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Limnology and productivity status in wetlands (Beels) of 24- South Parganas district, West Bengal

N Rishikanta Singh, SK Das, Sanjeev Kumar, Dibakar Bhakta, S Behera, TS Nagesh and Anandamoy Mondal

Abstract
The environmental parameters such as water temperature, pH, dissolved oxygen, transparency, free carbon dioxide and plankton biomass were monitored during the present study period between July, 2011 and June, 2012 from Bhara Haripota beel in Bhamanghata, South 24 Parganas district of West Bengal. Carp culture was practised in such beels and the physico-chemical parameters of water were found to be suitable for the growth of aquatic organisms. The water temperature varied from 20.6 °C to 31.0 °C, pH from 7.2 to 8.2, dissolved oxygen from 4.18 to 5.76 mg l^{-1}, transparency from 18.6 to 26.5 cm and free carbon-dioxide from 0.46 to 1.52 mg l^{-1}. The phytoplankton densities ranged from 1957 to 3652 organisms l^{-1} and zooplankton from 589 to 954 organisms l^{-1}. The present study indicates that the selected wetland is moderately productive in aspects of limnology parameters and suitable for commercial aquaculture.

Keywords: Limnological parameters, plankton production, Bhara Haripota beel, West Bengal

1. Introduction
Aquatic environment plays an important role in growth and influencing physiology of fishes [1]. The physico-chemical parameters are the major factors that control the dynamics and structure of the phytoplankton of aquatic ecosystem [2]. Changes in physico-chemical parameters directly affect the species composition of any ecosystem. Seasonal variations of such parameters influence the distribution, periodicity and quantitative and qualitative composition of biota. Fish subsists on natural food available in such water bodies. The availability and abundance of plankton, benthos, detritus etc. are influenced by different ecological factors. Understandings of these factors are of paramount importance in analysing growth as well as food and feeding habits of fishes [3]. Several studies have been conducted on physico-chemical parameters in aspects of productivity status of confined water bodies [3-9]. Studies also been conducted on physico-chemical parameters and phytoplankton community [10-12]. However, works related to physico-chemical parameters and production status of Bhara Haripota Bhery under east Kolkata wetland are rare. In the present study, environmental parameters such as temperature, pH, dissolved oxygen, free carbon dioxide and transparency were monitored in monthly intervals of a selected beel under east Kolkata wetland of West Bengal to know the productivity status of the ecosystem.

2. Materials and Methods
The physico-chemical characteristics of water of a 18 ha beel (Bhara Haripota, South 24 Parganas district of West Bengal) were studied at monthly intervals during morning hours (7 AM to 9 AM) for a period of 2011-12. The variations in water parameters such as temperatures, pH, dissolved oxygen, free carbon dioxide, transparency and plankton were estimated following standard methods [13]. The surface water temperature was recorded by using a mercury thermometer. The pH of the beel water was measured by using pH test kit of Advance Pharma Co. Ltd., Bangkok. Winkler's Method was followed for estimation of the dissolved oxygen. Free carbon dioxide content of water was measured by tritrametric method. The plankton samples were collected from subsurface water by filtering 50 litres of water through plankton net made up of bolting silk no. 25. The concentrated plankton samples were preserved by adding 5% formalin. The Sedgwick Rafter cell was used for quantitative estimation. Plankton was identified up to generic level following standard method [13, 14].

3. Results and discussion

3.1 Water temperature

The average monthly variation of water temperature is presented in Fig 1. It ranged from a minimum of 20.6 °C during January to a maximum of 31.0 °C during May. It was observed that water temperature was moderate (around 28 °C) during monsoon and post monsoon months. Then it exhibited a declining trend during winter months. Subsequently it started increasing from March onwards. Such fluctuations can be attributed to winter cold and summer heat. Water temperature exhibited negative significant correlation (r = -0.928, $p \leq 0.01$) with dissolved oxygen content of the water which might be due to decrease in solubility of oxygen in water. The present observations were similar to the work of [15], who reported water temperature of 19.5 to 31.0 °C at Ghanpur Lake, Warangal.

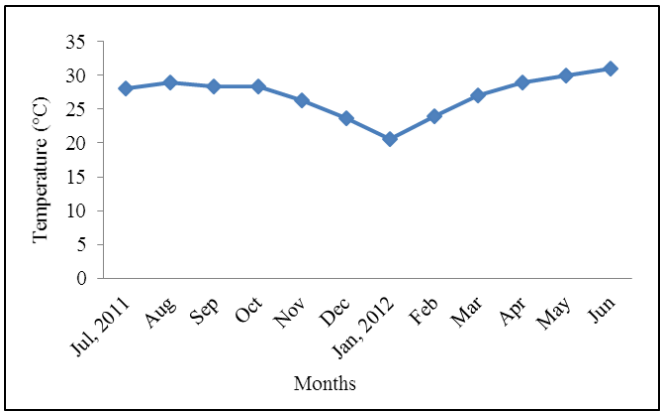

Fig 1: Average monthly variations of water temperature

3.2 pH

The monthly variation in the average values of pH is shown in Fig 2. The average values fluctuated from a minimum of 7.2 during September to a maximum of 8.0 during April. The pH of the water was found to be relatively low during monsoon and post monsoon. Then it was moderate during winter months and started increasing during summer seasons. Higher pH values during summer months can be attributed to faster microbial degradation of organic matter due to high temperature in summer season which bears similarity with works of [10]. The pH values exhibited positive significant correlation (r = 0.580 for phytoplankton and r = 0.803 for zooplankton) with plankton at 1% level of significance. Relative higher pH indicates favourable alkalinity of water which might have increased plankton density. The present work also has similarity with other workers like [16, 17].

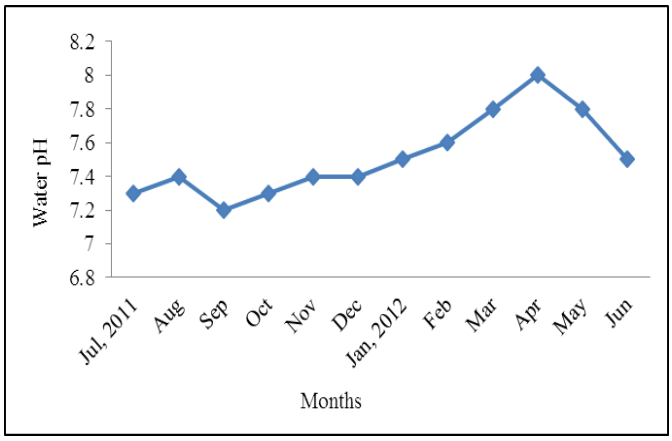

Fig 2: Average monthly variations of water pH

3.3 Dissolved Oxygen

The monthly fluctuation of mean dissolved oxygen values is shown in Fig 3. It ranged from a maximum of 5.76 mg l^{-1} during January to a minimum of 4.18 mg l^{-1} during May. The dissolved oxygen was found to be low during monsoon season which might be due to surface runoff and turbid water. Then it increased during post monsoon season. Highest magnitude of dissolved oxygen was found in winter season and minimum values during summer season. It bears similarity with earlier works [18]. It exhibited inverse significant correlation (r = -0.940, $p \leq 0.01$) with free carbon-dioxide. A similar finding was reported by [19] who observed DO value was 4.26 to 8.93 mg l^{-1} in sewage fed river of Mahanadi, Orissa.

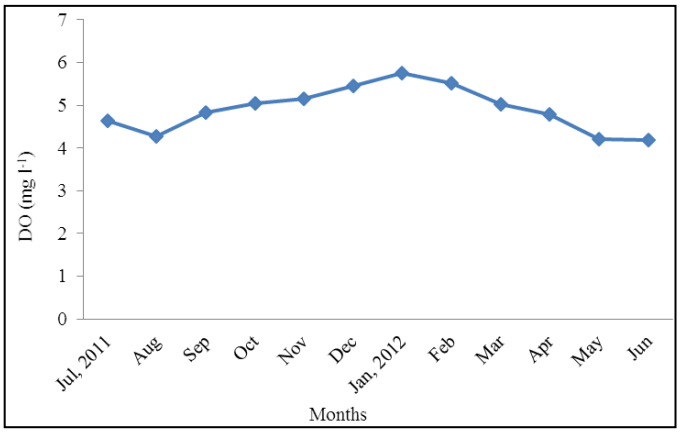

Fig 3: Average monthly variations of DO

3.4 Transparency

The monthly variation in the average values of transparency of water is being depicted in Fig 4. It ranged from a maximum of 26.5 cm during December to a minimum of 18.6 cm during the month of July. The transparency of a water body normally indicates its productivity. It was found minimum during monsoon month which could be due to ingress of silt laden water from surrounding area. It was relatively high during pre-summer and summer which bears similarity with earlier work [18]. It exhibited positive significant correlation (r = 0.575, $p \leq 0.05$) with dissolved oxygen content of the water. It can be attributed to higher light penetration into water causing photosynthesis by reducing carbon dioxide and increasing dissolved oxygen level. A higher transparency value of 27.3 to 74.0 cm from sewage fed river of Odisha and 40.7 to 96.2 cm from Ghanpur Lake, Warangal were reported [15 & 19]. A similar relationship between transparency and plankton production was also observed by [19] as well as [1].

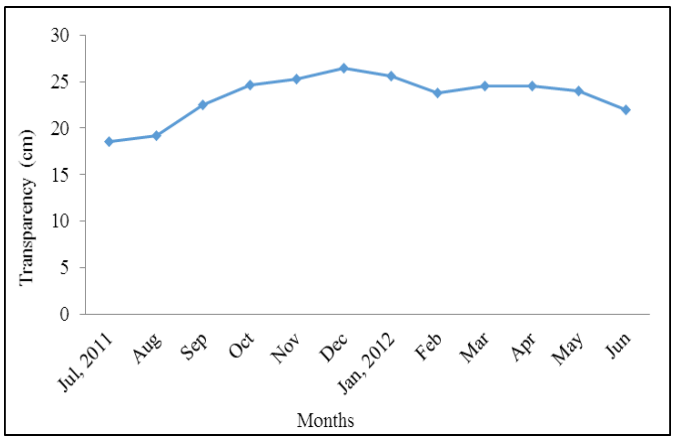

Fig 4: Average monthly variations of water transparency

3.5 Free carbon-dioxide

The Monthly fluctuation in the average values of free carbon dioxide of water is presented in Fig 5. The lowest value was recorded during the month of January (0.4 mg l^{-1}) and maximum during May (1.5 mg l^{-1}). Free carbon dioxide was found to be relatively more during monsoon season which might be due to influx of rain water from surrounding area containing decomposed matter and silt. It was low during winter months which might be due to utilization of carbon dioxide content of water by higher concentration of plankton. It was relatively high during summer months which can be due to the faster decomposition of organic matter and high temperature [10, 20 & 28]. Free carbon dioxide exhibited negative significant correlation (r = -0.914, $p \leq 0.01$) with temperature. A similar kind of observations in a community pond in Ganjam district of Orissa was also reported [11]. Similarly low free Carbon dioxide values of 0 to 8.1 mg l^{-1} were reported by [8] and high values with 28.6 to 72.4 mg l^{-1} by [1].

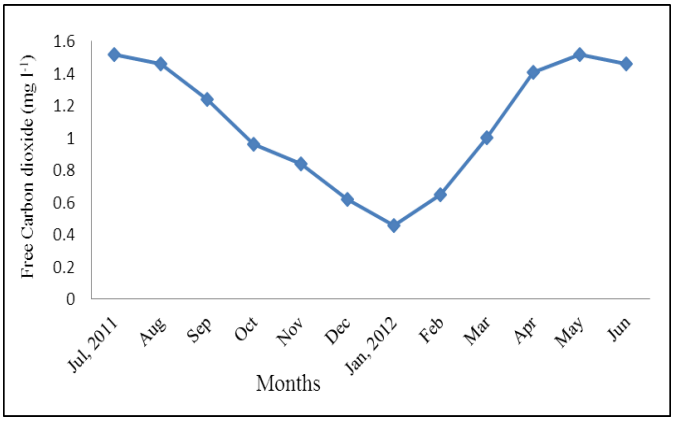

Fig 5: Average monthly variations of free CO_2

3.6 Total Plankton

The plankton densities were varied from 0.4 ml l^{-500} during February and 1.3 ml l^{-500} during August. Plankton plays an important role in the biological productivity of different water bodies. In a fish culture pond, the plankton is one of major food component for the fishes and is directly linked to the fish production. In the present study, the plankton density was relatively low during monsoon season. The surface runoff added to the water could have changed the physico-chemical properties of water leading to physiological stress on plankton community. It might have caused mortality and thus reduced the density which is in agreement with earlier work [10]. It exhibited positive significant correlation (r = 0.574, $p \leq 0.05$) with transparency. However, the zooplankton was relatively more during same period. The zooplankton in monsoon and post monsoon was maximum as compared to other seasons.

Population of phyto and zooplankton in the flood plain wetlands is generally low during the southern monsoon season and increasing thereafter when the environment becomes stable and the plankton population establishes utilizing inorganic nutrients and organic matter brought in by incoming flood or run-off water. The highly abundant phytoplankton population might be due to regular fertilization with organic fertilizers, residual feeds [21, 22] and decreased grazing pressure on phytoplankton due to bottom dwelling and omnivorous nature of mrigal and common carp [23]. There was significant positive correlation (r = 0.895, $p \leq 0.01$) between phytoplankton and zooplankton in the present study indicating zooplankton population flourishing with its forage item phytoplankton.

3.7Abundance of plankton

The interaction between fish and plankton is of utmost importance in poly-culture systems. Species with different feeding niches stocked at different densities can influence the natural food availability positively or negatively. In the present observation, marked fluctuations in the percentage composition of phytoplankton and zooplankton have been observed. Phytoplankton contributed an average value of 85.8% of total plankton with dominance of Chlorophyceae (39.6%), which corroborate with the earlier works of [24, 25]. The dominating role of Chlorophyceae in pond and wetlands were also reported by several workers [24-26]. The result also reported that the Cyanophyceae are dominant phytoplankton group contributing about 34.7% of the total phytoplankton population. Phytoplankton of both Chlorophyceae and Cyanophyceae were present in considerable quantities indicating a positive bearing with fish production [27].

3.8 Phytoplankton abundance and diversity

The monthly average percentage composition of phytoplankton is presented in Fig 6. The phytoplankton density in water was more in post-monsoon and summer seasons, with the highest being observed in the month of March (3652 numbers of organisms l^{-1}). The phytoplankton content was low during monsoon, with the lowest observed during June (1996 number of organisms l^{-1}). Twenty three genera were identified representing nine of Chlorophyceae, five of Cyanophyceae, four of Bacillariophyceae and five of Flagellates. The maximum value of Chlorophyceae was recorded in March (44.8%) and minimum in June (38.5%) and with average monthly value of 39.6%. Some of the encountered dominant genera were *Volvox*, *Pediastrum*, *Ankistrosdesmus*, *Closterium*, *Cosmarium*, *Euglena*, *Phacus*, *Sphaerocystis* and *Chlamydomonas*. The genera of Cyanophyceae encountered were *Anabaena*, *Oscillatoria*, *Microcystis*, *Nostoc* and *Spirulina*. The average monthly percentage composition of Cyanophyceae to the total phytoplankton was found to be 34.7%. The Bacillariophyceae (diatoms) comprised 12.9% of the total phytoplankton with maximum value (13.0%) was recorded in the month of June. Some of the dominant genera encountered were *Navicula*, *Diatoma*, *Cyclotella* and *Synedra*. The Flagellates comprised a monthly average of 6.8% of the total phytoplankton. Some of the dominant genera encountered were *Spirogyra*, *Ulothrix*, *Zygena*, *Cladophora* and *Oedogonium*.

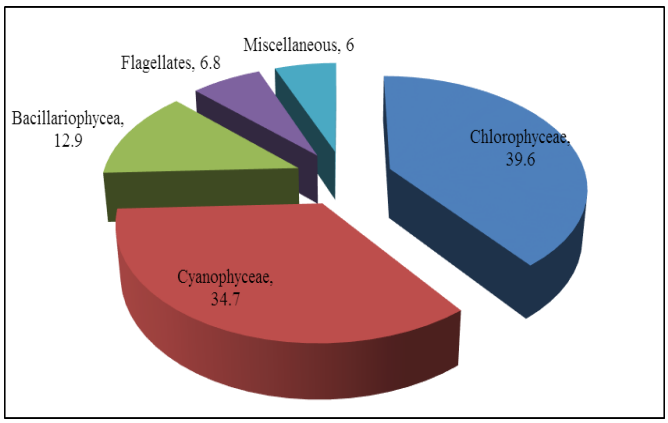

Fig 6: Average monthly percentage composition of phytoplankton

3.9 Zooplankton Abundance and Diversity

The monthly average percentage composition of zooplankton is presented in Fig 7. Zooplankton population in post monsoon and summer season was found maximum as

compared to other seasons. The Protozoan group comprised the maximum (30.7% in average) to the total zooplankton population, followed by Copepoda (20.1%), Rotifera (19.6%) and Cladocera (17.8%). Unidentified zooplankton and planktonic nekton were grouped under miscellaneous and comprised about 11.8% of the total zooplankton.

Twelve genera of zooplankton were encountered comprising three of Protozoa, three of Rotifera, three of Copepoda and three of Cladocera. The protozoans were represented by the genera *Amoeba*, *Trinema* and *Paramecium.* The group Rotifera were mainly represented by the genera *Brachionus*, *Keratella* and *Rotaria.* The copepods were mainly represented by the genera *Cyclops*, *Diaptomus* and *Cypris.* The dominant genera of Cladocera encountered were *Daphnia*, *Cenodaphnia* and *Moina.* It was found that physico-chemical parameters of water were within suitable range in the selected beel during the period of study. It might have caused occurrence of various genera of phytoplankton and zooplankton as good qualities which could influence fish growth and production suitably.

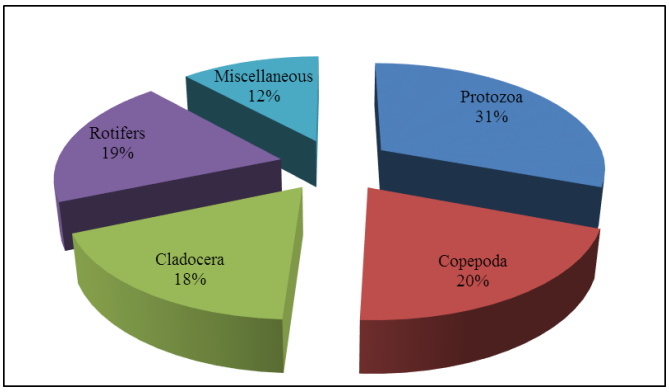

Fig 7: Average monthly percentage composition of zooplankton

4. Conclusion

Physico-chemical parameters of water were within suitable range in the selected beel under east Kolkata wetland during the period of study. Further contamination of water through domestic sewage was also been noticed which gradually reducing the productivity status of the ecosystem. Proper biological and chemical treatments of domestic sewage need to be done before discharge to the system for long run sustainable of the resources.

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