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Diversity and distribution of marine Macro algae in Karwar coastal waters, Karnataka, India

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Abstract

An ecological studywas conducted on species composition and monthly variations of marine macro algae with the fluctuating environmental parameters along Karwar coast, Karnataka, India between Jan 2018 to Jan 2019. A total of 11 seaweeds species were collected from Muduga coastal area. Chlorophyceae was represented by 5 taxa,Phaeophyceae was represented by 5 taxa and Rhodophyceae was represented by only one taxa.Both the phylum Phaeophyta and Chlorophyta were equal in dominance (each 5 species) than Rhadophyta. Monthly and seasonally seaweed distribution showed good abundances in pre-Monsoon and post-Monsoon rather than Monsoon, except for Phaeophyta group members.Occurrence and distribution varied with taxa according to environmental parameters but the green algal members were recorded abundant to other members.Pearson's Correlation pictodiagram explaining significant relationship between physico-chemical parameters and seaweeds abundancy revealed the positive and negative relationship.

Key words : Rocky coast, seaweeds, seasons and environmental parameters.

Rocky coast acts as an excellent biome for distribution, provides substratum as ajunction of anchorage of seaweeds in spite of barbarous environmental parameters like harsh temperature, fluctuating salinity, desiccation, tide ebb and flow and wave action[5,18]. Muduga one such coastal stretch comprises of rocky and muddy shorelines which are witnessed by variety of floral (macro algal) communitieswith distinctive morphology characters with benthic realm of the marine ecosystem.Macro algae (seaweeds) are multicellular photosynthetic benthic marine macro algae with various unique pigments like (carotene, fuxoxanthin, phycocyanin, phycoerythrin, xanthophylls, chlorophyll (a, b and c) for preparation of food via sunlight and nutrients, which are small to immensely giant, composite differentiated thallus attached forms with no distinguishable true stem, root and leaves,cosmopolitan on

rocky shores upon varied solid substratum like pebbles,dead corals,shells ,tidal pools in shallow low littorial areas of marine environments[5,6,19].

Seaweeds acts as excellent bio indicators of environmental stressors, biological processes and anthropogenic impacts on floral communities in coastal areas helpful in studying the exposure of the variability in diversity patterns of conservation, sustainable use of marine resources and impact due to environmental conditions[24,25]. Hence the prime concern is to monitor the marine flora and encourage use of rocky shore as educational resource for local schools, colleges and research institute for its conservation and management. The documentation will aid in baseline data to strict the future shoreline armouring and declare as marine biodiversity heritage of that region. The present study helps in determination of the temporal changes in composition and diversity of macro algae assemblages impacted by environmental parameters. It also aid in identifying the dominant species of the concerned seasons.

Description of the study area :

A survey of study area was carried out in order to know the diversity of macro algae along the coastal area of Muduga located in Karwar Taluka lying within grid of Lat: 14°44' 44.47"N and Long: 74°13'39.48"E (Fig. 1), with relation to fluctuating environmental parameters. Muduga coastal area have a long 3 km stretch of rocky and muddy shore with physical features of substratum having gigantic boulders, sediments having mangrovepneumatophores. Geo-morphologically having rocky boulders with attached bivalve shells and oysters

Sampling procedures:

The rockyintertidal zone was visited fortnightly to record algal species in all three seasons during studyperiod from Jan 2018 to Jan 2019, with reference to Karwar Tide Chart. Seaweeds were handpicked from Intertidal region during submergence of tide using random

Fig. 1. A map showing the study site Muduga Beach, Karnataka, West coast of India

sampling technique (Quadrant) and broughtto Laboratory in polythene bags. Fresh samples were viewed under light microscope forspecies identification. After careful wash and removal of dirt the samples were used for Herbarium preparation, leftover samples preserved in formalin (4%). For authentication of the sample taxonomic identification keys were referred, described by Beligirianga,Dharghalkar and Kavlekar[3,5]. Occurrence ofseaweeds are categorized as abundant (+++), less abundant (++), sparsely abundant (+) and absent (-) based on visible observation made at sampling site. Seasons were classified as pre-Monsoon (Feb-May), Monsoon(Jun-Sep) and post-Monsoon (Oct-Jan) represented in (Tables-1).

Table-1. Occurrence, Abundance and Monthly distribution of Seaweeds at Muduga Beach

Table 1			Monthly Observations at Muduga Beach												
Family		Marine Macro algae (Scientific names)	2018												2019
			POM	PREM				MON				POM			
			J	F	M	A	M	J	J	A	S	O	N	D	J
Chlorophyta															
		Ulva intestinalis L.	+	++	+	+	+	-	-	-	+	+	+	+	-
		Ulva clathrata (Roth.) C. Agardh	-	+	+	-	-	-	-	-	-	-	-	-	-
1	**Ulvaceae**	*Ulva lactuca* L.	+	+	+	-	-	-	-	-	-	-	-	+	-
		Chaetomorpha linum (Muller) Kutz.	+	-	+	+	+	-	-	-	-	-	-	-	-
2	**Cladophoraceae**	*Cladophora vagabunda* (L.) Hoek	-	+	-	-	-	-	-	-	-	-	-	-	-
Phaeophyta															
3	**Sargassaceae**	*Sargassum swartzii* C. Agardh	+	+	-	+	+	-	-	+	+	-	-	+	-
		Sargassum ilicifolium Turner C. Agardh	+	+	-	+	+	-	-	+	+	-	-	+	-
		Sargasssum polycystum C. Agardh	-	+	-	+	-	-	-	-	-	-	-	-	-
		Sargassum tenerrimum J. Agardh	+	-	-	+	-	-	-	+	+	-	-	-	-
4	**Sphacelariaceae**	*Sphacelaria tribuloides* Meneghini	-	-	-	+	+	-	-	-	-	-	-	-	-
Rhodophyta															
5	**Gelidiaceae**	*Gelidium pusillum* (Stackhouse) Le Jolis	+	+	+	-	-	-	-	-	+	+	+	-	-

Environmental parameters :

The coast receives torrential rain during monsoon with low saline conditions whereas the pre-monsoon season depicts extreme temperatures and saline profiles. Post-monsoon season experiences a moderate climate condition with stable environmental parameters. The pH, Water temperature (WT), Air temperature (AT), Salinity (SA) and Dissolved oxygen (DO) using pH meter, Thermometer, Refractometer and DO meter respectively. Nutrients analysis was done using nutrient analysis methods following APHA[1] guidelines.

Water and air temperatures measured in ^{o}C ranged from 22 in post-Monsoon to 30.1 in pre-Monsoon, 24in post-Monsoon to 32 in pre-Monsoon respectively. Salinity ranged from 30ppt in Monsoon to 35 ppt in pre-Monsoon. Dissolved oxygen ranged from 3.7 mg/L in pre-Monsoon to 5.2 mg/L in Monsoon. Nutrients like nitrate (NA), nitrite (NI) and ammonium (AMM) measured in micromoles kept fluctuating throughout the sampling period. Nitrate-(7.28 in post-Monsoon to 15.47micromoles in pre-Monsoon); Nitrite-(0.66 in Monsoon to 3.96 in post-Monsoon); Ammonium-(4.3 in post-Monsoon to 31.5 in monsoon).

Spatially assembled species of different communities and the various geomorphological gradients have proven rocky shore to be an ideal and convenient home to various fauna and flora. A total of 11 seaweeds species were collected from Muduga coastal area. Chlorophyceae was represented by 5 taxa, Phaeophyceae was represented by 5 taxa and Rhodophyceae was represented by only one taxa.In regard to distribution of species and families(dominance) at study site, among Chlorophyta, all 5 spp were present in pre-Monsoon,only one spp *Ulva intestinalis* in Monsoon and 3 spp in post-Monsoon. Among Phaeophyta, all 5 spp were present in pre-Monsoon,in Monsoon and post-Monsoon only 3 spp were present.Onlyone spp,*Gelidium pusillum* in pre-Monsoon and post-Monsoon with absence of species in Monsoon period was depicted among Rhodophyta.

The table emphasis on occurrence, composition and absence of species during different months and seasons of study site. Seasonal distribution of seaweeds reveals that regeneration ofseaweeds groups occur in post-Monsoon and adult matured species were found in pre-Monsoon. The moderate and feasible environmental parameters of pre-monsoon makeit possible in good collection of species. Monsoon period experienced torrential rain where most of the intertidal area is submerged and leads to decaying of the green filamentous algae whereas the brown algae species thrived well but restricted in number. Therefore few number of species were encountered from study site. Maximum abundance of seaweeds was recorded during pre and post-Monsoon which attributed to favourable environmental parameters were in Monsoon due to heavy rains, in significant receding of water limits the exploration of area, ocean currents are strong enough to ripe the fragile seaweeds, whereas the stronger anchor aged seaweeds like Genus *Sargassum* was recorded. Our research findings are in resemblance to Reddy *et al*[20] in seaweeds resources of India, Naik *et al*.[14] in Karwar Bay and by Rode and Sabale[21] in Sindhudurg District of Maharashtra.

At the beginning of the post-Monsoon season, a very complex community of all three types green, brown and red algae were observed. Among which the blooming of seaweeds species like *Ulva intestinalis, Ulva lactuca, Sargassum swartzii, Sargassum ilicifolium, Gelidium pusillum*was recorded. Similar observation was documented by Rhode and Sabale[21]. Greenalgal speciesthrived more in pre-monsoon compared to post –Monsoon and near to complete absence in Monsoon except *Ulva intestinalis* showed presence in September. Genus *Chaetomorpha* showed the presence in pre-Monsoon (Jan to April) rather than post-Monsoon, near to loosing colour from bright green to abrupt white lying as spaghettis all over the beach. The above results were in negative relation to the documentation of seaweeds by Rhode and Sabale[21].

The observations also revealed the regeneration of seaweeds groups with dominancein green algal members especially in March and April.Then again fall in the growth from July to September with increase in red algae, the above findings tailed with Sowjanya and Sekhar[22]. Another luxuriant crop of varied algal species including all three types were notice from November to February followed by fall in species growth in May and disappearance in Monsoon (June to July). While good growth was noticed in brown algal community during Monsoon (Aug-Sep).The aboveresults were tailed with Sowjanya and Sekhar[22] and Nair *et al.,* [15] respectively.

The present study observation of dominance in Chlorophyceae and Phaeophyceae followed by Rhodophyceae were in agreement with study recorded from Karwar bay by Beligirianga & Naik *et al*.,[3,14]. Frequent disturbances prevent the establishment of floral communities in various habitat, hence the lower species dominance is attributed to the fact of variation in environmental parameters and geomorphological substratum. Similar studies were conducted for requirement of particular substratum as a suitable niche for the algal diversity and its immediate environmental parameters as stated by Osman *et al* [16]while research through Mutton coastal waters, South Coast of India.

Hurtado and Critchley, Baleta and Nalleb[2,7] stated the substantial growth of Chlorophyceae family anchored over stable epitomized substrate was dwelled preferentially by seaweeds in sandy rocky pools and large boulders comparatively in shallow portion of the intertidal zones. Similar observations were noticed in the present study for seaweed species *Ulva lactuca* and *Chaetomorpha linum* found attached to rocky substratum.

Pearson's Correlation pictodiagram (Fig. 2) explaining significant relationship between physico-chemical parameters and seaweeds abundancy revealed *Ulva clathrata, Cladophora vagabunda, Sphacelaria tribuloides* and *Sargasssum polycystum* were negative in correlation to air temperature. The seaweed abundance rate decreases with increase in the air temperature hence the brown algal species were found in monsoon were the lower air temperatures were recorded. Similar observation were recorded by Lobban and Harrison, Ladah *et al*.,[11,12] in accordance to temperature, where it disrupts the metabolic processes, such as respiration and photosynthesis and in turn it greatly affects seaweed abundance.

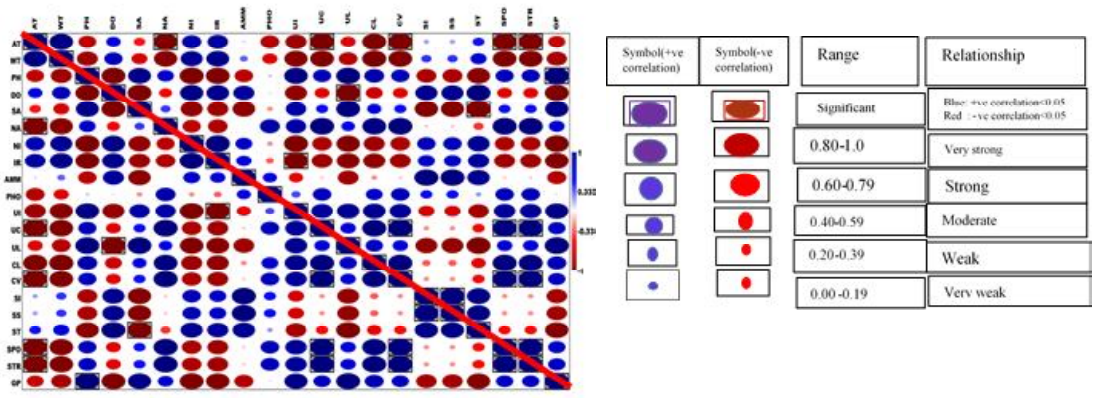

Fig. 2. Pearson's Correlation pictodiagram explaining significant relationship between physico chemical parameters and seaweeds abundancy with pearson's correlation coefficient 'r' value range below the diagonal.

Sargassum tenerrimum was in negative correlation to salinity as stated by Kirst, 1989, salinity causes osmotic and ionic stresses. All the green algal species were in positive correlation with nitrate, salinity and negative with nitrite, dissolved oxygen and ammonium, as has enhanced ability to proliferate blooms in eutrophication with optimal salinity around 15-24% but varies genetically from other Ulva species adapt itself to develop and flourish in different salinity regime[4,8,9,13].

The motive of study relates to amplify the knowledge on distribution and composition of seaweeds on seasonal changes along Karwar coast combating with environmental parameters on rocky shores. The correlation with regard to occurrence, abundance of marine macro algae with ecological aspects of hydro chemical parameters were carried out using the pearson's correlation. It concludes the positive and negative effect of the environmental parameters on variegated seaweeds differential based on its group. Due to higher eutrophication of coastal waters having rich nutrients ,the coast preferentially aided in growth of fewer seaweed species which could adapt to the environmental parameters fluctuations during study period. Hence the data would aid in knowing the potential seaweeds which adapt to environmental parameters and be used in Eco management techniques.

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