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Seasonal Variations of Green Seaweeds (Chlorophyta) from the Undi Coastal Area of Ratnagiri, Maharashtra

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In the present study, monthly and seasonal variations in abundance of green seaweeds from the coastal region of Undi, Ratnagiri district along the west coast of Maharashtra were investigated. Stratified random sampling was carried out during monthly lowest tides along the exposed intertidal rocky shore area. For the estimation of percentage coverage of seaweeds, photo-quadrate method was employed and for the quantitative estimation of green seaweeds, collected samples from the quadrate were sorted out separately as per species and wet/ fresh weights were taken for density and biomass estimation of respective seaweed species. A total of ten green seaweeds were found in the rocky shore of Undi, namely, *Bryopsis plumosa, Chaetomorpha antennina, Chaetomorpha crassa, Caulerpa racemosa, Caulerpa peltata, Caulerpa taxifolia, Caulerpa sertularioides, Ulva lactuca, Ulva fasciata and Valonia utricularis.* In the study area, most of the green seaweeds were recorded with maximum abundance during pre-monsoon and post-monsoon seasons, while in monsoon season, the abundance of most of the green seaweeds declined remarkably. Unlike other seaweeds, maximum biomass of seaweeds, *Bryopsis plumosa* and *Ulva lactuca* was recorded during monsoon season. Among the green seaweeds, species like *Caulerpa peltata, Ulva lactuca* and *Caulerpa taxifolia* were recorded throughout the year. During whole monsoon season, among green seaweeds, *Ulva fasciata* was totally absent while during late pre-monsoon, species like *Bryopsis plumosa, Chaetomorpha crassa, Caulerpa racemosa* and *Valonia utricularis* were totally absent. The maximum biomass of *Caulerpa peltata* was recorded in the month of February 2018 in pre-monsoon period. The water pH showed highly significant positive correlation with abundance of green seaweeds, *Caulerpa peltata* and *Ulva fasciata*. Green seaweeds were found to be abundant along the coastal margin of Ratnagiri, with species specific seasonal variations in their abundance.

(***Key words:*** *Chlorophyta, Coastal bioabundance, Seasonal variation, Seaweed*)

Marine algae, popularly known as 'Seaweeds' are one of the most beautiful groups of photosynthetic organisms which grow under the sea water. Seaweeds are multicellular macro-algae with complex differentiated thallus (Rao and Vaibhav, 2006). They are subdivided into four different groups: brown algae (Phaeophyta), red algae (Rhodophyta), green algae (Chlorophyta), and blue-green algae (Cyanophyta) (MacArtain *et al*., 2007). Seaweeds are primary producers and play a central role in coastal habitats (Harley *et al*., 2012). They support the coastal and marine bio-abundance (Christie *et al*., 2009) and are the base of food chain in the oceans. Seaweeds are the providers of ecosystem goods and services like food, medicine and storm protection (Ronnback *et al*., 2007). Distribution and abundance of seaweeds is affected by regional environmental and degree of exposure to disturbances like high temperatures, desiccation stress, herbivores and competition with coastal fauna and flora. The impacts of ongoing environmental variations in seaweed dominated ecosystems remain poorly understood (Harley *et al*., 2012).

Green seaweeds are important symbionts with a variety of fungi, bacteria, animals and plants. Green seaweeds are economically important as sources of industrial products, biofuels and food. Limited studies have been undertaken to evaluate the species abundance of seaweeds in India, no scientific studies have been carried out on the species composition of green seaweeds of Undi, Ratnagiri. Hence, the present study was undertaken with the objective to evaluate the impact of seasonal variations in environmental parameters on species composition of green seaweeds.

MATERIALS AND METHODS

The investigation on monthly distribution of seaweeds was carried out during June 2017 to May

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2018 on rocky shores of Undi, Ratnagiri district (Fig. 1). The intertidal zone *i.e*., the zone between high tide and low tide was selected for study purpose. For the present study, seven transects were marked at different locations perpendicular to shore line of rocky shore of Undi. On each transect, three stratified random samples were taken using 0.25 m^2 quadrate frame with hundred sub squares within it and photo quadrate method was used to estimate the percentage coverage of seaweeds (Schoeman *et al*., 2003). The collected macro marine algae were washed in sea water and fresh water thoroughly to remove the epiphytes and other contamination. Then after the segregation, washed green seaweeds samples were immediately transferred to laboratory for further analysis. For the quantitative estimation of green seaweed, collected samples from the quadrate were sorted out separately into species wise and wet/ fresh weight was taken for density and biomass estimation. During each sampling, in-situ parameters such as atmospheric temperature, water temperature, salinity, pH, dissolved oxygen and alkalinity were measured. Nutrients like inorganic phosphate, nitrite, nitrate and silicate were analysed by adopting the standard methods (APHA, 2005). Collected species of green sea weeds were preserved in 5% formalin solution for identification. Experimental data were analyzed by using suitable statistical methods (Zar, 2004)

RESULTS AND DISCUSSIONS

Monthly samplings of rocky coastal area of Undi in Ratnagiri for recording the green seaweed species were carried out during the year 2017-18 and the monthly occurrence of seaweeds along the Undi rocky shore is presented in Table 1. A total of 10 green seaweeds were collected from the study area *viz*., *Bryopsis plumosa, Chaetomorpha antennina, Chaetomorpha crassa, Caulerpa racemosa, Caulerpa peltata, Caulerpa taxifolia, Caulerpa sertularioides, Ulva lactuca, Ulva fasciata* and *Valonia utricularis* (Fig. 2). Among the green seaweed species, *Caulerpa peltata, Ulva fasciata* and *Caulerpa taxifolia* were recorded throughout the year. The maximum biomass of *Caulerpa peltata* (573.43 g m^{-2}) was recorded in the month of February, 2018. During monsoon season, green seaweeds *Ulva fasciata* was totally absent, while, during late pre-monsoon season, species like *Bryopsis plumosa, Chaetomorpha crassa, Caulerpa racemosa* and *Valonia utricularis* were totally absent. Unlike other seaweeds, maximum biomass of seaweeds, *Bryopsis plumosa* and *Ulva lactuca* was recorded during monsoon season.

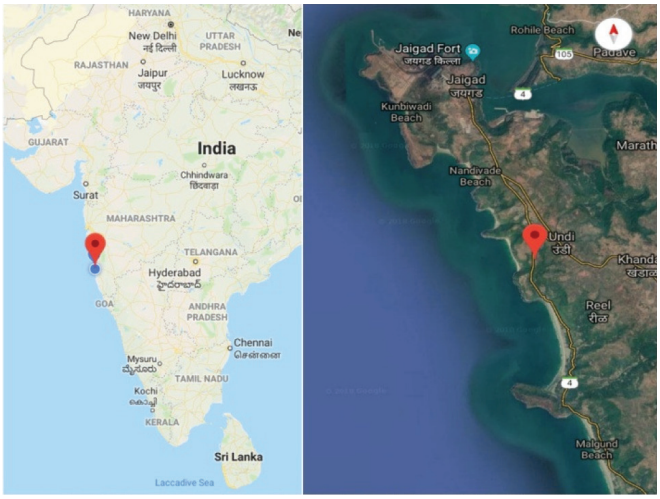
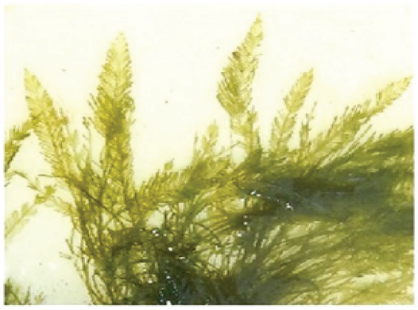


Fig 1. *Map showing the site of sampling at Undi, Ratnagiri coast*

In the study area, maximum species abundance of green seaweeds was recorded during pre-monsoon and post-monsoon than monsoon period. Higher species composition of green seaweeds was also observed during post-monsoon than pre-monsoon and monsoon (Fig.4). Maximum abundance of green seaweeds was recorded during pre-monsoon and post-monsoon which may be attributed to favorable environmental conditions with respect to variables like temperature, salinity, pH and nutrients. But in case of *Bryopsis plumosa* and *Ulva lactuca*, unlike other seaweeds, maximum biomass was observed during monsoon season which might be attributed to species specificity.

Along the Undi rocky shore, the water temperature showed significant negative correlation with abundance of *Caulerpa peltata* ($r = -0.685$, $P < 0.05$). The pH showed highly significant positive corelation with abundance of green seaweeds *Caulerpa peltata* ($r = -0.725$, $P < 0.01$) and *Ulva fasciata* ($r = 0.680$, $P < 0.05$). The salinity revealed significantly high negative correlation with abundance of *Chatomorpha antennina* ($r = -0.715$, $P < 0.01$).

The results of the present study are in agreement with earlier reports of Pariera and Almeida (2014) from Goa coast, Pawar and Al Tawaha (2017) from Uran coast of Maharashtra and Rode and Sable (2015) from Malvan and Kunakeshwar in Sindhudurg District of Maharashtra. The results of the study are in conjunction with Bhatade (2011) who also recorded the green sea weeds of Genus *Caulerpa, Chaetomorpha* and *Ulva* consistently from Alawa coast of Ratnagiri. High



(a). Bryopsis plumosa

(b) Chaetomorpha antennina

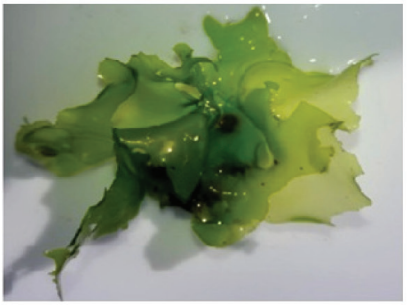
(c) Chaetomorpha crassa

(d) Caulerpa racemosa

(e) Caulerpa peltata

(f) Caulerpa taxifolia

(g) Caulerpa sertularioides



(h) Ulva lactuca

(i) Ulva fasciata

(j) Valonia utricularis

Fig. 2. *Green seaweeds from coastal water of Undi, Ratnagiri coast*

Table 1. *Occurrence (+) and Non-occurrence (-) of green seaweed species recorded in Undi, Ratnagiri coast*

S. No.	Green seaweeds	Jun-17	Jul-17	Aug-17	Sep-17	Oct-17	Nov-17	Dec-17	Jan-18	Feb-18	Mar-18	Apr-18	May-18
1.	*Bryopsis plumosa*	-	+	-	+	+	+	+	+	+	+	-	-
2.	*Chaetomorpha antennina*	-	+	-	+	+	+	+	+	+	-	+	+
3.	*Chaetomorpha crassa*	-	+	-	+	+	+	+	+	+	+	-	-
4.	*Caulerpa racemosa*	-	+	+	-	-	-	+	-	-	+	-	-
5.	*Caulerpa peltata*	+	-	+	+	-	+	+	+	+	+	+	+
6.	*Caulerpa taxifolia*	+	-	+	+	+	+	+	+	+	+	+	+
7.	*Caulerpa sertularioides*	+	-	-	+	+	+	+	+	-	+	+	+
8.	*Ulva lactuca*	+	+	+	+	+	+	+	+	+	+	+	+
9.	*Ulva fasciata*	-	-	-	-	+	+	+	+	+	+	+	+
10.	*Valonia utricularis*	+	+	+	+	+	+	+	+	+	+	-	-

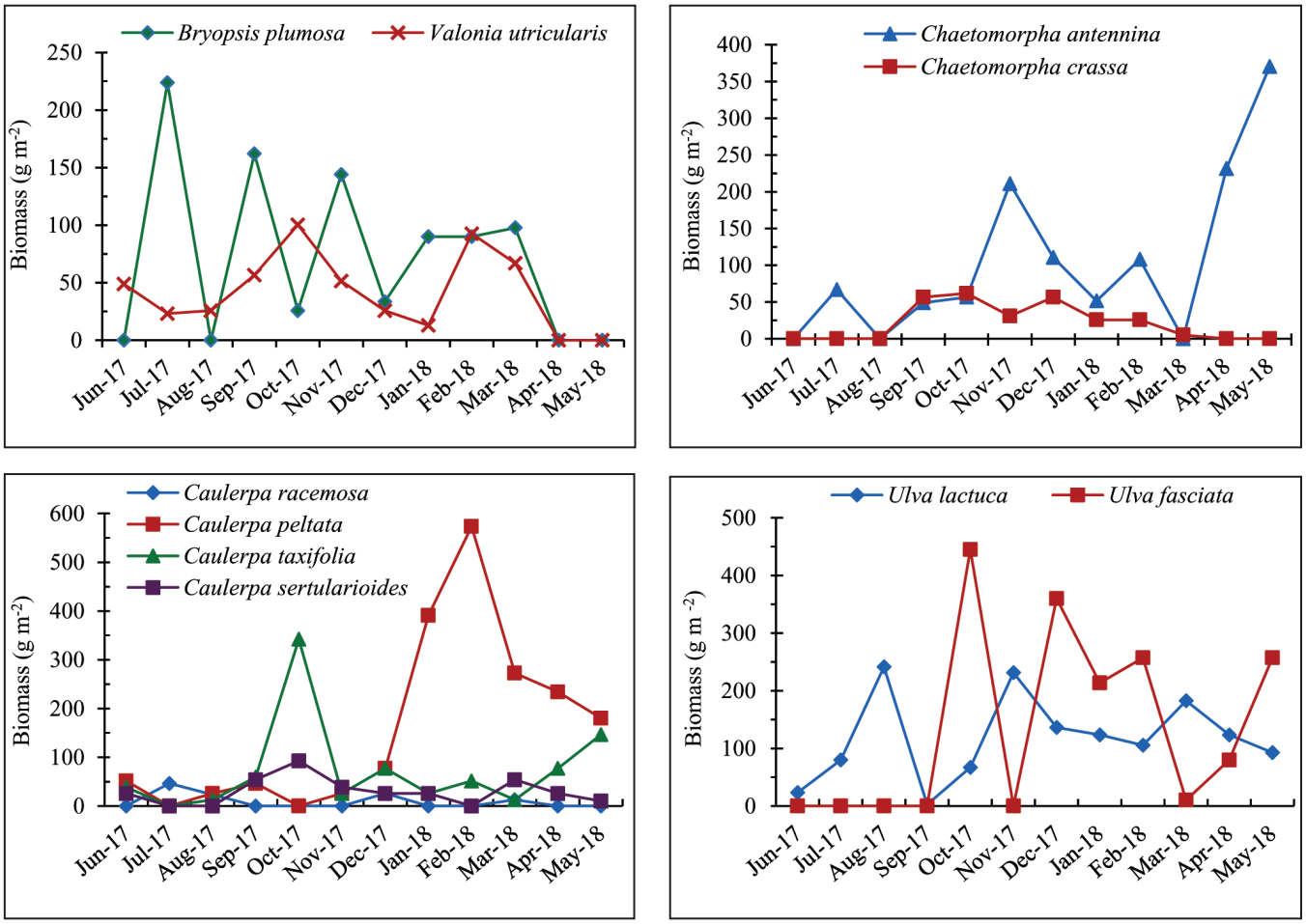


Fig. 3. *Monthly variation of green seaweed biomass along the Undi rocky shore during 2017-18*

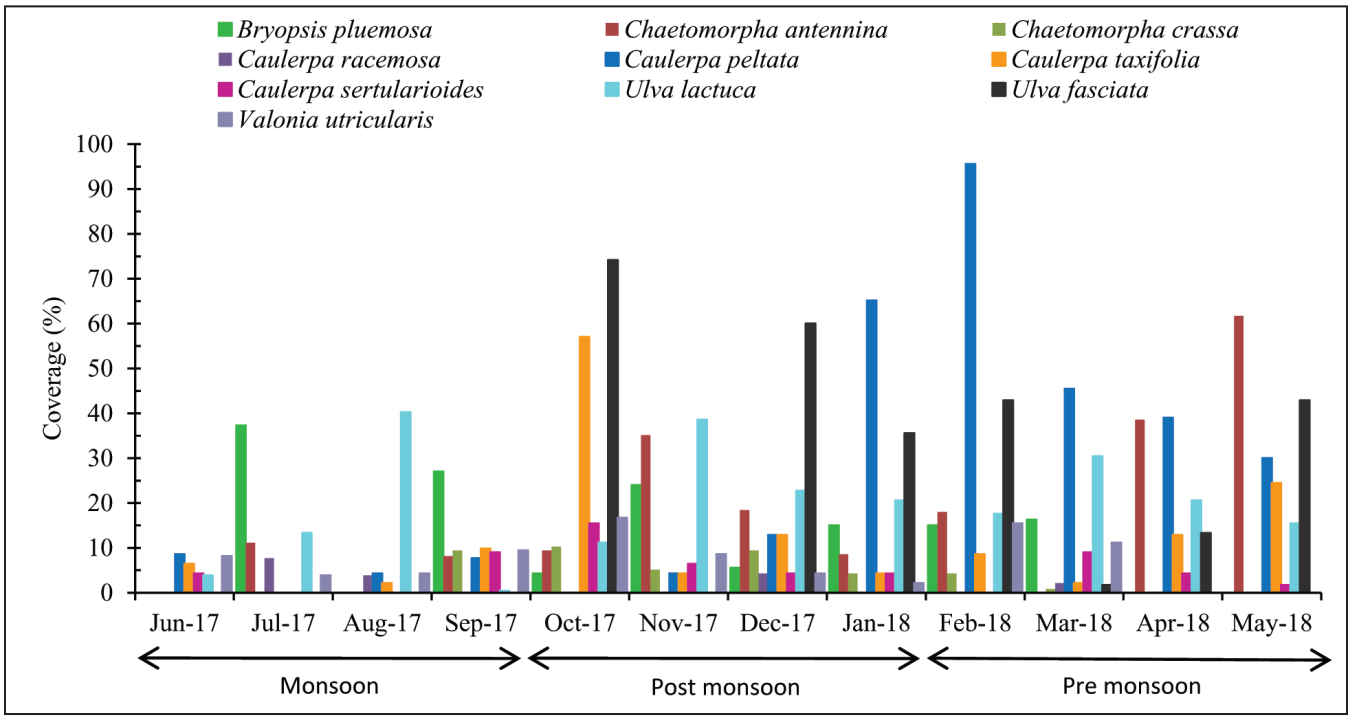


Fig. 4. *Seasonal distribution of green seaweeds during different seasons at Undi, Ratnagiri district*

abundance of most of the green seaweeds in post and pre-monsoon season may be attributed to the high availability of nutrients and favourable environmental conditions during the said period. Low abundance of green seaweed during monsoon may be due to the reduced salinity and pH values during this season.

There was significant variation in the abundance of green seaweed species in the coastal Undi coast of Maharashtra. Maximum occurrence of these weeds was observed during the pre- and post-monsoon periods. Green seaweeds were found to be abundant along the coastal margin of Ratnagiri, with species specific seasonal variations in their abundance which may be related to the changes in the physico-chemical properties of the coastal sea water.

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