Seasonal Variation of Zooplankton Density and Physicochemical Parameters of a Perennial Freshwater Body, Samudrabundh of Joypur, Bankura, West Bengal, India

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Water is the most essential and vital component required for the survival of all organisms in this earth. The physico-chemical and biological characteristics of a water body determine its efficacy for the production of plankton especially the zooplankton. Zooplankton are the most important primary consumer of aquatic food chain which in turn influence the productivity of finfishes in an aquatic body. The present study is primarily based on assessment of seasonal density and diversity as well as the physico-chemical condition of Samudrabundh, of Joypur block of Bankura district, West Bengal. Such type of assessment on this water body has not been done before this. The study was carried during March 2019 to February 2020. The water quality parameters which were used for study were temperature, pH, Dissolved Oxygen (DO), Free carbon dioxide (CO₂), Chloride, salinity, alkalinity and Total hardness. A total of 26 taxa of zooplankton were recorded. Out of which 8 species comprises of Rotifera, 05 species of Copepoda, 10 species of Cladocera and 03 species of Ostracoda. The total zooplankton density ranges from 756 (Ind/L) to 957 (Ind/L) which is quite lower than the desired value required for good fish culture. The study concludes that the water body is of soft water type and medium productive in nature.

Keywords: Physico-chemical, productive parameter, Zooplankton.
freshwater bodies are constantly getting polluted due to domestic wastes, sewages, industrial and agricultural effluents.

In aquatic food chains, zooplankton forms a major link in the energy transfer between autotrophs and heterotrophs. Zooplankton community are important members of aquatic food webs because they serve as an important food item for fishes and invertebrate predators.

The physicochemical properties and diversity of flora and fauna are two important pillars which determine the healthy status of an aquatic ecosystem. The physical, chemical and microbial characters of a water body determine its nutrient status. It is not possible to understand the biological phenomenon fully without the knowledge of water chemistry of the aquatic ecosystem. It is necessary to know the physicochemical properties of water to study the rearing practices of the fishes of water bodies.

No record about the physicochemical properties and zooplankton density and diversity of the perennial water body, Samudrabundh, of Joypur block of Bankura district, West Bengal is available earlier than this study. So, this study has been conducted to fill that lacuna and to make a quantitative analysis of the water of the aquatic body so that proper utilization of such a big perennial water body can be made.

MATERIALS AND METHODS

The study was conducted by collecting water samples and zooplankton samples from the perennial pond of Samudrabundh, Joypur, Bankura. It is located in 23°2’39.81 N and 87°26’12.45 E. Approximately its water area is 25 hectares. The study was conducted during the period of March, 2019 to February, 2020. For the ease of doing the job the study period was divided into four seasons viz. summer (March, 2019 to May, 2019), monsoon (June, 2019 to August, 2019), Post monsoon (Sep, 2019 to Nov, 2019), and Winter (December, 2019 to February, 2020). Random samples of water were collected between 7 A.M to 10 A.M. in the morning on any three days during each season. Instead of surface water, samples from a depth of 50 cm were collected for the study. For determination of Dissolved oxygen (DO), Free CO₂, PH, total alkalinity, hardness and salinity standard method of APHA (2008) was followed. For determination of Temperature thermometer marked with 0.01 graduated centigrade (°C) was used. PH was measured using a digital PH meter (Systronics model, 335). Turbidity was measured in NTU by using a nephelometer (Systronics, 338).

For zooplankton samples, 40 L of water was filtered using plankton net of 50 μm mesh size. Zooplankton samples were preserved in 10% formalin at the site itself. Sample was allowed to settle down for a day. Sedgwick Rafter plankton counting cell was used for counting of zooplankton to find out its density. The detailed study of the plankton was done by using OLYMPUS inverted stereoscopic microscope (Model MLX-B) fitted with a NIKON camera. Identification of plankton was done according to the character mentioned by Battish, 1992.

RESULTS AND DISCUSSION

Temperature

Temperature is an important physical factor that affects the quality of the water and considered as controlling factor for the fluctuation of plankton and functioning of the aquatic ecosystem. Water temperature in tropical waters in the range between 13.5°C and 32°C is found to be suitable for the development of the planktonic organisms. In the study site the temperature of water varies from 19.3°C in winter to 21.3°C in Summer.

In Samudrabundh water temperature shows positive correlation with pH, turbidity, free CO₂, salinity and total alkalinity. It shows negative correlation with DO, chloride, total hardness and total zooplankton.
chloride, total hardness and total zooplankton (Table 2).

**pH**

pH value ranges between 5.7 to 6.8 (Table 1). According to (Kurbatova, 2005) pH value between 6.0 and 8.5 is considered as medium productive nature of a reservoir. So the reservoir under study is considered as of medium productive nature.

In Samudrabundh pH shows positive correlation with free CO$_2$, salinity and total alkalinity. It shows negative correlation with DO, total hardness and total zooplankton (Table 2).

**Dissolved Oxygen**

Dissolved oxygen (DO) is a very crucial limnological parameter whose measurement is vital regarding the culture of any aquatic animal. Dissolved Oxygen (DO) in the study site varies from 3.0 mg/l in summer to 8.4 mg/l in winter. DO value less than 3.0 mg/l is considered as detrimental for fish growth. So, the DO value reaches its lowest threshold value during summer in the study area (Table 1).

In Samudrabundh, DO shows positive correlation with chloride, total hardness and total zooplankton. It shows negative correlation with free CO$_2$, salinity and total alkalinity (Table 2).

**Free CO$_2$**

Carbon dioxide in water bodies is mainly contributed by the respiratory activities of aquatic animals. In the study area the free CO$_2$ ranges from 10.2 mg/l in winter to 15.8 mg/l in summer (Table 1).

In Samudrabundh, free CO$_2$ shows positive correlation with Salinity and Total alkalinity. It shows negative correlation with

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**Table 1. Seasonal variation of hydrological parameters of Samudrabundh, Joypur, Bankura**

| Parameters        | Summer (Mar2019-May 2019) | Monsoon (June2019-Aug2019) | Post Monsoon (Sep2019-Nov2019) | Winter (Dec2019-Feb2020) |
|-------------------|----------------------------|----------------------------|-------------------------------|--------------------------|
| Temperature (C)   | 21.3                       | 20.3                       | 20.0                          | 19.3                     |
| Turbidity (NTU)   | 8.0                        | 9.3                        | 4.7                           | 4.0                      |
| pH                | 6.8                        | 6.6                        | 6.6                           | 5.7                      |
| DO (mg/l)         | 3.0                        | 3.1                        | 5.7                           | 8.4                      |
| Free CO$_2$(mg/l) | 15.8                       | 15.3                       | 12.7                          | 10.2                     |
| Chloride (mg/l)   | 36.7                       | 50.3                       | 44.9                          | 54.7                     |
| Salinity (mg/l)   | 128.6                      | 120.2                      | 112.0                         | 96.1                     |
| Alkalinity (mg/l) | 35.7                       | 39.3                       | 29.7                          | 26.7                     |
| Total hardness (mg/l) | 30.1                   | 33.7                       | 41.4                          | 47.1                     |
| Total zooplankton (Ind/L) | 879                  | 756                        | 957                           | 954                      |

**Table 2. Pearson Correlation matrix (r) between several hydrological parameter and total abundance of Zooplankton of Samudrabundh, Joypur, Bankura**

|.Temp| Turbidity| pH| D.O.| Free CO$_2$| Chloride| Salinity| Alkalinity| Total Hardness| T.Zoop |
|-----|----------|---|-----|------------|---------|---------|-----------|---------------|--------|
|     |          |   |     |            |         |         |           |               |        |
| Temp| 1        |
| Turbidity| 0.716| 1.000 |
| pH| 0.847| 0.651| 1.000 |
| DO| -0.881| -0.919| -0.894| 1.000 |
| Free CO$_2$| 0.907| 0.916| 0.885| -0.998| 1.000 |
| Chloride| -0.900| -0.361| -0.819| 0.661| -0.689| 1.000 |
| Salinity| 0.960| 0.822| 0.933| -0.972| 0.980| -0.818| 1.000 |
| Alkalinity| 0.703| 0.992| 0.704| -0.937| 0.927| -0.367| 0.834| 1.000 |
| T. Hardness| -0.949| -0.897| -0.853| 0.977| -0.990| 0.736| -0.982| -0.892| 1.000 |
| T.Zoop| -0.418| -0.933| -0.421| 0.748| -0.730| 0.011| -0.580| -0.933| 0.681| 1 |
chloride, total hardness and total zooplankton (Table 2).

According to Ellis (1937) dissolved free CO₂ should be less than 5mg/l for good fish production in water bodies. If the free CO₂ level is more than 20mg/l then it may cause hindrance with oxygen intake by fishes. In the present study the average free CO₂ varies between 10.2mg/l to 15.8mg/l which may be consider a little higher in context of fish production.

**Chloride**

Salts of sodium and potassium are mainly responsible for the chloride content of water. The chloride content of water in the study area ranges from 36.7mg/l in summer to 54.7mg/l in winter season (Table 1).

In Samudrabundh chloride shows positive correlation with total hardness and total zooplankton. It shows negative correlation with alkalinity (Table 2).

**Salinity**

In Samudrabundh salinity shows positive correlation with alkalinity. It shows negative correlation with total hardness and total zooplankton (Table 2).

**Total Alkalinity**

In the study area the total alkalinity ranges from 26.7mg/l in winter to 39.3mg/l in summer (Table 1).

In Samudрабundh alkalinity shows positive correlation with temperature, turbidity, pH, free CO₂, and salinity. It shows negative correlation with D.O., chloride, total hardness and total zooplankton (Table 2).

**Total hardness**

The hardness of water is also an important parameter which can indicates water quality. Sawyer (1960) has catagorised perennial water bodies into three groups according to their degrees of hardness. It is as follows: 0 – 75 mg/L = soft, 75 – 150 mg/L = moderately hard, 150 – 300 mg/L = hard, above 300 mg/L = very hard. As the water of the study area ranges between 30.1 mg/l to 47.1 mg/l, so the water of this perennial water bodies is considered soft in biochemical nature (Table 1).
Table 3. List of Zooplankton Groups obtained from Samudrabundh, Joypur, Bankura during study period

| Sl No | Group       | Zooplankton species                      |
|-------|-------------|------------------------------------------|
| 1     | CLADOCERA   | *Daphnia carinata*                       |
|       |             | *Daphnia magna*                          |
|       |             | *Daphnia retrocurva*                     |
|       |             | *Ceriodaphnia reaugi*                    |
|       |             | *Ceriodaphnia cornuta*                   |
|       |             | *Ceriodaphnia reticulata*                |
|       |             | *Bosmina longirostris*                   |
|       |             | *Moina micrura*                          |
|       |             | *Moina brachiata*                        |
|       |             | *Alona affinis*                          |
| 2     | ROTIFERA    | *Brachionus bidentata*                   |
|       |             | *Brachionus quadridentata*               |
|       |             | *Brachionus caudatus*                    |
|       |             | *Brachionus diversicornis*               |
|       |             | *Brachionus rubens*                      |
|       |             | *Keratella tropica*                      |
|       |             | *Lecane sp.*                             |
|       |             | *Asplanchna sp*                          |
| 3     | COPEPODA    | *Cyclops sp.*                            |
|       |             | *Mesocyclops leuckarti*                  |
|       |             | *Mesocyclops hyalinus*                   |
|       |             | *Diaptomus pallidus*                     |
|       |             | *Diaptomus denticornis*                  |
| 4     | OSTRACODA   | *Stenocypris sp.*                        |
|       |             | *Cyprinotus sp.*                         |
|       |             | *Cyprinotus nuda*                        |

In Samudrabundh total hardness shows positive correlation with D.O., chloride and total zooplankton. It shows negative correlation with temperature, turbidity, pH, free CO$_2$ and salinity (Table 2).

Zooplankton analysis

During the study period we have recorded a total of 26 taxa of zooplankton. Out of which 8 species comprises of Rotifer, 05 species of Copepoda, 10 species of Cladocera and 03 species of Ostracoda. The main dominant group in this pond is contributed by Cladocera. It constitutes 46% of the total zooplankton abundance, followed by Rotifer 43%, Copepoda 9% and Ostracoda 2% (Figure 1 and Table 3).

The density of Cladocera ranges from 361 (Ind/L) in summer to 441 (Ind/L) in post monsoon. The density of Rotifera ranges from 265 (Ind/L) in monsoon to 438 (Ind/L) in summer. The density of copepods ranges from 56 (Ind/L) in summer to 102 (Ind/L) in post monsoon. The density of Ostracoda ranges from 6 (Ind/L) in monsoon to 24 (Ind/L) in summer (Figure 2).

CONCLUSION

The study of the physicochemical factors of Samudrabundh reveals that its water turbidity is quite low, its pH value reveals that this water body is of medium productive in nature. The total hardness value suggests that the water body is of soft in nature. In some seasons the dissolved oxygen value remains at the critical level for fish production. Alkalinity is also quite low to support efficient fish production. Panov et al (1973) has suggested that for efficient fish production the zooplankton density of a water body must be above 1500 (Ind/L). But in the present study it has been observed that zooplankton density ranges from 756 (Ind/L) to 957 (Ind/L) which is quiet lower than the desired value. Hence it is concluded that the secondary plankton production in this water body is very less as required for high rate of fish yield. So, the study concludes that though this perennial water body bears a tremendous potentiality of fish culture the limnological features and planktonic abundance of this water body is not satisfactorily good for production of finfishes in them.

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Conflict of interest

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