WWJMRD2022; 8(02):155-164
www.wwjmrd.com
International Journal
Peer Reviewed Journal
Refereed Journal
Indexed Journal
Impact Factor SJIF 2017: 5.182 2018: 5.51, (ISI) 2020-2021: 1.361
E-ISSN: 2454-6615
DOI: 10.17605/OSF.IO/BVCW4

Sarasvathi, A
Department of Botany,
Annamalai University,
Annamalainagar, Tamil Nadu,
India.

A. Vetriselvi
Department of Botany,
Annamalai University,
Annamalainagar, Tamil Nadu,
India.

Correspondence:
Sarasvathi, A
Department of Botany,
Annamalai University,
Annamalainagar, Tamil Nadu,
India.

Seasonal Variation of Phytoplankton from Temple Ponds of Vellore District, Tamil Nadu

Sarasvathi, A, A. Vetriselvi

Abstract
A study was undertaken to record the monthly fluctuation in phytoplankton population in Vallimalai, Jlankandeswarar, Sri Margabandeswar and Simmaulam temple ponds water samples of Vellore district, Tamil Nadu, India, for a period of August 2020 to July 2021. Four groups of phytoplankton were recorded in the samples. They are i. Diatoms, ii. Green algae, iii. Blue greens and iv. Euglenoids. During the study, a total of 67 species, belong to 38 families and 57 genera were recorded in respective study area. Diatoms were found to be the dominant group with 52 species. Green algae formed second dominant group with 25 species. Blue greens came next in the order with 10 species followed by euglenoids with 4 species in the study area. With respect to population density, in station-1 the density varied from 225 to 5,450 cells/L with minimum during July-2020 (premonsoon) and maximum during February-2020 (post monsoon), in station-2, the population density it fluctuated between 103 and 7,346 cells/L with minimum during December-2020 (monsoon) and maximum during February-2021 (summer), in station-3, fluctuated from 102 to 7,961cells/L with minimum during April-2020 (summer) and maximum during May-2021 (summer) and in station-4, density of phytoplankton varied from 525 to 7.240 cells/L with minimum during March-2021 (post monsoon) and maximum during January-2021.

Keywords: Phytoplankton, Diversity, Temple tanks, Vellore district.

1. Introduction

Phytoplankton plays a vital role in the transfer of energy from primary to secondary level; hence, it acts as an integral part of aquatic ecosystem (Tiwari and Nair, 1998). Phytoplankton is a pre dominant type of plants found in aquatic system and its community and relative abundance undergoes continuous Changes at varying scales, and also used as good indicator of water Quality (Muhammad Ali, 2005). Phytoplankton species are predominantly autotrophic or holophytic organisms. They are the most important producer of organic substances, and the rate of energy is stored in the tiny organisms determines the basic primary productivity of the ecosystem.

Phytoplankton is a highly diverse group of photo-autotrophic non-vascular plant and they exist either as unicellular or multi-cellular microscopic algae in freshwater, brackish and marine water environs. They are diversified group of photosynthetic thallophytes which have a very significant role in productivity of the marine, estuarine and freshwater ecosystem that cover two-third of the earth's surface. They act as an agent for primary production and production of organic compounds from carbon dioxide in the presence of light, and a process that sustains the aquatic food web (Ghosal et al., 2011). Phytoplankton is important in relation to global primary production in the sea which justifies a substantial study of phytoplankton production (Raymont, 1980). The main components of the phytoplankton in the sea are diatoms, coccolithophorids and flagellates. Blue-green algae and green algae are abundant in fresh-water but are of lesser significance in the sea (Parsons et al., 1984). Therefore, in the present study, an extensive survey was made for the period of one year, in order to assess the diversity and distribution pattern of phytoplankton variation in the respective study area by using various statistical package. Moreover, the knowledge on the phytoplankton diversity and productivity of freshwater reservoir is still need in urban and suburban areas for the planning of aqua cultural practices. Therefore, an extensive study of

the phytoplankton diversity, richness, speciousness and their effects on plankton productivity were made for a period of one year with a view to increasing fish production in the selected area of temple tanks of Vellore district.

2. Material and Methods

Water samples were collected for season wise from the selected study area Vallimalai (Station 1), Jlankandeswarar (Station 2), Sri Margabandeswar (Station 3) and Simmaulam (Station 4) temple ponds water samples of Vellore district, Tamil Nadu, India, during August 2020 to July 2021. Phytoplankton samples were collected from the surface waters by towing a plankton net (mouth diameter 0.35m) made of bolting silk (No.25 mesh size 48 µ m) for half an hour. Subsequently, samples were preserved in 5% neutralized formalin and used for qualitative analysis. Forth quantitative analysis of phytoplankton, the settling method described by Sukhanova (1978) was adopted. Numerical plankton analysis was carried out using Utermohl's sedimentation technique. Samples were allowed to settle in the counting chamber for 3–5 min prior to enumeration. Counting of plankton was done with the help of ''Sedgwick- Rafter counting cell''. Plankton species were identified using standard works of Smith (1950). Further, the data were subjected to various univariate and multivariate methods available in PRIMER (Ver.6).

Vallimalai (Station 1)

Jlankandeswarar (Station 2)

Sri Margabandeswar (Station 3)

Simmaulam (Station 4)

3. Results

In the present study, four groups of phytoplankton were recorded in the samples. They are i. Diatoms, ii. Green algae, iii. Blue greens and iv. Euglenoids. During the study, a total of 67 species, belong to 38 families and 57 genera were recorded in respective study area. Diatoms were found to be the dominant group with 52 species. Green algae formed second dominant group with 25 species. Blue greens came next in the order with 10 species followed by euglenoids with 4 species in the study area. With respect to population density, in station-1 the density varied from 225 to 5,450 cells/L with minimum during July-2020 (premonsoon) and maximum during February-2020 (post monsoon), in station-2, the population density it fluctuated between 103 and 7,346 cells/L with minimum during December-2020 (monsoon) and maximum during February-2021 (summer), in station-3, fluctuated from 102 to 7,961cells/L with minimum during April-2020 (summer) and maximum during May-2021 (summer) and in station-4, density of phytoplankton varied from 525 to 7.240 cells/L with minimum during March-2021 (post monsoon) and maximum during January-2021.

Among the diatoms Astrionella glaciales, Bellerochea malleus, Bacillaria paradoxa, Bacteriastrum comosum, Chaetoceros lorenzianus, C. curvisetus, C. brivis, C. affinis, C. messanensis, C. indicus , Coscinodiscus centralis, C. gigas, C. granii, Cyclotella sp. Cylindrotheca closterium, Gyrosigma balticum, Leptocylindrus danicus, Lithodesmium undulatum, Nitzschia longissimi, T. frauenfeldii, O. sinensis, O. mobiliensis, Planktoniella sol, Pleurosigma angulatum, P. normanii, Rhizosolenia alata, R. styliformis, R. cylindrus, Skeletonema costatum,

Stephanopyxis palmeriana, Thalassionema nitzschioides, Thalassiosira punctigera, Thalassiothrix frauenfeldii, and Triceratium favus were found to be commonly occurring species in both the estuaries. With respect to diatoms, Ceratium furca, C. trichoserous, C. macrocerous, C. tripos Protoperidinium oceanicum, Dinophysis caudata and Phyrophacus steinii showed consistency in their occurrence in both the regions. Coming to blue greens Anabeana sp., Oscillatoria sp., Spirulina sp. and T. erythraeum and green algae Chlorella sp., Tetraselmis sp. were found to be common in the collection.

Numerical abundance of phytoplankton

With respect to population density, in station-1 the density varied from 225 to 5,450 cells/L with minimum during July-20 (premonsoon) and maximum during February-20 (post monsoon).

In station-2, the population density it fluctuated between 103 and 7,346 cells/L with minimum during December-20 (monsoon) and maximum during February-21 (summer).

In station-3, fluctuated from 102 to 7,961cells/L with minimum during April-20 (summer) and maximum during May-21 (summer). In station-4, density of phytoplankton varied from 525 to 7.240 cells/L with minimum during March-21 (post monsoon) and maximum during January-21 (post monsoon).

Percentage composition of phytoplankton

In station-1, diatoms at the top with a contribution of 58% followed by diatoms, blue greens and green algae with a percentage occurrence of 18%, 12% and 12% respectively to the samples collected in Vellore district temple ponds (Fig. 1). Likewise, in station-2, diatoms continued to be the dominant group with a percentage contribution of 63% followed by diatoms with 18%, bluegreen algae with 12% and green algae in 7% (Fig. 2). In station-3, diatoms with 57% and diatoms formed second dominant group with a percentage occurrence of 19%, blue greens and green algae came next in the order with a percentage occurrence of 14% and 10% respectively (Fig. 3). In station-4 diatoms at the top with a contribution of 46% followed by diatoms, blue greens and green algae with a percentage occurrence of 28%, 14% and 12% respectively (Fig. 4).

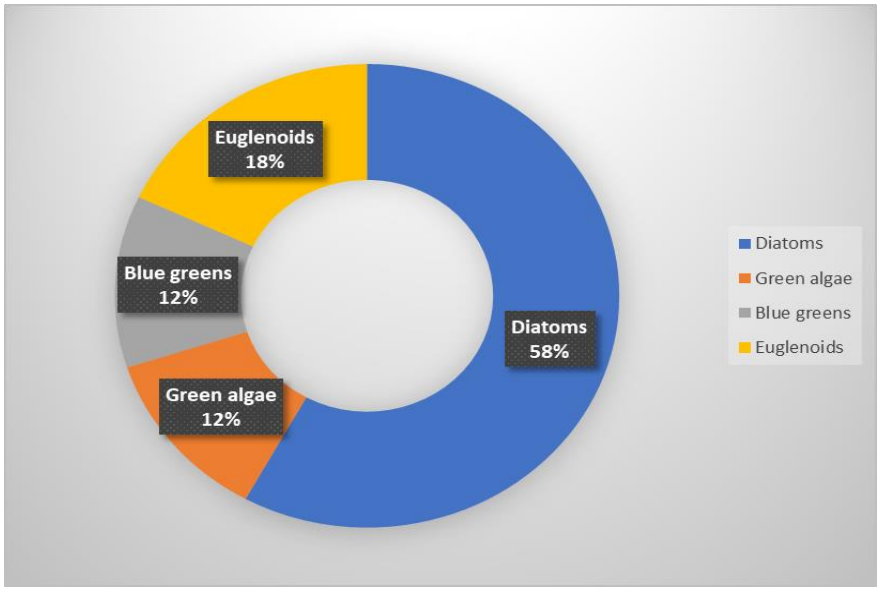

Fig. 1. Percentage composition of phytoplankton recorded in station 1.

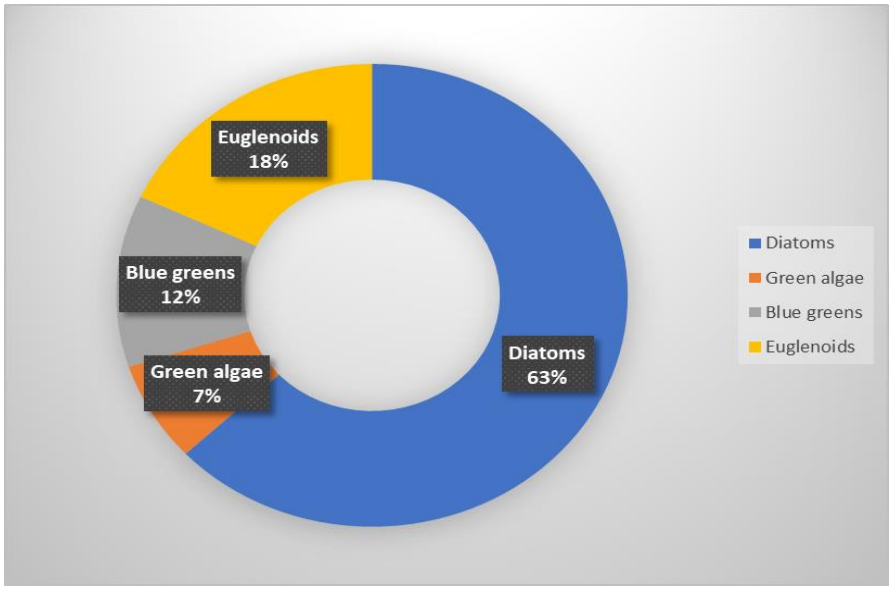

Fig. 2. Percentage composition of phytoplankton recorded in station 2.

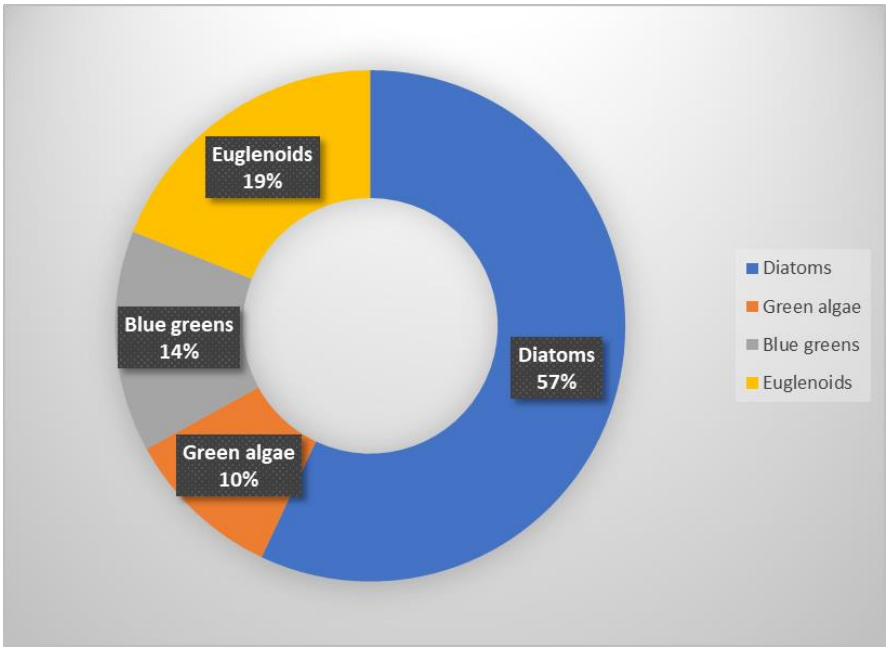

Fig. 3. Percentage composition of phytoplankton recorded in station 3.

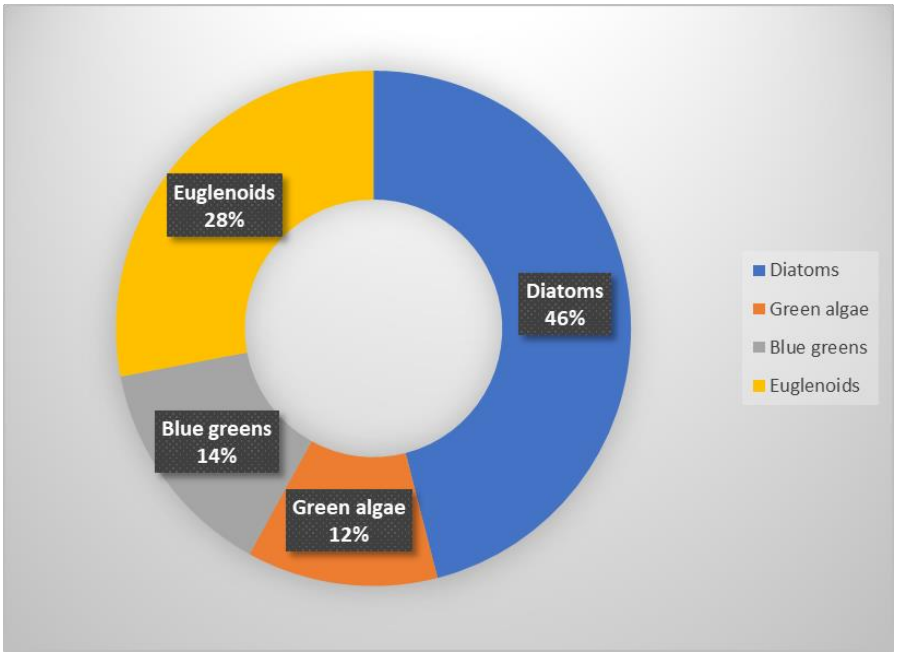

Fig. 4. Percentage composition of phytoplankton recorded in station 4.

Diversity indices

Species diversity (H')

In station-1, the species diversity varied from 2.21 to 3.33 with minimum during December-20 (monsoon) and maximum in June-21 (summer). In station-2, diversity index fluctuated between 1.69 and 3.32 with minimum value during November-20 (monsoon) and maximum during April-21 (summer). In station-3, it varied from 1.89 to 3.42 with minimum value during November-20 (monsoon) and maximum during April-21 (summer). At station-4, diversity index fluctuated from 2.21 to 4.37 with maximum during April-21 (summer) and minimum during November-20 (monsoon) Figs. 5-8.

Species richness (d)

In station-1, the species diversity varied from 2.16 to 3.45 with minimum during November-20 (monsoon) and maximum in June-21 (summer). In station-2, diversity index fluctuated between 2.48 and 3.33 with minimum value during January-21 (postmonsoon) and maximum during May-21 (summer). In station-3, it varied from 2.10 to 4.77 with minimum value during September-2020 (premonsoon) and maximum during May-21 (summer). At station-4, diversity index fluctuated from 3.24 to 4.79 with maximum during June-21 (summer) and minimum during November-20 (monsoon) Figs. 9-12.

Species evenness (J')

In station-1, the species diversity varied from 0.83 to 0.79 with minimum during October-20 (monsoon) and maximum in July-21 (summer). In station-2, diversity index fluctuated between 0.87 and 0.91 with minimum value during June-21 (summer) and maximum during March-21 (postmonsoon). In station-3, it varied from 0.88 to 0.98 with minimum value during December-20 (monsoon)

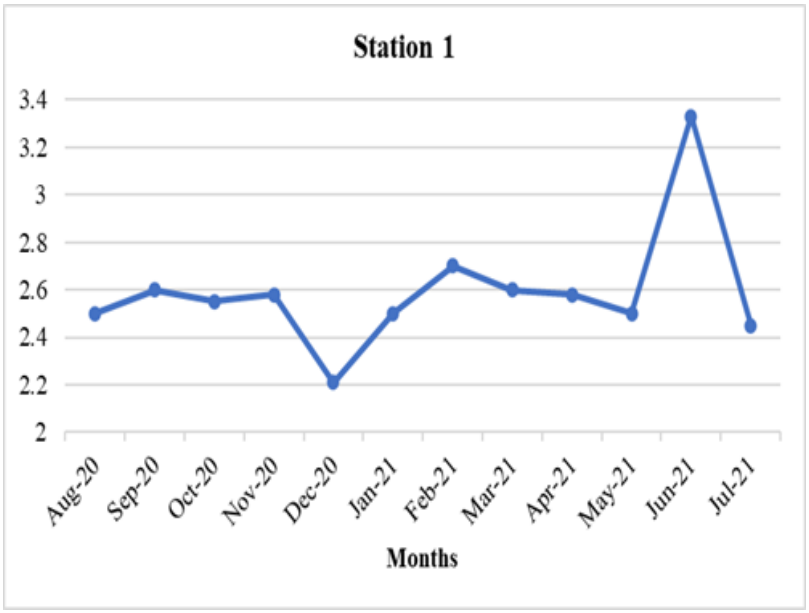

Fig. 5. Monthly variation of diversity indices in Shanon diversity (H') calculated for the phytoplankton species recorded in Station 1.

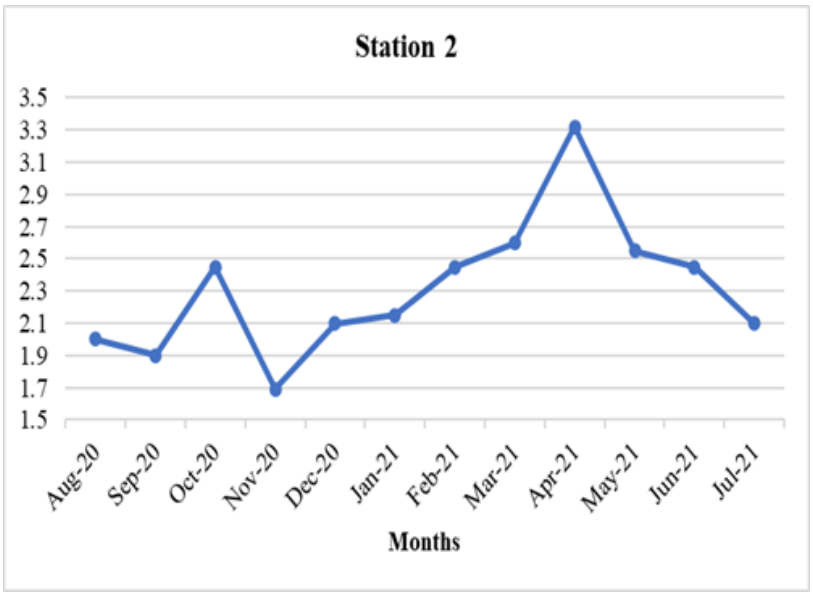

Fig. 6. Monthly variation of diversity indices in Shanon diversity (H') calculated for the phytoplankton species recorded in Station 2.

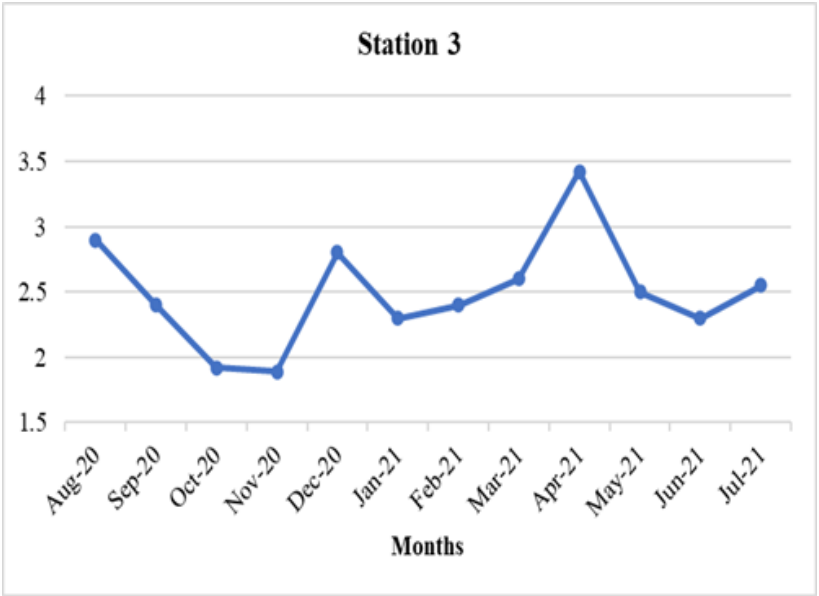

Fig. 7. Monthly variation of diversity indices in Shanon diversity (H') calculated for the phytoplankton species recorded in Station 3.

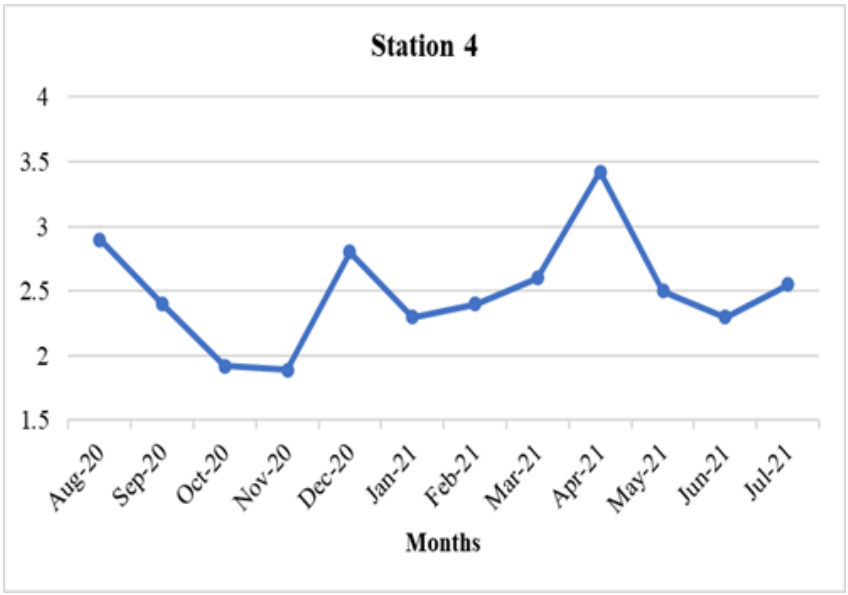

Fig. 8. Monthly variation of diversity indices in Shanon diversity (H') calculated for the phytoplankton species recorded in Station 4.

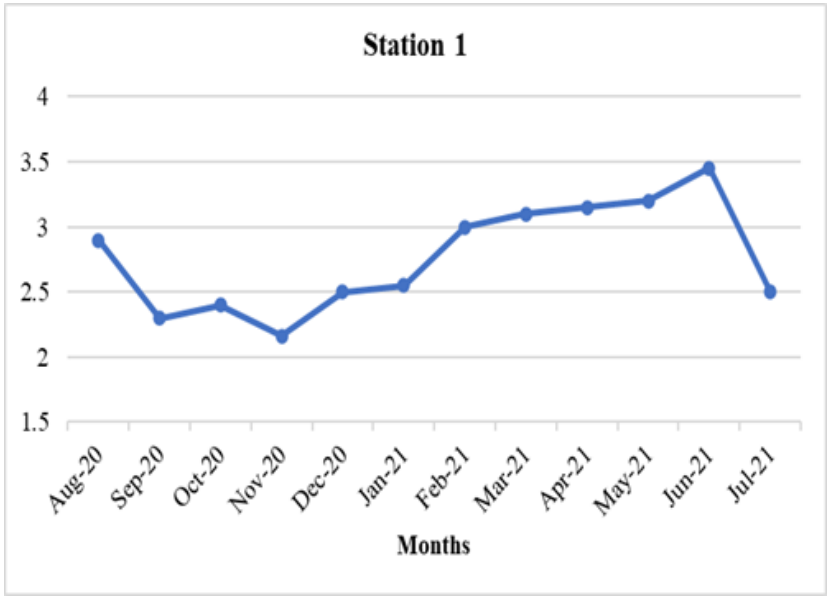

Fig. 9. Monthly variation of diversity indices in species richness (d) calculated for the phytoplankton species recorded in Station 1.

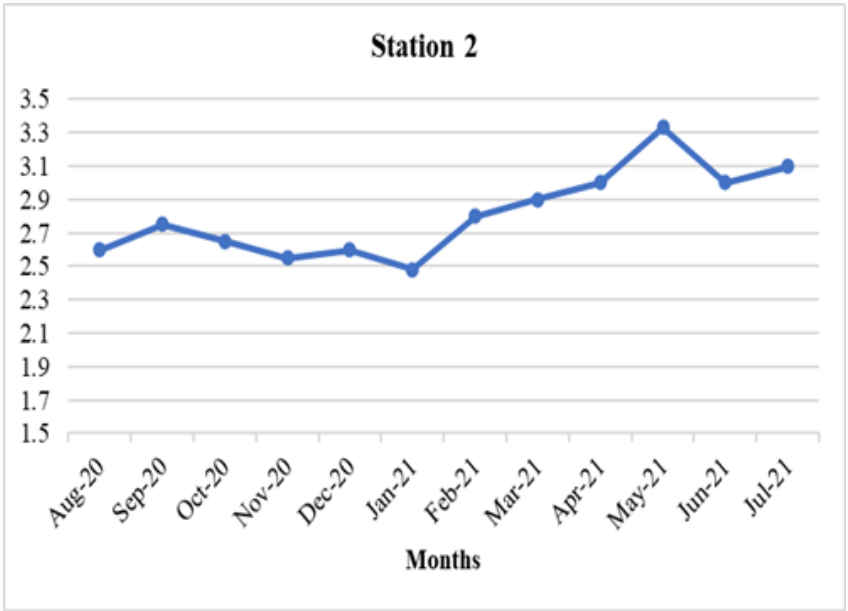

Fig. 10. Monthly variation of diversity indices in species richness (d) calculated for the phytoplankton species recorded in Station 2.

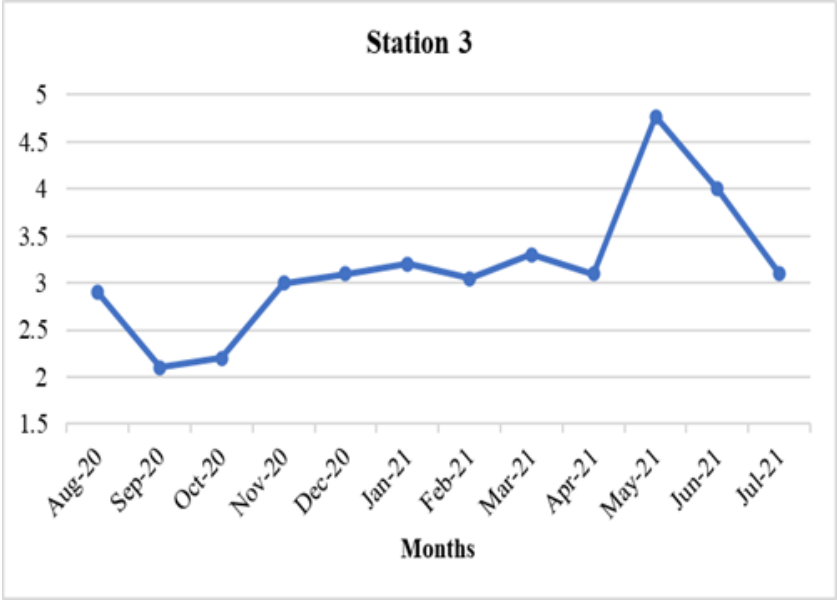

Fig. 11. Monthly variation of diversity indices in species richness (d) calculated for the phytoplankton species recorded in Station 3.

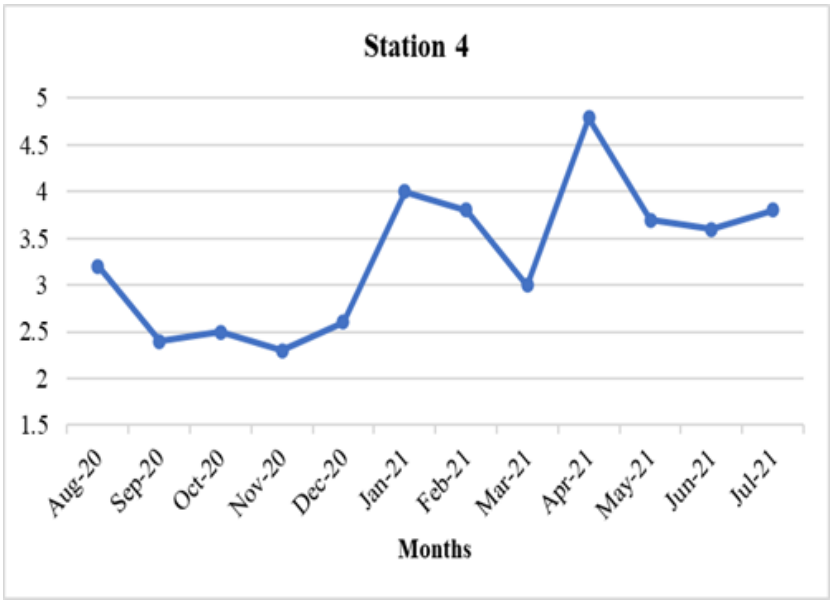

Fig. 12. Monthly variation of diversity indices in species richness (d) calculated for the phytoplankton species recorded in Station 4.

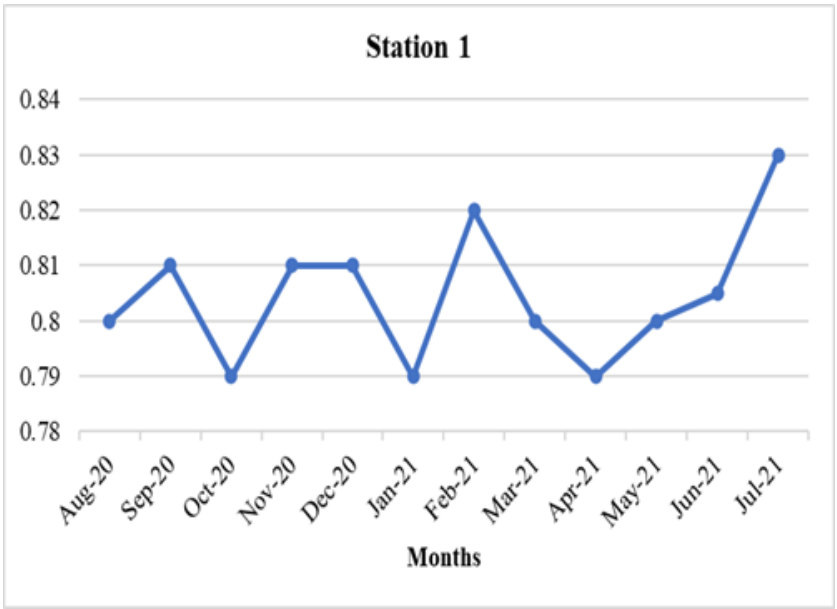

Fig. 13. Monthly variation of diversity indices in species evenness (J') calculated for the phytoplankton species recorded in Station 1.

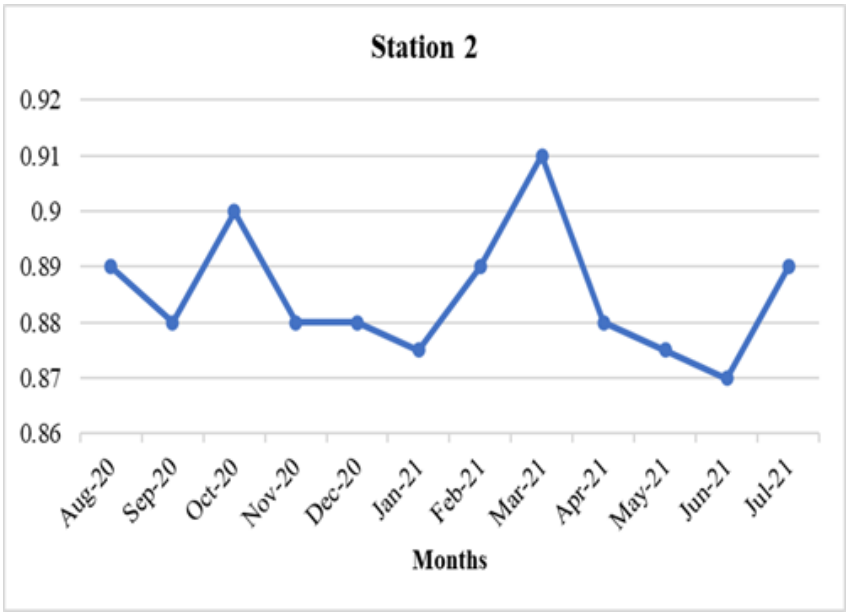

Fig. 14. Monthly variation of diversity indices in species evenness (J') calculated for the phytoplankton species recorded in Station 2.

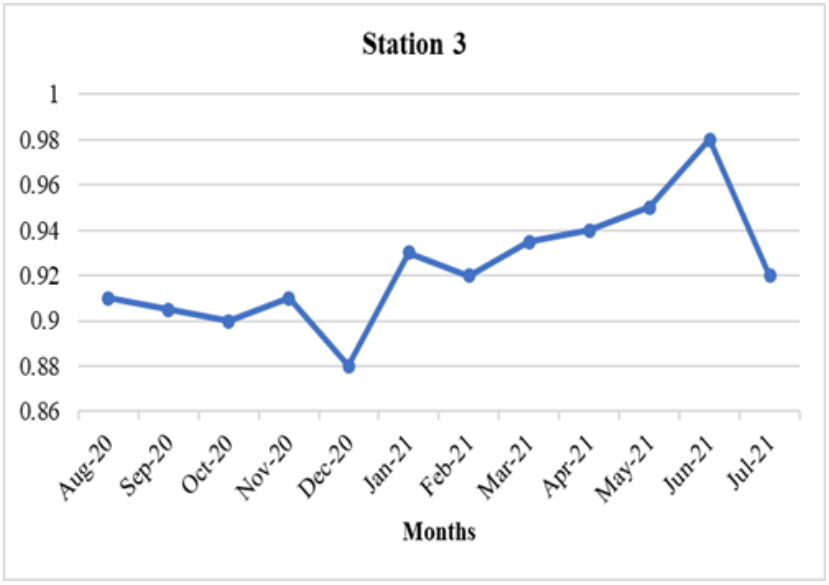

Fig. 15. Monthly variation of diversity indices in species evenness (J') calculated for the phytoplankton species recorded in Station 3.

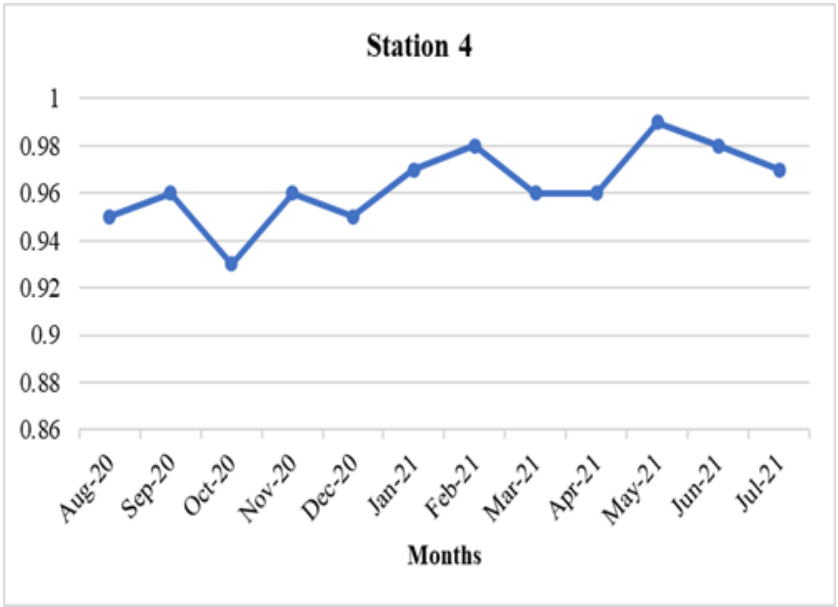

Fig. 16. Monthly variation of diversity indices in species evenness (J') calculated for the phytoplankton species recorded in Station 4**.**

and maximum during June-21 (summer). At station-4, diversity index fluctuated from 0.93 to 0.99 with maximum during May-21 (summer) and minimum during October-20 (monsoon) Figs. 13-16.

4. Discussion

Over the decades, the importance of phytoplankton diversity has been realized to be one of the environmental health assessments as indicators. In freshwater environments, either biotic or abiotic factors contributed substantially to the abundance and diversity of phytoplankton in the waters. In general, the distribution and abundance of phytoplankton in tropical waters, varied remarkably due to the seasonal environmental fluctuations, and these variations are well pronounced in the sheltered system of fresh waters (Silambarasan et al., 2016).

Phytoplankton studies are useful for identification of the physico-chemical and other biological conditions of the water in any aquatic ecosystem. Some groups of phytoplankton can hamper recreational value of surface water, particularly by forming thick surface scum, which reduces the use of amenities for water sports or large growth, which cause deoxygenation of the water leading to fish death (Whiton and Patts, 2000). Over the last few decades, there has been more concern about the processes influencing the development of phytoplankton communities, primarily in relation to physico-chemical factors (Elliott et al., 2002).

In the present study, the phytoplankton community, comprised of Diatoms, green algae, blue greens and Euglenoids, was studied at temple tanks of Vellore district. Diatoms were the most dominant group in all the stations throughout the study period, which could be ascribed to the fact that diatoms could thrive well in varying environmental changes as reported earlier by several researchers (Vengadesh Perumal, 2009) in the aquatic ecosystems. Madhu et al. (2007, 2010) was studied in West coast. Diatoms were followed by diatoms, whereas blue greens and green algae were represented by very few species during the study period. Nabout et al. (2006) also observed the predominance of Bacillariopyceae (diatoms) members followed by Chlorophyceae (blue greens) and Cyanophyceae (green algae) members during his study on phytoplankton community of Brazilian lakes, which lends supports to the results of the present study.

In aquatic environment, phytoplankton assemblage, structure and growth are affected by the different environmental factors that include salinity, nutrients, temperature etc. (Gasiunaite et al., 2005). Phytoplankton distribution and their growth depend on several environmental factors, which are varied with seasons and regions. In both the ecosystems studied, maximum density of phytoplankton was recorded during summer followed by post-monsoon and minimum density was during monsoon. Maximum density of phytoplankton could be attributed to the neritic element domination and availability of nutrients. As the hydrological parameters were in stable condition during post monsoon season, that might have favored to record more phytoplankton production was registered higher (Rajkumar et al., 2009). Besides, more number of phytoplankton during postmonsoon could be due to increased radiation or light intensity (Mani, 1992). Perumal et al. (2009) noticed higher density of phytoplankton during post-monsoon months and lower in monsoon on Kaduviyar estuary, India which corroborated well with the results of present investigation.

In the present study, a total of 67 species, belong to 38 families and 57 genera were recorded in all stations. The higher abundance and species diversity during summer and postmonsoon seasons might be due to the predominance of diatoms.

The higher phytoplankton abundance during summer and post monsoon season could be attributed to the increased salinity, pH, high temperature and high intensity of light penetration. Similar summer maxima and monsoonal minimal was reported earlier by Rajkumar et al. (2009). The abundance was lowest during monsoon season, when the water column was remarkably stratified to a large extent because of heavy rainfall, high turbidity caused by run-off, reduced salinity, decreased temperature and pH, overcast sky and cool conditions. However, during this season, freshwater algal forms like Anabaena sp., Oscillatoria sp., Chlorella sp., Lynbya sp., Spirogyra sp. Spirulina major and Microcystis sp. were also noticed. Similar observations have been made from different locations of east and west coast of India by Gouda and Panigrahy (1996) reported that fresh water forms such as green algae and blue green algae (Aranganathan and Sivakumar, 2021).

Thillai Rajasekar et al., (2005) have reported 124 species of phytoplankton in Coleroon estuary and 117 species in Vellar estuary during their two years of the study. This study thus showed almost fairly comparable results with the present results with respect to the species numbers. With regard to density, the maximum density was recorded during summer and post monsoon seasons and minimum during monsoon season. The high density recorded during summer could be attributed to more stable hydrographical conditions prevailed during that period.

Diversity index is a tool, which is applied to measure the species biodiversity in an ecosystem. A stressed environment typically has a lower number of species with one or two dominant species (those adapted to the stress) having many more individuals than the other species (Gao and Song, 2005). The conservation of biological diversity has become one of the major issues since the late twentieth century. There is worldwide recognition that reduction in the diversity of life will, sooner or later, affect us all in some manner. There are many diversity indices, some are total species-abundance ratio (e.g. Margalef index), others are derived from theoretical species abundance models and the number is based on the proportional abundance of the species (e.g. Shannon-Wiener) having different underlying principles, each index has its own strength and weakness.

Present study agrees with following studied by Edward and Ayyakkannu (1991) from Coleroon estuary and several other workers (Rajasegar, 2003) along the South east coast of India. The observed species richness values from both the regions are similar to those of phytoplankton abundance, and the maximum richness values were recorded during summer and postmonsoon seasons (Rajasegar et al., 2000). Similarly, the monsoonal minimum richness values were reported earlier by Saraswathi (1993) from the Arasalar and Kaveri estuaries.

5. Conclusion

Present study was undertaken to record the phytoplankton diversity, richness and speciesness of temple ponds of

Vellore district, Tamil Nadu, India. From this investigation it is observed, plankton density and diversity is higher in the summer season compared to premonsoon, monsoon and post monsoon seasons.

6. Acknowledgement
We are sincerely grateful to Professor and Head, Department of Botany, Annamalai University for providing us all necessary requirements for our research. and Prof.K.Sivakumar, Research Advisory Committee Member for his support and encouragement to fulfill this research work.

References

1. Aranganathan, A, Sivakumar K. Biodiversity of fresh water algae from Vellar river Cuddalore district of Tamil Nadu. International Journal of Botany Studies, 2021: 6(2): 63-70.
2. Edward, PJK, Ayyakkannu, K. Studies on the ecology of plankton community of Kollidam estuary, southeast coast of India. Phytoplankton Mahasagar Bull. Nat. Ins. Oceanog., 1991: 24: 89-97.
3. Elliott, JA, Irish AE, Reynolds CS. Predicting the spatial dominance of phytoplankton in light limited and incompletely mixed eutrophic water column using the Protech model. Freshwater Biology, 2002: 47: 433-440.
4. Gao X, Song J, Phytoplankton distributions and their relationship with the environment in the Changjiang estuary, China. Mar. Pollut. Bullet., 2005: 50: 327-335.
5. Gasiunaite ZR, Cardoso AC, Heiskanen AS, Henriksen P, Kauppila P, Olenina, I, Pikaityte R, Purina I, Razinkovas A, Sagert S, Schubert, S, Wasmund, N, Seasonality of coastal phytoplankton in the Baltic Sea: influence of salinity and eutrophication. Estuar. Coast. Shelf Sci., 2005: 65: 239-252.
6. Ghosal Rogers, Wray SMA, The effects of turbulence on phytoplankton. Aerospace Technology Enterprise NTRS Retrieved 16 June, 2011: 140-145.
7. Gouda R, Panigrahy RC, Ecology of phytoplankton in coastal waters off Gopalpur, East coast of India. Indian J. Mar. Sci., 1996: 2: 13-18.
8. Madhu NV, Jyothibabu R. Balachandran KK, Honey KU, Martin GD, Vijay JG, Shiyas CA, Guptha GVM, Achuthankutty CT, Monsoonal impact on planktonic standing stock and abundance in tropical estuary, Cochin back waters, India, Estuar. Coast. Shelf Sci., 2007: 73: 54-64.
9. Madhu NV, Jyothibabu R, Balachandran KK, Monsoon-induced changes in the size- fractionated phytoplankton biomass and production rate in the estuarine and coastal waters of southwest coast of India. Environ. Monit. Assess., 2010: 166(1&4): 521-528.
10. Mani P, Natural phytoplankton communities in Pitchavaram mangroves. Indian J. Mar. Sci., 1992: 23: 278-280.
11. Muhammad Ali, Studies on monthly variations of biological and physico-chemical parameters of Brackish water fish bond, Muzaffargarh. Pak. J. Res. Sci., 2005: 16(1): 27–38. Bahauddin Zakaria University, Multan, Pakistan.
12. Nabout JC, Nogueira IS, Oliveira LG, Phytoplankton community of flood plain lakes of the Araguaia River, Brazil in the rainy and dry seasons. J. Plank. Res., 2006 28: 181-193.
13. Parsons TR, Takahashi M, Hargrave B, Biological oceanographic Processes. (3rd Ed) Pergamon Press Ltd., Headington Hall, Oxford, OX3 ODW, England, 1984: 323pp.
14. Perumal NV, Rajkumar M, Perumal P, Rajasekar KT, Seasonal variation of phytoplankton diversity in the Kaduviyar estuary, Nagapattinam, south east coast of India. J. Environ. Biol., 2009: 30: 1035-1046.
15. Rajasegar M, Physico-chemical characteristics of the Vellar estuary in relation to shrimp farming. J. Environ. Biol., 2003: 24: 95–101.
16. Rajasegar M, Srinivasan M, Rajaram R, Phytoplankton diversity associated with the shrimp farm development in Vellar estuary, south India. Seaweed Res. Util., 2000: 22: 125–131.
17. Rajkumar M, Perumal P, Prabu VA, Perumal NV, Rajasekar KT, Phytoplankton diversity in Pichavaram mangrove waters from southeast coast of India. J. Environ. Biol., 2009: 30(4): 489-498.
18. Raymont, Plankton and productivity in the Oceans. Vol. I. Phytoplankton, Pergamon Press, New York, 1980: 489pp.
19. Saraswathi R, Hydrobiology of two estuarine systems (Arasalar and Kaveri) of the southeast coast of India with special reference of Plankton, Ph. D., Thesis, Annamalai University, India, 1993: 267pp.
20. Silambarasan ASS, Muthuvelu S, Murugesan P, Assemblages of phytoplankton diversity in different zonation of Muthupet mangroves. Regional Studies in Marine Science, 2016: 3: 234-241.
21. Sukhanova ZN, Settling without inverted microscope. In:Phytoplankton Manual, UNESCO, A. Sournia (Eds) Page Brothers (Norwich) Ltd. UK, 1978: 97pp.
22. Thillai Rajasekar K, Perumal P, Santhanam P, The phytoplankton diversity in the Coleroon estuary, southeast coast of India, J. Mar. Biol. Ass. India, 2005: 47: 127-132.
23. Tiwari LR, Nair VR, Ecology of phytoplankton from Dharamtar creek, West Coast of India. Indian J. Mar. Sci., 1998: 27: 302-309.
24. Vengadesh Perumal N, Rajkumar M, Perumal P, Thillai Rajasekar K, Seasonal variations of plankton diversity in the Kaduvaiyar estuary, Nagapattinam, Southeast Coast of India. J. Environ. Biol., 2009: 30(6): 1035-1046.
25. Whitton BA, Patts M, The Ecology of Cyanobacteria. Kluwer Academic Publishers, Netherlands, 2000: 120-126pp.