www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(4): 482-488

www.thepharmajournal.com
Received: 10-01-2023
Accepted: 11-02-2023

Satyendra Katara
Department of Fisheries Resource Management, College of Fisheries Science, Kamdhenu University, Veraval, Gujarat, India

Ashish Bhatt
Department of Fisheries Resource Management, College of Fisheries Science, Kamdhenu University, Veraval, Gujarat, India

Siddharth Jatav
Department of Fisheries Resource Management, College of fisheries science, CCS HAU, Hisar, Haryana, India

Arun Kumar
Department of Fisheries Resource Management, College of Fisheries Science, Kamdhenu University, Veraval, Gujarat, India

Bhavika Tandel
Department of Fisheries Resource Management, College of Fisheries Science, Kamdhenu University, Veraval, Gujarat, India

Ram Kumar Kurmi
Department of Fisheries Economics, Extension and Statistics, ICAR-CIFE, Mumbai, Maharashtra, India

Corresponding Author:
Satyendra Katara
Department of Fisheries Resource Management, College of Fisheries Science, Kamdhenu University, Veraval, Gujarat, India

Chlorophyceae seaweed diversity along Sikka Coast, Gulf of Kachcha, Gujarat

Satyendra Katara, Ashish Bhatt, Siddharth Jatav, Arun Kumar, Bhavika Tandel and Ram Kumar Kurmi

Abstract
The present study was on study of species diversity and abundance of chlorophyceae group of seaweed available at Sikka coast, Gujarat, India. During the study period a total of 16 green seaweed species were recorded from both the sites of Sikka coast i.e GSFC Jetty site and Vador site. These 16 species belongs to 4 orders, 6 family and 7 genus. *Ulva flexuasa* was highly dominant followed by *Cladophora* and *Ulva lactuca*. The frequency percentage values ranged from 0.00-66.67. The density ranged between 0.00-60.00. The highest percentage of density was shown by *Cladophora glomerata* during the month of February 2021. The abundance value ranged from 0.00-6.05. The highest abundance was show by *Ulva flexuosa* (6.05) during the month of December 2020.

Keywords: *Cladophora*, *Ulva flexuosa*, *Ulva lactuca*, species diversity etc.

1. Introduction
Seaweeds are also algae but they are differentiated from others in the sense that they are multicellular, macro thallic and large marine benthic algae (Ishakani *et al.*, 2016) [4]. This marine microalgae are generally classified as Rhodophyta (Red algae), Phaeophyta (Brown algae) and Chlorophyta (Green algae) on the basis of their nutritional composition, anatomy, pigmentation and morphology (Lalitha and Dhandapani, 2018) [7]. Seaweeds contain various inorganic and organic substances like other plants which can benefit human health (Kuda *et al.*, 2002) [6]. Seaweeds defend themselves against bacterial fouling by the production of secondary metabolites that prevent attachment and growth of bacterial colonizers (Cox *et al.*, 2010) [3].
The nutrients from aquaculture effluent are stripped by marine macroalgae (seaweeds) before their release to the environment (Chopin *et al.*, 2001; Neori *et al.*, 2004) [2, 11]. In nutrient-rich aquaculture, effluent seaweeds have high growth rates as nutrients are no longer a limiting growth factor as they often are in nature (Neori *et al.*, 2000) [12]. The culture of seaweeds can be adapted to cage, tank, or pond-based systems as seaweeds grow on a variety of substrate (Paul and Nys, 2008) [15].
From different parts of the Indian coasts a total of 770 species of seaweeds have been reported which includes 184 species of green, 166 species of brown and 420 species of red (Sahoo, 2010) [20]. Seaweed cultivation in India is still in the experimental stage and field cultivation of some economic seaweed has been attempted (Rao *et al.*, 2006) [18]. The cultivation of seaweeds has become necessary as the present natural seaweed stocks are not sufficient to meet industrial requirements. The highest seaweed cultivation is done in Asia among which 80% of contribution is from China, Japan, and Korea. The culture techniques for some commercially important seaweeds in India have been developed by the Central Marine Fisheries Research Institute (CMFRI) and Central Salt Marine Chemical Research Institute (CSMCRI) (Mohamed, 2015) [10].
Green seaweed (Chlorophyta) ranges from microscopic unicells to macroscopic multicellular algae (Lewis and McCourt, 2004) [8] in this way these green algae are very diverse in morphology. Among the macroalgae, they are rarely not more than a meter long. Chlorophytes carry plastids that contain chlorophyll a and b as well as starch (Lewis and McCourt, 2004) and are therefore known as photosynthetic eukaryotes. Carotenoids are also present but relatively few. Chlorophytes are mostly autotrophs but some heterotrophs are also known as (Polytoma, Prototheca, etc.). Some species of chlorophytes also exhibit a symbiotic relationships with lichens, ciliates, hydras, etc. Traditionally the green algae 4 were classified

in order or classes according to the morphological species concept (Pröschold and Leliaert, 2007) [17].

Chlorophyta has high diversity in tropical coral reefs and lagoons and are naturally abundant also found intermixed with associated seagrass habitats. Usually, they are found in the littoral zone with strong sunlight. Their availability in a given habitat depends on quality and quantity of light, suitable substrate, nutrients availability, intra, and interspecific competition, etc. Their photosynthetic capacity and algal pigments and adaptations to different light levels lead to their depth zonation within the habitat (Chaudhury *et al*., 2018).

Green algae like *Ulva*, *Caulerpa*, and *Enteromorpha* are used as salad and in soups and can also be used as an important food source for fishes, crustaceans, and gastropods. Food reserves are starch and fructosans. From several genera especially *Caulerpa*, *Chaetomorpha* and *Ulva* bioactive compounds like diterpenes, sesquiterpenes, triterpenes, and ceramides have been isolated (Manisseri *et al*., 2012) [9].

2. Materials and Methods

The current study was carried out in the coastal waters of the Sikka coast, Gulf of Kachchh (22° 49′ 17.7″N 77 latitude and 69° 20′ 33.8″E longitude) Gujarat. Samples were taken from the two sites *viz*, GSFC (Gujarat State Fertilizer Company) Jetty site and the Vador site of the Sikka coast, between the months of October 2020 and March 2021, during the lowest tide of the tide chart.

According to what the tide table said would happen, the field sampling was taken when the tide was at its lowest. Ecological measurements were made of the ambient temperature, the surface water temperature, and the types of green seaweed that were present in the field itself. The Belt Transect Method was applied to the investigation of the variety of species and amount of green seaweed at the station. For this $1m^2$ quadrate was used. When examining the variety and amount of seaweed, the species discovered beneath the quadrate was taken into account.

3. Result and Discussion

3.1 Species diversity at the Sikka coast

The entire intertidal area of the gulf of kachchh is rich with a diverse group of seaweed species. The Sikka coast particularly the Vador and GSFC Jetty (Gujarat State Fertilizer Company's Jetty) has been first 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 16 species of green seaweeds has been observed from both the sites of Sikka coast during the entire study period. These 16 species belongs to 4 orders, 6 family and 7 genus. 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 GSFC jetty during the month of March 2021 with about 11 species and the minimum number of species recorded from the GSFC jetty was 2 during the month of December. From Vador site the maximum number of species recorded was 5 during the month of March.

Table 1: Taxonomic classification of seaweed species from Sikka coast, Gujarat, India

Family	Genus	Species	GSFC	Vador
Order-Bryopsidales				
Caulerpaceae	*Caulerpa*	*racemosa* (Forsskal) J. Agardh	+	-
		taxifolia C. Agardh	+	+
		verticillata J. Agardh	+	-
		veravalensis Thivy & Chauhan	+	-
		Sertularoides (S.Gmelin) Svedelius	+	-
Halimedaceae	*Halimeda*	*tuna* C. Agardh	+	-
		macroloba Decaisne	+	-
Codieacea	*Codium*	*decorticatum* (Woodward) Howe	+	-
		geppiorum O. Schmidt	+	-
Order-Cladophorales				
Cladophoraceae	*Cladophora*	*glomerata* (Linnaeus)Kutzing	+	+
Order-Ulvales				
Ulvaceae	*Ulva*	*lactuca* Linnaeus	+	+
		reticulata Forsskal	-	+
		intestinalis Linnaeus	-	+
		flexuosa Wulf.	+	+
Order-Siphonocladals				
Boodleaceae	*Boodlea*	*Composita* (Harvey) Brand	+	-
	Struvea	*Anastomosans* (Harvey) Piccone & Grunow	+	+

+ Present and – Absent

3.2 Study on species abundance, species density and the frequency of seaweeds from the Sikka coast, Gujarat.

3.2.1 Frequency

The monthly percentage frequency of green seaweeds along the GSFC jetty site of the Sikka coast is presented in the figure (1). The frequency percentage values ranged from 0.00-66.67. The highest values were observed for *Ulva lactuca* during the month of March 2021.

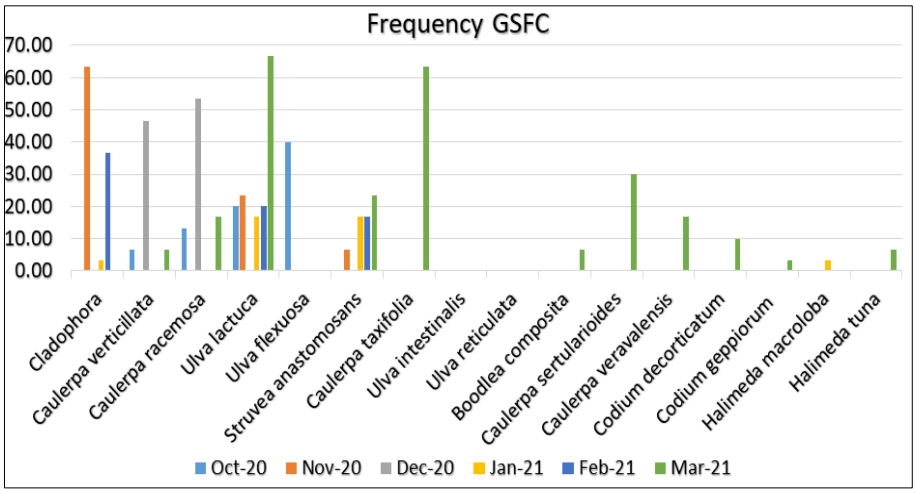


Fig 1: frequency of green seaweed at GSFC jetty site.

The monthly percentage frequency of green seaweeds along the Vador site of the Sikka coast is presented in the figure (2). The frequency percentage values ranged from 0.00-66.67. The highest values were observed for *Ulva flexuosa* during the month of December 2020.

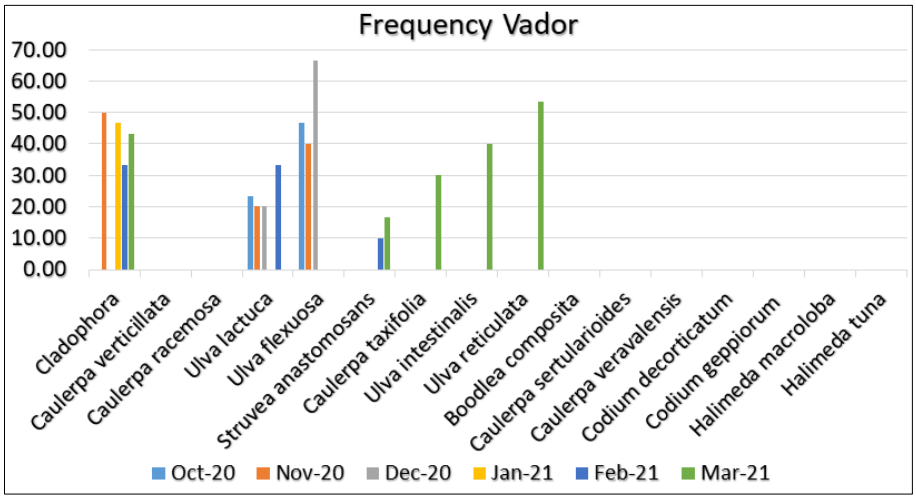


Fig 2: frequency of green seaweed at Vador site.

3.2.2 Density

The monthly percentage density of green seaweeds along the GSFC jetty site of the Sikka coast is presented in the figure (3). The density ranged between 0.00-60.00. The highest percentage of density was shown by *Cladophora glomerata* during the month of February 2021.

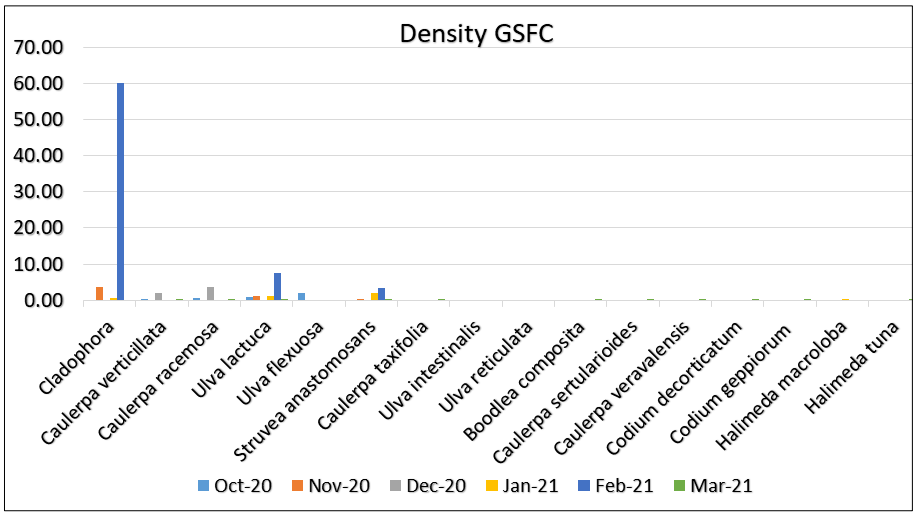


Fig 3: density of green seaweed at GSFC jetty site.

The monthly percentage density of green seaweeds along the Vador site of the Sikka coast is presented in the figure (4). The density ranged between 0.00-13.44. The highest percentage of density was shown by *Ulva flexuosa* during the month of December 2020.

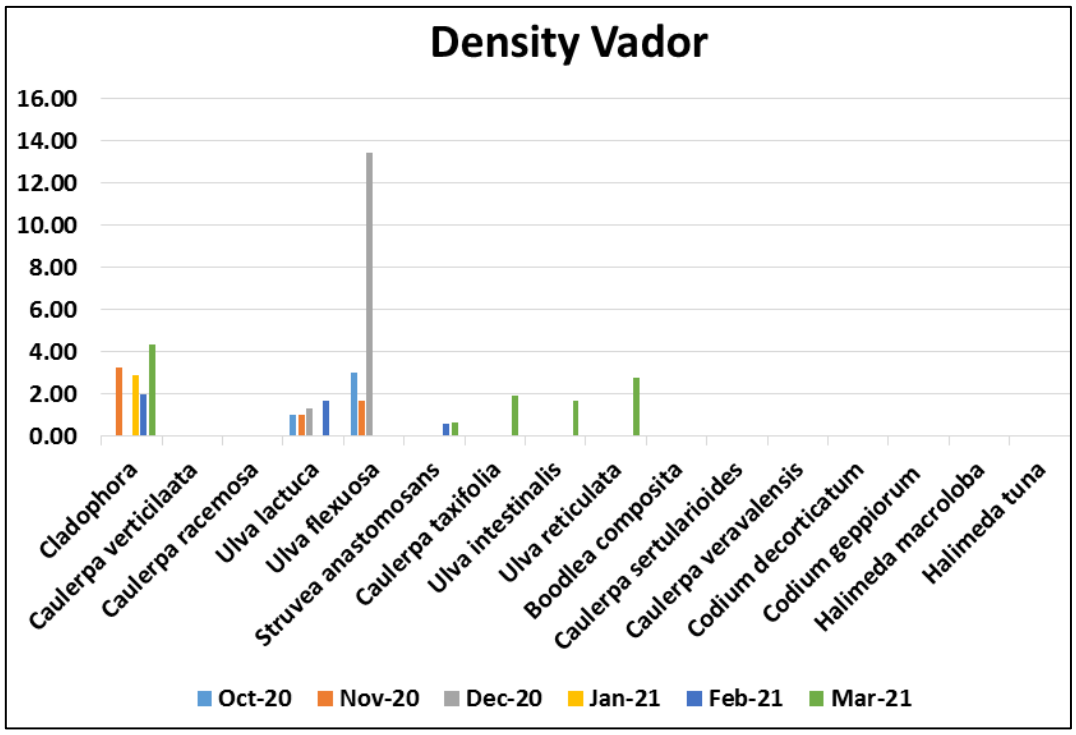


Fig 4: Density of green seaweeds at Vador site.

3.2.3 Abundance

The monthly variation in the abundance of seaweed from the GSFC jetty site of Sikka coast is presented in the figure (5). The abundance value ranged from 0.00-5.00. The highest abundance was show by *Cladophora* (5.00) during the month of January 2021.

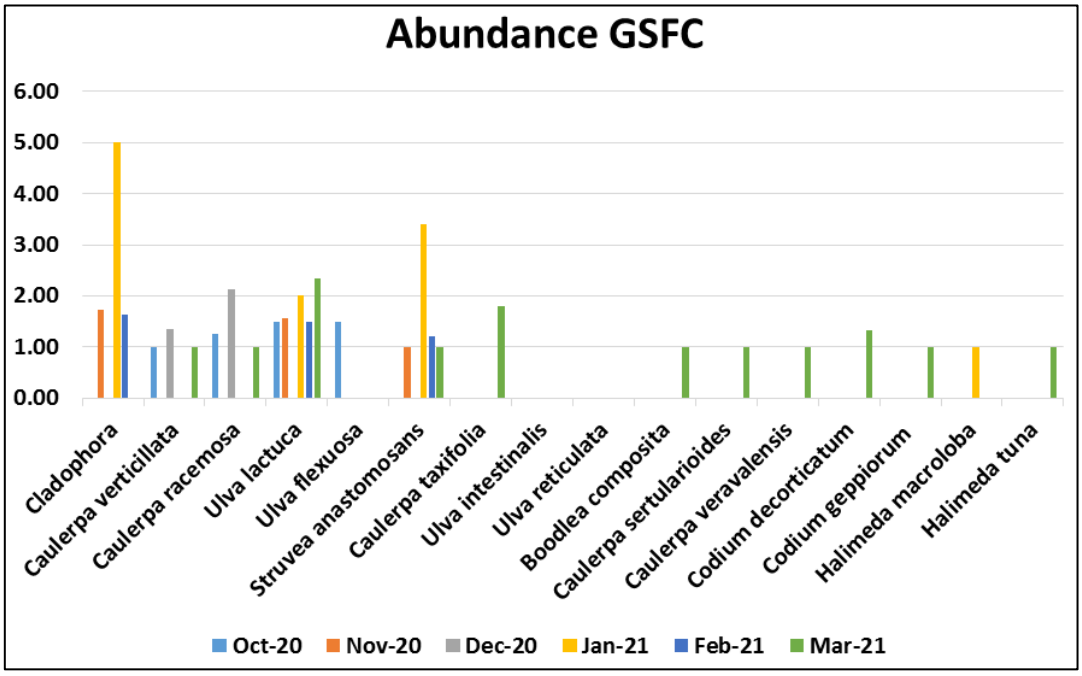


Fig 5: Abundance of green seaweed at GSFC jetty site

The monthly variation in the abundance of seaweed from the Vador site of Sikka coast is presented in the figure (6). The abundance value ranged from 0.00-6.05. The highest abundance was show by *Ulva flexuosa* (6.05) during the month of December 2020.

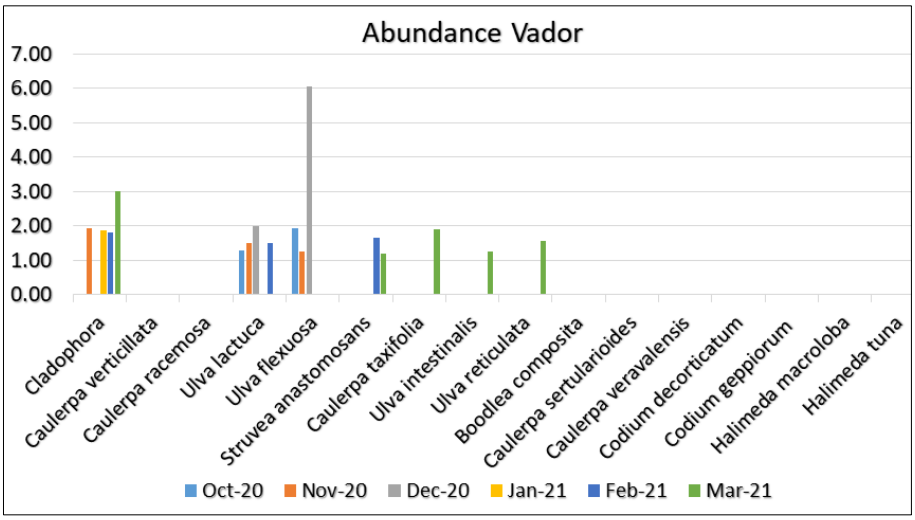
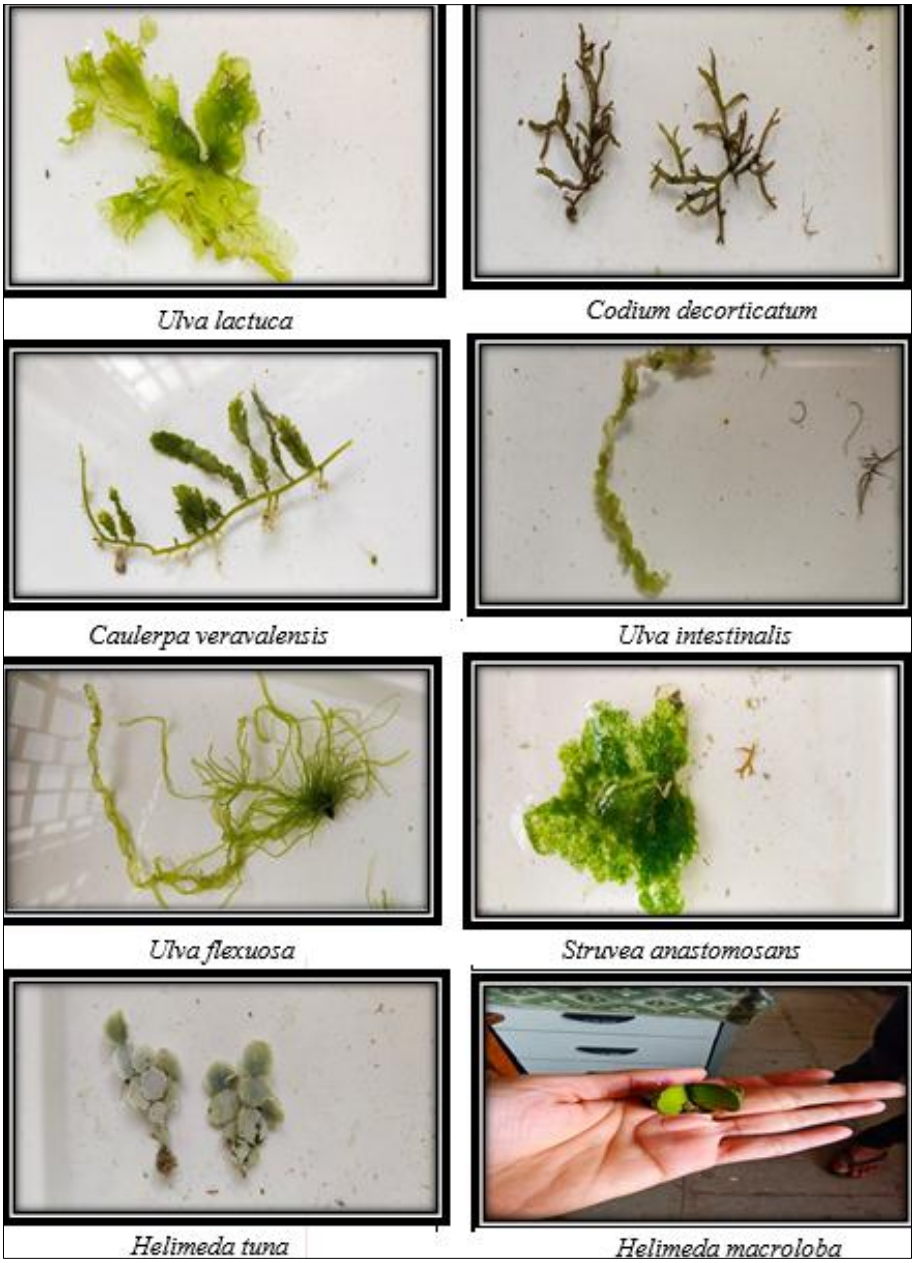


Fig 6: abundance of green seaweed at Vador site



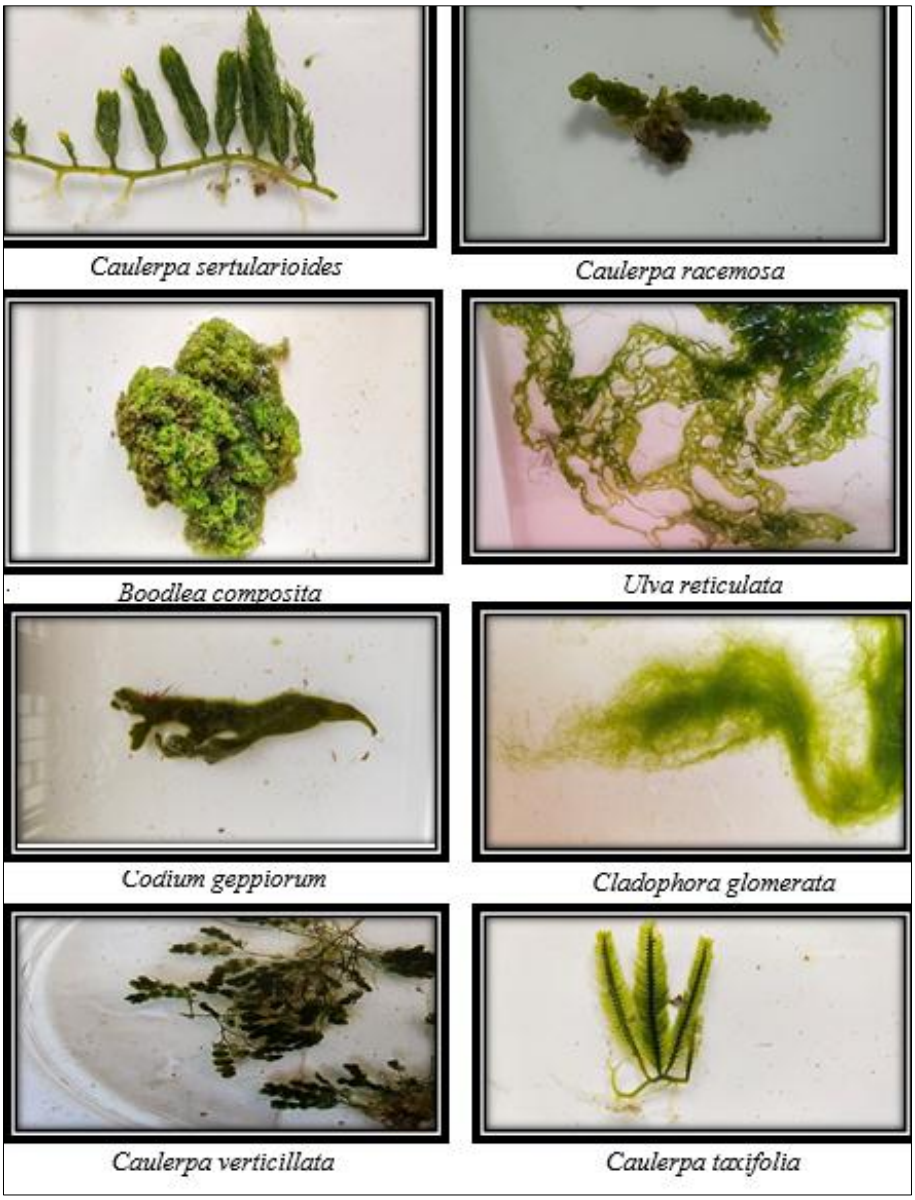


Fig 7: Chlorophyceae species collected from GSFC Jetty and Vador site, Sikka coast, Gujarat

4 Discussion

Species composition, diversity, abundance and density of seaweed varied significantly from site to site. A total of 16 species of seaweed was observed throughout the study period from both the sites. Pathak *et al.* (2020) [14] 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) [22] 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) [5] 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) [16] at Uran (Navi Mumbai), west coast of India, Sahoo *et al*. (2003) [21] at chilka lake, Thakur *et al*. (2008) [23] along Port Okha, northwest coast of India, Satheesh and Wesley (2012) [22] along the Kudankulam coastal waters, South-Eastern coast of India, Parthiban and Anantharaman (2018) [13] from the Tuticorin coast, India and Roy (2020) [19] within intertidal zone of Olaikuda and Vadakkadu, Rameshwaram, southeast coast of India. Ishakani *et al*. (2016) [4] 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.

5. Conclusion

The seaweed diversity at GSFC jetty site was high during most of the time then the Vador site. The seaweed density was also high most of the time at GSFC jetty site than the Vador site. 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.

6. Reference

1. Chaudhury NR, Sanghvi D, Jain B. Macroalgae Species as Zonal Indicators of Coral Reef: A Case Study from Bet Shankhodhar Reef, India. In Wetlands Management-Assessing Risk and Sustainable Solutions, Intech Open; c2018. p. 45-55.
2. Chopin T, Buschmann AH, Halling C, Troell M, Kautsky N, Neori A, *et al*. Integrating seaweeds into marine aquaculture systems: a key toward sustainability. J Phycol. 2001;37:975-986.
3. Cox S, Abu-Ghannam N, Gupta S. An assessment of the antioxidant and antimicrobial activity of six species of edible Irish seaweeds. International Food Research Journal. 2010;17(1):205-220.
4. Ishakani AH, Joshi NH, Ayaz M, Sumara K, Vadher KH. Assessment of seaweed diversity at veraval coast, Gujarat. Journal of Experimental Zoology, India. 2016;19(2):863-868.
5. Sahayaraj K, Jagvir Singh. Seasonal changes on the diversity and abundance of intertidal macroalgae at four Southern districts of Tamil Nadu, India. Ecologia. 2016;6:13-18.
6. Kuda T, Taniguchi E, Nishizawa M, Araki Y. Fate of water-soluble polysaccharides in dried Chorda filum a brown alga during water washing. Journal of Food Composition and Analysis. 2002;15:3-9.
7. Lalitha N, Dhandapani R. Proximate composition and amino acid profile of five green algal seaweeds from Mandapam Coastal regions, Tamil Nadu, India. The Pharma Innovation Journal. 2018;7(10):400-403.
8. Lewis LA, McCourt RM. Green algae and the origin of land plants. American journal of botany. 2004;91(10):1535-1556.
9. Manisseri MK, Antony G, Rao GS. Common Seaweeds and Seagrasses of India Herbarium, 2012, 1.
10. Mohamed G. Current trends and prospects of seaweed farming in India. Course manual of Winter School on Technological Advances in Mariculture for Production Enhancement and Sustainability; c2015. p. 78-84.
11. Neori A, Chopin T, Troell M, Buschmann AH, Kraemer GP, Halling C, *et al*. Integrated aquaculture: rationale, evolution and state of the art emphasizing seaweed biofiltration in modern mariculture. Aquaculture. 2004;231:361-391.
12. Neori A, Shpigel M, Ben-Ezra D. A sustainable integrated systems for culture of fish, seaweed and abalone. Aquaculture. 2000;186:279-291.
13. Parthiban C, Anantharaman P. Diversity and Biomass of Drift Seaweeds from the Tuticorin Coast, India. License this work is licensed under a Creative Commons Attribution 4.0 International License. 2018;19:72-86.
14. Pathak S, Bhatt AJ, Vandarwala UG, Vyas UD and Gautam P. Seaweed species diversity with relation to hydrological parameters from veraval and sikka coast, Gujarat, India. International Journal of Bio-resource and Stress Management. 2020;11(6):567-577.
15. Paul NA, De Nys R. Promise and pitfalls of locally abundant seaweeds as biofilters for integrated aquaculture. Aquaculture. 2008;281(1-4):49-55.
16. Pawar PR. Distribution pattern & species diversity of seaweeds at Uran (Navi Mumbai), west coast of India. International Journal of Pure and Applied Zoology. 2017;5(1):25-32.
17. Pröschold T, Leliaert F. Systematics of the green algae: conflict of classic and modern approaches. In: Brodie, J. & Lewis, J (eds.) Unravelling the algae. The past, present, and future of algal systematics. The Systematics Association Special Volume Series. 2007;75:123-153.
18. Reddy CRK, Rao PVS, Ganesan M, Eswaran K, Zaidi SH, Mantri VA. The seaweed resources of India. World Seaweed Resources. Eti Information Services Ltd., Wokingham, Berkshire, UK; c2006, 25.
19. Roy S. Seaweed diversity within intertidal zone of Olaikuda and Vadakkadu, Rameshwaram, southeast coast of India. Heliyon. 2020;6(7):e04585.
20. Sahoo D. *Common seaweeds of India*. IK International Pvt Ltd; c2010.
21. Sahoo D, Sahu N, Sahoo D. A critical survey of seaweed diversity of Chilika Lake, India. ALGAE-INCHON. 2003;18(1):1-12.
22. Satheesh S, Wesley SG. Diversity and distribution of seaweeds in the Kudankulam coastal waters, South-Eastern coast of India. Biodiversity Journal. 2012;3(1):79-84.
23. Thakur MC, Reddy CRK, Jha B. Seasonal variation in biomass and species composition of seaweeds stranded along Port Okha, northwest coast of India. Journal of earth system science. 2008;117(3):211-218.