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Studies on the Rotifer population in relation to some physico-chemical parameters.

Estudios sobre la población de rotíferos en relación con algunos parámetros físico-químicos.

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ABSTRACT

The present dissertation provides the results of the study done on the Rotifer population of a sewage fed wetland of West Bengal, India, along with the influence of some physico-chemical parameters on them. The water parameters studied were Water temperature (WT), pH, Dissolved Oxygen (DO), Carbon di Oxide (CO_2), Total alkalinity (TA), Dissolved Organic Matter (DOM) and Biological Oxygen Demand (BOD). During the study among the above mentioned water parameters WT varied from 15.5^oC to 32.75^oC, pH from 7.98 to 8.75, DO from 4.3 mg/lit to 16 mg/lit, CO_2 from 00 to 46 mg/lit, TA from 164 mg/lit to 251 mg/lit, DOM from 1.13 mg/lit to 4.73 mg/lit and BOD from 5.62 mg/lit to 28.8 mg/lit. One noticeable feature about the seasonal variation of those parameters in the wetland was that its variation pattern differs in actual magnitude. The wetland had fairly high DO content and pH was always alkaline. The water was also rich in DOM. BOD was moderate and not appreciably high as expected in a polluted aquatic system. The combine effect of above physico-chemical parameters might have promoted the luxurious growth of rotifer population of the wetland.

During the study except the above mentioned physico-chemical parameters of water, Rotifer population was also observed. A total of 22 species of 12 genera of rotifer were noticed during study. Among them 11 species were dominant and occur more than six months throughout the study period. This population in the wetland overwhelmingly predominated by *Brachionus* species. Not only that they were also numerically superior over other. Among *Brachionus* species, *Brachionus angularis* was most dominant.

From the statistical analysis different species of rotifer showed positive correlation with pH and inverse correlation with CO_2 and TA.

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Key Words:- Rotifer, Population, Sewage, Freshwater, Wetland, Physico-chemical, Parameter India.

RESUMEN

La presente disertación proporciona los resultados del estudio realizado sobre la población de rotíferos de un humedal alimentado con aguas residuales de Bengala Occidental, India, junto con la influencia de algunos parámetros físico-químicos sobre ellos. Los parámetros del agua estudiados fueron temperatura del agua (WT), pH, oxígeno disuelto (OD), dióxido de carbono (CO_2), alcalinidad total (TA), materia orgánica disuelta (DOM) y demanda biológica de oxígeno (DBO). Durante el estudio, entre los parámetros de agua mencionados anteriormente, el WT varió de 15.5°C a 32.75°C, pH de 7.98 a 8.75, OD de 4.3 mg / litro a 16 mg / litro, CO_2 de 00 a 46 mg / litro, TA de 164 mg / litro iluminado a 251 mg / litro, DOM de 1.13 mg / litro a 4.73 mg / litro y DBO de 5.62 mg / litro a 28.8 mg / litro. Una característica notable de la variación estacional de esos parámetros en el humedal fue que su patrón de variación difiere en la magnitud real. El humedal tenía un contenido de OD bastante alto y el pH siempre era alcalino. El agua también era rica en DOM. La DBO fue moderada y no apreciablemente alta como se esperaba en un sistema acuático contaminado. El efecto combinado de los parámetros físico-químicos anteriores podría haber promovido el crecimiento exuberante de la población de rotíferos del humedal.

Durante el estudio, excepto los parámetros físico-químicos mencionados anteriormente, también se observó la población de rotíferos del agua. Durante el estudio se observaron un total de 22 especies de 12 géneros de rotíferos. Entre ellas, 11 especies fueron dominantes y ocurren más de seis meses durante el período de estudio. Esta población en el humedal predominaba abrumadoramente por especies de *Brachionus*. No solo que también eran numéricamente superiores a otros. Entre las especies de *Brachionus*, *Brachionus angularis* fue la más dominante.

A partir del análisis estadístico, diferentes especies de rotíferos mostraron correlación positiva con pH y correlación inversa con CO_2 y TA.

Palabras clave: Rotífero, población, aguas residuales, agua dulce, humedal, físico-químico, parámetro, India.

INTRODUCTION

The vast and varied water bodies of India comprise rivers, lakes, reservoirs, wetlands, estuaries and brackish water. Those water bodies are the repositories of various kinds of living organisms. Out of that, wetlands are usually rich and diverse in their plant and animal life (Amose, 1970).

The living organisms and their nonliving environment are inseparably linked and they interact with one another continuously. It is therefore obvious that various physico-chemical parameters largely regulate the entire dynamics as well as homeostasis of an ecosystem. Physico-chemical parameters of water not only influence the occurrence and abundance of aquatic biota but also govern the productivity which forms the corner stone of community metabolism.

The Rotifer generally known as 'Wheel animalcule' is microscopic with ubiquitous presence in freshwater (95%). The cilia surrounding the mouth of the rotifers forms a circle called corona or wheel organ (Poggensee and Lenz, 1981). About 75% of rotifers are sessile. Except the sessile form about 100 species are completely planktonic and some of them may help natural ecosystem to maintain its healthy condition (Mulani *et al*., 2009). Both sessile and planktonic non predatory rotifers feed on sedimenting seston particles and phytoplankton while predatory rotifers feed actively on protozoans, small rotifers and other micro metazoans. The sensitivity of rotifer to environmental factors has made them an interesting and useful tool in studying pollution (Datta, 2001, Nogueira, 2001 and Kiran *et al*., 2007, Segers, 2008).

Though in India limnological studies have been done by Ghosh and Banerjee (1996), Shrivastav and Desai (1997), Thomas and Azis (1998), Sharma and Sharma (2000, 2012), Hulyal and Kaliwal (2008), Kunwar *et al.* (2011), Sukla *et al*. (2013), Watkar and Barbate (2013), Patel *et al.* (2013), Cleetus *et al*. (2015), Bhavan *et al*. (2015), Dede and Deshmukh (2015), Manickam *et al*. (2017), Singh and Sharma (2020), Sharma and Noroh (2020) and many others, studies on rotifer population and the impact of various physico-chemical parameters on them is still inadequate in India. This subject on the whole suffers from a considerable paucity of information in Indian context as the information available on rotifers from India is mostly from studies either on the taxonomic details (Sharma, 1983; Sharma and Naik, 1996; Varghese, 2006) or from the culture prospects of the group as a live feed in aquaculture (Gopakumar and Jayaprakash, 2001; Anitha, 2003) and this justifies the rationale of the present undertaking.

The present study differs from the earlier ones and put forwards the results of the investigation of a sewage fed fresh water wetland of West Bengal, India to understand the ecology and abundance of rotifer population.

MATERIALS AND METHODS

Study area: The studied wetland is 1.5 hectare in area, almost rectangular in shape. The average depth of this wetland is 1.5 meter. Raw waste water of domestic origin is released by Municipal Corporation of Kolkata into sedimentation tank. From there sewage water gets its entry into the wetland through channels which are controlled by a sluice gate.

No macro vegetation is kept in this wetland as it is profusely used for pisciculture round the year.

The present programme was started in January, 2018 and continued up to December, 2018 for 12 months in a sewage fed wetland near Kolkata, West Bengal, India. The collection of water and Zooplankton (rotifer) were done fortnightly between 8 am and 10 am in the morning of the sampling day. Fortnightly data were pooled together as monthly average. Tables and Figures representing the variation of biotic and abiotic parameters have been drawn accordingly.

HYDROLOGY:

Collection of water sample: water sample were collected from the wetland covering the less disturbed area by directly deeping polythene bottles, washed without detergents, rinsed with10% hcl, then with distilled water and dried at 95ºc before use. for the estimation of dissolved oxygen the sample was collected in 250 ml glass stoppered bottles taking all precaution and replacing the stopper tightly under water.

Analysis of water: The physic-chemical parameters of water studied are Water temperature (WT), pH, Dissolved Oxygen (DO), Carbon di Oxide (CO_2), Dissolved Organic Matter (DOM), Total Alkalinity (TA) and Biological Oxygen Demand (BOD). All the analysis of water samples were done according to the procedure stated by APHA (2005).

Zooplankton: Zooplankton was collected by filtering 50 lit. of water, collected from the sub-surface through a bolting silk net (mesh size 25µ). It was concentrated into 100 ml and preserved in the field with 8% formalin. Zooplankton was counted with the help of Sedgwick-Rafter plankton counting cell. Three or sometime four such counts were done for each sample and counts were pooled and coted as monthly average. Computation for the number of individuals /liter (ind/lit) was worked out by the formula as suggested by Welch (1948).

$$\text{Total Zooplankton (n)} = \frac{(a \times c)}{L}$$

n=No. of Zooplankton/lit of water

a=No. of Zooplankton in all count

c=Vol. of original concentration of sample in ml.

L=Vol. of original water sieved in lit.

RESULTS

Physico-chemical parameters: The results of the observation of physico-chemical parameters of water are shortly describe below and represented in Table-1.

The water parameters studied were Water temperature (WT), pH, Dissolved Oxygen (DO), Carbon di Oxide (CO_2), Total alkalinity (TA), Dissolved Organic Matter (DOM) and Biological Oxygen Demand (BOD). During the study among the above mentioned water parameters WT varied from 15.5°C to 32.75°C, pH from 7.98 to 8.75, DO from 4.3 mg/lit to 16 mg/lit, CO_2 from 00 to 46 mg/lit, TA from 164 mg/lit to 251 mg/lit, DOM from 1.13 mg/lit to 4.73 mg/lit and BOD from 5.62 mg/lit to 28.8 mg/lit. One noticeable feature about the seasonal variation of those parameters in the wetland was that its variation pattern differs in actual magnitude. The wetland had fairly high DO content and pH was always alkaline. The water was also rich in DOM. BOD was moderate and not appreciably high as expected in a polluted aquatic system.

Table-1: Monthly variations of physico-chemical parameters of water in a sewage fed Fresh water wetland.

	WT	pH	DO	CO_2	TA	DOM	BOD
January	15.5	8.25	7.6	20	227.5	4.73	10.05
February	21.25	7.98	4.3	25	251	3.04	13.8
March	27.5	8.0	8.3	19	240	1.13	18.4
April	28	8.15	16	46	164	1.13	28.8
May	32.75	8.75	9.2	26	166	1.73	17.2
June	31.75	8.5	6.4	00	191	4.05	13.8
July	30.63	8.07	4.7	11.5	194	1.6	10.2
August	30.55	8	6.77	14	184.84	2.07	5.62
September	31.6	8	6.1	12.5	195.5	2.29	7.9
October	28.33	7.99	5.2	23	207.5	2.33	9.8
November	25.22	8.14	7.3	23.16	205	1.41	6.45
December	21.85	8.23	8.8	21	219	2.48	8.6

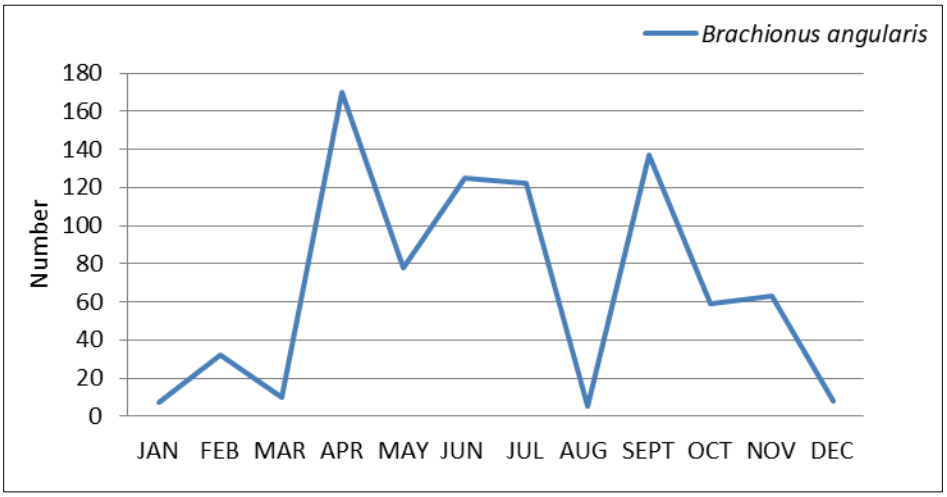

Fig. 1: Monthly fluctuation of *Branchionus angularis*.

Rotifer Population: A brief description of the periodicity of different species of rotifer has been given below with a view to emphasize their relative importance is depicted in Table-2. A total of 22 species of 12 genera of rotifer were noticed during study. Among them 11 species were dominant and occur more than six months throughout the study period. This population in the wetland overwhelmingly predominated by *Brachionus* species. Not only that they were also numerically superior over other. Among *Brachionus* species, *Brachionus angularis* was most dominant and observed throughout the entire study period with a minimum of 5 ind/lit and a maximum of 170 ind/lit. Altogether five small and large peaks of it were observed during study (Fig.-1). *B. rubens* another brachionoid was observed throughout the entire study period except April with a minimum and maximum values of 1 ind/lit and 29 ind/lit respectively. *B. caudatus* (minimum 1 ind/lit and maximum 99 ind/lit), *B. calyciflorus* (minimum 2 ind/lit and maximum 235 ind/lit) were found in nine months during observation. On the other hand *B. diversicornis* (minimum value 1 ind/lit and maximum value 380 ind/lit) and *B. forficula* (minimum 1 ind/lit and maximum 19 ind/lit) were recorded for eight months only. *Keratella tropica* another rotifer species occur throughout the study with a minimum of 1 ind/lit and a maximum of 39 ind/lit. This species shows three peaks during study (Fig-2). *Rotaria neptunia* was recorded throughout the study except April with a minimum of 1 ind/lit and maximum of 14 ind/lit. *Polyarthra multiappendiculata* (minimum 1 ind/lit and maximum 25 ind/lit), *Testudinella mucornata* (minimum 1 ind/lit and maximum 17 ind/lit) were found only during eight months. Whereas the minimum (45 ind/lit) and maximum (1218 ind/lit) valves of total rotifer were recorded in January and July respectively with three peaks (Fig- 3). All other rotifer species were recorded occasionally with less number of individuals.

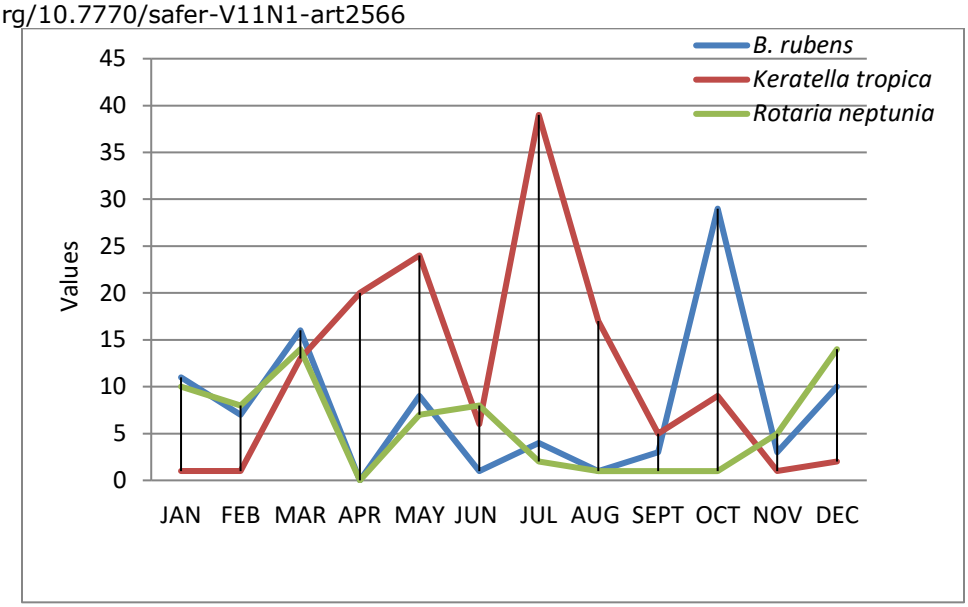

Fig. 2: Monthly fluctuation of different rotifer species.

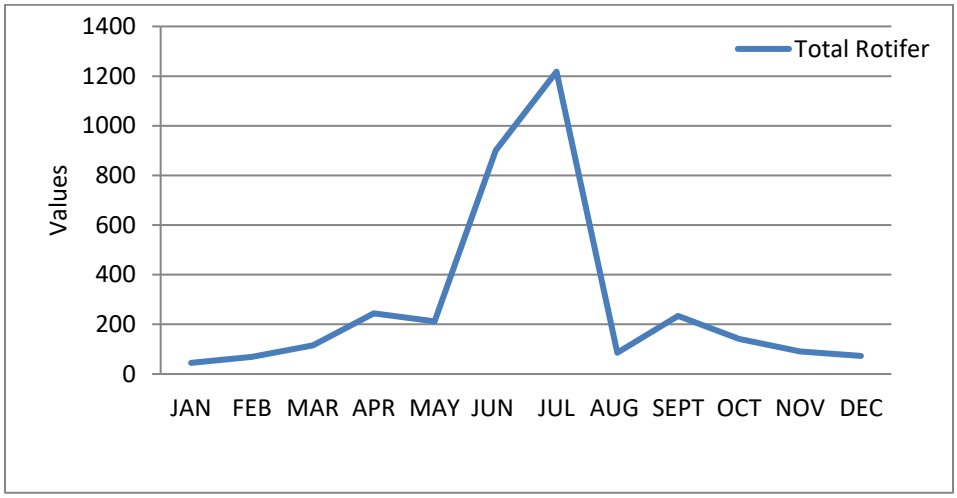

Fig. 3: Monthly fluctuation of total rotifer.

Table-2: Monthly numerical abundance of rotifer species (ind/lit) in a sewage fed fresh water wetland.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Asplanchna brightwelli	-	8	-	-	-	4	11	-	1	-	-	-

Anuraeopsis navicula -	-	-	-	-	-	-	1	1	2	1	-	-
Brachionus angularis	32	10	170	78	125	122	5	137	59	63	8	-
B. bidentata	-	1	-	-	-	-	1	-	-	-	1	-
B. caudatus	-	4	-	-	6	99	6	29	9	6	1	2
B. calyciflorus	-	4	-	-	34	235	61	17	10	15	4	2
B. diversicornis	1	-	-	-	3	380	109	7	45	8	1	-
B.falcatus -	-	-	-	-	1	9	-	1	-	1	-	-
B. forficula	1	-	-	-	-	3	19	2	8	1	1	2
B. quadridentatus	1	2	5	-	-	-	-	-	1	-	1	2
B. rubens	11	7	16	-	9	1	4	1	3	29	3	10
Keratella tropica	1	1	13	20	24	6	39	17	5	9	1	2
Epiphanes senta	12	-	-	-	-	-	2	-	1	-	-	-
Lepadella patella	-	-	15	-	-	-	792	-	-	-	1	1
Lecane bulla	-	-	21	-	-	-	3	1	1	-	-	2
Polyarthra multiappendiculata -	-	-	25	-	1	9	2	10	5	1	1
Filinia longiseta	-	-	-	-	45	21	14	1	-	-	-	-
F. opoliensis	1	-	-	-	-	-	1	-	-	1	-	1
F. terminalis	-	1	-	30	5	1	4	-	-	-	-	-
Testudinella mucornata	-	-	17	-	-	2	8	1	1	1	1	1
Philodina citrine	-	1	5	-	-	6	11	-	-	3	6	25
Rotaria neptunia	10	8	14	-	7	8	2	1	1	1	5	14
Total Rotifer	45	69	116	245	212	901	1218	86	234	141	91	73

STATISTICAL ANALYSIS: in order to delineate statistical relationship between the physic-chemical parameters of water and their potential effect on nine most prevailing rotifer species, simple correlation have been executed and the results were presented in table-3 and describe below.

Table:-3 : Simple correlation coefficient (r) between different rotifer species and physico-chemical parameters.

	WT	pH	DO	CO_2	DOM	TA	BOD
Brachionus angularis	.1608	.6270**	.2918	-.4124*	-.1920	-.5845**	-.0916
B. caudatus	.2006	.4387*	.1246	-.5656**	-.0235	-.3525	-.1952
B. calyciflorus	.1281	.3459	.1254	-.4541*	.0467	-.2590	-.1617
B. quadridentatus	-.0767	.3095	.0691	-.3073	.0952	.0348	.1450
B. rubens	-.1907	.0227	.1733	.0726	-.2365	.1488	.6446
Kiratela tropica	-.0089	.4553*	.3167	-.2829	-.2420	-.4457*	-.1155
Polyarthra multiappendiculata	.1349	.3189	.2414	-.3045	-.1731	-.1614	-.0983
Filinia longiseta	.1104	.6712**	.3381	-.4443*	-.2867	-.4807*	-.1615
Testudinella mucornata	.0852	-.1626	-.0798	-.0659	-.2795	.2288	-.0007
Rotaria neptunia	-.3779	.1269	.0829	-.0185	-.0901	.1503	-.2218
Total Rotifera	.2333	.5871**	.2088	-.5659**	-.2534	-.5418*	-.2084

* $P < 0.05$ ** $p < 0.01$

Brachionus angularis

This species showed significant positive correlation with pH (r =0.6270, P < 0.01) but significant negative correlation total alkalinity (r = -0.4124, P<0.05).

B. caudatus

Significant positive correlation was observed between this species and pH (r = 0.4387, P<0.05) but significant negative correlation with carbon dioxide (r = -0.5656, P<0.01).

B. calyciflorus

Here only significant negative correlation was observed with carbon dioxide (r = -0.4541, P<0.05).

Keratella tropica

Positive and significant correlation was recorded with pH (r = 0.4553, P< 0.05) while significant negative correlation with total alkalinity (r = -0.4457, P< 0.05).

Filinia longiseta

This species exhibited significant positive correlation with pH (r = 0.6712, P< 0.01) and significant negative correlation with total alkalinity (r = -0.4807, P< 0.05) and carbon dioxide (r = -0.4443, P< 0.05).

Total Rotifer

This group exhibited significant positive correlation with pH (r = 0.5871, P < 0.01) while significant negative correlation with total alkalinity (r = -0.5418, P<0.01) and carbon dioxide (r = -0.5659, P< 0.01).

On the other hand on significant correlation was noted between *B. rubens, Polyarthra multiappendiculata, Testudinella mucornata, Rotaria neptunia* and any physico-chemical parameters.

DISCUSSION

Throughout the study highest value of water temperature was noticed in May. Except this another small peak was also recorded in September i.e. a bimodal pattern of fluctuation was notice. The variation in monthly temperature largely depends on the changes in the solar radiation. High temperature during May is obviously due to high solar radiation and high humidity, whereas low temperature in January may probably due to decrease environmental humidity and declining period of sunshine. Temperature is one of the master limiting factors for its effect on the chemistry and biological relations in the organism, which in any water body mostly depends upon its morphometry, extent of solar radiation and density of planktonic substances (Rao, 1971). Therefore such a seasonal variation in water

temperature very well coincides with the optimal temperature range favorable for healthy growth of most aquatic organism.

Being a sewage fed wetland pH in most of the months had a value above 8 except very few months where pH was almost 8. All through the study it was found that pH was alkaline in nature. pH of water provides an index of general environmental condition and productivity of an aquatic ecosystem (Chapman,1992). In the present study low pH value during monsoon and post monsoon may be due to dilution of water, alkaline substances and low photosynthetic activity (Khan and Chowdhury, 1994). During study higher value was recorded mainly in summer. The summer maxima were also noted by Saran and Adoni (1982) and Kulkarni *et al*. (1988). This summer maxima of pH possibly results from increased photosynthesis utilizing free CO_2 present in water (Goldman, 1972). According to Golterman and Kouwe, (1980), natural waters mostly have alkaline pH although it varies. In the present study also pH was found alkaline throughout the investigation.

The variations of Dissolved Oxygen in water body depend on biotic and abiotic interaction, temperature, pollution load, photosynthesis and respiratory activity (Zutshi and Vass, 1978). The range of variation of DO in the present study has been found to be between 4.3 to 16 mg/lit. Such wide variation was also reported earlier (Kulshrestha *et al*., 1989, Adholia *et al*., 1990). In the present study lower values were obtained in monsoon and post monsoon which is probably due to reduced solar radiation, increase turbidity followed by reduction of photosynthesis (Sarangi, 1983). The high DO content during winter are largely attributed to low temperature rather than photosynthesis as low temperature has greater capacity to hold more DO (Vass and Langer, 1990).

Increase of free CO_2 content in natural water takes place following decomposition of organic matter and respiratory activities which get reduced due to photosynthesis, complete absence of free CO_2 in water signifies its complete utilization in photosynthesis (Sreenivasan, 1963) or being inhibited by presence of large amount of carbonate (Sahai and Sinha, 1969). In winter high value of free CO_2 is probably due to low temperature, low photosynthetic activity and higher rate of zoo planktonic productivity (Jackson, 1970). During monsoon and post monsoon low values of CO_2 is perhaps due to dilution by rain water forming week carbonic acid. Throughout the present study CO_2 content is high, perhaps due to high phytoplankton concentration and also due to sewage input.

Total alkalinity of water is its acid neutralizing capacity as used as a tool for the measurement of productivity of water body. The studied wetlands registered a considerable seasonal fluctuation in total alkalinity and are always high during winter. Such high concentration of total alkalinity is due to the process of the bottom deposit which is deposited through sewage input (Bandyopadhyay, 1985). On the other hand minimum

values were recorded in monsoon, perhaps due to dilution by rain water and also to the neutralization of carbonic acid.

The DOM in water is regarded as diluted soil extract, consisting largely of humic, non humic and many other compounds of organic matter produced within the basin or may arise as a result of direct decomposition of autochthonous or allochthonous matter (Hutchinson,1975). In the present case the wetland being tainted with external manipulation like sewage input, it has high bacterial load (Sarangi, 1983). It is observed from the present study, the wetland is rich in DOM because of periodical sewage influx and more due to presence of high phytoplankton.

BOD is the amount of oxygen utilized by microorganism in stabilizing the organic matter and the BOD values can be used as a measure of waste strength. During the study BOD values exhibited frequent rise and fall. Obviously the reason may be attributed to the periodical sewage intake (Patra, 2002).

Fresh water sparkling in sun light contains millions of organisms suspended passively or sometime weakly swimming in every liter. Organisms that passively drift by water current or float or swim weakly, comprise the plankton which include the free swimming zooplankton. Rotifers, the major groups of fresh water zooplankton, are man size to horse size on our scale up model and are mostly suspension feeder. The rotifers are almost universally present in fresh water and constitute an important component of zoobiota. The seasonal occurrence and abundance of different taxa of rotifer showed that genus *Brachionus* was the predominant form and numerically superior over other rotifer which corroborate the findings of Varghese and Krishnan, (2011). *B. angularis* was exceptionally abundant throughout the study and clearly dominant over other *Brachionus* species. Datta *et al*., (1987), reported that *Brachionus* was numerically abundant and that *B. angularis* was dominant. According to Sharma, 1996, *Brachionus* species were more abundant in alkaline water. Being an alkaline wetland a similar observation was also noted in the present study. The seasonal fluctuation of total rotifer is influence by the fluctuation *of B. angularis* alone. Higher abundance of *B. angularis* during summer and winter corroborates the observation of Datta *et al*., (1987). In the present observation it is also found that when more than one genus of rotifer dominate in one sample, only one genus show one dominant species. Abundance of *B. angularis* show higher values in the present study because of higher pH of the wetland, as pH has been implicated as a major factor exerting significant effect on it (Sharma, 1996).

From the statistical analysis also, a positive correlation is noted between pH and *B. angularis*. Abundance of *B. caudatus* was very high and the peaks were in monsoon and post monsoon. Higher abundance of *B. calyciflorus* and *B. diversicornis* were in monsoon months. The other species *B. rubens* was recorded throughout the study except once but

less in number. The remaining species of *Brachionus* shows very sporadic occurrence. This trend also observed by Sharma (1983). *Keratella trophica* was also abundant species which shows summer and monsoon maxima. As this species is easily ingested by *Asplanchna* and other predator therefore predation appears to be the principal factor in controlling the dynamics of it (Gilbert, 1980).

Studies show that *Filinia* species showed its abundance in monsoon which is in accordance with Ghosh, (1998). As this species can tolerate low level of O_2 and can reproduce in completely anaerobic condition, which can support the occurrence of this species. *Lecane sp.* was recorded occasionally perhaps due to alkaline nature of the wetland because *Lecane* is an acid water species (Glime, 2017). *Lepadella patella* other rotifer occurred only few months but with a maximum of 792 ind/lit as generally alkaline water contain few species but large number of individuals (Pennak, 1978). *Polyarthra multiappendiculata* occurs during 8 months with less number. Except these species all other rotifers species were recorded occasionally and their abundance was also low. The present wetland being rich in Brachionoid rotifera, provides a very congenial for the proliferation of *Asplanchna* but this is not reflected here perhaps due to being a large rotifer, it is subject to heavy predation pressure by fish population cultured in the wetland, which plays an important role more than physico- chemical characters (Deb *et al*., 1987).

During study total rotifer recorded significant numerical variations between different seasons. Present results recorded a small peak in pre monsoon and a large peak in monsoon which agreed with Ramalingappa *et al*., 2015. Total rotifer also registered significant numerical maxima in post monsoon which is in agreement with Sharma and Sharma (2012).

From the simple correlation analysis different species of rotifers showed a positive correlation with pH and inverse correlation with CO_2 and total alkalinity which supports the finding of Bandyopadhyay (1985).

CONCLUSION

As far as the physico-chemical characteristic as well as the rotifer population is concern the combine effect of physico-chemical factors of the wetland might have promoted the growth of the rotifer population as rotifer distribution and diversity is largely influenced by the decline of the water quality of the freshwater ecosystem.

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ABBREVIATION USED

Biological Oxygen Demand = BOD

Carbon di Oxide = CO_2

Dissolved Organic Matter = DOM

Dissolved Oxygen = DO

Individuals/ liter = ind/lit

Milligram/liter = mg/lit

Total alkalinity = TA

Water temperature = WT