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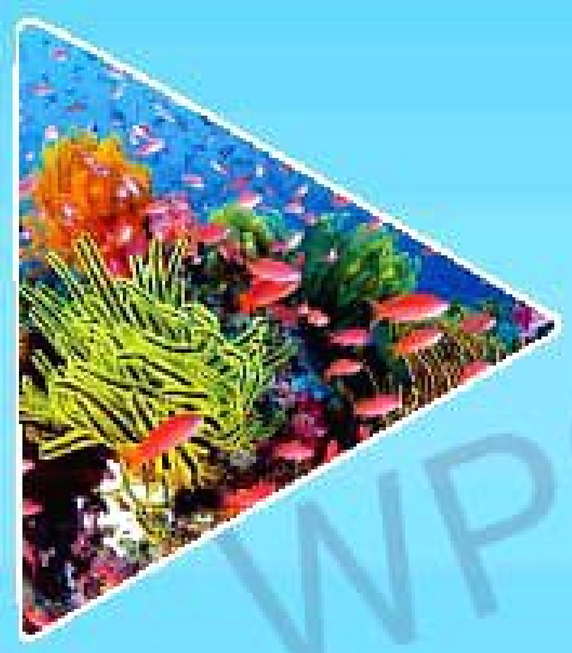

Department of Marine Biology, Microbiology and Biochemistry
School of Marine Sciences
Cochin University of Science and Technology
Fine Arts Avenue, Kochi – 682 016

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Ms. Sumayya. N.S.

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Distribution of microalgae in Azhikkode and Chettuva estuaries of Central Kerala

Divya, P.V., Prince, T.R, Viswam Murali and Sanilkumar M.G.*
Post Graduate and Research Department of Botany,
SNM College, Maliankara, Kerala
*Email: sanilmgs@yahoo.com

Abstract

Estuaries having a unique biological and physical quality and serve as one among the most productive ecosystems on earth. Microalgae are the vital component of estuarine food web and fuel the subsequent higher trophic levels. This paper describes the planktonic microalgal diversity of Azhikkode and Chettuva estuaries of Thrissur district with respect to the physico-chemical parameters during the post-monsoon season 2016. From this ground work 46 microalgal species from four major classes like Bacillariophyceae, Chlorophyceae, Dinophyceae, Cyanophyceae and Chrysophyceae have been identified. It includes four potential harmful species of *Ceratium* also. The dominant members were diatoms in both the stations.

Key words: Azhikkode, Chettuva, Estuary, Microalgal diversity.

Introduction

Estuaries are vital ecosystems characterized by a gradient of salinity and high productivity. Phytoplankters are the major component responsible for production in estuarine habitat and its distribution is influenced by various physico-chemical parameters. Phytoplankton have direct influence to coastal processes like oxygen and nutrient recycling and climatic processes (Nasser *et al.*, 2014). This makes this ecosystem an ideal habitat for most of the organisms. Microalgae were serves as food for many juvenile fishes and the present researches assured that they have great role in estuarine fisheries (Essian *et al.*, 2008). Among the epipelagic communities, diatoms are quickly respond to change in environmental variables and serve as good ecological indicators also (Effendi *et al.*, 2016; Buzancic *et al.*, 2016). Pigment characteristics along with species composition and abundance of

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PHYTOPLANKTON DYNAMICS AND PRODUCTIVITY OF ESTUARINE AND INLAND WATER BODIES OF CENTRAL KERALA

Divya, P.V.* and Sanilkumar, M.G.

DST-FIST Research Department of Botany, SNM College Maliankara (Affiliated to Mahathma Gandhi University Kottayam Kerala)
**Email: pvdivyadivakar@gmail.com*

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Biomass, Harmful bloom, Microalgae, NPP, and Pigment.

ABSTRACT

Phytoplankton communities are the base of marine and freshwater food webs, and played an important role by contributing approximately half of the world's primary production and in coupling global biogeochemical cycles.
This study investigates the relationships between phytoplankton biomass; productivity, nutrient distributions, and freshwater flow were examined in a seasonal study conducted in selected three different ecosystems like estuary, freshwater and brackish inland water bodies of Central Kerala, India. The three sites were sampled during the pre monsoon, monsoon and post monsoon from 2017-2018. The physical parameters pigments and primary productivity were as per estimated standard methods. A total of ninety nine species of microalgae were recorded during the period of study using standard monographs published from India and abroad. The potential toxic species, viz., *Dinophysis caudata*, *Gonyaulax* sp and potential harmful bloom producing microalgae *Ceratium* sp from estuarine station were recorded which highlights the need of continuous monitoring. The NPP was found to be more during PRM compared to monsoon in all the three station except freshwater body. The abundance and productivity show noticeable disparity with respect to environmental factors.

INTRODUCTION

Phytoplankter's are the base of the aquatic food web and dynamically interact with organisms at higher trophic levels in the ecosystem. They play an important role in primary production and are a major food source for many organisms, have vital ecological functions in providing connection between inorganic compounds and organic matter to make these available to higher trophic levels. Phytoplankton is considered as the most important component of the phytoplankton gathering in estuarine and shallow coastal environments, and they are responsible for more than 50% of marine primary production (Alongi, 1998).
These organisms are known to respond directly to changes in the physico chemical conditions of aquatic ecosystems and contribute to the major fishery resource around the world (Ren et al, 2017). Their composition fluctuates depending on hydro chemical conditions, such as light, temperature, salinity, pH, nutrients and turbulence. Recent works specify that they have role in extenuating the climate change and global warming; thereby affect the global CO_2 levels (Santhosh Kumar and Perumal, 2012). Nowa days, various anthropogenic activities have increased, which in turn enhance the nutrient concentration and leads to high productivity in coastal and estuarine environment.

METHODOLOGY

The area selected under study includes estuary and associated inland water bodies of Central Kerala. The periodicity of collection is seasonal from Pre monsoon 2017 to Post monsoon 2018.

50L of surface water will be filtered through 20µ mesh size phytoplankton net made of bolting silk and the filtrate preserved in 3% neutralized formaldehyde solution. Species identification to be done using a Nikon Eclipse-Ci-L Trinocular Phase contrast microscope and based on standard keys published from India and abroad (Allen and Cupp, 1935, Venkataraman, 1939, Cupp, 1943, Subrahmanyan, 1946, Hustedt, 1955, Desikachary, 1959, Hendey, 1964, Simonsen, 1974, Gopinathan, 1984, Hallegraeff *et al*., 1995, Tomas *et al*., 1997, ICAR monographs of freshwater algae, S K Das & Adhikary,2014, and Bellinger & Sigee , 2015.
Physical variables such as Temperature, Salinity, and pH; were measured *in situ* by using precision mercury thermometer, hand-held refractometer, and portable pH meter respectively. Chemical variables (viz., Nitrate, Nitrite, Phosphate and Silicate) will be estimated as per standard methods. (Strickland & Parson, 1972., Jia-Zhong & Fischer , 2006.,)
Light and dark bottle method (Gaarder and Gran, 1927) was employed for the estimation of primary productivity.

RESULT AND DISCUSSION

Seasonal variations of phytoplankton species composition, abundance, and productivity with respect to hydro-chemical factors, were recorded for period of Pre monsoon 2017 to Post monsoon 2018 at three different stations selected from Central Kerala. Azhikkode (Station 1) is an estuarine ecosystem, Purapillikavu (Station 2); a fresh water ecosystem and Cherai (Station 3); a back water ecosystem where people doing fish and prawn cultivation.

A total of ninety nine species of microalgae were recorded during the period of study from the study area, which are the representatives of Cyanophyceae, Chlorophyceae, Bacillariophyceae, Dinophyceae and Chrysophyceae. The species dominance was shown by Bacillariophyceae followed by Chlorophyceae. Diatoms were dominated in the estuarine and back water of Cherai. Cherai inland fish and prawn cultivating water body recently has to see polluted heavily by dumping domestic wastes near the road areas.

Among the total number of identified species seventy nine species were diatoms, followed by fifteen species of Chlorophyceae, eight species of dinoflagellates, four species of Cyanophyceae and one species of Chrysophyceae: *Dinobryon belgica*. While considering the whole three station the percentage contribution of each class of phytoplankton was thus in the increasing order as follows Chrysophyceae < Cyanophyceae < dinoflagellates < green algae < Diatoms (Figure 2-4). Usually diatoms were found to be dominant in estuarine environment, which could be attributed to the fact that they can be tolerating the widely changing hydrographical conditions (Senthilkumar et al., 2002, Silambarasan et al, 2015).

The most dominant phytoplankton taxa are *Oscillatoria sp., Closterium cornu, Cladophora sp., Pediastrum duplex, Staurastrum gracile, Amphora coffaeformis, Asterionella japonica, Coscinodiscus oculus- iridis, Ditylum sol, Melosira moniliformis, Thalassionema nitzschioides*, and *Trieres mobiliensis*. Among the seventy one species of diatoms twenty seven species restricted to estuarine station only and four species of dinoflagellates like *Ceratium furca, C. fusus, Dinophysis caudata* and *Protoperidiniumoceanicum*were only observed from here during the period of study.

Variation in phytoplankton distribution and species abundance were mostly influenced by the seasonal changes in environmental parameters like p^H, salinity, and temperature and it show significant difference between season and station during the present study (Table 1). Salinity show seasonal variation and a major limiting factor of phytoplankton diversity in coastal ecosystem (Vajravelu et al, 2017), the species diversity and population of station 1 and 3 were recorded minimumin the monsoon season compared to PRM.

The maximum species diversity has been observed at station1 (49sp) and station3 (38 sp) mainly by the dominance of diatoms while the number of species from the fresh water station was 29. The species diversity of three stations with respect to the season shows positive relation with the nutrient concentration phosphate and silicate (figure 5). The maximum value of silicate compared to other nutrients will support the dominance of diatoms in three stations. Effendi *et al* (2016) from Mahakam delta East Kalimantan island, Indonesia revealed that diatoms are indicative of moderate to high nutrient concentration. The dominance of diatoms during the current study may be attributed to the high silicate concentration, as silicate is the chief components of diatom frustules (Nasser *et al.*, 2014, Kristiansen and Hoell, 2002).

The abundance and productivity show noticeable disparity with respect to environmental factors. Total number of cells and NPP shows a significant relation with each other when comparing all the station in three seasons under study and validated by the report of Downing and Leibold (2002); that productivity increases with respect to species richness within single trophic level and that richness influences trophic structure. A commonly established principle of estuarine ecology is that phytoplankton production is highest in coastal systems that have the longest flushing times and retain nutrients and phytoplankton biomass Cloern et al. (2014)., Gilmartin and Revelante, (1978). Here also the NPP was found to be high at estuarine and back water during the PRM and POM (Figure1). While the station 2 has maximum NPP at MON and POM which is interrelated to the phytoplankton population and it was in accordance with the findings of Lind and Lind (2002) where phytoplankton production and biomass accumulation is determined by the duration of light in the freshwater lake and seasonal patterns of primary production showed highest rates in the rainy season.

Dinoflagellates of the genus *Ceratium*are predominantly marine but there are rare occurrences in freshwater. Many reports that *Ceratium is non*-toxic and has not been demonstrated as it is unpalatable, but its occurrence can cause damage to the environment since it can deplete resources (Wisniewski, 2007). The blooming of the species cause fish mortality in Thailand and Japan and attributed to oxygen depletion (Taylor *et al.*, 1995). In this study a species of *Ceratium*(4 cells/L) have been identified from station 2, the fresh water body.

There were potential toxic species, viz., *Dinophysis caudata, Gonyaulax* sp, *Gymnodinium*and two species of *Ceratium*; potential harmful bloom producing microalgae from station1 and station.2 were recorded which highlights the need of continuous monitoring. Depending on the type of species an increase in surface water temperature may affect the net growth of phytoplankton positively or negatively which in turn affect the total production also with respect to season. This is the first study investigating the phytoplankton communities and their environment from this area and is essential to set up the baseline of future studies.

Table 1.

	MUNAMBAM			MANJALI			CHERAI		
	PRM	MON	POM	PRM	MON	POM	PRM	MON	POM
p^H	7.5	8.2	7.2	7.1	7.6	7.5	7.2	7.1	7.6
Temp (°C)	30.7	28.8	31.3	30	27.2	30	31.3	30	30.2
Salinity(° Brix)	3.5	0.3	3.1	0	0	0	3	0	3
D.O (mg/L)	8.2	7.02	3.8	3.16	7.65	7.53	3.87	3.7	2.71

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CRITIQUE IN DISPUTES OF THE GENUS *ISCHAEMUM* (POACEAE), KERALA, INDIA.

Nithya Madhanan V.* and Sunil, C.N.

DST- FIST Research Department of Botany, S.N.M College, Maliankara
(Affiliated to Mahatma Gandhi University, Kottayam, Kerala)a
**Email: nithyamadhananv@gmail.com*

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ABSTRACT

The genus *Ischaemum* have been variously treated and classified by different authors in India. It is a complicated genus in the family Poaceae. Circumscriptions and relationships among species and sub- species of the diverse grass genera *Ischaemum* remains controversial. The objectives of this study were to analyze the controversy among the genus and to review the previous works on *Ischaemum*. As a part of the study an extensive field collection were done in all over Kerala. An interesting species of *Ischaemum* was reported and published during this time from Thrissur, Kerala. A comparative study was done by using collected specimens with available literatures. It is concluded that, currently there is no reliable classification on the genus is available. There should be a cumulative study on the genus by reviewing all the available literatures and also modern taxonomy might helps to solve these disputes.

INTRODUCTION

The grasses form the fourth largest angiosperm family- the Poaceae- in the world having about 10,000 species (Watson &Dallwitz, 1992; Clayton& Renvoize, 1986). It occurs in the great diversity of form and spread over a wide range of habitats (Simpson, 1990). In India, it forms the largest family which comprises about 1300 species belonging to 268 genera (Karthikeyan et al., 1989; Moulik, 1997). Being the largest family in India, it is also reported by a large number of endemic taxa (Jain, 1986). *Ischaemum* L., tropical genus (Clayton *et al.*, 2006) in the cosmopolitan family Poaceae. Peninsular Indian domain is having the maximum diversity and has shown high degree of endemism; *Ischaemum* L. is one of the dominant genera in India (Sampson *et al.*, 2001). The grass flora of Kerala is very rich and diverse. The family Poaceae occupies first position in the dominance among the angiosperms of Kerala state. *Ischaemum* L. is one of the dominant genera and it has shown very high degree of endemism in the state (Seema et al., 2005). The genus *Ischaemum* L. was established with two species, *I. muticum* L. and *I. aristatum* L. (Linnaeus 1753). Currently, it comprises 86 species (POWO 2018) worldwide. Almost all the species of *Ischaemum* are distributed in Warm and tropical regions of the world especially in Asia (Mabberly, 2008). Among grasses, the genus *Ischaemum* is the most complex, diverse, variable and difficult genera showing greatest complexity and diversity in South- East Asia, Especially in India (Singh& Rao, 2008).

Ischaemum is a complicated as well as an interesting genus in the family Poaceae. Because of the difficulty to identify and classify the genus, the works are limited to few numbers. Based on the phylogenic studies of GPWG (2001), it is considered that Andropogoneae are monophyletic in origin and described as forming a 'natural group because of the many similar morphological features exhibited by the constituent taxa'. As per the Kew plant list (POWO) 2018, 86 species of *Ischaemum* L. were recorded world wide 50 from India and 33 species from Kerala. The taxonomists who were contributed to the systematic study on the Genus *Ischaemum* L. in India are Sreevasthava & Nair (2010), Singh & Rao (2008), Sur (2001) and many botanists have added grass species as new taxa to the family Poaceae. There is no specific works on the genus in Kerala, the taxonomists include the genus in their works, are "Flowering plants of Kerala- ver.2" by Sasidharan (2011) is a software for plant identification. "Flowering plants of Kerala- A hand book" by Nayar et al. (2006), Kerala grasses by Sreekumar and Nair (1991). A detailed description and key was only in 'Kerala grasses'. Many botanists in Kerala have been contributed the new species to the genus *Ischaemum*. All species published were updated in the kew plant list. *I. kasargodensis* and *I. sreenarayanii* were the new species from Kerala, which is not included in the plant list.

MATERIALS AND METHODS

Kerala is one of the smallest states of India; *Ischaemum* shows rich diversity in the state. A detailed taxonomic survey and field explorations were conducted especially to the centers of endemism (Nayar, 1997) in the state for a period of 2 years. The different regions of the state were visited during the seasons October- March for collection and the collected plants were processed to make herbarium (Jain & Rao, 1977). After referring various floras, herbaria such as MH!, SNMH! and consultation with experts in grasses, the specimens were identified. Photographs of the flowering parts were taken by using Trinocular stereo zoom microscope- Nikon SMZ 745 T for the studies. The specimens were deposited in SNMH!.