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Seaweeds Diversity And Abundance Along Two Sites Of Kanniyakumari Coast,Tamilnadu, India

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ABSTRACT

The present study on species diversity and abundance of seaweed available at Kanniyakumari coast, Tamilnadu, India. There were 101 species of seaweed. of the 101 species, 31 were from the class of Chlorophyceae (30.69%), 50 species from Rhodophyceae (49.50%), and 20 species from Phaeophyceae (19.0%).seaweed species were recorded from the two sites of Kanniyakumari coast i.e Manavalakurichi site and Arokiyapuram site. These 101 species belongs to 20 orders, 20 family and 50 genus. Ulva faciata was highly dominant followed by Gracilaria and sargassum.The density ranged between in station one 3.00 5.25 and station two is 3.00-5.22. The highest percentage of density was shown by *Enteromorpha flexuosa* and *Caulerpa peltata* during 2017. The frequency percentage values ranged from between in station one 26.53 to 43.33.67 and station two 23.15 to 49.30. The abundance value ranged from collection site one 3.26.00-7.10. and and collection site two ranged 5.27-7.13. The highest abundance was show by *Enteromorpha flexuosa and Ulva faciata* during the month of December 2017. Species richness also calculated and presented.

Keywords: *Ulva faciata, Gracilaria carticata, Caulerpa recemosa*, species diversity etc.

INTRODUCTION

Macroscopic marine algae, popularly known as seaweeds, constitute one of the important living resources of the ocean. They were found attached to the bottom, in relatively shallow coastal waters areas upto 180 meter depth, on solid substrate such as rocks, dead corals, pebbles, shells and plants. India, a tropical south Asian country has a stretch of about 7,500 km coastline, excluding its island land with 2 million km1. The seaweed flora of India is highly diversified and comprises mostly of tropical species, in all, 271 genera and 1153 species of marine algae Seaweeds are macro benthic marine algae that contribute in the marine primary production on the shallow portion of seas and oceans while providing habitats for benthic communities. Seaweeds are named after the dominant photosynthetic pigment, which could be red, brown, green and blue-green algae. Underwater, it is distributed from the lower intertidal to the shallow subtidal zones of the marine environment. Their ability to adapt to the condition of the habitat results to the differ ences in their vertical and horizontal distribution. Thus, some species are only seen in the sheltered bays and coves while some are limited to the rocky exposed along the shore or margins of the reef. They constitute one of the important living resources of the ocean and were found attached to the bottom on solid substrates such as rocks, dead corals, pebbles, shells and plants (Sahayarajet al. 2014).Seaweeds arec primary producers and play a central role in coastal habitats (Harley et al. 2012). They support the coastal and marine biodiversity (Christie et al. 2009) and are the base of food chain in the

oceans (Figueiredo and Creed 2009). Seaweeds are not only of high ecological, but also of great economic importance (Domettila et al. 2013).This study was conducted to determine the species composition, total density and diversity of seaweeds found on the two sites of kanniyakumari cost.

MATERIALS AND METHODS

SAMPLING PROCEDURE

The investigation was carried out two sides of Kanniyakumari coast presents a very scenic point. The first site is Manavalakurichi situated at (24o50´ N, 66o 42.5´ E) on the south west coast of Arabian Sea and second site is Arrokiyapuram .It is not easily assessable; as a result it is still consist of undisturbed forms of flora and fauna. The jutting rocks lessen the force of the waves thus protecting the backwater beach and along with it the existing life. The beach starts with colored rocks at its front, the main boulder like forms, is exposed to the surface and slopes steep towards the sea. The sides of these rock formations are thickly covered with the biota especially rich in seaweed. When the tide is low the back area is fully exposed while at high tides even the facing rock zone gets submerged with seawater. Field surveys were undertaken in the selected sampling stations for a period of one year (January to December in 2017). Seaweeds were sampled by quadrat (1m2) method. Samples were selected at random as per requirement. It was carried out by selecting sampling points in the area using quadrat. Sampling points were selected in such a manner that every species of the study area has good chance of being selected. The quadrats were placed with approximately five meters distance in each segment. Each station was 1km long in which 0-3 quadrats were placed.

The seaweeds along with its holdfast were collected during low tide in the intertidal and sub-tidal region where the vegetation was discontinuous and occurring in patches. The samples were washed thoroughly with seawater to remove sand and other debris (marine soil debris, attached shell, mollusks adhering debris and associated biota). The second washing was done with demonized water to get rid of excess salts (Sivasankari et al., 2006). The samples were later preserved in formaldehyde (4%). Morphology of all the Seaweed samples were carefully examined. The morphological characteristics of the collected seaweeds were observed and identified using microscopic and macroscopic (such as frond size, leaf shape, leaf border, vesicles (air bladder), and receptacles) comparative analyses. The typical characteristics taken into account include internal structure, color, size & shape and by comparing to the existing photographs and data previously published for this region (Dinabandhu, 2010). The collected samples were for identification based on standard keys by Srinivasan (1969) & (1973), Rao (1987), Chennubhotla et al., (1987), Ganesapandian and Kumaraguru (2008), Jha et al., (2009) and with catalogue of benthic marine algae of Indian Ocean (Silva et al., 1996). UmamaheswaraRao (1970,1987 85 1999), Kaliaperumal*et.al.*(1995), Dhargarkar and DevanandKavlekar (2004). The samples were later preserved in formaldehyde (4%). The distribution (Dhargalker and DevanandKavlekar, 2004) of the seaweeds were calculated (class wise, order wise, family wise, and species wise)The number of seaweed species and the number of individuals in each species were counted for quantitative assessments like frequency, density abundance and richness. These four criterions were calculated using the following formulas.

Frequency: Total number of quadrats in which species occurred / Total number of quadrats studied
Density: Total number of species / Total number of quadrats studied
Abundance: Total number of particular species/Total number of all species
Richness: Total number of individual species in the quadrat.

RESULT AND DISCUSSION

SPECIES DIVERSITY

The entire intertidal area of the coast of knniyakumari rich with a diverse group of seaweed species. The Kanniyakumari coast particularly the Manavalakurichi and Arokkiyapuram surveyed. The survey has been carried out throughout the study period for the qualitative assessment of the seaweed flora inhabiting there and also to understand the coast characteristics. A total of 101 species of seaweeds has been observed from two sites of Kanniyakumari coast during the entire study period. There were 101 species of seaweed. 101 species, 31 were from the class of Chlorophyceae (30.69%), 50 species from Rhodophyceae

(49.50%), and 20 species from Phaeophyceae (19.0%).. These 101 species belongs to 20 orders, 20 family and 50 genus. Ulva faciata was highly dominant followed by Gracilaria and sargassum.

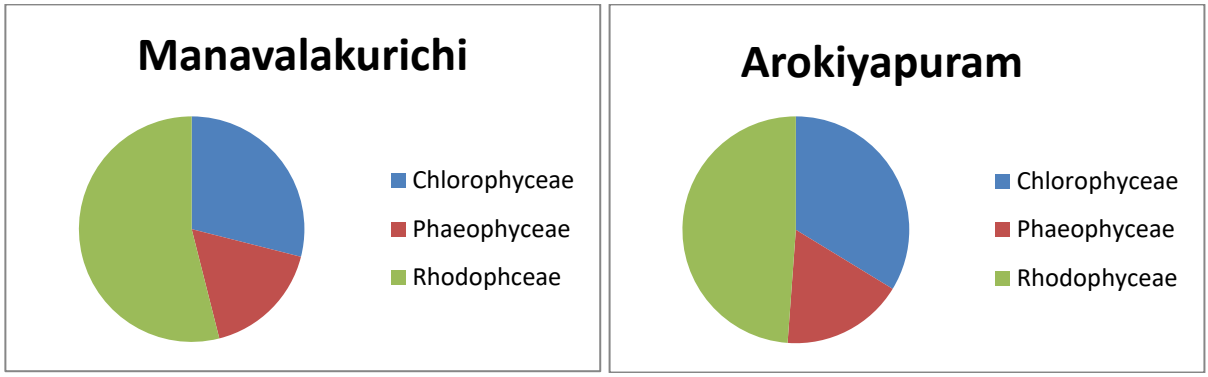

Fig 1. Composition of Seaweed species (a) Manavalakurichi(b) Arokkiyapuram Beach

Division of Rhodophyta was the most abundant seaweed in the both of beaches (Figure 1). Rhodophyta have wider adaptability compared with chlorophyta and phaeophyta. Rhodophyta are found in large numbers in vertical zones between the sea level to the bottom of the sea that is less suited to the Phaeophyta and Chlorophyta. Dead coral substrate or dead coral fragments are the most suitable subtrate for genus Acanthophora, Codium, Gelidiella, Galaxaura, Jania, Amphiroa and Gracilaria .A checklist of this seaweed species recorded during the entire study period is presented in the following table (1). During the study period, economically important seaweed species like Caulerpa, Ulva and Cladophora etc. were reported. Among them Ulva flexuosa was highly dominant followed by Cladophora and Ulva lactuca. The maximum number of species was recorded from the Arokkiyapuram during the month of March 2021 with about 65 species and the minimum number of species recorded from the Arokkiyapuram was 46 during the month of December. From Manavalakurichi site the maximum number of species 42 recorded was during the month of March. Minimum number of species recorded from manavalakurichi was 29 during the month of Augest

Table1:Taxonomic classification of seaweed species from Kanniyakumari coast,Tamilnadu, India.

S.No.	**DIVISION : CHLOROPHYTA** **CLASS : CHLOROPHYCEAE**	S1	S2
	Order : Ulvales Family : Ulvacea		
1	*Enteromorpha compressa (L.) Nees*	+	-
2	*Enteromorpha flexuosa (Wulfen) J. Ag.*	+	-
3	*Enteromorpha linza (L.) J. Ag.*	-	+
4	*Ulva fasciata Delile*	+	+
5	*Ulva lactuca L.*	-	+
6	*Ulva reticulata Forssk.*	-	+
	Order : Cladophorales Family : Cladophoraceae		
7	*Cladophora fasicularis (Bony) Kutzing*	+	+
8	*Chaetomorpha litorea Harvey*	-	+
9	*Chaetomorpha media (C. Ag.) Kuetzing*	+	+
10	*Chaetomorpha tortuosa Kuetzing*	-	+
11	*Chaetomorpha crasassa Kuetzing*	-	+
12	*Cladophora vagabunda (L.) Van den Hoek*	+	+
13	*Cladophora fasicularis. Kutzing*	+	+
	Order : Cladophorales Family : Siphonocladaceae		
14	*Boodelea composita (Harvy)Brand.*	+	+
	Order : Cladophorales Family : Valoniaceae		
15	*Valonipsis pachyma (Martens) Boergs*	+	+
	Order : Bryopsidales Family : Caulerpaceae		

16	*Bryopsis plumosa (Huds.) C. Ag.*	+	+
17	*Bryopsis pennata*	+	+
18	*Bryopsis hypnoides*	+	+
19	*Caulerpa chemnitzia (Esper) Web v Bosse*	-	+
20	*Caulerpa lateviren*s *Montagne*	+	+
21	*Caulerpa parvula Svedelius*	-	+
22	*Caulerpa peltata Lamour*	+	+
23	*Caulerpa racemosa (Forssk.) Web. v. Bosse*	+	+
24	*Caulerpa scalpelliformis (R. Br.) Web. v.*	+	+
25	*Caulerpa taxifolia (Vahl.) C. Ag.*	+	+
26	*Caulerpa microphysa Feldman*	+	+
27	*Caulerpa maxicana Kutzing*	+	+
	Order : Bryopsidales Family : Codiaceae	+	
28	*Codium decorticatum*	+	+
	Order : Bryopsidales Family : Halimedaceae		
29	*Halimeda macroloba*	-	+
30	*Halimeda opuntia*	+	+
31	*Halimeda tuna*	-	+
	DIVISION : PHAEOPHYTA **CLASS : PHAEOPHYCEAE**		
	Order : Dictyotales Family : Dictyoceae		
32	*Dictyota bartayresiana Lamouroux*	+	+
33	*Dictyota dichotoma (Huds.) Lamouroux*	+	-
34	*Dictyota divaricata Lamouroux*	+	-
35	*Dictyota pinnutifida Kutzing*	+	+
36	*Stoechospermum marginatum (C. Ag.) Kutzing*	-	-
37	*Hormophysa cuneiformis*	-	+
38	*Padina boergesenii Allender & Kraft*	+	+
39	*Padina pavonica (L.) Thivy ex Taylor*	+	+
40	*Padina tetrastromatica Hauck*	+	+
41	*Lobophora varigata Lamourex*	-	+
42	*Spatoglossum asperum J. Ag.*	-	+
43	*Spatoglossum variable Figari*	+	+
	Order :Scytosiphonales Family : Scytosiphonaceae		
44	*Colpomenia sinuosa (Mertens ex Roth) Derb. et Sol.*	+	-
45	*Hydroclathrus clathratus (C.Ag)Howe*	+	+
46	*Rosenvingea intricata (J. Ag.) Boergesen*	+	-
	Order :Fucales Family : Sargassaceae		
47	*Sargassum duplicatum C.Ag*	+	+
48	*Sargassum linearifolium (Turner) C.Ag.*	+	+
49	*Sargassum ilicifolium (Turn.) J. Ag.*	-	+
50	*Sargassum tenerriumJ.Agarth*	-	+
51	*Sargassum wighti Grevile*	+	+
	DIVISION : RHODOPHYTA **CLASS : RHODOPHYCEAE**		
	Order :Halymeniales Family : Halymeniaceae		
52	*Cryptonemia coriacea Schmitz*	+	+
53	*Cryptonemia lomation (Bertoloni) J. Ag.*	-	+
54	*Liagora ceranoides Lamouroux*	+	+
55	*Grateloupia filicina (Wulf.) J. Ag.*	+	+
56	*Halymenia floresia (Clem.) C. Ag.*	+	+

	Order :Gelidiales Family : Gelidiaceae		
57	*Gelidium micropterum Kuetz. A.*	-	+
58	*Gelidium pusillum (Stackhouse) Le Jolis*	+	+
59	*Gracilaria corticata J. Ag.*	+	-
60	*Gracilaria crassa (Harvey) J. Ag.*	+	+
61	*Gracilaria cylindrica Boergesen*		+
62	*Gracilaria edulis (Gmelin) Silva*	+	+
63	*Gracilaria fergusonii J. Ag.*	+	+
64	*Gracilaria foliifera (Forsskal) Boergesen*	+	+
65	*Gracilaria kanyakumariensis Umamaheswara Rao*	-	+
	Order :Corallinales Family : Corallinaceae		
66	*Amphiroa anceps (Lamarck) Decaisne*	+	-
67	*Amphiroa foliacea Lamouroux*	+	-
68	*Amphiroa fragilissima (L.) Lamouroux*	+	-
69	*Amphiroa rigida Lamouroux*	+	+
70	*Cheilosporum spectabile (Harvey) Weber van Bosse*	+	+
71	*Jania rubens (L.) Lamouroux*	+	+
72	*Portieria hornemannii (Lyngbye) Silva*	+	+
	Order :Gigartinales Family : Cystocloniaceae		
73	*Hypnea flagelliformis Greville ex J. Ag.*	+	+
74	*Hypnea musciformis (Wulf.) Lamouroux*	+	-
75	*Hypnea valentiae (Turner) Montagne*	+	+
76	*Ahnfeltiopsis densa (J. Ag.) Silva et Decew*	+	+
	Order :Gigartinales Family : Solieriaceae		
77	*Sarconema scinaioides Boergesen*	+	+
78	*Solieria robusta (Grev.) Kylin*	+	+
79	*Coralina berteroi*	+	+
80	*Jania ruben*	+	+
81	*Rhodeminia sonderi Silva*	+	+
82	*Botrycladia leptopoda (J.Agardh) Kylin*	-	+
	Order :Rhodymeniales Family : Rhodomeniaceae		
83	*Gelidiopsis variabilis (Grev.) Schmitz*	+	-
	Order :Rhodymeniales Family : Champiaceaeae		
84	*Champia indica Boergesen*	-	-
85	*Champia compressa Harvey*	+	+
86	*Champia glomerata Harvey*	-	+
87	*Champia parvula (Agardh) Harvey*	+	-
	Order :Ceramiales Family : Ceramiaceae		
88	*Ceramium procumbens Setchell et Gardner*	+	+
89	*Centroceras clavulatum (C. Ag.) Montagne*	+	+
90	*Spyridia hypnoides (Bory) Papenfuss*	+	+
91	*Spyridia filamentosa Harvey*	+	+
92	*Griffithsia corallinoides (Linnaeus) Trevisan*	+	+
93	*Dictyurus purpurascens Bory*	-	+
94	*Enantiocladia prolifera (Greville) Falkenberg*	+	+
95	*Neurymenia fraxinifolia (Mertens) J. Ag.*	+	+
	Order :Ceramiales Family : Rhodomelaceae		
96	*Acanthophora muscoides (L.) Bory*	+	+
97	*Acanthophora spicifera (Vahl.) Boergesen*	+	+
98	*Laurencia flagellifera J. Ag.*	+	+
99	*Laurencia obtusa (Hudson) Lamouroux*	+	+

100	*Laurencia papillosa (Forsskal) Greville*	+	+
101	*Laurencia pedicullariodes Harvey*	+	+

I.Class wise distribution:

The present study on seaweeds recorded 3 classes namely Chlorophyceae, Phaeophyceae and Rhodophyceae during the study period from January 2017 to December2017. The Class, Chlorophyceae is represented by 3 order namely Bryopsidales, , Cladophorales, and Ulvales, The Class, Phaeophyceae is represented by 3 order namely Dictyotales Scytosihonales and Fucales. The Class, Rhodophyceae is represented by 6 order namely Ceramiales, Corallinales, Gelidiales, Rhodomeniales , Halminiales and Rhodomelales.

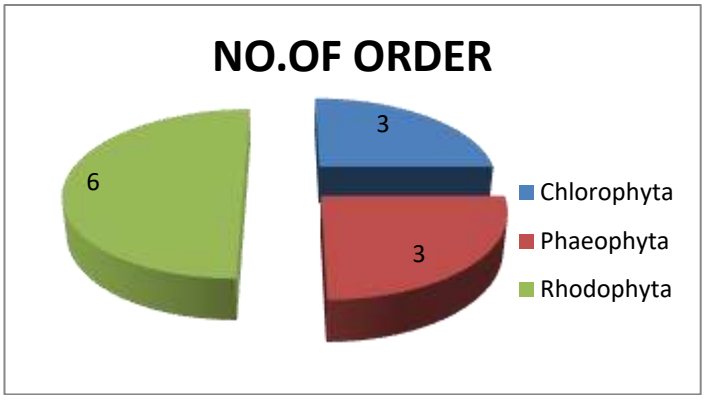

Fig. **2:Class wise distribution seaweed species from Kanniyakumari coast,Tamilnadu, India**

II.FAMILY WISE DISTRIBUTION:

The Class, Chlorophyceae is represented by 7 families namely Bryopsidaceae, Caulerpaceae, Cladophoraceae, Siphonocladaceae Ulvceae and Valoniaceae Coadiaceae and Halimedaceae. The Class, Phaeophyceae is represented by 3 families namely Dictyotaceae, Scytosihonace and Sargassaceae. The Class, Rhodophyceae is represented by families namely Ceramiaceae, Corallinaceae, Gelidiaceae, Champiaceae, Rhodomeniaceae, Soliericeae, Cystocloniaceae, Halminiaceae and Rhodomelaceae.

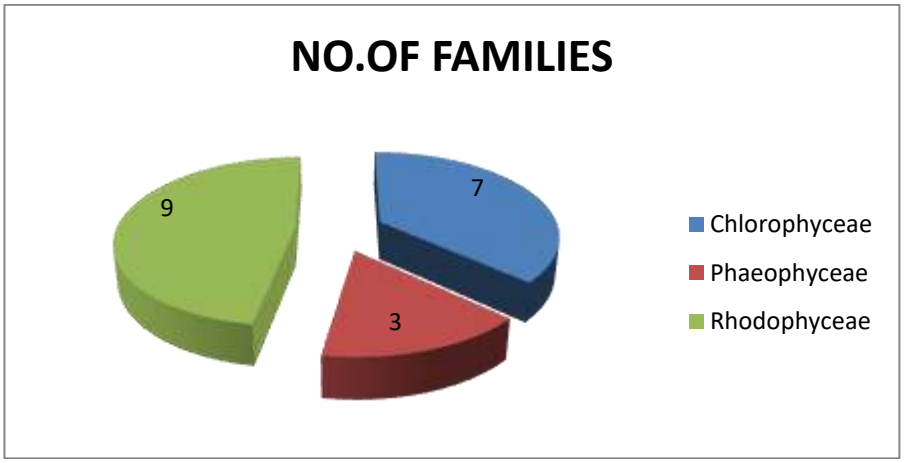

Fig .**3: Order wise distribution seaweed species from Kanniyakumari coast,Tamilnadu, India**

III. SPECIES WISE DISTRIBUTION:

The study recorded 100 species of seaweeds (Macro algae) belonging to 19 families and 50 genera. During the entire study period Gracilaria corticata was most dominant species during Caulerpa racemosa , Hypnea valentiae Padina tetrastromatica , Caulerpa taxifolia and Ulva fasciata) was most common species by Hypnea valentiae Gracilaria corticata Caulerpa fastigiata , Padina tetrastromatica Sargassum tenerrimum Caulerpa taxifolia and Caulerpa racemosa. Caulerpa taxifolia was, followed by Ulva fasciata Gracilaria corticata Grateloupia lithophila Sargassum tenerrimum Hypnea valentiae Chaetomorpha antennina Padina tetrastromatica Enteromorpha compressa (Gracilaria corticata was Caulerpa taxifolia

Hypnea valentiae Grateloupia lithophila Sargassum tenerrimum Ulva fasciata Chaetomorpha antennina and Caulerpa fastigiata are most coomon species found in all stations

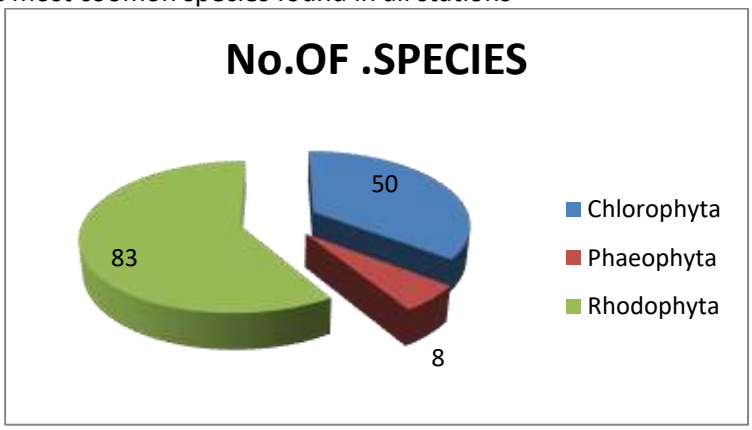

Fig :4 Species wise distribution seaweed species from Kanniyakumari coast,Tamilnadu, India

DENSITY

The monthly percentage density of seaweeds along collection site of Manavalakurichi along the Kanniyakumari coast is presented in the figure (5). The density ranged between 3.00 5.25. The highest percentage of density was shown by *Enteromorpha flexuosa* during the month of February 2017. The monthly percentage density of seaweeds along the Arokkiyapuram site of the Kanniyakumari coast is presented in the figure (6). The density ranged between 3.00-5.22. The highest percentage of density was shown by *Caulerpa peltata and Caulerpa peltata* during the month of December 2017.

FREQUENCY

The monthly percentage frequency of seaweeds along the Collection site of Manavalakurichi the Kanniyakumari coast is presented in the figure The frequency percentage values ranged from 26.53 to 43.33.67. The highest values were observed for *Caulerpa racemosa* during the month of March 2017.In Second collection site the frequency value recorded from 23.15 to 49.30 *Valoniopsis pachynema and Caulerpa peltata* respectively figure (6).

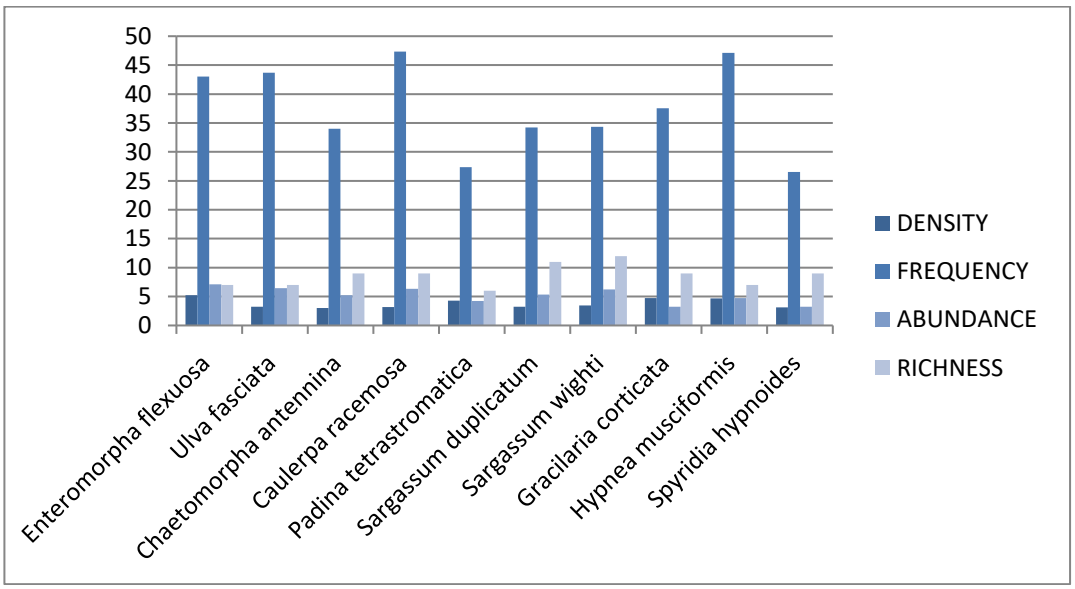

Fig 5.Variations in the Density, Frequency, Abundance and Richness in site one Manavalakurichi

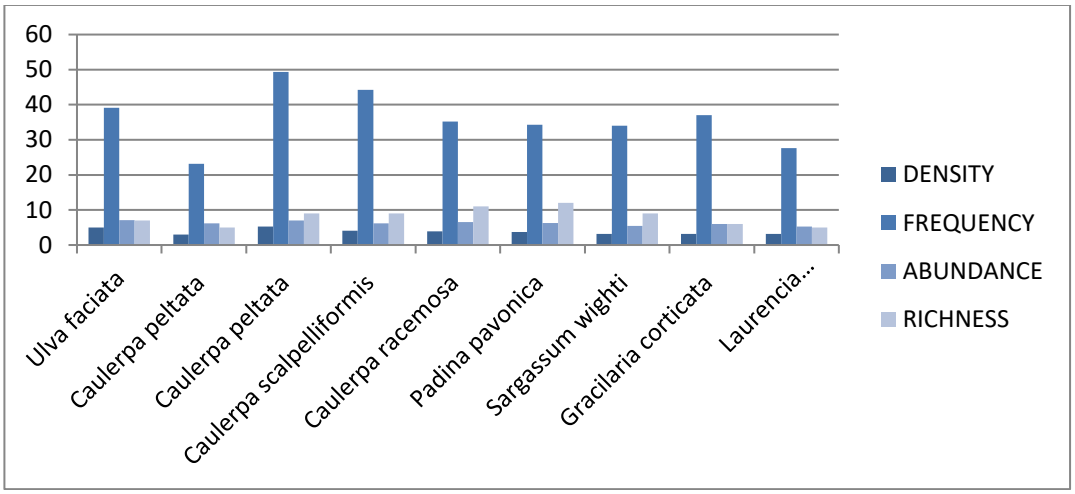

Fig **6.Variations in the Density, frequency,Abundance and Richness in site two Arokiyapyram**

ABUNDANCE

The monthly variation in the abundance of seaweed from the First collection site of the Kanniyakumari coast is presented in the figure (5). The abundance value ranged from 3.26.00-7.10. The highest abundance was show by *Enteromorpha flexuosa* during the month of January 2017. The monthly variation in the abundance of seaweed from the second site is presented in the figure (6). The abundance value ranged from 5.27-7.13. The highest abundance was show by *Ulva faciata* during the month of December 2017

RICHNESS

Species richness varied across intertidal zone, richness was lower at the higher than at the middle and low intertidal zones without differing between the middle and low zones Richness also varied among the shores, richness was lower at Manavalakurichi than at Arokiyapuram.. The elevation 2 shore interaction was not significant meaning that the vertical trend in richness was similar for all shores.

DISCUSSION

Species composition, diversity, abundance and density of seaweed varied significantly from site to site. A total of 53 species of seaweed was observed throughout the study period from kanniyakumari coast. John peter paul et al. (2013) carried out the study on the seaweed diversity in relation to hydrological parameters from Veraval and Sikka coast and find out 14 species of chlorophyceae at sikka coast .During the study period the maximum number of species 11 was recorded from the GSFC jetty during the month of March 2021. Satheesh and Wesley (2012) conducted a study on the diversity and distribution of seaweeds in the Kudankulam coastal waters. They recorded a total of 32 seaweed species from the coast out of which 15 species belonged to the group chlorophyceae. They found that during pre-monsoon and monsoon periods the seaweed abundance on test panels was high and was low in post-monsoon season. During the study period among the seaweeds collected Ulva flexuosa was highly dominant followed by Cladophora and Ulva lactuca. Sahayaraj and Singh (2016) recorded seasonal changes on the diversity and abundance of intertidal macroalgae at four southern districts of Tamil Nadu, India and recorded that genus Gracilaria dominated in South West monsoon (15.28%) followed by Ulva in winter (14.81%). Besides, Caulerpa scalpelliformis distributed in all season. There were variations in the density of marine macroalgae between the 2 sites of the Sikka coast. The density varied from species to species at both the sites. At GSFC jetty site the maximum density was showed by Cladophora glomerata (60%) during the month of February 2021 while at Vador site the maximum density was of Ulva flexuosa (13.44%) during the month of December 2020. Result of the present study are satisfied with earlier reports of Pawar (2017) at Uran (Navi Mumbai), west coast of India, Sahoo et al. (2003) at chilka lake, Thakur et al. (2008) along Port Okha, northwest coast of India, Satheesh and Wesley (2012) along the Kudankulam coastal waters, South-Eastern coast of India, Parthiban and Anantharaman (2018) from the Tuticorin coast, India and Roy (2020) within intertidal zone of Olaikuda and Vadakkadu, Rameshwaram, southeast coast of India. Ishakani et al. (2016) in their study along the veraval coast recorded total 67 species of seaweeds out of which 21 species

belonged to chlorophyceae, 32 species to rhodophyceae and 14 species to pheaophyceae. A similar observation related to chlorophyceae was recorded in the present investigation also.

CONCLUSION

The seaweed diversity at Arokiyapuram coast was high during most of the time then the Manavalakurichy coast. The seaweed density was also high most of the time at Arokiyapuram coast than the Manavalakurichy coast. This could be attributed to the fact that green seaweeds require large amount of exposure to sunlight as compared to the brown and red seaweeds. Thus the variation in the diversity of green seaweeds also varied with amount of exposure hours of the sunlight. Seaweed diversity information is very important as seaweeds are arguably the largest biomass in the ocean and hence are one of the biggest providers of marine bioactive substances that can be used to develop functional foods, in addition to drugs, cosmetics, and other novel health-related products.

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