



Bio diversification and seasonal abundance of phycofloral scenedesmaceae in kothandaramar temple tank, West Mambalam, Chennai

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Abstract

The present study aimed to document the freshwater microalgal diversity of the Scenedesmaceae family and their seasonal occurrence in Kothandaramar Temple Tank, West Mambalam, Chennai. The study recorded a total of 28 species belonging to 8 genera of microalgae. The seasonal variation of individual species was recorded from 2021 to 2023. Four seasonal patterns—winter, summer, monsoon, and post-monsoon—were observed throughout the two-year study period. Results revealed that *Tetrademus obliquus*, *Scenedesmus smithii* var. *linearis*, *Desmodesmus armatus* var. *longispina*, and *Pectinodesmus javanensis* were reported in all four seasons of the study period. Based on Algaebase, the current names of 10 species from this family were reported for the first time in this study area.

Keywords Scenedesmaceae · Seasonal pattern · Temple tank · *Pectinodesmus* · *Pseudodidymocystis* · *Verrucodesmus*

Introduction

Microalgae are globally ubiquitous and highly diverse, existing in myriad forms and sizes. They are primary producers enriched in freshwater, saline water, soil, and brackish water, constituting a vast group of photosynthetic organisms found in freshwater in various forms, such as individual cells, colonies, or extended filaments (Chatterjee et al., 2006). Green algae are an ancient and diverse group, collectively classified in the division Chlorophyta. Approximately 8,000 species have been described, and an estimate of 5,000 species are yet to be described (Hadi et al. 2016). Green algae are rich sources of protein, carbohydrates, and essential fatty acids, playing a vital role in aquatic ecosystems (Rishi et al. 2016). Algal distribution is largely dependent on the size and water quality of the local environment. Many algal forms can spread throughout a water body, leading to the formation of algal blooms (Johnston 1966; Sreeja

et al. 2018). The green color of a pond is often indicative of high species richness of algae, particularly green algae, which are known for their diverse and vibrant green pigments (Desingurajan et al. 2021). On the AlgaeBase website, the genus *Scenedesmus* and related genera belonging to the order Sphaeropleales, family Scenedesmaceae, are reported with 639 taxa (Guiry and Guiry, 2014). The genus *Scenedesmus* is described based on field materials, focusing on characteristics such as cell shape, presence of horns, spines, lateral ridges, and cell measurements. The cells are typically arranged in linear forms, with or without spines on their terminal cells. *Scenedesmus* forms coenobia consisting of 1, 2, 4, 8, and 16 cells, reflecting their cellular organization. The amount of lipids, proteins, and other substances can vary depending on the number of algae in each coenobium (Srivastava et al. 2018). The cell walls of *Scenedesmus* are composed of sporopollenin and a hemicellulosic layer, which can appear smooth or have submicroscopic structures. Each cell contains a single well-developed chloroplast and a parietal pyrenoid. Due to their morphological and molecular characteristics, several genera within the *Scenedesmus* group have been distinguished and separated.

The genus *Desmodesmus* differs slightly from *Scenedesmus* as it displays certain structures on the cell wall, such as spines, rosettes, teeth, and warts, while *Scenedesmus* has a

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non-ornamented cell wall (Phinyo et al. 2017). The genus *Pectinodesmus* is characterized by ellipsoidal and spindle-shaped cells with longitudinal ridges, similar to the genus *Acutodesmus*, but they differ in molecular phylogeny. The genus *Comasiella* is distinguished by coenobia surrounded by mucilage, with curved and elongated cells featuring obtuse cell poles. Genus *Verrucodesmus* is distinguished by elongated cells with ovate to obtuse ends and many granules on the cell wall, with coenobia embedded in mucilage (Hegewald et al. 2010, 2013; Krienitz and Bock 2012).

The purpose of this study was to record the algal taxa from the Kothandaramar Temple tank (KRT) in West Mambalam, Chennai, which will provide insights into its historical and cultural importance (Anuja and Chandra 2012). Temple tanks play a crucial role in recharging local groundwater and are usually attached to temples. Presently, there are about 2359 temple tanks (Sankaran and Thiruneelagandan 2015). The protection and preservation of the environment in South India are influenced by three major ecological traditions: temple tanks, sacred trees, and sacred groves (Amirthalingam and Muthukrishnan 2004). Algae play a prominent role in maintaining the aquatic ecosystem of the tank and act as a water reservoir for future generations (Shubha and Sreeja 2019). Ponds are a type of lentic system that includes reservoirs, lakes, puddles, and pools. They may contain various forms of algae, including free-floating (planktonic), benthic (attached to sediments), and epiphytic (attached to plants and other objects) algae (Girish Kumar et al. 2014). The present work was an attempt to explore the phytoplankton species in the Kothandaramar Temple which is in the neighbourhood of West Mambalam in Chennai, India. This temple is more than 150 years old and has a large temple tank within the premises.

Materials and methods

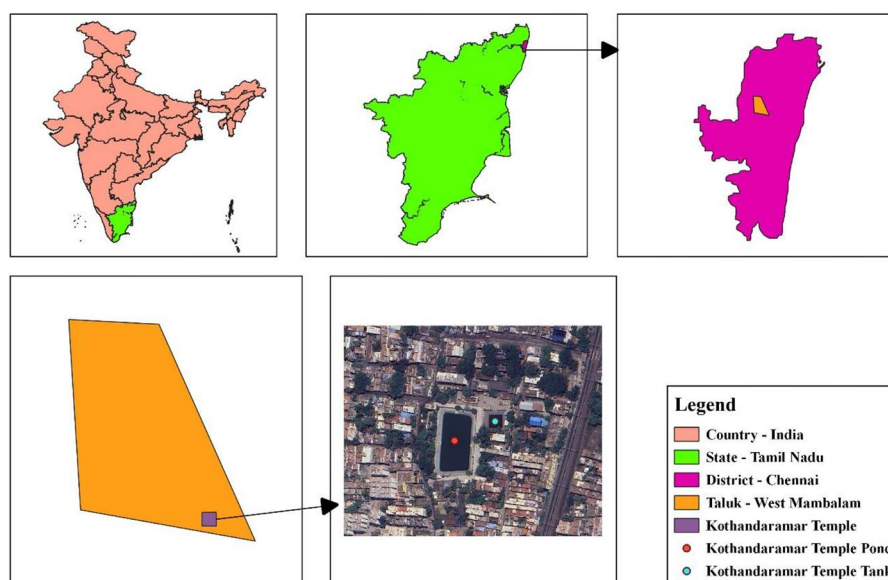
The study area

The study area which is the Kothandaramar Temple is situated in West Mambalam, Chennai, Tamil Nadu, South India, at coordinates 13°02'04.2"N and 80°13'32.7"E. The temple has a large, 15-feet deep temple tank that serves as a habitat for various fish, bird species, phytoplankton, and zooplankton. This tank is one of the oldest temple tanks in Chennai and is considered eternal. Rainwater collected from the temple grounds through a well-designed pipeline network is the only water supply for the tank. The water in the tank is not used by anyone in the vicinity.

Sample collection and identification

The water sample was taken from the KRT regularly between July 2021 and June 2023. Samples were collected from different locations in the temple tank using a phytoplankton net with a 0.2 mm mesh, and were then divided into four distinct sampling bottles. One of the bottles was fixed with 4% formaldehyde solution, while the others were taken to the laboratory (Desingurajan and Sankaran 2021). For ten minutes, the samples were centrifuged at 2,000 rpm. After centrifugation, the samples were examined under a Magnus microscope and images were captured using a Nikon digital camera (Coolpix E8400). The dimensions of the microalgae were measured using Nikon software. Books, monographs, and internet resources on morphotaxonomy were used to identify the samples. Prescott (1962) and Philipose (1967) were among the monographs and books on algal flora used for identification. The online algal database AlgaeBase (Guiry 2021) was used to confirm the species and determine

Fig. 1 Geographical represent of the study area



their most current nomenclature. The detected algal data were analyzed using Microsoft Excel (Version 2013).

Results

Diversity

The current study focused on the Scenedesmaceae family from the study area of the KRT in West Mambalam, Chennai. Through this investigation, a total of 28 species belonging to 8 genera were identified. The dominant genera were *Scenedesmus* (32%) and *Desmodesmus* (32%), followed by *Tetradesmus* (14%), *Comasiella* (7%), *Pseudodidymocystis* (4%), *Steinedesmus graevenitzii* (4%) and *Pectinodesmus* (3%) (Fig. 2).

Seasonal presence of the year 2021–2022

Tetradesmus obliquus, *Scenedesmus smithii* var. *linearis*, *Desmodesmus armatus* var. *longispina* and *Pectinodesmus javanensis* species were observed in all the four seasons during the first year 2021–2022 (winter, summer, monsoon and post monsoon), followed by *Tetradesmus incrassatulus*, *Scenedesmus quadricauda* var. *bicaudatus* (summer, monsoon and post monsoon), *Scenedesmus quadricauda*, *Desmodesmus armatus*, *Desmodesmus armatus* var. *bicaudatus* and *Desmodesmus brasiliensis* (winter, summer and monsoon), *Desmodesmus subspicatus* (winter, summer and post monsoon) all the seven species were present in three seasons in first year followed by *Tetradesmus wisconsinensis*, *Tetradesmus lagerheimii* and *Scenedesmus producto-capitatus* (summer and monsoon), *Scenedesmus abundans* var. *longicauda* (monsoon and post monsoon), *Desmodesmus denticulatus* (winter and post monsoon), *Desmodesmus armatus* var. *major* (winter and monsoon) and *Comasiella arcuata* var. *platydisca* (winter and summer) these seven

species were present in two seasons in the first year. This was followed by *Scenedesmus naegelii* and *Desmodesmus protuberans* (winter), *Scenedesmus acunae*, *Comasiella arcuata* and *Steinedesmus graevenitzii* (post monsoon) were present in a single season in a year. Other algae including *Scenedesmus parisiensis*, *Desmodesmus maximus* and *Verrucodesmus verrucosus* were not recorded in the same study period (Table 1; Figs. 3 and 4).

Seasonal presence of the year 2022–2023

Tetradesmus incrassatulus, *Scenedesmus quadricauda*, *Scenedesmus producto-capitatus* and *Scenedesmus quadricauda* var. *bicaudatus* were present in all the four seasons (winter, summer, monsoon and post monsoon). In second study period 2022–2023 other species such as *Tetradesmus wisconsinensis*, *Scenedesmus abundans* var. *longicauda*, *Scenedesmus tropicus* and *Desmodesmus subspicatus* (winter monsoon and post monsoon), *Desmodesmus armatus* and *Desmodesmus armatus* var. *longispina* (summer, monsoon and post monsoon) were observed in three seasons followed by *Scenedesmus naegelii*, *Desmodesmus protuberans*, *Desmodesmus maximus*, *Comasiella arcuata*, *Comasiella arcuata* var. *platydisca*, *Steinedesmus graevenitzii*, *Verrucodesmus verrucosus* and *Scenedesmus parisiensis* (monsoon), *Desmodesmus armatus* var. *major* (Post monsoon), *Desmodesmus denticulatus* (winter), these eleven species were present in only one season in the study period. *Tetradesmus obliquus*, *Scenedesmus smithii* var. *linearis* and *Desmodesmus brasiliensis* were not found in all the four seasons in the study period (Table 1; Figs. 3 and 4).

Fig. 2 Species richness of KRT

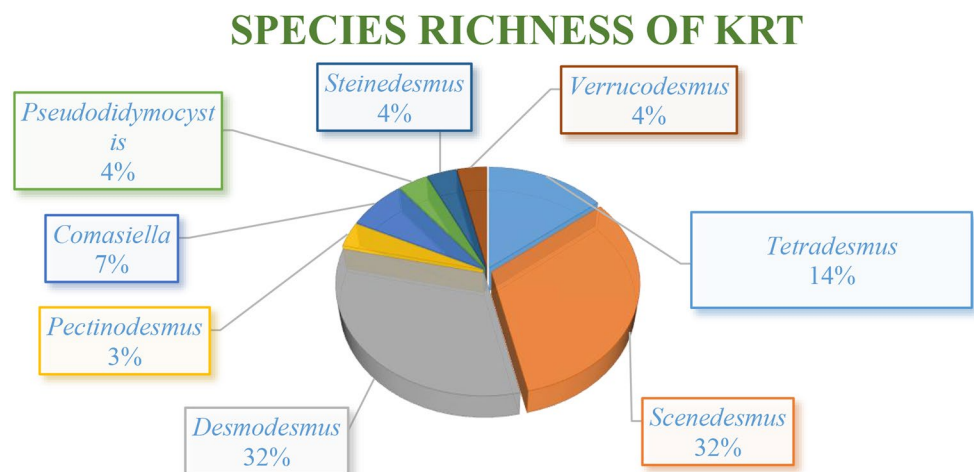


Table 1 Seasonal abundance during the study period

| Binomial | 2021–2022 | | | | 2022–2023 | | | |
|---|-----------|--------|---------|--------------|-----------|--------|---------|--------------|
| | winter | summer | Monsoon | Post monsoon | winter | summer | Monsoon | Post monsoon |
| <i>Tetradesmus obliquus</i> | + | + | + | + | - | - | - | - |
| <i>Tetradesmus wisconsinensis</i> | - | + | + | - | + | - | + | + |
| <i>Tetradesmus incrassatulus</i> | - | + | + | + | + | + | + | + |
| <i>Tetradesmus lagerheimii</i> | - | + | + | - | - | - | - | - |
| <i>Scenedesmus quadricauda</i> | + | + | + | - | + | + | + | + |
| <i>Scenedesmus abundans</i> var. <i>longicauda</i> | - | - | + | + | + | - | + | + |
| <i>Scenedesmus smithii</i> var. <i>linearis</i> | + | + | + | + | - | - | - | - |
| <i>Scenedesmus naegelii</i> | + | - | - | - | - | - | + | - |
| <i>Scenedesmus acunae</i> | - | - | - | + | - | - | - | - |
| <i>Scenedesmus producto-capitatus</i> | - | + | + | - | + | + | + | + |
| <i>Scenedesmus parisiensis</i> | - | - | - | - | - | - | - | + |
| <i>Scenedesmus tropicus</i> | - | - | + | - | + | - | + | + |
| <i>Scenedesmus quadricauda</i> var. <i>bicaudatus</i> | - | + | + | + | + | + | + | + |
| <i>Desmodesmus protuberans</i> | + | - | - | - | - | - | + | - |
| <i>Desmodesmus denticulatus</i> | + | - | - | + | + | - | - | - |
| <i>Desmodesmus subspicatus</i> | + | + | - | + | + | - | + | + |
| <i>Desmodesmus armatus</i> | + | + | + | - | - | + | + | + |
| <i>Desmodesmus armatus</i> var. <i>longispina</i> | + | + | + | + | - | + | + | + |
| <i>Desmodesmus armatus</i> var. <i>bicaudatus</i> | + | + | + | - | + | + | + | + |
| <i>Desmodesmus brasiliensis</i> | + | + | + | - | - | - | - | - |
| <i>Desmodesmus maximus</i> | - | - | - | - | - | - | + | - |
| <i>Desmodesmus armatus</i> var. <i>major</i> | + | - | + | - | - | - | - | + |
| <i>Pectinodesmus javanensis</i> | + | + | + | + | + | + | + | + |
| <i>Comasiella arcuata</i> | - | - | - | + | - | - | + | - |
| <i>Comasiella arcuata</i> var. <i>platydisca</i> | + | + | - | - | - | - | + | - |
| <i>Pseudodidymocystis planctonica</i> | - | - | - | - | - | - | + | - |
| <i>Steinedesmus graevenitzii</i> | - | - | - | + | - | - | + | - |
| <i>Verrucodesmus verrucosus</i> | - | - | - | - | - | - | + | - |

Discussion

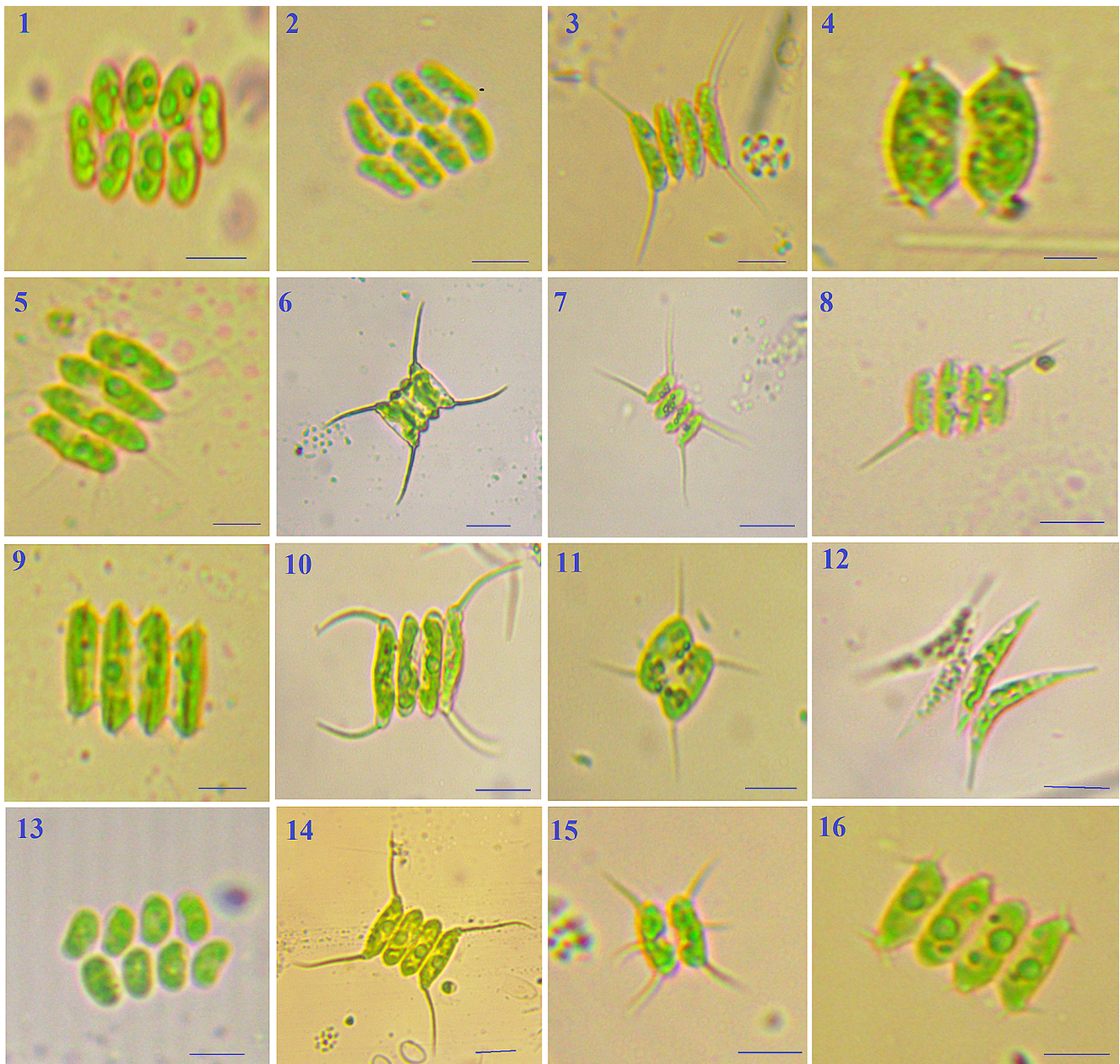
Diversity

The diversity of *Scenedesmus* and *Desmodesmus* (Chlorophyceae) was explored by Johnson et al. in 2007, focusing on the phylogenetic patterns of species at Itasca State Park, Minnesota, USA (Johnson et al. 2007). Roy (2017) published a study on 27 species of *Scenedesmus* in the eutrophic wetlands of an Indian Ramsar site (Roy et al., 2017). Desingurajan and Sankaran explored the distribution of *Scenedesmus* and related genera in Kolavai, a freshwater lake in Tamil Nadu, Southern India, in the year 2021 (Desingurajan and Sankaran 2021). Phinyo et al. (2017) found a total of 35 taxa comprising six genera in their study. They reported three species of *Acutodesmus*, one species of *Comasiella*, twenty-two species of *Desmodesmus*, two species of *Pectinodesmus*, five species of *Scenedesmus*, and two species of *Verrucodesmus*. *Scenedesmus* is one of the species-rich genera that elucidate the species diversity

and richness of phytoplankton in the Damodar River of the Bermo sub-division (Arpana 2010).

Seasonal variation

Through multivariate statistical analysis, the Scenedesma-ceae family was found to be predominant, accounting for 36.6% of the phytoplankton community during the post-monsoon and summer seasons in the Noyyal River (Kumar and Thomas 2019). Yang et al. (2021) showed that the dominant genus in eukaryotic phytoplankton communities in an urban river was *Desmodesmus* in spring and *Pseudopediastrium* in summer. Rao and Pragada explored the seasonal abundance of microalgae in the Pandi Backwaters of the Godavari Estuary, Andhra Pradesh, India, identifying 57 phytoplankton species (Rao and Pragada 2010). The vertical distribution and seasonal abundance of intertidal microalgae on a rocky shore in New South Wales were studied (Underwood 1984).



— 10 µm

Fig. 3 1. *Comasiella arcuata*, 2. *Comasiella arcuata* var. *platydisca*, 3. *Desmodesmus protuberans*, 4. *Desmodesmus denticulatus*, 5. *Desmodesmus subspicatus*, 6. *Desmodesmus armatus*, 7. *Desmodesmus armatus* var. *longispina*, 8. *Desmodesmus armatus* var. *bicaudatus*, 9. *Desmodesmus brasiliensis*, 10. *Desmodesmus maximus*, 11. *Des-*

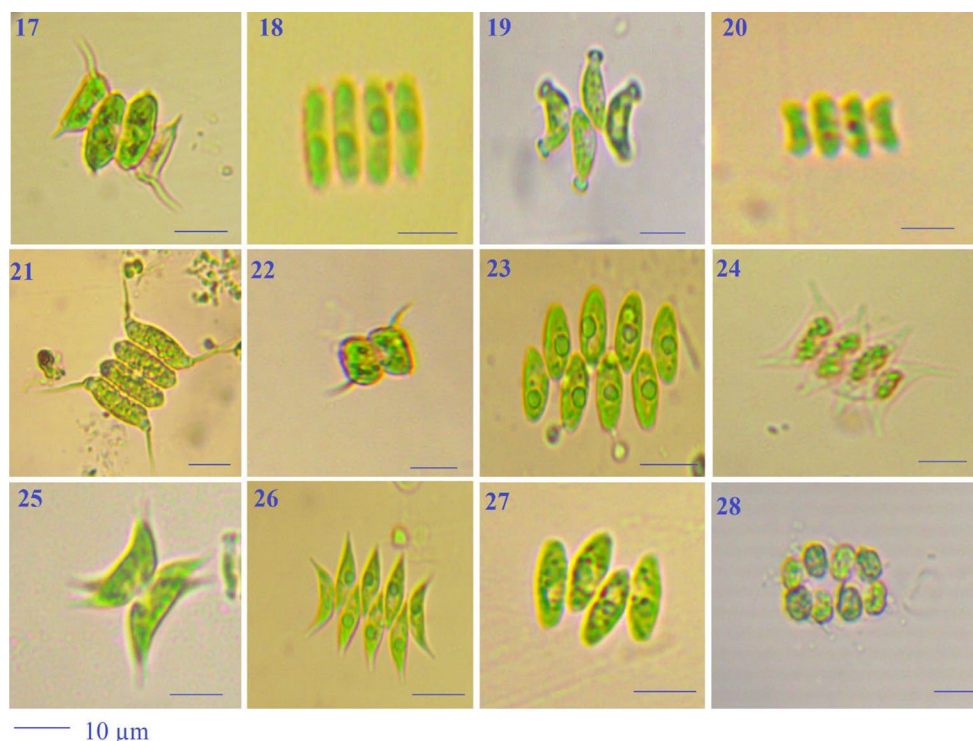
modesmus armatus var. *major*, 12. *Pectinodesmus javanensis*, 13. *Pseudodidymocystis planctonica*, 14. *Scenedesmus quadricauda*, 15. *Scenedesmus abundans* var. *longicauda*, 16. *Scenedesmus smithii* var. *linearis*

Conclusion

Total of 28 species of genus *Tetradesmus* (4), *Scenedesmus* (9), *Desmodesmus* (9), *Pectinodesmus* (1), *Comasiella* (2), *Pseudodidymocystis* (1), *Steinedesmus* (1), *Verrucodesmus* (1) have been reported in the study period of two years from the study area KRT. *Tetradesmus obliquus*, *Scenedesmus*

smithii var. *linearis*, *Desmodesmus armatus* var. *longispina* and *Pectinodesmus javanensi* were reported in all the four seasons of study period. *Scenedesmus naegelii*, *Desmodesmus protuberans*, *Desmodesmus maximus*, *Comasiella arcuata*, *Comasiella arcuata* var. *platydisca*, *Steinedesmus graevenitzii*, *Verrucodesmus verrucosus*, *Scenedesmus parisiensis*, *Desmodesmus armatus* var. *major*,

Fig. 4 17. *Scenedesmus naegelii*, 18. *Scenedesmus acunae*, 19. *Scenedesmus producto-capitatus*, 20. *Scenedesmus parisiensis*, 21. *Scenedesmus tropicus*, 22. *Scenedesmus quadricauda* var. *bicaudatus*, 23. *Steinedesmus graevenitzii*, 24. *Tetradesmus obliquus*, 25. *Tetradesmus wisconsinensis*, 26. *Tetradesmus lagerheimii*, 27. *Tetradesmus incrassatulus*, 28. *Verrucodesmus verrucosus*



Desmodesmus denticulatus, these eleven species were only reported in one season and the entire seasonal pattern was recorded. These species have been reported for the first time from the Kothandaramar Temple Tank in Chennai.

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