© 2023, Centre for Advanced Research in Agricultural Sciences
Research Journal of Agricultural Sciences
Volume 14; Issue 05 (Sep-Oct 2023); pp 1316–1321
CARAS

ISSN: 0976-1675 (P)
ISSN: 2249-4538 (E)

Full Length Research Article

Preliminary Study on the Abundance of Phytoplankton Diversity of Vaduvur Bird Sanctuary Lake Water

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Abstract

The group of organisms known as freshwater phytoplankton, which is taxonomically and functionally varied, is essential to the biogeochemical cycle. A healthy aquatic ecosystem depends heavily on phytoplankton for nutrient intake, the food chain, and ecosystem maintenance. The entire water column is dominated by phytoplankton, a significant primary producer that also sustains life underwater. We studied the availability of species in freshwater phytoplankton samples from the Vaduvur bird sanctuary. The goal of the study is to catalogue the variety of phytoplankton in Tamil Nadu, India's Vaduvur bird sanctuary in the Thiruvarur District. We identified 16 species of phytoplankton, including 6 Bacillariophyceae, 4 Chlorophyceae, 5 Cyanophyceae, and 1 Euglenophyceae. Consequently, the results of the current investigation showed that Bacillariophyceae dominated the ecosystem, followed by Chlorophyceae, Cyanophyceae, and Euglenophyceae.

***Key words*: Microbiology, Phytoplankton, Wetland, Aquatic ecology, Vaduvur bird sanctuary**

The Vaduvur lake is one of the oldest and largest lake of Tamil Nadu. This is very significant Lake in South India. This lake is important ecosystem for fishes and birds. The lake being used for multipurpose utility such as irrigation, migratory birds, fish catching washing and bathing. Biodiversity means the variability among the living organisms from all source including terrestrial lake, freshwater and marine other aquatic ecosystem and ecological complex of which they are part biochemical interactions in the plankton. In plankton ecology, biological and physical dynamics are coupled, structuring how plankton interact with their environment and other organisms [1]. Phytoplankton is a predominant type of a plant found in most lake water. The quality of phytoplankton is a good indicator of water quality. The high relative abundance of *chlorophyta* is an indicator of productive water. Indian researchers reported the several studies on the phytoplankton distribution with availability of light [2], phytoplankton is the occurring in fresh water ecosystems small or fast-flowing rivers may lack a true plankton simply because there is insufficient time for the algae to reproduce effectively [3]. It can be distinguished between limnoplankton (lake phytoplankton), heleoplankton (phytoplankton in ponds), and potamoplankton (river phytoplankton [4]. They differ in size as the environment around them changes. They are affected negatively by the change in salinity in the water.

Phytoplankton is a polyphyletic group with extreme variation in shape, size, colour, type of metabolism, and life history traits [5]. Phytoplankton is a unicellular microscopic floating plant organism that differs in size from< 1µm to 500 µm [6]. The phytoplankton is mainly classified into four classes namely *Bacillariophyceae*, *Chlorophyceae*, *Cyanophyceae* and *Euglenophyceae*. Phytoplankton is the type of algae that lives in freshwater and thereby flourishes the aquatic ecosystem. The photic zone of freshwater ponds, lakes, and rivers as well as marine habitats such as backwaters, mangroves, estuaries, and seas, is populated by phytoplankton. They optimize their home in the upper strata using numerous mechanisms like using gas vacuoles to another using flagella and adaptive metabolic process [7]. Phytoplankton could be a key module of aquatic biota, because it serves as the major primary producer of the aquatic ecosystem and also play a vital role in nitrogen fixation. Consequently, it is important in connecting the biotic and abiotic components in the aquatic ecosystem by forming the basement of the food chain as higher tropic level [8]. Studies of the ecology of fresh water phytoplankton have provided a better insight in to the interaction between competition and predation. Phytoplankton is a tremendous biological indicator in a fluid environment. Due to their short life span, planktons respond to environmental changes too quickly. This study aims to document the phytoplankton species in Vaduvur Bird Sanctuary, Thiruvarur district, Tamil Nadu.

Received: 17 Mar 2023; Revised accepted: 04 Sep 2023; Published online: 21 Sep 2023

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Citation: Chandrakala N, Eswari J. 2023. Preliminary study on the abundance of phytoplankton diversity of Vaduvur bird sanctuary Lake water. *Res. Jr. Agril. Sci.* 14(5): 1316-1321.

Phytoplankton obtain energy through the process of photosynthesis and must therefore live in the well-lit surface layer (termed the euphotic zone) of an ocean, sea, lake, or other body of water. Phytoplankton account for about half of all photosynthetic activity on earth [9]. Their cumulative energy fixation in carbon compounds (primary production) is the basis for the vast majority of oceanic and also many freshwater food webs (chemosynthesis is a notable exception) while almost phytoplankton species are obligate photoautotrophs, there are some that are mixotrophic and other, non-pigmented species that are actually heterotrophic (the latter are often viewed as zooplankton) [10]. Of these, the best known are dinoflagellate genera such as *Noctiluca* and *Dinophysis*, that obtain organic carbon by ingesting other organisms or detrital material.

Phytoplankton live in the photic zone of the ocean, where photosynthesis is possible. During photosynthesis, they assimilate carbon dioxide and release oxygen. If solar radiation is too high, phytoplankton may fall victim to photo degradation. Phytoplankton species feature a large variety of photosynthetic pigments which species-specifically enables them to absorb different wavelengths of the variable underwater light [11]. This implies different species can use the wavelength of light different efficiently and the light is not a single ecological resource but a multitude of resources depending on its spectral composition. By that it was found that changes in the spectrum of light alone can alter natural phytoplankton communities even if the same intensity is available. For growth, phytoplankton cells additionally depend on nutrients, which enter the ocean by rivers, continental weathering, and glacial ice meltwater on the poles. Phytoplankton release dissolved organic carbon (DOC) into the ocean. Since phytoplankton are the basis of marine food webs, they serve as prey for zooplankton, fish larvae and other heterotrophic organisms. They can also be degraded by bacteria or by viral lysis. Although some phytoplankton cells, such as dinoflagellates, are able to migrate vertically, they are still incapable of actively moving against currents, so they slowly sink and ultimately fertilize the seafloor with dead cells and detritus [12].

Phytoplankton are crucially dependent on minerals. These are primarily macronutrients such as nitrate, phosphate or silicic acid, whose availability is governed by the balance between the so-called biological pump and upwelling of deep, nutrient-rich waters. Phytoplankton nutrient composition drives and is driven by the Redfield ratio of macronutrients generally available throughout the surface oceans. However, across large areas of the oceans such as the Southern Ocean, phytoplankton are limited by the lack of the micronutrient iron. This has led to some scientists advocating iron fertilization as a means to counteract the accumulation of human-produced carbon dioxide (CO_2) in the atmosphere. Large-scale experiments have added iron (usually as salts such as ferrous sulfate) to the oceans to promote phytoplankton growth and draw atmospheric CO_2 into the ocean. Controversy about manipulating the ecosystem and the efficiency of iron fertilization has slowed such experiments.

Phytoplankton depend on B vitamins for survival. Areas in the ocean have been identified as having a major lack of some B Vitamins, and correspondingly, phytoplankton. The effects of anthropogenic warming on the global population of phytoplankton is an area of active research. Changes in the vertical stratification of the water column, the rate of temperature-dependent biological reactions, and the atmospheric supply of nutrients are expected to have important effects on future phytoplankton productivity.

The effects of anthropogenic ocean acidification on phytoplankton growth and community structure have also received considerable attention. Phytoplankton such as coccolithophores contain calcium carbonate cell walls that are sensitive to ocean acidification. Because of their short generation times, evidence suggests some phytoplankton can adapt to changes in pH induced by increased carbon dioxide on rapid time-scales (months to years). Phytoplankton serve as the base of the aquatic food web, providing an essential ecological function for all aquatic life. Under future conditions of anthropogenic warming and ocean acidification, changes in phytoplankton mortality due to changes in rates of zooplankton grazing may be significant. One of the many food chains in the ocean-remarkable due to the small number of links-is that of phytoplankton sustaining krill (a crustacean similar to a tiny shrimp), which in turn sustain baleen whales.

The El Niño-Southern Oscillation (ENSO) cycles in the Equatorial Pacific area can affect phytoplankton. Biochemical and physical changes during ENSO cycles modify the phytoplankton community structure. Also, changes in the structure of the phytoplankton, such as a significant reduction in biomass and phytoplankton density, particularly during El Nino phases can occur. Being phytoplankton sensitive to environmental changes is why it is used as an indicator of estuarine and coastal ecological conditions and health. To study these events satellite ocean colour observations are used to observe these changes. Satellite images help to have a better view of their global distribution [13].

Phytoplankton forms the vital source of energy as primary producers and serves as a direct source of food to the other aquatic and animals [14]. Systematic and ecological studies on *Chlorophyceae* of North India and their relationship with water quality were made [15]. In these systems phytoplankton is of great importance as a major source of organic carbon located at these bases [16]. Phytoplankton is small organisms that play a crucial role in the food chain. While increased amounts of phytoplankton provide more food for organisms at higher tropic levels, too much phytoplankton or toxin producing phytoplankton or toxin producing phytoplankton can harm the over health of the Bay [17-18].

About four thousand million years ago, life initiated in an aquatic environment. Today most of the taxonomic phyla dwell in an aquatic environment. In an aquatic environment, phytoplankton is most ubiquitous, unicellular and microscopic life form. Phytoplankton collectively accounted about half of the earth's primary producers. However, light penetration, temperature, nutrient enrichment, toxic substances, mixing of water, parasites, herbivores and heterotrophic microorganism activities influenced the phytoplankton growth [19]. In recent years, researchers have participated in the study of phytoplankton ecology of freshwater lakes in India.

The importance of water was realized as far back as a means of sustenance of life which was expressed in the Greek Philosopher's cryptic saying "Water is best". Galileo, the great physicist of the Italian Renaissance made an attempt to study water physically. The extensive work of who is regarded as the father of Modern Limnology gave an impetus to study this subject intensively. Algal flora of some muddy rain water pools by [20] Algal ecology by [21], Distribution of Euglenophyceae by and work on plankton ecology by are all important landmarks in the study of limnology.

Phytoplankton are producers of aquatic ecosystem. These are autotrophic components of the plankton community and a key part of oceans, seas and fresh water ecosystem. Also are very important organisms from ecological point view. Most of the aquatic food chains. Begin with them. Therefore, these remained popular subject for research during last couple centuries. The literature of such studies is available and while collecting most of the research the difficulties are faced by most of the researches.

To improve predictions of fresh water ecosystem responses to environmental and climate change, plankton physiologists and ecologists need to determine how to qualify and parameterize the key physiological responses of plankton that will in turn affect fresh water food webs and the carbon – climate system. Current community composition and primary production are predicted typically using simplistic phytoplankton growth models based on nutrient uptake kinetics for a limited number of nutrients, usually some combination of nitrogen, phosphorus, silicon and iron.

Role of phytoplankton

In the diagram on the right, the compartments influenced by phytoplankton include the atmospheric gas composition, inorganic nutrients, and trace element fluxes as well as the transfer and cycling of organic matter via biological processes. The photo synthetically fixed carbon is rapidly recycled and reused in the surface ocean, while a certain fraction of this biomass is exported as sinking particles to the deep ocean, where it is subject to ongoing transformation processes, e.g., remineralisation [22]. Phytoplankton contribute to not only a basic pelagic marine food web but also to the microbial loop. Phytoplankton are the base of the marine food web and because they don't rely on other organisms for food, they make up the first trophic level. Organisms such as zooplankton feed of these phytoplankton which are fed on by other organisms and so forth until the fourth trophic level is reached with apex predators. Approximately 90% of total carbon is lost between trophic levels due to respiration, detritus, and dissolved organic matter. This makes the remineralization process and nutrient cycling performed by phytoplankton and bacteria important in maintaining efficiency. Phytoplankton blooms in which a species increases rapidly under conditions favorable to growth can produce harmful algal blooms (HABs).

Fig 1 Study area of Vaduvur bird sanctuary

MATERIALS AND METHODS

Study area

The Vaduvur bird sanctuary is a man-made fresh water ecosystem, created and declared as a bird sanctuary in 1999 by Tamil Nadu and it is located in Thiruvarur district, which is known for "The Granary of South India". The sanctuary is located 21km toward the east of Thanjavur and 20 km toward the west of Mannargudi and spread across 1.28 sq.km. The sanctuary was declared as important bird area in 2004 (Criteria A1). The sanctuary has vegetation which mainly consists of *Acacia nilotica*, *Azadirachta indica*, *Prosopis chilensis* and *Tamarindus indica*, which were planted under sanctuary management programme. In addition, Vennaru River is the main source of water to the Vaduvur Lake. The region is rich in coconut groves, paddy field and other vegetation. The sanctuary rich biodiversity attracts thousands of birds every year.

Methods of sample collection

The water samples were collected with 250 ml water bottles from the surface of the water and immediately filtered with plankton net which is made up of nylon bolting cloth with 50µm mesh size to avoid contamination. Water sample were collected from the lake water on monthly basis. Immediately after collection of plankton samples were preserved in 10% formalin 10cc formalin diluted to10cc of distilled water.

Phytoplankton samples were centrifuged using 10 to 30 ml graduated centrifuges tubes. The samples were allowed to settle down by storing for24 hours informalin. The pellet was subjected to microscopic analysis for species identification. The species of phytoplankton were separated under a light microscope by using inoculation needle to isolate the species. Individual phytoplankton species were mounted on glass slides on a drop of 20% glycerin for further analysis followed by [23].

Phytoplankton identification

The taxonomical identification of phytoplankton from the collected sample was carried out under the light microscope at 46 x and 100 x magnifications and they were photographed using a smart phone manually. Monographs, standard manuals and text books were used to identify the phytoplankton [24-26].

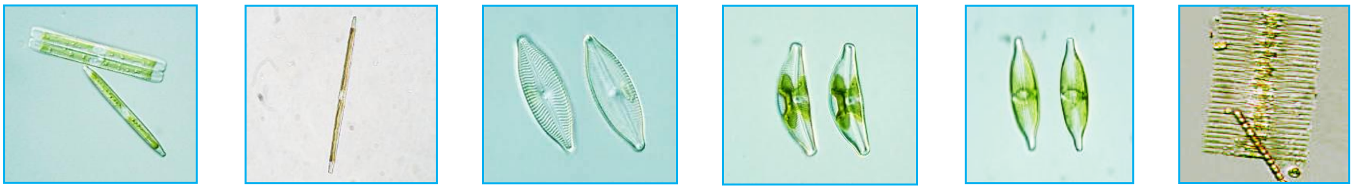
RESULTS AND DISCUSSION

In the present study on the quantitative analysis of phytoplankton of Vaduvur lake water taken monthly pattern and the density of phytoplanktons identified. They belong to the family of Bacillariophyceae (6 Species), Chlorophyceae (4 Species), Cyanophyceae (5 Species), Euglenophyceae (1 Species). The phytoplankton analyzed from the lake water sample were identified and listed (Table 1).

The population density trend showed gradual increase during post-monsoon period and monsoon season Chlorophyceae, Bacillariophyceae and cyanophyceae were recorded in large numbers during the study period and the Bacteriophyceae was dominant there are several reports available on the distribution density. Species diversity and ecology of plankton in different water bodies [27].

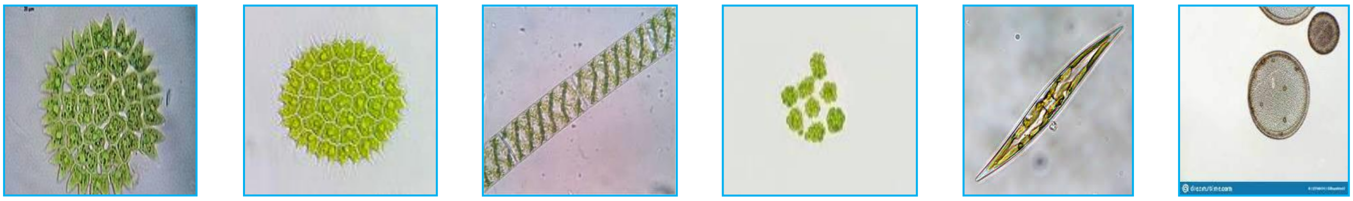
Hence based on the diversity of phytoplankton population highly abundance in the month of December (monsoon). The phytoplankton density due to the presence of high photo synthetic activity in the lake waters. Many reports are available on the plankton diversity of Indian lakes [28-30].

Fresh water phytoplankton is one of the most diverse widespread organisms on the earth. In any ecosystem in this universe, not a single organism can survive indefinitely and independently, because all species were inter linked with each other and have a cyclic transformation of nutrients. Similarly, phytoplankton plays a significant role as a primary producer and base of the feed web in the aquatic ecosystem [31]. On the other hand, some phytoplankton species become toxic to the water bodies and results in the water becoming unfit for human consumption. Phytoplankton is important in any ecosystem because it performs a variety of environmental tasks and is essential not only to the aquatic ecosystem but also to the social structure [32]. Even the sudden increase in population growth rate and deforestation which leads to climate change can modify the environmental factors and alter the taxonomical comption, structure and seasonal dynamics in phytoplankton. Though Vaduvur lake is highly potential for aquatic organisms and various migratory birds, the impact of climate change on the lake and its ecosystem needs a deeper exploration.



a) *Synedra ulna* b) *Nitzschia palea* c) *Navicula gastrum* d) *Navicula cuspidate* e) *Cymbella tumida* f) *Fragilaria Crotonensis*

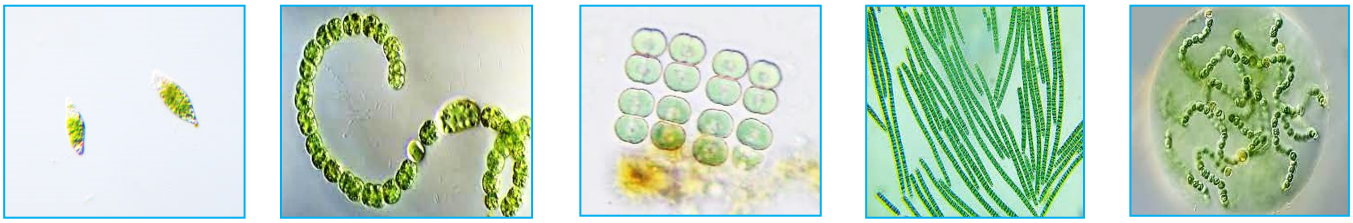
Fig 1 Collected Bacillariophyceae species



a) *Pediastrum duplex* b) *Pediastrum boryanum* c) *Spirogyra sp.* d) *Pandorina sp.* e) *Pleurosigma sp.* f) *Volvox sp*.

Fig 2 Collected Chlorophyceae species

The diversity of healthy aquatic life such as fishes, turtles, shells reptiles, important migratory birds such as spot- billed pelican, Bar- headed goose, Black-winged stilt and Northen shoveler etc., and carnivores like smooth-coated offers are the significance of the study area, because of the rich food source and healthy primary producers in Vaduvur Bird sanctuary. By attracting thousands of land and water birds, aquatic lives, plankton diversity band benefiting to agriculture and humans maybe considered Vaduvur Bird Sanctuary as a best model for the other bird sanctuaries. Hence, phytoplankton which forms one of the primary producers of the sanctuary, demands conservation and deeper insights to their diversity, conservation and production.



a) *Euglena sp.* b) *Anabaena sp.* c) *Merismopedia sp* d) *Spirulina sp.* e) *Nostoc*

Fig 3 Collected Euglenophyceae and Cyanophyceae species

Table 1 List of phytoplankton in Vaduvur bird sanctuary

Group	Genus	Family	Species
Bacillariophyceae (Haeckel, 1878)	Fragilaria (Lyngbye, 1819)	Fragilariaceae (Grev. 1833)	*Fragilaria crotonensis Fragilaria capunia* (Desm. 1830)
	Synedra (Ehrenberg, 1830)	Fragilariaceae (Grev. 1833)	*Synedra acus* (kutzing, 1844)
	Cymbella (C.Agardh 1830)	Cymbellaceae	*Synedra vaucheriae* (kutzing, 1844)
	Nitzchia (Hassal 1845)	Bacillariaceae	*Syndera ulna* (Ehrenberg, 1832)
	Navicula (Bory de SaintVincent, 1822)	Naviculaceae (Kutz. 1844)	*Cymbella aequalis* (W.Smith 1855)
		Cymbellaceae (Grev. 1833)	*Nitzchia dissipata* (Rabenhorst, 1860) *Nitzchia palea* (W.Smith, 1856) *Navicula anglica* (Ralfs 1861) *Navicla gracilis Navicula gastrum* (Kutzing, 1844) *Navicula cuspidata* (Kutzing, 1844)

Chlorophyceae (Willein Warming, 1884) (green algae)	Pediastrum (Meyen, 1829) Spirogyra (Link 1820) Volvox (Linnaeus, 1758) Pandorina (Bory, 1826) Chlamydomonas (C.G Ehrenberg, 1786)	Hydrodictyaceae (Dumortier, 1829) Zygnemataceae (Kutzing, 1843) Volvocaceae Volvocaceae Chlamydomonodaceae	*Pediastrum boryanum* (Meneghini, 1840) *Pediastrum duplex* (Meyen 1829) *Spirogyra sp. Desmidium sp.* *Volvox sp.* *Pandorina sp.* *Chlamydomonas sp*
Euglenophyceae (Schoen., 1925)	Euglena (Ehrenberg, 1830)	Euglenaceae (Carter, 1859)	*Euglena sp*
Cyanophyceae Sachs, 1874 (blue green algae)	Anabaena Oscillatoria (Vauc. ex Gomont, 1892) Merismopedia (Meyen 1839) Spirulina (Gomont, 1892) Nostoc (Vaucher & Flahault, 1886)	Nostocaceae Osillatoriaceae (Engler, 1898) Merismopediaceae Spirulinaceae (Gomont, 1892) Nostocaceae	*Anabaena sp.* *Oscillatoria putrida Oscillatoria sp.* *Merismopedia sp.* *Spirulina sp.* *Nostoc sp.*

CONCLUSION

Ecosystem structure is intricately tied to species diversity and distribution, which complicates the relationship between biodiversity and ecosystem. So, a species' capacity to fully carry out its function and offer services to the ecosystem may change in response to changes in the ecosystem structure, which could ultimately lead to the disturbance of the ecological balance. Due to the impending rapid environmental changes and global warming, phytoplankton, which is an important base primary producer, is prone to losing its diversity, which in turn causes changes in the taxonomical composition and seasonal dynamics. The quality and health of the specific aquatic ecosystem can be better understood by a long-term investigation of phytoplankton diversity in freshwater and marine ecosystems. The present investigation had given the baseline data on the phytoplankton diversity in the Vaduvoor Bird Sanctuary Lake in Thiruvarur district (Tamil Nadu), which needs to be thoroughly explored to ascertain the relationship between ecological structure and producer diversity. To implement additional conservation measures, the climatic characteristics of the sanctuary must be further associated with the dominant class of Bacillariophyceae, which is followed by Chlorophyceae, Cyanophyceae, and Euglenophyceae. In order to manage the water and the ecosystem that it is a part of sustainably, the study also raises concerns about the ongoing monitoring of phytoplankton variety and significant hydrological elements.

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