SUMMARY OF UGC-MINOR RESEARCH PROJECT 2014-2016

Principal Investigator: Dr. Sreeja Krishnan

Assistant Professor, Department of Botany, Sree Narayana College, Cherthala

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A STUDY ON THE SPECIES DIVERSITY OF THE ALGAL FLORA IN THE TEMPLE PONDS OF CHAVARA PANCHAYATH, KOLLAM DISTRICT, KERALA, INDIA

INTRODUCTION

Biological assessment is a useful alternative for assessing the ecological quality of aquatic ecosystems. The maintenance of a healthy aquatic ecosystem depends on the abiotic properties of water and the biological diversity of the ecosystem. Both lentic and lotic water bodies are inhabited by phytoplanktonic organisms. Algae, the principle primary producers, are photosynthetic thallophytes, usually microscopic, unicellular and colonial or multicellular organisms which perform the maximum quantum of photosynthetic activity than any living organisms in this world. Many forms spread throughout the water body and cause turbidity of water and algal blooms. Ponds are the part of the lentic systems which also include pools, puddles, reservoirs, lakes and paddy fields. The ponds may contain different types of phyco-components like planktons, benthos, epiphytic etc. The appearance of algae is most probably seasonal.

Water quality evaluation has attained wide recognition in recent years due to increasing destruction of the aquatic environment. Knowledge of the medium is essential for the scientific approach to the problem of pollution. Investigations on the hydrographical parameters along with pollution monitoring studies have been conducted in

various water bodies of many parts of the world. Ponds that have a high water quality possess properties that make it a high valued resource to society and nature. Commonly water quality is assessed through the use of many different parameters and methods ranging from simple test kits measuring parameters such as pH to much more complex electronic sensor platforms that can measure a wide variety of parameters. For each parameter, the quality of the water is generally reported with reference to a specific standard, to allow the quantitative measurement of that factor to be stated as a qualitative statement about the body of water. Often, standards are set by governing organizations such as the Environmental Protection Agency.

The objective of the work is to analyse the water quality status of the six temple ponds of Kollam District and to analyse the presence of algae in these ponds. Two of the temple ponds are in the industrial area of KMML. Large scale industrialization have caused concern regarding the pollution of ground water. KMML factory releases the effluents into the nearby areas, thereby posing serious threat to the water quality of this region. Therefore, the physico-chemical characterization of two temple pond water in the industrial area is the prime requisite to understand the extent of pollution in these ponds. And also to detect the diversity of algae by using Labovision KXR20 Research Microscope, Cmos Camera-3.0 pixels with Drivers & Image Capturing Softwares.

METHODOLOGY

The algal flora and water quality of Arackalkulam (Site 1) , Kottankulangara (Site 2) , Parimanam (Site 3), Payalakkavu (Site 4), Shivanada (Site 5), Subramanya Temple Ponds (Site 6) of Chavara Panchayath of Kollam District were studied. The algal flora were identified with Standard literature.

For the study of physico-chemical analysis, twenty parameters that are temperature, pH, free CO_2, total alkalinity, acidity, turbidity, electrical conductivity, total hardness, total dissolved solid, calcium, magnesium, chloride, sulphate, phosphate, fluoride, nitrate, iron, dissolved oxygen, BOD and COD were used. Algae preserved in 4% formalin were investigated under Trinocular Research Microscope Labovision KXR 20 with Image Analysing Software.

RESULTS AND DISCUSSION

I. ALGAL ANALYSIS

The distribution and diversity of algal taxa in the six temple ponds are as follows.

From Site 1, ten species of algae were collected : *Chlamydomonas globosa , Cladophora crispate, Bulbochaete keralense & Chara gymnopitys* from Class Chlorophyceae, *Tabellaria flocculosa, Navicula salinarum & Pinnularia gibba* from Class Bacillariophyceae, *Spirulina princeps* & *Scytonema stuposum* from Class Cyanophyceae

From Site 2, eight species were collected from this site: *Spirogyra bichromatophora, Spirogyra borgeana, Spirogyra marvillosa, Zygnema excrassum & Penium cucurbtinum* from Class Chlorophyceae, *Amphora delicatissima* from Class Bacillariophyceae, *Oscillatoria agardhii & Oscillatoria amoena* from Class Cyanophyceae.

From Site 3, five species of algae were identified from Class Chlorophyceae: Characium pringsheimii, *Scenedesmus acuminatus, Microspora irregularis, Oedogonium echinospermum & Cosmarium blyttii* and From Site 4, single species of algae *Scenedesmus acuminatus* from Class Chlorophyceae was identified.

From Site 5, two algal species were collected- *Nacvicula cari & Pinnularia conica* from Class Bacillariophyceae.

From Site 6, two species of algae one from Class Bacillariophyceae- *Staurastrum crenulatum* and one from Class Cyanophyceae- *Aphanocapsa pulchra* were identified.

A total of 28 algal species were identified from the study sites. The Chlorophycean algal species were seen predominant in all the six ponds followed by Class Bacillariophyceae and Class Cyanophyceae. The presence of more diatoms and blue-green algal forms indicate pollution.

II. PHYSICO-CHEMICAL CHARACTERIZATION OF WATER

Water quality study is essential for setting base line conditions and standards. Against these standard, results of further studies can be evaluated. A total of twenty different physico-chemical parameters were analysed. The physico-chemical parameters of water studied were water temperature (°C), pH, free CO_2 (mg/l), total alkalinity (mg/l), acidity (mg/l), turbidity (NTU), electrical coductivity (µs/cm), total hardness (mg/l), total dissolved solid (mg/l), calcium (mg/l), magnesium (mg/l), chloride (mg/l), sulphate (mg/l), phosphate (mg/l), flouride (mg/l), nitrate (mg/l), iron (mg/l), DO (mg/l), BOD (mg/l) and COD (mg/l).

There are so many factors which influence the water quality. Altitude also play a significant role in governing the thermal regions of the water bodies. It has been seen that with the increase in the altitude there was a corresponding decline in the water as well as the air temperatures, which in turn control the biological activity of these water bodies.

Water temperature is one of the most important factors in aquatic environment (Singh et al., 2005). The surface water temperature was always a little lower than atmospheric temperature. The water temperature is between 30°C-34°C. According to Zajic (1971) water with temperature above 30°C is unfit for public use. The rise in temperature of the water leads to an increased rate of the chemical reaction.

pH is a common index of water body. pH express the intensity of acidity and alkalinity. Welch (1952) is of the opinion that pH plays an important roles in aquatic life, especially when some other factors are in unfavourable range. The values range between 2-5. The sites are highly acidic in nature.

Free CO_2 appears to be an important component of the buffering systems of water bodies. Free CO_2 in the sites range between 42mg/l to 63mg/l. Higher concentration of free CO_2 in the samples can be attributed to the presence of decomposable organic matter in the bottom as suggested by Unni (1972). CO_2 diffuses mostly into water from atmosphere resulting in carbonic acid, which affects the pH of water. The high saturation levels of oxygen and CO_2 have been found to have toxic effects on aquatic biota.

Total alkalinity is a measure of the concentration of bases. TA may be due to the presence of carbonate, bicarbonate and hydroxide in natural waters (Jain & Sharma, 1997). The value of alkalinity range between below the detectable level to 132 mg/l. The value of Site 3 exceeded the higher desirable limit given by WHO (1992). In Site 2 sample, which shows the least concentration of alkalinity. According to Nayak *et al*., (1982) and Ghosh and George (1989), the higher alkalinity indicates pollution. High alkalinity is commonly observed during summer due to decomposition of organic matter in water body.

Acidity means the acid content of water. Acidic range was between 22.0mg/l to 180mg/l. Comparably Site 2 sample shows the high content of acid.

Turbidity in the open water zone is commonly caused by organic matter. The value range between 3.42NTU-4.68NTU. The desirable limit of turbidity become 5.0. Comparably the present records were very low. This may be due to the settlement of silt, clay and heavy suspended particles.

Electrical conductivity is a measure of how well solution conducts electricity and is correlated with salt content. Higher value of conductivity shows higher concentration of dissolved ions. The electrical conductivity was between 211µs/cm and 482µs/cm.

Total Hardness of water is not a pollution parameter but indicates water quality mainly in terms of Ca^{2+} and Mg^{2+} expressed as $CaCO_3$ (De, A.K, 2006). Hardness of water reflects the higher concentration of many cations. Total Hardness range between 134mg/l and 266mg/l. Hardness levels, above 500mg/l are generally considered to be unacceptable (WHO, 1992). The recorded values were less than this limit. Water hardness upto 60mg/l is considered as soft water, and from 61-120mg/l is considered as moderately hard water, from 121-180mg/l as hard water and above 180mg/l as very hard water (Kannan, 1991).

Total Dissolved Solids include inorganic matters and can affect various uses of water resources. In the present records, the value range between 115mg/l and 355mg/l. TDS values in the range of 150-250mg/l make the water unfit for any use (Ranu *et al*., 1991).

Calcium level was between 43.28mg/l and 101.80mg/l. According to Ohle (1955) any value above 25mg/l indicates calcium rich water. As per this definition the water in the ponds were rich in calcium.

Magnesium level was between 22.04mg/l and 39.09mg/l. The desirable limit of magnesium was 30mg/l. In this record, Site 2 sample shows high content of magnesium. High values of magnesium suggest a close affinities between magnesium concentration and inorganic pollution. Zafar (1964,1966) and Munawar (1970) have also found a direct correlation between these two parameters.

Chloride is a highly reactive compound and is used as a disinfectant. Chloride is not generally harmful to human beings, but high chloride is considered as unsafe. In the Site 1 sample, chloride content was 30.0mg/l and Site 6 sample was 520mg/l. According to WHO (1992) the limit for chloride is 250mg/l. In the six samples, Site 6 sample was much higher

in chloride content. Gopal and Durve (1989) observed that high chloride content of water with an annual average of 83.7mg/l is an indication of organic pollution. Site 6 sample indicates organic pollution.

Sulphate is a naturally occurring anion in all kinds of waters. In the present study, the sulphate content in Site 1 sample was 0.34mg/l and Site 4 sample was 0.813mg/l. The range of sulphate content in two sample are too low based on the desirable limit. High sulphate value might due to low water level during summer, supported by Agarkar and Garode (2000).

Phosphate is one of the vital constituent to monitor the plankton growth. Higher concentration of phosphate indicates the pollution. The phosphate content in Site 1 sample was 0.2mg/l and Site 5 sample was 0.113mg/l. The permissible limit is 0.1mg/l. It shows that both samples are polluted. But phosphate concentration above 0.5mg/l indicates pollution (Jain *et al*., 1996). Higher value may be due to the presence of detergents in sewage waste dumped in the pond. Of the elements present in living organisms, ecologically phosphorous is quite important, because the ratio of phosphorous to other elements in organisms tends to be considerably greater than the ratio in the primary sources of the biological elements.

Fluoride was below the detectable level in both samples. This shows that fluoride content was too low in the present study.

Nitrate content in Site 1 sample was 0.303mg/l and Site 3 sample was 0.127mg/l. The values are lower than 1.0mg/l, the permissible limit.

Iron is considered an essential heavy metal. The permissible level of iron is 1.0mg/l. Iron content in the Site 1 sample was below the detectable level and Site 6 sample was 2.63mg/l.

Dissolved oxygen is an important water quality parameter. Oxygen content of a fresh water body is depleted in numerous ways. DO is an index of physical and biological process going on in the water, the presence of oxygen demanding pollutants like organic wastes causes rapid depletion of DO from water(Jameel, 1998). DO level range between1.23mg/l to 3.5mg/l. DO level was much lower than the desirable limit. Its depletion is the most critical manifestation of pollution (Shaji *et al*., 2010).

BOD determination is a most useful technique to use the level of organic pollution in water. In unpolluted waters BOD is lower while it is higher in the case of polluted ones (Hynes, 1971). Presence of decomposable organic wastes and the organic pollutants cause a BOD raise in proportion to volume of organic materials in waters (Gupta and Sharma, 2002). The permissible limit of BOD is 5mg/l (WHO, 1992). In the present study, BOD level in Site 1 sample was 3.9mg/l and Site 6 sample become 20.26mg/l. The water from the Site 6 sample have BOD values much higher than the permissible limit. Higher values indicate that untreated organic wastes are being leached out to the ground water as observed by Adeleye and Adeleye (2003).

COD is the total measurement of all chemicals in the water. This test is commonly used to indirectly measure the amount of organic compounds in water. The permissible limit of COD is 10mg/l (WHO, 1992). In the present study, COD level in Site 1 sample was 6.3mg/l and Site 6 sample become 22.6mg/l. The water from the Site 2 sample have higher value than permissible limit. Higher value of COD indicates the presence of oxidizable organic matter (Garg, 1998; Chandrashekar *et al*., 2003).

From this study it is found that Site I & II were less polluted, as there was no interference of industrial effluents in these areas. The algal taxa were seen limited in range and members from Class Chlorophyceae were found dominant along with members from Class

Bacillariophyceae and Cyanophyceae. The water from this area can be used for domestic purpose.

The water quality parameters of Site III showed extreme values but still Class Chlorophycean members were the only representatives.

The Site IV water was found to be mestrophic with single species of algae which is a Chlorophycean member.

The Site V showed moderate values in water quality parameters but Site VI was highly polluted due to the interference of untreated industrial effluents. The water quality parameters showed that water in this area is highly polluted with members from Class Bacillariophyceae and Cyanophyceae. Chlorophyceaen members were totally absent. There is representatives from Class Bacillariophyceae only in Site V and the algal taxa was also limited in range.

The study on the algal and water quality parameters showed that the ecology of the Sites I, II, IV & V was mesotrophic and that of Site III & VI was eutrophic and is leading towards more pollution.

These data showed that the temple ponds of Chavara Panchayat of Kollam District near to the industrial area of KMML was highly polluted than any other area. The progress of the country since independence has been phenomenal but rapid industrialization has also brought with the problem of environmental pollution. Today almost everything around us viz. the air we breathe, the water we drink and even the soil we grow our food on, are heavily polluted.

The Kerala Minerals and Metals Ltd. (KMML) is an industrial complex is situated at Sankaramangalam, Chavara in Kollam District. KMML is a public sector unit which is polluting water sources, degrading the environment and posing a public health hazard. KMML is located at 8°59698'N latitude and 70°31917'E longitude. The area extend of

KMML is about 210 acres. The plant manufacturing Titanium dioxide was responsible for the deterioration in the quality of ground water sources. The pollution had badly affected the flora and fauna in and around the factory area. On one hand, the industry is strengthening the economy of our nation, on the other hand the industry is discharging gaseous, liquid and solid wastes in air, water and soil and thus polluting local and nearby environment. Although there is a proper effluent discharging system, a part of the waste water is being discharged into the road side canal without any treatment, posing serious threat to the water quality of this region. The study revealed that pollution from KMML has also affected the water of Site III & VI.

CONCLUSION

From this study on the algal and physico-chemical parameters of the six temple ponds of Chavara Panchayat, Kollam District, Kerala it can be assessed that four among these temple ponds are mesotrophic and two are leading towards eutrophication which is Parimanam Temple Pond and Subramanya Swami Temple Pond because of the discharge of effluents from the industrial area. Hence measures should be taken to minimize pollution and to conserve biodiversity.

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