IRANIAN JOURNAL OF BOTANY 28 (2), 2022
DOI: 10.22092/ijb.2022.128208

A SURVEY OF SEAWEEDS IN INTERTIDAL AREAS ALONG THE VERAVAL COAST OF INDIA

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Received 2022.07.04; accepted for publication 2022.12.16

Dangar, K., Vyas, S., Karangiya, R. & Gadhvi, K. 2022.12.30: A survey of seaweeds in intertidal areas along the Veraval Coast, of India. *Iran. J. Bot. 28(2):200-208.* Tehran.

The western coast of Gujarat, India, specifically the Veraval coastal area, was the site of the present study, which is situated at 20˚54 N latitude and 70˚21 E longitude. It has a flat, rocky inter-tidal belt with numerous tidal pools and crevasses. Seaweeds were noticed intermittently; some species were only seen for brief periods, whereas others were obtainable for two to three months. From October 2020 to February 2022, seaweed was harvested from the inter-tidal zones during the experiments. Seaweeds were found during the study period, but they weren't always there. Some species were only observed for a brief time, and other species only appeared during a particular season. The species that were collected were taxonomically identified and categorized. A checklist of the species available was prepared along with their potential utilization. A total of 83 species were identified throughout the investigation, with Rhodophyta having more species than Chlorophyta and Phaeophyta collectively. During the diversity survey, economically important species like *Ulva lactuca*, *Ulva fasciata*, *Sargassum* sp., and *Caulerpa sp*., were reported. Among them, *Ulva lactuca*, *Sargassum* sp. was highly dominated followed by *Gracilaria* spp.

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Keywords: Species diversity; potential utilization; seaweeds; checklist; Veraval

بررسی جلبک‌ها در مناطق بین جزر و مدی در امتداد ساحل وراوال، هند

کیران دانگار: دانشجوی دکتری، گروه علوم زیستی دانشگاه باکتا کاوی نارسین متا

سوهاس ویاس: استاد گروه علوم زیستی دانشگاه باکتا کاوی نارسین متا

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کاملش گادهوی: دانشجوی دکتری گروه علوم زیستی دانشگاه باکتا کاوی نارسین متا

سواحل غربی گجرات، هند، به ویژه منطقه ساحلی Veraval، محل مطالعه حاضر بود که در عرض جغرافیایی ۲۰ درجه شمالی و طول جغرافیایی ۷۰ درجه شمالی واقع شده است. این منطقه دارای یک کمربند بین جزر و مدی صاف و صخره‌ای با حوضچه‌های جزر و مدی و شکاف‌های متعدد است. جلبک‌ها در دوره‌های نامنظم ظاهر می‌شدند. برخی از گونه‌ها فقط برای دوره‌های کوتاهی دیده شدند، در حالی که برخی دیگر برای دو تا سه ماه قابل دستیابی بودند. از اکتبر ۲۰۲۰ تا فوریه ۲۰۲۲، جلبک‌ها در طول دوره آزمایش‌ها از مناطق بین جزر و مدی برداشت شدند. در طول دوره مطالعه برخی از گونه‌ها فقط برای مدت کوتاهی مشاهده شدند و گونه‌های دیگر فقط در طول یک فصل خاص ظاهر شدند. گونه‌های جمع‌آوری شده شناسایی و دسته‌بندی شدند و چک لیستی از گونه‌ها به همراه استفاده بالقوه آنها تهیه شد. در مجموع ۸۳ گونه در طی بررسی شناسایی شدند و در مجموع جلبک‌های قرمز (Rhodophyta) گونه‌های بیشتری از جلبک‌های سبز (Chlorophyta) و قهوه‌ای (Phaeophyta) داشتند. در طی بررسی،

گونه‌های مهم اقتصادی مانند Ulva lactuca، Ulva fasciata، Sargassum spp. و Caulerpa spp. گزارش گردیدند که در میان آنها، Ulva lactuca، Sargassum spp. و بعد از آن‌ها Gracilaria بسیار فراوان‌تر بودند.

INTRODUCTION

Seaweeds are plant-like organisms that can be free-floating or firmly attached to rocks. They are considered a substantial renewable resource for numerous bioactive natural compounds. They are primordial plants from the plant kingdom's Thallophyta division, which lack genuine roots, stems, or leaves. They are typically divided into three taxonomic groupings Chlorophyceae (green algae), Phaeophyceae (brown algae), and Rhodophyceae based on their pigment profiles, morphological, anatomical, and reproductive characteristics (red algae). It has been gradually recognized that some of the seaweed's constituents are more excellent and valuable than their equivalents on land as a result of the lengthy history of utilizing seaweed for a wide range of purposes.

India is one of the notorious "mega biodiversity countries" along with China, Mexico, and Brazil. The biodiversity of coastal flora and fauna in India expects to acquire special attention. The country stands to benefit from a long coastline with a diverse coastal seaweed flora that has tremendous potential for utilization in food, feed, chemicals, pharmaceuticals, fertilizers, etc. Due to eutrophication, coastal development, aquaculture, and climatic change, coastal habitats are subjected to a plethora of stresses. While several species may disappear, a few that responded to these challenges will be capable of expanding their distribution. Therefore, researching coastal diversity is essential for comprehending global change and is of major significance on a worldwide scale (Jha 2009).

Biodiversity reflects in variety, which is the spice of life, and genetic diversity is a vital part of development in all spheres. In a nutshell, biodiversity is an umbrella term used to describe the quantity, variety, and variability of living things in an assemblage. Gujarat, on the southwest coast of India, is located between 20° and 24° N and 68° and 74° E, creating a unique marine habitat that is inhabited by a wide range of macro algae species. Gujarat has the longest coastline, at 1,600 Kilometres (Pathak 2020).

Veraval, which is known for its luxuriant growth of a diverse group of seaweeds on the Saurashtra coast, is discovered to have large amounts of seaweeds. The intertidal zone of Veraval is placed at a latitude of 20.9° N and a longitude of 70.37° E. The 3.5 km long Veraval coastline in Gujarat has a rocky substrate, a surface covered with mud, and a wide assortment of zoanthids species. (Dangar 2021). According to Barot & al. (2015), about 6000 species of seaweeds have been identified and are grouped as Chlorophyta (green), Phaeophyta (brown), and Rhodophyta (red). Although numerous studies have been conducted to assess the species diversity of seaweeds in India, the Veraval coast is tide-dominated and the tides are semi-diurnal. The average tide amplitude is 2.28 m. The period lasts for approximately 5 hours, while the flood phase lasts for approximately 6-7 hours. A unique environment for the luxuriant growth of diverse seaweed species is created by the region's 3884 mm of annual precipitation on average and 12-36°C temperature range (Pawar 2017).

Seaweeds are threatened in developing nations as they are affected by several human activities. The imperative for studies on the taxonomy and species diversity for improved management of marine algae is driven by growing concern over the destruction of seaweed resources and changes in the diversity of various living forms. The distribution of marine algae has been the subject of extensive investigations in a number of Indian coastal regions.

MATERIALS AND METHOD

The present study was conducted on the Veraval coast, south-central Gujarat state, west-central India (fig. 1), which is one of the important places of interest for algal growth in the country currently, during the year as compared to other parts of the country. The coast is characterized by rocks made up of tertiary formations alternating with patches of sand deposits making the area more hospitable for the growth of all types of seaweed throughout the year (Borgesen 1934).

Sample collection

A random sampling technique has been applied in the algal collection procedure. Collections of macroalgal specimens were carried out at four different sites on the Veraval coast. All the specimens were collected from the intertidal region during winter (November, December, January, and February) in the years 2020 & 2021. The collection was made during dawn and morning hours from their natural habitats. The collection of the samples was done using long forceps and scalpels. The fresh specimens were temporarily preserved in 4% formalin solution and brought to the laboratory. Later, some of the collected specimens were permanently preserved in a formaldehyde solution. The cleaned algal biomass was then subjected to be identified taxonomically and classified according to seaweeds of India (Jha B, Reddy CR, 2009).

Fig.1. Map of the study area, showing the intertidal area of the Veraval Coast.

RESULTS AND DISCUSSION

The Veraval Coast of Gujrat is a unique marine habitat characterized by high seaweed biodiversity. Results of the present study indicated the occurrence of 83 seaweed species belonging to 24 families and 42 genera in the study area (Table 1).

Recorded species during the present investigation belonged to 3 phyla; Rhodophyta (44 species, 13 families, and 24 genera). *Gracilaria* and *Scinaia* showed the maximum species diversity. Whereas, the least distributed red algae were *Solieria robusta*. Among the members of Chlorophyta (24 species belonging to 8 families and 13 genera). Caulerpaceae was the most abundant and Cladophoraceae and Siphonocladaceae were the least abundant families. *Caulerpa* and *Ulva* were the most abundant genera and *Caulerpa racemosa* was the most frequent species. On contrary, *Valonia aegagropila* showed the lowest species richness. similarly, Phaeophyta (15 species belonging to 4 families and 5 genera viz. Scytosiphonaceae, Dictyotaceae, Cystoceiraceae, and Sargassaceae, Dictyotaceae was the most abundant family followed by Sargassaceae, whereas Scytosiphonaceae showed the least abundance. *Sargassum* was the most abundant genus but maximum species diversity was reported in *Dictyota*. Same as *Iyengaria* showed the minimum species diversity. The dominance of Rhodophyta over Chlorophyta and Phaeophyta algae during the present study indicated the presence of rocky and coralline substrate essential for the attachment. The species composition of seaweeds largely depends upon the season, population structure, and several other ecological factors (Krishnamurthy 1967).

The result (Fig.2) showed the distribution pattern of species sample collection belonging to the class in coast Veraval, November to May, whereas very few species are available during other months (Joshi and Murthy 2004). From June to September (monsoon season in Gujarat) the wave action is very high and so the exposure is very less which hampers the survey work. So, we have selected the four months of winter (November, December, January, and February) for this work, shown in Fig. 2, which satisfies the preliminary condition for the survey. In our study, the species diversity and abundance of seaweeds were found to be maximum in February in comparison to November, December, and January.

The result (Table 1) showed recorded species during the study period. Class Rhodophyta showed the maximum number of species, i.e., 46 species followed by Phaeophyta and Chlorophyta during the study period. The presence of mineral-rich seaweed *Ulva* and *Enteromopha* shows that the coast is rich in diversity of economically important species. The Phaeophyta group of species also showed considerable diversity with commercially important species viz. *Iyengaria stellata Dictyota dichotoma, Sargassum cinctum, Padina tetrastomatica, Sargassum tenerrimum, Spathoglossum asperum*. Species of *Sargassum* are extensively used for the extraction of alginic acid and sodium alginate. The members of Rhodophyta also contain economically important species like *Griffithsia opuntioides, Gelidium micropterum, Gelidiella acerosa, Amphiroa anceps, Gracilaria corticata, Hypnea musciformis, Laurencia cruciata, Laurencia papillosa,* and *Rhodymenia sonderi* are very important agar yielding species. From the survey, it is postulated that in general Chlorophyceae and Phaeophyceae were observed during the initial months of the survey while the majority of Rhodophyceae were found from January and February month.

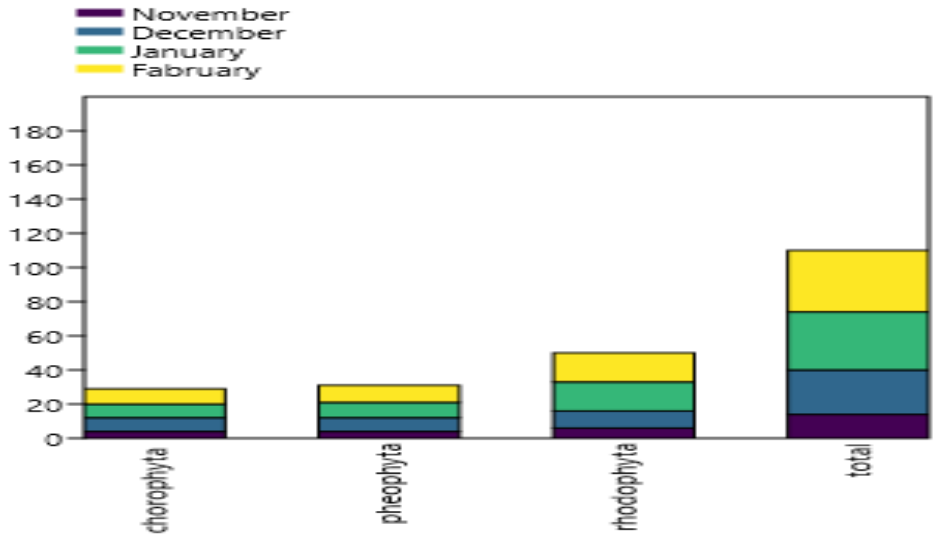

Fig. 2. Sample collection during -November, December, January, and February (2021-22).

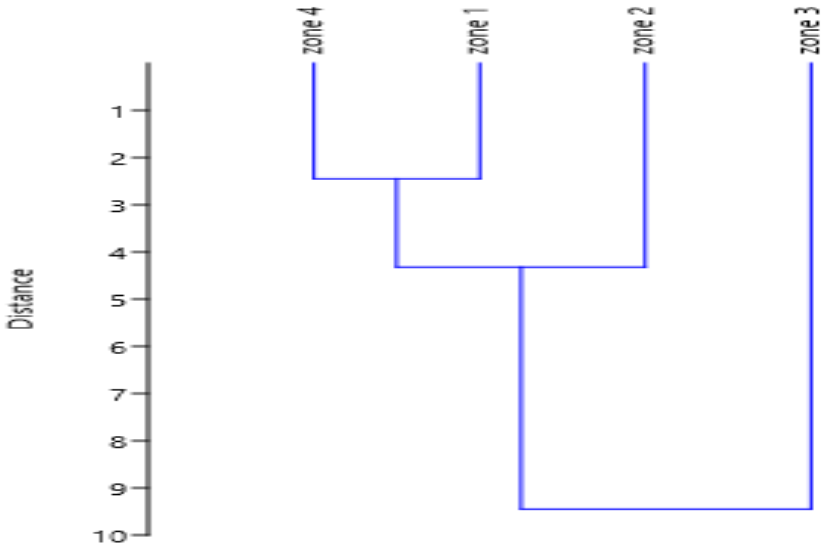

Fig. 3. Dendrogram showing Bray-Curtis similarity-distance matrix.

The Bray-Curtis similarity and Distance matrix seaweed cluster analysis shown in Fig 3. at different zones was conducted and a dendrogram was prepared for graphical presentation. The seaweed cluster analysis in relation to different zonations showed the similarity of Zone 01 to Zone 04, while Zone 03 exhibited a clear distance from Zone 01. Zone 02 and Zone 03 showed quite a similarity. This zonation pattern gives a prompt indication towards preferences for the water-inundated areas to avoid a long period of desiccation for the Phaeophyta and Rhodophytes. Bray-Curtis similarity, clearly revealed the healthy nature of the seaweed ecosystems and species estimation showed that the sample size of the present study was quite adequate and the effort taken to list all the species was also quite sufficient**.**

Table 1. The list of seaweed species recorded from the Veraval coastal area, their abundance from November 2020 to February 2021, and their potential utilization. Abbreviations: HF = Human Foods; BS= bio-stimulator; FM = Fish meal; M = Manure; D = Drugs; F = Fodder; OF = Organic Fertilizer; AU= Agriculture Use; BP=Biofuel Production; CA= Cosmetic Application; ALG = Alginates; AGA = Agar; C = Carrageenan. The references for column 5 are Soe-Htun 2009; Ali 2021; Popescu 2013; Maneein & Milledge 2018; Pereira 2018).

No.	Family	Species	November	December	January	February	Potential utilization
Chlorophyta							
1	Boodleaceae	*Boodlea composita* (Harvey) Brand	–	+	+	+	D, F, FM, HF, OF
2	Bryopsidaceae	*Bryopsis pennata* Lamouroux	–	+	–	–	F, FM, OF, BS
3	Bryopsidaceae	*Bryopsis plumosa (*Hudson) C. Agardh	–	–	–	+	F, FM, OF, BS
4	Caulerpaceae	*Caulerpa microphysa* (Weber Bosse) Feldmann	–	+	–	–	D, F, FM, HF, OF
5	Caulerpaceae	*Caulerpa racemosa* (Forsskål) J. Agardh v. *corynephora* (Montagne) Weber-van Boss	+	+	+	+	D, F, FM, HF, OF
6	Caulerpaceae	*Caulerpa racemosa* (Forsskål) J.Agardh var. *turbinata* (J.Agardh) Euban	+	+	+	–	D, F, FM, HF, OF
7	Caulerpaceae	*Caulerpa scalpelliformis* (Turner) C. Agardh var. *denticulata* Børgese	–	–	+	+	D, F, FM, HF, OF BS
8	Caulerpaceae	*Caulerpa sertularioides* (S.Gmelin) Howe f. *brevipes* (J.Agardh) Svedeliu	+	+	–	–	D, F, FM, HF, OF
9	Caulerpaceae	*Caulerpa veravalensis (*Thivy & Chauhan)	–	+	–	–	D, F, FM, HF, OF
10	Cladophoraceae	*Chaetomorpha crassa* (C. Agardh) Kützing	–	–	–	+	F, FM, M, OF, BP
11	Siphonocladaceae	*Chamaedoris auriculata* Børgesen	+	+	+	+	F, FM, M, OF
12	Boodleaceae	*Cladophoropsis javanica* (Kützing) P. Silva	+	+	+	+	D, F, FM, HF, OF
13	Codiaceae	*Codium decorticatum* (Woodward) Howe	+	+	–	–	D, F, FM, HF, OF
14	Codiaceae	*Codium dwarkense* Børgesen	–	+	–	+	D, F, FM, HF, OF
15	Ulvaceae	*Enteromorpha flexuosa* (Wulf.) J. Agardh subsp. *flexuosa*	–	–	–	+	D, FM, HF, OF, BS
16	Siphonocladaceae	*Struvea anastomosans* (Harvey) Piccone & Grunow ex Piccone	–	–	+	+	F, FM, M, OF

Table 1. Continued:

17	Bryopsidaceae	*Tricleocarpa fragilis* (Linnaeus) Huisman & Townsend	–	–	+	+	F, FM, OF, AU
18	Ulvaceae	*Ulva clatharata* Roth	–	+	+	–	CA, D, FM, HF, OF
19	Ulvaceae	*Ulva lactuca* Linnaeus	+	+	+	–	D, FM, HF, OF, CA
20	Ulvaceae	*Ulva rigida* C. Agardh	+	+	+	+	D, FM, HF, OF, CA, BP
21	Valoniaceae	*Valonia aegagropila* C. Agardh	–	–	+	+	F, FM, M, OF
22	Valoniaceae	*Valonia utricularis* (Roth) C. Agardh	–	–	–	+	F, FM, M, OF
23	Valoniaceae	*Valoniopsis pachynema* C. Agard	–	+	–	+	F, FM, M, OF
Phaeophyta							
24	Scytosiphonaceae	*Colpomenia sinuosa* (Martens ex Roth) Derbes & Solier	–	–	+	+	D, F, FM, HF, M
25	Cystoceiraceae	*Cystoseira indica* (Thivy & Doshi) Mairh	+	+	+	+	ALG, D, HF, OF
26	Cystoceiraceae	*Cystoseira trinodis* (Forsskål) C. Agardh	–	–	+	+	ALG, D, HF, OF
27	Dictyotaceae	*Dictyopteris australis* (Sonder) Askenasy	–	+	+	+	ALG, D, FM, HF
28	Dictyotaceae	*Dictyopteris delicatula* Lamouroux	–	+	+	+	ALG, D, FM, HF
29	Dictyotaceae	*Dictyopteris serrata* (Areschoug) Hyot	–	+	–	–	ALG, D, FM, HF
30	Scytosiphonaceae	*Iyengaria stellata* (Børgesen) Børgesen	–	–	+	+	ALG, D, F, FM, HF, M
31	Dictyotaceae	*Lobophora variegata* (Lamouroux) Womersley ex Oliveria	–	+	+	+	ALG, D, FM, HF
32	Dictyotaceae	*Padina tetrastromatica* Hauck	+	+	–	–	ALG, D, FM, HF ca, AU
33	Sargassaceae	*Sargassum cinctum* J. Agardh	+	+	–	–	ALG, D, HF, OF
34	Sargassaceae	*Sargassum cinereum* J. Agardh	–	+	+	–	ALG, D, HF, OF
35	Sargassaceae	*Sargassum prismaticum* Chauhan	+	+	+	+	ALG, D, HF, OF
36	Sargassaceae	*Sargassum tenerrimum* J. G. Agardh	+	+	+	+	ALG, D, HF, OF
37	Dictyotaceae	*Spatoglossum asperum* J. Agardh	+	+	–	–	ALG, D, FM, HF
38	Dictyotaceae	*Stoechospermum marginatum* (C. Agardh) Kützing	–	–	–	+	ALG, D, FM, HF
Rhodophyta							
39	Rhodomelaceae	*Acanthophora nayadiformis* (Delile) Papenfuss	–	–	+	+	C, F, FM, HF, M, BS

Table 1. Continued:

40	Rhodomelaceae	*Acanthophora specifera* (Vahl) Børgesen	–	–	_	+	C, F, FM, HF, M, BS
41	Corallinaceae	*Amphiroa anceps* (Lamark) Decaisne	+	+	+	+	F, FM, M, OF
42	Corallinaceae	*Amphiroa fragilissima* (Linnaeus) Lamouroux	–	+	+	+	F, FM, M, OF
43	Bonnemaisoniaceae	*Asparagopsis taxiformis* (Delile) Trevisan	–	–	+	+	F, FM, M, OF
44	Ceramiaceae	*Ceramium cruciatum* collins & Harvey	–	–	+	+	F, FM, M, OF
45	Champiaceae	*Champia compressa* Harvey	–	–	+	+	F, FM, HF, OF
46	Champiaceae	*Champia globulifera* Børgesen	–	–	+	+	F, FM, HF, OF
47	Champiaceae	*Champia parvula* (C. Agardh) Harvey	–	–	+	–	F, FM, HF, OF
48	Champiaceae	*Champia somalensis* Hauk	–	+	–	–	F, FM, HF, OF
49	Rhodomelacea	*Chondria armata* (Kützing) Okamura	–	+	–	+	AGA, D, FM, HF
50	Rhodomelacea	*Chondria dasyphylla* (Woodward) C. Agardh	–	–	–	+	AGA, D, FM, HF
51	Halymeniaceae	Cryptonemia undulata Sonder	+	+	+	+	F, FM, OF
52	Gelidiellaceae	*Gelidiella acerosa* (Forsskål) J. Feldmann	+	+	–	–	AGA, F, FM, HF
53	Gelidiellaceae	*Gelidiopsis variabilis* (J. Agardh) Schmitz	+	+	–	–	AGA, F, FM, HF
54	Gelidiellaceae	*Gelidium micropterum* Kützing	–	–	+	–	AGA, F, FM, HF BP
55	Gracilariaceae	*Gracilaria corticata* (J. Agardh) J. Agardh var. cylindrica Umamaheswara Rao	–	+	+	+	AGA, F, FM, HF, BS
56	Gracilariaceae	*Gracilaria fergusonii* J. Agardh	–	–	+	+	AGA, F, FM, HF, BS
57	Gracilariaceae	*Gracilaria foliifera* (Forsskål) Børgesen	+	+	+	+	AGA, F, FM, HF
58	Gracilariaceae	*Gracilaria textorii* (Suringar) De Toni	+	+	_	_	AU, AGA, F, FM, HF, BS
59	Halymeniaceae	*Grateloupia filicina* (Lamouroux) C. Agardh	_	_	+	+	C, F, FM, HF
60	Halymeniaceae	*Grateloupia indica* Børgesen	+	+	+	+	C, F, FM, HF
61	Wrangeliaceae	*Griffithsia corallinoides* (Linnaeus) Trevisan	–	–	+	–	AU, F, FM, M, OF
62	Wrangeliaceae	*Griffithsia opuntioides* J.Agardh	–	+	–	–	F, FM, M, OF

Table 1. Continued:

63	Halymeniaceae	*Halymenia porphyraeformis* Parkinson	–	–	+	+	C, F, FM, HF, OF
64	Halymeniaceae	*Halymenia venusta* Børgesen	–	+	–	–	C, F, FM, HF, OF
65	Hypneaceae	*Hypnea esperi* bory-de saint	–	+	–	–	C, F, FM, HF, M
66	Hypneaceae	*Hypnea fl agelliformis* Greville ex J. Agardh	–	+	–	+	C, F, FM, HF, M
67	Hypneaceae	Hypnea musciformis (Wulfen) Lamouroux	+	+	–	–	C, F, FM, HF, M
68	Hypneaceae	*Hypnea pannosa* J. Agardh	+	+	–	–	C, F, FM, HF, M
69	Hypneaceae	*Hypnea spinella* (C. Agardh) Kützing	–	–	+	–	C, F, FM, HF, M
70	Hypneaceae	*Hypnea valentiae* (Turner) Montagne	–	–	+	+	C, F, FM, HF, M
71	Corallinaceae	*Jania rubens* (Linnaeus) Lamouroux	+	+	–	–	F, FM, M, OF
72	Solieriaceae	*Kappaphycus alvarezii*(Doty) Doty ex P. Silva	–	+	–	+	F, FM, HF, M, BS
73	Rhodomelacea	*Laurencia majuscula* (Harvey) Lucas	+	+	–	–	AGA, D, FM, HF
74	Rhodomelacea	*Laurencia obtuse* (Hudson) Lamouroux	–	+	+	–	AGA, D, FM, HF
75	Rhodomelacea	*Laurencia papillosa* (C. Agardh) Grevill	–	–	–	+	AGA, D, FM, HF
76	Solieriaceae	*Meristotheca papulosa* (Montagne) J. Agardh	–	+	+	+	F, FM, HF, M
77	Rhodymeniaceae	*Rhodymenia sonderi* P. Silva	–	–	+	+	F, FM, M, OF
78	Solieriaceae	*Sarconema fi liforme* (Sonder) Kylin	–	+	+	+	F, FM, HF, M
79	Solieriaceae	*Sarconema scinaioides* Børgesen	–	–	+	+	F, FM, HF, M
80	Galaxauraceae	*Scinaia carnosa* (Kützing) J. Agardh	–	–	+	–	F, FM, M, OF
81	Solieriaceae	*Solieria chordalis* (C. Agardh) J. Agardh	+	+	+	+	F, FM, HF, M
82	Solieriaceae	*Solieria robusta* (Greville) Kylin	–	–	+	+	F, FM, HF, M
83	Wrangeliaceae	*Wrangelia tanegana* Harve	–	–	+	+	F, FM, M, OF

According to Table 2. Water temperatures ranged from 28 to 32.0ºC during the sampling of different months. November saw the highest temperatures, while February saw the lowest. Numerous processes, including photosynthesis, respiration, bicarbonate degradation, increased metabolic activity of autotrophs, breakdown of organic materials, sedimentation, and discharge from sewage or mines, are responsible for pH changes. Several things can create fluctuations. CO_2 is removed from the atmosphere by photosynthesis, respiration, the breakdown of bicarbonate, an increase in the metabolic activity of autotrophs, the decomposition of organic matter, sedimentation, and wastewater or discharges. The pH value pattern throughout the current inquiry varied significantly between 7.8 and 8.1, with a high pH value of 8.32 during February and a minimum value of 7.8 during November. Based on the current study, pH and seaweed variety have a fruitful relationship. The quantity of dissolved oxygen in water is one of the crucial elements for sustaining a diverse range of aquatic life. The dissolved oxygen level fluctuates during the experimental period from 5.64 to 7.55 mgl-1. Throughout the whole sampling period, the EC showed extremely small variations. Between 5.04 and 2.56 ms were the range of EC values.

Table 2. Monthly value of hydrological parameters along Veraval Coasts (November 2021-February 2022).

Parameters	**November 2021**	**December 2021**	**January 2022**	**February 2022**
Temperature (ºC)	32	30	31.6	28
pH	7.8	7.9	8	8.1
Dissolved oxygen (ppm)	5.64	7.55	6.52	7.45
EC(ms)	5.04	2.56	4.39	3.95

ACKNOWLEDGMENTS

This study was supported by Bhakta Kavi Narsinh Mehta University, Department of life science, Junagadh. We thank Dr. Suhas Vyas sir for providing the guidance and also thankful to Department of Education, Government of Gujarat for providing the SHODH fellowship

REFERENCES

Ali, A. & Jayaraman, J. 2021: Biostimulant properties of seaweed extracts in plants: Implications towards sustainable crop production. -Plants 10, 531:3

Barot, M., Kumar, J. & Kumar, N. R. 2015: Seaweed species diversity in relation to hydrochemical characters of Okha Coast Western India. –Int. J. Recent Res. Rev. 8: 16-28.

Børgesen, Frederik.1934: Some Indian Rhodophyceae especially from the shores of the Presidency of Bombay: IV. -Bulletin of Miscellaneous Information, Royal Botanic Gardens, Kew: 1-30.

Dangar, K., Varsani, V. & vyas, S. 2021: Characterization of sodium alginate extracted from brown seaweeds growing on Veraval coast, Gujarat. -Plant Science Today. 8: 45-48.

Jha, B., Reddy, C., Thakur, M.C. & Rao, M.U. 2009: Seaweeds of India: the diversity and distribution of seaweeds of Gujarat coast, Vol. 3. -Springer Science & Business Media.

Joshi, N.H. & Murthy, M.S. 2004:Ecological studies on Sargassum species at port Okha (Gujrat). -Seaweed Res. Utiln 26:63-71.

Krishnamurthy, V. Raju, P. V. & Thomas, P. C. 1975: On augmenting seaweed resources of India. -J mar biol. Ass. India. 17: 181-185.

Maneein, S. Milledge, J.J. Nielsen, B.V. & Harvey, P.J. 2018: A review of seaweed pre-treatment methods for enhanced biofuel production by anaerobic digestion or fermentation. -Fermentation 4:100.

Pathak, S. Bhatt, A.J. Vandarwala, U.G, Vyas, U.D. & Gautam, P. 2020: Seaweed species diversity with relation to hydrological parameters from Veraval and Sikka coast, Gujarat, India -International Journal of Bio-resource and Stress Management, 11: 567-577.

Pawar, P.R. 2017: Distribution pattern & species diversity of seaweeds at Uran (Navi Mumbai), west coast of India. -International Journal of Pure and Applied Zoology 5:25-32.

Pereira, L., 2018: Seaweeds as a source of bioactive substances and skin care therapy—cosmeceuticals, algotherapy, and thalassotherapy. -Cosmetics 5: 68.

Popescu, M. 2013: Agricultural uses of seaweed extracts. -Current trends in Natural Sciences. 2: 36-39.

Soe-Htun, U. & al. 2009: Checklist, distribution and potential utilization of marine algae of Myanmar I: Chlorophyta (green algae) and Phaeophyta (brown algae). -Jour. Myan. Acad. Arts & Sci. 7: 2.