



Surf Zone Phytoplankton Abundance During Winter Season on the Velneshwar Coast of Ratnagiri, West Coast of India

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Abstract – Velneshwar beach is frequented by pilgrimage and tourism activities. Surf zone of this beach is chosen to study phytoplankton abundance with the main objective to create inventory of phytoplankton species. Due to anthropogenic disturbances, species composition for the locality needs attention and intent is to comprehend the chronic changes in their population structure. In this regards, species richness, evenness and diversity values were calculated. These values were optimal for stations LT10 to LT7 and LT1 and LT2 which were protected due to rocky nature, and LT3 to LT6 were categorized as exposed disseminative type of beach showed below optimal values. Disseminative beaches are affected by heavy wave action and swash effect, hence, mixed phytoplankton populations were evident. In all, we found 19 genera, amongst these *Biddulphia*, *Coscinodiscus* and *Nitzschia* showed two species each and *Pleurosigma* showed three species. Among all genera, the average composition of *Chaetoceros* was found to be highest (1240 cell.l⁻¹), followed by *Coscinodiscusexcentricus* and *Coscinodiscusgigas* together showed (473 cell.l⁻¹), as well as *Pleurosigmaangulatum*, *Pleurosigmagalapagense* and *Pleurosigmaelongatum* together showed (413 cell.l⁻¹). Physico-chemical parameters such as DO, salinity, pH and temperature were found to be optimal and did not vary significantly among stations. Phytoplankton abundance did not show significant correlation with that of physico-chemical parameters (DO, pH and temperature) except salinity, 0.44 ($p \leq 0.05$).

Keywords – Surf Zone, Phytoplankton, Species Richness, Evenness, Diversity Index, nMDS, Physico-Chemical Parameters Velneshwar, West Coast of India.

I. INTRODUCTION

Studies on and around the coastal regime of Ratnagiri are scarce compared to the studies carried out on south west coast comprising Cochin and north west coast comprising Mumbai. The studies have been focused mainly for the pelagic zone of the mentioned areas as it signifies the fishery potential areas. Community structure of surf zone phytoplankton of Manglore during south west monsoon has been studied earlier by Raveesha *et al.* (2010) found that, diatoms dominated the population of phytoplankton. In this regards surf zone is chosen in view that, the beach is frequented by pilgrimage and tourism activities. The surf zone phytoplankton population is subjected to heavy wave action and are unstable and patchy, these patches accumulate in the inner surf-zone as re-suspension of benthic stocks in events of increased wave energy (Röriget *al.* 2006). Hence mixed populations are characteristic features of surf zones. Once these,

populations are in the water column, photosynthesis increases and the resulted biomass can form very rich trophic chains on the beach ecosystem especially for intertidal fauna. Dense accumulations of certain species of surf- zone phytoplankton are a common feature on such beaches. Their accumulations result in dark green to brown discoloration of surf-zone water (McLachlan & Lewin, 1981). It has been cited by Talbot & Bate (1986), that, the seeding or inoculation of the inner surf zone occurs from and offshore stocks of the cells. From inner surf zone to surf zone, diatoms achieve dominance above less dominant species and cell number increases well above those seaward of the surf zone. Densely populated phytoplankton thus forms the basis for the production of zooplankton, fishes, shell fish etc. (Santhnamet *al.* 1987). Hence, it is hypothesized that, in surf zone, the so formed primary consumers can form rich source of food for migrating as well as sessile fauna. To mention tourism and pilgrimage can considerably hamper the functioning of surf zone not only by frequenting but also surging domestic runoffs in surf zones can alter the population structure. Hence phytoplankton composition for the locality needs attention and intent is to comprehend the chronic changes in their population structure.

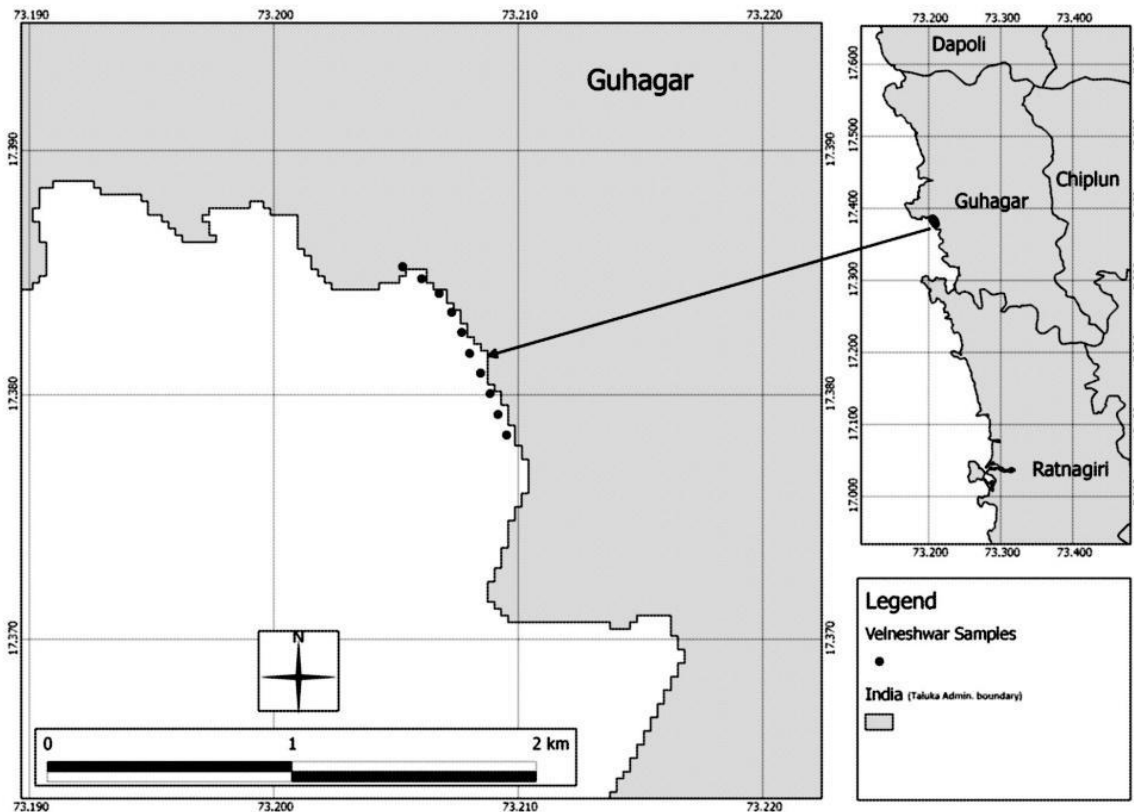
Phytoplankton studies include a variety of taxonomic groups (cyanobacteria, diatoms, dinoflagellates, silicoflagellates, coccolithophorids, and many other flagellates) that inhabit the water column. According to Sourniaet *al.* (1991), marine phytoplankton of the world may include as many as 17 classes and an estimated number of 498 ± 15 genera and $3,910 \pm 465$ species. Phytoplankton species are predominantly autotrophic or holophytic organisms they build organic matter from inorganic materials present in their environment. Marine phytoplankton is the most important producer of organic substances and the rate at which energy is stored up by these tiny organisms determine the basic primary productivity of the ecosystem. Under favorable conditions phytoplankton is capable of remarkably rapid growth, sometimes producing its own weight of new organic materials within 24 hours, a rate greater than that achievable by terrestrial plants. All other living forms of higher trophic levels are directly or indirectly dependant on phytoplankton for energy supply and therefore, perform vital functions (Chandyet *al.* 1991). These marine floras, in the process of photosynthesis, also extract carbon dioxide from the atmosphere, and, as a result, they play an important role in the balance of greenhouse gases that control global climate (Alles, 2011).

II. MATERIALS AND METHODS

A. Location of study area

Velneswar coast is famous for its celestial beauty as well as religious activities and thus, is a beach with significant anthropogenic disturbances. Along with it the area also shows activities related to fish catching on small

scale. The area lies between $17^{\circ} 22' 42.20''$ N to $17^{\circ} 23' 07.01''$ N and $73^{\circ} 12' 34.33''$ E for station 1 and $17^{\circ} 23' 07.01''$ N to $73^{\circ} 12' 19.2''$ E for station 10 are depicted in (Figure 1). Ten stations were sampled in the surf zone of the beach between 15:00 to 17:00 Hrs. They were named as Low Tide (LT1 to LT10).



Samples for physico-chemical parameters such as DO, Salinity, pH were collected in 1 liter capacity jar. These parameters were measured using hand held portable probes for DO (Lutron-5509) and pH (HANNA instruments) and refractometer for salinity. Temperature was measured using hand held centigrade thermometer. Phytoplankton collection was done using conical nylon bags (30cm diameter) made up of 30 no. bolting silk cloth is used for filtering 100 L of surface water with a bucket of 25 liters volume and the

plankton was thus concentrated. The net was washed again with sea water and concentrated plankton was collected in 100 ml volume screw capped airtight plastic bottles. The samples were preserved on site by adding 1 ml of Lugol's iodine. The sample was allowed to settle prior to analysis. Water was siphoned with a tube with net having 20 μ m mesh size tied on one end to prevent the loss of the phytoplankton. The sample was concentrated to 20 ml using this method (Santhanam *et al.* 1987).

The enumeration of phytoplankton was carried out by obtaining one ml of plankton sample from the stock through the Stampel pipette. This volume was transferred to a Sedgwick Rafter counting cell. The phytoplankton species-wise were counted. This was repeated by taking

more one ml of sample twice and from average of the three samples data was calculated. Thus, average number of phytoplankton present in a liter of water sample was then calculated and final results are expressed as no of cells. l^{-1} . Univariate methods such as Margalef sp. richness, Pielou's sp. evenness, Shannon-Wiener diversity index, and Simpson index as well as nMDS analysis were carried out using PRIMER 5 Statistics software.

III. RESULTS AND DISCUSSION

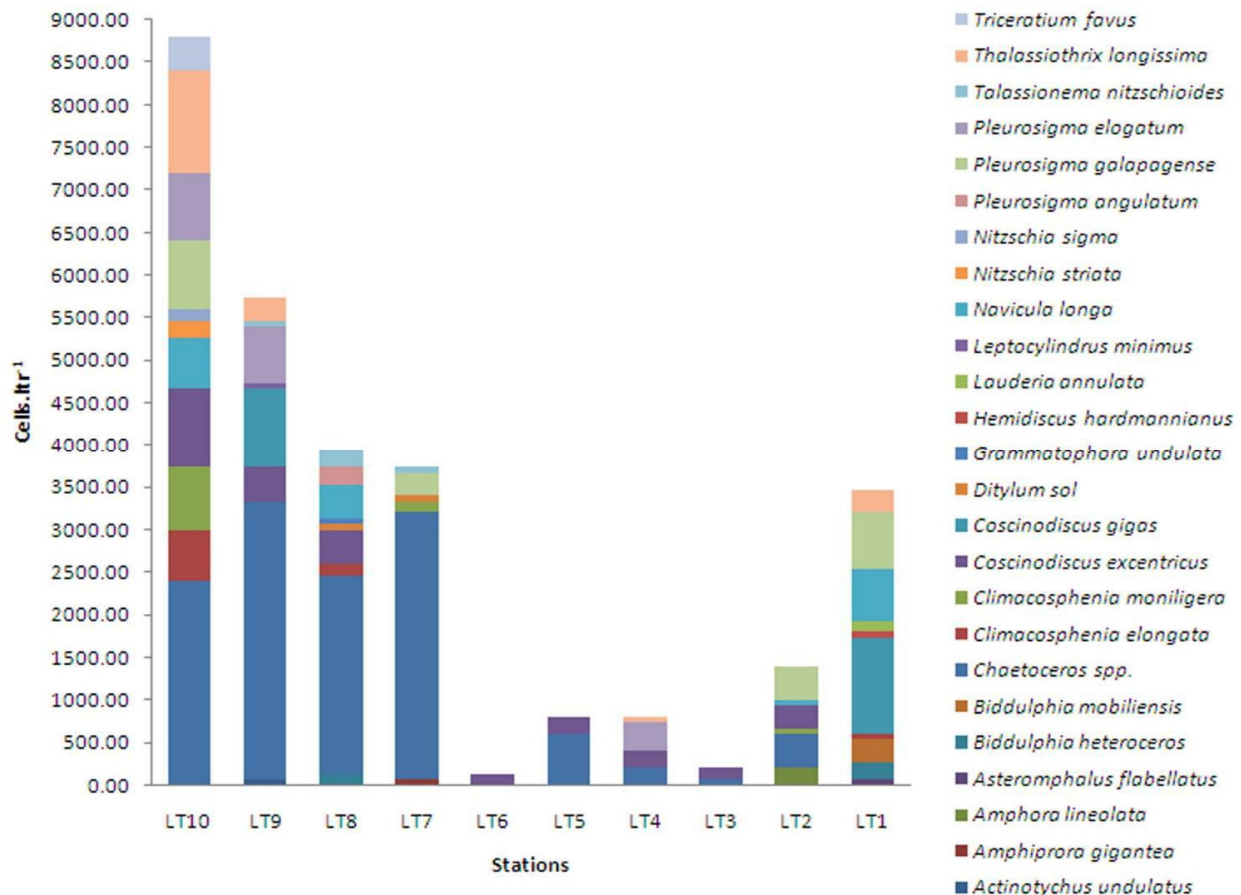
A total of 19 genera were identified in 10 samples, from this *Biddulphia*, *Coscinodiscus* and *Nitzschia* illustrated two species each and *Pleurosigma* showed three species. Diatom was the only abundant group found. *Chaetoceros* was the most abundant genus followed by *Coscinodiscus* and *Pleurosigma*. Earlier studies (Kadam and Tiwari, 2011) also suggest the dominance of diatomic population. They have studied phytoplankton and abiotic factors from Dahanu creek and have reported 52 genera with

Coscinodiscus being highest in abundance. Other than that, the studies have been done (Patil and Anil, 2011) on east coast shows variations in phytoplankton in monsoon influenced tropical estuary. The dominance of

Skeletonemaw was determined in their study positively by the extent of low-saline stratified conditions. The community structure of phytoplankton in relation to physico-chemical properties of coastal waters on Kalpakam coast has been studied by Sahu *et al.* (2012). Diatoms were found to be dominated in the coastal water with around 185 species of phytoplankton.

Indices related to species richness, evenness and species diversity were calculated by using the entire set of species in each sample. The ranges of these indices (Table 2) are

suggestive of differences in patterns of their occurrences (Ignatiades, 1992). All species were selected for nMDS analysis on the basis of their frequency of occurrence (in all samples) and their relative abundance (in each sample). During present study it was observed that, the total number of phytoplankton cells per liter was highest at station LT10 being 8800, followed by LT9 (5733), LT8 (3933) and LT7 (3733) LT1 (3466). Variations in total number of phytoplankton cells per liter have been depicted in (Figure 2).



The Margalef's species richness index confirms that, the species recorded were highest with values being 1.101, 0.808, 0.966, 0.607, and 1.104 respectively for LT10, LT9, LT4, LT7 and LT2 and has been depicted in Table 1. From Pielou's evenness index it can be observed that individuals are evenly distributed except for LT7 where, value is lowest being 0.37. This value is comparatively less indicating uneven distribution of species for that station. From Shannon-Wiener diversity index it can be seen that at station LT10 the structure of habitat is more stable and balanced. The station LT7, LT 5 and LT3 indicate disturbance with lowest values being 0.670, 0.562 and 0.636. It was observed that at station LT10 it was the nature of the beach with the stable rocky structure which limited the wave breaking and flourished the various types of algae. This station comparably showed no wave action

and hence shows highest species density and diversity. LT6, LT5 and LT3 were observed to be show less densities of phytoplankton (Figure 2) with an exception of slightly higher densities at LT4. The stations from LT6 to LT 3 are exposed, dissipative type of beaches as described previously during introduction. This can be the reason why, due to high wave action, the environment is less stable. For Simpson's diversity index based on the value of 0.2883 calculated for E_D for station LT7 we could describe the equitability, or evenness of individuals' distributions among families, in this community as relatively low. For LT10 to LT8 as well as for LT1, LT2 and LT4, equitability, or evenness of individuals' distributions among families is comparably high. For Simpson's diversity index the equitability and evenness was found to be highest for LT10 and LT1 (Table 1).

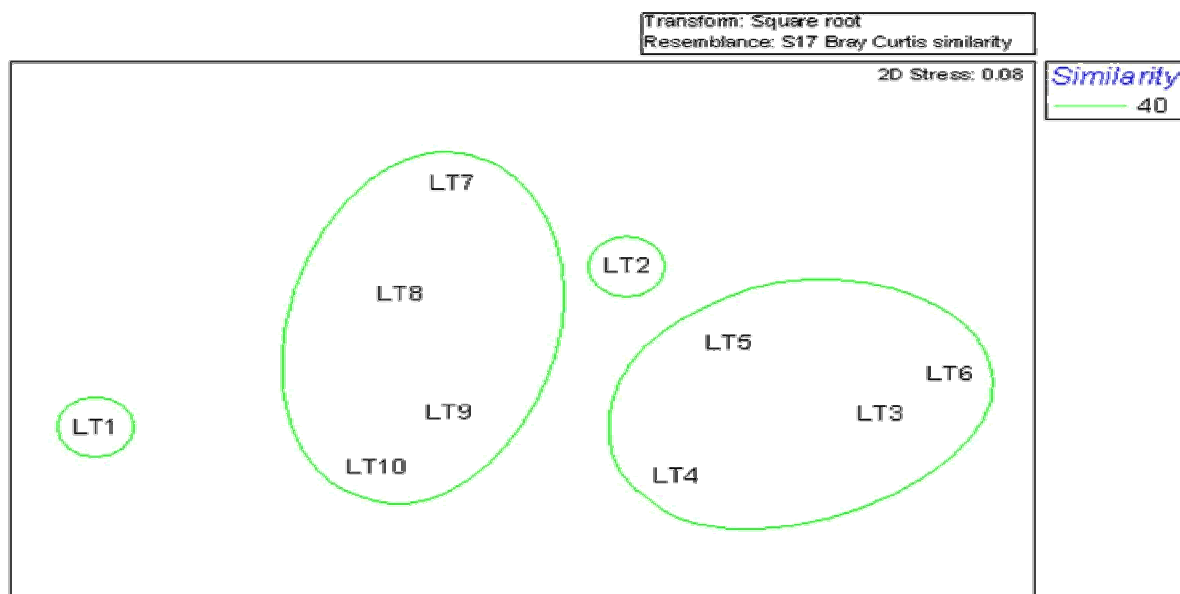
Table 1. Richness, Evenness, Shannon-Wiener diversity index and Simpson's index

Sample	No of Sp.	Abundance (Cells.l ⁻¹)	Margalef sp. richness	Pielou's sp. evenness	Shannon-Wiener diversity index	Simpson index
	S	N	d	J'	H'(log _e)	1-Lambda'
LT10	11	8800	1.101	0.9022	2.163	0.8603
LT9	8	5733	0.8089	0.6492	1.35	0.628
LT8	9	3933	0.9665	0.6578	1.445	0.6195
LT7	6	3733	0.6079	0.374	0.6702	0.2883
LT6	1	133	0	0	0	0
LT5	2	800	0.1496	0.8113	0.5623	0.3755
LT4	4	800	0.4488	0.9125	1.265	0.6953
LT3	2	200	0.1887	0.9183	0.6365	0.4467
LT2	6	1400	0.6902	0.8928	1.6	0.7761
LT1	10	3467	1.104	0.8245	1.899	0.8087

nMDS carried out revealed similarity at 40% and four distinct groups were formed (Figure 3).

The group 1 comprised of stations LT3 to LT6 and was dominated by only two genera *Coscinodiscus* contributing 76.11 % and

Chaetoceros spp.23.89 %. Group 2 comprised of station LT7 to LT10 were dominated by *Chaetoceros* (63.59%) and *Coscinodiscus* (10.92%) together they contribute to 74.51%. Group 3 and 4 comprised only one station each and are separated from other groups distinctly.



From richness, evenness and diversity indices as well as from cell densities (Figure 2) that stations LT7 to LT10 and Station LT1 and LT2 showed values within their optimal limits. It was observed that these stations were less affected by the anthropogenic disturbances. Particularly stations LT7 to LT10 showed high densities (Figure 2), at these stations the beach was observed to be rocky in nature. Due to this rocky nature of the beach wave braking was limited and was found to show the algal overgrowth and clam waters. This might be the reason why the densities of phytoplankton are higher at stations LT10 to LT8 in particular. There have been few estimates of benthic micro- floral densities from marine sands and values are known to reach 10³cells.cm⁻³ under optimal conditions. These beaches are classified as either open (exposed) or non-open (sheltered) beaches. The exposed

beaches can be defined as reflective, intermediate or dissipative (Short and Wright, 1983). Dissipative beaches such as the Velneshwar coast have fine sand, heavy wave action, flat slopes, and wide surf- zones where foaming or spilling breakers gradually dissipate their energy (McLachlan, 1990). This dissipated energy thus, makes these beaches most unstable and limit phytoplankton occurrence.

In case of environmental parameters major physico-chemical parameters such as DO, temperature and pH did not vary much and showed no significant correlation among phytoplankton abundance (Log₁₀transformed) except salinity. Salinity showed significant correlation 0.44 (p≤0.05). The correlation matrix of these parameters is shown in (Table 2).

Table 2: Correlation coefficients between phytoplankton cells and physico-chemical parameters at $p \leq 0.05$.

	Cells Log ₁₀	pH	Temp	Salinity
Cells Log ₁₀	1			
pH	-0.01	1.00		
Temperature	-0.13	0.10	1.00	
Salinity	0.44	-0.08	-0.24	1.00

Sahu et al. (2012) found salinity to be an important parameter influencing the species composition, standing stock and succession. On similar note salinity influenced the standing stock positively during present study. One way ANOVA was carried out to see whether there were any significant differences amongst parameters for 10 stations. It was observed that, there were no significant differences ($p \leq 0.05$) amongst parameters for different stations on Velvishwar coast.

IV. CONCLUSION

Due to re-suspension and swash effects of the waves, surf zone phytoplankton can be mixed population of pinnate as well as centric diatoms. Phytoplankton show significant variations in abundance depending on its environs. From this, it is hypothesized that, phytoplankton abundance probably depends on the beach morphology and swash period as well as swash speed. Their values were optimal for stations at both ends which were protected due to its rocky nature, rather than middle stations where beach was of exposed dissipative type. Further study in this regard is necessary. It was observed that, on same beach physico-chemical parameters did not vary significantly amongst stations.

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