1 (300)	-	-	1 (100%)	-	-	-	-	-	-	-	-	-
4	September	1 (300)	-	2 (600)	-	-	1 (50%)	-	-	-	1 (100%)	-	-	-	-	1 (50%)
	ZONE - NEHRUNAGAR															
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1	June	5 (1500)	-	8 (2400)	-	-	-	-	-	-	-	-	-	5 (100%)	-	8 (100%)
2	July	-	3 (900)	4 (1200)	-	-	2 (50%)	-	-	-	-	1 (33%)	-	-	2 (67%)	2 (50%)
3	August	5 (1500)	6 (1800)	9 (2700)	-	2 (33%)	3 (33%)	-	-	-	-	-	-	5 (100%)	4 (67%)	6 (67%)
4	September	2 (900)	2 (600)	1 (300)	-	-	-	-	-	-	-	1 (50%)	-	2 (100%)	1 (50%)	1 (100%)
	ZONE - AASHINAGAR															
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1	June	13(3900)	8 (2400)	15 (4500)	-	-	7 (47%)	6 (46%)	-	2 (13%)	1 (8%)	-	1 (7%)	6 (46%)	8 (100%)	5 (34%)
2	July	8 (2400)	8 (2400)	12 (3600)	-	4 (50%)	6 (25%)	-	-	3 (25%)	-	-	-	8 (100%)	4 (50%)	3 (25%)
3	August	14 (4200)	14 (4200)	18 (5400)	-	2 (14%)	-	-	-	-	-	-	8 (45%)	14(100%)	12 (86%)	10 (56%)
4	September	-	-	8 (2400)	-	-	3 (38%)	-	-	-	-	-	-	-	-	5 (62%)
	ZONE - MANGALWARI															
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1	June	2 (600)	11 (3300)	4 (1200)	1 (50%)	8 (73%)	3 (75%)	-	1 (9%)	1 (25%)	-	-	-	1 (50%)	2 (18%)	-
2	July	3 (900)	12 (3600)	5 (1500)	1 (33%)	5 (42%)	2 (40%)	2 (67%)	-	-	-	-	-	-	7 (58%)	3 (60%)
3	August	1 (300)	12 (3600)	4 (1200)	1 (100%)	4 (34%)	-	-	3 (25%)	2 (50%)	-	5 (41%)	-	-	-	2 (50%)
4	September	-	7 (2100)	3 (900)	-	5 (71%)	1 (33%)	-	-	-	-	-	-	-	2 (29%)	2 (67%)
	ZONE - SATRANJIPURA															
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1	June										-	-	-			-
2	July										-	-	-	-		
3	August						-				-		-	-	-	
4	September									-	-	-	-	-		

Table 2 : Zooplanktons Identified (Qualitative Analysis) in June

Protozoa	**Copepoda**	**Ostracoda**	**Rotifera**
Arcella hemisphaerica	*Cyclops sp.* *Nauplius*	*Cypris sp.*	*Keratella tropicana* *Brachionus calyciflorus*
Nassula sp			*Brachionus angularis*
Malacophryx sp. *Centropyxis sp.*			*Brachionus bidentata* *Brachionus plicatilis* *Filinia longiseta* *Asplanchna priodanata*

Table 3 : Area wise correlation of protozoa

	Laxmi nagar	Dharampeth	Hanuman nagar	Dhantoli	Gandhibagh	Lakadganj	Sataranjipura	Nehrunagar	Aashinagar	Mangalwari
Laxminagar	1.000									
Dharampeth	**-0.747**	1.000								
Hanuman nagar	-0.728	**0.440**	1.000							
Dhantoli	0.638	-0.987	**-0.314**	1.000						
Gandhibagh	0.800	-0.249	-0.471	**0.119**	1.000					
Lakadganj	-0.980	0.762	0.577	-0.668	**-0.816**	1.000				
Sataranjipura	0.000	0.000	0.000	0.000	0.000	**0.000**	1.000			
Nehrunagar	-0.530	0.503	0.917	-0.424	-0.100	0.367	**0.000**	1.000		
Aashinagar	0.940	-0.500	-0.631	0.372	0.956	-0.937	0.000	**-0.324**	1.000	
Mangalwari	0.849	-0.981	-0.592	0.939	0.381	-0.839	0.000	-0.604	**0.626**	1.000

It is noted that there is a cyclic correlation in all the areas. (Table 3)

Table 4 : Monthwise correlation of protozoa

Protozoa	*June*	*July*	*August*	*September*
June	1			
July	0.649	1		
August	0.626	0.514	1	
September	0.443	**0.763**	0.562	1

From table 4, it is concluded that the Protozoa are Positively Correlated with all months and highly correlated in July with September month and positively correlated with June to July month also with July to August, the correlation value is decreasing and August to September it is positively correlated with slightly increasing correlation value.

Table 5 : Zooplanktons Identified (Qualitative Analysis) in July

Protozoa	**Copepoda**	**Ostracoda**	**Rotifera**
Euplotes patella	*Cyclops sp.* *Nauplius*	*Cypris sp.*	*Keratella tropicana* *Brachionus calyciflorus*
			Brachionus forficula *Brachionus caudatus*
			Rotaria sp. *Asplanchna priodanata*

Table 6 : Area wise correlation of ostracoda

	Laxmi nagar	Dhara-mpeth	Hanuman nagar	Dhantoli	Gandhibagh	Lakadganj	Sataranjipura	Nehrunagar	Aashinagar	Mangalwari
Laxminagar	1.000									
Dharampeth	**0.000**	1.000								
Hanuman nagar	0.000	**0.000**	1.000							
Dhantoli	0.000	0.000	**0.000**	1.000						
Gandhibagh	-0.870	-0.246	0.000	**0.000**	1.000					
Lakadganj	0.000	0.000	0.000	0.000	**0.000**	1.000				
Sataranjipura	0.000	0.000	0.000	0.000	0.000	**0.000**	1.000			
Nehrunagar	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	1.000		
Aashinagar	-0.927	-0.187	0.000	0.000	0.991	0.000	0.000	**0.000**	1.000	
Mangalwari	0.081	-0.800	0.000	0.000	-0.127	0.000	0.000	0.000	**-0.118**	1.000

It is seen that the correlation between all the areas is in decreasing manner. (Table 6)

Table 7 : Monthwise correlation of ostracoda

Ostracoda	*June*	*July*	*August*	*September*
June	1			
July	**0.806**	1		
August	0.059	0.523	1	
September	-0.041	0.198	0.211	1

From table 7, it is concluded that Ostracoda is Positively correlated in all the months and highly positive correlated in June with July month and negatively correlated in June with September month and positively correlated with June to July and July to August and August to September in decreasing way.

Table 8 : Zooplanktons Identified (Qualitative Analysis) in August

Protozoa	**Copepoda**	**Rotifera**
Nassula ornata	*Cyclops sp.* *Nauplius*	*Brachionus budapestinensis*
Tetrahymena pyriformis		*Brachionus caudatus* *Lecane sp*
		Keratella tropicana *Keratella quadrata* *Filinia sp* *Asplanchna sp*

Table 9 : Area wise correlation of copepoda

	Laxmi nagar	Dharampeth	Hanuman nagar	Dhantoli	Gandhibagh	Lakadganj	Sataranjipura	Nehrunagar	Aashinagar	Mangalwari
Laxminagar	1.000									
Dharampeth	**0.000**	1.000								
Hanuman nagar	0.599	**-0.783**	1.000							
Dhantoli	-0.889	0.000	**-0.610**	1.000						
Gandhibagh	0.519	0.772	-0.231	**-0.630**	1.000					
Lakadganj	-0.700	0.707	-0.956	0.577	**0.218**	1.000				
Sataranjipura	0.000	0.000	0.000	0.000	0.000	**0.000**	1.000			
Nehrunagar	-0.700	0.707	-0.956	0.577	0.218	1.000	**0.000**	1.000		
Aashinagar	0.278	-0.863	0.913	-0.440	-0.366	-0.762	0.000	**-0.762**	1.000	
Mangalwari	0.081	-0.816	0.784	-0.333	-0.378	-0.577	0.000	-0.577	**0.968**	1.000

It is seen that there is a cyclic correlation in all the areas. (Table 9)

Table 10 : Monthwise correlation of copepod

Copepada	*June*	*July*	*August*	*September*
June	1			
July	**0.830**	1		
August	**0.808**	0.417	1	
September	0.694	0.629	0.364	1

From table 10, it is concluded that Copepada is positively correlated in all months and highly correlated in June with July and june with August month and positively correlated with June to July and July to August.

Table 11 : Zooplanktons Identified (Qualitative Analysis) in September

Protozoa	**Copepoda**	**Ostracoda**	**Rotifera**
Paramecium	*Cyclops sp.* *Nauplius*	*Cypris sp.*	*Anuraepsis fissa*

Table 12 : Area wise correlation of rotifera

	Laxmi nagar	Dharampeth	Hanuman nagar	Dhantoli	Gandhibagh	Lakadganj	Sataranjipura	Nehrunagar	Aashinagar	Mangalwari
Laxminagar	1.000									
Dharampeth	**-0.072**	1.000								
Hanuman nagar	0.666	**0.471**	1.000							
Dhantoli	0.667	-0.200	**0.754**	1.000						
Gandhibagh	0.758	-0.570	0.448	**0.875**	1.000					
Lakadganj	0.605	-0.662	-0.187	0.132	**0.579**	1.000				
Sataranjipura	0.000	0.000	0.000	0.000	0.000	**0.000**	1.000			
Nehrunagar	0.099	0.686	0.808	0.480	0.000	-0.727	**0.000**	1.000		
Aashinagar	0.311	0.890	0.821	0.255	-0.135	-0.507	0.000	**0.850**	1.000	
Mangalwari	0.595	-0.510	-0.197	-0.009	0.432	0.977	0.000	-0.732	**-0.411**	1.000

It is seen that for the first four areas correlation is increasing in nature and then there is no correlation in Lakhadganj and Satranjipura further it is highly increased and then again it highly decreased. (Table 12)

Table 13 : Monthwise correlation of rotifera

Rotifera	*June*	*July*	*August*	*September*
June	1			
July	**0.738**	1		
August	**0.826**	0.560	1	
September	0.539	0.381	**0.718**	1

From table 13, it is concluded that rotifera are positively correlated in all the months and highly correlated in June with July and June with August and August with September .It is also noted that Rotifera are positively correlated with June to July month also positively correlated with July to August the correlation value is decreasing and also in august to September it is positively correlated with increasing correlation value.

Null Hypothesis: There is no significant differnce between the small organisms like Protozoa, Ostracoda, Copepada&Rotifera of the Zooplanktons in **Area wise**.

ANOVA					
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*
Between Groups	1375546.875	3	458515.625	2.847	0.051
Within Groups	5798437.5	36	161067.7083		
Total	7173984.375	39			

Conclusion: Accept the Null Hypothesis, that means insignificant in the small organisms of Zooplanktons in **Area wise**.

Null Hypothesis: There is no significant differnce between the small organisms like Protozoa, Ostracoda, Copepada&Rotifera of the Zooplanktons in the rainy season.

ANOVA					
Source of Variation	SS	df	MS	F	P-value
Between Groups	550218.75	3	183406.25	5.650	0.012
Within Groups	389525.00	12	32460.42		
Total	939743.75	15			

Conclusion:Reject the Null hypothesis, that means there isdifferncе between the small organisms of Zooplanktons in the Rainy Season.

Fig. 2 Protozoa

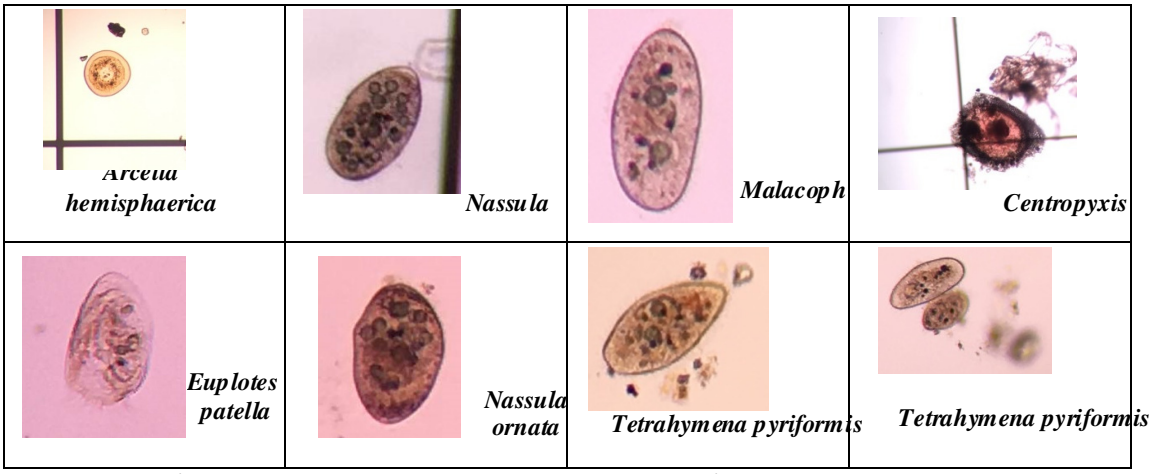


Fig. 3 Ostracoda

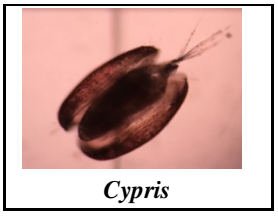


Fig. 4 Copepoda

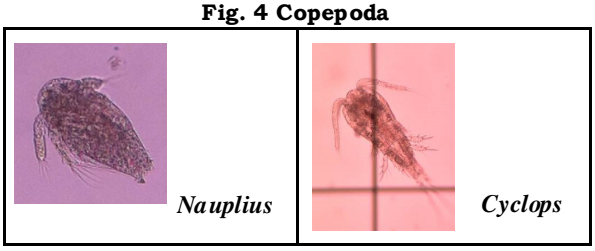
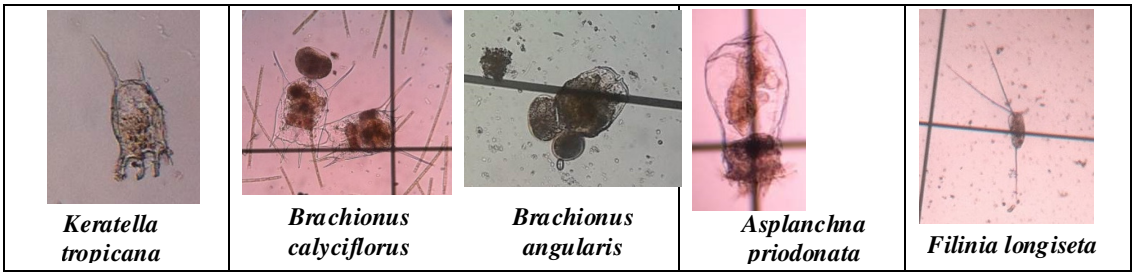
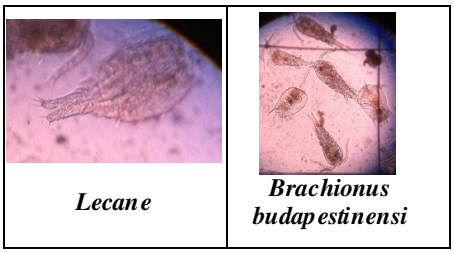


Fig. 5 Rotifera





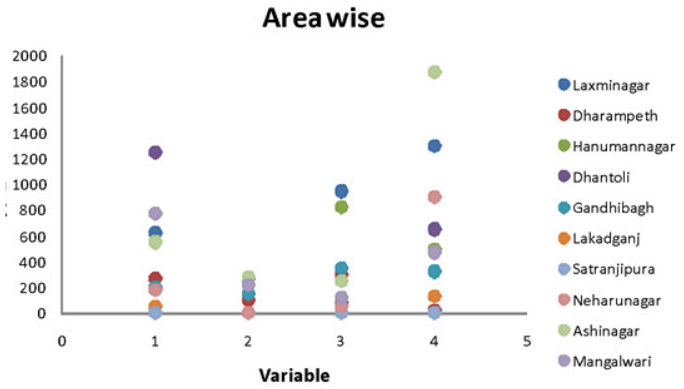


Fig. 6 : Graphical representation of area wise composition of zooplankton

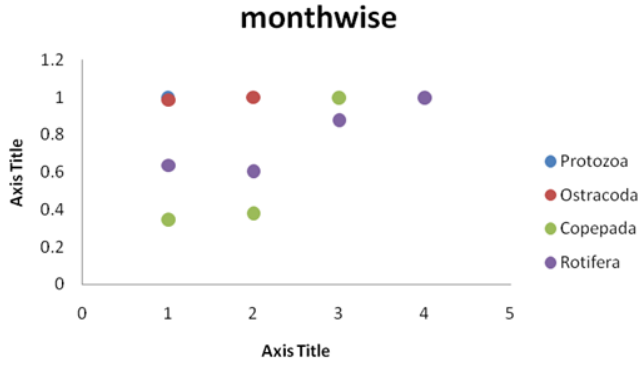


Fig. 7 : Graphical representation of month wise composition of zooplankton

The work on well water is very scanty and therefore these results are not comparable with other authors but, the present investigation can be compared with other fresh water reservoir studies. The other ecological factors and plankton communities together from a comprehensive ecosystem and as in any ecosystem, there are interactions between the other factors and the plankton. These interactions are directly or indirectly subjected to the complex influences some of which results in quantitative changes i.e. increase or decrease of size of the population (Welch 1952). During this study a distinct fluctuation of zooplankton population in ten zones as well as four months was observed. This fluctuation is due to the impact of different ecological factors such as commencement of monsoon (June), moderate

rain (July) and heavy rain (August) and post monsoon (September). The present results are accordance with Zorka Dulic et al., (2006), md. Abdul Bashar et al., (2015) found nearly same results during the study on lake water. The present study partially agrees with the study of above lake water analysis.

In present investigation copepoda found as a second dominant group among all the group of zooplankton. A study conducted by Islam et al., (2007) also found the similar findings. Similar result was observed by Ganpati (1943) and he found that copepoda was a dominant order among zooplankton in the garden pond.

In the present investigation the maximum diversity was recorded during June and July i.e., commencement of monsoon. These results are comparable with George (1964) observed maximum population of zooplankton in November, January i.e. calm water conditions.

Conclusion :

Zooplanktons may exist in a wide range of environmental conditions. At the same time they are also a very good bioindicators to assess the pollution of any freshwater body. The presence of rotifers and copepodes reveals that the wells are being organically polluted. The 8 zones out of 10 are badly affected due to various anthropogenic activities such as entry of domestic waste run offs, contamination of wells due to seepage from toilets which are adjustant to the open wells, dumping of garbage and ill maintenance. From the above study we can make the conclusion that a strict vigilance and general awareness is required so that proper maintenance of this essential reservoir can be done and further studies in this regard is essential to measuring the diversity of zooplanktons and other pollution indicators to maintain the water quality.

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