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ROLE OF TEMPERATURE IN PHYTOPLANKTON DISTRIBUTION AT TWO SAMPLING LOCATIONS OF BATTICALOA LAGOON, SRI LANKA

Sathananthan.S

ABSTRACT

Batticaloa Lagoon is a very large Estuarine Lagoon in Batticaloa District, eastern Sri Lanka. The city of Batticaloa is located on land between the lagoon and the Ocean. Batticaloa district is flourished with three lagoons, such Batticaloa lagoon, Valaichchenai Lagoon and Vakari Lagoon. Among them, Batticaloa lagoon is the largest lagoon in Batticaloa District. Batticaloa lagoon is a long and narrow lagoon situated in the east coast of Sri Lanka with the total area of approximately 11,500 ha of water.

Two sampling locations Palameenmadu (A) and Sathurukkondan (B) were selected during the study period 2023. The water samples were collected in Dry season (June) and Rainy season (October). The Water Temperature shows significant impact on the enhancement of phytoplankton numbers and Salinity, Nutrient and Depth also show considerable impact on the numbers of phytoplankton members. A greater number of Bascillariophyceae members were identified in warm temperature compare to Cyanophyceae, and Chlorophyceae members.

More number of Desmids were identified in low Salinity and low Salinity particularly in the rainy season. Temperature and nutrient supply are key environmental drivers that control phytoplankton growth and productivity. Water temperatures strongly influence their growth rates. Phytoplankton in warmer equatorial waters grow much faster than their cold-water cousins. (Wikipedia).

Diatoms (Bacillariophyceae) are generally considered to be better adapted to lower temperatures than are other algae. (Lürling M., Eshetu F., Faassen E.J., Kosten S., Huszar V.L.M., 2013)

Index Terms: *Phytoplankton, Zooplankton, Larvae, Algal bloom, Physio-chemical, Genus, Species diversity, Species density, Species composition, Estuary, Bascillariophyceae, Dinophyceae, Chlorophyceae, Cyanophyceae, Sand bar, Streams, Taxa, Euphotic zone, Epipelagic zone, Protista, Cyanobacteria, Diatoms, Coccolithophores, Photosynthetic bacteria, Oligotrophic, Mesotrophic. Eutrophic, Hypereutrophic.*

1. INTRODUCTION

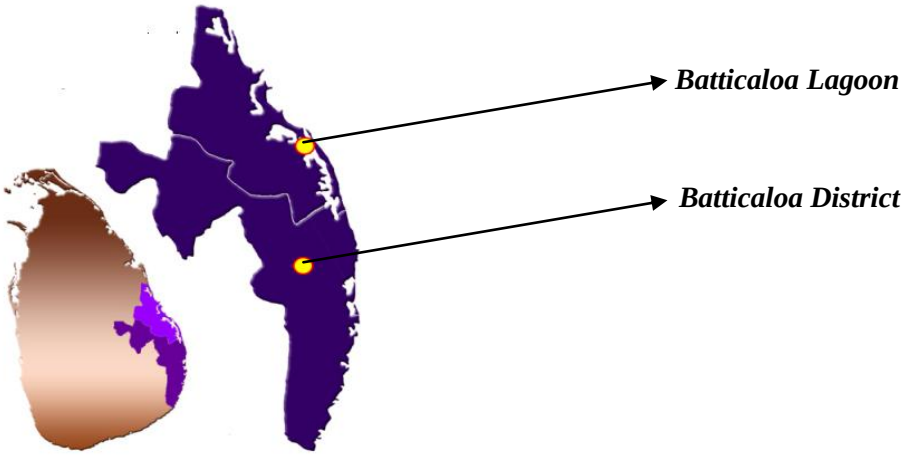
1.1. Batticaloa District in Sri Lanka

Batticaloa is in the Eastern Coast of Sri Lanka on a flat coastal plain boarded by the Indian Ocean in the east occupies a central part of the Eastern Sri Lanka. Also, Batticaloa has a Nickname, "Land of the singing fish" due to musical sounds that related to fish or aquatic

creature in the Batticaloa Lagoon near the Kallady Bridge. Its average elevation is around 5 m (16 ft). Batticaloa District is one of the 25 Districts of Sri Lanka, the second level administrative division of the country. The district is administered by a District Secretariat headed by a District Secretary appointed by the central government of Sri Lanka. The capital of the district is the city of Batticaloa. The district of Batticaloa occupies the central part of the Eastern Province. It covers land area of approximately 2854 square Km. and internal waterway of square of 229 square km. the district accounts for 3.8% of the country's total Land Area.

Batticaloa is a main city situated in the Eastern Province of Sri Lanka. This city is relatively different, Physically and Environmentally. This consists of Peninsula and Islands. Favourable the environment in the lagoon fishing industry has created a conducive situation especially for the expansion of prawn farming.

Annual rainfall in Batticaloa is 1,615.30 mm. Unlike in the other district mineral resource available here are limited. Sea shell, pan grass, cane, and forest timber are mineral resources available. The district has a population of 626,341 Density of population is 219 persons per square km in Batticaloa district. The principal categories of land use in the Batticaloa Municipality have been commercial, residential, agriculture, scrubland, mangroves, and Barren land, which were classified to identify the spatial and temporal changes. Annual rainfall in Batticaloa is 1,615.30 mm. Unlike in the other district mineral resource available here are limited. Sea shell, pan grass, cane, and forest timber are mineral resources available. (Wikipedia).



The Location of Batticaloa Lagoon in Batticaloa District in Sri Lanka

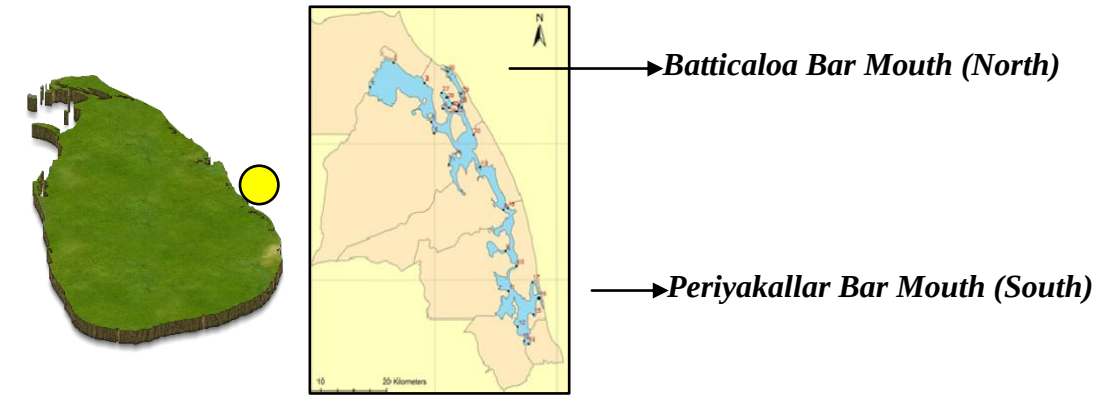
1.2. Batticaloa Lagoon in Batticaloa District

Batticaloa Lagoon is a very large Estuarine Lagoon in Batticaloa District, eastern Sri Lanka. The city of Batticaloa is located on land between the lagoon and the Ocean. Batticaloa district is flourished with three lagoons, such Batticaloa lagoon, Valaichchenai Lagoon and Vakari Lagoon. Among them, Batticaloa lagoon is the largest lagoon in Batticaloa District. Batticaloa

lagoon is a long and narrow lagoon situated in the east coast of Sri Lanka with the total area of approximately 11,500 ha of water.

The lagoon is 56 km long. This lagoon extends from Eravur (Batticaloa district) in the north to Kalmunai (Ampara district) in the south. This lagoon opens into the sea at two points. One in the southern end of the lagoon at Kallar and the other is midway of the lagoon at Palameenmadu which is close to the Batticaloa town. Both are narrow and approximately 200 m wide. The width of the water flow at their openings varies with the seasons. During the dry season the width of the bar mouth of the lagoon decreases and gradually it gets closed with the onset of the north east monsoon which piles up the sand bar by the end of dry season. Later with the rains and with the lagoon mouth closed.

The lagoon is fed by a number of small Rivers. It is linked to the sea by a two narrow channels, one at Batticaloa and the other at Periyakallar. During the dry season these channels are blocked by Sand Bars. The Lagoon is surrounded by a densely populated region used for cultivating rice, coconut and other crops. The surrounding land is used for shrimp farming and rice cultivation. The lagoon has extensive mangrove swamps and some sea grass beds. The lagoon attracts a wide variety of water birds. (Wikipedia).

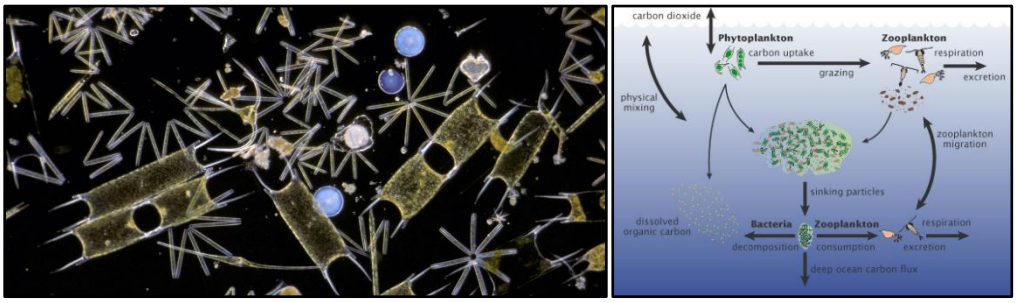


Bar Mouth at Batticaloa (North) and Periyakallar (South)

1.3. Phytoplankton

Phytoplankton are the autotrophic components of the plankton community and a key part of ocean and freshwater ecosystems. Phytoplankton, also known as microalgae, are similar to terrestrial plants in that they contain chlorophyll and require sunlight in order to live and grow.

Most phytoplankton are buoyant and float in the upper part of the ocean, where sunlight penetrates the water. Phytoplankton also require inorganic nutrients such as nitrates, phosphates, and sulfur which they convert into proteins, fats, and carbohydrates. Phytoplankton are the foundation of the aquatic food web, the primary producers, feeding everything from microscopic, animal-like zooplankton to multi-ton whales. Small fish and invertebrates also graze on the plant-like organisms, and then those smaller animals are eaten by bigger ones.(Wikipedia).



Phytoplankton and Re-Cycling Pattern

Microscopic organisms that live in watery environments, both salty and fresh. Phytoplankton are microscopic plants, but they play a huge role in the aquatic food web. Like plants on land, phytoplankton perform photosynthesis to convert the sun's rays into energy to support them, and they take in carbon dioxide and produce oxygen. "Marine photosynthesis is dominated by microalgae, which together with Cyanobacteria, are collectively called phytoplankton." Phytoplankton are extremely diverse, varying from photosynthesizing bacteria (cyanobacteria), to plant-like Diatoms, to armour-plated Coccolithophores. (Wikipedia).

Cyanobacteria **Diatoms** **Coccolithophores**

Phytoplankton are microscopic plants floating around in marine and aquatic ecosystems that produce 50-80% of the world's oxygen. Besides providing food for countless other organisms, they are so effective at absorbing carbon dioxide that some have suggested growing phytoplankton as a solution to climate change. Phytoplankton and algae form the bases of aquatic food webs. They are eaten by primary consumers like zooplankton, small fish, and crustaceans. Primary consumers are in turn eaten by fish, small sharks, corals, and baleen whales. (Wikipedia).

2. OBJECTIVE

The composition and abundance of phytoplankton vary widely in the diverse aquatic ecosystems, exhibiting sometimes a pronounced seasonal succession, influenced by diverse factors such as temperature and salinity (Muylaert et al. 2000). The composition, population number and diversity of phytoplankton are important indicators of water quality, regarded as

important indicators of aquatic health. Just like plants on land, phytoplankton contain chlorophyll, the green pigment that enables photosynthesis. When phytoplankton are abundant the Bay is a greenish-blue hue. In their absence, the water is often clear and bluer, reflecting the color of the sky above. Phytoplanktons are the first bio- indicators of pollution in aquatic ecosystems. Phytoplankton assemblages are generally more sensitive to pollution than other assemblages (Whitton et al. 1995). Therefore, they are the best biological indicators of pollution in the aquatic habitat (Javed, 2006).

Phytoplankton assemblage and aquatic ecosystems are always influenced by environmental factors therefore these environmental changes and threats must be understood in any ecosystem. Excessive growth of phytoplankton in water can also be among the causes of water pollution. However, these wastes are biodegradable (waste that can decompose). The large bacterial population present in the water can decompose the organic matter. These bacteria consume the oxygen present in the water. Phytoplankton remove carbon dioxide from the water for photosynthesis. Carbon dioxide is acidic in water, and the pH of water will increase during the day as phytoplankton remove carbon dioxide for photosynthesis. (https://www.globalseafood.org/advocate/phytoplankton-impact-water).

The pH of water is a very important conventional variable of water quality, as extremely high or low pH values can be damaging to the use of water. Water that has a pH lower than 5.0 or greater than 9.6, becomes harmful for different reasons. Elevated pH levels cause damage to the gills and skin of aquatic fish and other organisms. If levels continue to rise above a pH level of 10.0, aquatic organisms will die from ammonia poisoning. However, some fish like African cichlids can tolerate high pH levels (up to 9.5) in freshwater environments.
(https://atlas-scientific.com/blog/how-does-ph-affect-water-quality/)

The followings are taken for the consideration and Estimation;

1. the phytoplankton composition, species diversity & the density of different phytoplankton species of the lagoon in different seasons.
2. the role of physio – chemical properties on the occurrence of phytoplankton assemblage in the lagoon water.
3. the sequence of changes in their biomass with the nutrient enrichment of the lagoon due to releases from the catchments.
4. the condition of the lagoon water during blooms.
5. the possibility of using species diversity & density of phytoplankton in the lagoon and diversity indices for the prediction of water quality using phytoplankton as environmental indicators.

3. METHODOLOGY

3.1. Study area and sampling locations of Batticaloa Lagoon

The Batticaloa lagoon is categorized into three basins, which are Northern basin, Southern basin and Intermediate basin. During 2023 investigation period, in June (Hot season) and

October (Rainy season) water samples were collected and both sampling regions are located at Intermediate basin which are Palameenmadu area (A) [which is Estuarine (Bar Mouth) closed in Hot season and Opened in Rainy season and Sathurukkondan area (B) surrounded by Mangrove vegetation and wet lands with migratory birds, which receives drainage from Paddy lands, hotels, catchments areas, during rainy season by surface run-off. The Atmospheric temperature, Water temperature, Salinity and pH were measured directly at the sampling locations.

Water samples were collected at 10 m distance away from the shore by using a boat. So, at Palameenmdu (A) and Sathurukkondan (B) during hot season two water samples were collected and at Palameenmdu (A) and Sathurukkondan (B) during Rainy season two samples were collected, totally 4 water samples were collected and analyzed. The phytoplankton members were identified at genus level. In this study the Batticaloa lagoon and its catchment was considered as an interacting ecosystem. Any activity within the catchment may influence the quality of water in its inlets thus causing changes in the phytoplankton assemblage of the lagoon. These changes could cause changes in the phytoplankton biomass within the lagoon. Therefore, specifically two sampling regions were selected to represent seasonal variation of phytoplankton in the lagoon. Both sampling locations are fishing areas.

Sampling Location Palameenmadu (A)

Sampling Location Sathurukkondan (B)

Comparatively the sampling location Sathurukkondan (B) shows low salinity, low Conductivity and low depth than the sampling location Palameenmadu (A). Stars indicate the sampling locations in the Batticaloa Lagoon during the study period 2023.

3.2. Collection of water samples, Sampling procedure and Estimation of Phytoplankton at Genus level

Sampling was done in June (Hot season) and November (Rainy season) at Palameenmadu (A) area and Sathurukkondan (B) area respectively, during the investigation periods 2023. At each

sampling region water samples were collected from the boat at 9.00 am. to 10.00 am. At each sampling location, water samples were collected 10 m away from the shore by using a water sampler (Science First^{TM} 1.5L Water Sampler) with a volume of 1.5 L operated from the boat. The collected water samples were immediately transferred to sterile bottles and 100 ml of collected samples were again transferred to another sterile bottle then fixed with 1 ml Lugol's solution and covered with aluminum foil and placed in undisturbed box. The collected water samples were transferred to laboratory as quick as possible and maintained for 24 hrs. under undisturbed condition. Then the settled phytoplankton mass was carefully separated byusing a micro pipette and estimated the species composition by using hemocytometer.

3.3. Phytoplankton Composition and Enumeration

For phytoplankton studies 1.5 L with the help of water sampler water sample was collected and transferred to 1.5 L Amber bottles, the bottles, which contain water samples, were covered with thin aluminum foil to protect from sunlight and then immediately transferred to laboratory as quick as possible. The 100 ml of the water sample was taken from the amber bottle and treated with Lugol's solution at the rate of 100:1 in order to fix and preserve the phytoplankton for 24 hours. The Lugol's solution was prepared by dissolving 10 g of pure iodine and 20 g of KI in 200 ml of distilled water to which 20 ml glacial acetic acid was added three days prior to sampling. The solution was kept in amber bottles. Iodine, which is usually prepared as Lugol's solution, offers the double advantage of making cells heavy enough to settle. Therefore, the preservation and counting of many flagellates was made possible. Therefore, the most suitable phytoplankton preservative is Lugol's solution, which can be used for all forms including the naked flagellates. The major preservatives in use today (formalin, Lugol's solution, and glutaraldehyde) are discussed. (Wetzel, R. G., & Likens, G.E. 1991).

3.4. Isolation of phytoplankton

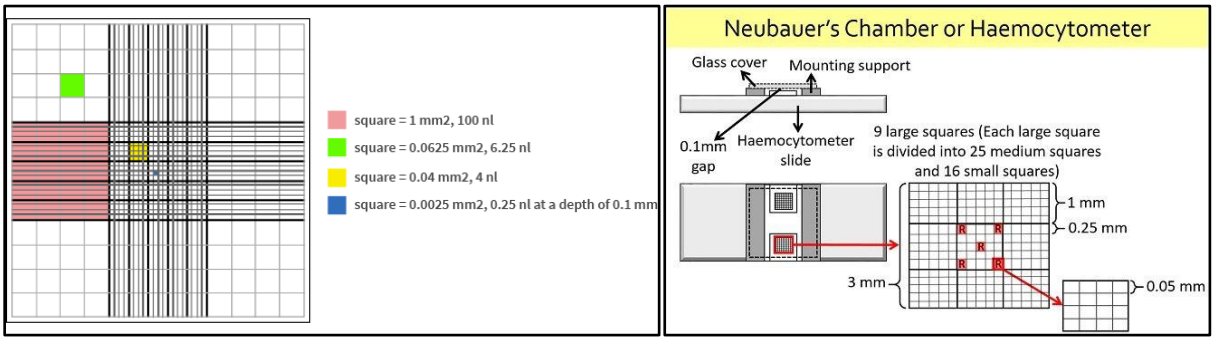
From the preserved water sample 90 ml of supernatant was removed carefully by using a syringe and also it was confirmed that the supernatant did not have any algal cells. The remaining concentrated 10 ml of the sample was centrifuged at 4000 r.p.m. for 15 minutes. After centrifuging 9 ml of supernatant was removed carefully by using a syringe and also it was confirmed that the supernatant does not have any algal cells. The final 1ml concentrated solution of 100 ml sample, was subjected to species composition and algal counts (Anon, 1992a).

Identification was done at genus level by using a key "Phytoplankton Identification". (http://oceandatacenter.ucsc.edu/PhytoGallery/phytolist.html).

Identification at Genus level was done by the following method. At the beginning the distinguishing features of each species were carefully recorded. In this regard the following identification parameters were considered, which are presence or absence of plastids (prokaryotes or eukaryotes), unicell (motile or non-motile & shape of the cell), colony (motile or non-motile cells), filamentous (shape of cells, presence or absence of any frustule's projections).

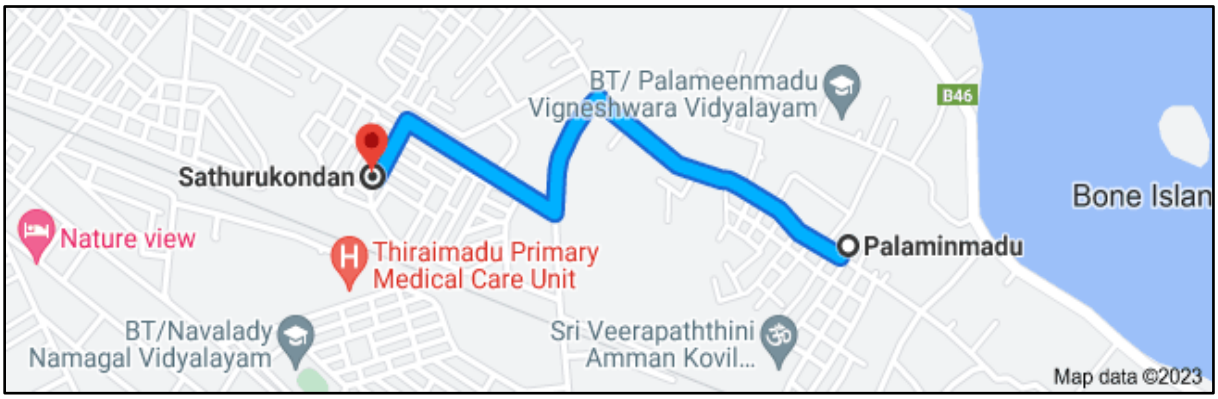
3.5. Counting of phytoplankton:

Counting of phytoplankton was done by using a Neubauer's Chamber or Haemocytometer through Compound Microscope (Olympus / Tokyo No: 615534). From the concentrated 1ml sample, sub samples were taken using a pipette and placed on the Haemocytometer for identification and counting. Counting was done in triplicates for enumeration of phytoplankton density. Observation made through low power (4x10x= 40x) and medium power (10x10x=100x). The volume of squares of Haemocytometer was pre-calculated as follows.



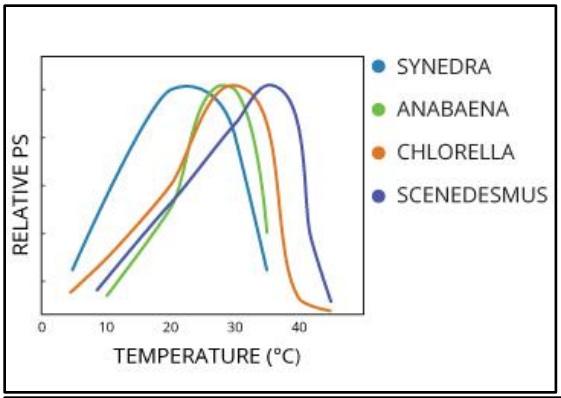
4. RESULT AND DISCUSSION

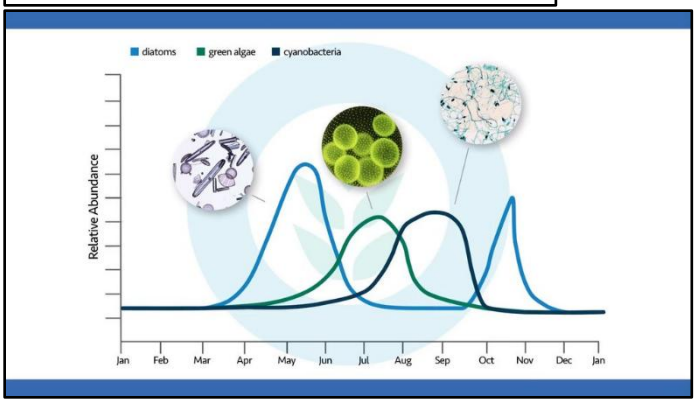
4.1. Physico-Chemical Parameters of Batticaloa Lagoon

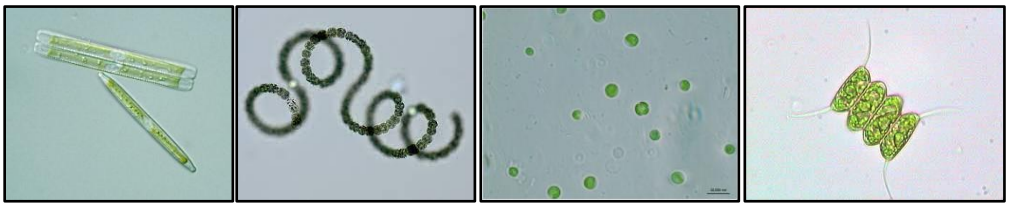


The Distance between Palameenmadu and Sathurukkondan is 1.7 Km

Temperature is an important factor affecting distribution and productivity of phytoplankton (Behrenfeld *et al.*, 2006; Finkel *et al.*, 2010). Species distributions often track the changes of isotherms (Walther *et al.*, 2002; Gregory *et al.*, 2009). The limits of species distribution may be determined by physiological tolerance to temperature extremes or by indirect factors such as solar radiation, nutrients or biotic interaction that covary with temperature in aquatic ecosystems (Brown, 1995). Knowledge of the temperature tolerance curves or thermal reaction norms is essential for predicting how organisms and ecosystems will respond to future climate change (Follows *et al.*, 2007; Thomas *et al.*, 2012).







Synedra ***Anabaena*** ***Chlorella*** ***Scenedesmus***

Light Intensity often correlates with Temperatures, but it can impact algae in different ways. More light often fuels more algal growth, but too much can actually hurt algae. For example, ultraviolet light, or UV rays, may negatively impact some types of algae, like diatoms. They have a hard time dealing with those types.
(https://www.sepro.com/stewards-of-water/archive/algae-corner-growth-factors-seasonality)

Phytoplankton are Ectotherms and are thus directly influenced by Temperature. They experience temporal variation in temperature which results in a selection pressure. Moreover, phytoplankton growth rates increase with increasing of temperature, almost doubling with each 10°C increase in temperature. warmer temperatures have a negative influence on phytoplankton growth because the most likely explanation is that the warmer the surface waters become, the less mixing there is between those waters and deeper, more nutrient-rich water.
(https://www.google.com/search?q=effect+of+temperature+on+phytoplankton).

However, deep cold waters are characteristically nutrient-rich, with nutrients upwelling from the deeper layers to the surface where they can be utilized by the phytoplankton. Phytoplankton require nutrients such as nitrates, phosphates, silicates and iron, all of which are found in the deep layers of cold water. Phytoplankton are very sensitive to environmental change (Doney et al. 2012), and both temperature and irradiance are among the key environmental drivers whose distribution is predicted to continue changing in the future (De Stasio et al. 1996; Boyd et al. 2015).

4.1.1. Water Temperature

The water temperature measured in June (dry season) at the sampling location Palameenmadu (A) was 30^{o}C. The depth in this location is 3 m. This sampling location (A) receives Sea water intrusion close to Bar mouth. the sampling location (A).The water temperature measured in October (rainy season) at the sampling location A was 29^{o}C.

The water temperature measured at the sampling location Sathurukkondan (B) in June (dry season) and October (rainy season) were 32^{o}C and 30^{o}C respectively. This sampling location is located close to the wet land area and surrounded by paddy lands, Temples, mini market and small shops.

4.1.2. Salinity

The salinity measured at the sampling location Palameenmadu (A) in June (dry season) and October (rainy season) were 35 ppt and 24 ppt respectively, and the salinity measured at the sampling location Sathurukkondan (B) June (dry season) and October (rainy season) were 4 ppt and 2 ppt respectively. The distance from Palameenmadu (Bar mouth) to A (Sathurukkondan) is 1.7 Km.

4.1.3. Conductivity

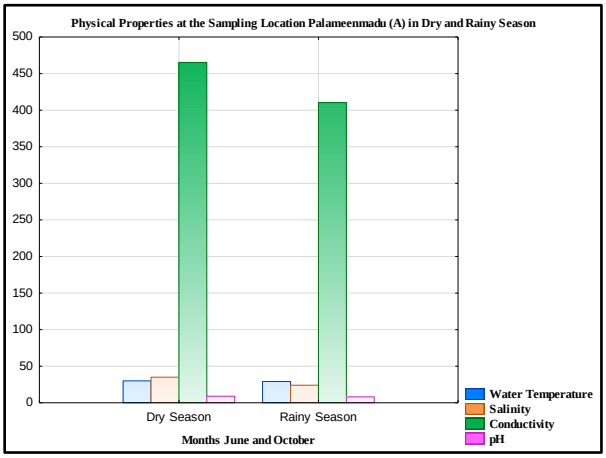
The conductivity measured at the sampling location Palameenmadu (A) in June (dry season) and October (rainy season) were 465µS/cm and 410µS/cm respectively, and the conductivity measured at the sampling location Sathurukkondan (B) in June (dry season) and October (rainy season) were 320µS/cm and 290µS/cm respectively.

4.1.4. pH

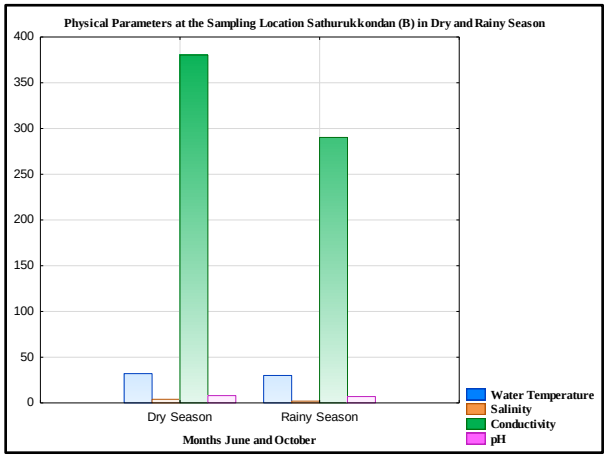
The pH measured at the sampling location Palameenmadu (A) in June (dry season) and October (rainy season) were 9 and 8 respectively, and the pH measured at the sampling location Sathurukkondan (B) in June (dry season) and November (rainy season) were 8 and 7 respectively.

Physical parameters in June (Dry season) 2023 at the sampling locations

Palameenmadu (A) and **Sathurukkondan (B)** in **Batticaloa Lagoon**				
Sampling locations	**Water Temp. ^{o}C**	**Salinity ppt**	**Conductivity µS/cm**	**pH**
Palameenmadu (A)	30	35	465	9
Sathurukkondn (B)	32	4	380	8
Physical parameters in **October (Rainy season) 2023** at the sampling locations **Palameenmadu (A)** and **Sathurukkondan (B)** in **Batticaloa Lagoon**				
Sampling locations	**Water Temp. ^{o}C**	**Salinity ppt**	**Conductivity µS/cm**	**pH**
Palameenmadu (A)	29	24	410	8
Sathurukkondn (B)	30	2	290	7



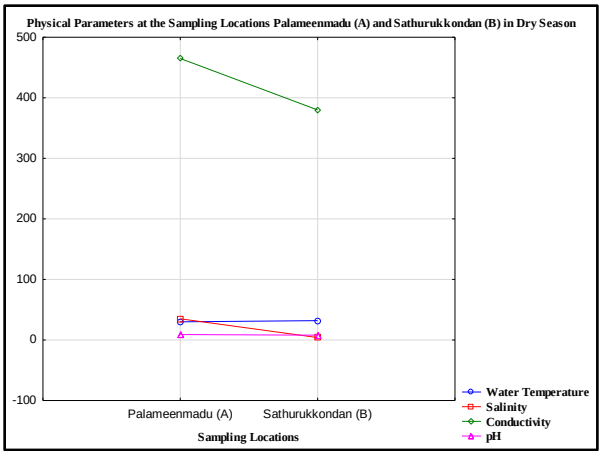
Graph-I



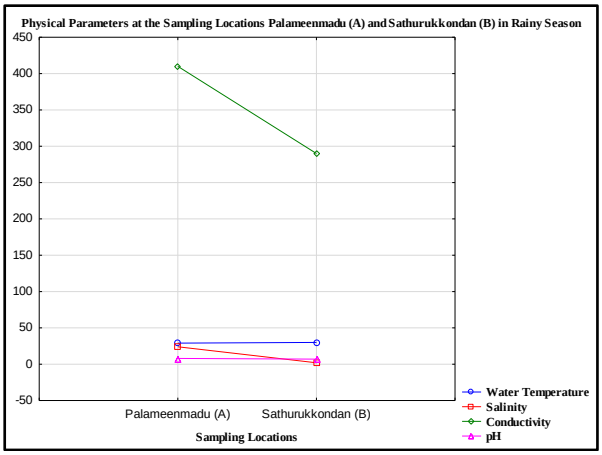
Graph-II

Graph-I: Physical Parameters (Water Temperature, Salinity, Conductivity and pH) at the Sampling Location Palameenmadu (A) in Dry and Rainy Season.

Graph-II: Physical Parameters (Water Temperature, Salinity, Conductivity and pH) at the Sampling Location Sathurukkondan (B) in Dry and Rainy Season.



Graph-III



Graph-IV

Graph-III: Physical Parameters (Water Temperature, Salinity, Conductivity and pH) at the Sampling Location Palameenmadu (A) and Sathurukkondan (B) in Dry Season.

Graph-IV: Physical Parameters (Water Temperature, Salinity, Conductivity and pH) at the Sampling Location Palameenmadu (A) and Sathurukkondan (B) in Rainy Season.
Comparatively the sampling location B (Sathurukkondan) shows higher temperature in dry and rainy season due to low depth and water current. The sampling location A (Palameenmadu) is comparatively higher depth and the water current also high and close to the Bar mouth.

Bar Mouth close to Palameenmadu Sathurukkondan

Water temperature is a key factor affecting phytoplankton bloom dynamics in shallow productive coastal waters and could become crucial with future global warming by modifying bloom phenology and changing phytoplankton community structure, in turn affecting the entire food web and ecosystem services. Warmer conditions may reduce the abundance and primary productivity of phytoplankton - microscopic photosynthetic algae that form the base of the marine food web. This decrease results from enhanced stratification, less vertical mixing and reduced nutrient supply to the Euphotic Zone. Temperature and nutrient supply are key environmental drivers that control phytoplankton growth and productivity. Water temperatures strongly influence their growth rates. Phytoplankton in warmer equatorial waters grow much faster than their cold-water cousins.(Wikipedia).

During the study period in 2023 at the sampling location B (Sathurukkondan) in dry and rainy season at the temperature 32^{o}C and 30^{o}C respectively a greater number of Cyanobacteria members were identified and Chlorophyta members and then Bascillariophyta and Dinoflagellates members. Temperature is a key driver of phytoplankton community composition and has both direct and indirect effects. The indirect effects include alterations in water column stability, nutrient recirculation, phosphorus release from the sediment as well as changes in grazer populations, which also shape the phytoplankton community structure. (Winder, M.; Sommer, U., 2012), (Jeppesen, E.;et al 2010).

During the study period in 2023, at the sampling location A (Palameenmadu) during rainy season compare to dry season more Bascillariophyta members were identified. Eutrophication symptoms are exacerbated by rising temperatures and heat waves, often resulting in increasing cyanobacteria blooming. (Paerl, H.W.; Huisman, J. Blooms.,2008).

Before species go extinct, rising temperatures will alter species dominance. Therefore, phytoplankton evenness (a measure of how equitable species are distributed within the community) is expected to be even more responsive to rising temperatures than richness (Hillebrand et al., 2008).The effect of temperature on phytoplankton physiology and metabolic processes is well known. First, under light-saturated conditions, higher temperature increases specific phytoplankton productivity by acting on photosynthetic carbon assimilation

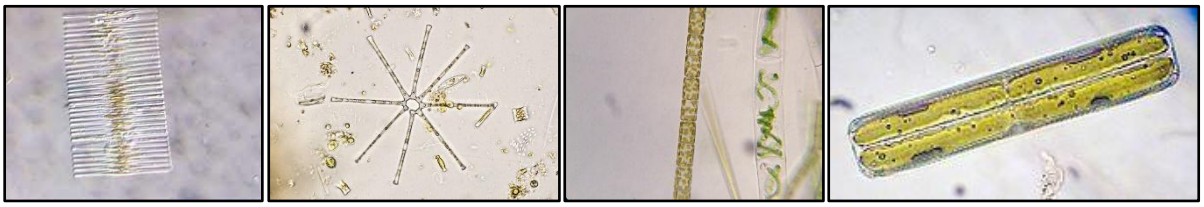
Another study showed that warming had positive effects on phytoplankton biomass but was strongly negatively affected by decreasing nutrient flux at higher temperatures (Lewandowska et al. 2014). A decrease in cell size can come about by direct effects of the environment on phytoplankton, e.g., higher temperature increasing metabolism, or indirectly, where environmental conditions alter grazing pressure on phytoplankton abundance, composition and cell size (Winder and Sommer, 2012).

Some diatom species even form serious blooms in spring and cause a series of ecological problems, such as low water transparency, bad odors, clogging or sedimentation in water treatment processes, and a decrease in the perceived aesthetic value of the water body. (Kolmakov V.I., Gaevskii N.A., Ivanova E.A., Dubovskaya O.P., Gribovskaya I.V., Kravchuk E.S., 202)

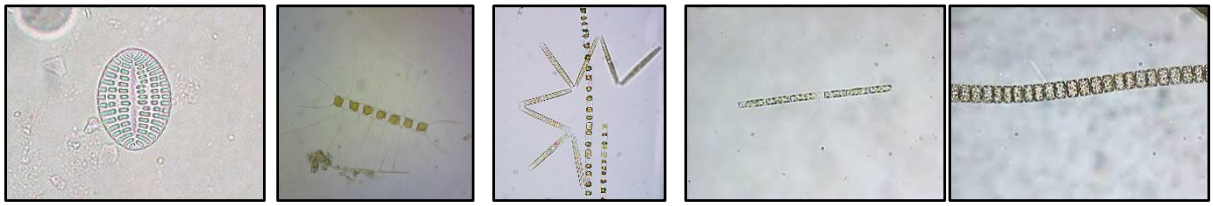
Phytoplankton members Identified at the sampling location A (Palameenmadu) during dry season (June) in the study period 2023:

Stephanodiscus ***Coscinodiscus*** ***Gyrosigma*** ***Pleurosigma***

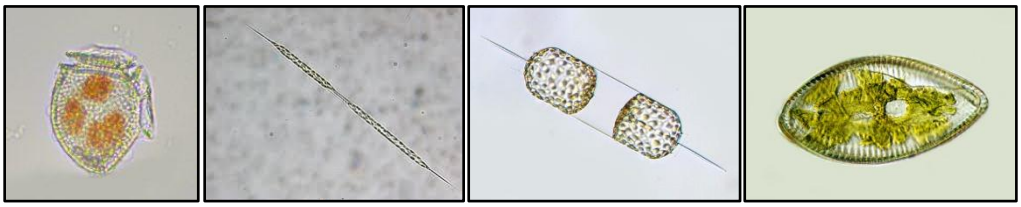
Navicula *Nitzchia* *Cymbella* *Synedra*



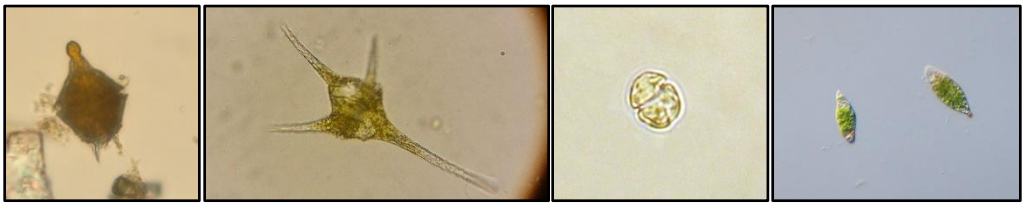
Fragillaria *Asterionella* *Melosira* *Pinnularia*



Cocconeis *Chaetoceros* *Thalassionema* *Leptocylindrus* *Detonula*



Dinophysis *Rhizosolenia* *Ditylum* *Surirella*



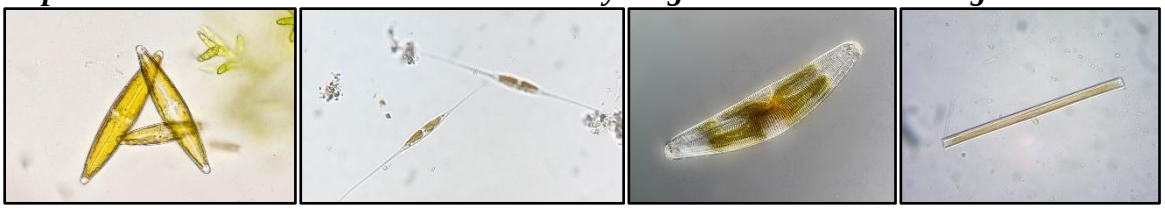
Gonyaulax *Ceratium* *Gymnodinium* *Euglena*

Oscillatoria *Mougeotia* *Coccolithophore* *Stigonema*

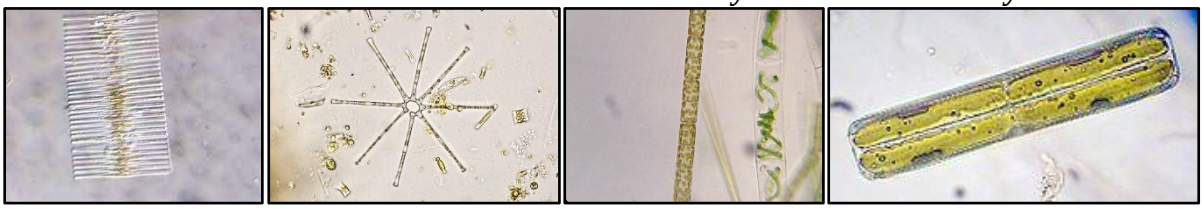
More number of Bascillariophycean and Dinophycean members were identified in dry season and Cyanophycean and Chlophycean members were identified in low numbers.

Phytoplankton members Identified at the sampling location A (Palameenmadu) during rainy season (October) in the study period 2023:

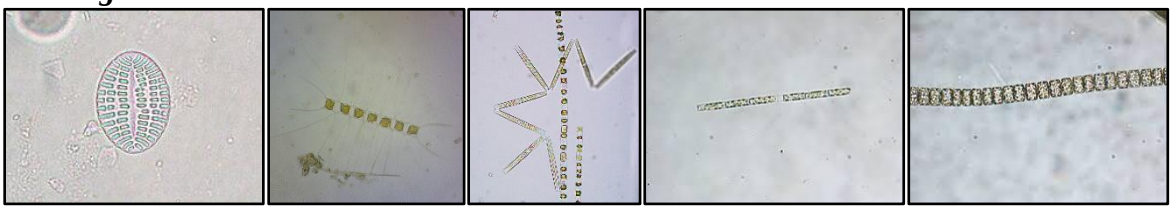
Stephanodiscus ***Coscinodiscus*** ***Gyrosigma*** ***Pleurosigma***



Navicula ***Nitzchia*** ***Cymbella*** ***Synedra***

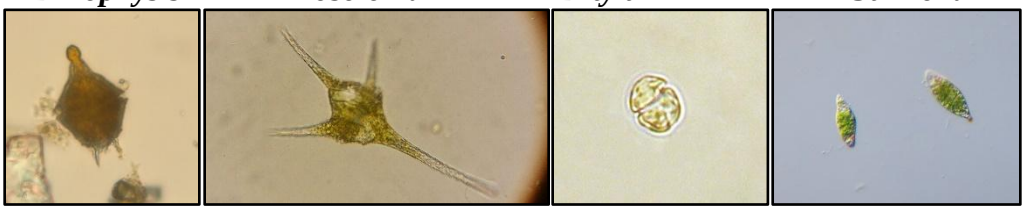


Fragillaria ***Asterionella*** ***Melosira*** ***Pinnularia***



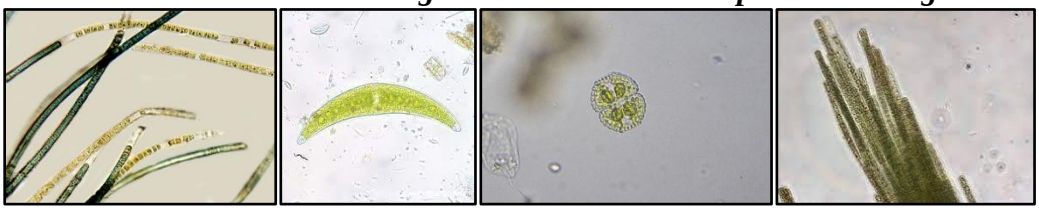
Cocconeis ***Chaetoceros*** ***Thalassionema*** ***Leptocylindrus*** ***Detonula***

Dinophysis ***Rhizosolenia*** ***Ditylum*** ***Surirella***



Gonyaulax ***Ceratium*** ***Gymnodinium*** ***Euglena***

Oscillatoria *Mougeotia* *Coccolithophore* *Stigonema*



Lyngbya *Closterium* *Cosmarium* *Aphanizomenon*

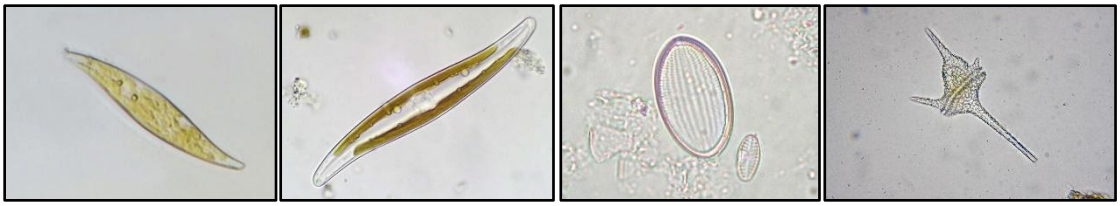
At the sampling location A (Palameenmadu) during rainy season (October) compare to dry season (June) additionally four members were identified which are two Cyanophycean members (*Lyngbya* and *Aphanizomenon*) and two Desmids (*Closterium* and *Cosmarium*). Desmids are freshwater organisms and in the rainy season the low salinity may be the reason for the presence of Desmids. Desmids are primarily found in freshwater habitats, such as ponds, rivers, and lakes. There, they may live as phytoplankton, on the bottom as benthic dwellers, or on the submerged portions of plants. They may also be found in saline waters, or in snow or ice. (Handbook of Protoctista, ed. by L. Margulis et al., 1990 Jones and Bartlett, chapter 9 by R. W. Hoshaw, R. M. McCourt, and J. Wang.)

Phytoplankton members Identified at the sampling location B (Sathurukkondan) during dry season (June) in the study period 2023:

Anabaena *Microcystis* *Oscillatoria* *Merismopedia* *Lyngbya*

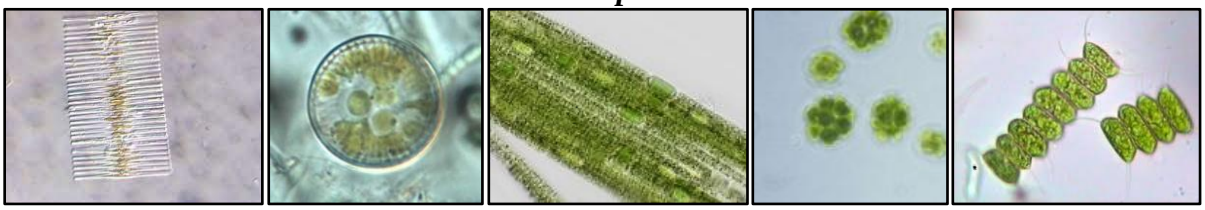
Phacus *Euglena* *Spirogyra* *Oedogonium* *Zygnema*

Navicula *Nitzchia* *Stephanodiscus* *Coscinodiscus*

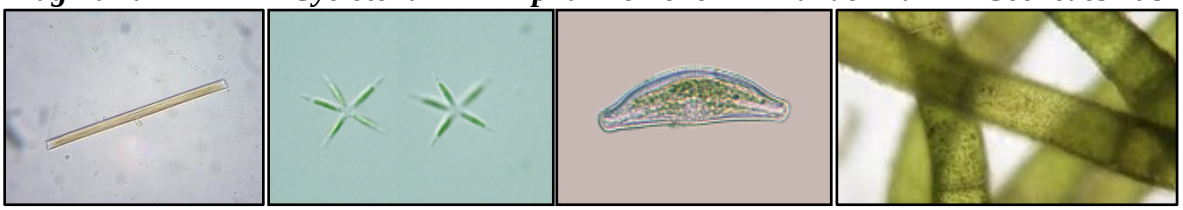


Pleurosigma *Gyrosigma* *Cocconeis* *Ceratium*

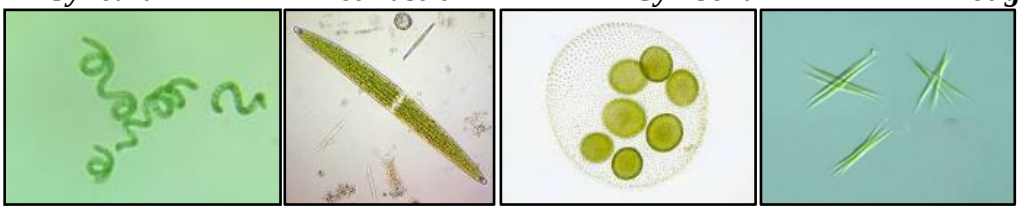
Surirella *Pinnularia* *Bidulphia* *Chaetoceros* *Rhizosolenia*



Fragillaria *Cyclotella* *Aphanizomenon* *Pandorina* *Scenedesmus*



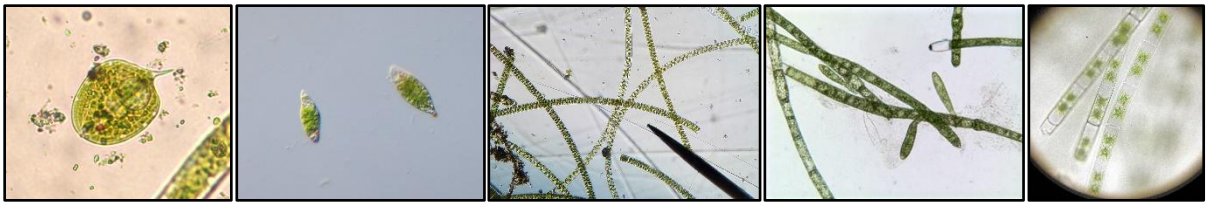
Synedra *Actinastrum* *Cymbella* *Mougiotia*



Spirilina *Closterium* *Volvox* *Ankistrodesmus*

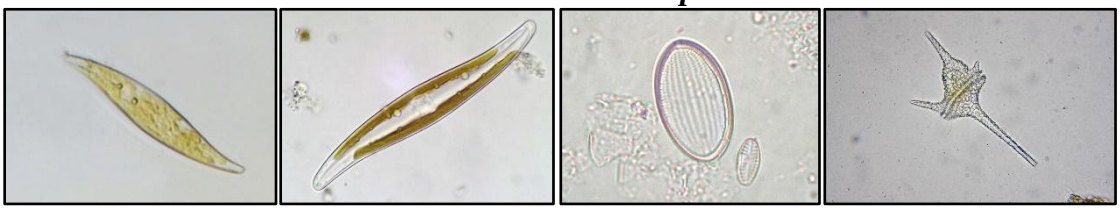
Phytoplankton members Identified at the sampling location B (Sathurukkondan) during rainy season (October) in the study period 2023:

Anabaena *Microcystis* *Oscillatoria* *Merismopedia* *Lyngbya*



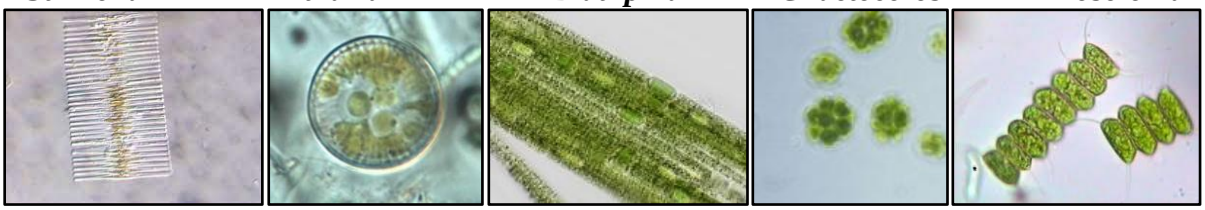
Phacus *Euglena* *Spirogyra* *Oedogonium* *Zygnema*

Navicula *Nitzchia* *Stephanodiscus* *Coscinodiscus*

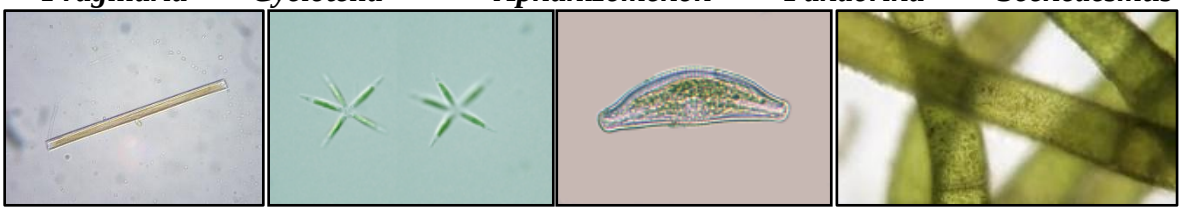


Pleurosigma *Gyrosigma* *Cocconeis* *Ceratium*

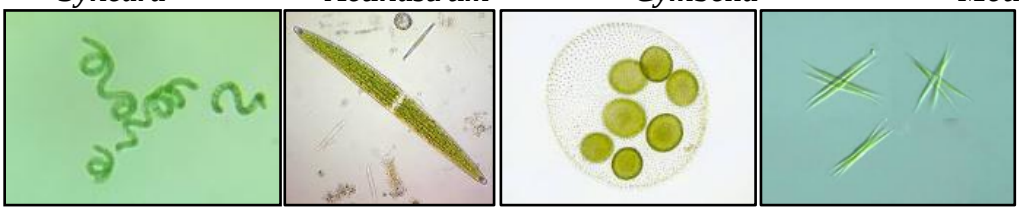
Surirella *Pinnularia* *Bidulphia* *Chaetoceros* *Rhizosolenia*



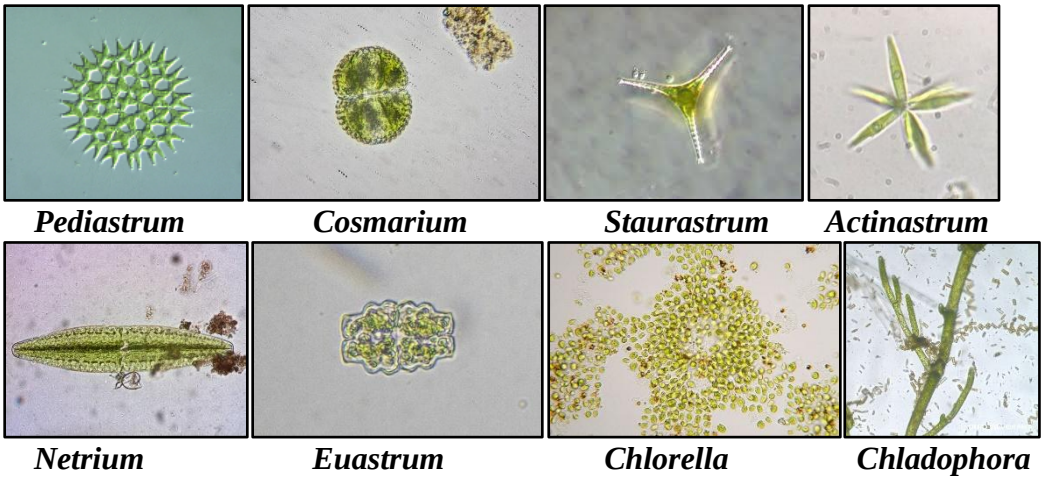
Fragillaria *Cyclotella* *Aphanizomenon* *Pandorina* *Scenedesmus*



Synedra *Actinastrum* *Cymbella* *Mougiotia*



Spirilina *Closterium* *Volvox* *Ankistrodesmus*



The sampling location B (Sathurukkondan) is compared to the sampling location A (Palameenmadu) having low Salinity and low Depth. In the sampling location B members were identified in different divisions namely Cyanophyceae, Bascillariophyceae, Dinophyceae, Chlorophyceae. Compare to Dry season a greater number of Desmids were identified in Rainy season.

5. CONCLUSION

The Water Temperature enhancing the number of members at the sapling locations, but the Salinity, Nutrients, and Depth of the sampling locations also having impact on the distribution of members. In high Salinity locations with high temperature a greater number of Bascillariophyceae members and low number of Cyanophyceae members were identified and in addition a greater number of Desmids were identified at the low saline sampling locations. At the sampling location A (Palameenmadu) a greater number of Bascillariophyceae members and low number of Cyanophyceae members were identified and in rainy season few numbers of Desmids were identified. At the sampling location B (Sathurukkondan) Bascillariophyceae, Dinophyceae, Cyanophyceae, and Chlorophyceae members were identified. Comparatively a greater number of Cyanophyceae members were identified. In rainy season a greater number of Desmids were identified.

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