Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2019; 7(3): 327-331

Received: 16-03-2019
Accepted: 20-04-2019

**TH Dave**
Department of Fisheries Resource Management, College of Fisheries Science, Junagadh Agricultural University, Veraval, Gujarat, India

**DT Vaghela**
Department of Aquatic Environment Management, College of Fisheries Science, Junagadh Agricultural University, Veraval, Gujarat, India

**BG Chudasama**
Department of Harvest and Post-Harvest, College of Fisheries Science, Junagadh Agricultural University, Veraval, Gujarat, India

**Correspondence**
**TH Dave**
Department of Fisheries Resource Management, College of Fisheries Science, Junagadh Agricultural University, Veraval, Gujarat, India

# Status, distribution and diversity of some macroalgae along the intertidal coast of Okha, Gulf of Kachchh, Gujarat in India

**TH Dave, DT Vaghela and BG Chudasama**

**Abstract**
The Coast of Okha (22°28'N and 69°05'E) situated at the mouth of "Gulf of Kachchh" on the north western most part of Saurashtra in Gujarat. The coast harbours a great variety of seaweeds, gastropods and corals at exposed intertidal zone. The present study highlights seaweed occurrence, distribution and diversity along the coast. The experiment carried out from November-2016 to October – 2017. The coast was divided into three zones vertically to observe differences of seaweed abundances and diversity along the coast i.e. Zone 01 (0-250mt vertical stretch from HHTL to lower intertidal zone), Zone 02 (250-500mt distance from shore) and Zone 03 (500-750mt). In the present study, a random quadrate sampling method with vertical transact method was opted. The different species of seaweeds found within 1.0 m2 quadrate were collected along with their holdfast or rhizoid. Of the total recorded 39 species of seaweeds, chlorophytes showed maximum species i.e. 16, followed by Rhodophytes (13 species) and Phaeophytes (10 species). The All the zones were covered by seaweeds in different proportions and densities. The chlorophytes preferred upper stretch of the coast followed by Phaeophytes and Rhodophytes at mid-intertidal and Low-intertidal zones. The *Caulerpa sertularioides*, *Caulerpa racemosa*, *Ulva lactuca*, *Ulva clathrata* and *Ulva fasciata* showed maximum abundance followed by *Spatoglossum asperum*, *Sirophysalis trinodis*, *Cystoseira indica*, *Sargassum marginatum* var. *diotis*, *Sargassum tenerrimum*, *Sargassum swartzii*.

**Keywords:** gulf of kachchh, seaweeds, abundance, diversity

## Introduction
There are many different fundamentals of diversity. The major four theoretical components viz. compositional diversity, structural diversity, the degree to which the entities differ and functional diversity forms the whole diversity on earth (Sala and Knowlton, 2006) [1]. In ecological studies, it is often the transformation of the entire community that matters, not simply the variation in one or a few species. The change in environmental factors associated with tides makes the intertidal zone most vulnerable and extreme of any marine environment. One of the important component of marine biodiversity is intertidal zone which resided by many flora and fauna. The intertidal seaweed flora offers food, oxygen, shelter, hiding places and attachment platforms to the many intertidal organisms which is one of the vital phenomenon for the coastal biodiversity. There are about 8,000 species of marine macroalgae along the world's coastline and they may extend as deep as 270m (Luning, 1990) [2]. Intertidal areas are the most accessible of marine habitats and because of this ready access offer a significant opportunity to observe and document the effects of climate change over the intertidal biodiveresity. There are many scientists surveyed intertidal biodiversity of Okha (Kohn, 1969; Misra, 1960; Chauhan and Mairh, 1978; Thakur *et al*., 2008; Bhanderi and Trivedy, 1975 and Murthy *et al.*, 1978) [3-8] indicated presence of rich seaweed diversity and abundances. The rocky Okha coast of Gulf of Kachchh having many advantageous coastal features including semi-diurnal tides, clear water, gradual slope towards the sea, numerous tidepools and puddles supports rich biodiversity of the intertidal populations.

## Materials and Methods
The seaweeds were collected monthly at intertidal zone as and when maximum exposure available. The random 45 quadrates of 1.0 $m^2$ were applied at each zone. The number of seaweeds frond calculated to observe population densities at each zone. The samples were collected at a minimum tidal height to get maximum exposure of the coast. The seaweeds were

primarily identified with quick reference keys and photographic plates (Krishnamurthy and Joshi; Joshi and Dodiya, 2012) [9, 10], and transferred to laboratory in 5.0% formaldehyde solution in zip locked plastic bags. Then seaweeds were identified with standard taxonomic keys from standard reference manuals and website portals (Dhargalkar and kavlekar, 2004, Biodiversity Portal of India, WoRMS) [11-13]. The sampling collection method and vertical zonation distribution was illustrated in the figure 1.

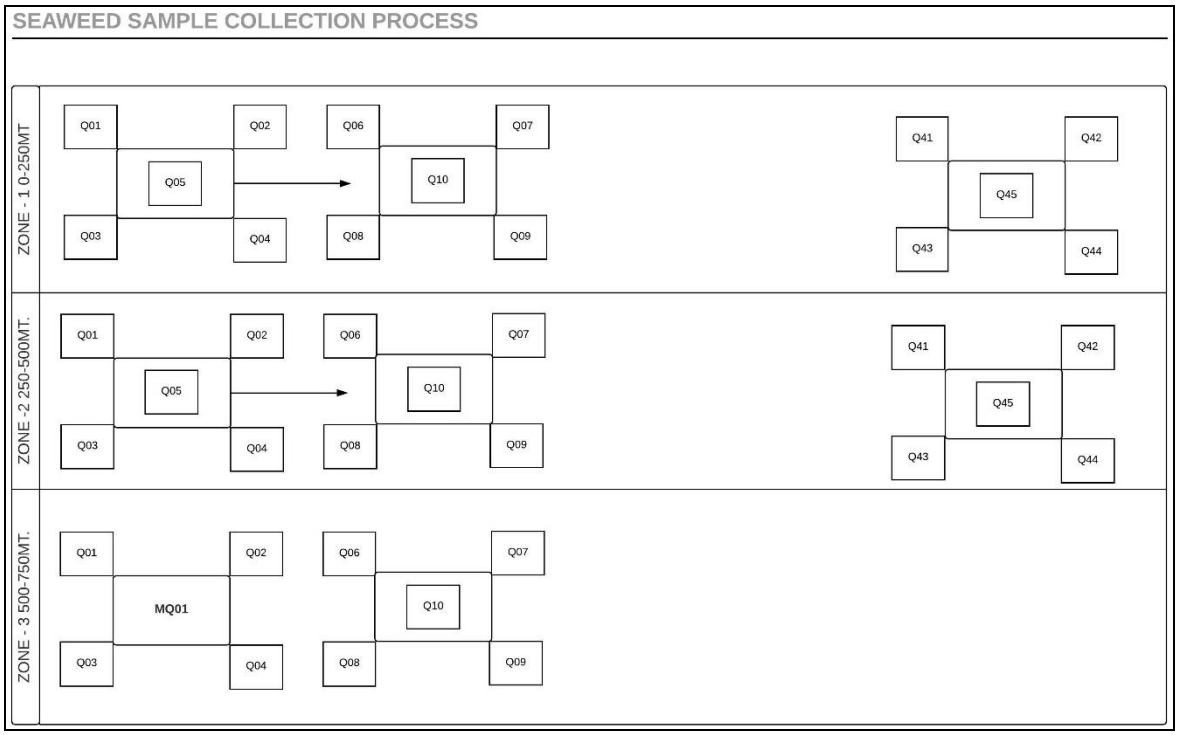


**Fig 1:** Sample collection protocol

## Results and Discussion

Among the total 39 seaweeds recorded, 16 species from Chlorophytes, 10 species of Phaeophytes and 13 Species from Rhodophytes observed (Table 1.). The maximum species were recorded from the Ulvaceae (6 Species) family, followed by Caulerpaceae (4 Species), Sargassaceae (4 Species) and Dictyotaceae (4 species).

**Table 1:** Recorded seaweed species classification

| Species | Order | Family |
|---|---|---|
| **Class: Chlorophyceae** | | |
| *Caulerpa racemosa* | Bryopsidales | Caulerpaceae |
| *Caulerpa sertularioides* | Bryopsidales | Caulerpaceae |
| *Caulerpa veravalensis* | Bryopsidales | Caulerpaceae |
| *Caulerpa taxifolia* | Bryopsidales | Caulerpaceae |
| *Codium elongatum* | Bryopsidales | Codiaceae |
| *Halimeda macroloba* | Bryopsidales | Halimedaceae |
| *Halimeda tuna* | Bryopsidales | Halimedaceae |
| *Cladophora vagabunda* | Cladoohorales | Cladophoraceae |
| *Boodlea composita* | Cladophorales | Siphonocladaceae |
| *Phyllodictyon pulcherrimum* | Siphonocladales | Boodleaceae |
| *Ulva intestinalis* | Ulvales | Ulvaceae |
| *Ulva lactuca* | Ulvales | Ulvaceae |
| *Ulva reticulata* | Ulvales | Ulvaceae |
| *Ulva rigida* | Ulvales | Ulvaceae |
| *Ulva clathrata* | Ulvales | Ulvaceae |
| *Ulva fasciata* | Ulvales | Ulvaceae |
| **Class: Phaeophyceae** | | |
| *Iyengaria stellata* | Chordariales | Scytosiphonaceae |
| *Dictyota ciliolata* | Dictyotales | Dictyotaceae |
| *Padina boergesenii* | Dictyotales | Dictyotaceae |
| *Padina tetrastromatica* | Dictyotales | Dictyotaceae |
| *Spatoglossum asperum* | Dictyotales | Dictyotaceae |
| *Cystoseira indica* | Fucales | Cystoceiraceae |
| *Sirophysalis trinodis* | Fucales | Sargassaceae |
| *Sargassum marginatum* | Fucales | Sargassaceae |
| *Sargassum tenerrimum* | Fucales | Sargassaceae |

| | | |
|---|---|---|
| *Sargassum swartzii* | Fucales | Sargassaceae |
| **Class: Rhodophyceae** | | |
| *Porphyra vietnamensis* | Bangiales | Bangiaceae |
| *Centroceras clavulatum* | Ceramiales | Ceramiaceae |
| *Ceramium tenerrimum* | Ceramiales | Ceramiaceae |
| *Polysiphonia denudata* | Ceramiales | Rhodymeniaceae |
| *Spyridia alternans* | Ceramiales | Ceramiaceae |
| *Amphiroa anceps* | Corallinales | Corallinaceae |
| *Halymenia venusta* | Cryptonemiales | Halymeniaceae |
| *Halymenia porphyriformis* | Cryptonemiales | Halymeniaceae |
| *Hypnea musciformis* | Gigartinales | Hypneaceae |
| *Gracilaria corticata* | Gracilariales | Gracilariaceae |
| *Dermonema virens* | Nemaliales | Liagoraceae |
| *Scinaia carnosa* | Nemaliales | Scianiaceae |
| *Botryocladia leptopoda* | Rhodymeniales | Rhodymeniaceae |

The Chlorophytes showed maximum population density at the upper stretches of the coast. *Caulerpa sertularioides* showed maximum population density 16.72 ± 12.60 at the zone 01 followed by 13.17 ± 9.24 and 2.70 ± 5.21 at Zone 02 and Zone 03 respectively. The zone 01 also occupied abundantly by *Caulerpa racemosa*, *Ulva lactuca*, *Ulva clathrata* and *Ulva fasciata* with mean values 16.04 ± 13.64, 10.95 ± 11.59, 6.79 ± 7.39 and 6.17 ± 5.63 respectively (Table 2). The Zone 02 showed higher diversities of both Phaeophytes and Rhodophytes than Chlorophytes. The *Spatoglossum asperum* showed highest population density of 10.58 ± 7.45 followed by *Sirophysalis trinodis*, 9.87 ± 8.12; *Cystoseira indica*, 9.63 ±6.23; *Sargassum marginatum* var. *diotis*, 9.46 ± 7.61; *Sargassum tenerrimum*, 9.12 ± 7.41 and *Sargassum swartzii*, 9.06 ± 7.27.

The rhodophytes exhibited very good diversity all along the coast, especially at Zone 02 and Zone 03, lower intertidal zone. The quantitative aspects of Rhodophytes showed higher population densities of *Gracilaria corticata*, *Polysiphonia denudata* and *Amphiroa anceps* followed by *Halymenia porphyriformis*, *Spyridia alternans* and *Porphyra vietnamensis*. Total 13 species of red seaweeds recorded at the study area, of which most of them showed presence at Zone 01 and Zone 02. The population densities were highest at the Zone 03 and Zone 02 while Zone 01 showed the scanty distribution of Rhodophytes.

**Table 2:** Seaweed species population densities (No./$M^2$)

| Seaweed Species | Zone 01 | | Zone 02 | | Zone 03 | |
|---|---|---|---|---|---|---|
| | **Mean** | **SD** | **Mean** | **SD** | **Mean** | **SD** |
| *Caulerpa racemosa* | 16.0 | 13.6 | 11.9 | 10.31 | 2.09 | 4.29 |
| *Caulerpa sertularioides* | 16.7 | 12.6 | 13.1 | 9.24 | 2.70 | 5.21 |
| *Caulerpa veravalensis* | 5.34 | 4.09 | 4.71 | 3.86 | 1.49 | 2.67 |
| *Caulerpa taxifolia* | 5.12 | 4.22 | 5.53 | 3.93 | 1.86 | 3.24 |
| *Codium elongatum* | 3.97 | 4.10 | 3.99 | 4.03 | 1.13 | 2.51 |
| *Halimeda macroloba* | 4.17 | 4.50 | 3.18 | 3.54 | 1.66 | 3.13 |
| *Halimeda tuna* | 4.01 | 4.16 | 3.27 | 3.75 | 1.11 | 2.11 |
| *Cladophora vagabunda* | 4.57 | 4.42 | 4.24 | 4.37 | 1.36 | 2.60 |
| *Boodlea composita* | 4.73 | 4.25 | 3.85 | 3.46 | 1.41 | 2.97 |
| *Phyllodictyon pulcherrimum* | 4.15 | 3.56 | 3.66 | 3.36 | 0.83 | 2.10 |
| *Ulva intestinalis* | 5.03 | 4.70 | 3.98 | 3.80 | 0.77 | 2.08 |
| *Ulva lactuca* | 10.9 | 11.5 | 7.18 | 6.41 | 1.67 | 4.06 |
| *Ulva reticulata* | 4.53 | 4.18 | 3.97 | 3.95 | 0.93 | 2.24 |
| *Ulva rigida* | 4.30 | 3.42 | 4.18 | 3.55 | 1.72 | 3.31 |
| *Ulva clathrata* | 6.79 | 7.39 | 5.00 | 4.46 | 1.46 | 2.94 |
| *Ulva fasciata* | 6.17 | 5.63 | 6.57 | 5.03 | 1.87 | 3.47 |
| *Iyengaria stellata* | 1.62 | 3.52 | 6.50 | 5.48 | 3.10 | 4.31 |
| *Dictyota ciliolata* | 1.60 | 3.48 | 6.58 | 4.18 | 2.76 | 3.39 |
| *Padina boergesenii* | 1.28 | 3.29 | 6.41 | 5.09 | 4.44 | 5.25 |
| *Padina tetrastromatica* | 2.12 | 4.99 | 9.61 | 7.95 | 4.20 | 5.76 |
| *Spatoglossum asperum* | 2.04 | 5.12 | 10.5 | 7.45 | 4.92 | 4.88 |
| *Cystoseira indica* | 1.76 | 4.02 | 9.63 | 6.23 | 3.52 | 5.09 |
| *Sirophysalis trinodis* | 3.02 | 5.88 | 9.87 | 8.12 | 4.26 | 5.30 |
| *Sargassum marginatum* | 1.96 | 5.00 | 9.46 | 7.61 | 2.88 | 3.72 |
| *Sargassum tenerrimum* | 1.25 | 3.69 | 9.12 | 7.41 | 4.71 | 5.41 |
| *Sargassum swartzii* | 1.81 | 4.44 | 9.06 | 7.27 | 4.20 | 5.00 |
| *Porphyra vietnamensis* | 0.21 | 1.31 | 5.02 | 4.60 | 7.52 | 5.03 |
| *Centroceras clavulatum* | 1.38 | 3.60 | 6.07 | 6.18 | 5.96 | 6.14 |
| *Ceramium tenerrimum* | 0.05 | 0.58 | 5.14 | 6.06 | 6.63 | 6.22 |
| *Polysiphonia denudata* | 0.09 | 1.00 | 3.49 | 5.37 | 11.8 | 10.1 |
| *Spyridia alternans* | 0.47 | 2.13 | 5.27 | 6.52 | 8.50 | 7.91 |
| *Amphiroa anceps* | 1.05 | 2.82 | 3.14 | 5.24 | 10.5 | 8.03 |
| *Halymenia venusta* | 0.61 | 2.32 | 6.99 | 5.18 | 8.20 | 6.01 |

| | | | | | | |
|---|---|---|---|---|---|---|
| *Halymenia porphyriformis* | 0.54 | 2.14 | 6.26 | 6.23 | 8.58 | 6.89 |
| *Hypnea musciformis* | 0.05 | 0.57 | 2.93 | 4.01 | 6.16 | 4.42 |
| *Gracilaria corticata* | 0.26 | 1.98 | 7.76 | 8.11 | 11.91 | 8.88 |
| *Dermonema virens* | 0.51 | 1.87 | 5.25 | 4.39 | 6.38 | 4.59 |
| *Scinaia carnosa* | 0.05 | 2.90 | 2.22 | 3.21 | 4.45 | 2.71 |
| *Botryocladia leptopoda* | 0.23 | 3.70 | 4.2 | 5.21 | 5.96 | 4.97 |

The Zonal abundance distribution (% of total species individuals fronds) also supported a wide range of fluctuations in densities of seaweeds at different zones (Figure 2). The chlorophytes exhibited maximum percentages of total individual fronds recorded in entire study at Zone while at the same time Phaeophytes showed maximum presence at Zone 02. The lower-intertidal zone-3 was found with maximum abundances of red seaweeds.

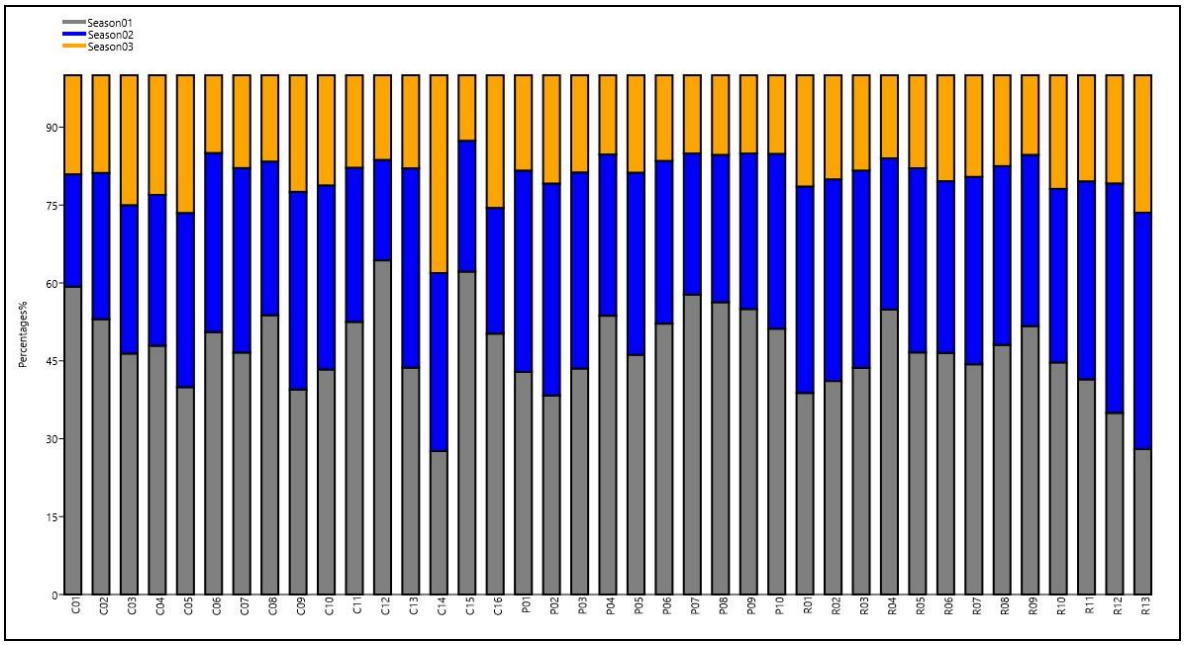


**Fig 2:** Seasonal seaweed abundance distribution (% of total species individuals)

The Bray-Curtis similarity and Distance matrix seaweed cluster analysis at different zones was conducted and dendrogram prepared for graphical presentation (Figure 3).


**Fig 3:** Dendrogram showing bray-curtis similarity-distance matrix

The seaweed cluster analysis in relation to different zonation showed the similarity of 60.40% (Table 3) of Zone 01 to the Zone 02, while Zone 03 had exhibited only 32.43% similarity to Zone 01. The Zone 02 and Zone 03 showed 62.61% similarity. This zonation pattern gives a prompt indication towards preferences for the water inundated areas to avoid long period of desiccation for the Phaeophyceae and Rhodophytes.

**Table 3:** Zone similarity – Distance matrix

| Step | Clusters | Distance | Similarity | Joined 1 |
|---|---|---|---|---|
| 1 | 2 | 37.38786 | 62.61214 | 2 |
| 2 | 1 | 39.60712 | 60.39288 | 1 |
| Similarity Matrix | | | | |
| | Zone 01 | Zone 02 | Zone 03 | |
| Zone 01 | * | 60.3929 | 32.4273 | |
| Zone 02 | * | * | 62.6121 | |
| Zone 03 | * | * | * | |

## Conclusion

The Okha coast harbours a rich biodiversity of seaweeds. The rocky shore with many tidepools, Puddles and Gradual slope towards the sea supports a preferred habitat for the seaweeds. The intertidal zone with different exposure to desiccation and direct sunlight leads to zonation patterns among the seaweed species. The upper horizontal stretches of the coast were found mostly occupied by chlorophytes, while the mid-intertidal and low-intertidal zones preferred by phaeophytes and rhodophytes.

## References

1. Sala E, Knowlton N. Global Marine Biodiversity Trends. Annual Review of Environment and Resources. 2006; 31(1):93-122. https://doi.org/10.1146/annurev.energy.31.020105.100235.

2. Luning K. Seaweeds. Their environment, biogeography, and ecophysiology. Wiley, New York. 1990, 527.
3. Kohn AJ. A Visit to Okha. Bios. 1969; 1:3-9.
4. Misra JN. The ecology, distribution and seaweed succession of the littoral algae on the west coast of India; *In*: Proceeding Symposium on Algology (ed.) P Kachiroo, ICAR, New Delhi. 1960, 187-203.
5. Chauhan VD, Mairh OP. Report on survey of economic seaweeds resources of Saurashtra coast. India Salt Research and Industry. 1978; 14(2):21-41.
6. Thakur C, Reddy C, 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; 117:211-218.
7. Bhanderi PP, Trivedy YA. Seaweed resources of Hanumandandi reef and Vumina reef near Okha port, Gujarat. Indian Journal of Marine Sciences. 1975; 4:97-99.
8. Murthy MS, Bhattacharya M, Radia P. Ecological studies on the intertidal algae at Okha (India). Botanica Marina. 1978; 21:381-386.
9. Krishnamurthy V, Joshi HV. Central Salt and Marine Chemicals Research Institute. A check-list of Indian marine algae. Bhavnagar, India, 1970, 36.
10. Dodia SK, Joshi HV. Study if seaweed diversity along the islands of Gulf of Kachchh, Gujarat Ecology Commission. 2012, 99.
11. Dhargalkar VK, Kavlekar D. Seaweeds: A field manual. National Institute of Oceanography, Dona Paula, Goa, 2004, 42.
12. Vattakaven T, George R, Balasubramanian D, Réjou-Méchain M, Muthusankar G, Ramesh B *et al*. India Biodiversity Portal: An integrated, interactive and participatory biodiversity informatics platform. Biodiversity Data Journal 2016; 4: e10279. https://doi.org/10.3897/BDJ.4.e10279.
13. WoRMS Editorial Board. World Register of Marine Species. Available from http://www.marinespecies.org at VLIZ. Accessed 2019-01-23. doi:10.14284/170.