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ENUMERATION OF PHYTOPLANKTON WITH RESPECT TO PHYSICO–CHEMICAL PARAMETERS IN A NATURAL SPRING POND AT KALKULAM TALUK, KANYAKUMARI DISTRICT, TAMILNADU, INDIA

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Abstract

The selected perennial water body for the present investigation is a spring pond located in Thickanamcode, at Kalkulam Taluk, Kanyakumari District. The physico-chemical characteristics, phytoplankton diversity, primary productivity and trophic status have been studied from October, 2010 to March, 2011. The nutrient status of the ponds are characterized as acidic pH, low level of calcium, magnesium, potassium and sodium salts, considerably high levels of chlorides and bicarbonates, absence of carbonate and sulphate and higher dissolved oxygen content. Higher species diversity, high level of dissolved oxygen and moderate chemical constituents indicated that this fresh water aquatic ecosystem is oligotrophic to oligo-mesotrophic status.

Key words : Phytoplankton, spring pond, species diversity.

Introduction

Phytoplankton are representing the microscopic algal communities in aquatic biota. The planktonic study is very useful tool for the assessment of water quality. The diversity of an aquatic system refers to the richness of biological variations in terms of the number of species found there in. The occurrence of algae in aquatic ecosystem cannot be considered alone, but in relation to the prevailing environmental conditions particularly physico-chemical parameters (Chattopadyay and Banerjee, 2007).

Algae are very sensitive to many of the land derived substances both organic and inorganic. They serve as an important ecological component of aquatic ecosystems and have been reported to be good indicator of quality (Cascallair *et al.*, 2002). In course of development, lentic water bodies pass from an oligotrophic to eutrophic status due to the changes of various biotic and abiotic components time to time (Danielkutty and Sobha, 2006).

Spring ponds are nature's gift, their occurrence make the surroundings flourish and these are rare in Kanyakumari District. The systematic study in such ponds are meager. Taking this into consideration, a perennial spring pond in Thickanamcode village of Kalkulam Taluk has been selected for this study.

Materials and Methods

The investigation was carried out in a natural spring pond named Konkankuzhi, for a period of six months from October, 2010 to March, 2011. Water samples were collected monthly from different sites. About 5 litres of water was filtered through the plankton net (mesh size 40 micron) to yield 50 ml of sample. The concentrates were preserved with 4% formalin. Subsequently the samples were identified under the microscope for the enumeration of phytoplankton. The organisms were identified using monographs and manuals of Fritsch (1977), Anand (1998) and Perumal and Anand (2009). Physico–chemical parameters like temperature, pH, EC, carbonate, bicarbonate, chloride, sulphate, calcium, magnesium, sodium, potassium, dissolved oxygen, BOD and COD were analyzed as per the standard methods (Trivedi and Goel, 1984; APHA, 1998).

The diversity index of the phytoplankton was calculated by Shannon-Wiener's diversity index $\left(\overline{H}\right)$ method (Shannon and Wiener, 1963). Dominance index (SI) was calculated using Simpson's dominance index (Simpson, 1949).

Table 1 : Seasonal variation of the physico-chemical parameters (Oct. 2010 – Mar. 2011).

No.	Parameters	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
1.	Atmosphere temperature (°C)	28°C	26°C	28°C	26°C	29°C	28°C
2.	Water temperature (°C)	24°C	25°C	26°C	25°C	27°C	27°C
3.	EC (ds/m)	0.12	0.12	0.112	0.16	0.138	0.091
4.	pH	5.76	6.02	6.12	5.7	6.36	5.9
5.	Carbonate (ppm)	Nil	Nil	Nil	Nil	Nil	Nil
6.	Bicarbonate (ppm)	24.40	24.40	30.50	18.30	48.81	30.50
7.	Chloride (ppm)	28.36	21.27	35.45	35.45	53.17	21.27
8.	Sulphate (ppm)	Nil	Nil	Nil	Nil	Nil	Nil
9.	Calcium (ppm)	12.02	10.01	8.01	6.01	6.01	10.01
10.	Magnesium (ppm)	1.21	1.21	8.01	6.07	8.50	1.21
11.	Sodium (ppm)	9.42	8.96	7.88	8.92	11.97	6.82
12.	Potassium (ppm)	1.95	31.27	4.02	1.17	1.95	2.34
13.	Dissolved oxygen (mg/*l*)	9.0	10.6	8.6	9.8	3.0	3.8
14.	BOD (mg/*l*)	5.3	3.2	4.8	6.5	7.2	12.0
15.	COD (mg/*l*)	20.8	23.8	18.7	45.6	47.2	46.4

Table 2 : Seasonal variation of biological parameters (Oct. 2010 – Mar. 2011).

Biological parameters		Period of study (Oct. 2010 – Mar. 2011)					
		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Phytoplankton (Number of cells/l)	Chlorophyceae	8600	11800	12400	4800	24400	8600
	Bacillariophyceae	6800	8400	4600	15800	3200	3000
	Cyanophyceae	4400	3200	7400	5000	2400	400
	Chrysophyceae	Nil	Nil	1200	800	400	400
	Total	19800	23200	25600	26400	30400	12400
Primary productivity ($gC/m^3/day$)	Gross primary productivity	2.7	3.6	3.3	3.6	5.7	2.7
	Net primary productivity	2.7	0.9	1.5	1.2	1.2	1.2
	Respiration	1.0	1.8	1.2	1.6	0.6	1.0

Results and Discussion

The physico–chemical parameters analyzed were reported in table 1. The atmospheric temperature varied from 26°C during rainy day to maximum 29°C during hot sunny day and water temperature ranged from 24°C to 27°C. Variation of water and atmospheric temperature were marked. There is a very close similarity between the atmosphere and water temperature due to shallow depth of the pond and also the small amount of macrophytic vegetation, which follows the same pattern as observed for natural ponds (Saad, 1973 and Misra *et al*., 1975). pH remained acidic to neutral range throughout the study period. The pH is an important variable in the assessment water quality within the aquatic ecosystem. The EC values of the study area varied from 0.091 ds/m to 0.16 ds/m.

The bicarbonate values ranged from 18.30 ppm to 48.81 ppm and showed wide range of fluctuation. The change in bicarbonate level influenced the pH. The chloride values varied from 21.27 ppm to 53.17 ppm. Highest level of chloride concentration was observed during the month of February 2011, when the pond has very low level of water. A similar increase was reported by Jayakumar and Karpagam (2005). They also stated that the high chloride concentration of the pond water may be due to high rate of evaporation or due to organic waste of animal origin.

Table 3 : Enumeration of phytoplankton (Oct. 2010- Mar. 2011).

Class	Phytoplankton	Period of study					
		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Chlorophyceae	*Botryococcus sudeticus* Lemm.	-	-	+	+	+	-
	Bulbochaete pygmaea Pringsheim	-	+	+	-	+	-
	Chlorella vulgaris Beyerinck	+	-	+	+	-	-
	Chlorococcum humicola (Naegeli) Rabenhorst.	-	+	+	-	+	-
	Closterium acutum (Lymb.) Brebissi	+	-	-	-	-	-
	Closterium decorum Breb	+	+	-	-	-	-
	Closterium leibleinii Ralfs ex Kutz.	-	+	+	+	-	-
	Cosmarium hammeri Nordst.	-	-	+	+	+	+
	Cosmarium botrytis Menegh	-	-	+	+	+	-
	Cosmarium munitum J.Rzicka	-	+	+	+	+	-
	Cosmarium nitidulum Dc Not	+	+	+	-	-	-
	Cosmarium obsoletum Reinsch	-	+	+	+	+	+
	Cosmarium portianum W.Archer	+	+	+	+	-	-
	Dactylococcus infusionum Nageli	+	-	+	+	+	+
	Desmidium swartzii Raif	+	+	+	+	+	-
	Dimorphococcus lunatus A. Braun	-	-	-	-	-	-
	Euastrum inermius (Nordst) Turner	+	+	+	+	+	+
	Mesotaenium macrococcum Kutzing	-	+	+	+	+	+
	Micrasterias pinnatifida (Kutzing) Ralfs	-	-	-	+	+	-
	Microspora foliacea Bailey	-	+	-	+	-	-
	Microspora sp.	-	+	+	+	-	-
	Microspora loefgrenii (Nordst) Lagerhei	-	-	-	+	+	+
	Oedogonium giganteum kutzing	-	-	+	-	+	-
	Pandorina morum (Muller) Bory	-	-	-	-	-	+
	Pleurotaenium trabecula (Ehrenberg) Nageli	-	+	+	-	+	-
	Scenedesmus acutus Meyen	-	-	-	-	+	-
	Scenedesmus armatus (Chod) G.M. Smith.	-	-	-	-	+	-
	Staurastrum bieneanum Reben horst	+	+	+	+	+	+
	Staurastrum gemmulatus Turner	+	+	+	+	-	-
	Staurastrum gracile Ralfs	-	+	+	+	+	-
	Stigeoclonium subsecundum Kutz.	-	-	-	-	+	-
	Spirogyra elliptica Jao.	+	-	-	-	+	+
	Spirogyra gratiana Transeau	-	+	-	+	+	-
	Spirogyra weberi Kutz	-	-	+	+	+	+
	Ulothrix subconstricta G.S. West.	+	+	+	+	+	+
Bacillariophyceae	*Acanthes inflata* (Kutz) Grun.	-	+	-	+	+	-
	Amphora coffeaeformis (Ag.)Kutz	-	-	+	-	+	-
	Amphora veneta Kutz.	+	-	+	-	-	-
	Anomoneis sphaerophora E.Pfitzer	-	-	-	+	-	+
	Coloneis bacillum Grunow Cleve	-	-	-	-	-	-
	Coloneis undulate Krammer	+	+	+	+	+	+

Table 3 continued....

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	Cymbella cymbiformis Ag.	-	-	-	+	+	+
	Cymbella turgida Cleve	-	-	+	+	-	-
	Fragilaria pinnata Ehrenberg	+	-	+	+	+	-
	Fragilaria intermedia Grun	+	+	+	+	+	+
	Fragiliaria vaucheriae Kutz	+	+	+	+	+	+
	Fragiliaria virescence Ralfs	-	-	+	+	+	+
	Gomphonema acminatum Ehr	-	-	+	+	-	-
	Gomphonema spaerophorum Ehr	-	+	+	-	+	-
	Melosira granulata (Ehr) Ralfs	+	-	+	+	-	-
	Navicula cincta (Ehr) Kutz	+	-	+	-	-	-
	Navicula cryptocepha Kutz.	+	-	-	-	-	-
	Navicula protracta Grun.	-	+	-	+	+	-
	Navicula rhynocephala Kutz.	-	-	-	-	-	-
	Navicula salinarum Grun.	+	+	+	+	+	+
	Nitzchia obtuse W.Smith	+	-	+	-	-	-
	Nitzchia palae (Kutzing) W.Smith	+	-	-	-	-	+
	Pleurosigma angulatum W.Smith	-	+	-	-	+	-
	Pinnularia intermedia Lagerstedt	-	+	-	+	+	-
	Pinnularia stomatophora (Gneow) Cleve	+	+	+	+	+	+
	Stauroneis anceps Ehr.	+	-	+	-	-	-
	Surirella elegans Kutz	-	+	+	-	-	-
	Synedra tabulate Ehr	+	-	-	+	-	-
	Tabellaria flocculosa (Roth.) Kutz.	-	-	-	-	+	+
Cyanophyceae	*Anabaena consticta* Geitler.	-	+	+	-	-	-
	Aphanocapsa delicatissima West.	-	-	+	+	-	-
	Aphanocapsa grevillei (Hass.) Rabenhorst.	+	-	+	+	-	-
	Arthrospira massartii Kuffareth	-	-	-	-	-	+
	Chroococcus punctata Nag.	-	+	-	-	-	-
	Chroococcus minor (Kutz.) Nageli	-	+	-	-	-	-
	Chroococcus turgidius (Kutz.) Nag	-	+	+	-	-	-
	Gloeocapsa gigas W&GS West.	-	+	+	-	-	+
	Lyngbya cryptovaginata Schkorbatov	+	-	-	-	-	-
	Merismopedia punctata Meyen.	-	+	-	+	-	-
	Oscillatoria calcuttensis Biswas.	+	+	+	+	+	+
	Oscillatoria obscura Biswas.	+	+	+	+	+	+
	Oscillatoria perornata Skuja	-	+	+	-	-	-
	Synechocystis aquatilis Sauvageau	-	-	-	+	+	+
Chrysophyceae	*Dinobryon sertularia* Ehr.	-	-	+	+	-	-
	Dinobryon divergens Ehr.	-	-	+	+	+	+

(+ Present, - absent)

Table 4 : Species diversity index and dominance index (Oct. 2010- Mar. 2011).

Month	$\overline{H}$	SI
Oct.	1.26	0.45
Nov.	1.85	0.32
Dec.	1.94	0.4
Jan.	2.13	0.24
Feb.	2.84	0.2
Mar.	1.35	0.55

The level of calcium varied from 6.01 ppm to 12.02 ppm. Calcium values gradually decreased from October, 2010 to February, 2011 and a slight increase was recorded in March, 2011. Magnesium ranged from 1.21 ppm to 8.50 ppm. Sodium varied from 6.82 ppm to 11.97 ppm. Maximum amount of sodium was reported during the month of February, 2011. Highest level of potassium (31.27 ppm) was reported during the month of November, 2010. Similar variations were reported in fresh water bodies by Venkatasubramani *et al*. (2005).

The highest level of oxygen 10.6 mg/l was reported during the month of November, 2010. High value of dissolved oxygen in monsoon may be due to impact of rainwater resulting in aeration, while low value may be due to decomposition and restricted flow of water from the spring during summer months (Latha and Mohan, 2010). The level of BOD varied from 3.2 to 12 mg/l. The BOD values were higher during the summer months as reported by Sanap *et al*. (2006). The level of COD varied from 18.7 mg/l to 47.2 mg/l. The estimated chemical oxygen demand values showed fluctuations throughout the study period.

The gross primary productivity values ranged from 2.7 gC/m^3/day to 5.7g C/m^3/day (table 2). The net primary productivity values ranged from 0.9 to 2.7g C/m^3/day. The primary productivity of the tropical aquatic system is area dependent (Gopalakrishnan *et al.*, 1991).

Phytoplankton enumeration studies in the experimental pond showed diversified members belonging to four major classes namely Cyanophyceae, Chlorophyceae, Bacillariophyceae and Chrysophyceae. Chlorophyceae members were recorded in highest number. Seasonal variation in the density of Chlorophyceae showed that it was in a peak during the month of February, 2011. This is in concordance with the reports of Tiwari *et al.* (2001) and Sanap *et al.* (2006). Bacillariophyceae members were abundant in the month of January, 2011. The Cyanophyceae showed a gradual increase in quantity with highest number during the month of December, 2010. Chrysophyceae members were reported in most of the observations.

The class Chlorophyceae was represented by different species. The members *Staurastrum bieneanum*, *Euastrum inermius*, *Closterium decorum*, *Cosmarium botrytis*, *Dactylococcus infusionum*, *Plerotaenium trabecula*, *Ulothrix subconstricta* were found throughout the study period. Most of these are clean water algae indicated the lesser pollution of this pond. The members of Bacillariophyceae such as *Caloneis undulate*, *Fragilaria intermedia*, *Fragilaria vaucheriae*, *Navicula salinarum*, *Pinnularia stomatophora* were investigated in all the observations. The Cyanophyceae members *Oscillatoria obscura* and *O. calcuttensis*, were reported in all the observations. Chrysophyceae members *Dinobryon sertularia* and *Dinobryon divergens* were also recorded (table 3). The periodic collection of the desmid species has clearly indicated that most of the species flourished well during the early summer months (Vidyavati, 2007).

Shannon Wiener index value ranged from 1.26 to 2.84. Species diversity index was higher in February, 2011 (table 4). The rich species diversity is supported by a clear environment (Kavitha and Balasingh, 2007). The total number of species in a community is an index of species richness. The dominance index value varied from 0.2 to 0.55. Higher the dominance index value lower the species diversity. This is in accordance with the findings of Sivakumar and Senthilkumar (2007) in perennial ponds.

It is evident that this pond is rich in diversity. A well balanced phytoplankton community that enjoys an even representation of several species indicating the dynamic nature of this aquatic ecosystem. Higher production may be due to high species diversity, which ultimately resulted in high rate of photosynthesis.

Conclusion

Investigations regarding the enumeration of phytoplankton species diversity and physico-chemical parameters indicated that this pond is in oligotrophic to oligo-mesotrophic status. Conservation of such natural spring pond will help in the ground water recharging, agricultural development and maintenance of wetland ecosystems, which in turn improves the economical status of the society.

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