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PHYTOPLANKTON SPECIES DIVERSITY IN THE PARAMBIKULAM-ALIYAR IRRIGATIONAL CANALS (TAMILNADU, INDIA)

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ABSTRACT

Phytoplankton biodiversity in the Parambikulam-Aliyar irrigational canals (Latitude 10º15'and 10º30' N and Longitude 76º50' and 77º10' E), Tamilnadu, South India were studied at five stations (S1-S5), Kulanaickenpatti canal (S1), Seelakkampatti canal (S2), Poosaripatti canal (S3), Kongalnagaram canal (S4) and Pethappampatti canal (S5). Totally 22 species of phytoplankton, of which 9 species of Cyanophyceae (blue green algae), 7 species of Chlorophyceae (green algae) and 6 species of Bacillariophyceae (diatoms) were recorded. The total number of species recorded in each station was found to be in the following order, S1 > S2 = S5 > S4 > S3 (20, 15=15, 12 and 8 respectively). Therefore, diversity vise, S1 was superior with more number of species and S3 was inferior with less number of species. As appreciable number of phytoplanktons species were recorded in these irrigational canals, they can be utilized for inland aquaculture purposes if manages properly.

KEY WORDS ;Phytoplankton, Biodiversity, Cyanophycaeae, Chlorophyceae, acillariophyceae.

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INTRODUCTION

Phytoplanktons are defined as drifting or wandering plants. They are single-celled, normally microscopic (< 100 µm in diameter) and are autotrophs. Various factors can promote or inhibit phytoplankton growth. These include sunlight, salinity, temperature, pH, tides, water currents and nutrients, such as nitrogen, phosphorus, carbon, silica, iron etc., Phytoplankton is normally present in all types of water and are very beneficial to the ecosystem depending upon their numbers. These organisms are main producers of the aquatic food web. Zooplanktons (microscopic drifting or wandering animals) are feed upon phytoplankton. Phytoplanktons are important in maintaining the global carbon cycle. During photosynthesis, phytoplankton uses carbon and returns oxygen to the water and atmosphere. When plankton die, the organism sinks to the bottom of the water body taking the carbon with them, thus creating a "carbon sink". The amount of oxygen released into the atmosphere by phytoplankton is estimated to be around 50%.

Phytoplanktons are a good indicator of environmental change. However, if environmental conditions are perfect (i.e. sunlight, temperature, salinity etc.), phytoplankton can double the rate of reproduction in the same time period. The diversity and rarity of indigenous freshwater biota depends upon the habitat. The freshwater ecosystem are of either lotic or lentic types, lotic include streams, canals, waterfalls, rivers and rivulets. The lentic system includes the pools, puddles, ponds, reservoirs, lakes and the agricultural fields like paddy fields. The freshwater ecosystem is consisted of various types of planktons (free floating), benthos (attached to sediments), epiphytic algae (attached on stones, sand, mud and rock of reservoir and lakes). Depending on the seasons the algae appears and disappears. Algae are microscopically small, unicellular organisms, some of these form colonies and reach size visible to naked eye as minute green particles. The organisms are finely dispersed throughout the water and may cause considerable turbidity showing the maximum algal bloom.

Available literature indicated that abundance of plankton in the Parambikulam-Aliyar irrigational canals was related to water level; the low mean depth coinciding with a higher density of plankton, mainly contributed by *Microcystis*. The low mean depth of 2.6 m during March to June 1983 resulted in a *Microcystis* bloom of 95.95 ml m^{-3}. During 1984, when the mean depth remained high (6.1 to 14.9 m), there was no bloom. The relatively high water temperature of the reservoir favours the dominance and abundance of the *Microcystis* (Sugunan, 1995). The hydrobiology (physico-chemical factors including temperature, pH, dissolved oxygen, dissolved carbon dioxide, alkalinity, chlorides and phosphates) of the Aliyar river has been investigated by Sankaran (1984) and recorded 53 algal species and seasonal variations in the succession of algae at two points viz, Anamalai and Ambarampalayam of the Aliyar river. Sheeba and Ramanujan (2005), has studied the phytoplankton in Ithikkara rivers, Kerala showed marked difference in the composition and distribution of various algal groups. They have pointed out presence of 135 species of phytoplankton belongs to the members of Cyanophyceae, Chloraphyceae, Bacillariophyceae, Euglenophyceae, Chrysophyceae, Dinophyceae and Rhodophyceae. A number of workers have reported many algal species as indicators of water quality (Ahmad, 1996; Naik *et al*., 2005; Nandan and Aher, 2005). Zargar and Ghosh (2006) in a study on Kadra reserviour of Karnataka listed several algal forms belonging to Chlorophyceae, Cyanophyceae, Bacillariophyceae and Euglenophyceae are indicators of water pollution. Progressive enrichment of water with nutrients leads to mass production of algae, which in turn increases productivity and other undesirable biotic changes.

Study of the distribution of plankton in aquatic system in general and freshwater ecosystem in particular is gaining a momentum as for as aquaculture is concerned. Therefore, in the present study, we made an attempt to enumerate phytoplankton species in the Parambikulam-

Aliyar irrigational canals at five different stations to know their spatial distribution and to prepare a check list for the species recorded.

MATERIALS AND METHODS

STUDY AREA

Aliyar river was built up due to Parambikulam-Aliyar irrigational canal project in 1961 (Latitude 10º15'and 10º30' N and Longitude 76º50' and 77º10' E). Parambikulam river in Kerala State on the Western side of Anamalai hills and Aliyar river in Tamilnadu on the eastern slope of Anamalai hills, Western Ghats. The Aliyar River extends in a north-western direction from the dam (Map). The river is joined by two streams, the Upper near Anamalai and Palar near Ambarampalayam. The Palar extending from Thirumoorthi dam east of Aliyar dam. The Aliyar River flows further west into Kerala providing water supply to the adjoining villages and towns.

The plankton samples were collected from five stations along the river (Map): Station-1, Kulanaickenpatti canal (S1); Station-2, Seelakkampatti canal (S2); Station-3, Poosaripatti canal (S3); Station-4, Kongalnagaram canal (S4) and Station-5, Pethappampatti canal (S5).

COLLECTION OF SAMPLES

The plankton samples in the lotic system were collected qualitatively by towing method using plankton net made up of bolten silk (mesh 25, diameter of the pore 30 µm). The collection was again filtered by using 50 µm mesh sized hand filter to separate-out the zooplankton. The phytoplankton samples were then immediately preserved by using 4% formalin (aqueous solution of formaldehyde) and stored in polythene bottles until used.

BIOLOGICAL IDENTIFICATION

The preserved plankton samples were subjected to microscopic analysis (LABOMED CX R2 microscope). Phytoplankton species were identified by referring the standard works (Venkataraman, 1939; Subramanyan, 1946; Iyengar and Venkataraman, 1951; Desikachary, 1959; Prescott, 1962; Philipose, 1967**;** Cox, 1996; Anand, 1989, 1998; Mahendraperumal and Anand, 2008; Arulmurugan *et al*., 2010). The phytoplankton species identified were presented in plates 1-3.

RESULTS AND DISCUSSION

Algae are distributed in almost all types of habitats. Algae are otherwise called as 'sea weed', which are chlorophyll bearing autotrophic thallophytes. The thalli show great variation in organization. They include motile unicellular forms, motile colonial forms, palmelloid, filamentous, heterotrichous, siphonaceous, uniaxial and multiaxial. The cells constituting the thalli are basically of two kinds prokaryotic and eukaryotic. The cells in all members of algae remain surrounded by a cellulose cell wall which encloses the protoplast. Members of cyanophycea have a prokaryotic cellular organization while all other members show eukaryotic organization. Simply, the algae have been classified into 11 classes. They are chlorophyceae, xanthophyceae, chrysophyceae, baceillariophyceae, cryptophyceae, dinophyceae, chloromonadinae, euglenineae, phaeophyceae, rhodophyceae, and myxophyceae (cyanophyceae).

Phytoplankton, the chlorophyll bearing organisms, chlorophyceae (green algae), cyanophyceae (blue green algae) and bacillariophyceae (diatoms) are primary producers forming the base of the autotrophic food chain were identified in this study. The results obtained for these phytoplankton biodiversity at different sampling stations are presented in table-1. Overall, 22 species of

phytoplankton were identified, of which 9 species were cyanophyceae, 7 species were chlorophyceae and 6 species were bacillariophyceae (plates 1-3).

Map: Sample stations at Parambikulam-Aliyar irrigational canals

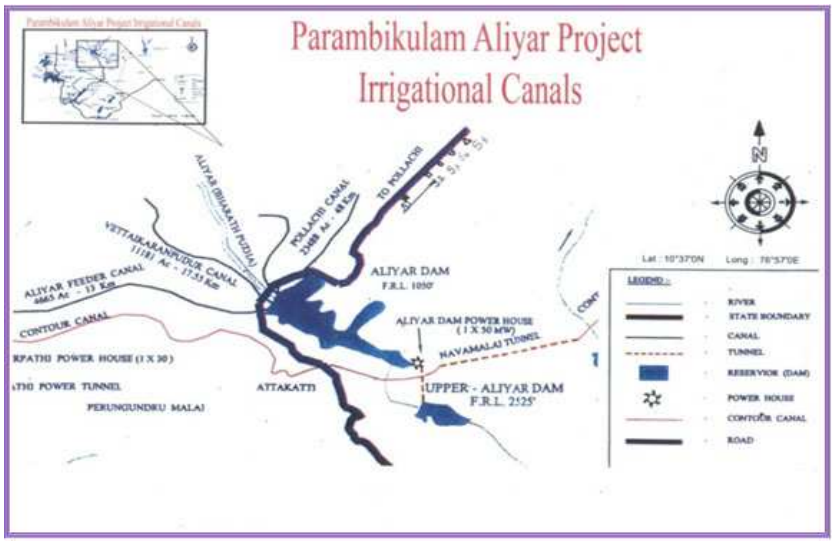

Plate-1: **Cyanophyceae (Figures, 1-9)**
1. *Aphanocapsa pjulchra* (Kutz.) Rabenh, 2. *Chroococcus minutes* Kutz, 3. *Microcystis aeruginosa* Kutz, 4. *Oscillatoria cortiana,* (Menegh.ex).Gomont, 5. *Oscillatoria Subbrevis* Schmiddle, 6. *Phormidium fragile* (Menegh.) Gomonti, 7. *Spirulina labyrinthiformis* (Mengh) Gomont, 8. *Synechococcus aeruginosus* Nag, 9. *Synechocystis aqutilis* Sauv.

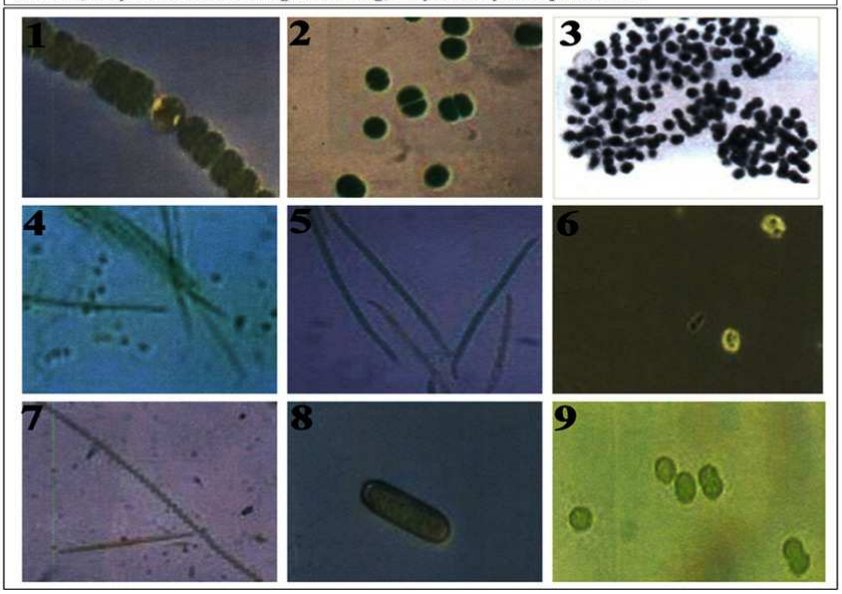

Plate-2: **Chlorophyceae (Figures, 10-16)**

10. *Chlorella vulgaris* Beijerinik, 11. *Pediastrum duplex* Meyen, 12. *Rhizoclonium crassipellitum*, 13. *Scenedesmus quadricauda*, 14. *Spirogyra hyaline* Cleve, 15. *Ulothrix aequalis* Kuetzing , 16. *Ulothrix zonata* (Weber.et.Mohr) Kuetz.

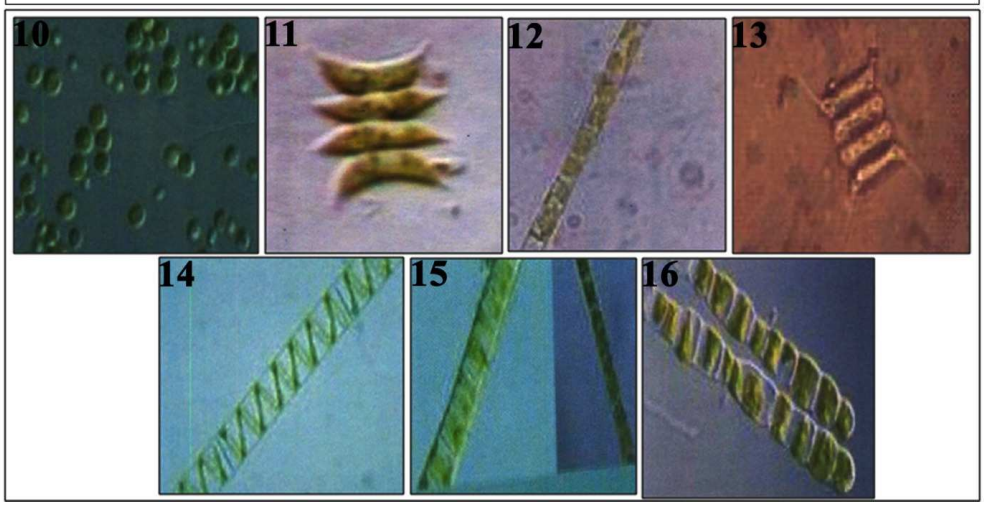

Plate-3: **Bacillariophyceae (Figures, 17-22)**

17. *Cyclotella meneghiniana* kuetzing, 18. *Amphora coffeaformis* (Aga), 19. *Amphora coffeaformis* (Aga) , 20. *Gomphonema lanceolatum* (Ehr), 21. *Melosira granulata* (Ehr.) Ralfs, 22. *Navicula radiosa* Kuetz.

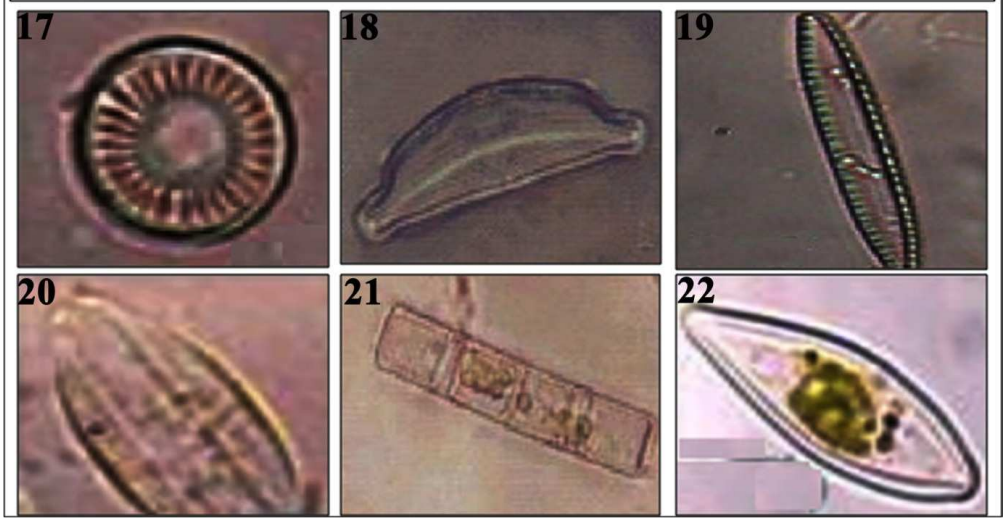

Table 1
Distribution of phytoplankton in different stations along the irrigational canals of Parambikulam-Aliyar Rivers

S. No.	Name of the Phytoplankton	S1	S2	S3	S4	S5	Total
Cyanophyceae - 9 Species							
1	*Aphanocapsa pulchra* (Kutz.) Rabenh	**+**	**+**	**-**	**-**	**-**	**2**
2	*Chroococcus minutes* Kutz	**+**	**+**	**+**	**+**	**-**	**4**
3	*Microcystis aeruginosa* Kuetz *****	**+**	**+**	**+**	**+**	**+**	**5**
4	*Oscillatoria cortiana,* (Menegh.ex).Gomont	**+**	**+**	**-**	**-**	**+**	**3**
5	*Oscillatoria Subbrevis* Schmiddle	**+**	**+**	**-**	**+**	**+**	**4**
6	*Phormidium fragile* (Menegh.) Gomont	**+**	**+**	**-**	**+**	**+**	**4**
7	*Spirulina labyrinthiformis* (Menegh) Gomont	**+**	**-**	**-**	**+**	**+**	**3**
8	*Synechococcus aeruginosus* Nag	**+**	**+**	**+**	**-**	**+**	**4**
9	*Synechocystis aqutilis* Sauv	**+**	**-**	**-**	**-**	**-**	**1**
	Total species recorded	**9**	**7**	**3**	**5**	**6**	
Chlorophyceae - 7 Species							
10	*Chlorella vulgaris* Beijerinik	**+**	**+**	**-**	**-**	**-**	**2**
11	*Pediastrum duplex* Meyen.	**+**	**-**	**-**	**+**	**+**	**3**
12	*Rhizoclonium crassipellitum* West & West	**+**	**-**	**-**	**+**	**+**	**3**
13	*Scenedesmus quadricauda* (Turpin.) Breb.*****	**+**	**+**	**+**	**+**	**+**	**5**
14	*Spirogyra hyaline* Cleve	**+**	**+**	**+**	**-**	**+**	**4**
15	*Ulothrix aequalis* Kuetz	**+**	**+**	**-**	**-**	**-**	**2**
16	*Ulothrix zonata* (Weber.et.Mohr) Kuetz	**+**	**+**	**-**	**-**	**-**	**2**
	Total species recorded	**7**	**5**	**2**	**3**	**4**	
Bacillariophyceae - 6 Species							
17	*Cyclotella meneghiniana* kuetz.	**-**	**+**	**+**	**+**	**+**	**4**
18	*Amphora coffeaformis* (Aga)	**+**	**-**	**-**	**+**	**+**	**3**
19	*Fragilaria brevistriata* Grun	**+**	**-**	**-**	**+**	**+**	**3**
20	*Gomphonema lanceolatum* (Ehr)	**+**	**-**	**-**	**+**	**+**	**3**
21	*Melosira granulata* (Ehr.) Ralfs	**-**	**+**	**+**	**-**	**+**	**3**
22	*Navicula radiosa* Kuetz	**+**	**+**	**+**	**-**	**-**	**3**
	Total species recorded	**4**	**3**	**3**	**4**	**5**	
	Among the total Species	**20**	**15**	**8**	**12**	**15**	

+ Present, - Absent, * Species observed common in five stations

CYANOPHYCEAE OR CYANOBACTERIA (BLUE-GREEN ALGAE/ BLUE-GREEN BACTERIA/ CYANOPHYTA):

The name "cyanobacteria" comes from the color of the bacteria. They obtain their energy through photosynthesis. The ability of cyanobacteria to perform oxygenic photosynthesis is thought to have converted the early reducing atmosphere into an oxidizing one, which dramatically changed the composition of life forms on Earth by stimulating biodiversity and leading to the near-extinction of oxygen-intolerant organisms. According to endosymbiotic theory, chloroplasts in plants and eukaryotic algae have evolved from cyanobacterial ancestors via endosymbiosis. Photoautotrophic, oxygen-producing cyanobacteria created the conditions in the planet's early atmosphere that directed the evolution of aerobic metabolism and eukarotic photosynthesis.

Cyanobacteria include unicellular and colonial species. Colonies may form

filaments, sheets or even hollow balls. Some filamentous colonies show the ability to differentiate into several different cell types: vegetative cells, the normal, photosynthetic cells that are formed under favorable growing conditions; akinetes, the climate-resistant spores that may form when environmental conditions become harsh; and thick-walled heterocysts, which contain the enzyme nitrogenase, vital for nitrogen fixation. Heterocysts may also form under the appropriate environmental conditions (anoxic) when fixed nitrogen is scarce. Heterocyst-forming species are specialized for nitrogen fixation and are able to fix nitrogen gas into ammonia (NH_3), nitrites (NO_2^-) or nitrates (NO_3^-) which can be absorbed by plants and converted to protein and nucleic acids. Cyanobacteria can be helpful in agriculture as they have the capability to fix atmospheric nitrogen to soil (atmospheric nitrogen is not bioavailable to plants).

Cyanobacteria are arguably the most successful group of microorganisms on earth. They are the most genetically diverse; they occupy a broad range of habitats across all latitudes, widespread in freshwater, marine and terrestrial ecosystems, and they are found in the most extreme niches such as hot springs, salt works, and hypersaline bays. Cyanobacteria fulfill vital ecological functions in the world's oceans, being important contributors to global carbon and nitrogen budgets.

There were 9 species of cyanophyceae members recorded in this study. All the 9 species were found in station-1 followed by 7 species in station-2, 6 species in station-5, 5 species in station-4 and 3 species in station-3 (plate 1).

***Aphanocapsa pulchra* (Kutz.) Rabenh. 1865**

Spherical shaped cells (measure up to 4.5µm diameter) are arranged loosely in the homogenous mucilaginous matrix (Desikachary, 1959; Cramer, 1984). Colony belongs to this species are in the form of a gelatinous mass. This species was found to be present in two stations, S1 and S2 (Fig. 1of plate 1).

***Chroococcus minutus* (Kuetz) Naeg. 1849**

Cells are spherical in shape or oblong, light-blue green in colour, single or in groups of 2-4 individuals. Cells with sheath up to 6-10 µm broad, and without sheath 4-7.5 µm sheath not laminated, colorless (Anand, 1989; Chandra *et al*., 2003). This species was found to be present in S1, S2, S3 and S4 (Fig. 2 of plate 1).

***Microcystis aeruginosa* Kuetz* Menegh. 1846**

Spherical shaped or elongated, colorless, densely packed cells with 3.0-6.5 µm in diameter. Cell colonies were with gas vacuoles (Desikachary, 1959). Rounded colonies are slightly larger than broad when young, later becoming colonies clathrate with distinct hyaline colonial mucilage. This species was found to be present in all the five stations (Fig. 3 of plate 1).

***Oscillatoria cortiana,* Menegh.ex.Gomont. 1842**

Thallus dull blue green in colour, trichomes straight slightly constricted at the joints, 5.5-6.0 µm broad, gradually tapering at the ends and bent not capitates (Desikachary, 1959). Cells measure about 5.4-7.5 µm long, at the ends up to 9 µm long, septa not granulated, and end cell obtuse without calyptras (Desikachary, 1959). It was found in S1, S2 and S5 (Fig. 4 of plate 1).

***Oscillatoria Subbrevis* Schmiddle 1893**

Trichomes single, 5.0 µm broad, nearly straight and not attenuated at the apices. Cells measure about 1-2 µm long, not granulated at the cross walls, end cell rounded, calyptras absent and hormogones present (Desikachary, 1959). It was found in S1, S2, S4 and S5 (Fig. 5 of plate 1).

***Phormidium fragile* (Menegh.) Gomont. 1978**

Thallus mucilaginous, brownish blue green and sheath diffluent. Trichomes more or less flexible, entangled or nearly parallel, distinctly constricted at the cross walls, septa not granulated, attenuated at the ends, filaments up to 1.5-3.1 µm broad, cells nearly quadrate, end cells acute, conical and

calyptras absent (Desikachary, 1959). It was found in S1, S2, S4 and S5 (Fig. 6 of plate 1).

***Spirulina labyrinthiformis* (Menegh) Gomont. 1892**

Trichome a unicellular in appearance, 1 µm broad and very regularly coiled and forming a dirty dark blue green thallus, spirals close to each other, spirals measure about 2-2.5 µm broad (Desikachary, 1959). It was found in S1, S4 and S5 (Fig. 7 of plate 1).

***Synechococcus aeruginosus* Nageli. 1849**

Cylindrical cells of 6-9 µm broad, 9-15 µm long, single or 2-4 cells together. Cell contents homogenous and light blue-green in colour and individual sheath was not visible (Desikacharyz, 1959). This species was found to be present in S1, S2, S3 and S5 (Fig. 8 of plate 1).

***Synechocystis aquatilis* Sauv. 1892**

Spherical shaped cell (5-6 µm broad), single or in double, pale blue green in colour without distinct mucilage sheath (Desikachary, 1959). It was found in S1 only (Fig. 9 of plate 1).

CHLOROPHYCEAE (GREEN ALGAE)

The chlorophyceae are one of the classes of green algae, distinguished mainly on the basis of ultrastructural morphology, especially by the arrangement of their flagella. Members of the chlorophycean “clockwise” (CW) clade have flagella that are displaced in a CW direction (1–7 o'clock) e.g. Chlamydomonadales. Members of the "directly opposed" (DO) clade have flagella that are DO direction (12–6 o'clock) e.g. Sphaeropleales. They are usually green due to the dominance of pigments chlorophyll-a and chlorophyll-b. The chloroplast may be discoid, plate-like, reticulate, cup-shaped, spiral or ribbon shaped in different species. Most of the members have one or more storage bodies called “pyrenoids” located in the chloroplast. Pyrenoids contain protein besides starch. Some algae may store food in the form of oil droplets. Green algae usually have a rigid cell wall made up of an inner layer of cellulose and outer layer of pectose.

There were 7 species of chlorophyceae members found in different sampling stations. All the 7 species were found to be present in Station-1 followed by 5 species in stations-2, 4 species in station-5, 3 species in station-4 and 2 species in station-3 (plate 3).

***Chlorella vulgaris* Beijerinik. 1890**

Spherical shaped cells with a thin cell membrane usually solitary or in small colonies. Chloroplast parietal, cup shaped or laminates and with a pyrenoid which is sometimes indistinct. Cells usually measure about 25 µm (Mahendraperumal and Anand, 2008). This species was found to be present in S1 and S2 (Fig. 10; plate 2).

***Pediastrum duplex* Meyen. 1829**

More or less H-shaped cells, bodies are polygonal, granulated and have horn-like projections. Intercellular spaces were large and oval. Colony of this species form plate like structure with 4-64 cells, measures about 80 µm in diameter (Iyengar and Venkataraman, 1951; Philipose, 1967). It was found in S1, S4 and S5 (Fig. 11; plate 2).

***Rhizoclonium crassipellitum* (West & G. S. West). 1897**

Basal cells with short and rhizoidal (narrow, twisted and root-like) branches (Chandra *et al*., 2003). This species was found to be present in S1, S4 and S5 (Fig. 12; plate 2).

***Scenedesmus quadricauda* (Turpin.) Breb.* 1835**

Colonies usually four celled, rarely eight celled. Cells measure about 50 µm long and 60 µm breadth (Philipose, 1967). This species was found to be present in all five stations (Fig. 13; plate 2).

***Spirogyra hyaline* Cleve. 1868**

Cells cylindrical, or slightly inflated, cells measure between 45-130 µm in size (Randhawa, 1959). It was found in S1, S2, S3 and S5 (Fig. 14; plate 2).

***Ulothrix aequalis* Kuetzing. 1845**

Green filaments long and cylindrical cells, 34.2 µm long and 15.2 µm broad. Pyrenoid single, cell wall thin (Sankaran, 2005). This species was found to be present in S1 and S2 (Fig. 15; plate 2).

***Ulothrix zonata* (Weber & Mohr) Kuetz. 1836**

Green filaments made of short cylindrical or modified basal cells, some slightly swollen. 3.2-6.4 µm long and 9.6 µm broad. Cell wall thin, Chloroplast band shaped completely covering, without fimbricate margin. Pyrenoid was more than one (Sankaran, 2005). It was found in S1 and S2 (Fig. 16; plate 2).

BACILLRIOPHYCEAE (DIATOMS):

Diatoms are a major group of algae, and are one of the most common types of phytoplankton. Most diatoms are unicellular, although they can exist as colonies in the shape of filaments or ribbons (e.g. *Fragilaria*), fans (e.g. *Meridion*), zigzags (e.g. *Tabellaria*), or stellate colonies (e.g. *Asterionella*). Diatoms are producers within the food chain. A characteristic feature of diatom cells is that they are encased within a unique cell wall made of silica (hydrated silicon dioxide) called a frustule. These frustules show a wide diversity in form, but usually consist of two asymmetrical sides with a split between them, hence the group name.

In this study there were 6 species of bacillriophycea members recorded. Among these 5 species were found in station-5 followed by 4 species in station-4 and 3 species were found to be present in each of stations 1, 2 and 3(plate 3).

***Cyclotella meneghiniana* kuetzing. 1844**

Frustules discoid in valve view, rectangular and undulated in griddle view, margin view well defined, coarsely striated and the striate wedge-shaped. The central portion at first straight appears to be quite smooth, but under very high magnifications show extremely fine radially arranged punctae. Cells are in 20 µm size (Anand, 1998; Mahendraperumal and Anand, 2008). This species was found to be present in S2, S3, S4 and S5 (Fig. 17; plate 3).

***Amphora coffeaformis* (Aga). 1827**

Frustules in griddle view are elliptic lanceolate, truncate. Valves are arch like on the dorsal margin and slightly concave or straight on the ventral margin. End of the valves slightly protracted. Striae were delicate. Cells measure about 40 µm long and 20 µm breadth (Venkataraman, 1939). It was found in S1, S4 and S5 (Fig. 18; plate 3).

***Fragilaria brevistriata* Grunowin Van Heurch. 1885**

Frustules in griddle view linear, rectangular, forming small bands. Valves are linear, lanceolate with round ends. Striae were very short and marginal. Cells are 110 µm long and 5 µm breadth (Venkataraman, 1939). This species was found to be present in S1, S4 and S5 (Fig. 19; plate 3).

***Gomphonema lanceolatum* (Ehr) Grunow. 1865**

Valves linear-lanceolate with attenuated rounded ends; raphe thin, straight, median central nodule bent unilaterally, terminal fissures curved forming question mark; axial area narrow, linear-lanceolate; central area broad, somewhat rectangular, unilateral, having an isolated punctae on opposite side; striae coarsely punctuate radiate and parallel, median short striae widely placed. Cells are 80 µm long and 15 µm breadth (Mahendraperumal and Anand, 2008). It was found in S1, S4 and S5 (Fig. 20; plate 3).

***Melosira granulata* (Ehr.) Ralfs. 1861**

Frustules were cylindrical, robust and stiff detached filaments. Mantle portions cylindrical, disc flat. Small pseudo sulcus was present or somewhat shallow. Neck firely big. Mantle line straight, parallel mantle surface punctuate, puncta coarse in more or less spiral rows. The outer shell always coarsely punctuate, their puncta rows being parallel. The same cells have spines projecting outside as well as inside the cells. Cells long 10 µm, breadth 10 µm (Anand, 1998;

Mahendraperumal and Anand, 2008). This species was found to be present in S2, S3 and S5 (Fig. 21; plate 3).

***Navicula radiosa* Kuetzing. 1844**

Valves linear-lanceolate, gradually attenuated towards rounded ends; raphe thin, straight, median, with distinct close set, unilaterally bent central nodule; axial area linear, central area broad, somewhat elliptical; striate coarse lineate, curved and slightly radiate in the middle becoming convergent towards the poles, long 40 µm, breadth 25 µm (Anand, 1998; Mahendraperumal and Anand, 2008). It was found in S2 and S3 (Fig. 22; plate 3).

Planktons are cosmopolitan in nature and are found in all water bodies, irrespective of their altitude, attitude and physico-chemical condition. Their food value for the aquatic organisms has been acknowledged by all the workers in this field. Considering its great importance as food for aquatic animals including fishes and prawns, their presence ensures productivity. Freshwater ecosystems are subject to temporal changes that cause uncertainty in phytoplankton composition and assemblage (Cetin, 2000; Calijuri *et al*., 2002). Therefore changes were recorded among the station studied (Table 1). In the present study a total of 22 species of phytoplankton diversity were recorded. Among them, a Cyanophyceae member was found to be more followed by Chlorophyceae and Bacillariophyceae.

In this study, among Cyanophyceae member *Microcystis aeruginosa* was recorded in all five stations studied, followed by *Chroococcus minutes*, *Oscillatoria Subbrevis, Phormidium fragile* and *Synechococcus aeruginosus* in four stations, *Oscillatoria cortiana* and *Spirulina labyrinthiformis* in three stations, *Aphanocapsa pulchra* in two stations and *Synechocystis aqutilisi* in one station only. Similarly Chlorophycean members *Scenedesmus quadricauda* was recorded in all five stations studied and followed by *Spirogyra hyaline* in four stations, *Pediastrum duplex* and *Rhizoclonium crassipellitum* in three stations and *Chlorella vulgaris, Ulothrix aequalis* and *Ulothrix zonata* in two stations. Among Bacillariophyceaen members *Cyclotella meneghinianai* was recorded in four stations studied, followed by *Amphora coffeaformis, Fragilaria brevistriata*, *Gomphonema lanceolatum*, *Melosira granulata* and *Navicula radiosa* in three stations.

Subramanian, (2000) have reported freshwater micro-algae of Sathamangalam area temple tank, pond, lake and roadside puddles of Virudhachalam Taluk of Tamil Nadu. Most important algae collected were *Gloeocapsa nigrescens*, *Spirulina sp*, *Oscillatoria sancta*, *Anabaena variabilis*, *Nostoc commune*, *Scenedesmus arctuatus*, *Oedogonium sp*, *Zygnema sp,* and *Spirogyra indica* etc., The growth and abundance of phytoplankton varies with season, depth, metrology and water properties, which in turn reflect on diversity of organisms within the ecosystem (Boyd, 1982; Rao *et al*., 1990; Mathivanan and Jayakumar, 1995; Mathivanan *et al*., 2007; Senthilkumar and Sivakumar, 2008; Radhakrishnan *et al*., 2009; Basu *et al*., 2010; Shanthi *et al*., 2010). Rajkumar (2001) has studied the bio-diversity and quantitative distribution of phytoplankton of a polluted freshwater pond. He reported phytoplanktonic components and their seasonal distribution in the polluted freshwater pond located at Pollachi. A total of 36 genera and 42 species were recorded and identified. The total phytoplankton was lower in summer and least in monsoon. The major groups of algae found were Bacillariophyceae, Cyanophyceae, Chlorophyceae, Euglenophyceae and Dinophyceae. It has been reported that the flora of four freshwater habitats (all of them located Pollachi and Udumalpet, Coimbatore District, Tamil Nadu), such as Krishnan Anaikattikulam pond, Alampalayam pond, Aliyar River at Anaimalai section and Amaravathi River at Udumalpet section a total of 61 species of diatoms have been recorded in these water bodies (Rajakumar, 2005).

It has been reported that the basic process of phytoplankton production was

dependent upon temperature, turbidity and nutrients (Sreenivasan *et al*. 1979;

Sukumaran and Das 2002; Scheffer, 1998; Hubble and Harper, 2002; Hirose *et al*., 2003). In this study, estimation of phytoplankton species diversity revealed that among the stations studied, S1 was found to be more productive as more number of species distribution was recorded. This was followed by S2 (which was equal to S5), S4 and S3. At the outset, since phytoplankton diversity was recorded in these irrigational canals, they were productive and can be utilized for aquaculture purposes.

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