Eco. Env. & Cons. 28 (August Suppl. Issue) : 2022; pp. (S266-S271)
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ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2022.v28i04s.040

Phytoplankton Groups in the Estuarine Mangrove Creeks of Edakochi (Kerala), Southwest Coast of India: A Preliminary Study

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(Received 3 December, 2021; Accepted 23 January, 2022)

ABSTRACT

The present work focused on the ecological studies in the mangroves of the Edakochi region, Kerala (India) with special reference to phytoplankton groups. This wetland is situated on the banks of Vembanad Lake, the largest Ramsar site of Kerala. Sampling was carried out from February to June 2017. 5 true mangrove species and 2 semi- mangrove species were noted from the Edakochi region. A total of 25 phytoplankton species were recorded from different stations comprising 15 species of Bacillariophyceae, 7 species of Dinophyceae, 1 species of Cyanophyceae, 1 species of Chlorophyceae and 1 species of Ciliateae. In each station the species composition was found in an order of Bacillariophyceae > Dinophyceae > Cyanophyceae > Chlorophyceae > Ciliatae. Bacillariophyceae contributed 60% of the species, whereas Dinophyceae contributed 28%. Cyanophyceae, Chlorophyceae and Ciliateae contributed 4% each. The highest number of species (19) was recorded during March and the highest cell density was recorded during April (1143/l). The lowest cell density was recorded in June (844/l). From the study results, it was noted that the highest number of species in March was due to the favorably increased salinity. The shift in the salinity regime may be the reason for the lowest number of species in June. Alternation in species diversity influences various ecosystem phenomenon, such as nutrient retention, primary productivity and vegetation dynamics. The study findings depict good species diversity of phytoplankton in the Edakochi mangrove ecosystem.

Key words: *Mangroves, Phytoplankton, Edakochi, Marine ecology*

Introduction

Mangroves are defined as any vascular plant or community that occurs in areas subject to periodic fresh and saltwater inundation. Tolerance to salt and brackish water is a major trait shared by all of these plants. These are unique ecosystems that can persist in saline water and can be found predominantly in the intertidal zones of tropical and subtropical regions around the world (Valiela *et al.,* 2001). Mangroves are ecologically significant because they supply food, act as breeding sites, and nurseries for a variety of food fish and shellfish. These mangrove swamps also act as sediment traps and nutrient sinks. Mangroves are of crucial concern for the biogeochemical cycling of carbon and related elements along tropical continental margins because of their high primary production, organic matter turnover rates, and continual exchange with terrestrial and marine ecosystems (Jennerjahn and Ittekkot, 2002). As per the status report of the Government of India publication, the total area of mangroves in India was reckoned at about 6740 km^2. This covered 7% of the world's mangroves and 8% of the Indian coast (Untawale, 1987). Together, the Sunderbans of India and Bangladesh make up the world's largest block of mangroves. Mangroves are found in eight coastal districts of Kerala, the largest of which is Kannur (755 ha), followed by Kozhikode (293 ha), Ernakulam (260 ha), Alappuzha (90 ha), and Kottayam (80 ha) (Muraleedharan *et al.,* 2009). Mangroves are one of the highly vulnerable ecosystems, and they've been disappearing at an alarming rate in recent years. Several human activities destroy mangroves including shrimp farming, agriculture, deforestation, urban settlement, tourism and infrastructure development (Sheue, 2003). Other effects include river water contamination from heavy metals, oil spills, pesticides, and other chemicals, as well as a deviation in their path of flow. In many countries over the last 30 years, the establishment of shrimp farms has been the primary cause of mangrove decline (Hamilton, 2011). In general, the health and fertility of mangrove environments are reflected through the productivity of phytoplankton and zooplankton as primary and secondary producers, respectively (Prabhakaran *et al.,* 2021). The availability of phytoplankton influences the distribution of consumer organisms, such as immediate herbivore zooplankton. In addition, phytoplankton has a high nutrient content, which makes them a valuable food item in the aquatic food chain (Khatoon *et al.,* 2010). Thus, in the food web of estuarine ecosystems, phytoplankton plays an important role. Research on community structure and diversity of phytoplankton, and their importance in mangrove estuaries, is somewhat limited. This study is an attempt made to understand the area's rich biodiversity with the goal of developing steps to provide more attention to this fragile ecosystem.

Study Area

The study was constituted in the region of Ernakulam district of Kerala (India). Edakochi (9°91′64′′N and 76°291′4′′E) is one of the estuarine mangrove-rich location in south Kochi (Fig. 1). It is situated on the southern bank of Kochi backwaters. It is bounded by the Palluruthy to the west, Aroor to the south and Kumbalam to the east. This wetland is situated on the banks of Vembanad Lake, which meets the Arabian Sea in the West. Vembanad Lake (9°34′60′′ N, 76°25′0′′ E) is the largest Ramsar site and most productive life-supporting coastal wetland in Kerala. It spread over 3 districts; Ernakulam, Kottayam, and Alappuzha having a length of 96 km and a surface area of 1512 km^2.

Fig. 1. Map showing study area

Materials and Methods

The present study was carried out during a period from February 2017 to June 2017. The distribution of mangroves in the randomly selected areas was studied by field visits and visual census surveys. Quadrate analysis was used for the entire study in which the study area was divided into two regions. Each region was again subdivided into 4x4 sizes of 3 quadrates. A total number of six quadrates were laid down in the study area and the species present in each quadrate along with the density and abundance were noted. Plant species were identified with the help of taxonomists and standard references (Duke, 1993; Tomlinson, 1986; Sheue *et al.*, 2009). Phytoplankton samples were collected from five random locations of the study area on monthly basis. The samples were collected and concentrated to 10 ml by filtering 20 L of water through plankton net (20 µm mesh size). For additional qualitative and quantitative studies, the phytoplankton specimens were stored in 0.4 percent Lugol's solution. Identification and quantification were carried out following the standard literature and methodologies (Welch, 1948; Subrahmanyan, 1959; Tomas, 1997). The individual species were counted using a Sedgwick-Rafter counting cell and the numbers are expressed as cells/l (Welch, 1948).

Results and Discussion

During the study period, 5 true mangrove species and 2 semi- mangrove species were noted from the Edakochi region (Table 1). Sonneratiaceae, Rhizophoraceae, and Avicenniacea were the three families to which the true mangrove belongs. The semi-mangrove species identified belong to two families, Pteridaceae and Papilionaceae, respectively. On analyzing the density and abundance in Station 1, *Avicennia officinalis* were the densest species having the value of 43, whereas *Bruguiera conjugata* having 27, *Bruguiera cylindrica* having 30.3, *Rhizophora mucronata* having 30 and *Sonneratia caseolaris* having 5.6 were the following dense species. *Avicennia officinalis* were the most abundant species (43) followed by *Bruguiera conjugata* (27), *Bruguiera cylindrica* (30.3), *Rhizophora mucronata* (30) and *Sonneratia caseolaris* (8.5). At Station 2 *Avicennia officinalis* were the highly dominated species. The density of the *Avicennia officinalis* was 42.3, which implies the highest densest species from the study results. *Bruguiera gymnorrhiza* were having a density value of 30.6. *Bruguiera cylindrica* was the next dense species with a density of 24.3. The density of *Rhizophora mucronata* was 17.3 and *Sonneratia caseolaris* were having the least density value of 3.3.

In estuarine ecosystems, mangrove habitats are often termed as nutrient trap. These nutrients support high primary productivity, which in turn promote high levels of secondary production. Phytoplankton plays a key role to make such regions highly productive. Phytoplankton communities are vital in aquatic environments and act as initial biological components from which the energy is transferred to higher organisms through the food chain. The phytoplankton was assessed quantitatively and qualitatively in regard to their abundance in mangrove creeks. A total number of 25 phytoplankton species were identified (Table 2). Among them, 15 species were diatoms (Bacillariophyceae), 7 species dinoflagellates (Dinophyceae), 1 species blue-green algae (Cyanophyceae), 1 species were green algae (Cholorphyceae) and 1 species ciliate (Ciliateae). Bacillariophyceae contributed 60% of the species, whereas Dinophyceae contributed 28%. Cyanophyceae, Chorophyceae and Ciliateae contributed 4% each (Fig. 2). The highest cell density of 240 cells/l was contributed by *Chaetoceros* sp. during March and also showed a high average cell density. On monthly basis, the highest cell density of 1143 cells/l was recorded during the month of April. The highest number of species (19) was recorded during March and the highest cell density were recorded during April (1143/l). The lowest cell density was recorded in June (844/l). From the observations, it

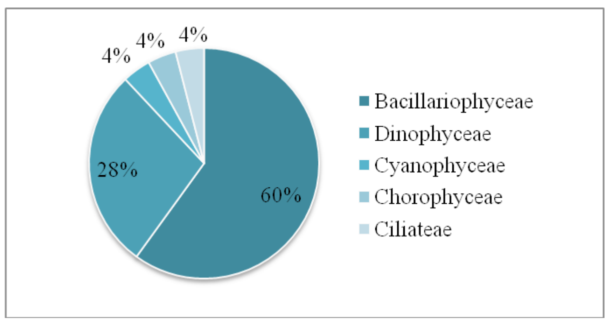

Fig. 2. Percentage composition of phytoplankton groups

Table 1. Taxonomic list of mangroves identified from the study area

Sl. No	Species	Family	Habit	Type
1	*Avicennia officinalis*	Avicenniaceae	Tree	True mangrove
2	*Bruguiera conjugata*	Rhizophoraceae	Tree	True mangrove
3	*Bruguiera cylindrica*	Rhizophoraceae	Tree	True mangrove
4	*Rhizophora mucronata*	Rhizophoraceae	Tree	True mangrove
5	*Sonneratia caseolaris*	Sonneratiaceae	Tree	True mangrove
6	*Acrostichum aureum*	Pteridaceae	Fern	Semi mangrove
7	*Derris trifoliata*	Papilionaceae	Shrub	Semi mangrove

can be concluded that the highest number of species in March was due to the increased salinity. The shift in the salinity regime may be the reason for the lowest number of species in June. Class Bacillariophyceae and Dinophyceae were the dominant group among the others followed by Chlorophyceae. The distribution and abundance of other classes varied remarkably and in each station, *Oscillatoria* sp. (Cyanophyceae) were abundantly seen and it could be due to the freshwater influxes. In each station, the species composition was found to be in an order of Bacillariophyceae > Dinophyceae > Chlorophyceae > Ciliatae. Phytoplankton alone contribute more than 95% of primary production in oceanic waters (Habeebrehman *et al*., 2008). However, the shallow neritic zones of coastal areas are comparably more productive due to the combined production of unicellular algae, macroalgae, symbiotic algae of coral reefs, and sea grasses (Littler *et al*., 2006). Overall, the drifting microalgal (phytoplankton) population plays a major role in determining the productivity of the estuarine, coastal and marine environment. Most studies reveal higher productivity in the summer season. High productivity in summer in the estuarine environment is a common phenomenon, which could be attributed to neritic element domination, high light intensity, clear water condition, availability of nutrients, and high phytoplankton biomass (Rajasekar *et al.,* 2005). Seasonal variation of productivity in the mangrove estuarine regime was also found to be distinct in different studies. Higher primary productivity was observed in the summer season at the Kaduviyar mangrove estuary of India. It has also been argued that this greater productivity could be due to the influence of population density of phytoplankton, neritic element domination, higher salinity, surface water temperature, and clear water conditions as well as the availability of nutrients (Kurian, 1984). The low primary productivity recorded during winter could be the result of reduced phytoplankton population (Rajasegar *et al.,* 2000). The present findings of phytoplankton showed lower abundance when compared with the other studies, which could be probably related to the short duration of the study. Further long-term research in this area may reveal the elevated mangrove-associated phytoplankton abundance in these areas. Man-

Table 2. Taxonomic list of phytoplankton identified from the study area

Class	Order	Family	Genus	Species
Bacillariophyceae	Naviculales	Naviculaceae	Navicula	*Navicula radiosa*
Bacillariophyceae	Naviculales	Pleurosigmataceae	Pleurosigma	*Pleurosigma* sp.
Bacillariophyceae	Coscinodiscales	Coscinodiscaceae	Coscinodiscus	*Coscinodiscus granii*
Bacillariophyceae	Biddulphiales	Biddulphiaceae	Biddulphia	*Biddulphia aurita*
Bacillariophyceae	Chaetocerotales	Chaetocerotaceae	Chaetoceros	*Chaetoceros orientalis*
Bacillariophyceae	Lithodesmiales	Lithodesmiaceae	Ditylum	*Ditylum sol*
Bacillariophyceae	Thalassiosirales	Thalassiosiraceae	Thalassiosira	*Thalassiosira decipiens*
Bacillariophyceae	Thalassiosirales	Skeletonemataceae	Skeletonema	*Skeletonema costatum*
Bacillariophyceae	Thalassionematales	Thalassionemataceae	Thalassionema	*Thalassionema* sp.
Bacillariophyceae	Triceratiales	Triceratiaceae	Triceratium	*Triceratium* sp.
Bacillariophyceae	Bacillariales	Bacillariaceae	Nitzschia	*Nitzschia scaplliformis*
Bacillariophyceae	Bacillariales	Bacillariaceae	Bacillaria	*Bacillaria varians*
Bacillariophyceae	Fragilariales	Fragilariaceae	Asterionellopsis	*Asterionellopsis* sp.
Bacillariophyceae	Rhizosoleniales	Rhizosoleniaceae	Rhizosolenia	*Rhizosolenia* sp.
Bacillariophyceae	Hemiaulales	Hemiaulaceae	Eucampia	*Eucampia* sp.
Dinophyceae	Gonyaulacales	Ceratiaceae	Ceratium	*Ceratium s.p*
Dinophyceae	Gonyaulacales	Goniodomataceae	Alexandrium	*Alexandrium* sp.
Dinophyceae	Gonyaulacales	Goniodomataceae	Pyrodinium	*Pyrodinium* sp.
Dinophyceae	Dinophysiales	Dinophysiaceae	Dinophysis	*Dinophysis* sp.
Dinophyceae	Noctilucales	Noctilucaceae	Noctiluca	*Noctiluca* sp.
Dinophyceae	Peridiniales	Peridinaceae	Peridinium	*Peridinium* sp.
Dinophyceae	Peridiniales	Protoperidinaceae	protoperidinium	*Protoperidinium* sp.
Cyanophyceae	Nostocales	Oscillatoriaceae	Oscillatoria	*Oscillatoria limosa*
Ciliateae	Oligotrichida	Codonellopsidae	Codonellopsis	*Codonellopsis* sp.
Chlorophyceae	Sphaeropleales	Hydrodictyaceae	Pediastrum	*Pediastrum duplex*

groves serve a critical component in the estuarine ecosystem's biodiversity and energy flow, as well as in sustaining food chains, with phytoplankton functioning as a primary producer. Primary consumers such as zooplankton, finfish, and shellfish eat phytoplankton, which commences the marine food chain (Sridhar *et al*., 2006). Though primary and secondary production reflects the fertility and health of mangrove habitats in general. Falling leaves, branches, and other debris produce a lot of litter in mangrove habitats. In the mangrove regions, detritus decomposition assists in the generation of dissolved organic matter (DOM) and the release of nutrients. This organic waste and nutrients have the potential to enrich the coastal sea and estuary, so supporting fisheries (Lee, 1990). Despite their vital role in protecting human resources and biodiversity, India's unique mangrove habitats have been under severe threat from indiscriminate exploitation of mangrove resources for a variety of purposes including fodder, fuel wood, building materials, alcohol, paper, charcoal, and medicine (Upadhyay, 2002). Apart from that, conversion of forest land to aquaculture and agriculture, overgrazing, port and harbor development, expansion of human settlement, urbanization, industrialization, and chemical pollution are all important factors that contribute to the decline of mangroves (Blasco and Aizpuru, 1997; Naskar and Mandal, 1999; Upadhyay, 2002).

Conclusion

The findings of the study depicts that the knowledge on phytoplankton abundance and distribution is vital for evaluating the region's overall aquatic health status and such studies are scanty in this region. Examining the phytoplankton status in the estuarine mangrove area is necessary to understand the hydrographic feature and its influence on the organisms around the region. This work will provide an ideal data on phytoplankton diversity and mangrove ecosystem of Edakochi region of Ernakulam district, southwest coast of India, and it may be inevitable in further wetland-based management and conservation strategies.

Acknowledgments

All the authors are grateful to Kerala University of Fisheries and Ocean Studies, Kochi.

Conflict of Interest

There is no conflict of interest.

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