



Comparison of physico-chemical parameters and phytoplankton species diversity of two perennial ponds in Sattur area, Tamil Nadu

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Abstract: Investigations were carried out on the diversity of phytoplankton in relation to physico-chemical parameters with respect to pollution status of two perennial ponds of Sattur area, Tamil Nadu. Fifty species were identified belonging to Chlorophyceae, Bacillariophyceae, Cyanophyceae and Euglenophyceae. High value of physico-chemical parameters and low phytoplankton diversity were recorded in the Chinnapperkovil pond, whereas low value of physico-chemical parameters and high phytoplankton diversity were recorded in the Nallanchettipatti pond. Class Chlorophyceae qualitatively and quantitatively dominated in both the habitats when compared to other taxa. Present study revealed that phytoplankton species richness (R1 and R2) was comparatively higher (R1: 5.43 ± 0.53 ; R2: 3.00 ± 0.27) in Nallanchettipatti pond. The species diversity was high (H' : 3.08 ± 0.37 ; N1: 14.05 ± 0.63 ; N2: 12.55 ± 0.94) in Nallanchettipatti pond compared to Chinnapperkovil pond (H' : 2.25 ± 0.15 ; N1: 12.59 ± 0.80 ; N2: 8.54 ± 0.61). *Anabaena aequalis*, *Nitzschia bilobata*, *Navicula membranacea*, *Scenedesmus annatus*, *Pediastrum leonensis*, *Frustulia rhomboides*, *Microcystis aeruginosa*, *Oscillatoria angusta*, *Closterium acerosum* species dominated in Chinnapperkovil pond and *Spirogyra maxima*, *Zygnema caeruleum* and *Fragilaria oceanica* dominated in Nallanchettipatti pond. Abundance of such specific taxa (e.g. *Closterium acerosum*, *C. diana*, *C. lineatum*, *Anabaena aequalis*, *Oscillatoria angusta* and *Navicula membranacea*) in the Chinnapperkovil and Nallanchettipatti (e.g. *Merismopedia glauca* and *Fragilaria oceanica*) ponds suggests that these taxa can be considered as pollution indicators. Phytoplankton species diversity and physico-chemical parameter profiles indicate the Chinnapperkovil pond to be meso-eutrophic whereas the Nallanchettipatti pond is oligo-eutrophic.

Key words: Phytoplankton, Physico-chemical parameters, Ponds, Diversity, Shannon's index

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Introduction

Water supports life on earth and around which the entire fabric of life is woven. Ponds, as sources of water, are of fundamental importance to man. However, pond may have been a natural water sources exploited by man at different time to meet different needs, or may have been created for a multitude of different purpose e.g. domestic or agricultural use, for transport, defense, ritual or industrial use, social aggrandizement, swimming, fish farming or the creation of the picturesque (Ress, 1997; Narayan *et al.*, 2007; Bishnoi and Malik, 2008).

The major problems effecting standing water bodies have been recognized for at least two decades, but their quantification and classification of environmental managers has proved elusive. The Indian environment managers/researchers has recently described the condition of Indian freshwater resources and their management as a prominent environmental problem with nutrition enrichment, acidification and domestic waste, sewage, agricultural and industrial effluents contamination by toxic substances identified as major impacts (Sachidanandamurthy and Yajurvedi, 2006; Parashar *et al.*, 2008; Shekhar *et al.*, 2008; Senthikumar and Sivakumar, 2008; Laskar and Gupta, 2009). The requirement of water to all living organisms, from micro-organisms to man, is a serious challenge today because all water resources are polluted

due to unplanned urbanization and industrialization. In India, natural ponds are estimated to have an area of about 0.72 million ha, most of which are found in the vicinity of villages, places of religious worship and other human inhabitations (Isaiarasu and Mohandoss, 1998; Kamat and Sima, 2000; Shiddamallayya and Pratima, 2008). This makes them quit vulnerable for human impact and changes day by day, measuring which would probably give a clear picture about the pollution stress on them (Isaiarsu and Mohandoss, 1998; Raja *et al.*, 2008).

The qualitative and quantitative studies of phytoplankton have been utilized to assess the quality of water (Adoni *et al.*, 1985; Chaturvedi *et al.*, 1999; Ponmanickam *et al.*, 2007; Shekhar *et al.*, 2008). Phytoplanktons are the primary producers forming the first trophic level in the food chain. Diversity of planktonic organisms is quite high in fertile standing water bodies. Phytoplankton diversity responds rapidly to changes in the aquatic environment particularly in relation to silica and other nutrients (Eggs and Aksnes, 1992; Chellappa *et al.*, 2008). Several phytoplankton species have served as a bioindicators (Vareethiah and Haniffa, 1998; Bianchi *et al.*, 2003; Tiwari and Chauhan, 2006; Hoch *et al.*, 2008) and it is a well suited tool for understanding water pollution studies (Ahmad, 1996). Although, a number of studies have been carried out on ecological conditions of freshwater bodies in various parts of India (Rana, 1991; Sinha and Islami, 2002; Singh *et al.*, 2002; Tiwari and Chauhan, 2006), information on relationship between physico-

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chemical parameters and plankton indicators of water pollution is limited (Ahmad and Siddiqui, 1995; Rana, 1996; Dadhich and Saxena, 1999; Rajagopal et al., 2006; Bhuiyan and Gupta, 2007).

Studies on planktonic composition and morphometric, physical and chemical characterization of water bodies are necessary to obtain basic knowledge on the biodiversity in a given region. Therefore, present work is aimed to study the physico-chemical characteristics and phytoplankton species diversity to measure the pollution status of two perennial ponds of Sattur area, Tamil Nadu.

Materials and Methods

Study area: Two perennial ponds were selected, in which Chinnapperkovil pond (a) is situated in the Madurai bypass road about 0.5 km away from Sattur bus stand (Fig. 1). It receives domestic effluents from residential buildings around the pond. A match factory and automobile workshop situated near the pond, dump the waste materials and chemicals on the bank of the pond. The area of the pond is 5.0 ha and mean depth is 7.5 m. 150 families were living around the pond. The pond water is used for bathing the cattle's and construction purpose. During rainy season the pond overflows and emits noxious smell. Whereas Nallanchettipatti pond (b) is located at the Irukkankudi temple, about 8 km from Sattur (Fig. 1). This pond gets water from Kolvarpatti dam. It also receives domestic effluents from Nallanchettipatti village and surface run off from agricultural field. The surface area of pond is 8.5 ha and average depth of 4.85 m. During rainy season, this pond water is used for irrigating 750 acres of Nallanchettipatti village people (200 families) and occasionally used for bathing.

Collection of samples: Water samples were collected from selected habitats for seven months from June to December 2000. Samples were collected periodically every month during morning hrs between 9.00 and 11.00 A.M. 50 liters of surface water was filtered through standard plankton net. The collected plankton samples were transferred to polyethylene bottles and preserved with 5% formalin.

Biological analysis: Plankters were studied under microscope and identified with the help of standard references (Adoni et al., 1985; Agarker et al., 1994). Quantitative analysis was made using a plankton-counting cell (Sedgwick rafter). Phytoplankton species richness, diversity and evenness were carried out using the method of Ludwig and Reynolds (1988) and Ismael and Dorgham (2003).

Physico-chemical analysis: Temperature (air and surface water) was recorded on the spot using Centigrade thermometer. The pH of the water samples was measured by using the gun pH meter on the spot. Physico-chemical analysis (electrical conductivity, alkalinity, salinity, phosphate, calcium hardness, magnesium hardness, total hardness, dissolved oxygen and

biological oxygen demand) of the sample was done according to standard methods (APHA, 1975).

Results and Discussion

The fluctuation of phytoplankton density and physico-chemical characteristics of water at both ponds are depicted in Tables 1 and 2 respectively. Altogether fifty species of phytoplankton were identified, of which 24 species belonged to the class Chlorophyceae, 14 belonged to class Cyanophyceae and 11 belonged to class Bacillariophyceae and one species Euglenophyceae. Among Chlorophyceae, numerical superiority was found in the case of *Spirogyra maxima* (28.3 no./l). *Microcystis wesenbergii* (10.0 no./l) repeated abundance among Cyanophyceae. Among the Bacillariophyceae, *Frustulia rhomboides* (14.14 no./l) abundant. *Euglena gracilis* (2.57 no./l) was the only species of Euglenophyceae observed in Nallanchettipatti pond alone. Fifty taxa were encountered from the two-perennial ponds in Nallanchettipatti pond phytoplankton diversity with forty-six species and Chinnapperkovil pond with thirty species. Dominance of class Chlorophyceae in Nallanchettipatti pond might be due to high dissolved oxygen and fair amount of pH, alkalinity and total hardness. Singh and Nayak (1990) and Bajpai and Agarker (1997) have also observed that green algae prefer water with high concentration of dissolved oxygen.

High density of phytoplankton species diversity and physico-chemical parameters exhibited during study period except the month of September and October 2000. This may be due to physico-chemical factors greatly influenced by phytoplankton population. On the other hand, during rainy season (Sept. - Oct. 2000) cloudy weather, low transparency and heavy flood caused the decline of phytoplankton density and physico-chemical parameters. Similar observations have been made by Rana (1991, 1996) and Pundhir and Rana (2002). Among the 50 taxa, 22 taxa occurred in almost all the collections (*Anabaena aequalis*, *Micocystis aeruginosa*, *M. wesenbergii*, *Nostoc caeruleum*, *Merismopedia glauca*, *Oscillatoria angusta*, *Chlorella vulgaris*, *Nitella opaca*, *Pediastrum simplex*, *P. leonensis*, *Spirogyra maxima*, *Zygnema caeruleum*, *Diatoma vulgare*, *Frustulia rhomboides*, *Nitzschia bilobata*, *Navicula membranacea*, *Fragilaria oceanica* species were occurred both ponds; *Spirulina laxa*, *Microspora aequabilis* occurred only Nallanchettipatti pond and *Closterium diana*, *C. diana*, *C. lineatum* occurred only Chinnapperkovil pond). Among the twenty two taxa, the nine taxa were most dominating (Table 1). In the present study *Spirogyra* sp. (28.3 no./l) formed the major component of phytoplankton in Nallanchettipatti pond and *Closterium acerosum* (15.57 no./l) in Chinnapperkovil pond. These two species indicate the eutrophic nature of water bodies (Bajpai and Agarker, 1997; Adesalu and Nwankwo, 2008).

It is remarkable that the Chlorophyceae population was the most abundant group in both ponds followed by Cyanophyceae, Bacillariophyceae and Euglenophyceae (Table 3). Thus qualitatively Chlorophyceae formed the largest group and was

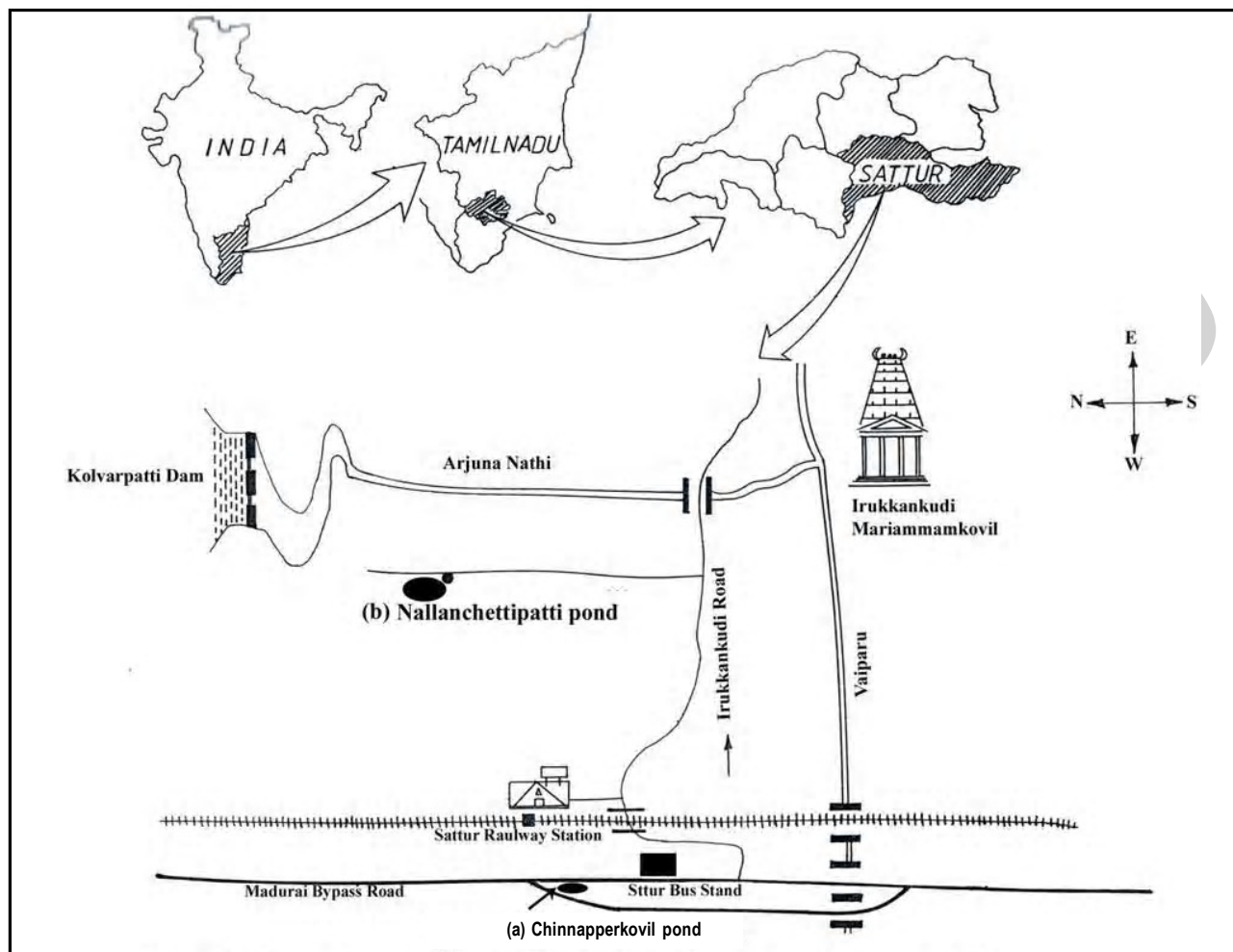


Fig. 1: Map showing the location of the study area in Sattur

followed by other groups. Quantitatively also Chlorophyceae dominated over other groups and contributed as much as (48 %) to the total phytoplankton population. In both ponds, Chlorophyceae population was most abundant during June and July 2000. Devika *et al.* (2006) also recorded high population during summer and suggested that this might be due to physical rather than chemical conditions in which the water temperature and transparency had a direct relationship with phytoplankton population. Ven Den Hoeck *et al.* (1995) reported that higher Chlorophyceae are a large and important group of freshwater algae. About 2650 species of Chlorophyceae have been described from the different parts of the world and 350 genera have so far been authenticated.

Chinnapperkovil pond contains high amount of physico-chemical parameters like, pH (8.2) alkalinity (135.44 ppm), salinity (80.71 ppm), electrical conductivity (748.2 μ mhos cm^{-1}), phosphate (24.7 ppm), total hardness (107.1 ppm), biological oxygen demand (5.42 ppm) and low dissolved oxygen (2.8 ppm) and phytoplankton diversity (30 no. of sp. l^{-1}) (Tables 1,2) as compared to Nallanchettipatti pond. According to Kurbatova (2005), Tanner *et al.* (2005) and Parashar *et al.* (2008) reported that the range of pH

(7.2 to 7.8), alkalinity (80 to 120 ppm), dissolved oxygen (7.02 to 8.73 mg l^{-1}) and biological oxygen demand (1.4 to 2.4 ppm) is the normal level of drinking water reservoir. In the case of Chinnapperkovil pond the hydrobiological parameter values were comparatively higher in the normal level of drinking water; this might be due to over loading of nutrition, which indicates high level of organic pollution. This observation is in agreement with Vamos (1994) and Sachidanandamurthy and Yajurvedi (2006). Meshram (2005) reported that overloading of nutrients and dissolved matter in water bodies affect the plankton diversity. In Chinnapperkovil pond, *Nitzschia bilobata*, *Navicula membranacea*, *Scenedesmus annatus*, *Pediastrum leonensis*, *Frustulia rhomboides*, *Microcystis aeruginosa*, *M. wesenbergii*, *Oscillatoria angusta*, *Anabaena aequalis*, *Closterium sphaericum* and *C. acerosum* were dominate. These species have also been reported from eutrophic water bodies (Bajpai and Agarker, 1997; Pundhir and Rana, 2002). Chellappa *et al.* (2008) pointed out that *Closterium* sp. and *Scenedesmus* sp. are found in meso-trophic water bodies. This observation is in agreement with the findings of Nandan and Aher (2005), Isaiarasu and Mohandoss (1998) and Tiwari and Chauhan

Table - 1: Phytoplankton density in the water sample of two perennial ponds during June- December 2000

Phytoplankton (No.sp. l ⁻¹)	Chinnapperkovil pond								Nallanchettipatti pond							
	J	J	A	S	O	N	D	Density	J	J	A	S	O	N	D	Density
I. Cyanophyceae																
<i>Anabaena aequalis</i>	2	18	4	5	2	4	7	6	7	2	2	2	4	2	0	2.17
<i>Aphanocapsa delicatissima</i>	0	0	0	0	0	0	0	0	3	2	0	2	2	0	2	1.57
<i>Aphanizomenon flos-aquae</i>	0	0	0	0	0	0	0	0	5	2	0	0	0	0	2	1.28
<i>Coelosphaerium dubium</i>	0	8	0	0	6	4	0	2.6	4	4	0	2	0	0	0	1.42
<i>Gloeotrichia natans</i>	2	0	0	0	0	0	0	0.28	0	0	2	0	2	4	0	1.3
<i>Lyngbya aestuarii</i>	0	0	0	0	0	0	0	0	0	2	0	0	2	0	0	0.6
<i>Microcystis aeruginosa</i>	33	12	7	0	4	5	8	9.9	12	8	3	0	1	0	7	4.42
<i>Microcystis wessenbergii</i>	25	12	6	6	5	4	12	10	5	22	0	0	2	0	10	5.6
<i>Merismopedia glauca</i>	10	7	5	4	5	4	5	5.71	8	4	2	4	0	0	2	2.9
<i>Mougeotia scalaris</i>	0	0	0	0	0	0	0	0	2	2	0	2	0	0	2	1.14
<i>Nostoc caeruleum</i>	7	16	3	8	0	4	2	5.71	10	4	3	2	6	0	13	5.42
<i>Oscillatoria angusta</i>	20	7	2	5	5	5	10	7.71	0	12	2	2	12	8	5	5.9
<i>Spirulina laxa</i>	0	0	0	0	0	0	0	0	13	4	4	0	4	6	5	5.14
<i>Synechocystis trididemni</i>	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0.9
II. Chlorophyceae																
<i>Askenasyella clamydopus</i>	0	0	0	0	0	0	0	0	18	7	0	2	0	0	2	4.14
<i>Actinastrum aciculare</i>	0	0	0	0	0	0	0	0	0	2	0	0	1	1	3	1
<i>Ankistrodesmus falcatus</i>	0	5	0	0	2	0	3	1.42	14	3	3	0	1	1	1	3.3
<i>Chlorella vulgaris</i>	2	2	1	0	0	0	1	0.85	13	12	17	0	7	2	10	8.71
<i>Chara longifolia</i>	3	2	0	0	0	4	2	1.57	2	0	2	6	4	2	0	2.3
<i>Cladophora glomerata</i>	5	2	1	0	0	0	2	1.42	7	4	0	0	2	0	0	1.9
<i>Characium gracilipes</i>	0	0	0	0	0	0	0	0	12	2	2	0	0	2	0	2.57
<i>Closterium sphaericum</i>	7	4	12	0	0	0	5	4	3	7	5	0	0	2	2	2.71
<i>Closterium acerosum*</i>	12	13	17	0	2	12	12	12.14	0	0	0	0	0	0	0	0
<i>Closterium diana*</i>	35	25	13	5	3	13	15	15.57	0	0	0	0	0	0	0	0
<i>Closterium lineatum</i>	17	10	2	5	2	2	6	6.3	0	0	0	0	0	0	0	0
<i>Closterium depressum</i>	3	5	7	2	0	2	4	3.14	0	0	0	0	0	0	0	0
<i>Elakatothrix gelatinosa</i>	0	0	0	0	0	0	0	0	0	2	0	0	0	2	4	1.14
<i>Hydrodictyon reticulatum</i>	0	0	0	0	0	0	0	0	17	5	2	2	0	0	4	4.28
<i>Microspora aequabilis</i>	0	0	0	0	0	0	0	0	8	12	7	5	3	2	7	6.28
<i>Nitella opaca</i>	10	6	8	2	0	4	8	5.42	10	5	1	2	2	8	8	5.14
<i>Pediastrum leonensis***</i>	28	22	7	5	15	7	8	13.14	25	22	16	5	3	2	0	10.42
<i>Pediastrum simplex</i>	17	12	8	4	0	5	7	7.6	8	14	6	0	0	4	4	5.14
<i>Scenedesmus annatus</i>	15	10	12	0	0	5	13	7.9	3	0	0	0	0	0	4	1
<i>Spirogyra maxima**</i>	8	2	1	0	0	4	2	2.42	52	34	20	20	12	28	32	28.3
<i>Spirotaenia condensata</i>	0	0	0	0	0	0	0	0	23	15	12	0	1	5	7	9
<i>Ulothrix lamellosa</i>	3	3	0	0	0	0	0	0.85	17	5	0	0	0	2	2	3.71
<i>Uronema acutum</i>	0	0	0	0	0	0	0	0	2	0	0	2	0	3	2	1.3
<i>Zygnema caeruleum**</i>	10	7	5	0	0	0	1	3.28	10	14	12	0	14	12	20	11.71
III. Bacillariophyceae																
<i>Asterionella formosa</i>	0	0	0	0	0	0	0	0	13	0	0	2	0	0	2	2.42
<i>Cocconeis diminuta</i>	0	0	0	0	0	0	0	0	0	2	2	0	0	1	0	0.71
<i>Diatoma vulgare</i>	17	5	7	3	0	3	5	5.71	3	7	6	2	0	17	5	5.71
<i>Gomphonema acuminatum</i>	0	0	0	0	0	0	0	0	3	2	0	2	0	0	3	1.42
<i>Fragilaria oceanica**</i>	2	3	2	0	2	2	7	2.57	20	23	15	2	2	12	15	12.71
<i>Frustulia rhomboides*</i>	25	27	18	2	2	15	10	14.14	23	18	2	2	0	4	14	9
<i>Navicula membranacea*</i>	20	27	15	5	2	8	8	12.14	18	15	8	2	2	12	12	9.9
<i>Nitzschia bilobata*</i>	17	25	10	3	12	15	10	13.14	12	4	7	0	0	10	10	6.14
<i>Pinnularia viridis</i>	0	0	0	0	0	0	0	0	8	15	8	2	2	12	12	8.42
<i>Synedra capitata</i>	0	0	0	0	0	0	0	0	0	0	2	2	1	0	0	0.71
<i>Tabellaria fenestrata</i>	7	5	3	0	0	2	5	3.14	13	17	5	0	0	2	0	5.28
IV. Euglenophyceae																
<i>Euglena gracilis</i>	0	0	0	0	0	0	0	0	7	5	1	0	1	2	2	2.57
Total number of Individuals	362	302	174	64	69	133	176	185.03	433	341	181	76	93	170	235	217.82
Total number of Species	28	29	25	15	15	21	27		38	38	31	23	25	29	34	
No. of species/site								30								46

* = Most dominant in Chinnapperkovil pond, ** = Most dominant in Nallanchettipatti pond, *** = Most dominant in both ponds, J = June, J = July, A = August, S = September, O = October, N = November, D = December

(2006). They reported that high amount of phosphate, calcium and nitrogen influence the growth of *Microcystis aeruginosa*, *Closterium sphaericum*, *C. acerosum*, *Scenedesmus annatus*, *Oscillatoria angusta*, *Navicula membranacea*, *Nitzschia bilobata*, *Chlorella vulgaris* and *Spirogyra maxima*. They also suggested that the organisms of this species attain high or low diversity according to their tolerance to environmental conditions (Isaiarasu and Alfred Mohandoss, 1998; Ali and Abd el-Salam, 1999). Above nine taxa were identified as indicators of organic pollution from the Chinnapperkovil pond when compared to Nallanchettipatti pond.

The present findings show that the Nallanchettipatti pond has low amount of pH (7.3), alkalinity (96.9 ppm), salinity (60.0 ppm), total hardness (70.0 ppm), and high amount of dissolved oxygen (5 ppm) and phytoplankton diversity (45 no. of sp. l⁻¹). Only thirteen taxa were reported abundant in this pond. Maximum abundance was found in *Spirogyra maxima* (25.1 no. l⁻¹) followed by *Fragilaria oceanica* (12.7 no. l⁻¹) and *Zygnema caeruleum* (11.7 no. l⁻¹). Chaturvedi *et al.* (1999) reported that above taxa indicates atrophic nature of water body; except for *Fragilaria oceanica* and it indicates oligo-trophic nature of water body (Bajpai and Agaker, 1997). Shekhar *et al.* (2008) reported that *Navicula membranacea* species as indicators of sewage pollution. Gupta and Shukla (1990) identified *Anabaena aequalis*, *Oscillatoria angusta*, *Spirulina laxa*, as indicators of organic pollution. Ahmad (1996) and Vareethiah and Haniffa (1998) had earlier identified *Microcystis aeruginosa*, *M. wesenbergii*, *Chlorella vulgaris*, *Navicula membranacea*, *Gloeotrichia natans* and *Spirogyra maxima* as indicators of sewage pollution. Adesalu and Nwankwo (2008) reported that *Closterium spp.* as bacterial indicators of long-standing pollution or hazardous pollution and increase with an increase in nutrients, which is in agreement with this study.

Anabaena aequalis, *Oscillatoria angusta*, *Nitzschia bilobata*, *Fragilaria oceanica*, *Navicula membranacea*, *Microcystis aeruginosa*, *M. wesenbergii*, *Chlorella vulgaris*, *Gloeotrichia natans* were identified in the above earlier studies as indicators of sewage/organic/hazardous pollution (Gupta and Shukla, 1990; Ahmad, 1996; Adesalu and Nwankwo, 2008; Chellappa *et al.*, 2008). In the present investigation, above nine phytoplankton species were also found in the Chinnapperkovil pond. It is important to note that the 20 specific taxa (*Aphanocapsa delicatissima*, *Aphanizomenon flos-aquae*, *Lyngbya aestuarii*, *Mougeotia scalaris*, *Spirulina laxa*, *Synechocystis trididemni*, *Askenasyella clamydopus*, *Actinastrum aciculare*, *Characium gracilipes*, *Elakatothrix gelatinosa*, *Hydrodictyon reticulatum*, *Microspora aequabilis*, *Spirotaenia condensata*, *Uronema acutum*, *Asterionella formosa*, *Cocconeis diminuta*, *Gomphonema acuminatum*, *Pinnularia viridis*, *Synedra capitata* and *Euglena gracilis*) were present only in the Nallanchettipatti pond, which were absent in Chinnapperkovil pond. It may possible due to high organic and sewage pollution, most of the algae flora, which were

sensitive to pollution, did not grow in Chinnapperkovil pond. This observation is in agreement with the findings of Ahmad (1996) and Vareethiah and Haniffa (1998).

High mean value of Shannon's index (H') was recorded in Nallanchettipatti pond (3.08±0.37) compared to Chinnapperkovil pond (2.25±0.15) (Table 4,5). Dash (1996) reported that higher the value of Shannon's index (H') the greater is the planktonic diversity. Low values of Shannon's index were recorded during September and October 2000 at Chinnapperkovil and Nallanchettipatti ponds. This may be due to high downpour recorded as 244.2 mm and 100.9 mm. This report gains support from Adesalu and Nwankwo (2008) and Rajagopal *et al.* (2010). They reported that the low value of Shannon's index of phytoplankton population in rainy season is due to dilution of medium, water loss through outlet and silting. Bajpai and Agaker (1997) reported that the species diversity would be low following the disturbance such as flood.

Out of the two perennial ponds, the phytoplankton species richness (R1 and R2) was found to be high in Nallanchettipatti pond (R1: 5.43±0.53; R2: 3.00±0.27) than the Chinnapperkovil pond (R1: 4.25±0.29; R2: 2.08±0.05). High Margalef's (R1) and Menhinick's index (R2) value was observed during June and July 2000. Mukherjee (1997) reported that higher species richness (R1 and R2) is characterized by larger food chain. The mean value of the evenness index ranges between E1: 0.96±0.03; E2: 0.74±0.03 at Nallanchettipatti pond, E1: 0.89±0.01; E2: 0.68±0.05 at Chinnapperkovil pond. It is reported that species diversity implies both richness and evenness in the number of species and equitability for the distribution of individual among the species (Vadrucci *et al.*, 2007; Rajagopal *et al.*, 2009).

The present findings show that there are certain members of species in the Chlorophyceae and Cyanophyceae which are tolerant to organic pollution and resist the stress caused by pollutants. Abundance of such taxa in the polluted habitats suggests their possible use as "indicator organism". The hydrobiological characteristics and some phytoplankton organism (*e.g. Closterium acerosum*, *C. diana*, *C. lineatum*, *Anabaena aequalis*, *Oscillatoria angusta* and *Navicula membranacea*) of the Chinnapperkovil pond indicate its over loading of organic (nutrients) substances and suggest its meso-eutrophic nature whereas Nallanchettipatti pond the hydrobiological characteristics indicates fairly amount of organic substances and some specific phytoplankton organisms (*e.g. Merismopedia glauca* and *Fragilaria oceanica*) its indicates and suggest that oligo-eutrophic nature. In both ponds, specific indicating phytoplankton organisms was already reported that the biological indicator of eutrophication (Bajpai and Agaker, 1997; Adesalu and Nwankwo, 2008; Shekhar *et al.*, 2008). Therefore, the results of this investigation suggest that the Chinnapperkovil and Nallanchettipatti pond water already reached the eutrophication

Table - 2: Physico-chemical parameters of two perennial ponds during June to December 2000

Parameters	Chinnapperkovil pond								Nallanchettipatti pond							
	J	J	A	S	O	N	D	Mean \pm SE	J	J	A	S	O	N	D	Mean \pm SE
Air temperature (°C)	31	30	32	29	30	29	31	30.3 \pm 0.42	29	31	28	30	28	28	31	29.3 \pm 0.52
Water temperature (°C)	28	28	29	27	28	26	28	27.7 \pm 0.36	27	29	27	28	26	26	29	28.0 \pm 0.48
pH	8.2	8.5	8.3	7.3	7.8	8.4	8.8	8.2 \pm 0.18	7.5	7.29	7.5	7	7.2	7.15	7.56	7.31 \pm 0.08
EC (μ mhos cm^{-1})	750	737	806	650	775	700	820	748 \pm 22.6	305	280	285	250	295	200	415	290 \pm 24.7
Rainfall (mm)	0	25.8	16.9	244.2	100.9	78.9	72	77 \pm 31.2	0	25.8	16.9	244.2	100.9	78.9	72	77 \pm 31.2
Alkalinity (ppm)	137	140	147	115	135	125	147	135 \pm 4.41	110	100	95	75	90	95	113	97.0 \pm 4.82
Salinity (ppm)	78	85	70	97	80	85	70	80.7 \pm 3.6	50	64	55	72	65	59	55	60 \pm 2.83
Phosphate (ppm)	35	27	30	16	20	20	25	24.7 \pm 2.5	12	15	11	8	10	12	12	11.4 \pm 0.81
Calcium hardness (ppm)	75	70	55	40	50	50	60	57.1 \pm 4.62	55	45	40	30	35	35	35	39.3 \pm 3.17
Magnesium hardness (ppm)	65	55	50	30	45	40	45	47.1 \pm 4.21	50	35	35	20	25	20	30	30.7 \pm 4.0
Total hardness (ppm)	150	135	105	70	95	90	105	107 \pm 10.30	105	80	75	50	60	55	65	70 \pm 7.08
Dissolved Oxygen (ppm)	2.5	2.8	1.2	3.5	2.35	1.5	2.5	2.33 \pm 0.29	3.2	5.6	3.15	6.5	5	4.5	7	5 \pm 0.56
BOD (ppm)	7	5	5.5	5	6	4.5	5	5.42 \pm 0.31	3	2.5	3.1	3.5	3	2.5	3	2.95 \pm 0.14

J = June, J = July, A = August, S = September, O = October, N = November, D = December, EC = Electrical conductivity, BOD = Biological oxygen demand

Table - 3: Temporal variation in the species diversity belonging to different group of phytoplankton in two perennial ponds during June to December 2000

Month	Chinnapperkovil pond				Nallanchettipatti pond			
	CYA	CHL	BAC	EUG	CYA	CHL	BAC	EUG
June	7	15	6	0	10	18	9	1
July	7	16	6	0	12	17	9	1
August	6	13	6	0	8	13	9	1
September	5	6	4	0	7	8	8	0
October	6	5	4	0	9	11	4	1
November	7	10	6	0	4	16	8	1
December	6	15	6	0	9	16	8	1
Total no. of sp./ genus	8	16	6	0	14	20	11	1
Total no.sp. / pond		30				46		

CYA = Cyanophyceae, CHL = Chlorophyceae, BAC = Bacillariophyceae, EUG = Euglenophyceae

Table - 4: Phytoplankton species richness, diversity and evenness of Chinnapperkovil pond during June to December 2000

Diversity Indices	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Mean \pm SE
Richness No	28	29	23	15	15	21	25	22.28 \pm 2.15
R1 (Margalef's index)	4.884	5.528	4.372	3.254	3.553	4.011	4.212	4.25 \pm 0.29
R2 (Menhinick's index)	2.223	2.251	2.030	1.900	2.105	1.924	2.173	2.08 \pm 0.05
Diversity LAMBDA	9.489	8.160	3.108	0.144	3.170	0.164	4.657	4.12 \pm 1.37
H' (Shannon's index)	2.691	2.700	2.374	1.777	1.668	2.132	2.474	2.25 \pm 0.15
N1	14.751	15.605	12.987	10.091	10.615	11.023	13.117	12.59 \pm 0.80
N2	10.538	10.234	8.253	6.082	8.851	6.897	8.987	8.54 \pm 0.61
Evenesse1	0.921	0.965	0.880	0.841	0.845	0.891	0.910	0.89 \pm 0.01
E2	0.719	0.985	0.665	0.544	0.559	0.617	0.689	0.68 \pm 0.05

N1 = Hill's first diversity, those most sensitive to changes in rare species, N2 = Hill's second diversity, those most sensitive to changes in common species, LAMBDA = Simpson's index, E1 = Pielous evenness, E2 = Sheldon evenness, SE = Standard error

Table - 5: Phytoplankton species richness, diversity and evenness of Nallanchettipatti ponds during June to December 2000

Diversity Indices	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Mean \pm SE
Richness No	38	38	31	23	25	29	34	31.14 \pm 2.24
R1 (Margalef's index)	6.978	7.532	4.153	3.851	4.675	4.995	5.851	5.43 \pm 0.53
R2 (Menhinick's index)	3.702	3.844	3.065	1.612	2.748	2.942	3.125	3.00 \pm 0.27
Diversity LAMBDA	9.425	9.907	6.772	0.098	0.061	5.072	5.476	5.25 \pm 1.50
H' (Shannon's index)	4.715	3.813	2.536	2.187	2.107	2.552	3.653	3.08 \pm 0.37
N1	15.438	16.031	14.335	12.474	11.336	13.817	14.932	14.05 \pm 0.63
N2	15.118	16.171	10.890	9.515	10.351	12.640	13.221	12.55 \pm 0.94
Evenesse1	1.052	1.124	0.901	0.897	0.880	0.925	0.952	0.96 \pm 0.03
E2	0.801	0.895	0.734	0.685	0.642	0.705	0.784	0.74 \pm 0.03

N1 = Hill's first diversity, those most sensitive to changes in rare species, N2 = Hill's second diversity, those most sensitive to changes in common species, LAMBDA = Simpson's index, E1 = Pielous evenness, E2 = Sheldon evenness, SE = Standard error

stage. However, these water bodies have to be preserved for their intended use, protect its biota; a sustainable and holistic management planning is necessary for conservation of these ponds.

Some preventative measures which can be taken to decrease the organic and nutrient load on pond. (1) Insure there is a substantial grass buffer strip surrounding the surface water, (2) Insure drainage from livestock facilities does not drain directly into surface water, (3) Insure domestic sewage and gray water has been remediate prior to dumping into a surface water and (4) To initiate recycling programs and dangerous goods drop-off locations to insure used pesticides container contents, thinners, lubricants etc. These above few measures which can be taken to decrease the organic and nutrient load on surface water thereby reducing the problems associated with eutrophication i.e. nuisance aquatic blooms.

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