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RESEARCH ARTICLE

Assessment of Physico-chemical Parameters and Zooplankton Community at Gopalaswamy Tank, Chitradurga, Karnataka

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Abstract

Objectives: The present work deals with the study of physico-chemical parameters along with diversity and abundance of zooplanktons to analyse the trophic status of Gopalaswamy tank, Chitradurga, Karnataka, India. **Methods:** A total of 18 physico-chemical parameters were analysed for a period of two years from July 2019 to June 2021 using EuTech PCS multi-parameter testing probe, secchi disc, hygrometer and titration methods. Zooplanktons were identified and counted under Sedge Wick Rafter counting cell, which holds 01ml of zooplanktons sample spread over one thousand cells. **Findings:** The water body exhibits low transparency because of the algal bloom and the water is more alkaline with excess nutrient load due to high value of phosphate, sulphate and nitrates. Three groups of zooplanktons comprising 18 species were recorded. Almost 50% of the zooplanktons observed were eutrophic indicators. Cladocera was the species rich group with 09 species, followed by Copepoda having 05 species and Rotifera with 04 species. However, Copepoda was the most abundant group with 993 individuals (47%), followed by Rotifera with 579 individuals and Cladocera with 545 individuals (26%). Out of these 18 species, *Diaphanosoma sarsi, Diaphanosoma excisum, Bosmina longirostris, Ceriodaphnia cornuta, Ceriodaphnia reticulata, Simocephalus vetulus, Brachionus falcatus, Brachionus forficula* and *Lecane ludwigi* were indicator species. The variations in the physico-chemical characters, zooplanktons and their inter-relation depict the deterioration of the water body and the need of conservation as the water body harbors eutrophic indicator species. **Novelty:** The study is the first report on water quality parameters and zooplanktons diversity of the historic and scientifically built water body that never dried though it is situated in arid zone between the rocky terrains. The investigation has revealed the increased nutrient load which supported the abundance of indicator species and responsible for the process of eutrophication. The study suggests that, conservation strategies are essential to revive and protect the

water body.

Keywords: Gopalaswamy tank; Chitradurga; Zooplanktons; Correlation; Conservation

1 Introduction

The physico-chemical and biological factors support in determining the health of a water body[1]. The composition, diversity and productivity of the population in the water body is also affected by these[2]. Evaluation of zooplankton yields an idea about aquatic ecosystem management and restoration[3]. Zooplankton engages an important role in shaping the aquatic ecosystem, impacting the activities of aquatic ecosystem and trophic state. It is important to study the effect of stressors like physico chemical parameters on freshwater bodies as it alters the abundance of zooplanktons[4]. Zooplanktons exhibit rapid responses to changes in the aquatic environment, hence are called indicators of status of their habitat[5]. Response of water bodies enclose contrastive disturbances and nutrient loading[6]. Monitoring and maintaining the solidarity of aquatic ecosystems can be done using bio-indicator planktons[7]. The present work was undertaken to study the variation in physico-chemical parameters along with diversity and distribution of zooplanktons at Gopalaswamy tank, Chitradurga, Karnataka.

2 Methodology

2.1 Sampling site

Gopalaswamy tank (14º 21´N, 76º 39´E) is situated inside the Chitradurga fort near the Gopalaswamy temple located 4 km away from the city. The water body is a man-made tank built against a massive rock which collects the rain water and forms a reservoir. The tank has a depth of 10 – 12 meter at the centre. The dam built across the water body has a canal for passing excess water.

2.2 Sample collection

Water samples were collected monthly in the early hours between 6:00 and 9:00 A.M. for two years (July 2019 to June 2021). The gap from February to June 2020 is due to the pandemic lockdown where collection of samples was not accessible. Water quality parameters like temperature, pH, salinity and conductivity were recorded using EuTech PCS multi-parameter testing probe. Secchi disc was used to determine the transparency and Hygrometer for humidity. Standard methods[8] were used in the analysis of chemical aspects of water. For zooplankton studies one liter of water was collected by sieving 100 liters of water through nylon bolting net (68μm). The sieved samples were left undisturbed for 24 hours and the supernatant was decanted to increase the zooplankton concentration. Concentrated samples were fixed with 2 ml of glycerin and 4% formaldehyde. Qualitative and quantitative assessment was performed under Olympus CH 20i optical microscope using specialized literature[9,10] under Sedgwick rafter counting cell, which holds 01ml of zooplankton sample spread over one thousand cells.

3 Results and Discussion

3.1 Abiotic factors

During the present study 18 different Physico-chemical variables were analysed at Gopalaswamy tank for a period of two years from July 2019 to June 2021

(**Supplementary Table 1**). Air temperature varied from 19.7 to 27 °C. The highest air temperature (27 °C) was observed in the month of July 2019 and lowest (19.7 °C) during December 2020. Average air temperature was 23.42 ± 0.42 °C. Water temperature ranged from 22 to 27 °C with an average of 24.10 ± 0.33 °C, its highest value of 27 °C was recorded in January 2020 and lowest value 22 °C was observed in the months of August 2019 and December 2020. Humidity ranged between 32 and 72%. The highest humidity recorded during the study period (72%) was in September 2019 and lowest (32%) in the month of November 2019. Average humidity observed was 44.55 ± 1.98%. Humidity of Gopalswamy tank was positively correlated with nitrate (r=0.696, P<0.01). Range of transparency was 30 to 80 cm with an average of 54.25 ± 3.68 cm. Highest transparency (80 cm) was recorded in the months of October 2020 and March 2021 and lowest (30 cm) in the month of October 2019. Transparency showed numerous significant positive correlations with calcium (r=0.629, P<0.01), hardness (r=0.624, P<0.01), free carbon dioxide (r=0.620, P<0.01), chlorides (r=0.538, P<0.05), dissolved oxygen (r=0.460, P<0.05) and Cladocera (r=0.456, P<0.05). The negative correlation of transparency was with magnesium (r=-0.497, P<0.05). pH at Gopalswamy tank varied between 7.5 and 10.1. The highest pH value of 10.1 was observed in the month of April 2021 and lowest (7.5) in the month of October 2020. Its average value was 8.77 ± 0.17. Water remained alkaline throughout the study period. Similar pattern was observed in Bommanahalli reservoir[11]. Electrical conductivity ranged between 134.9 and 205 μmhoS/cm with an average value of162.67 ± 4.634 μmhoS/cm. The highest value of electrical conductivity (205 μmhoS/cm) was recorded during the month of June 2021 and the lowest (134.9 μmhoS/cm) during October 2019. Electric conductivity had positive correlations with total dissolved solids (r=0.998, P<0.01), salinity (r=0.976, P<0.01), calcium (r=0.477, P<0.05) and hardness (r=0.465, P<0.05). Ionic concentration of the water body determines conductivity[12]. Total dissolved solids varied between 96 and 142 ppm with an average value of 114.91 ± 3.104 ppm. Highest TDS of 142 ppm was observed in the month of June 2021 and lowest (96 ppm) during October 2019. Total dissolved solids had significant positive correlation with salinity (r=0.973, P<0.01), calcium (r=0.470, P<0.05) and hardness (r=0.458, P<0.05). Salinity values varied between 67.7 and 103.4 ppt and the average salinity value was 83.08 ± 2.215 ppt. The highest recorded salinity (103.4 ppt) was in the month of June 2021 and lowest (67.7 ppt) was during October 2019. Salinity was positively correlated with calcium (r=0.602, P<0.01) and hardness (r=0.593, P<0.01). Dissolved oxygen had an average value of 13.53 ± 0.661 mg/L that ranged from 7.4 to 18.1 mg/L during the study. Highest dissolved oxygen value (18.1 mg/L) was recorded in the month of October 2020 and lowest (7.4 mg/L) during September 2019. Dissolved oxygen showed significant negative correlation with magnesium (r=-0.581, P<0.05). Decrease in DO is mainly by respiration, oxidation and organic processes[13]. The chloride value varied from 10.3 to 21 mg/L. Maximum of 21 mg/L chloride was recorded during the month of August 2020 and minimum of 10.3 mg/L chloride was recorded in the month of November 2019 with an average of 15.80 ± 0.634 mg/L. Chloride was significantly positively correlated with free carbon dioxide (r=0.690, P<0.01) and phosphate (r=0.577, P<0.01) while it was negatively correlated with nitrate (r=-0.475, P<0.05). The highest concentration of chloride is directly correlated to pollution[14]. The free CO_2 value remained almost constant (1.32 mg/L) during the study period with an average value of 1.15 ± 0.065 mg/L. The lowest values of free CO_2 (0.66 mg/L) were recorded during the months of August, September, October, November of 2019 and July 2020. Free carbon dioxide had significant positive correlation with phosphate (r=0.504, P<0.05), hardness (r=0.494, P<0.05), calcium (r=0.481, P<0.05) and negative correlation with nitrate (r=-0.544, P<0.05) (**Supplementary Table 2**). Organic degradation and respiration of organisms are the cause for free carbon dioxide in water[15]. The values of alkalinity in the water body ranged from 13 to 30 mg/L. The highest values were observed in the months of October 2019, November 2020 and May 2021. The lowest value of alkalinity was recorded during September 2019. Average value of alkalinity was 21.6 ± 1.08 mg/L. Carbonates, bicarbonates, hydroxyl, phosphate and silicate are the grounds for total alkalinity[14]. Calcium values at Gopalswamy tank varied from 20.4 to 50.6 mg/L with an average value of 35.95 ± 2.48 mg/L. The highest recorded calcium (50.6 mg/L) was in the month of February 2021 and the lowest (20.4 mg/L) was during January 2020. Calcium expressed significant positive correlation with hardness (r=0.994, P<0.01) but negative correlation with magnesium (r=-0.536, P<0.05). Increased photosynthesis, consumption of CO_2, carbonates from bicarbonates is precipitated as calcium[16]. Magnesium values varied from 0.19 to 1.45 mg/L. The highest value of 1.45 mg/L was recorded in September 2019, February and September 2020 and the lowest value of 0.19 mg/L was recorded in July 2019 and August 2020. The average value of magnesium was 0.80 ± 0.09 mg/L. Magnesium was negatively correlated only with hardness (r=-0.535, P<0.05). Calcium values remained higher than magnesium throughout the study. In the present study total hardness as $CaCO_3$varied from 51.2 to 128.6 mg/L. The highest value (128.6 mg/L) was recorded in February 2021 and lowest (51.2 mg/L) was observed in August and December 2019. The average value was 93.24 ± 6.149 mg/L. Phosphate levels at Gopalswamy tank ranged from 0.008 to 0.024 mg/L with an average value of 0.016 ± 0.001 mg/L. The highest value of 0.024 mg/L was recorded during January 2021 and the lowest (0.008 mg/L) was in November 2019. In this water body Sulphates had an average value of 0.100 ± 0.004 mg/L and it ranged from 0.08 to 0.18 mg/L. The highest value (0.18 mg/L) was recorded in January 2020 and lowest (0.08 mg/L) in December, 2019. Sulphate showed negatively correlated with Copepoda (r=-0.491, P<0.05) (**Supplementary Table 2**). Nitrates varied from 0.34 to 4.11 mg/L with its highest value observed during

September 2019 and in the month of December 2020. Average nitrate value was 0.815 ± 0.188 mg/L. Excess nitrate leads to eutrophication[17].

The variation in the physico-chemical parameters of the water body depicts the status and allows us to know the remediation to be taken to conserve. The ionic variation observed during the study period notes the highest values during summer and lowest during rainy seasons. These ionic parameters that correlate are electric conductivity, total dissolved solids and salinity. The increase in calcium makes significant change in the hardness of water body.

3.2 Biotic factors

A total of 18 species of Zooplanktons from three groups were recorded during the study period in the water body of which Cladocera was leading with the highest number of nine species (50%) represented with five families having 26% of abundance with 545 individuals (**Supplementary Table 3 and 4**). Daphniidae was the major group with three species. Bosminidae, Sididae had two species each while Macrothricidae and Moinidae had 01 species each. *Diaphanosoma sarsi* was the most abundant species with 128 individuals. *Diaphanosoma* sp. thrives in eutrophic environment[18]. *Bosmina longirostris, Ceriodaphnia cornuta, Ceriodaphnia reticulata, Diaphanosoma sarsi, Diaphanosoma excisum and Simocephalus vetulus* are reported as eutrophic indicators[19,20]. Considering the diversity indices, Cladocera of Gopalswamy tank had the least Dominance_D (0.1567). Simpson_1-D (0.8433) and Shannon_H (1.999) indices secured the first position (**Supplementary Table 4**).

Copepoda was represented with five species (28%) belonging to two families and was the second species rich group in this water body. However, it was the leading group which had 47% of abundance with 993 individuals (**Supplementary Table 3 and 4**). Similar observations were made at Bommanahalli, Reservoir of Uttara Kannada where Copepoda was second highest species rich group with maximum abundance and highest number of individuals[11]. In this group Cyclopidae family comprised three species followed by Diaptomidae with two species. *Heliodiaptomus viduus* was the most abundant species with 265 individuals (**Supplementary Table 3**). Dominance_D (0.2285), Simpson_1-D (0.7715) and Shannon_H (1.521) of Copepoda stood second in diversity indices with other groups of zooplanktons at Gopalswamy tank (**Supplementary Table 4**).

During the study, four Rotifers (22%) belonging to three families showed 27% of abundance with 579 individuals (**Supplementary Table 3 and 4**). Family Brachionidae was represented with two species while Lecanidae and Testudinellidae had one species each. *Brachionus falcatus* was the most abundant species counting 404 individuals. Filter feeding, parthenogenetic reproduction and high fecundity makes the Rotifera group abundant[21]. Even though the number of individuals recorded was low, 07 months of the study period were species rich (**Supplementary Table 3**). All the Rotifers observed during the study period were eutrophic indicators[22]. Brachionus and Monostyla (Lecanidae) families are reported as higher trophic state indicators[21]. In diversity indices, Rotifers showed the highest value of Dominance_D (0.5401) and they were in third position in Simpson_1-D (0.4599) and Shannon_H (0.8357) indices (**Supplementary Table 4**).

The diversity indices of zooplankton exhibit a pattern demonstrating the reasons for variation in the biotic factors. The number of individuals observed during the study period shows the highest abundance for Copepoda but least abundance of Cladocera even though it has the highest species richness. The ecological factor (transparency) affects the occurrence of zooplankton (Cladocera). Rotifera stands second in abundance as the nutrient load furnishes favourable condition to flourish. The highest dominance of Rotifera is due to the frequent encounter of the same taxa. Simpson and Shannon diversity indices show the highest value for Cladocera as the number of taxa are high. Copepoda shows consistency in their occurrence and holds first place in evenness. Considering the conservation point of view, the abundance of Cladocera should increase which is possible only when the algal bloom reduces. The consistency, frequency and diversity of Copepoda show less predation. The abundance of Rotifera shows nutrient enrichment which is a sign of worsening the water body status.

4 Conclusion

The water body exhibits low transparency due to the algal bloom and it was more alkaline with an average pH value of 8.77 ± 0.17 and the highest pH value reached 10.1. The highest value of phosphate, sulphate and nitrate indicates the excess nutrient load in the water body. The algal bloom, alkalinity, nutrient load indicates the eutrophic condition of the water body; however the electric conductivity values are in permissible limit. The assessment of physico-chemical parameters showed unsuitability of water for potability. The zooplankton study showed that, though the water body has supported maximum number of species belonging to Cladocera, the highest abundance was recorded by Copepoda group. Distribution of Cladocera depends on the transparency hence diversity is high and abundance is low. Rotifera comprised the lowest taxa but had the highest dominance in distribution. Dominance is due to the favorable conditions of nutrient load. *Brachionus falcatus* was the most abundant Rotifera indicating higher trophic state of the water body in addition *Diaphanosoma sarsi* was the most abundant Cladoceran which also indicates the eutrophic aquatic environment. The water body harbors more than 50% of the indicator species giving

an anticipation of deterioration in the upcoming days, hence regular monitoring, assessment and remediation measures are needed to protect and conserve the historic water body.

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