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**RESEARCH ARTICLE**

# Physico-chemical parameter influenced Zooplankton diversity in some ponds of south western part of Bankura town of WB, India

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## *Abstract*

The Bankura district of West Bengal is with full of static water bodies like pond, reservoir, water tank etc. Most of these water bodies are being used by the local residents for their daily purposes. The unaware use of water causes some changes in physico-chemical parameters of some ponds of Bankura town. This project work reveals the fact that, how these changes in parameter influences the Zooplankton diversity. Among Zooplankton mainly the Rotifers play an important role (as bio-indicator) to know the water quality of studied perennial water bodies.



## Introduction

Water is considered as the elixir of life and is consumed in greatest quantity throughout the world for drinking, bathing, washing, irrigation and also for aquaculture purpose. Rivers, ponds, lakes and tanks are the major sources of water. Functional parameters of an ecosystem attributes to the ecological significance and resulting from the interactions between its physical, chemical and biological components. These interactions result in the creation of a variety of niches which are inhabited by various organisms thus providing a habitat for plants, animals and micro organisms in an ecosystem and thus determine the tropic dynamics of the aquatic body.

The study of fresh water fauna specially Zooplankton even in a particular area is extensive and complicated phenomenon due to environmental, physical, geographical and chemical variations involving ecological extrinsic and intrinsic factors. Distribution of Zooplankton and their variation at different zones of water body is known to be influenced by physico-chemical parameters of water.

During the last several decades, the water quality of the Indian water bodies has been deteriorating due to continuous discharge of industrial wastes and domestic sewage (Krishnan *et. al.*, 2007). Freshwater ecosystems are affected by physico-chemical elements both directly and indirectly in various ways. It is necessary to know the physico-chemical properties of aquatic bodies to study the rearing practice of the fishes in them (Jhingran, 1991). The ecological studies on south-western part of Bankura town of Bankura district of West Bengal (WB), India (**Figure 1**) has been investigated to know the physico-chemical and biological parameters which includes diversity and distribution of Zooplankton for a period of six month and the collected data are being discussed with an emphasis on their significance and interrelationship among them. The physico-chemical parameters studied are atmospheric temperature, water temperature, pH, alkalinity, total hardness, chloride ion, dissolved Oxygen, free Carbon dioxide and the Zooplankton as biological parameter.

## Materials and Methods

### Sampling Programme and Procedure

The total study was carried out consecutively for six months from January to June, 2014 at six different sites of Bankura town (from **Figure 3-8**). The main aim of present study is to investigate the physico-chemical and biological characteristics of some pond water of the south western part of Bankura town. The water samples were collected from six different ponds of Bankura town. From the **Figure 2** collected from satellite map it is quite clear that the six sites (S-1, S-2, S-3, S-4, S-5 and S-6) of water collection were divided into three parts along with duplicate pond sites in each three parts. S-1 and S-2 are the two ponds of Rajgram, Bankura. The S-1 is not so well known pond but the S-2 pond is known as Daser Bandh. S-2 pond is used by the villagers for common purpose and fishing; the names of S-3 and S-4 ponds are Padma Pukur and Sar Bagan respectively and these two ponds S-3, S-4 are situated at the outs cart of the township. These two ponds are situated beside the SBSTC Depot. of Bankura. We can visualize a huge dump of biomedical wastes even now and then at this side because the Bankura Sammilani Medical College is situated nearby. The last two ponds namely S-5 known as Had Pukur of Lokepur and S-6 known as Majher Gora of Lokepur have been taken in consideration. The main three different water collecting sites are Rajgram, which is a thick populated village of Bankura town; Area adjacent to SBSTC Bus Depot., which is the outs cart of township and the Lokepur that is moderately thick populated part of a town.

The water samples for dissolved Oxygen (DO) analysis were collected in sterile BOD glass bottles between 6.00 A.M. to 8.00 A.M. from 50 cm. depth from each collection sites. The hydrogen ion concentration (pH), dissolved Oxygen (DO), free Carbon dioxide ($CO_2$), Alkalinity, Hardness and presence of Chloride ion were determined following standard methods (APHA, AWWA, WEF, 2005). The values were compared with standard values of BIS [Bureau of Indian Standards] (2003), Khanna and Bhutiani (2008). A Celsius thermometer (scale ranging from 0°C to 100°C) was used to measure air and surface water temperature. pH of water was measured directly using a digital electrode pH meter (Systronics, Model No. SYS–335). The chemicals used for analysis of all the parameters were all of analytical AR grade.

For the collection of Zooplankton a modified Heron Tranter net was taken with a round metallic frame of 0.625 sq. m area. The filtering cone was made up of Nylon bolting silk plankton net (No. 25 mesh size 50 μ) was used for collection of Zooplankton. Collected samples were transferred to labeled vials containing 5% formalin. Quantitative analysis and identification was done on a Sedgwick Rafter Counter cell by taking 1 ml sample. The Plankton was observed & documented using Olympus Trinocular Microscope (Model-MLX B) attached with Nikon Coolpix Camera. Detailed taxonomic identification was earned out with Tonapi (1980), Needham and Needham (1962), APHA, AWWA, WEF, (2005), Kodarkar (1992) and Hosmani (2008).

Most of the chemicals used here of highest purity available.

## Results and Discussion

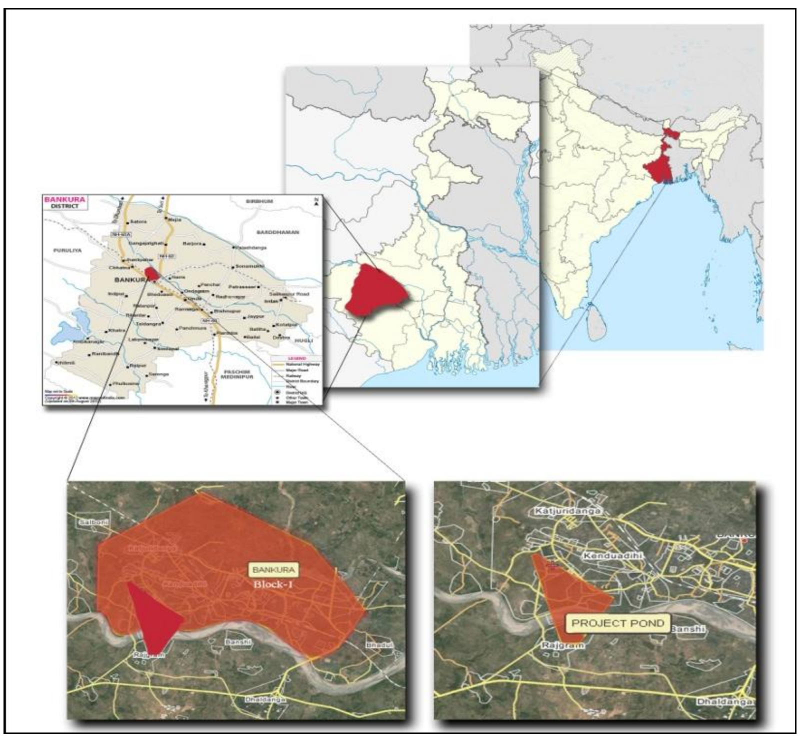


**Figure 1: Map of study area**


**Figure 2: Sattelite view of the selected ponds at the study area**

**Figure 3: S-1 (Pond of Tantipara, Rajgram, Bankura); satellite view of S-1; photograph during sampling**

**Figure 4: S-2 (Daser Band, Rajgram, Bankura); satellite view of S-2; photograph during sampling**

**Figure 5: S-3 (Padmapukur, Near SBSTC Depot.); satellite view of S-3; photograph during sampling**

**Figure 6: S-4 (Sar Bagan, Near SBSTC Depot.); satellite view of S-4; photograph during sampling**

**Figure 7: S-5 (Had pukur, Lokepur, Bankura); satellite view of S-5; photograph during sampling**

**Figure 8: S-6 (Majher gora, Lokepur, Bankura); satellite view of S-6; photograph during sampling**

**Table-1: Summary of physico-chemical and biological parameters (Mean ± S.E., N=6) of different pond water of south western part of Bankura town during January to June, 2014**

| | **S-1** | **S-2** | **S-3** | **S-4** | **S-5** | **S-6** | **BIS standard** |
|---|---|---|---|---|---|---|---|
| Place | Tantipara, Rajgram | Daser Band, Rajgram | Padmapukur, Near SBSTC Depot. | Sar Bagan, Near SBSTC Depot. | Had pukur, Lokepur | Majher gora, Lokepur | -- |
| Latitude | 23°12'58.10 "N | 23°12'56.08" N | 23°14'11.84" N | 23°14'13.28" N | 23°13'37.23" N | 23°13'36.12" N | -- |
| Longitude | 87°2'10.50" E | 23°12'56.08" N | 87°1'51.14"E | 87°1'53.94"E | 87°2'42.36"E | 87°2'45.14"E | -- |
| Size of pond | ~ 8 M radius | ~ 130 M diagonally | ~ 8 M diagonally | ~ 7.5 M diagonally | ~ 85 M diagonally | ~ 35 M radius | -- |
| Shape of pond | Almost circular | Almost rectangular | ~ Square | ~ Square | Almost square | Almost circular | -- |
| Air temperature ($^0$C) | 34.6 ± 3.2 | 33.8 ± 3.8 | 35.3 ± 3.4 | 35.8 ± 2.9 | 32.5 ± 3.5 | 32.6 ± 2.8 | -- |
| Water temperature ($^0$C) | 20.2 ± 2.1 | 21.1 ± 2.0 | 22.4 ± 1.9 | 23.1 ± 2.3 | 24.0 ± 2.1 | 24.2 ± 1.9 | -- |
| Type of pond | Perennial | Perennial | Perennial | Perennial | Perennial | Perennial | -- |
| pH | 5.38 ± 0.68 | 7.56 ± 0.71 | 6.04 ± 0.68 | 5.46 ± 0.69 | 6.89 ± 0.62 | 6.98 ± 0.54 | 6.5 – 8.5 |
| DO (mg/L) | 1.54 ± 0.29 | 5.58 ± 0.43 | 1.15 ± 0.12 | 2.13 ± 0.35 | 4.77 ± 0.26 | 3.98 ± 0.15 | Upto 6.0 |
| Free $CO_2$ (mg/L) | 4.32 ± 0.21 | 1.98 ± 0.23 | 4.66 ± 0.29 | 4.35 ± 0.19 | 3.06 ± 0.38 | 3.29 ± 0.32 | -- |
| Chloride ions (mg/L) | 37.0 ± 0.32 | 18.0 ± 0.21 | 6.0 ± 0.12 | 16.0 ± 0.26 | 28.0 ± 0.42 | 17.0 ± 0.15 | Upto 250 |
| Alkalinity (mg/L) | 167.4 ± 5.42 | 154.9 ± 3.95 | 135.6 ± 4.21 | 132.4 ± 3.65 | 146.2 ± 4.57 | 143.1 ± 3.5 | 50 – 200 |
| Total hardness (mg/L) | 215.8 ± 7.2 | 178.5 ± 7.3 | 204.6 ± 7.1 | 210.2 ± 7.5 | 192.6 ± 7.0 | 172.8 ± 6.9 | Upto 300 |
| Cladocera (Nos./L) | 325 ± 17 | 75 ± 6 | 0 ± 0 | 425 ± 22 | 25 ± 3 | 25 ± 2 | -- |
| Copepoda (Nos./L) | 25 ± 4 | 100 ± 8 | 0 ± 0 | 25 ± 2 | 175 ± 7 | 100 ± 8 | -- |
| Rotifera (Nos./L) | 275 ± 14 | 125 ± 8 | 25 ± 2 | 50 ± 4 | 25 ± 3 | 25 ± 2 | -- |
| Ostracoda (Nos./L) | 50 ± 4 | 50 ± 3 | 25 ± 3 | 50 ± 5 | 0 ± 0 | 0 ± 0 | -- |
| Larva and Protozoa (Nos./L) | 75 ± 7 | 100 ± 9 | 100 ± 8 | 50 ± 4 | 0 ± 0 | 0 ± 0 | -- |
| Worm (Nos./L) | 0 ± 0 | 0 ± 0 | 50 ± 4 | 75 ± 6 | 25 ± 2 | 0 ± 0 | -- |

The physico-chemical parameters of six different ponds of south western part of Bankura town from January to June, 2014 are being summarized in Table–1. The values of different physico-chemical parameters are Mean ± S.E. where N=6. Some observable variations in physico-chemical parameters were observed in all the ponds as all these six ponds are located at various places. The water temperature varies from 20.2 to 24.4 $^0$C with seasonal changes. The air temperature ranges minimum from 32.5 to maximum to 35.3 $^0$C (**Table-1**). Similar types of changes in water temperature were observed by Sen *et. al.*, 2011; Srivastava and Srivastava, 2011; Majumder and Dutta, 2014. *Cypris sp.*, *Lecane luna* and *Mytilina ventralis* were obtained when the water temperature was above 30 degrees, while *B. urceolaris, Asplancha seiboldi*, *Pompholyx sulcata* and *Hexarthra fennica* were recorded below 20 degrees. Rests of the rotifers were obtained between 20-30 degrees range of temperature (Pattnaik B. Sai Ram (2014).

Hydrogen ion concentration (pH) of pond water is considered an important chemical parameter that determines the suitability of water for various purposes. pH of water is very important for the biotic communities because most of the aquatic organism are adapted to an average pH. The average pH values of the water of the study area (the six ponds) during the six month period vary from minimum 5.46 to maximum of 7.56 (**Table-1**). This result has been supported by the finding of Chaurasia and Pandey (2007). The lowest pH value was found may be due to heavy rainfall (Shiddamallaya and Pratima, 2008; Majumder and Dutta, 2014). In the present investigation pH ranges between 5.46–7.56 shows acidic to slightly alkaline condition of the pond water. Mary (1989) reported that pH of polluted water fluctuates in the range of 8.0–9.0. A common factor causing pH level to rise over 9.0 is intense photosynthetic activity resulting from algal growth in enriched waters causing eutrophic condition (Gabriela and Paez, 2007). The BIS (2003) limits the pH of drinking water between 6.5 and 8.5. So, it can definitely be said from water pH point of view that, the water of S-1, S-3 and S-4 can never be used for drinking purpose, but after proper treatment these ponds may be used for fishing purpose.

The level of dissolved Oxygen (DO) at S-2 pond was found to be highest 5.58 mg/L (**Table-1**) amongst all the ponds. Actually the surface diffusion of gases plays a major role in maintaining the levels of dissolved gases in a surface water body like pond (Parikh and Mankodi, 2012). Moreover, comparatively smaller amounts of DO are produced by the photosynthetic organisms residing in the pond as a result of their photosynthetic activities. With a balance in the natural ecosystem, the pond which has aquatic plants will have slightly more DO in comparison to the pond having scarce aquatic flora. Although the aquatic vegetation is important to maintain the productivity of a pond ecosystem; their growth may be accelerated with continuous addition of nutrients. If this growth remains unchecked, it leads to formation of a mat of floating algae which eventually covers the whole surface of the water body. This does not allow the surface diffusion of gases leading to depleted oxygen levels in the water causing death and decay of aquatic organisms in anoxic condition. The DO level of S-1 pond water is 1.54 mg/L may be due to a thick algal bloom on its surface. The DO level at S-3 and S-4 ponds were also very low (1.15 and 2.23 mg/L respectively) may be due to lack of submerged phytoplankton and also due to lack of transparent water. Rotifers respire by their whole body since they do not have respiratory organs. They were unable to live in anaerobic conditions as well as low DO condition such as S-3. Copepods obtained from sewage ditch and S-3 indicates that they can tolerate micro aerobic habitats, showing poor DO content in the pond such as S-4. *Paramoecium sp., Euglina sp., Chlamydomonas sp*., *Keratella cochlearis, B.urceolaris* and *Monostyla bulla* were found in water where good sunlight falls up to the depth. Lecanes and more algal bodies were observed in the water reservoir where more numbers of hydrophytes were found. Similar observation found by Pattnaik B. Sai Ram (2014). Some of the aquatic plants, when decomposed in anaerobic conditions are known to be producing toxic chemicals such as “Strychnine” which are not only harmful to the aquatic organisms but also to cattle and other organisms including aquatic birds that rely on the pond (Sharma, 2009). In high temperature the solubility of oxygen is lowered and also the organic substances are degraded. Concentration of DO is inversely proportional to temperature at a given time. DO value show significant positive correlation with Zooplankton. Similar conclusion has been drawn by Ahmad and Krishnamurthy, 1990; Singh and Singh, 1993.

Free carbon dioxide ($CO_2$) is also one of the important factors in aquatic habitat. It is highly soluble in water and is the main source of carbon pathway in the nature. Plants absorb the free carbon dioxide present in both atmosphere and water. Carbon dioxide in water bodies is contributed by the respiratory activity of animals. In present study the Carbon dioxide content ranges from 1.98mg/l. to 4.66 mg/l. & the S-1 pond show the lowest value. In water bodies $CO_2$ react with water and forms carbonic acid, which soon dissociates into carbonates and bi carbonates, which alters pH of water.

Alkalinity of water is the capacity to neutralize strong acids that gives primarily a function of carbonate, bi-carbonate and hydroxide content and formed due to the dissolution of $CO_2$ in water. In the present investigation alkalinity values varied from 132.4–167.4 mg/L of which maximum value (167.4 mg/L) was observed at S–1 and minimum value (132.4 mg/L) at S–4.

The hardness of water is not a pollution parameter but indicates water quality. Waters are often categorized according to degrees of hardness as follows: 0 – 75 mg/L = soft, 75 – 150 mg/L= moderately hard, 150 – 300 mg/L= hard, above 300 mg/L= very hard. In the present investigation, total hardness level varied from 172.8 mg/l to 215.8 mg/L. This may be due to the presence of high content of Calcium and Magnesium ions in addition to Sulphate and Nitrate ions (Angadi *et. al.*, 2005). Kaur and Sharma (2001) reported that generally maximum hardness values in the water body found at summer. Increase in hardness value can be attributed to the decrease in water volume and simultaneous increase in the rate of evaporation at high temperature, as a result high loading organic substances, detergents and other pollutants (Rajgopal *et. al.*, 2010). Here the S-1, S-3 and S-4 pond show the moderately high level of hardness as those pond water eutrophic or polluted & also contain low water volume, where as the S-2, S-5 and S-6 pond show the low level of hardness as those are contain large water volume.

Chloride values in the present study were found ranging between 6.0 to 37.0 mg/L of which, maximum value (37.0 mg/L) was noticed at S–1 and the minimum value (6.0 mg/L) at the S–3 pond. Majumder and Dutta (2014) also found this range of chloride value at Dwarakeshwar river of Bankura. The higher concentration of chloride is considered to be an indicator of higher pollution due to higher organic waste of animal origin. Venkatesharaju *et. al.* (2010) observed that the higher concentration of chloride in the summer period may be due to increased temperature, low level of water and sewage mixing. The chloride content in the body regulates badly the process of osmoregulation. *L. ovalis*, *Heliodiaptomous*, *Cypris*, *Heterocypris* and *P. vulgaris* were found in ponds having low chloride contents. *Lecane luna* could tolerate chloride content up to 25-60 mg/L. *Hexarthra fennica*, *Cypris sp.* and *B. plicatilis* had shown high chloride toleration capacity.

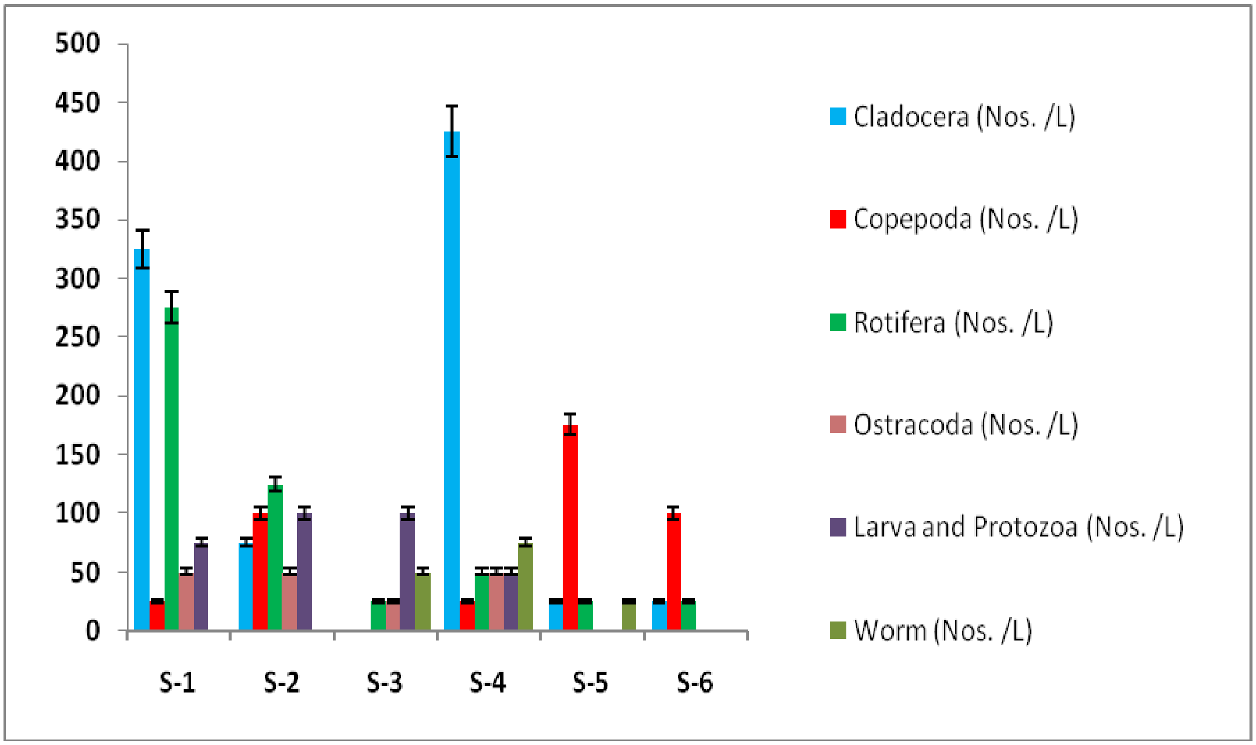


**Figure 9: Graphical representation of some biological parameters of pond water of south western part of Bankura town during January to June, 2014**

**Figure 10: Dense population of Cladocerans, Nematod and common Rotifer in S-4, S-3 & S-1 respectively**

**Table-2: Abundance of Zooplankton at study sites**

| | | Counting in study site (as per Nos./L) | | | | | |
|---|---|---|---|---|---|---|---|
| **Sl. No.** | **Genera** | **S-1** | **S-2** | **S-3** | **S-4** | **S-5** | **S-6** |
| | **Cladocera** | | | | | | |
| 1. | *Daphnia sp.* | 126 | 23 | - | 51 | - | - |
| 2. | *Bosmina sp.* | 24 | - | - | - | - | - |
| 3. | *Moina sp.* | 153 | 52 | - | 324 | 25 | 25 |
| 4. | *Ceriodaphnia sp.* | 22 | - | - | 50 | - | - |
| | **Total** | **325** | **75** | **0** | **425** | **25** | **25** |
| | **Copepoda** | | | | | | |
| 5. | *Cyclops sp.* | 25 | 74 | - | 25 | 104 | 74 |
| 6. | *Mesocyclops sp.* | - | 26 | - | - | 46 | 26 |
| 7. | *Diaptomus sp.* | - | - | - | - | 25 | - |
| | **Total** | **25** | **100** | **0** | **25** | **175** | **100** |
| | **Rotifera** | | | | | | |
| 8. | *Brachionus bidentata* | 123 | 77 | 25 | 25 | - | - |
| 9. | *Brachionus diversicornis* | 50 | - | - | - | - | - |
| 10. | *Brachionus quadridentata* | 27 | 23 | - | - | | 25 |
| 11. | *Keratella tropica* | 53 | - | - | - | 25 | |
| 12. | *Filinia sp.* | - | - | - | - | - | - |
| 13. | *Asplanchna sp.* | 47 | 25 | - | 25 | - | - |
| | **Total** | **275** | **125** | **25** | **50** | **25** | **25** |
| | **Ostracoda** | | | | | | |
| 14. | *Cypris sp.* | 50 | 25 | 25 | 50 | - | - |
| 15. | *Stenocypris sp.* | - | 25 | - | - | - | - |
| | **Total** | **50** | **50** | **25** | **50** | **0** | **0** |
| 16. | Nauplius larva | 50 | 23 | 54 | 25 | - | - |
| 17. | Zoea larva | - | - | 21 | - | - | - |
| 18. | *Paramoecium sp.* | - | 27 | - | - | - | - |
| 19. | *Euglena sp.* | 25 | 50 | 25 | 25 | - | - |
| | **Total** | **75** | **100** | **100** | **50** | **0** | **0** |
| 20. | **Worm** | **-** | **-** | 50 | 75 | 25 | **-** |
| | **Grand Total** | **750** | **450** | **200** | **675** | **250** | **150** |

**Table-3: Diversity index, richness and evenness in study sites**

| **Study site** | **Diversity Index** | **Species Richness** | **Species Evenness** |
|---|---|---|---|
| S-1 | 1.79 | 2.87 | 0.62 |
| S-2 | 2.25 | 2.65 | 0.84 |
| S-3 | 1.79 | 2.30 | 0.78 |
| S-4 | 1.80 | 2.83 | 0.63 |
| S-5 | 1.36 | 2.39 | 0.57 |
| S-6 | 1.26 | 2.17 | 0.58 |

Zooplankton is an integral component of aquatic ecosystem and comprises of microscopic animal life that passively float or swim freely. The principle components of Zooplankton in lentic environment are represented by taxonomic group of Rotifera, Cladocera, Copepod and Ostracoda. Rotifera comprises of the second most abundant group of Zooplankton. The rotifera group is represented by 6 genera. The most dominant being *Brachionus sp.*, represented by 3 species viz., *Brachionus bidentata*, *B. qudridentata* and *B. diversicornis*. The others were, *Keratella tropica*, *Asplanchna sp.* and *Filinia sp.*. Here the rotifers are considered to respond more quickly to environmental changes than crustacean Zooplankton. They appear to be more sensitive indicators of changes in water quality (Gannon and Stemberger, 1978). Information on the acute toxicity tests of lead (Pb) on *Brachionus sp.* is available in literature (Snell & Janssen, 1998). Presence of *Brachionus sp.* is the indication that the pond is organically polluted. This is in also agreed by Ahmed *et. al.*, 2012; Dutta and Patra, 2013. Studies carried out by Yi-Lomg Xi, Xiao-ping and Zhao-Xia Chu (2006) had shown that DDT, Dicophol, Estradiol and other pesticides do had a direct impact on growth, fecundity and survival of rotifers. From **Figure 3** it can easily be said that pond water of S-1 was with maximum number of rotifers (**Figure 9**), as the S-1 is eutrophic pond and show the maximum level of alkalinity. This data supported by Hutchinson (1967) as he observed that species of genus Brachionus are very common in temperate and tropical waters, which indicates alkaline nature of the water bodies. Another side the other five ponds (namely S-2, S-3, S-4, S-5 and S-6), the water is containing moderate numbers of rotifers. Among Zooplankton, cladocera is the dominant group. This group is represented by *Daphnia sp.*, *Moina sp.*, *Ceriodaphnia sp.* and *Bosmina sp.* Cladocerans are important food source for fry, fingerlings and adult of many economically important fish species. Next Copepoda comprises the third most abundant group of Zooplankton & this group is represented by *Cyclops sp.*, *Mesocyclops sp.*, and *Diaptomus sp.* The cladocerans and copepods are widely referred as tolerant species, present in all kinds of waters (Verma and Dalela, 1975) and in the present study cladocerans are maximum in S-1 & S-4 and both ponds are some extend polluted (**Figure 10**). Cladocerans are also reported to be the indicators of eutrophic nature of water bodies (Sharma, 2001). Here copepods are moderately flourished in S-1, S-2, S-3, S-4 and S-6, where as S-5 show the maximum number. Ostracoda comprises of the least abundant group of Zooplankton and this group is represented by *Cypris sp.*, and *Heterocypris sp.*. In the present study they are show least abundance in number. Highest species diversity, richness, evenness was observed in S-2, which in commonly use for fish reservoir at monsoon in Rajgram (**Table-3**). According to Guy (1992) the study of Zooplankton is necessary in fisheries; aquaculture and paleolimnological research as it provide food for fish in freshwater lakes and play a major role in fish production. Rotifers are globally recognized as pollution indicator organisms in the aquatic environment (Kamble and Meshram, 2005). According to Guy (1992), phytoplankton abundance fluctuates with changes in environmental factors and grazing by Zooplankton. Zooplankton distribution is non homogenous. Some are mainly found in the littoral waters while others are in selected limnetic waters.

## Conclusion

Management of water body like pond essentially requires an understanding of physico-chemical and biological conditions. The aquatic environment is an area controlled by the changes in factors such as light, heat, humidity and contamination of various effluents in the water body. It can also be said the overall productivity of a water body is directly regulated by physico-chemical as well as by biological parameters. From the above investigation, it may be concluded that the values of different physico-chemical parameters at all the six sites during the six months are in the range prescribed by BIS (2003). The most important finding of this work is having a moderate number of Zooplankton diversity in the six studied water bodies of south western part of Bankura town. As rotifers are suppose to act as bio-indicators for fish culture; so it can easily be said that besides being used by the local residents the water of these ponds may easily be used for fishing purpose with a little management. The study is quite useful in further investigation and in improvement of quality and quantity of the Zooplankton community. Biodiversity is rightly considered as an index of sound health of habitat and strong base for better evolution.

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