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Original Research Paper

Hydrochemistry and Seasonal Fluctuation of Plankton in Arasankulam Pond at Veppampattu in Thiruvallur District of Tamil Nadu, India

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ABSTRACT

The present paper deals with the study of physico-chemical parameters along with plankton diversity in Arasankulam pond situated at Veppampattu in Thiruvallur district of Tamil Nadu. The fluctuations in physico-chemical characteristics were noted during the study period from January to December 2009. The results show that the zooplankton diversity was lesser as compared to phytoplankton. The plankton community showed seasonal fluctuations. The phytoplankton community was consisting of members of Bacillariophyceae, Chlorophyceae, Cyanophyceae and Euglenophyceae. The zooplankton community was represented by Cladocerans, Copepods, Ostracods and Rotifers. The ecological significance of the plankton diversity and the seasonal variation have been discussed in light of the available literature.

INTRODUCTION

In recent times there has developed an increasing awareness on the value of knowledge of freshwater bodies. Freshwater ponds appear to be ideal models of biotope for studies on microecology and microcosms (Ganapathy 1980). Manmade lakes and ponds or impounded water body are peculiar biotopes requiring intensive detailed investigations. Most of the reports on pond ecosystems include the work of Munawar (1970), Saha & Pandit (1986), Rajendran Nair (2000) and Sedamkar & Angadi (2003).

The biodiversity of phytoplankton and zooplankton in water bodies shows a correlation with reference to their occurrences and the physico-chemical characteristics. The phytoplankton serve as producers in food chain in aquatic ecosystems and the productivity of pond depends upon the quality of water. The zooplankton depend upon the availability of phytoplankton and form the second trophic level in aquatic food chains. The phytoplankton and zooplankton provide food for fishes and therefore play an important role in fisheries. At several places there is scarcity of freshwater. Any kind of pollution of water will further enhance difficulty in procuring it naturally. Thus, there is an urgent need to generate information about water quality and plankton diversity, which form the basis of aquatic production. In the present investigation, focus has been laid on the study of water quality in terms of physico-chemical characteristics and plankton diversity of the Arasankulam pond, situated at Veppampattu in Thiruvallur district of Tamil Nadu.

MATERIALS AND METHODS

Study area: Arasankulam pond is located at Veppampattu nearly 15 km away from Chennai city, which stretches between latitude 13°07'30" N and longitude 80°01'05" E. No study has been done till date on this pond. Therefore, the present work was undertaken for an extensive survey of phytoplankton and zooplankton diversity in relation to physico-chemical factors. The collected water samples were analysed for various physico-chemical parameters by following the standard methods of APHA (1989). The density of population of phytoplankton groups was estimated fortnightly (monthly average mean was taken), followed by the methods of Rao (1955). Further, the algae were isolated from these water samples and identified with help of monographs.

Zoo planktons were collected using a conical net with a mesh size of 120 µm approximately. The samples were preserved with 4% formalin. The species were identified with the help of identification keys (Sehgal 1983, APHA 1989). The quantitative estimation was carried out by Sedgwick Rafter cell method.

RESULTS AND DISCUSSION

Physico-chemical environment has profound influence on biotic components in aquatic ecosystems. It controls biodiversity, biomass and distribution of biotic communities. The physical and chemical parameters exert their influence both individually and collectively and their interactions produce a biotic environment which ultimately conditions

the origin, development and finally succession of biotic communities.

The analysis of physico-chemical characteristics (Table 1) reveal that the water and atmospheric temperature ranged from 24-32°C and 29-36°C, whereas the turbidity varied from 0.6-10.58 NTU. pH values showed a variation from 7.2-8.5. The total alkalinity ranged from 92-126 mg/L. As the pond water is alkaline, hence favourable for the growth of the fishes.

Dissolved oxygen (DO) is another vital parameter regulating survival of aquatic life. It was found to be maximum in the month of January 2009 i.e., 7.8 mg/L, and minimum in March 2009, as 3.5 mg/L. It shows inverse relation with the water temperature. The maximum chloride concentration was recorded to be 55 mg/L in May, while the minimum of 32 mg/L during January 2009. Total hardness ranged between 96 mg/L and 138 mg/L, which is within the permissible limit of drinking water standard (BIS 1991). As the pond water is not hard, it can be used for all domestic purposes.

The nutrient contents like nitrate, phosphate, nitrite and silicate showed variation from 0.26 to 5 mg/L, 0.36 to 0.95 mg/L, 0.003 to 0.14 mg/L and 19.32 to 55.74 mg/L respectively. Iron ranged from 0.02 to 0.29 ppm, and did not exceed the permissible limit. There was absence of manganese in the water samples throughout the period of study.

It is generally believed that temperature is one of the important factors in aquatic ecosystems. Chako & Krishnamoorthy (1954) could not establish any correlation between water temperature and plankton variation. In the present study the total alkalinity increased in summer and decreased in monsoon period. This supports the observations of Munawar (1970), Saha & Pandit (1986) and Rajendra Nair (2000) that the accumulation of bicarbonate in summer is due to increased rate of decomposition. They have discussed the interrelationship among pH, carbon dioxide, alkalinity, calcium, carbonate and bicarbonate. This work confirms that the similar generalization is true for the Arasankulam pond under present study.

Hardness was found to be maximum in summer, and minimum in monsoon (Rajendran Nair 2000) and dissolved oxygen being minimum in summers and maximum in winters. Dissolved oxygen showed an inverse relationship with water temperature, which is probably due to two reasons, in summers at high temperature rate of oxidation of organic matter in water increase and oxygen is consumed in this process. Secondly, at higher temperature the water has a lesser oxygen holding capacity and surplus oxygen is lost to the atmosphere (Munawar 1970, Saha & Pandit 1986 and Rajendran Nair 2000).

Higher chloride content is considered as an index of water pollution. Munawar (1970), Saha & Pandit (1986) have reported lower chloride values in unpolluted pond. In the present study, chloride range was within permissible limit. It showed the positive correlation with water temperature, turbidity, hardness, alkalinity, conductivity and negative correlation with pH and dissolved oxygen. The phosphate content being higher in monsoon and post monsoon, is probably due to the influx through rain water (Munawar 1970). This showed positive correlation with pH, dissolved oxygen and negative correlation with water temperature, hardness, alkalinity and chloride. Similar findings were reported by (Rajendran Nair 2000).

Nitrate, ammonia, silicate and sulphate content of the Arasankulam pond was found to be higher during monsoon period and lower in summer; similar seasonal trends has been reported by Munawar (1970). A comparison of physico-chemical characteristics in Arasankulam pond showed that values for most parameters were below permissible limit except total alkalinity.

The seasonal variations in water quality characteristics of the pond have a marked influence on the numerical abundance of plankton. Relation between these parameters and plankton diversity has been studied by Dutta et al. (1954), Meshram & Dhande (2000) and Mazher Sultana & Sharief (2004). The present analysis showed the abundance of phytoplankton as compared to zooplankton (Tables 2 & 3).

In the present study 33 species of phytoplankton and 15 species of zooplankton have been recorded. Of the total plankton, 15 belong to Chlorophyceae (*Scenedesmus dimorphus, S. quadricauda*, *Pediastrum duplex*, *Oocystis gigas*, *Spirogyra* sp., *Chlamydomonas* sp., *Ankistrodesmus* sp., *Pandorina* sp., *Desmid* sp., *Oedogonium* sp., *Zygnema* sp., *Chlorococcales* sp., *Volvox* sp.), 9 to Cyanophyceae (*Microcystis aeruginosa*, *Anabaena* sp., *Oscillatoria* sp., *Chroococcus minutus*, *Lyngbya* sp., *Nostoc* sp., *Spirulina* sp., *Merismopedia* sp.), 7 to Bacillariophyceae (*Navicula* sp., *Gomphonema* sp., *Cyclotella* sp., *Synedra* sp., *Fragillaria* sp., *Nitzchia* sp.), 2 to Euglenophyceae (*Euglena* sp., *Phacus* sp.), 5 to Cladocerans (*Daphnia* sp., *Ceriodaphnia* sp., *Moina* sp., *Alona* sp., *Daphnia nauplius* sp.), 4 to Copepods (*Thermocyclops* sp., *Mesocyclops* sp., *Diaptomus* sp., *Cyclops* sp.), 4 to Rotifers (*Keratella* sp., *Brachionus* sp., *Asplanchna* sp.) and 2 to Ostracods (*Cypris* sp., *Stenocypris* sp.) (Tables 2 and 3). In the present study, the annual periodicity shows that Chlorophyceae dominates and constitutes 33% of the total phytoplankton population, followed by Bacillariophyceae (29%), Cyanophyceae (23%) and Euglenophyceae (14%). Maximum density of phytoplankton was recorded in summer, and minimum in winter.

Table 1: Physico-chemical characteristics of Arsankulum pond at Veepampattu from January-December 2009.

No.	Parameters	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Atm. Temperature	29	32	34	35	36	35	33	31	27.5	28	26	26
2	Water Temperature	26	28	30	30	32	29	29	29	25.5	26	24	24
3	Turbidity	4.4	4.6	0.9	7	0.6	0.6	9.6	10.6	11.2	12	13.5	12.5
4	Conductivity	361	444	488	520	545	552	569	585	600	612	650	660
5	pH	7.79	8.03	8.54	7.32	7.29	8.01	8.11	8.5	8.86	9.2	8.84	8.8
6	Alkalinity	96	116	126	134.5	108	110	92	122	114.5	110.6	108	110
7	Total hardness	96	115	130	138	128	130	110	108	114	118.5	128.5	116.6
8	DO	7.8	5.35	3.5	3.8	5.05	5.56	5.82	6.58	6.93	6.59	7.04	7.53
9	Chloride	32	38	42	51	55	52	42	44	48	52	54	55
10	Nitrate	2	4	0.26	4	3	5	2	4	4.3	5.5	3.2	2.5
11	Nitrite	0.07	0.02	0.003	0.09	0.12	0.14	Nil	0.05	0.05	0.03	0.04	0.04
12	Phosphate	0.47	0.64	0.47	0.36	0.92	0.95	0.7	0.93	093	0.94	0.95	0.95
13	Iron	0.15	0.21	0.02	0.11	0.16	0.25	0.28	0.27	0.28	0.29	0.29	0.28
14	Silica	19.32	53.65	20.32	55.74	33.08	43.52	23.7	30.25	45.05	56.8	58.04	59.55
15	BOD	4	7	10	12	8	6	4	8	15.6	14.09	16.05	10.08
16	COD	16.35	25.12	28.2	37.65	2.54	7.6	10.6	15.20	16.78	20.53	22.30	20.08

The values are in mg/L except pH, temperature (ºC), turbidity (NTU) and conductivity (micromhos/cm).

Table 2: Monthly occurrence of phytoplankton in Arasankulum pond from January-December 2009.

Period	Cyanophyceae	Chlorophyceae	Bacillariophyceae	Euglenophyceae	Total
Jan	10	18	16	27	71
Feb	20	28	21	25	94
Mar	30	40	25	16	111
Apr	35	45	30	16	126
May	26	45	30	10	111
Jun	24	35	23	12	94
Jul	12	36	12	07	67
Aug	20	15	10	08	53
Sep	20	12	31	02	65
Oct	18	10	23	03	54
Nov	16	08	22	01	47
Dec	08	06	20	02	36
Total	209	298	263	129	893
Percentage	23.40%	33.37%	29.45%	14.44%	

Table 3: Monthly occurrence of zooplankton in Arasankulum pond from January-December 2009).

Period	Cladocera	Ostracoda	Copepoda	Rotifera	Total
Jan	26	10	15	16	67
Feb	28	12	17	12	69
Mar	15	08	28	28	79
Apr	28	10	25	30	77
May	12	10	28	25	63
Jun	13	15	18	22	87
Jul	10	15	20	20	65
Aug	26	14	18	18	80
Sep	15	15	12	08	50
Oct	07	10	08	10	35
Nov	10	5	14	12	41
Dec	10	8	16	10	49
Total	202	132	217	211	762
Percentage	26.50%	17.32%	28.47%	27.69%	

Zooplankton in water of Arasankulam pond belong to four main taxonomic groups, Copepoda, Rotifera, Cladocera and Ostracoda. The knowledge of their abundance, species diversity and spacial distribution is important in understanding profodynamics and trophic progression of water bodies as pointed out by Mathew (1977), Verma & Dutta Munshi (1987) and Pulle & Khan (2003).

The monthly average and total number of copepods varied from 8 to 28 per litre during the year 2009. Copepod population was found to be higher in the summer, while lower in monsoon and winter. Water temperature and availability of food organisms affect the Copepoda population.

The monthly average of total number of Cladocera was observed to vary from 7 to 28 per litre during the study period. They were maximum in summer and winter, and minimum in premonsoon. The maximum population of Cladocera in winter may be attributed to favourable temperature and availability of abundant food in the form of bacteria, nanoplankton and suspended detritus (Baker 1979). During summer and monsoon, the factors like water temperature, dissolved oxygen, turbidity, and transparency play an important role in controlling the diversity and density of Cladocera. The monthly average of total number of rotifers varied from 8 to 30 per litre. Rotifer populations are very useful in indicating the water quality, particularly in pollution studies (Mazher Sultana & Sharief 2004). Chandrasekhar (1996) observed that in summer and monsoon, the factors like water temperature, turbidity, transparency and dissolve oxygen play an important role in controlling the diversity and density of rotifers. In the present study, the rotifer number was found maximum in summer, and minimum in winter, which corroborates with the work of Pulle & Khan (2003).

The ostracod population in the pond was higher in monsoon and lower in winter and summer. The higher population of ostracod during monsoon may be due to the abundance of fine detritus to which omnivorous organisms switch over during monsoon from their natural benthic habitat and use bacteria, moulds and algae as food (Tonapi 1980). Thus, it may be concluded that the density of plankton is dependent on different abiotic factors either directly or indirectly.

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