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Research Article
Seasonal Changes on the Diversity and Abundance of Intertidal Macroalgae at Four Southern Districts of Tamil Nadu, India

[1]K. Sahayaraj and [2]Jagvir Singh

[1]Crop Protection Research Centre, St. Xavier's College, Palayamkottai 627002, Tamil Nadu, India
[2]Ministry of Earth Science, Prithvi Bhavan, IMD Campus, Opp. India Habitat Centre, Lodi Road, New Delhi 110 003, India

Abstract

Objective: The aim of the study was to analyze the populations of macroalgal in relation to four seasons in Tamil Nadu, India. **Methodology:** Fortnightly replicate of marine macroalgae were collected from four Southern districts of Tamil Nadu, India for a period of 12 months continuously. More than 435 specimens were collected from Tamil Nadu coast from April, 2010-March, 2011. More number of genus (30) as well as species (64) was recorded during Southwest monsoon. **Results:** The genus Gracilaria dominated in South West monsoon (15.28%) followed by Ulva in winter (14.81%). Besides, *Caulerpa scalpelliformis* distributed in all season in more than 10%. Season specific macroalgae was observed in Tamil Nadu. For instance, *Amphiroa anceps, Bryopsis plumose, Caulerpa scalpelliformis* (equal proportions) in summer, *Gracilaria corticata* in both South West and North East monsoons and *Caulerpa scalpelliformis* in winter. *Acanthophora spicifera, Enteromorpha compressa, Galoxaura marguata* and *Sarconema filiforme* recorded only during South West monsoon. *Hormophysa triquetra* was recorded only at summar, whereas *Hypnea musciformis* during winter. Abiotic factors have not influence on the distribution of macroalgae in the study areas. **Conclusion:** Hence, it is recommended to study the influence of other factors like seawater physio-chemical parameters and nutrient concentrations on the population level of macroalgae in the study area. Further the data is very much useful for specific plant collectors for their research work.

Key words: Average distribution, dominance, monsoon, summer, winter

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Corresponding Author: K. Sahayaraj, Crop Protection Research Centre, St. Xavier's College, Palayamkottai 627002, Tamil Nadu, India
Tel: + 91 4624264376 Fax: + 91 462 256 1765

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Summer, winter and monsoon are the prominent seasons of Tamil Nadu, India. Seaweeds are considered as biologically important resources[1-3]. Marine macroalgae mainly found in the relatively shallow water of intertidal zones. The topography of Tamil Nadu broadly consists of the coastal plains in the East and seaweeds were abundant in the Eastern coast extending from Rameswaram in the North to Tuticorin, Tiruchendur and Kanyakumarii in the South; in the Western coast and Andaman Nicobar islands and Lakshadweep. Furthermore, Tamil Nadu coast also shares the East-coast with the states of Andhra Pradesh, Orissa and West Bengal. Its growth[4-7] and population of marine macroalgae varies with seasons at Gulf of Mannar[8], mouth to Bay of Bengal, Orissa coast[9] and Sanya Bay, China[10].

This kind of fluctuation of seaweeds were undertaken in California[11] from 1981-1983, Texas lagoons[12], Thiruchendur shore[13], Gulf of Mannar[14] of Tamilnadu; West coast[15], Indian Ocean region[16] of India. Biotic and abiotic variation in inter-tidal zone is a common phenomenon of sea[17,18]. Very recently, Sahayaraj *et al.*[19] reported distribution and diversity of macroalgal seaweeds from four districts of Tamil Nadu, India. But they failed to relate with the abiotic factors of the study area. Hypothesis is that any relation with abiotic factors and abundance of seaweeds. The aim of this study was to analyze the populations of macroalgal in relation to four seasons namely summer (March-May), North East monsoon (October-December), South West monsoon (June-September) and winter (January-February) in Tamil Nadu, India.

MATERIALS AND METHODS

Fortnightly regular trips were undertaken to four Southern districts of Tamil Nadu namely Kanyakumari district (Manavalakurichi, Kanyakumari, Circular fort), Thoothukudi (Manapaad, Tuticorin, Therkukalmaedu), Tirunelveli (Idhinthakarai, Kootapuzhi, Uvari), Ramnadu (Kizhakarai, Mandapam, Rameshwaram) during summer (March-May), North East monsoon (October-December), South West monsoon (June-September) and winter (January-February) from June, 2009 to May, 2010 for the observations of seaweeds distribution and abundance. In total 24 visits were undertaken for a location during the hours of low tides.

Seaweeds were collected by hand picking method up to 1.5 m from the seashore. Familiar as well as previously identified seaweeds were only counted in this study.

Density of seaweeds was counted using 1x1 m transect. All algal species, in the randomly placed transect was handpicked[19]. Three locations were randomly selected each site. The distance between each was between 80-100 m. Collected seaweeds were washed thoroughly with seawater to remove all unwanted impurities, adhering sand particles and also epiphytes. These were sorted out species-wise, washed in seawater and weighed on a physical balance separately. The seaweeds were identified at Central Salt and Marine Algal Research Station (CSMARS), Mandapum. Ecological observations like atmospheric temperature, species of seaweeds available and their densities were made in the field itself. Rainfall data of each district was obtained from the meteorological stations of district head quarters.

Depends up on the number of specimens collected, they were graded as 1 (1-5 specimens), 2 (6-10 specimens), 3 (11-15 specimens) and 4 (16-20 specimens) and represented in Table 1. In overall manner, the abundance of A Specific Species (ASS) was calculated using the following equation:

$$\text{ASS} = \frac{\text{Total No. of a specific species collected from a season}}{\text{Total No. of species collected in a season}}$$

Average density of specific species data of individual season was subjected to ANOVA and Tukey's test with SPSS (version 15.0). Individual month algal total species population was correlated with rainfall and temperature (mean value of all four districts) and correlation coefficient (r^2) was recorded using SPSS (version 15.0).

RESULTS

Total 33 genus belong to red (Rhodophyta), green (Chlorophyta) and brown (Phaeophyta) algae were recorded. Total number of seaweed genus was maximum in South West monsoon (30 genus), followed by North East Moonsoon (20 genus) and equal in both summer and winter seasons (20 genus). High (75 species) and low (10 species) number of seaweed was recorded during June, 2009 and March, 2010, respectively. Species belong to Gracilaria (brown algae-Phaeophyta) was more abundant in monsoons. Similarly, species of Ulva (green algae-Chlorophyta) and Podina (brown algae-Phaeophyta) were common in winter and summer, respectively (Table 2).

Table 1: Seasonal specific macro algae (%) of various genuses recorded at various seasons at Tamil Nadu during June 2009 to May 2010

	Seasons			
Species	Summer	South West monsoon	North East moonsoon	Winter
Acanthophora spicifera	0	4	0	0
Amphiroa fragilissima	1	2	0	0
Enantiocladia prolifera	1	1	0	0
Enteromorpha compressa	0	5	0	0
Enteromorpha intestinalis	0	4	0	0
Galoxaura marguata	0	1	0	0
Gelidium pusillum	0	1	0	1
Halimeda tuna	2	2	0	1
Hormophysa triquetra	1	0	0	0
Hypnea valentiae	3	0	0	1
Hypnea musciformis	0	0	0	1
Liagora ceranoides	0	1	1	1
Polysiphonia sp.	0	1	0	1
Padina gymnospora	0	0	1	1
Padina pavonica	0	0	3	1
Sarconema filiforme	0	3	0	0
Spatoglossum asperum	2	4	4	0
Turbinaria ornata	2	2	1	0
Udotea flabellum	0	2	1	0
Valeniopsis pachynema	0	8	3	3
Total 20	7 (35%)	15 (75%)	7 (35%)	9 (45%)

Table 2: Number of specimens, total number of genus and dominant genus recorded in tamil nadu coast during 2009-2010 at various seasons. Value in parentheses indicates percentage of overall specimens collected from tamil nadu coast

Seasons	Total No. of seaweeds recorded	Total No. of genus recorded	Dominant genus	Species observed (%)
Summer	67 (15.40)	20	*Podina* spp.	10.47
South West monsoon	229 (52.62)	28	*Gracilaria* spp.	15.28
North East moonsoon	85 (19.54)	23	*Gracilaria* spp.	9.41
Winter	54 (12.41)	21	*Ulva* spp.	14.81

Average density of specific species: Average genus representation was ranged between 0.014-0.119, 0.00872-0.153, 0.01-0.117 and 0.018-0.129 for summer, South West monsoon, North East monsoon and winter, respectively (Table 3). Agin it was prooved in average genus respresentation analysis that both monsoons has *Gracillaria* spp., (0.015 and 0.117 for South West monsoon, North East monsoon, respectively). Species of Podina (0.119) and Ulva (0.129) were dominated in summer and winter, respectively. Significantly high number of seaweed genus was recorded during North East monsoon (df 10,21, F = 5.964, p = 0.0005) followed by kouth East monsoon (df 10,21, F = 4.128, p = 0.005) and in summer.

Dominant and seasonal specific species: *Amphiroa anceps, Bryopsis plumose* and *Caulerpa scalpelliformis* were dominated in summer (11.0% each), whereas *Caulerpa scalpelliformis* prevailed in winter (12.3%). *Gracilaria corticata* was the predominant species in monsoons (20.0 and 17.6% for North East moonsoon and South West monsoon, respectively), (Fig. 1) in the southern coastal region of Tamil Nadu. However, *Bryopsis plumose, Caulerpa scalpelliformis, Caulerpa veravalensis, Chaetomorpha antennina, Chaetomorpha crassa Gracilaria corticata, Gracilaria edulis, Jania adhaerens, Liagora ceranoides, Lobophora variegata, Padina gymnospora, Padina pavonica* and *Stoechospermum marginatum* were present in all seasons (Fig. 1).

In total 32 speices were aboundant, among them 35% each was recoreded during summer and North East monsoon period respectively. Totally 75 and 45% species were recorded in South West monsoon and winter season, respectively. However, no correlation was obtained between the rainfall (r^2 = 0.2137), temperature (r^2 = 0.2383) and seaweed population. These may be due to migration and reproduction of species. *Hormophysa triquetra* was found to be exclusive in summer, whereas *Acanthophora spicifera, Enteromorpha compressa, Galoxaura marguata* and *Sarconema filiforme* were found to be exclusive in South West monsoon (Table 3).

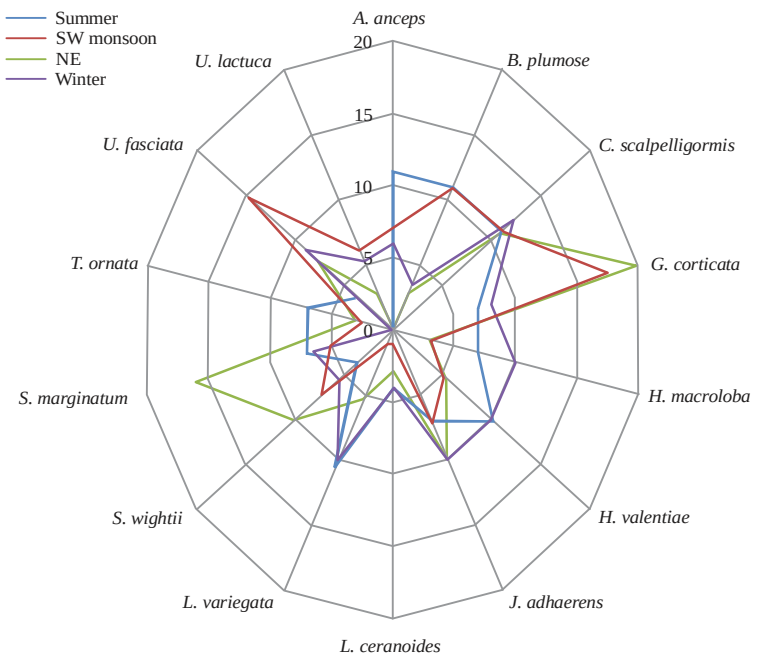

Fig. 1: Dominant species (%) of various genuses recorded at various seasons at Tamil Nadu coast during 2009-2010

Table 3: Average density of macroalgae genus recorded at Tamil Nadu in summer, South West monsoon, North East moonsoon and winter during 2009-2010

	Seasons			
Genus name	Summer	South West monsoon	North East moonsoon	Winter
Amphiroa	0.052	0.034	0	0.037
Acanthophora	0	0.017	0	-
Bryopsis	0.044	0.039	0.011	0.018
Caulerpa	0.059	0.061	0.070	0.092
Ceramium	0.015	0.026	0	0.018
Chaetomorpha	0.104	0.052	0.070	0.055
Chondrococcum	0	0	0.011	0
Cladophora	0	0	0.023	0
Enantiocladia	0.015	0.043	0	0
Galoxaura	0	0.004	0	0
Gelidium	0	0.004	0	0.018
Gracilaria	0.089	0.153	0.117	0.111
Grateloupia	0	0	0.011	0
Halimeda	0	0	0.011	0.0370
Halimeda	0.059	0.022	0	0
Hormophysa	0.014	0	0	0
Hypnea	0.045	0.083	0.082	0.055
Jania	0.029	0.031	0.047	0.055
Laurencia	0	0.004	0.035	0.018
Liagora	0.104	0.004	0.011	0.018
Lobophora	0.044	0.004	0.0232	0.018
Padina	0.119	0.087	0.047	0.074
Sargassum	0.029	0.026	0.059	0.111
Sarconema	--	0.083	0	0
Spatoglossum	0.029	0.017	0.047	0
Stoechospermum	0.029	0.017	0.070	0.018
Spyridia	0	0.013	0.023	0
Polysiphonia	0	0.004	0	0.018
Turbinaria	0.104	0.00872	0.011	0
Ulva	0.104	0.096	0.047	0.129
Udotea	0	0.00872	0.011	0
Valeniopsis	0	0.035	0.035	0.055
Total	20 (60.61%)	28 (84.84%)	23 (69.66%)	21 (63.63%)

DISCUSSION

The economically viable species of seaweeds such as Hypnea, Gelidiella, Gracelaria, Stiechospermum, Hydroclathums, Clathatus, Padina and Caulerpa are largely distributed in the Gulf of Mannar (http://www.moef.nic.in/soer/state/SoE%20report%20of%2 0 Tam ilnadu. pdf). All available seaweeds were reported in India by Sahoo[20]. All genuses were recorded in this study area, considering the importance we undertake this study. Low seaweed population in summer might be due to high temperature, low nutrient level[21] and sand fluctuations at the area[22]. Since we have not studied nutrient and san fluctuations, we are not sure about these factors. However, both temperature and rainfall does not have any influence on seaweed population. Similar result was also observed by Kotiya *et al.*[23] in nine different coastal area of Gujarat coast, India. But, Daly and Mathieson[22] further reported that high algae was observed during monsoon might be due to low temperature, low salinity, low desiccation and increased nutrient concentrations in ambient waters. Galleria was the common genus distributed in Tamil Nadu during monsoon.

Presnce of *Hormophysa triquetra* in summer shows that the species was highly tolerant to temperature, because temperature as a contributory factor which regulate seaweed population[24]. Previously, it was reported[25] that *Hypnea musciformis* was due to lower water level which exposed the seaweed to air and temperature and control the density, growth of this plant in Indian coast. In Kenya, Moorjani[16] studied seasonal changes in marine algal flora. She reported that richest flora occurs, during the end of Southeast monsoon when temperature is lower, which shows that in Kenya also seasonal changes in marine algal standing crop is related to monsoonic changes. These kinds of changes alter seaweeds hotspots as well as their diversity[26]. *Sargassum* sp., a common seaweed of Gulf of Mannar[27] in India.

CONCLUSION

Observation reveals that along with abiotic factors many industries emerged from this region causes declining of seaweeds. More studies are necessary to prove our clime in near future. Further, climatic change decides the presence and absence of specific seaweed in Tamil Nadu as reported in other parts of the world.

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