Distribution and diversity of marine algae from eight localities in Gulf of mannar coastal regions, India

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ABSTRACT

The present study highlights morphology, distribution and physiochemical parameter of marine algae occurring during April 2018 - March 2019 from eight localities of gulf of mannar coastal region, India. In this study a total number of 106 species of marine algae belonging to 50 genera were recorded from eight stations. Among the 8 stations maximum of 45 species belonging to 30 genera were recorded in Tuticorin and minimum number of 12 species belonging to 8 genera were recorded to Erwadi, Algae growth is totally absent in the supra littoral fringe. The sub-littoral fringe showed a large number of marine algae in the form of mixed algal turf with Sargassum - Gracilaria as the dominant constituent of the zone. However, many between the littoral and infralittoral zones.

Key Words

Gulf of mannar, Distribution, Diversity, Marine algae, Coastal region, Subtidal, Littoral Fringe.

1. Introduction

Marine algae (Seaweeds) are considered as ecologically and biologically important component in the marine ecosystems. Marine algae make a substantial contribution to marine primary production and provide habitat for nearshore benthic communities (Mann, 1973; Williams & smith 2007). Marine algae are primitive type of plants. They are key space occupiers of rocky shores and interact with other organisms and here play a key role in overall

coastal biodiversity. They are found on rocks in the inertidal zone as a giant underwater forest. In India macro algal resources are found in many coastal areas, especially along the maritime states of Gujarat, Tamil Nadu, Andaman-Nicobar Islands and Lakshadweep. But our efforts to utilise the algal biomass for making products of commercial value are very limited when compared with countries of Indo pacific region. The macro algal diversity is very high along the Indian shores. OZA and Zaidi (2001) listed 844 species of marine algae and the number of species reported to date (up to 2010) is 896 (Umamaheswara Rao is press). The marine algae occurring between Mandapam, kilakarai and Gulf of manner Islands including Krusadai Island were recorded during the seaweed resources survey conducted along the Tamil Nadu coast by central marine fisheries Research Institute, central salt & marine chemical Research institute and dept of Fisheries, govt of Tamil Nadu during 1971, 1976 (Anon, 1978). Marine algae from Indian coasts have been fairly well surveyed since several decades.

India is one among 12 mega-biodiversity countries and 25 hot spots of richest and highly endangered eco-regions of the world. Among the Asians Countries, India is perhaps the only one that has a long record of inventories of coastal and marine bio-diversity dating back to at least two centuries. However, these are so diverse in space, time and taxon that it is almost impossible to review all records and reports. It terms of marine environment, India has a coastline of about 8000 km, an Exclusive Economic Zone of 2.02 Million km^2 adjoining the continental regions and the offshore islands and a very wide range of coastal ecosystems such as estuaries, lagoons, mangroves, back waters, salt marshes, rocky coasts, sandy stretches and coral reef which all characterized by unique biotic and abiotic properties and process. The present study was undertaken with view to know the changes taken place in the algal composition and the seasonal changes in the distribution and diversity during one year period (April 2018 to March 2019) from eight important algae growing localities of Gulf of mannar

regions, southeast coast of India. The information collected in the present investigation would be very much useful to the marine algae industries about the occurence of economically important agar and algin yielding algae for commercial exploitation and collection of seed materials from the available localities for cultivation. The data collected for a period of one year from April 2018 to March 2019 an presented in this communication.

2. Materials and Methods

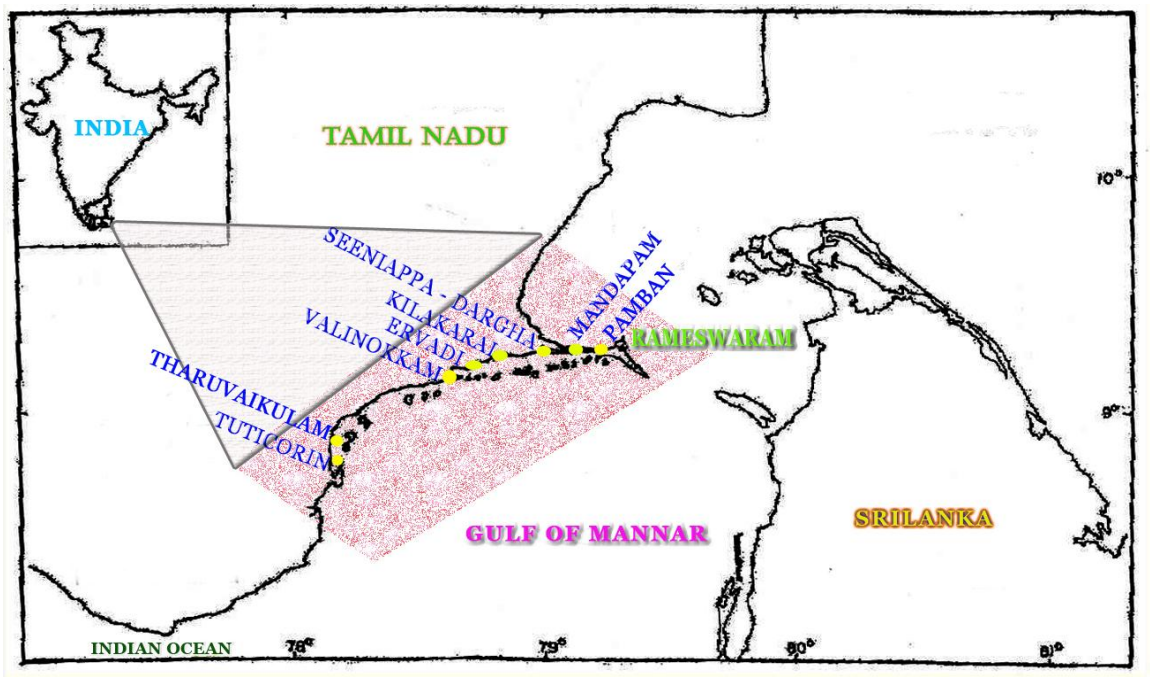


Figure - 1 Map showing the study localities in Gulf of Mannar, India.

2.1. Collection of Seaweeds

The survey of marine algae from selected localities of Gulf of mannar region was made following by the quadrat method of boardsedh (1955). Marine algae from the intertidal and subtidal regions were devised taking into consideration of the heterogeneous distribution of the marine algal vegetation which were growing attached to the discontinuous and patchy substratum. The coastline between Pamban and Tuticorin was studied for one year during the summer, pre-monsoon, monsoon and post-monsoon season in for one year during April 2018

to March 2019. Eight stations namely Pamban, Mandapam, Seeniappa-Dargha, Kilakarai, Ervadi, Valinokkam, Tharuvaikulam and Tuticorin (Fig. 1) were selected for sample collection at Gulf of Mannar region, southeast coast Tamil Nadu. The criteria for the selection of these stations are

i) Distribution of seaweeds

ii) Abundance of different species of seaweeds

iii) Geography of the study area

At each sampling station, three transects were established one at the centre and each one on either side at a distance of 100 m. Along the three transects which lie perpendicular to the shoreline, depth wise seaweed samples at intertidal (0 m), 0.5, 1.0, and 1.5 and 2.0 m depths were collected with the help of skin divers. A plumb line was used to fix the depths. For fixing a sampling point from the shore into the sea was moved along transect previously aligned by erecting two poles on the shore until a particular depth was reached. A canoe was employed for collecting samples from more than 1 m depths.

2.2 Identification

The collected marine algae were identified by referring the literature published by Krishnamurthy et al. (1968), Joshi et al. (1971), Umamaheswara Rao (1970, 1972 and 1987), Menaz et al. (1983), Kaliaperumal et al. (1984) and Kalimuthu et al. (1992). The identification of marine algae was also confirmed by Dr. N. Kaliaperumal, Former Principal Scientist & Scientist-In- Charge, Regional Centre of Central Marine Fisheries Research Institute (CMFRI), Mandapam camp, Tamilnadu.

3. Result

3.1 Distribution and diversity of Marine Algae

Distribution and diversity studies were made from the 8 localities during summer, pre-monsoon, monsoon and post-monsoon season from April 2018 to March 2019. In each

season 120 quadrats algal samples were collected from total number of from all 8 stations and a total in seaweeds were collected from 480 quadrats during April 2018 to March 2019. A total number of 106 species of marine algae belonging to 50 genera were recorded from all stations. Among the 8 stations maximum of 45 species belonging to 30 genera were recorded in Tuticorin and minimum number of 12 species belonging to 8 genera were recorded in Ervadi (Table-1). A total number of 13 genera and 20 species from Pamban, 18 genera and 38 species from Mandapam, 13 genera and 20 species from Seeniappa Dargha, 22 genera and 33 species from Kilakarai, 8 genera and 12 species from Ervadi, 21 genera and 32 species from Valinokkam, 9 genera and 13 species from Tharuvaikulam and 30 genera and 45 species from Tuticorin were recorded (Table -2) . The number of species varied from one station to another among these 8 stations studied. Tuticorin showed highest species diversity (45 species) and Ervadi showed low species diversity (12 species). The distribution and abundance of red algae were fairly high (41 species) when compared to all the other groups of algae in the Gulf of Mannar Coastal regions.

3.2 Percentage of distribution of marine algae in the study area:

In the present study, among the three groups of marine algae Rhodophyceae constituted maximum percentage of species (38.68%) in the study areas followed by Chlorophyceae (34.91%), Phaeophyceae (25.47 %) and Cyanophyceae (0.94 %) (Table - 3, Fig-3).

Table -1

List of Marine algae recorded from eight localities in Gulf of Mannar region, Southeast Coast of Tamilnadu during April, 2018 to March, 2019

S. No.	Name of the Species	Pamban	Mandapam	Seeniappa -Dargha	Kilakarai	Ervadi	Valinokkam	Tharuvaikulam	Tuticorin
	Chlorophyceae								
1	*Bryopsis hypnoides* Lamouroux	+	-	-	+	-	-	-	-
2	*Bryopsis plumosa* (Hudson) C. Agardh	-	-	+	-	-	-	-	-
3	*Caulerpa cupressoides* (Vahl) C. Agardh	+	+						
4	*Caulerpa fastigiata* Montagne	-	+	-	-	-	+	-	-
5	*Caulerpa fergusonii* G. Murray	-	-	-	-	-	-	-	+
6	*Caulerpa laetevirens* Montagne	-	-	+	-	-	+	-	-
7	*Caulerpa macrophysa* (Sonder ex Kuetzing) G. Murray	+	-	-	-	-	-	-	-
8	*Caulerpa peltata* Lamouroux	+	+	-	-	-	-	-	-
9	*Caulerpa racemosa* (Forsskal) J. Agardh	-	+	+	-	-	-	-	-
10	*Caulerpa racemosa var. macrophysa* (Sonder ex Kuetzing) W. R. Taylor	-	-	-	-	+	-	-	-
11	*Caulerpa scalpelliformis* (R. Brown ex Turner) C. Agardh	-	+	-	+	+	+	-	+
12	*Caulerpa sertularioides* (S. Gmelin) Howe	-	+	-	-	-	+	-	-
13	*Caulerpa taxifolia* (Vahl) C. Agardh	+	-	+	-	-	+	-	-
14	*Caulerpa verticillata* J. Agardh	-	-	-	-	-	+	-	-
15	*Chaetomorpha aerea* (Dillwyn) Küetzing	-	-	-	+	-	-	-	-
16	*Chaetomorpha antennina* (Bory de Saint-Vincent) Kuetzing	-	-	-	-	-	+	-	-
17	*Chaetomorpha crassa* (C. Agardh) Kuetzing	-	-	-	-	-	-	-	+
18	*Chaetomorpha linoides* Küetzing	-	+	-	-	-	-	-	-
19	*Chaetomorpha linum* (O. F. Mueller) Kuetzing	-	+	-	-	-	-	-	-
20	*Cladophora fascicularis* (Mertens ex C. Agardh) Küetzing								
21	*Cladophora sp.*	-	+	-	-	-	+	-	-
22	*Codium adhaerens* C. Agardh	-	-	-	+	-	-	+	-
23	*Codium decorticatum* (Woodward) Howe	-	-	-	+	-	-	+	+

24	*Codium tomentosum* Stackhouse	-	-	-	-	-	-	+	+
25	*Enteromorpha compressa* (Linnaeus) Nees	-	-	-	+	+	+	+	-
26	*Enteromorpha prolifera* (O. F. Müller) J. Agardh	-	-	-	-	-	-	-	+
27	*Halimeda gracilis* Harvey ex. J. Agardh	+	+	-	-	-	-	-	-
28	*Halimeda macroloba* Decaisne	-	+	-	-	-	-	-	+
29	*Halimeda opuntia* (Linnaeus) Lamouroux	-	+	-	-	-	-	-	+
30	*Halimeda tuna* (Ellis & Solander) Lamouroux	+	+	-	-	-	-	+	-
31	*Rhizoclonium sp.*	-	-	-	-	-	+	-	-
32	*Ulva fasciata* Delile	-	-	-	+	+	-	-	-
33	Ulva flexuosa **(**Wulfen) J. Agardh	-	-	-	+	-	-	-	-
34	*Ulva intestinalis* (Linnaeus) Nees	-	-	-	+	-	-	+	-
35	*Ulva lactuca* Linnaeus	-	-	-	+	-	-	-	+
36	*Ulva reticulata* Forsskal	-	-	-	+	+	-	-	+
37	*Valonia utricularis* (Roth) C. Agardh	-	-	+	-	-	+	-	+
38	*Valoniopsis pachynema* (G. Martens) Boergesen	-	-	+	-	-	-	-	-
	Phaeophyceae								
39	*Anthophycus longifolius* (Turner) Küetzing	+	-	-	-	-	-	-	-
40	*Chnoospora implexa* J. Agardh	-	-	-	-	-	+	-	-
41	*Colpomenia sinuosa* (Mertens ex Roth) Derbes & Solier	-	-	-	+	-	-	-	-
42	*Dictyota dichotoma* (Hudson) Lamouroux	-	+	-	+	-	-	-	+
43	*Dictyota sp.*	-	-	+	-	-	-	-	-
44	*Hormophysa cuneiformis* (J. Gmelin) P. Silva	-	+	-	-	-	-	-	-
45	*Lobophora variegata* (Lamouroux) Womersley ex Oliveira	-	-	-	-	-	-	-	+
46	*Padina boergesenii* Allender & Kraft	+	+	+	-	-	-	-	-
47	*Padina gymnospora* (Küetzing) Sonder	-	-	-	-	-	-	-	+
48	*Padina pavonica* (Linnaeus) Thivy	-	-	-	-	-	-	+	+
49	*Padina tetrastromatica* Hauck	+	+	-	-	-	-	-	-
50	*Rosenvingea intricata* (J. Agardh) Boergesen	-	-	-	-	-	-	-	+
51	*Sargassum cinereum* J. Agardh	+	-	+	-	-	-	-	-
52	*Sargassum cristaefolium* C. Agardh	-	-	-	-	-	-	-	+
53	*Sargassum ilicifolium* (Turner) C. Agardh	-	-	+	-	-	-	-	-
54	*Sargassum plagiophyllum* C. Agardh	-	-	+	-	-	-	-	-
55	*Sargassum polycystum* C. Agardh	-	-	+	+	-	+	-	-

56	*Sargassum sp.*	-	-	-	-	-	+	-	-
57	*Sargassum tenerrimum* J. Agardh	+	+	-	-	-	-	-	+
58	*Sargassum wightii* Greville	+	+	+	-	-	+	-	+
59	*Spatoglossum asperum* J. Agardh	-	-	-	+	-	+	-	+
60	*Sphacelaria sp.*	-	-	-	-	-	+	-	-
61	*Stoechospermum marginatum* (C. Agardh) Kuetzing	-	+	+	-	-	-	-	+
62	*Turbinaria conoides* (J. Agardh) Kuetzing	+	+	+	-	-	-	-	-
63	*Turbinaria decurrens* Bory de Saint-Vincent	-	-	+	-	-	-	-	-
64	*Turbinaria ornata* (Turner) J. Agardh	-	+	-	+	+	-	-	-
	Rhodophyceae								
65	*Acanthophora spicifera* (Vahl) Boergesen	-	+	+	+	-	+	-	+
66	*Agardhiella subulata* (C. Agardh) Kraft & Wynne	-	-	-	+	-	-	-	+
67	*Amphiroa anceps* (Lamarck) Decaisne	-	-	-	+	-	-	+	+
68	*Amphiroa fragilissima* (Linnaeus) Lamouroux	-	-	-	-	-	-	+	-
69	*Centroceras clavulatum* (C. Agardh) Montagne	-	-	-	-	-	-	-	+
70	*Ceramium sp.*	-	-	-	-	-	+	-	-
71	*Champia parvula* (C. Agardh) Harvey	-	+	-	-	-	+	-	-
72	*Galaxauraa oblongata* (J. Ellis and Solander) Lamouroux	-	-	-	-	-	-	-	+
73	*Gelidiella acerosa* (Forsskal) J. Feldmann & G. Hamel	+	-	-	-	+	-	-	-
74	*Gelidiopsis variablis* (J. Agardh) Schmitz								
75	*Gracilaria canaliculata* Sonder	-	+	-	-	+	+	-	+
76	*Gracilaria corticata* (J. Agardh) J. Agardh *var cylindrica* Umamaheswara Rao	-	-	-	-	-	+	-	-
77	*Gracilaria corticata var corticata* (J. Agardh) J. Agardh	+	+	+	+	-	+	-	+
78	*Gracilaria debilis* (Forsskal) Boergesen	-	-	-	-	-	-	-	+
79	*Gracilaria edulis* (S. Gmelin) P. Silva	-	-	-	+	-	-	-	-
80	*Gracilaria fergusonii* J. Agardh								
81	*Gracilaria foliifera* (Forsskal) Boergesen	-	-	-	+	-	-	-	+
82	*Gracilaria megaspore* (Dawson) Papenfuss	-	-	-	-	-	-	-	+
83	*Gracilaria verrucosa* (Hudson) Papenfuss	-	+	-	+	-	-	-	-
84	*Gracilariopsis megaspora* Dawson	-	-	-	-	-	-	-	+
85	*Grateloupia filicina* (Lamouroux) C. Agardh	-	-	-	-	-	+	-	-

86	*Grateloupia lithophila* Boergesen	-	+	-	-	-	+	-	-
87	*Halymenia dilatata* Zanardini	-	-	-	-	-	-	-	+
88	*Halymenia floresia* (Clemente Y. Rueio) C. Agardh	-	-	-	-	+	-	-	+
89	*Halymenia venusta* Boergesen	-	-	-	+	-	-	-	-
90	*Herposiphonia sps.*	-	-	-	-	-	+	-	-
91	*Heterosiphonia sps.*	-	-	-	-	-	+	-	-
92	*Hypnea musciformis* (Wulfen) Lamouroux	-	+	-	-	-	-	-	-
93	*Hypnea pannosa* J. Agardh	+	-	-	-	-	+	-	-
94	*Hypnea valentiae* (Turner) Montagne	-	+	+	+	-	-	-	-
95	*Jania rubens* (Linnaeus) Lamouroux	-	-	-	-	-	+	-	-
96	*Cheilosporum spectabile* Harvey ex Grunow	-	-	-	-	-	-	-	+
97	*Laurencia flagelliformis* J. Agardh	-	-	-	+	-	-	-	-
98	*Laurencia obtusa* (Hudson) Lamouroux	-	+	-	-	-	-	-	-
99	*Laurencia papillosa* (C. Agardh) Greville	-	+	-	-	-	-	-	-
100	*Laurencia poiteaui* (Lamouroux) Howe	-	-	-	-	-	+	-	-
101	*Laurencia sp.*	+							
102	*Neurymenia fraxinifolia* (Mertens ex Turner) J. Agardh	-	-	-	-	-	-	-	+
103	*Portieria hornemannii* (Lyngbye) P. Silva	-	-	-	+	-	-	-	-
104	*Sarconema filiforme* (Sonder) Kylin	-	-	-	+	-	-	-	-
105	*Solieria robusta* (Greville) Kylin	-	-	-	-	-	-	-	+
	Cyanophyceae								
106.	*Lyngbya majuscula* (Dillwyn) Harvey	-	+	-	-	-	-	-	-

+ Available - Not available

Table -2

Genera and Species of Marine Algae distribution in eight localities at Gulf of Mannar Region, Southeast Coast of Tamil Nadu during April, 2018 to March, 2019

Name of Stations	Chlorophyceae		Phacophyceae		Rhodophyceae		Cyanophyceae		Total	
	Genera	Species	Genera	Species	Genera	Species	Genera	Species	Genera	Species
Pamban	3	6	5	9	5	5	-	-	13	20
Mandapam	4	14	6	9	7	14	1	1	18	38
Seeniappa-Dargha	5	7	5	10	3	3	-	-	13	20
Kilakarai	7	13	5	6	10	14	-	-	22	33
Ervadi	3	5	2	3	3	4	-	-	8	12
Valinokkam	6	11	4	7	11	15	-	-	21	32
Tharuvaikulam	4	7	2	2	3	4	-	-	9	13
Tuticorin	7	11	8	12	15	22	-	-	30	45

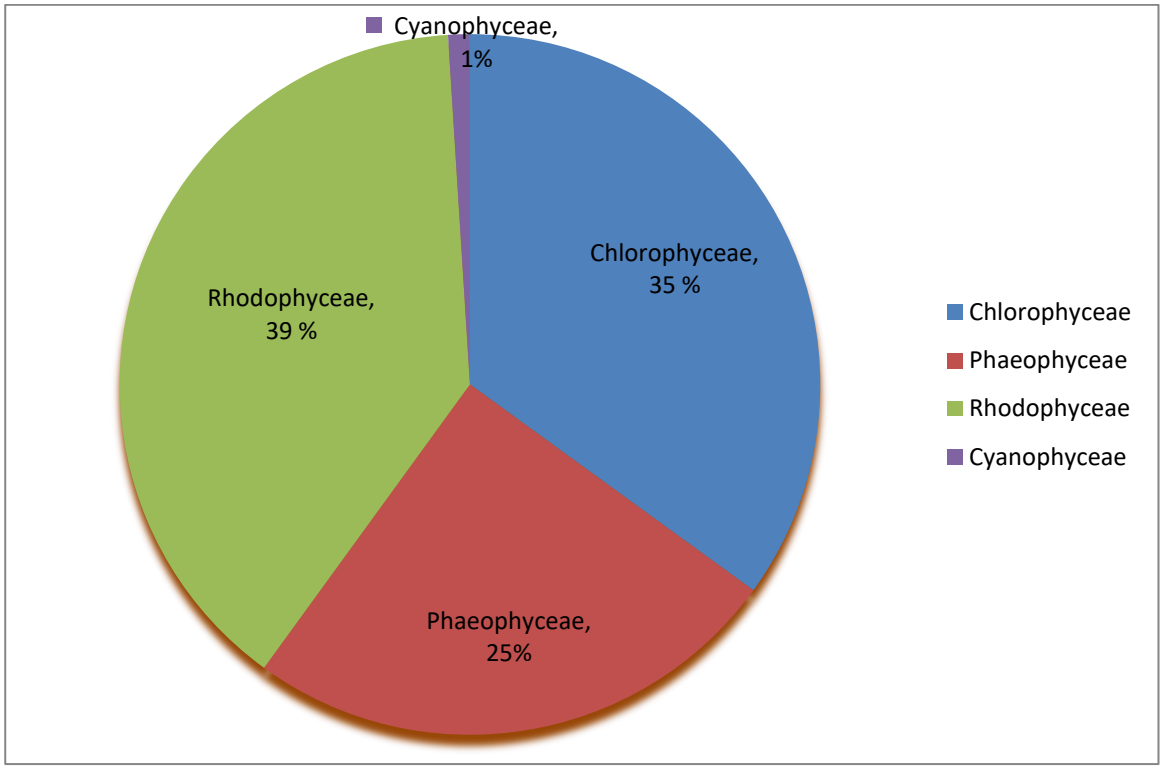
Table-3

Percentage of marine algae species distribution in gulf of mannam region during April 2018 - March 2019

S. No.	Class	No. of Species		Percentage of Distribution (in %)
		Genus	Species	
1.	Chlorophyceae	10	37	34.91
2.	Phaeophyceae	13	27	25.47
3.	Rhodophyceae	26	41	38.68
4.	Cyanophyceae	1	1	0.94
5.	Total	50	106	100

Figure -2

Percentage of Marine Algae species distribution in Gulf of Manner Regions



4. Discussion

On the impact of Tsunami on 26th December, 2004 on the eastern and southeast coast of India (Mantri, 2006) resulted in the damage and major change in the intertidal region of India (Jain et al. 2005). These changes resulted in the vast change in the seaweed biota and the recent update on the seaweed diversity in these coast is not enough (Mantri, 2005). Eventhough few work were carried out soon after the impact of Tsunami (Mantri, 2006) and later in the some parts of the southeast coast like Kudankulam coast (Satheesh and Wesley, 2012), Muttom coast (Domettila et al. 2013). There is scanty of work reported in the marine algal diversity of Gulf of Mannar region after the impact of Tsunami after December 2004. This present work would be surely special in attempting the study of diveristy of seaweed from 8 localities (namely Pamban, Mandapam, Seeniappa Dargha, Kilakarai, Ervadi, Valinokkam, Tharuvaikulam and Tuticorin) of Gulf of Mannar region.

Seaweeds grow in the intertidal as well as in the sub tidal region up to a certain depth where 0.1% photosynthetic light is available. Seaweed were surveyed during four season viz., summer (April-June), pre-monsoon (July-September), monsoon (October-December) and post-monsoon (January to March) from 8 different stations during low tide in the year 2017-2018 by Line transect sampling method. Total of 106 species of marine algae were recorded in the present study belongs to 50 genera were recorded from all stations in which maximum of 45 species belongs to. 30 genera were recorded in Tuticorin which is much lesser than the earlier report in which 42 genus and 56 species were reported by Kaliaperumal and Pandian (1984) and Krishnamurthy and Joshi (1970) have reported 81 species from Tuticorin coast and minimum of 12 species belongs to 8 genera were recorded in Ervadi. In this present study the marine algae sample were collected from the intertidal (0 m) and subtidal (0.5,1.0,1.5 and 2.0 m) depths which is obvious from the studies made at

Tuticorin (Varma 1960; Mahadevan and Nagappan Nayar, 1967) and in Mandapam (Umamaheswara Rao, 1972 and 1973; Subbaramaiah *et al.* 1977) that algae also grown in deep water. The decrease in the number of algae of various groups in the present study is less when compared with the earlier studies may be due to the detachment and washing away of the attached algae by the enormous forces produced by the wave during the tsunami on December 2004 and this leads to the change in the ecological pattern of the algae.

In the present study the distribution and abundance of red algae were fairly high (41 species) when compare to all the other groups of seaweed forms along the Gulf of Mannar coastal region similar trend in the tropical distribution pattern of Marine algae of Orissa coast was described by Rath and Adhikary, (2006) in which the diversity of marine algae in the coast showed the members of Rhodophyta were dominant followed by Chlorophyta. Among three seasons, species diversity was rich in Post-Monsoon season (February - May) followed by monsoon and very less in pre-monsoon, which was in agreement with earlier reports (Kalimuthu *et al.* 1992; Darsis and Arunkumar, 2008). Even in the same locality occurrence of the seaweeds varied and this may be due to dynamics of nutritional status and physico-chemical parameters over the period of time (Sreekala Devi *et al.* 2004). In the present study *Caulerpa scalpelliformis, Sargassum .wightii* and *Gracilaria corticata* var. *corticata* was found to the most predominant species in the study area which is similar with works of Saravanan *et al.*, (2015) at Nochiyurani coast of Gulf of Mannar.

5. Conclusion

In this present study, totally 106 species of marine algae belongs to 50 genera were recorded from all stations studied. In which Tuticorin was recorded with the maximum of 45 species belongs to 30 genera were recorded and minimum of 12 species belongs to 8 genera were recorded in Ervadi. Algae growth is totally absent in the supra littoral fringe. The sub-littoral fringe showed a large number of marine algae in the form of mixed algal turf with

Sargassum - *Gracilaria* as the dominant constituent of the zone. However, many other Rhodophyceae members dominated in the region between the littoral and intra-littoral zones. This is probably due to their pigmentation (Phycoeritherin, Fucoxanthin) which can trap sun light even under low light by the algae for efficient photosynthesis. The composition and seasonal abundance of marine algae depend mainly on factors like temperature, salinity, water current, substrate, tide range and nutritional availability. The ability of marine algae to adapt to different light regime determine the vertical distribution in the intertidal and substidal region. Although an understanding of the biology of gulf of mannar region, macro algae has increased considerably a lot more remain to be studied with regards to the structures and biodiversity of the algae communities. Life histories of the individual species, adaptation to the seasonal variation and their physiological mechanism to grow and survive in gulf of manager coastal waters.

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