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Biomass and percent cover of marine macro algae at five south-western intertidal areas of Gulf of Kachchh

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Abstract

Gujarat is situated on the north- western part of peninsular India.The state has two major gulfs, namely, Gulf of Khambhat and Gulf of Kachchh (GoK) which embrace diverse coastal habitats as well as biota of ecological significance. The GoK is the biggest gulf on the west coast of India in the Arabian Sea having 42 islands fringing with corals and mangroves which provide congenialhabitat for proliferation of seaweeds, nesting birds and animals.In the present research work a totalof 123 species of marine macro algae were collected and identified. These include 35 Chlorophyta, 25 Phaeophyta and 63 Rhodophyta from the five intertidal areas of GoK.Thehighest percentage cover (54.2%) was observed in Paga reef and the lowest percentage cover (16.6%) was found in Boria reef. The Cheney's ratio of 3.9 indicated a mixed algal flora in this studied area.The maximum and minimum seaweeds biomass was recorded in Panero reef (0.16 kg/sq. m.) and Boria reef (0.06 kg/sq. m.),respectively.In the studied area, the maximum algal biomass was observed for green algae (0.19 kg/sq. m.).

Key words: Algae, Biomass, Gulf of Kachchh, Percentage cover, Seaweeds.

Introduction

Indian coastline stretches about 5700 km covering 9 states on mainland and about 7500 km including islands and union territories (Oza and Zaidi, 2001). Macroscopic marine algae are also known as seaweeds, a renewable natural resource, found growing in large quantities along the Indian coast. The major seaweed growing areas include Gulf of Kuchchh, Gulf of Mannar, Palk Bay, Lakshadweep and Andaman and Nicobar islands (Kaliaperumal *et al.*, 1998).

The Gulf of Kachchh (22˚15' to 23˚40'N and 68˚20' to 70˚40'E) is the wedge-link extension of the Arabian Sea, which penetrates into the landmass. The Gulf of Kachchh has an area of 7,350km^2 (Nair,2002) and has east west orientation. Because of its unique position, *i.e.* nearest to the Tropic of Cancer, funnel-like shape and resonance effects, the GoK experiences very high tides-roughly the highest anywhere along the Indian Coast. The Gulf is a semi-enclosed coastal indentation with predominance of mangrove ecosystems, coral reef and associated rich algal diversity. Sahoo*et. al* (2001) comprises a check-list of total 770 species from Indian coast of which 30%,*i.e.,*280 species were reported from Gujarat coast. India possesses 434 species of red seaweeds, 194 species of brown seaweeds and 216 species of green seaweeds, hence 844 species of seaweeds are reported fromIndia,among that 202 seaweeds species were reported from Gujarat (NAAS, 2003). Jha *et al.* (2009) reported 198 species of seaweeds belonging to 101 genera from the Gujarat coast. Further Gujarat Ecological Commission –GEC (2013) reported 78 seaweeds from Gulf of Kachchh. Distribution of marine algae in the southern and northern coasts of the GoK exhibited a clear cut contrast. While the algal growth was luxuriant on the southern coast, the northern coast had very poor algal biodiversity (http://www.icmam.gov.in/GOK.PDF). Availability of large inter tidal expanse (1-5km) with gradual slope and the coralline substratum on the southern coast favored luxuriant growth of diverse species of algae in the Marine National Park & Sanctuary as well as other area.One important measurable aspect of marine plant communities is biomass. Biomass is the standing stock or mass of a species or community. Hameed and Ahmed (1999) studied seasonal variation in seaweeds biomass from the rocky shore of Pacha, near Karachi, Pakistan (Arabian Sea).

In the present work an attempt was made to investigate the diversity, distribution, percent coverand biomass estimation of marine macro algae in 5 south-western intertidal areas of GoK.

Material and Methods

Study area

In the present investigation for the seaweed study, five south western intertidal areas of the GoK were explored during winterseasonsof 2013-2015. The brief description of study site is given in table-1 and Fig-1.

Table-1 Description of Study area

Sampling Site	General features	Transects	Quadrates	studied area
Ajad Latitude -N22˚22'985'' Longitude- E69˚18'523''	It is a submerged reef with Reef vegetation.	6	30	0.0030 ha.
Boria Latitude -N22˚23'610'' Longitude- E69˚15'201''	It is a submerged reef.	5	25	0.0025 ha.
Okha Latitude -N22˚28'779'' Longitude- E69˚04'780''	It is located at the mouth of gulf. The reef is characterized by rocks with patches of sand deposits.	8	44	0.0044 ha.
Paga Latitude -N22˚26'944'' Longitude- E69˚14'134''	It is an oval shaped submerged type of reef with marsh vegetation.	7	35	0.0035 ha.
Panero Latitude -N22˚22'502'' Longitude- E69˚24'985''	It is a submerged reef with algal vegetation.	19	95	0.0095 ha.
Total		45	229	0.0229 ha.

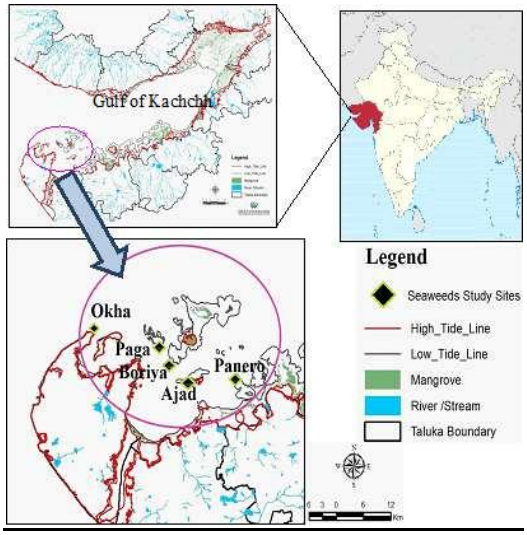

Fig.1 Map showing the five sampling sites

Sampling technique:

Random sampling was followed for quantitative assessment of the seaweeds in the selected study area as it is more common and easy to study the seaweeds in the field (Naik*et. al.* 2015). Line transects were laid perpendicular to the coast from low tide line to high tide line. Distance of 100 m was maintained between two subsequent transects. Quadrates, measuring 1 m^2 (Fig.-2), were placed at the sampling points with an interval of 20 meters in the line transects.Percentage cover(canopy cover) of seaweed (GEER Foundation, 2004) was estimated in the present study by visible observations through grid.Collectedmaterials were kept in the polythene bags/containers with proper labelling for further preservation and identification at the later stage in the laboratory.The species were identified using published literature and web base source (Jha*et al.,* 2009; Sahoo*et al.,* 2001, www.algaebase.org).Documentation was done in the form of photographs as well as seaweeds specimen were preserved by preparing herbarium anddeposited in the GEER Foundation, Gandhinagar, Gujarat for future reference.

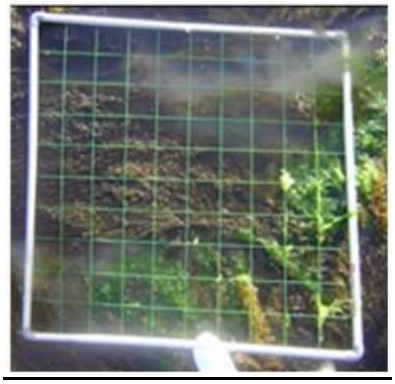

Fig.2 Seaweeds sampling by laying quadrates

During biomass allocation seaweeds samples were collected by hand from the quadrate. Collected samples were cleaned of epiphytes and debris and rinsed in clean seawater on the site. After that seaweeds were categorised according to their respective divisions *i.e.* Chlorophyta, Phaeophyta and Rhodophyta. Wet weights (kg/m2) of the samples were taken with the help of digital weighing balance (Promptscale). Final dry weight of seaweeds were taken after complete drying at <60˚C. The following analytical methods were adapted for analysis

- The alagal cover was calculated by following formula.

$$\text{Percent Cover} = \frac{\text{Total area covered by species ((canopy cover)}}{\text{Total area sampled}}$$

- Cheney's floristic ratio

The nature of the studied seaweed flora was calculated by Cheney's floristic ratio (Cheney, 1977).

$$\text{Cheney's floristic ratio} = \frac{\text{Number of Rhodophyta Spp. (R)} + \text{Number of Chlorophyta Spp(C).}}{\text{Number of Phaeophyta Spp. (P)}}$$

Result and Discussion

In the present study, a total of 123 macro algal species belonging to 69 Genera and 40 Families were recorded. The ratio of Family to Genera and Species was observed to be 1:1.7:3. Diversity of Seaweeds comprised of 63species of Rhodophyta, 35 of Chlorophyta and 25of Phaeophyta (Annexure-1).Thehighest percentage of species diversity was found in Rhodophyta (51%), followed by Chlorophyta (30%) and Phaeophyta (20%) (Fig.3).In the present study red algae have the highest species diversity (63 species) than the other groups of seaweeds. Similar observation is also recorded for Southern Indian Coast (Baluswamy, 2006; Subbarao and Mantri, 2006). It may be due to the fact that the red algae are less influenced by some factors such as temperature, drought, wind and tides as compare to the other groups of algae (green and brown) (Dowes, 1981).

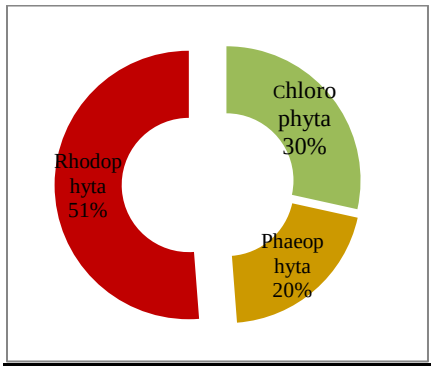

Fig. 3 Division wise species diversity of seaweeds in the 5 intertidal areas of South-western GoK

Among the five surveyed intertidal areas, the highest species richness (50 spp.) was recorded in PaneroandOkhafollowed by Paga (39 spp.) and Boria (38 spp.). The lowest species richness was found in Ajad reef (28 spp.) (Fig.4). A comparative analysis of these five sites revealed that maximum number of Rhodophyta (27 species) was found in Okha reef, whereas Panero reef was represented with the maximum number of Chlorophyta (16 species) and Phaeophyta (13 species). On the other hand, Ajad reef area showed minimum number of Rhodophyta (11species) and Chlorophyta (7 species), whereas minimum number of Phaeophyta species (9species) were found in Okha and Boria reef area (Table-2). The variation in seaweeds diversity may be due to condition of environment establishing favourable regime of temperature, salinity and nutrients. In addition to this, the sunlight is another factor which governs and will prosper these macrophytic flora especially in intertidal zone (Naik*et. al.* 2015).

Table-2 Number of genera and species of seaweeds recorded at the 5 intertidal areas of South-western Gulf of Kachchh

Name of the site	Chlorophyta			Phaeophyta			Rhodophyta		
	Family	Genera	Species	Family	Genera	Species	Family	Genera	Species
Panero	8	10	16	3	8	13	10	16	21
Paga	3	4	8	4	7	11	10	15	20
Boria	5	5	11	3	6	9	10	13	18
Ajad	4	5	7	4	6	10	8	10	11
Okha	8	8	14	4	8	9	16	23	27

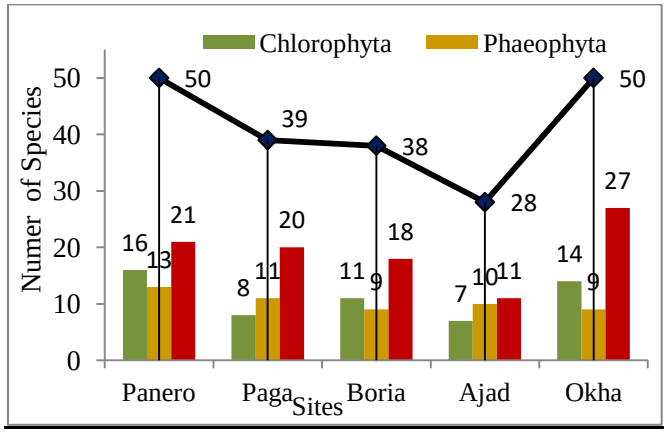

Fig. 4 Species richness at the 5 intertidal areas of South-western Gulf of Kachchh

During the estimation of total percent cover it was observed that Paga reef represents the highest percentage cover (54.2/Sq.m.)of seaweeds followed by Panero (42.9/Sq.m.), Okha (38.4/ Sq.m.) and Ajad (28.0/Sq.m.). On the other hand the lowest total percentage cover (14.8/Sq.mt.) was recorded in Boria reef. The highest chlorophyta percent cover (52.1/Sq.m.) was found in Paga reef and the lowest percent cover (8.5/ Sq.m.) was recorded in Boria. Paneroreef was represented with the highest percent cover (24.2/Sq.m.) of Phaeophyta and Paga reef showed the lowest percent cover (0.9/Sq.m.) of Phaeophyta. The highest (6.3/Sq.m.) and the lowest (1.3/Sq.m.) percent cover of Rhodophyta was recorded in Okha and Paga reef respectively (Fig. 5).

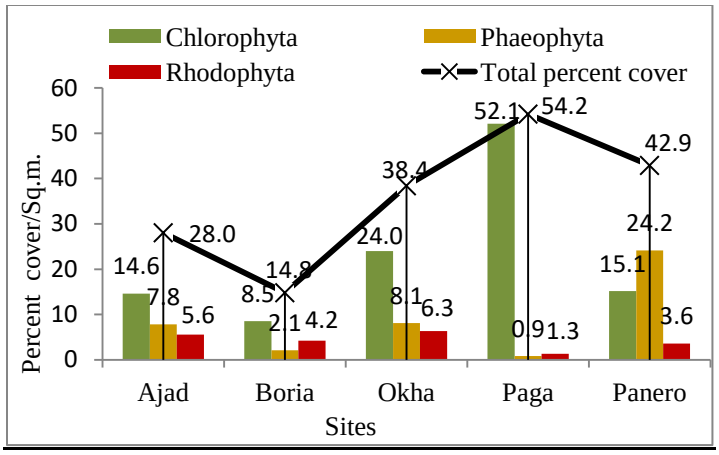

Fig.5 Percent cover at the 5 intertidal areas of South-western GoK

Species wise percent cover of Chlorophyta(Fig. 6) was also estimated during the research work. It was revealed that *Ulva lactuca* (GA-21) shows the highest percent cover (27.4/Sq.m.), followed by *Caulerpa racemosa* (GA-3, 25/Sq.m.) and *Caulerpa peltata* (GA-2,23/Sq.m). The lowest percent cover (0.5/Sq.m.) among chlorophyta species was found in *Codiumdwarkens*(GA- 6) and *Caulerpa verticilata*(GA-11).

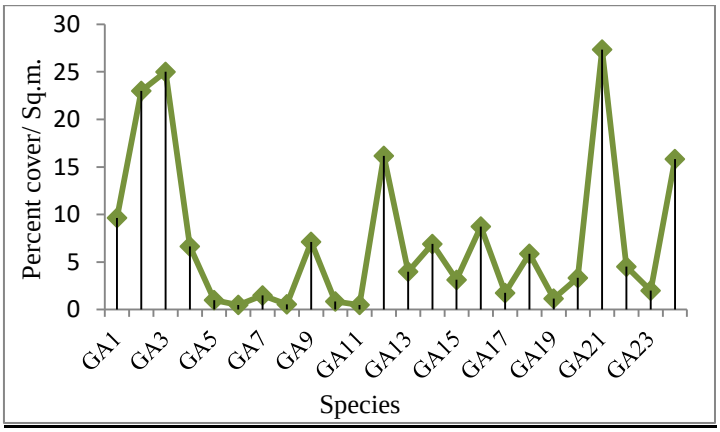

Fig.6 Species wise percentage cover of Chlorophyta

(The abbreviations used in Fig.6 GA- Green Algae, GA1- *Caulerpa microphysa*, GA2-*Caulerpa peltata*, GA3-*Caulerpa racemosa*, GA4-*Caulerpa taxifolia,* GA5-*Caulerpa veravalensis*, GA6-*Caulerpa verticilata,* GA7-*Chaetomorpha crassa*, GA8-*Chaetomorpha spiralis,*GA9-*Caulerpa racemosa* V. *macrophysa,* GA10-*Cladophora vagabunda,* GA11-*Codium dwarkens,* GA12-*Dictyosphaeria cavernosa,*GA13-*Enteromorphacompressa,* GA14-*Enteromorphaintestinalis,* GA15-*Enteromorpha linza,* GA16-*Halimeda macroloba, GA17-Halimeda tuna, GA18-Monostroma latissimum,* GA19-*Struvea anastomosans,*GA20-*Udotea indica,* GA21-*Ulva lactuca,* GA22-*Ulva rigida,* GA23-*Valonia oxidantalis,* GA24-*Valonia aegagropila*)

The species wise percentage cover of Brown algae is shown in Fig.7. Among the 22 species recorded from the quadrate study, the maximum percent cover (15.10/ Sq.m.) was observed in *Spatoglossumasperum*(BA20), followed by *Lobophora variegeta*(BA10; 14.44/Sq.m.) and *Sargassum cinctum*(BA15; 12.48/Sq.m.). On the other hand *Colpomeniasinuosa*(BA1) shows the minimum percentage cover(0.74/Sq.m).

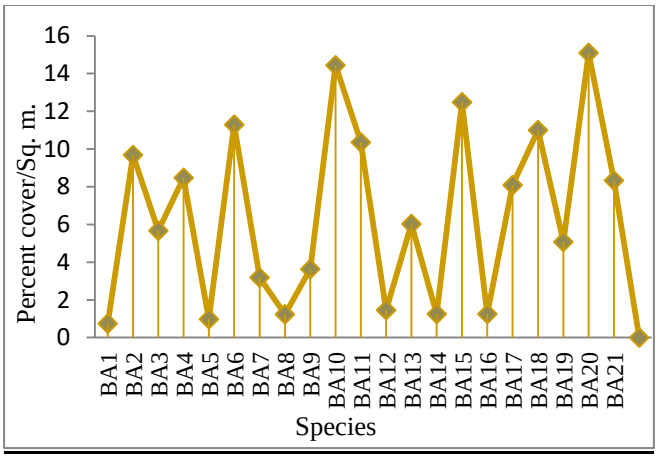

Fig.7 Species wise percentage cover of Phaeophyta

(The abbreviations used in Fig.7 BA- Brown Alga BA1-*Colpomenia sinuosa*, BA2-Cystoseira *indica*, BA3-*Dictyopteris australis* , BA4-*Dictyopteris delicatula*, BA5-*Dictyota ciliolate*, BA6-*Dictyota cervicornis*, BA7-*Dictyota dichotoma*, BA8-*Hincksia mitchelliae*, BA9-*Iyengaria stellate*, BA10-*Lobophora variegeta*, BA11-*Padina boergesenii*, BA12-*Padina boryana*, BA13-*Padina tetrastromatica*, BA14-*Rosenvingea intricate*, BA15-*Sargassum cinctum*, BA16-*Sargassum cinerium*, BA17-*Sargassum prismaticum*, BA18-*Sargassum tenerrimum*, BA19-*Sargassum vulgare*, BA20-*Spatoglossum asperum* , BA21-*Stoechospermum marginatum*)

The study of species wise percentage cover of Rhodophyta(Fig.8) revealed that, the maximum percentage cover (22.3/Sq.m.) was found in *Gracilleriacorticata* (RA33), followed by *Gelidiellaacerosa* (RA15; 20.5/Sq.m.), *Laurenciapapillosa* (Ra30;14.5/Sq.m.) and *Gracilaria dura* (RA17, 11.5/Sq.m.). The species of Rhodophyta with minimum percentage cover (0.2/Sq.m.) was found in *Scinaiamonoliformis*(RA38).

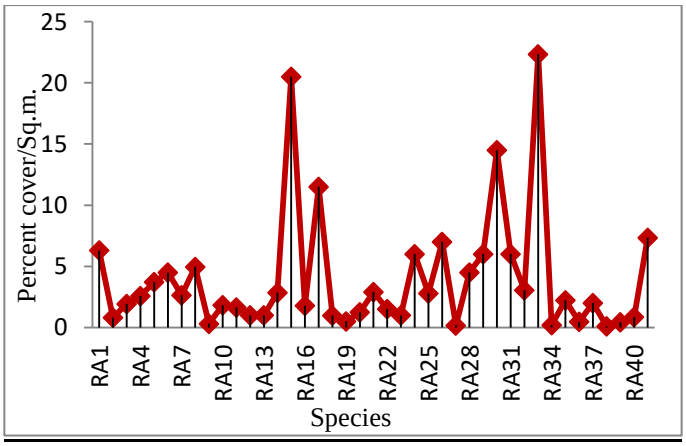

Fig.8 Species wise percentage cover of Rhodophyta

(The abbreviations used in Fig.8 RA- Read Algae RA1-*Acanthophora dendroides*, RA2-*Acanthophora nayadiformis*, RA3-*Acanthophora specifera*, RA4-*Ahnfeltia plicata*, RA5-*Amphiroa fragilissima*, RA6-*Botryocladia leptopoda*, RA7-Centeroceras *clavuclatum*, RA8-*Ceramium cruciatum*, RA9-*Champia compressa*, RA10- *Champia indica*, RA11-*Chondracanthus acicularis*, RA12-*Condria armata*, RA13- Corallina berteroi, RA14-*Digenea simplex*, RA15-*Gelidium acerosa*, RA16-*Gelidium micropterum*, RA17-*Gracilaria dura*, RA18-*Gracilaria foliifera*, RA19-*Gracilaria salicornia*, RA20-*Gracilaria textorii*, RA21-*Gracilaria verrucosa*, RA22-*Cheilosporum spectabile*, RA23-*Grateloupia indica*, RA24-*Hypnea esperi*, RA25- *Hypnea musciformis*, RA26-*Hypnea pannosa*, RA27- *Hypnea valentiae*, RA28-*Jania rubens*, RA29-*Kappaphycus alvarezii*, RA30-*Laurencia papillosa*, RA31- *Laurencia platyclada*, RA32-*Laurentia obtuse*, RA33-*Gracilleria corticata*, RA34-*Lophocladia lallemandi*, RA35-*Peyssonnelia obscura*, RA36-*Platysiphonia delicate*, RA37-*Polysiphonia denudate*, RA38-*Scinaia monoliformis*, RA39-*Solieria chordalis*, RA40-*Solieria robusta*, RA41-*Spyridia filamentosa*)

For the comparison of seaweed flora of different geographical region like tropical and temperate, Cheney (1977) suggested R+C/P ratio. A value of <3.0 indicates a temperate or cold-water flora, while values of >6.0 indicate a tropical flora; intermediate values represent a mixed (*i.e.* warm temperature) flora (Mathieson, 2009). The Cheney ratio for the present collection is 3.9,which reveal mixed type of flora for the area under consideration.Sakhalkar and Mishra (2014) have reported the same observation,*i.e*., Cheney ratio- 4.6 and mixed type of marine benthic algae flora intertidal zone of Konkan Coast (Maharashtra).

Similarity among the five studied reef areas of GoK based on seaweeds species composition through Bray-Curties similarity measure:

Considering the occurrence of the species and its composition, reef areas of Paga and Boriawere found to be the highest with 68% similarity with each other. The detailed similarity among all the five studied reef areas is given in Fig.9.

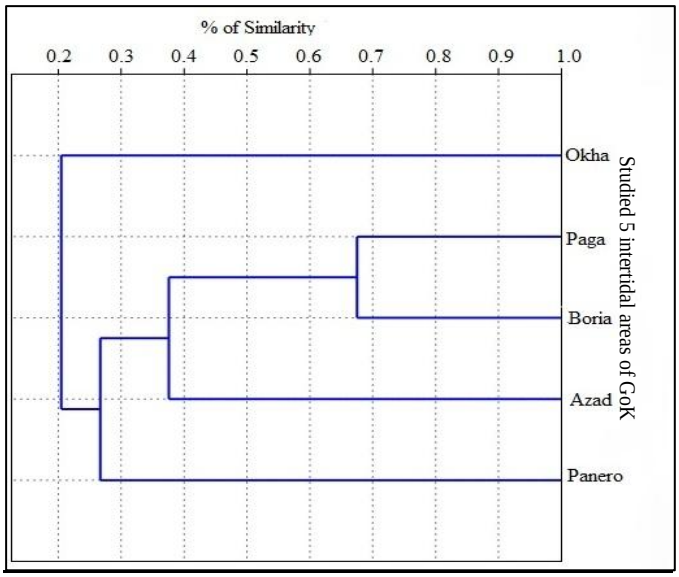

Fig. 9 Similarity among the five intertidal areas of GoK based on seaweeds species

During seaweed biomass allocation it was observed that biomass of chlorophyta was highest (0.19kg/Sq.m) followed by Rhodophyta biomass (0.17 kg/ Sq.m) and Phaeophyta biomass (0.15kg/Sq.m). Locationwise total seaweeds biomass estimation is shown in Fig.- 10. It was observed that Panero reef area have the maximum (0.16 kg/ Sq.m.) biomass of seaweeds, followed by Ajad and Okha with same biomass of seaweeds *i.e.* 0.11 kg/Sq.m. The minimum total biomass (0.06 kg/ Sq.m.) was found in Boria reef area.The highest (0.06kg/ Sq. m.) biomass of chlorophyta was recorded in Ajad reef and the lowest (0.02 kg/ Sq. m.) was found in Paga and Boria reef. On the otherhand the highest (0.06 kg/ Sq. m.) biomass of Phaeophyta was estimated in the reef areas of Panero and the lowest (0.02 kg/ Sq. m.) was found in Boria and Ajad reef. The maximum (0.043 kg/ Sq. m.) biomass of Rhodophyta was observed in Okha reef and the minimum (0.026 kg/ Sq. m.) was found in Boria reef.

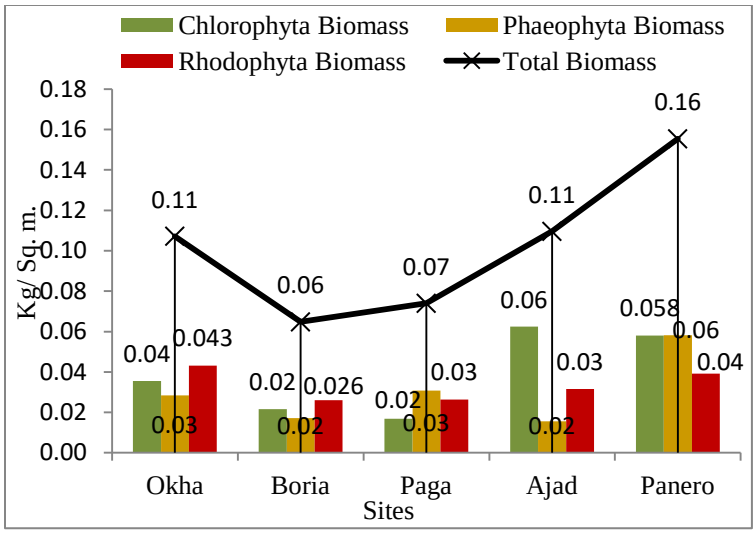

Fig. 10 Seaweeds biomass estimation at the 5 intertidal areas of South-western Gulf of Kachchh

The biomass as well as species composition of stranded seaweeds largely depend upon season, population structure and several other ecological factors (Krishnamurthy, 1967). Further, the vegetation cover, age and height of individual plants, morphology and structure of thallus also contribute to the drifting of seaweeds (Norton et al., 1982). The biomass of seaweed drifted to the coast can be correlated with the abiotic factors that prevailed before or during the collection period (McQuaid, 1985). Increased nutrients are probably the most important human impact on the macro algae of the reef at the current time. Run-off of nutrients from agriculture and grazing lands has been suggested to be causing increases in biomass and shifts in species composition of the natural macro algal flora in the inshore reef (Bell PRF and Elmetri I, 1995).

Conclusion

The GoK is very rich in seaweeds diversity. Diversity of macro marine algal community is highly valued now, as they are the primary producers and base of food chain in the ocean. The present study shows that the seaweeds have a large variety (123 species) in intertidalfive studied area. Among the five studied area Okha and Panero reef shows the maximum species diversity as well as the highest total biomass of seaweeds. On the other hand total Paga reef represented with the highest percentage cover of macro marine algae. The present study will serve as a primary input towards monitoring and sustaining the diversity of seaweeds in the five south-western intertidal areas of GoK.

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Annexure 1 Checklist of Marine Macro Algal (Seaweed) species in the five intertidal areas of GoK

No.	Species name	Family	1	2	3	4	5
Division – Chlorophyta							
1	*Acrosiphonia orientalis* J. Agardh P. Silva	Acrosiphoniaceae	-	-	+	-	+
2	*Bryopsis pennata* Lamouroux	Bryopsidaceae	-	-	-	-	+
3	*Bryopsis plumose* (Hudson) C. Agardh	Bryopsidaceae	-	-	-	-	+
4	*Caulerpa taxifolia* (Vahl) C. Agardh	Caulerpaceae	+	-	-	+	+
5	*Caulerpa microphysa* (Weber van Bosse)	Caulerpaceae	+	-	-	+	-

No.	Species name	Family	1	2	3	4	5
	J.Feldmann						
6	*Caulerpa peltata* Lamouroux	Caulerpaceae	-	+	+	-	-
7	*Caulerpa racemosa* (Forsskål) J. Agardh	Caulerpaceae	-	-	+	-	-
8	*Caulerpa racemosa* (Forsskål) J. Agardh v. *macrophysa* (Sonder ex Kützing) Taylor	Caulerpaceae	-	+	+	+	+
9	*Caulerpa racemosa* v. *occidentalis* (J. Agardh) Børgesen	Caulerpaceae	-	+	+	-	-
10	*Caulerpa scalpelliformis* (Brown ex Turner) C. Agardh v. *denticulate* Børgesen	Caulerpaceae	-	-	+	-	+
11	*Caulerpa sertularioides* (S. Gemelin) Howe	Caulerpaceae	-	-	+	-	-
12	*Caulerpa veravalensis* Thivy & Chauhan	Caulerpaceae	+	+	-	-	-
13	*Caulerpa verticilata* J. Agardh	Caulerpaceae	-	-	-	-	+
14	*Chaetomorpha crassa* (C. Agardh) Kützing	Cladophoraceae	-	-	-	-	+
15	*Chaetomorpha spiralis* Okamura	Cladophoraceae	-	-	-	-	+
16	*Cladophora vagabunda* (Linnaeus) van den Hoek	Cladophoraceae	+	-	-	-	-
17	*Cladophoropsis javanica* (Kützing) P. Silva	Boodleaceae	+	-	-	+	+
18	*Codium decorticatum* (Woodward) Howe	Codiaceae	+	-	-	-	-
19	*Codium dwarkense* Børgesen	Codiaceae	-	-	+	+	-
20	*Dictyosphaeria cavernosa* (Forsskål) Børgesen	Siphonocladaceae	+	-	-	-	-
21	*Enteromorpha compressa* (Linnaeus) Nees	Ulvaceae	-	-	-	+	-
22	*Enteromorpha flexuosa* (Wulf.) J. Agardh	Ulvaceae	+	+	+	-	+
23	*Enteromorpha intestinalis* (Linnaeus) Nees	Ulvaceae	+	+	-	-	-
24	*Enteromorpha linza* (Linnaeus) J. Agardh	Ulvaceae	+	-	-	-	-
25	*Halimeda macroloba* Decaisne	Halimedaceae	+	+	+	-	-
26	*Halimeda tuna* (Ellis & Solander) Lamouroux	Halimedaceae	-	-	+	-	-
27	*Monostroma latissimum* Wittrock	Monostromataceae	+	-	-	-	-
28	*Struvea anastomosans* (Harvey) Piccne & Grunox ex Piccone	Boodleaceae	+	-	-	-	-
29	*Udotea indica* A. & E. Gepp.	Udoteaceae	-	-	-	-	+
30	*Ulva reticulate* Forsskål	Ulvaceae	+	-	-	-	-
31	*Ulva conglobate* Kjellman	Ulvaceae	+	-	-	-	-
32	*Ulva lactuca* Linnaeus	Ulvaceae	-	+	-	+	-
33	*Ulva rigida* C. Agardh	Ulvaceae	+	-	-	-	-
34	*Valonia aegagropila* C. Agardh	Valoniac*eae*	-	-	-	-	+
35	*Valonia utricularis* (Roth) C. Agardh	Valoniaceae	-	-	-	-	+
Division - Phaeophyta							
36	*Colpomenia sinuosa* (Martens ex Roth) Derbes & Solier	Scytosiphonaceae	-	-	-	-	+
37	*Cystoseira indica* (Thivy & Doshi) Mairh	Sargassaceae	+	+	-	-	-
38	*Cystoseira trinodis* (Forsskål) C. Agardh	Sargassaceae	-	+	+	-	-
39	*Dictyopteris australis* (Sonder) Askenasy	Dictyotaceae	-	+	+	-	+
40	*Dictyopteris delicatula* Lamouroux	Dictyotaceae	+	-	-	-	-
41	*Dictyota cervicornis* Kützing	Dictyotaceae	+	-	-	+	-
42	*Dictyota ciliolate* Kützing	Dictyotaceae	+	-	-	-	-
43	*Dictyota dichotoma* (Hudson) Lamouroux	Dictyotaceae	-	+	+	-	+
44	*Dictyota pinnatifida* Kützing	Dictyotaceae	-	-	-	+	-
45	*Hincksia mitchelliae* (Harvey) Silva	Acinetosporaceae	-	+	+	+	-
46	*Iyengaria stellate* (Børgesen) Børgesen	Scytosiphonaceae	-	-	-	+	-
47	*Levringia boergesenii* Kylin	Chordariaceae	-	-	-	-	+
48	*Lobophora variegate* (Lamouroux) Womersley ex Oliveria	Dictyotaceae	-	-	-	-	+
49	*Padina boergesenii* Allender & Kraft	Dictyotaceae	-	+	+	+	+
50	*Padina boryana* Thivy	Dictyotaceae	+	-	-	+	+
51	*Padina tetrastromatica* Hauck	Dictyotaceae	+	+	+	+	-

No.	Species name	Family	1	2	3	4	5
52	*Rosenvingea intricate* (J. Agardh)Børgesen	Scytosiphonaceae	+	+	-	-	-
53	*Sargassum cinctum* J. Agardh	Sargassaceae	+	+	+	+	-
54	*Sargassum cinerium* J. Agardh	Sargassaceae	-	-	-	-	+
55	*Sargassum johnstonii* Setchell & Gardner	Sargassaceae	-	+	+	-	-
56	*Sargassum prismaticum* Chauhan	Sargassaceae	+	-	-	+	-
57	*Sargassum tenerrimum* J. Agardh	Sargassaceae	+	-	-	-	-
58	*Sargassum vulgare* C. Agardh	Sargassaceae	+	+	+	-	-
59	*Spatoglossum asperum* J. Agardh	Dictyotaceae	+	-	-	+	-
60	*Stoechospermum marginatum* (C. Agardh) Kützing	Dictyotaceae	+	-	-	-	+
Division - Rhodophyta							
61	*Acanthophora dendroides* Harvey	Rhodomelaceae	+	+	+	+	-
62	*Acanthophora nayadiformis* (Delile) Papenfuss	Rhodomelaceae	-	-	+	-	-
63	*Acanthophora specifera* (Vahl) Børgesen	Rhodomelaceae	-	-	+	-	+
64	*Ahnfeltia plicata* (Hudson) Fries	Ahnfeltiaceae	+	-	-	-	-
65	*Amphiroa fragilissima* (Linnaeus) Lamouroux	Corallinaceae	+	+	-	-	-
66	*Asparagopsis taxiformis* (Delile) Trevisan	Bonnemaisoniacece	-	-	+	-	-
67	*Botryocladia leptopoda* (J. Agardh) Kylin	Rhodymeniaceae	+	-	+	-	-
68	*Botryocladia pseudodichotoma* (Farlow) Kylin.	Rhodymeniaceae	-	+	-	-	-
69	*Centroceras clavulatum* (C. Agardh) Montagne	Ceramiaceae	-	-	+	+	-
70	*Ceramium cruciatum* Collins & Harvey	Ceramiaceae	+	+	+	+	-
71	*Champia compressa* Harvey	Champiaceae	-	+	+	-	-
72	*Champia indica* Bøgesen	Champiaceae	-	+	-	+	-
73	*Cheilosporum spectabile* Harvey ex Grunow	Corallinaceae	-	-	-	-	+
74	*Chondracanthus acicularis* (Roth) Frederiq	Gigartinaceae	-	-	-	+	-
75	*Chondria armata (Kützing) Okamura*	Rhodomelaceae	-	+	+	-	-
76	*Coelarthrum muelleri* (Sonder) Børgesen	Rhodymeniaceae	+	+	-	-	-
77	*Corallina berteroi* Montagen ex Kützing	Corallinaceae	-	-	-	-	+
78	*Cryptonemia undulate* Sonder	Halymeniaceae	-	-	-	-	+
79	*Dasya punicea* Meneghini ex Zanardini	Dasyaceae	-	-	-	-	+
80	*Digenea simplex* (Wulfen) C. Agardh	Rhodomelaceae	+	-	-	-	-
81	*Gastroclonium iyengarii* K. Srinivasan	Champiaceae	-	-	-	-	+
82	*Gelidiella acerosa* (Forsskål) J. Feldmann	Gelidiellaceae	+	-	-	-	-
83	*Gelidium micropterum* Kützing	Gelidiaceae	-	-	-	-	+
84	*Gracilaria corticata* (J. Agardh) J. Agardh	Gracilariaceae	+	+	-	-	-
85	*Gracilaria corticata* (J. Agardh) J. Agardh var. *cylindrical* Umamaheswara Rao	Gracilariaceae	+	-	-	-	-
86	*Gracilaria dura* (C. Agardh) C. Agardh	Gracilariaceae	+	-	-	-	-
87	*Gracilaria foliifera* (Forsskål) Børgesen	Gracilariaceae	-	-	-	-	+
88	*Gracilaria salicornia* (C. Agardh) Dawson	Gracilariaceae	-	-	-	+	-
89	*Gracilaria textorii* (Suringar) De Toni	Gracilariaceae	+	-	-	-	-
90	*Gracilaria verrucosa* (Hudson) Papenfuss	Gracilariaceae	+	-	-	-	-
91	*Grateloupia indica* Børgesen	Halymeniaceae	-	-	-	-	+
92	*Griffithsia corallinoides* (Linnaeus) Trevisan	Wrangeliaceae	-	-	-	-	+
93	*Haloplegma duperreyi* Montagne	Wrangeliaceae	-	-	-	-	+
94	*Heterosiphonia crispella* (C. Agardh) Wynne	Dasyaceae	-	-	+	-	-
95	*Heterosiphonia muelleri* (Sonder) De Toni	Dasyaceae	-	-	-	-	+
96	*Hypnea esperi* Bory de Saint-Vincent	Cystocloniaceae	+	-	-	-	-
97	*Hypnea musciformis* (Wulfen) Lamouroux	Cystocloniaceae	+	-	-	-	+
98	*Hypnea pannosa* J. Agardh	Cystocloniaceae	-	+	-	-	-
99	*Hypnea valentiae* (Turner) Montagne	Cystocloniaceae	-	+	+	-	+

No.	Species name	Family	1	2	3	4	5
100	*Hypoglossum heterocystideum* (J. Agardh) J. Agardh	Delesseriaceae	-	-	-	-	+
101	*Jania rubens* (Linnaeus) Lamouroux	Corallinaceae	+	-	-	-	-
102	*Kappaphycus alvarezii* Doty) Doty ex P. Silva	Solieriaceae	+	-	-	-	-
103	*Laurencia glandulifera* (Kützing) Kützing	Rhodomelaceae	+	-	-	-	-
104	*Laurencia majuscula* (Harvey) Lucas	Rhodomelaceae	-	-	-	-	+
105	*Laurencia obtuse* (Hudson) Lamouroux	Rhodomelaceae	-	+	+	-	+
106	*Laurencia papillosa* (C. Agardh) Greville	Rhodomelaceae	+	-	-	-	-
107	*Laurencia platyclada* Børgesen	Rhodomelaceae	-	+	+	-	-
108	*Leveillea jungermannioides* (Haring & G. Martens) Harvey	Rhodomelaceae	-	-	-	-	+
109	*Lophocladia lallemandi* (Montagne) Schmitz	Rhodomelaceae	+	+	-	-	-
110	*Peyssonnelia obscura* Weber na Boss	Peyssonneliaceae	-	-	-	+	-
111	*Platysiphonia delicate* (Clemente) Cremades	Sarcomeniaceae	-	+	+	+	+
112	*Polysiphonia denudate* (Dillwyn) Greville	Rhodomelaceae	-	+	+	+	+
113	*Rhodymenia dissecta* Børgesen	Rhodymeniaceae	-	-	-	-	+
114	*Rhodymenia sonderi* P. Silva	Rhodymeniaceae	-	-	-	-	+
115	*Scinaia carnosa* (Kützing) J. Agardh	Scinaiaceae	-	+	+	-	+
116	*Scinaia complanata* (Collins) Cotton	Scinaiaceae	-	+	+	-	-
117	*Scinaia monoliformis* J. Agardh	Scinaiaceae	-	-	-	-	+
118	*Sebdenia flabellate* (J. Agardh) Parkinson	Sebdeniaceae	-	-	-	-	+
119	*Solieria chordalis* (C. Agardh) J. Agardh	Solieriaceae	-	+	+	+	-
120	*Solieria robusta* (Greville) Kalin	Solieriaceae	-	+	-	+	-
121	*Spyridia alternans* Børgesen	Spyridiaceae	-	-	-	-	+
122	*Spyridia filamentosa* (Wulfen) Harvey	Spyridiaceae	+	-	-	-	-
123	*Tricleocarpa fragilis* (Linnaeus) Huisman & Townsend	Galaxauraceae	-	-	-	-	+
Total			**50**	**39**	**38**	**28**	**50**
1=Panero,2=Paga,3=Boria, 4=Ajad, 5=Okha, + = Present, - = absent							

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