# Studies on Epiphytic Microalgae in Two Freshwater Lakes of Central Tamil Nadu

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**Abstract:** ***There were species of epiphytic microalgae in the two lakes was under study, of which 33 species belonged to Bacillariophyceae, 24 species belonged to Chlorophyceae and 30 species belonged to Cyanophyceae. Eichhornia crassipes, Pistia stratiotes,Trapa bispinosa, Salvinia molesta, Salvinia minima, Azolla, Jussiaea, Hydrilla, Ceratophyllum, Vallisneria, Potamogeton crispustypha, Scirpus, Sagitytaria, Limnophila heterophylla and P. pusillus, were the dominant aquatic plants which harbour epiphytic microalgae in freshwater lakes of the present study. The number of epiphytic microalgae on the plant surface increased with the increase in the density of microalgae in the lake waters.***

**Keywords:** Ephiphytic microalgae, Aquatic Plants, Freshwater lakes, Bacillariophyceae, Chlorophyceae, Cyanophyceae.

## 1. Introduction

Microalgae which make up the starting point of aquatic food chains are either planktonic in water bodies or attached to various substrata immersed or partly submerged in the water (Borowitzka and Borowitzka, 1990). Though thousands of the species of microalgae are confined to marine habitats (Borowitzka *et al*., 1985), good numbers of microalgae are found to be reported from freshwater habitats (Raja *et al*., 2007). In freshwater bodies such as lakes, ponds, wells, streams, rivers, pools, tanks and dams, microalgae are found to be attached to stones (epilithic), mud or sandy bottom (epipellic), aquatic plants (epiphytic) and to animals (epizoic). Aquatic plants that are rooted at the bottom or that are growing at the shallow margins of water bodies seem to be good substrata for a many species of microalgae in freshwater habitats. However, the occurrence and distribution of such epiphytic algae have hardly been studied in the Kolvavoy freshwater lake of Kanchipuram district and Perumal lake of Cuddalore district. This study is an attempt to fill up the gap in the similar line of research.

In aquatic ecosystem, algae constitute a major part of producers so that whatever alters the growth and diversity of algae also affects distribution of other organisms (Palmer, 1980). Moreover algal diversity and composition are determined by the physico-chemical conditions of the waters has been reported by Zahamensky, (1973), Singh and Srivastava (1980), Vetri selvi (2012) and Prathap Singh and Regini Balasingh (1912). Benthic algae are believed to be the good indicators of water quality (Cascaller *et al*., (2002) while epiphytic and epizoic algae are the indicators of turbidity and mixing of water in the habitats (Cattaeneo (1978). Epiphyticalgae of freshwater habitats (Catteeneo, 1978; Chandra *et al.*, 2003; Malliswar *et al*., 2007&, Thirumal Thangam *et al*., 2010) and marine waters (Borowitzka, 1990; Durai and Pandiyan, 2011) were already investigated. The water quality of Perumal lake and Kolavoy lake were investigated by Vetri selvi (2012) but the distribution of epiphytic algae therein remain unresolved so far. Therefore, epiphytic algal specimens were collected from these two lakes to investigate the occurrence and distribution of epiphytic algae in the lakes.

## 2. Materials and Methods

Perumal lake (Lat. 11º 35´N, Long. 79º 40´E) in Cuddalore district and Kolavoy lake (Lat. 12º 43´N, Long. 79º 49´ E) in Kanchipuram district were surveyed for their epiphytic micro algal flora composition. Host plants that harboured epiphytic algae were collected every month of 2013 either by uprooting the entire plant in the case of small plants or by picking the leaves or by saprophyte nature stems. After cleaning the collected plants with freshwater, their surfaces were scraped with a scalpel and gently squeezed with water to collect algal samples which were then concentrated in vials using centrifugation and preserved in 4% formaldehyde solution. The samples were stained with Lugol's iodine solution as done by Fredrick *et al.*, (2011) and examined under a light microscope to identify various species of epiphytic algae according to the standard monographs of Fritsch (1965) Desikachary (1959) and Trivedy and Goel (1986), Anand (1998), Prescott (1964) and Krishnamurthy (2000). To count the number of epiphytic algae on plant surfaces, the collected plants were washed with water, cut into small pieces, stained with Lugol's iodine solution and viewed under a light microscope.

## 3. Result and Discussion

The present survey reveals that there were 87 species of epiphytic microalgae in the two lakes under study, of which 33 species belonged to Bacillariophyceae, 24 species belonged to Chlorophyceae and the remaining 30 species belonged to Cyanophyceae (Table-1). Among the total of 87 species, 72 species were common to both the lakes while 7 species (*Scenedesmus armatus*, *Selenastrum biraianum*, *Closterium calosporum*, *Aphanothece bullosa*, *Merismopedia punctata*, *Oscillatoria terebriformnis*, and *Calothrix fusca*) are restricted to Perumal lake and 8 species (*Anomoeneis sphoerophora*, *Gloeocapsa nigrescens*, *Gloeocapsa punctata*, *Arthrospira jenneri*, *Oscillatoria magartifera*, *Oscillatoria sancta*, *Phormidium pachydermaticum* and *Homeothrix varians*) are found only in the Kolavoy lake.

The difference in the distribution of various algal components in these lakes was determined by the spatial

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separation and physic-chemical parameters of water in the lakes as have been well documented by Catteneo (1978), Singh *et al*. (1980), Vetri selvi (2012), Prathap Singh and Regini Balasingh (1912), Cascaller *et al*. (2002), Chandra *et al*., (2003), Malliswar *et al*., (2007), Thirumal Thangam *et al*. (2010) and Durai and Pandiyan (2011). Slightly alkaline pH range (7.9 – 8.7), low salinity level (1.2-2.5mg/L) and high level of nutrients in these lakes favour the growth of planktonic, benthic and epiphytic microalgae (Vetri selvi, 2012). High proportion of organic matter (Solanki and Vora, 2003 and Gupta, 2002) and human activities like discharge of domestic and industrial wastes in to the lakes change the water qualities and affect the distribution of aquatic fauna and microalgae (Moss, 1980; Verma, 2002 and Kaushik *et al*., 2002).

**Table 1:** List of epiphytic algae in Perumal lake and Kolavoy lake.

| No. | Name of algal species | Perumal Lake | Kolavoy Lake |
|---|---|---|---|
| Class: **Bacillariophyceae** | | | |
| 1. | *Achnanthes inflata* Kutz. | + | + |
| 2. | *Amphora ovalis* Kutz. | + | + |
| 3. | *Anomoeneis serians* (Breb.) Celve | + | + |
| 4. | *Anomoeneis sphoerophora* (Kutz.) | - | + |
| 5. | *Cymbella tumida* (Breb.) | + | + |
| 6. | *Diatoma vulgaris* Bory | + | + |
| 7. | *Eunotia monodon* Her. | + | + |
| 8. | *Eunotia pectinalis* (Kutz.) Rabenh. | + | + |
| 10. | *Fragillaria intermedia* Grun | + | + |
| 11. | *Frustulia rhomboids* (Ehr.) De Toni | + | + |
| 12. | *Gomphonema herculeana* (Ehr.) Cleve | + | + |
| 13. | *Gomphonema parvulum* (Kutz.) | + | + |
| 14. | *Mastogloia oxigua* Lewis | + | + |
| 15. | *Navicula cincta* Kutz. | + | + |
| 16. | *Navicula capitatoradiata* Kutz. | + | + |
| 17. | *Navicula cuspidate* Kutz. | + | + |
| 18. | *Navicula pupulla* | + | + |
| 19. | *Navicula radiosa* Kutz. | + | + |
| 20. | *Navicula viridula* | + | + |
| 21. | *Nitzschia amphibia* Grun. | + | + |
| 22. | *Nitzschia brebissonii* W. Smith | + | + |
| 23. | *Nitzschia palaceae* (Kutz.) | + | + |
| 24. | *Nitzschia palea* (Kutz.) | + | + |
| 25. | *Nitzschia plana* Wm. Sm. | + | + |
| 26. | *Nitzschia vitrea* Norman | + | + |
| 27. | *Pinnularia braunii* Grun. | + | + |
| 28. | *Pinnularia interrupta* W. Smith | + | + |
| 29. | *Pinnularia viridis* (Nitzsch) Ehr. | + | + |
| 30. | *Surirella elegans* Ehr. | + | + |
| 31. | *Synedra ulna* (Nitz.) | + | + |
| 32. | *Tabellaria fenestrate* | + | + |
| 33. | *Tabellaria quadrisepta* | + | + |
| Class: **Chlorophyceae** | | | |
| 1. | *Tetraspora lubrica* (Roth) Ag. | + | + |
| 2. | *Pediastrum boryanum* (Turp.) Menegh. | + | + |
| 3. | *Pediastrum duplex* Meyen | + | + |
| 4. | *Pediastrum simplex* Hey. var. Biwanse Fukush | + | + |
| 5. | *Pediastrum tetras* (Ehr.) Ralfs. | + | + |
| 6. | *Scenedesmus armatus* (Chodat) Smith | + | - |
| 7. | *Selenastrum biraianum* Reinsch | + | - |
| 8. | *Tetraedron trigonum* (Nag.) Hansg. | + | + |
| 9. | *Ulothrix variables* | + | + |
| 10. | *Cladophora glomerata* (L.) Kutz. | + | + |
| 11. | *Cladophora crispata* (Roth) Kutz. | + | + |
| 12. | *Euastrum bidentatum* Nag. | + | + |
| 13. | *Euastrum insulare* (Wittr.) Roy | + | + |
| 14. | *Euastrum spinlosum* | + | + |
| 15. | *Netrium digitus* (Ehr.) Itz & Rothe | + | + |
| 16. | *Spirogyra rhizobrachialis* | + | + |
| 17. | *Spirogyra subsalsa* | + | + |
| 18. | *Spirogyra varians* | + | + |
| 19. | *Closterium purvulum* Nageli | + | + |
| 20. | *Closterium calosporum* Wittrock | + | - |
| 21. | *Cosmarium botrytis* Menegh | + | + |
| 22. | *Cosmarium depressum* (Naeg.) Lund | + | + |
| 23. | *Cosmarium subcostatum* Nordst | + | + |
| 24. | *Netrium digitus* Ehrbg. Itzigsohn & Rothe | + | + |
| Class: **Cyanophyceae** | | | |
| 1. | *Aphanocapsa grevillei* (Hass.) Rabenh | + | + |
| 2. | *Aphanothece bullosa* (Menegh). Rabenh | + | - |
| 3. | *Chroococcus dispersus* (V. Keissler) Lemm | + | + |
| 4. | *Chroococcus macrococcus* (Kutz.) Rabenh | + | + |
| 5. | *Chroococcus minor* (Kutz.) Nageli | + | + |
| 6. | *Chroococcus prescottii* Drouet & Daily | + | + |
| 7. | *Gloeocapsa magma* (Breb.) Kutz. | + | + |
| 8. | *Gloeocapsa nigrescens* Nag. | - | + |
| 9. | *Gloeocapsa punctata* Nag. | - | + |
| 10. | *Merismopedia elegans* G.M. Smith | + | + |
| 11. | *Merismopedia punctata* Meyen | + | - |
| 12. | *Microcystis flos-aquae* (Wittr.) Kirchner | + | + |
| 13. | *Arthrospira jenneri* Stizenb. et Gomont | - | + |
| 14. | *Arthrospira platensis* (Nordst) | + | + |
| 15. | *Lyngbya martensiana* Mengh. Ex. Gomont. | + | + |
| 16. | *Lyngbya versicolor* (Vartm) Gom. | + | + |
| 17. | *Oscillatoria chlorina* Kutz. ex Gomont | + | + |
| 18. | *Oscillatoria curviceps* Ag. ex Gomont | + | + |
| 19. | *Oscillatoria laetevirsesis* (Grouan) Gomont. | + | + |
| 20. | *Oscillatoria magartifera* Kutz Ex Gomont. | - | + |
| 21. | *Oscillatoria obtusa* | + | + |
| 22. | *Oscillatoria sancta* | - | + |
| 23. | *Oscillatoria terebriformnis* | + | - |
| 24. | *Oscilltoria tenuis* Ag. Ex Gomont | + | + |
| 25. | *Phormidium pachydermaticum* Fremy | - | + |
| 26. | *Nostoc calcicola* Breb ex. Born et Flah. | + | + |
| 27. | *Nostoc muscorum* | + | + |
| 28. | *Calothrix fusca* (Kutz.) Born et. Flah. | + | - |
| 29. | *Calothrix tenella* | + | + |
| 30. | *Homeothrix varians* | - | + |

+ Present, - absent in the lake.

**Table 2:** The percentages of various classes of epiphytic microalgae in the lakes

| Lake | Algal class | Total No. of species | Epiphytic species | % |
|---|---|---|---|---|
| Perumal lake | Bacillariophyceae | 71 | 32 | 45.07 |
| | Chlorophyceae | 56 | 24 | 42.85 |
| | Cyanophyceae | 46 | 23 | 50.00 |
| Kolavoy lake | Bacillariophyceae | 75 | 32 | 42.66 |
| | Chlorophyceae | 60 | 21 | 35.00 |
| | Cyanophyceae | 53 | 26 | 49.05 |

In Perumal lake 45.07 % of Bacillariophyceae, 42.85% of Chlorophyceae and 50% of Cyanophycean species lead epiphytic mode of life while the other species found as planktons and benthic forms. In the meantime, in Kolavoy lake 42.66 % of Bacillariophyceae, 35.00% of Chlorophyceae and 49.05 % of Cyanophycean species live as epiphytes on the surface of aquatic plants (Table 2). Almost all these epiphytic species lives as plankton in the water in all the seasons, which implies that the microalgae are really planktons but they begin to lead the epiphytic mode of life when they settle on the surface of aquatic plants.

Table 3 illustrates the seasonal variations in the density of microalgae in lake water and on the surface of aquatic plants. During the pre-monsoon 671 individuals of Bacillariophyceae, 441 individuals of Chlorophyceae and 371 individuals of Cyanophyceae were observed per 1 litre of lake water and at the same season 32 individuals of Bacillariophyceae, 26 individuals of Chlorophyceae and 24 individuals of Cyanophyceae were observed in 1cm$^2$ leaf-area of aquatic plants. During the monsoon 642 individuals of Bacillariophyceae, 401 individuals of Chlorophyceae and 186 individuals of Cyanophyceae were observed per 1 litre of lake water and in the meantime, 23 individuals of Bacillariophyceae, 21 individuals of Chlorophyceae and 19 individuals of Cyanophyceae were observed in 1cm$^2$ leaf-area of aquatic plants. In the post- monsoon season, 670 individuals of Bacillariophyceae, 412 individuals of Chlorophyceae and 256 individuals of Cyanophyceae were observed per 1 litre of lake water and in the same season 32 individuals of Bacillariophyceae, 25 individuals of Chlorophyceae and 27 individuals of Cyanophyceae were observed in 1cm$^2$ leaf-area of aquatic plants. In the summer months 746 individuals of Bacillariophyceae, 523 individuals of Chlorophyceae and 398 individuals of Cyanophyceae were seen in 1 litre of lake water while 40 individuals of Bacillariophyceae, 28 individuals of Chlorophyceae and 29 individuals of Cyanophyceae were observed in 1cm$^2$ leaf-area of aquatic plants.

**Table 3:** Average density of different classes of planktonic and epiphytic microalgae in the lakes during different seasons

| Algal class | Season* | No. of algal individuals per litre of water | Epiphytic individuals per 1cm$^2$ leaf-area |
|---|---|---|---|
| Bacillariophyceae | Pre-monsoon | 671±14 | 32±3 |
| | Monsoon | 462±18 | 23±2 |
| | Post Monsoon | 670±11 | 32±4 |
| | Summer | 746±9 | 40±3 |
| Chlorophyceae | Pre-monsoon | 441±8 | 26±2 |
| | Monsoon | 401±10 | 21±1 |
| | Post Monsoon | 412±12 | 25±3 |
| | Summer | 523±14 | 28±2 |
| Cyanophyceae | Pre-monsoon | 371±7 | 24±2 |
| | Monsoon | 186±8 | 19±1 |
| | Post Monsoon | 256±9 | 27±2 |
| | Summer | 398±14 | 29±3 |

* Pre-monsoon = July–Sept; Monsoon = Oct – Dec; Post-monsoon = Jan – March; Summer = April – June.

High density of green algae in freshwaters is found to be dependent on high level of nutrients affecting the water quality and on the coexisting biotic communities (Malliswar *et al.*, 2007; Murugesan and Sivasubramanian, 2008). Members of Chlorophyceae flourishwell both in polluted and unpolluted waters (Sanap *et al.*, 2008) but presence of more number of desmids indicates the slightly oligotrophic nature of the water (Rajasulochana *et al.*, 2008). Patrik (1943) is of the opinion that *Spirogyra* and diatom species are indicators of eutrophication. Presence of *Ankistrodesmus fulcatus*, *Chlorella vulgaris*, *Scenedesmus quadricauda*, *Oscillatoria limosa*, *Cyclotella meneghiniana*, *Nitzschia acicularis and Synedra ulna* indicates some organic pollutants in the water (Sanap *et al.*, 2008; Palmer, 1969). Large number of Bacillariophyceae indicates bad quality of water (Verma, 2002) and hence good indicators of water pollution (Prasad and Singh, 1996). Flourishing growth of *Nitzschia* sp., *Navicula* sp., *Fragilaria*, *Synedra*, *Melosira* and *Cocconeis* indicates the presence of water pollutants and inferior quality of lake water for drinking (Nair *et al.*, 1981; Misra *et al.*, 2008*;* Kapila Manoj and Chevli Bhavesh, 2008; Murugan, 2008). *Pediastrum* sp. *a*nd *Closterium* sp. are indicators of inflow of freshwater into the lakes (Bhatt *et al.*,1999).

During the monsoon, the density of microalgae in the lake water decreases due to the dilution of water by rain and then the algal density increases gradually up to the summer because of fast evaporation and more water consumption; the algal density then decreases in the pre-monsoon because of low evaporation and little rains. As the algal density in the water increases, the number of epiphytic algae on the leaves increases from the monsoon to the summer and then their number declines gradually towards the monsoon. This observation makes out a clear point that the number of epiphytic algae on the surface of aquatic plants is directly related to the density of microalgae in the lake water. Kavitha *et al.*, (2005), Sarah *et al.*, (2004) and Thirumal Thangam *et al*., (2010) stressed that the large population of epifloral communities may be due to the high amount of nutrients present in the water and nutrients availability to microalgae. But, the nutrients availability alone could not be the correct reason for the occurrence of epiphytic microalgae in freshwater bodies, because the nutrients availability would help for fast growth of microalgae in the water, which of course lead to an increase in the density of microalgae in the water. As the algal density of water increases, the number of epiphytic individuals would increase gradually.

There has hardly been any specific host specificity among the freshwater epiphytic microalgae. Almost all the species of aquatic macrophytes submerged in the water harbour the epiphytic microalgae. Dorsal side of the leaf of *Nymphaea*and *Nelumbium*had no epiphytic microalgae at all but their ventral surface harbours dense growth of epiphytic algae due to the direct contact of between the water and leaf surface. The ventral surface of the leaves accommodate 12±3 - 68±14 individuals of epiphytic algae per 1cm$^2$ area while the petioles of these leaves bear 18±4 - 76±14 individuals of epiphytic algae per 1cm$^2$ area. Likewise, exposed surfaces of *Eichhornia crassipes*, *Pistia stratiotes*, *Trapa bispinosa*, *Salvinia molesta*, *Salvinia minima*, *Azolla* and *Jussiaea* sp. do not support the growth of epiphytic microalgae but their surfaces in direct contact with water harbour dense growth of epiphytic algae (15±9 -39±12 individuals / 1cm$^2$ area). Submerged hydrophytes such as *Hydrilla* sps., *Ceratophyllum* sps., *Vallisneria* sps., *Potamogeton crispus* and *P. pusillus* harbour 13±5 -32±13 individuals / 1cm$^2$ area because these plants grow a little in water containing much suspended particles and algal blooms. Rooted emergent hydrophytes such as *Typha, Scirpus, Sagitytaria and Limnophila heterophylla* harbour 12±8 -49±9 individuals / 1cm$^2$ area of submerged parts. Further, it is observed that Cyanophycean and Chlorophycean algae are attached to the plant surface by mucilage envelope or mucilage stalk while the members of Bacillariophyceae are attached to the plant surface mainly by their spines or hooks. These observations coincide with the findings of Vetri selvi (2012), Prathap Singh and Regini Balasingh (1912), Cascaller *et al*., (2002), Chandra *et al.*, (2003), Malliswar *et al*., (2007), Thirumal Thangam *et al*., (2010) and Durai and Pandiyan (2011).

From these facts it is concluded that microalgae which have mucilage covering on their surface or mucilage stalk or small spines on the surface, most often lead epiphytic life when the floating individuals had an opportunity to adhere with the surface of aquatic plants. Aquatic plants having rough surface due to the presence of trichomes or silica harbour more number of epiphytic microalgae compared to plants having smooth non-sticky surface. Nutrients availability favours the growth of all the species of microalgae in general but nothing other than high density of microalgae in water is important for the flourishing growth of epiphytic algae on the plant surfaces.

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