

LIMNOLOGICAL STATUS OF SATIKUND POND AT HARDWAR (U.A.)

D.R. Khanna and Rakesh Bhutiani

Department of Zoology and Environmental Sciences

Gurukula Kangri Vishwavidyalaya, Hardwar-249404 (INDIA)

Corresponding author : Dr. D.R. Khanna, 405, Vivek Vihar, BHEL Road, Avs Vikas, Hardwar-249407

ABSTRACT

The limnological study of Satikund pond at Hardwar was made for a period of one year. For this study the water samples were collected from three different points in a pond once in each month and the results are presented for winter, summer and monsoon seasons. DO, pH, hardness, magnesium, and chloride were found maximum while free CO₂, BOD, potassium and calcium were found minimum in winter season. Total coliform organism (MPN) and SPC were found maximum in rainy season. MPN were found minimum in winter, while SPC were found minimum in summer season. Among phytoplankton concentration was dominated by the diatoms (*Gomphonema*, *Synedra*, *Diatoma*, *Melosira*, *Nitzschia*), while among zooplankton only three genera were recorded, with *Euglena* as the dominant species. A positive relationship between plankton and DO was observed while negative relationship was found between plankton and BOD.

INTRODUCTION

Ponds may be found in most regions of adequate rainfall. Since they contain a rich and varied life and illustrate principles of the pond ecosystem, these are very favourable sites for class study. The Satikund pond is situated at Kankhal in the district Hardwar of Uttaranchal, According to a old story, the Devi "SATI" daughter of Daksha Prajapati and wife of Lord Shiva, burnt herself at this place by the yogagni, because she could not tolerate the insult of her lord. The devotees of the goddess attach great sanctity to it.

Satikund pond is more or less square in shape with cemented bathing ghat at its western side. It is a 300 × 150 meter pond with a mean depth of around 1.75 m. It remains filled with water during whole year, but attaining maximum water during monsoon and minimum in winter. The effluent of some houses enters in to it. It contains a number of phytoplankton including diatoms, blue green algae, green algae etc. and many types of zooplankton. The water of this pond is used for drinking by cattle and for irrigation of land and garden.

MATERIAL AND METHODS

The ecological status of Satikund pond was studied during three seasons (winter, summer and monsoon). Samples were collected monthly during morning hours. The physico-chemical and biological parameters were determined as per standard methods¹⁻³.

RESULTS AND DISCUSSION

The various observations of water of Satikund pond are in table 1-7. The temperature is one of the most important factors in an aquatic environment. In the present study, the average water temperature was recorded as ($23.96 \pm 5.39^\circ\text{C}$). Temperature showed an inverse relationship with dissolved oxygen in all seasons, as also observed by others^{5,6}. Maximum dissolved oxygen was recorded in winter season (10.61 ± 0.31 ppm), which decreased in the summer and monsoon seasons due to increase in turbidity. Its minimum value was observed in monsoon season as also reported by Khanna *et al.*⁴ During summer and monsoon season high temperature results in decrease of pH as also reported by^{7,8}. Several workers⁹⁻¹¹ have also reported that free CO_2 influence the alkalinity and pH of water.

Table 1. Physico-chemical parameters of Sati kund pond during various season

| Parameters | | Winter | Summer | Monsoon | Average |
|--------------------|----------------------|--------------------|--------------------|-------------------|--------------------|
| Temperature | ($^\circ\text{C}$) | 16.70 ± 0.35 | 25.60 ± 0.71 | 29.60 ± 0.21 | 23.96 ± 5.39 |
| Transparency | (cm) | 72.00 ± 3.90 | 53.10 ± 2.31 | 25.30 ± 0.90 | 50.123 ± 19.18 |
| Turbidity | (N.T.U.) | 0.30 ± 0.80 | 3.60 ± 1.32 | 4.69 ± 0.15 | 2.86 ± 1.86 |
| Total solids | (mg/l) | 196.31 ± 13.41 | 275.11 ± 15.89 | 410.0 ± 21.11 | 292.14 ± 88.25 |
| Suspended solids | (mg/l) | 111.0 ± 7.61 | 75.00 ± 3.12 | 155.0 ± 9.00 | 113.66 ± 32.71 |
| pH | | 7.91 ± 0.13 | 8.10 ± 0.15 | 8.30 ± 0.00 | 8.10 ± 0.15 |
| Dissolved oxygen | (mg/l) | 10.61 ± 0.31 | 8.60 ± 0.32 | 7.95 ± 0.40 | 9.05 ± 1.13 |
| Total alkalinity | (mg/l) | 100.31 ± 5.91 | 76.00 ± 4.72 | 89.60 ± 4.80 | 88.63 ± 9.94 |
| Free CO_2 | (mg/l) | 3.81 ± 0.67 | 5.91 ± 0.95 | 7.20 ± 1.15 | 5.64 ± 1.39 |
| Hardness | (mg/l) | 93.60 ± 3.97 | 73.00 ± 4.15 | 81.09 ± 3.20 | 82.56 ± 8.45 |
| BOD | (mg/l) | 2.91 ± 0.30 | 3.91 ± 0.25 | 4.60 ± 0.41 | 3.80 ± 0.69 |
| Chloride | (mg/l) | 12.65 ± 0.59 | 7.93 ± 0.62 | 11.96 ± 0.43 | 10.84 ± 2.08 |
| Calcium | (mg/l) | 12.68 ± 0.86 | 17.93 ± 0.72 | 22.45 ± 1.12 | 17.68 ± 3.99 |
| Magnesium | (mg/l) | 2.75 ± 0.90 | 2.66 ± 0.70 | 2.50 ± 1.30 | 2.63 ± 0.09 |
| Sodium | (mg/l) | 3.81 ± 0.19 | 4.00 ± 0.26 | 2.97 ± 0.11 | 3.59 ± 0.43 |
| Potassium | (mg/l) | 2.31 ± 0.03 | 2.96 ± 0.30 | 4.92 ± 0.38 | 3.39 ± 1.10 |

\pm = Standard deviation

Table 2 : Microbiological Parameters of Satikund pond during various seasons.

| Parameters | Winter | Summer | Monsoon | Average |
|------------------|---------------------|---------------------|---------------------|----------------------|
| MPN/100 ml | 210.50 ± 1.23 | 297.00 ± 0.11 | 315.00 ± 0.00 | 274.16 ± 45.61 |
| SPC/100 ml | 22.14 ± 3.52 | 19.13 ± 6.45 | 23.62 ± 132.61 | 21.63 ± 1.86 |
| Phytoplankton/ml | 1470.00 ± 28.30 | 1790.00 ± 21.42 | 1640.00 ± 17.14 | 1633.33 ± 130.72 |
| Zooplankton/ml | 165.00 ± 40.14 | 195.00 ± 15.84 | 235.00 ± 22.18 | 198.33 ± 21.25 |

\pm = Standard deviation

Table 3 : Quantitative analysis of the plankton of Satikund pond during various seasons.

| Parameters | Winter | Summer | Monsoon | Average |
|----------------------|----------------|--------------|--------------|------------------|
| Total phytoplankton | 1470 ± 28.30 | 1790 ± 21.42 | 1640 ± 14.14 | 1633.33 ± 130.72 |
| Diatoms/ml | 575 ± 21.41 | 890 ± 37.16 | 815 ± 22.4 | 760 ± 134.35 |
| Green algae/ml | 495 ± 23.42 | 566 ± 29.34 | 545 ± 19.41 | 535.33 ± 29.78 |
| Blue green algae/ml | 400 ± 18.16 | 334 ± 22.42 | 280 ± 17.11 | 338 ± 49.07 |
| Total zooplankton/ml | 165 ± 40.14 | 195 ± 15.84 | 235 ± 22.18 | 198.33 ± 28.67 |
| Total Plankton/ml | 1635 ± 43.19 | 1985 ± 27.61 | 1875 ± 31.16 | 1831 ± 146.13 |
| | Percentage (%) | | | |
| Diatoms | 35.16 | 44.83 | 43.46 | 41.15 |
| Green algae | 30.27 | 28.51 | 29.06 | 29.28 |
| Blue green algae | 24.46 | 16.82 | 14.93 | 18.73 |
| Zooplankton | 10.09 | 9.82 | 12.53 | 10.81 |

± = Standard deviation

Table 4 : Status of Chlorophyceae (Green algae) in Satikund pond during various seasons.

| Genera | Winter | Summer | Monsoon | Average |
|-----------------------|----------------|----------------|----------------|----------------|
| <i>Ankistrodesmus</i> | 0.00 ± 0.00 | 135.00 ± 3.91 | 0.00 ± 0.00 | 45.00 ± 63.63 |
| <i>Clamydomonas</i> | 95.00 ± 2.31 | 102.00 ± 1.69 | 105.00 ± 2.11 | 100.66 ± 4.18 |
| <i>Clostridium</i> | 86.00 ± 4.91 | 92.00 ± 2.69 | 210.00 ± 6.13 | 129.33 ± 57.09 |
| <i>Cladophora</i> | 125.00 ± 7.63 | 0.00 ± 0.00 | 0.00 ± 0.00 | 41.66 ± 58.92 |
| <i>Cosmarium</i> | 97.00 ± 1.16 | 0.00 ± 0.00 | 0.00 ± 0.00 | 32.33 ± 45.72 |
| <i>Oedogonium</i> | 23.00 ± 0.75 | 111.000 ± 6.31 | 0.00 ± 0.00 | 44.66 ± 47.83 |
| <i>Spirogyra</i> | 0.00 ± 0.00 | 82.00 ± 2.19 | 195.00 ± 3.62 | 92.33 ± 79.94 |
| <i>Ulothrix</i> | 0.00 ± 0.00 | 23.00 ± 1.11 | 35.00 ± 1.16 | 19.33 ± 14.52 |
| <i>Zygnema</i> | 69.00 ± 2.76 | 21.00 ± 0.90 | 0.00 ± 0.00 | 30.00 ± 28.87 |
| GRAND TOTAL | 495.00 ± 23.42 | 566.00 ± 29.34 | 545.00 ± 19.14 | 535.30 ± 29.78 |

± = Standard deviation

Table 5 : Status of bacillaroiphyceae (diatoms) in Satikund pond during various seasons.

| Genera | Winter | Summer | Monsoon | Average |
|-------------------|----------------|----------------|----------------|-----------------|
| <i>Amphora</i> | 0.00 ± 0.00 | 182.00 ± 12.31 | 0.00 ± 0.00 | 60.66 ± 85.79 |
| <i>Cyclotella</i> | 77.00 ± 2.31 | 0.00 ± 0.00 | 0.00 ± 0.00 | 25.66 ± 36.29 |
| <i>Cymbella</i> | 0.00 ± 0.00 | 147.00 ± 9.19 | 0.00 ± 0.00 | 49.00 ± 69.29 |
| <i>Diatoma</i> | 89.00 ± 1.96 | 192.00 ± 11.32 | 135.00 ± 13.13 | 138.66 ± 42.12 |
| <i>Gomphonema</i> | 39.00 ± 0.81 | 172.00 ± 17.81 | 211.00 ± 22.16 | 140.66 ± 42.12 |
| <i>Melosira</i> | 96.00 ± 3.63 | 0.00 ± 0.00 | 205.00 ± 35.71 | 100.33 ± 83.74 |
| <i>Nitzschia</i> | 131.00 ± 9.87 | 0.00 ± 0.00 | 185.00 ± 19.19 | 105.33 ± 77.61 |
| <i>Navicula</i> | 79.00 ± 2.67 | 0.00 ± 0.00 | 0.00 ± 0.00 | 26.33 ± 37.24 |
| <i>Pinnularia</i> | 0.00 ± 0.00 | 88.00 ± 7.32 | 29.00 ± 3.23 | 39.00 ± 36.61 |
| <i>Synedra</i> | 64.00 ± 1.99 | 109.00 ± 7.89 | 50.00 ± 5.67 | 74.33 ± 25.17 |
| Grand Total | 575.00 ± 21.41 | 890.00 ± 37.16 | 815.00 ± 22.40 | 760.00 ± 134.35 |

± = Standard deviation

Table 6 : Status of cyanophyceae (Blue green algae) in Satikund pond during various seasons.

| Genera | Winter | Summer | Monsoon | Average |
|---------------------|----------------|----------------|----------------|----------------|
| <i>Anabena</i> | 39.00 ± 1.10 | 0.00 ± 0.00 | 0.00 ± .000 | 13.00 ± 18.38 |
| <i>Nodularia</i> | 0.00 ± 0.00 | 87.00 ± 3.92 | 0.00 ± .000 | 29.00 ± 41.01 |
| <i>Nostoc</i> | 83.00 ± 17.61 | 123.00 ± 16.73 | 0.00 ± .000 | 68.66 ± 50.60 |
| <i>Oscillatoria</i> | 123.00 ± 8.90 | 64.00 ± 8.80 | 109.00 ± 21.72 | 98.66 ± 25.17 |
| <i>Polycystis</i> | 75.00 ± 10.17 | 60.00 ± 6.65 | 95.00 ± 9.97 | 76.66 ± 14.33 |
| <i>Rivularia</i> | 57.00 ± 12.93 | 0.00 ± 0.00 | 76.00 ± 3.97 | 44.33 ± 32.29 |
| <i>Spirulina</i> | 23.00 ± 7.77 | 0.00 ± 0.00 | 0.00 ± 0.00 | 7.66 ± 10.84 |
| GRAND TOTAL | 400.00 ± 18.16 | 334.00 ± 22.42 | 280.00 ± 17.11 | 338.00 ± 49.07 |

± = Standard deviation

Table 7 : Status of zooplankton in Satikund pond during various seasons.

| Genera | Winter | Summer | Monsoon | Average |
|-----------------|----------------|----------------|----------------|----------------|
| <i>Amoeba</i> | 37.00 ± 3.62 | 0.000 ± 0.000 | 0.00 ± 0.000 | 12.33 ± 17.44 |
| <i>Euglena</i> | 82.00 ± 2.63 | 111.00 ± 4.50 | 235.00 ± 6.76 | 142.66 ± 66.35 |
| <i>Notholca</i> | 46.00 ± 1.95 | 84.00 ± 3.15 | 0.00 ± 0.00 | 43.33 ± 34.34 |
| Grand Total | 165.00 ± 40.14 | 195.00 ± 15.84 | 235.00 ± 22.18 | 198.33 ± 28.67 |

± = Standard deviation

The average value of transparency was 50.13 ± 19.18 cm, being maximum in winter and minimum in rainy season. The reduction in monsoon has been attributed to increase in turbidity. Similar pattern was reported in lake Suraha¹². The turbidity, total solids and total suspended solids were found maximum in monsoon and minimum in winter. The turbidity, total solids, total suspended solids were found closely interrelated with one another and cause common effect upon the pond and its aquatic life as also stated by Khanna³.

Maximum BOD (4.60 ± 0.41 ppm) was recorded in monsoon and minimum in winter. Higher BOD was due to higher biological activity at higher temperature while lower value indicates low biological activity at lower temperature¹³.

Calcium concentration was found more as compared to magnesium. The continuous increase of Ca-Mg concentrations in the pond results in hardening of water. Their addition is due to use of detergents and soaps. This pattern agrees with studies of the workers^{14,15}. Average value of alkalinity (88.63 ± 9.94 mg/l) was almost equal to hardness (82.56 ± 8.45 mg/l).

The average number of plankton observed during the course of study were $1831.66 \pm 146.13 \text{ ml}^{-1}$. Average of total phytoplankton were $1633.33 \pm 130.72 \text{ ml}^{-1}$ and that of zooplakton was $198.33 \pm 28.67 \text{ ml}^{-1}$. The results indicate that the number of plankton were affected due to temperature, content of total solids, transparency and turbidity of water. The findings were similar to lakes in Kashmir and

Nainital^{16,17}. In the present study bacillarophyceae was found to be dominating group as also reported by¹⁶. The average percentage of different groups were noted as Bacillarophyceae (41.15%) in summer, Chlorophyceae (29.28%) in winter and Cyanophyceae (18.73%) in monsoon (Fig. 1).

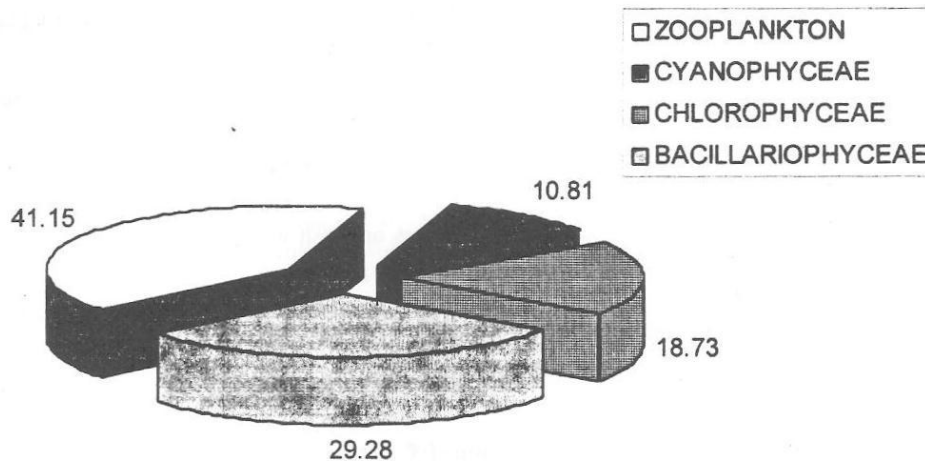


Fig. 1. Yearly percentage of plankton

The average count of bacteria and MPN were $274.16 \pm 45.61/100\text{ml}$ and $21.63 \pm 1.8/100\text{ml}$ respectively. These were found higher in monsoon, as also reported by Das and Upadhyay¹⁷. The high values of SPC and MPN index were also found directly related to organic pollution load. In addition to this, seasonal variations in temperature, turbidity, DO, free CO_2 and BOD were also responsible up to certain limit.

CONCLUSION

Considering higher load of coliform bacteria and SPC in Satikund pond, water is not fit for drinking purposes but it can be used for bathing and irrigation.

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