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Research Article

# SEASONAL VARIATION AND DIVERSITY OF PHYTOPLANKTON COMMUNITY IN VELLAR ESTUARY, SOUTHEAST COAST OF INDIA

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## ABSTRACT

In the present study, seasonal variation and diversity of phytoplankton community in Vellar estuary carried out for a period of one year during 2012. A total of 81 phytoplankton species belonging to three groups namely diatoms, dinoflagellates and blue greens were recorded from the sample collected in Vellar estuary. Of these, diatoms were found to be the dominant group with 63 species. Dinoflagellates formed next group with 10 species blue greens came next in the order with 6 and green came last in the order with 2 species in all the stations. Density of phytoplankton varied from 1,560 to 44,140 Cells/L with maximum during postmonsoon season and minimum during monsoon season. Diversity indices also calculated in different station of Vellar estuary.

**Key words:** Phytoplantkon, diversity indices, Vellar estuary, population density

## INTRODUCTION

Estuaries are among the most productive, diverse, economically important, and hydrologically variable ecosystems on Earth (Hobbie, 2000). A bulk of the world's commercial and recreational fish stocks depend on estuaries as nurseries, refuges and feeding grounds. Estuarine and coastal watersheds support approximately 75% of the world's human population and the number of coastal residents continues to rise (Vitousek *et al.,* 1997). The productive nature and resourcefulness of estuaries depends on nutrient inputs. Current nutrient loading rates often exceed those needed to sustain desirable production leads to excessive production of organic matter. Many estuaries are now facing nutrient-over-enrichment, or "too much of a good thing" in the form of nutrient-enhanced primary production (D'Elia, 1987; NRC, 2000). This condition prevail excessive production of organic matter in the form of algal blooms and earlier literature also supports (Nixon, 1995)

The marine and estuarine food webs of spun with the energy of phytoplankton. The fascinating creatures like dolphins, whales or other marine mammals, the school of shark or benthic oysters in the intertidal zones are dependent on the phytoplankton either directly or indirectly for their food and nutrients. The effect is achieved due to key role of planktonic organisms in the turnover of organic matter and energy through the ecosystem. Phytoplankton forms the foundation stone of world fishery. Based on fundamental knowledge on the phytoplankton species composition, density, and physiological state of organisms, it is possible to assess the degree of water pollution. It is important to know the probability and possible rate of water ''self-purification'' due to filtering and metabolic activities of planktonic organisms (Nelson *et al*., 1995).

In estuarine and shallow coastal environments, phytoplankton is considered as the most important component of the phytoplankton assemblage. They are responsible for more than 50% of marine primary production. They are amongst the major representatives of the seasonal coastal blooms and, have traditionally been considered the main source of food for herbivorous zooplankton. The phytoplankton assemblages in a given locale respond rapidly to environmental changes and, can thus provide highly informative assessments of the biotic integrity or impairment of aquatic systems. Further, some species tolerant to wider variations in their environment would prove useful for a reliable characterization of environmental variability (Stevenson and Pan, 1999).

Variation in phytoplankton community composition depends on the availability of nutrients, temperature, and light intensity and on other limnological factors. Normally phytoplankton follows a fairly recognizable annual cycle of growth, but sometimes the synchrony in their normal annual cycle is disrupted by explosive growth of some species (Vaulot, 2001)

Diversity, distribution, and variation in the biotic parameters provide a good indication of energy turnover in aquatic environments (Forsberg, 1982). Within these environments phytoplankton are located at the base level and are represented as a major source of organic carbon (Gaikwad, *et al*., 2004). Their sensitivity and fluctuation in species composition are usually a suitable explanation to demonstrate the alteration within an ecosystem (Devassy and Goss, 1988). Species diversity responds to changes in environmental gradients and may characterize many interactions that can establish the intricate pattern of community structure. Our present investigation focuses on a comprehensive study of phytoplankton diversity, their species composition, population density, and community characterization.

## MATERIAL AND METHODS

### Study area:

The Vellar estuary (lat. $11^0$ 29' N and $79^0$ 46' E) is always open with the Bay of Bengal and is said to be a "true estuary" as there is no complete closure of the mouth. The river vellar flowing on the southeast coast of India originates in the Shervarayan Hills of Salem District. After meandering through a distance of 480 kms, it forms the estuarine system at Parangipettai (formerly known as Porto Novo), before it joins the Bay of Bengal. This estuary enters in Cuddalore district through Viriddhachalam, Kammapura and Settiya Thope, and then it runs in between Bhuvanagiri and Keerappalayam. This estuary connects with Veeranam Lake near Kattumannarkoil and Rayanallur (Fig.1).

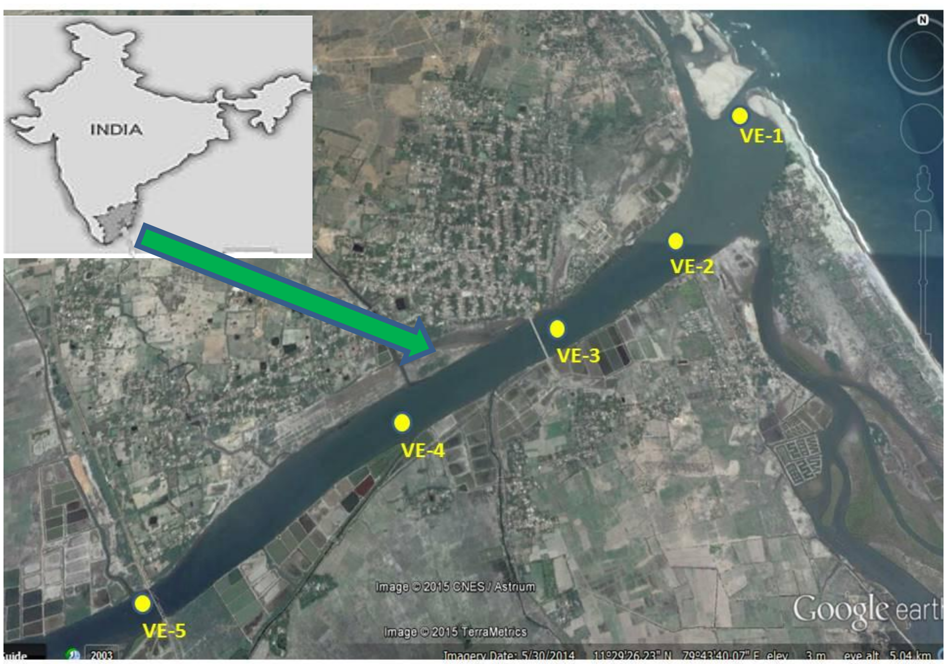



**Figure 1:** Map showing the study area

## Phytoplankton analysis:

Phytoplankton samples were collected from the surface waters by towing a plankton net (mouth diameter 0.35 m) made of bolting silk [No.25 mesh size 48 μm) for half an hour. These samples were preserved in 5% neutralized formalin and used for qualitative analysis. For the quantitative analysis of phytoplankton, the settling method described by Sukhanovo (1978) was adopted. Numerical plankton analysis was carried out using Utermohl's inverted plankton microscope. Fixed samples were enumerated using a Sedgwick–Rafter counting slide on a light microscope. Counting of plankton was done with the help of "Sedgwick– Rafter counting cell" as per the procedure given by Wetzel and Likens (2000). Samples were allowed to settle in the counting chamber for 3–5 min prior to enumeration. More than ten fields of view were randomly selected across each slide and repeated three times. Further, the data were subjected to various univariate methods available in PRIMER ver. 6. The phytoplankton species were identified using standard works of Smith (1950), Desikachary (1959).

# RESULTS

Monthly variations of phytoplankton species composition, population density, species diversity, richness, evenness were recorded for period of one year from January 2012 to December 2012 at Vellar estuary, in the study period; five different stations were selected for sampling.

## Species composition:

A total of 81 phytoplankton species belonging to three groups namely diatoms, dinoflagellates and blue greens were recorded from the sample collected in Vellar estuary. Of these, diatoms (bacillariophyceae) were found to be the dominant group with 63 species Dinoflagellates (dinophyceae) formed next group with 10 species blue greens (cyanophyceae) came next in the order with 6 and green algae (chlorophyceae) came last in the order with 2 species in all the stations.

Among the diatoms, *Bellerochea malleus*, *Coscinodiscus centralis, C. radiatus, C. granii, C. gigas, Chaetoceros indicus, C. affinis, C. messanensis, Leptocylindrus danicus, Thalassionema nitzschioides, Triceratium favus*, *Cyclotella* sp*. Cylindrotheca closterium, Eucampia zoodiacus, Lithodesmium undulatum, Nitzschia longisima, N. sigma, Odentella mobilensis, O. sinensis, Pleurosigma normanii, P. elongatum, Rhizosolenia alata, R. styliformis, Skeletonema costatum* and *Thalassiothrix frauenfeldii* were found to be the common species in the samples collected in various stations. Coming to dinoflagellates, *Ceratium furca, C. trichoceros, C. macroceros* and *prorocentrum micans* and blue green algae *Merismopedia glauca, Oscillatoria* sp*. Spirulina* sp. and *Trichodesmium erythraeum* showed consistency in their occurrence in the samples collected in different stations of Vellar estuary.

## Percentage composition:

When the results of percentage composition of phytoplankton were viewed, diatoms constituted the maximum with 79% to the total, dinoflagellates found to be next dominant group with 10%. Blue greens and green algae contributed respectively 7% and 4% to the total phytoplankton species collected (Fig. 2).

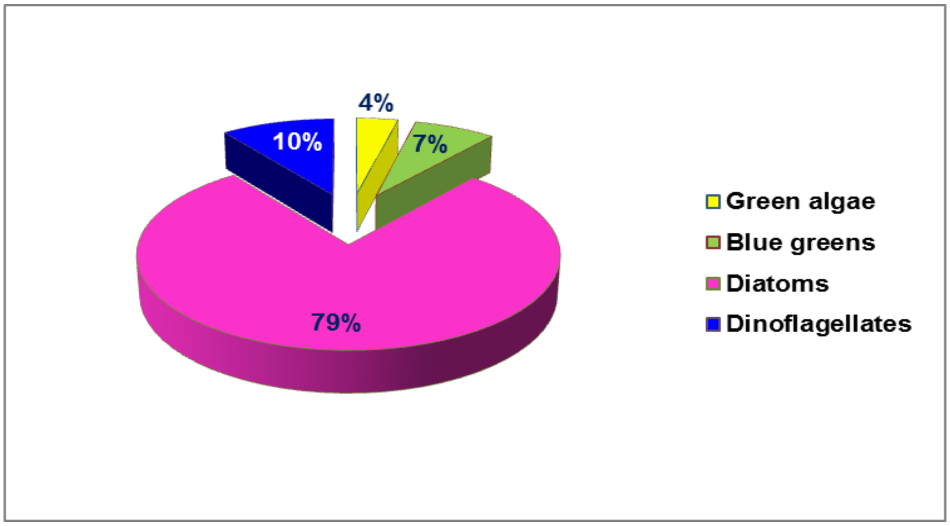



**Figure 2:** Percentage composition of Phytoplankton recorded in various stations of Vellar estuary

## Population density:

Density of phytoplankton varied from 1,560 to 44,140 Cells/L with maximum during postmonsoon season and minimum during monsoon season (Fig.3).

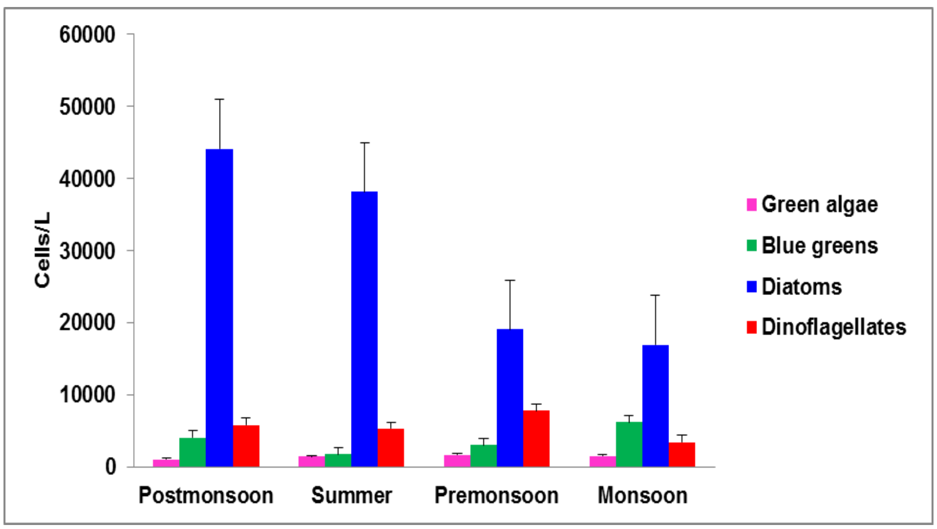
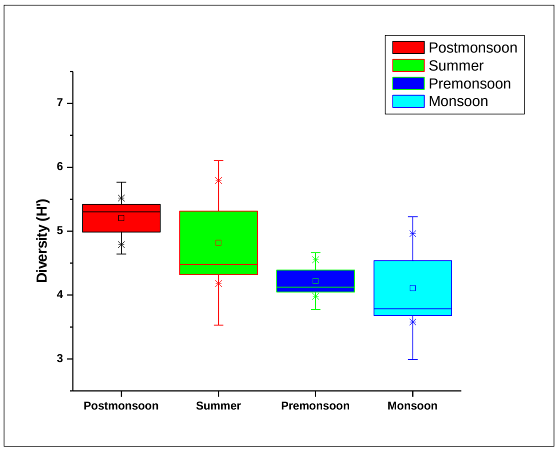


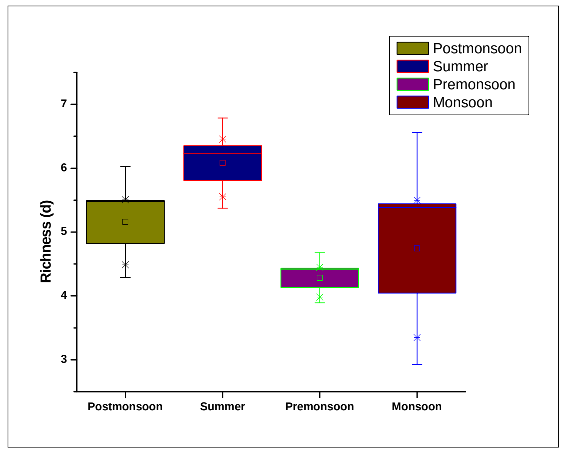

**Figure 3:** Population density of Phytoplankton recorded in various stations of Vellar estuary

## Diversity Indices:

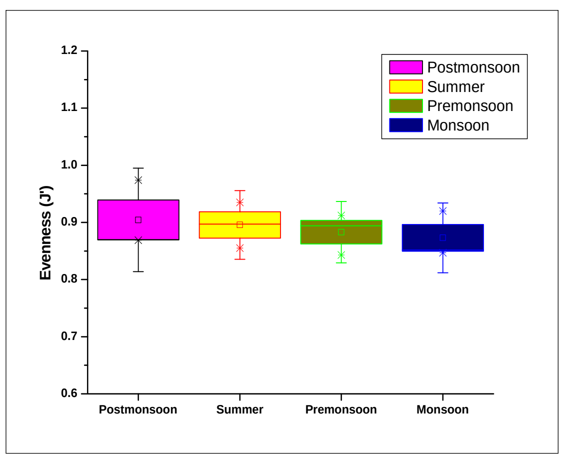
In Vellar estuary, during the study period, the phytoplankton species diversity (H') varied from 3.785 to 5.519 with maximum during postmonsoon season and minimum during monsoon season. The species richness (d) ranged between 3.348 and 6.454 with maximum during summer season and minimum during monsoon season. The species evenness varied from 0.847 to 0.974 with the maximum during postmonsoon season and minimum during monsoon season (Fig. 4).




**a**




**b**




**c**

**Figure 4:** Seasonal variations of diversity indices (a) diversity; (b) richness; (c) evenness calculated in different stations of Vellar estuary

## Multivariate statistical analysis:

## Cluster and Multi-dimensional scaling analysis (MDS):

In the present study, cluster analysis was drawn to find out the degree of similarity among the stations of Vellar estuary. Cluster analysis (or classification) is helpful to find out natural groupings of samples, such that samples within a group are more similar to each other than the samples in different groups. In the present study, data of phytoplankton abundance collected in different stations were allowed as input for cluster analysis. The dendrogram revealed that samples collected at different stations of Vellar estuary got grouped separately indicating their similarity. This fact was further conformed through MDS, which was also revealed the same pattern of groupings as recognized in cluster analysis. The stress values (0.01), which is overlying on the top-right corner of the MDS plot, was also found to be low signifying the good ordination pattern of the samples (Fig. 5&6).

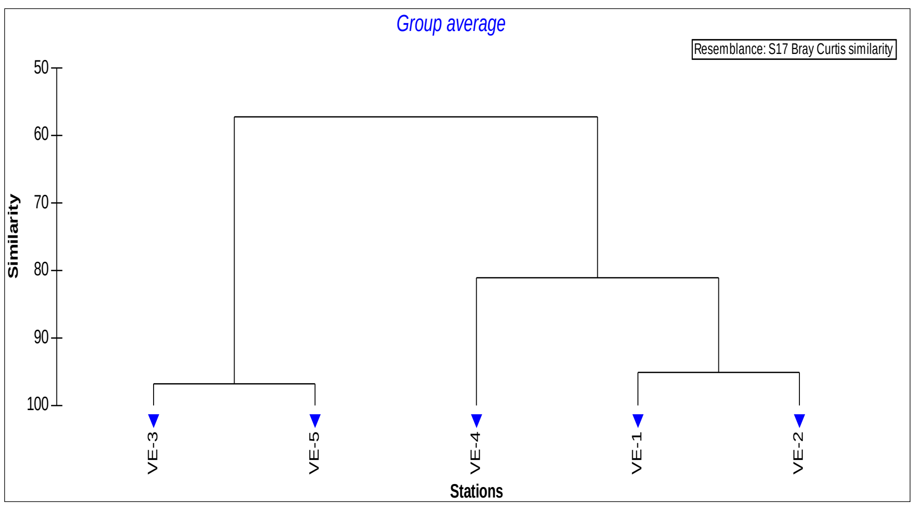



**Figure 5:** Dendrogram drawn for the phytoplankton samples collected in different station of Vellar estuary

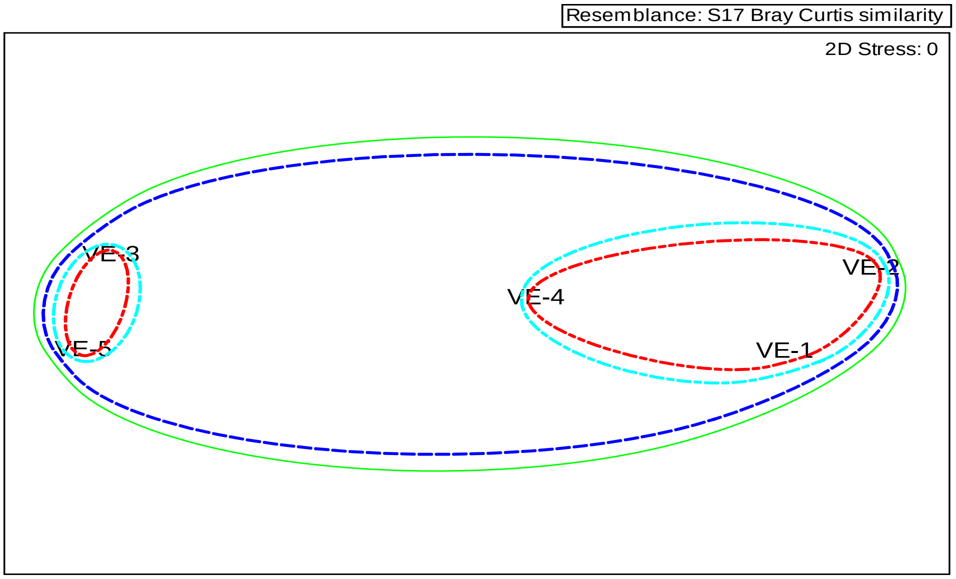



**Figure 6:** MDS drawn for the phytoplankton samples collected in different station of Vellar estuary

## DISCUSSION

Phytoplankton recorded in the present study period, consisted of 81 species from all the stations. During the study diatoms were found to be the dominant group followed by dinoflagellates, blue greens and green algae in all the stations. Percentage contribution of each group of phytoplankton was thus in the decreasing order as follows. Diatoms> dinoflagellates> blue greens > green algae. Generally diatoms were found to be dominant estuarine environment, which could be due to the fact that the diatoms can be tolerating the widely changing hydrographical conditions (Mani, 1992; Kannan and Vasantha, 1992; Rajasekar *et al*., 2000; Gowda *et al*., 2001; Senthikumar *et al*., 2002).

Presently observed high population density and species diversity during postmonsoon and summer might be due to the predominance of diatoms, *Bellerochea malleus*, *Coscinodiscus centralis, C. radiatus, C. granii, C. gigas, Chaetoceros indicus, C. affinis, C. messanensis, Leptocylindrus danicus, Thalassionema nitzschioides, Triceratium favus*, *Cyclotella* sp. *Cylindrotheca closterium, Eucampia zoodiacus, Lithodesmium undulatum, Nitzschia longisima, N. sigma, Odentella mobilensis, O. sinensis, Pleurosigma normanii, P. elongatum, Rhizosolenia alata, R. styliformis, Skeletonema costatum* and *Thalassiothrix frauenfeldii* were found to be the common species in the samples collected in various stations. Coming to dinoflagellates, *Ceratium furca C. trichoceros, C. macroceros* and *prorocentrum micans* and blue green algae such as, *Merismopedia glauca, Oscillatoria* sp. *Spirulina* sp. and *Trichodesmium erythraeum* were recorded. The phytoplankton abundance maximum during postmonnsoon season could be attributed to the increased salinity, temperature, pH and intensity of light penetration during the season (Mani and Krishnamurthy, 1989).

The abundance of phytoplankton 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* sp. and *Microcystis* sp. were also noticed. Similar observation were earlier made by Patterson Edward and Ayyakkannu (1991), Gouda and Panigrahy (1996), Rajasegar *et al*. (2000), Thillai Rajasekar *et al*. (2005), Rajkumar *et al*. (2009), Perumal *et al*. (2009).

Species diversity varied from 3.785 to 5.519 with maximum during postmonsoon season and minimum during monsoon season, due to the upwelling of the nutrients. Similar trend was reported earlier by Akpan and Offem, (1993) along the southeast coast of India. Species richness was maximum (6.454) during summer and minimum (3.348) during monsoon season. Low species richness recorded during monsoon and high values recorded during summer season could be correlated with nutrients influx as suggested earlier by Rajasekar *et al*, (2000). Species evenness index ranged between 0.847 and 0.974 with maximum during postmonsoon and minimum during monsoon season. Similar finding are reported earlier by Sukumaran *et al*. (2014) in Muthupetai coastal waters.

In the present study, cluster analysis revealed that the two major clusters, such as stations VE-1 and VE-2 were more densely populated than stations VE-3 and VE-5 were grouped to form a separate cluster based on species composition and abundance. The stations (VE-4) were grouped separately. Further, this was confirmed through MDS plot. Investigation similar to this was carried out by Vaheeda (2008) in Kerala coastal waters.

## CONCLUSIONS

The Vellar estuary is subjected to seasonal fluctuation in phytoplankton abundance depending upon the seasonal tidal amplitude and fresh water influx resulting in continuous exchange of organic, inorganic, plant and animal matters. This estuarine ecosystem was a resourceful place for the phytoplankton species abundance. The present study, baseline information of diversity and distribution of phytoplankton community would form a useful tool for the further ecological assessment and monitoring of these ecosystems.

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