J. Recent Trends Biosci., 2(2): 20-25. 2012

ISSN 2249-376X

Ecology of seaweeds along Thirumullavaram shore line, Kerala

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Abstract

The present study reports the seasonal distribution of seaweeds at Thirumullavaram coast in relation to physico-chemical parameters such as salinity, dissolved oxygen, temperature, wave action and dissolved nutrients. Tidal height was high during most of the time of collection. The highest tide was noticed during December with the amplitude of 1.19 m. The annual mean dissolved oxygen was 6.74 mg/l and salinity was 30.36ppt. Chlorophytes such as, *Ulva fasciata, U. lactuca, Enteromorpha intestenalis,E.compressa, Chaetomorpha antennina, C. basiretosa* abundant during monsoon and few in pre-monsoon whereas, Rhodophycean algae such as *Gracilaria corticata, G.folifera,Hypnea musciformis,Hypnea valentiae* and *Centroceras clavulatum* were abundant during monsoon. The Phaeophytes were sparse during monsoon and more in pre-monsoon. Whereas, the algal species diversity was highest during November (36 species). Many species like *U. fasciata, Caulerpa peltata, C. antennina, C. sertularioides, C.taxifolia Gracilaria. corticata, G. folifera, G. lithophila* and *Hypnea. musciformis* were recorded throughout the study period. The absence of brown algae during monsoon season was noticed. However, the highest number was recorded during post monsoon particularly in November. Data on phosphate-phosphorus levels showed high values from April to July and minimum (0.15µg.at/l) in December. The Nitrite-nitrogen level was minimum during October and comparatively high during the monsoon months. The nitrate-nitrogen values were high during monsoon and post-monsoon periods. In July only 19 seaweed species were recorded. The high level of nutrients, dissolved oxygen and moderate temperature in the Thirumullavaram shore favors the growth of seaweeds.

Keywords: *Rhodophytes, seaweeds, Chlorophytes, Phaeophytes*

Introduction

Thirumullavaram is situated on the west coast ($8^0 42'$ N Latitude and $76^0 34'$ E Longitude) in Kollam district of Kerala state. The shore is partially formed of rocky and sand substratum and subjected to heavy wave action. The shore line is divisible into different zones depending on the influence of tides and the nature of the substratum. The substratum in the inter-tidal and up to sub-tidal zones is composed of laterite rocks and scattered granite boulders which offer variant habitat for floral growth. Seaweeds are simple plants widely distributed from the tidal level to a considerable depths, floating freely or attached to substrates (Kaladharan and Reeta, 2003). Generally, tide pools on rocky shore provides a unique habitat for seaweeds (Munda, 1981; Nybakken,1988) and many animals including fish (Bonotto, 1976). Detailed surveys of seaweed resources of Kerala were carried out by Nair *et al.* (1982), Nair and Shobha (1983), Silas (1987), Chennubhotla *et al.* (1988), Nair *et al.* (1993) and Saji Susan Mathew (1991). The above studies have shown the luxuriant growth of many species of green, brown and red algae along the southern coast of Kerala. Rich seaweed beds are also present in the vicinity of Varkala and Vizhinjam (Kaliaperumal, 2005). Surveys were also carried out on the distribution of seaweeds by Leena and Prabha Devi (2004) at Thirumullavaram coast and Sulekha and Panikkar (2006) along Kollam coast. The present study mainly deals with the physico-chemical characteristics of the seawater and the seasonal variation of the seaweeds on this coast.

Materials and Methods

The seaweeds found on the shore as well as growing on the rocky area in the intertidal zone were collected by hand picking. Complete

plants with holdfast were detached carefully, preserved in 5% formalin and brought to the laboratory for identification. Taxonomic determination was made by using morphological characters and authentic keys as mentioned by Dawes (1981), Gopinathan and Panigrahy, (1983), Umamaheswara Rao (1987) and Dhargalkar and Kavlekar (2004). Imaging survey (Herring, 2002) was also used during monsoon seasons. Nomenclature used in present study has been adopted from WWW. Algaebase.org. The study was conducted for a period of 12 months from Decemeber 2007 to November 2008. Regular fortnightly samples of water and macro algae were taken from the site. The surface water samples were collected from the inter-tidal region for the analysis of dissolved oxygen, salinity, pH and dissolved nutrients such as nitrite-nitrogen, nitrate-nitrogen and phosphate-phosphorus. The water samples were fixed in BOD bottles for dissolved oxygen estimation immediately after collection. Dissolved oxygen of water samples were estimated by using modified Winkler method as described by Strickland and Parsons (1972). The hydrogen ion concentration (pH) was measured by using digital pH meter (Systronics 335).The instrument was calibrated with standard buffers of pH 4, 7 and 9.2 before taking the reading. Salinity was determined by following the Mohr-Knudson's titrimetric method (Grasshoff *et al*., 1983). The dissolved nutrients, Nitrate-nitrogen, Nitrite-nitrogen and Phosphate-Phosphorus were determined spectro-photometrically using standard procedures described by Strickland and Parsons (1972).

Results

Physico-chemical parameters

Fortnightly variations in the physico-chemical parameters of water such as pH, salinity, dissolved oxygen, phosphate-phosphorus, nitrite-nitrogen and nitrate-nitrogen are presented in Table1.

pH of sample water varied between 7.15-8.34 at Thirumullavaram. The average pH value for the entire study period was 7.84 and the maximum pH (8.34) observed during November. The dissolved oxygen (DO) was found to vary from 5.375 mg/l (February and August) to 9.5 mg/l in May. The annual mean dissolved oxygen was found to be 6.74 mg/l. The mean salinity of the sample varied from 28.78 ppt (July) to 31.76 ppt (May). The mean salinity obtained for the entire study period was 30.36ppt. The phosphate-phosphorus levels showed highest values in April and July (1.4 µg.at/l) and minimum (0.285 µg.at/l) in August. Annual mean phosphate-phosphorus value was found to be 0.748 µg.at/l. The lowest nitrite-nitrogen level (0.085µg.at/l) was found during October and comparatively higher value found during the monsoon months. The nitrate-nitrogen concentration fluctuated between a low value 0.925 µg.at/l in January to 7.55 µg.at/l during October.

Species composition

The present study showed the presence of 20 species of Chlorophytes, 15 species of Rhodophytes and seven species of brown algae. The Chlorophytes were predominant among the seaweeds in terms of species as well as their distribution and constituted 47.62 % of the total species identified from this region. The Phaeophytes and Rhodopohytes were represented as 16.67% and 35.71% respectively. Among Chlorophytes, *Caulerpa* (six species), *Ulva* (four species) and *Cladophora* (three species) were the dominant genera. The major genera of red algae in terms abundance are *Gracilaria, Grateloupia, Gelidium* and *Hypnea*. The brown seaweeds *Sargassum*, *Padina and Turbinaria* were more common and also predominant. The genera *Ulva, Caulerpa, Gracilaria, Hypnea, Ceramium and Grateloupia* occurred throughout the study period. The chlorophytes *U. fascita, U. lactuca, C. prolifera, C. peltata, C. sertularioides C. taxifolia, G. corticata* and *G. folifera* were found in all seasons. Commercially important seaweeds of Thirumullavaram coast includes six species of Agarophytes, four species of Agaroidophytes, seven species of Alginophytes and 23 species (54.76%) of edible seaweeds.The Alginophytes, Agarophytes and Agaroidophytes represented in the order 16.67%, 14.29% and 9.52% respectively. During monsoon (May to July) Chlorophycean namely *U. fasciata, U. lactuca, E intestinalis, C antennina*, and *C. basiretosa* were predominant during monsoon and Rhodophytes like *G. corticata* and *G.folifera* were dominant in monsoon and post monsoon, however, *G. lithophila, H.musciformis, H.*

valentiae and *C. clavulatum* are dominant in post monsoon. In general the phaeophytes were sparse and minimum during pre and post monsoon. During the study period a definite zonation pattern was observed with regard to several species of seaweeds. *U. fasciata, U. lactuca, C. antennina, E.compressa, G. lithophila, G. filicina and C. clavulatum* were found to grow on the rocks at the upper littoral zone. Rocks exposed to high wave action and swells harbored algae with strong holdfast like *C. antennina, G. lithophila, G. acanthophora, Sargassum, Hypnea* and *Caulerpa* in the mid littoral zone. The green alga, *C. peltata* grows on rocks in the mid littoral zone was constantly covered and uncovered by water. The species *C. sertularioides* was found on the sides of small rock pools in the mid littoral zone. These pools were exposed for the major part of the day during low tide. The Lower littoral zone was inhabited by species of *Sargassum, Dictyota and Turbinaria.*

Discussion

The utilization of seaweeds as food and as raw material for industries highlights the economic importance and potentials of this resource. The increasing contributions of the seaweed industry to foreign trade as well as food in some Asian countries have emphasized the need to develop the large but untapped potentials of seaweeds. Thirumullavaram is characterized by luxuriant growth of seaweeds. A number of factors seem to control the presence or absence of seaweeds. Significant among these are water and air temperature, tidal amplitude and the quality and quantity of light (Dubey, 2005). The present study reports the seasonal distribution of algae at Thirumullavaram in relation to environmental parameters. Many reports are available on the distribution, taxonomy and ecology of the marine algae from different regions of the Indian coast (Mantri, 2004; Narayan and Miyashita, 2005; Rao and Mantri, 2006; Sulekha and Panikkar, 2006). The algal biotope is considered to be an important area in providing food, living space and refuge to diverse group of fauna (Leena and Prabha Devi, 2004). High turbidity in seawater is found to affect the species composition, community, structure, biomass availability, growth rate of seaweeds (Tewari *et al.,* 2004). Rainfall also influences other water quality parameters directly or indirectly). The number of algae were comparatively less during this period. In the present study the pH of the seawater ranged from 7.15 to 8.34. This is well within the pH range (7.5 to 8.5) of normal seawater (Pinnet, 1992). Mean pH value for a season were lowest (7.51) during monsoon months might be due to the heavy rainfall and flooding during that period. Fluctuations in dissolved oxygen and salinity also influence the pH (Anirudhan,1988). In the present study pH showed significant positive correlation ($r = 0.726$) with seaweed growth. Dissolved oxygen was high during monsoon months (June to October). The inter-tidal rocky substratum and wave action leads to turbulence which facilitates dissolution of oxygen. Besides, the influx of freshwater during rainy period impart high oxygen level in surface water. According to Rauch, (2006), spatial and temporal changes of physical and chemical factors affect the occurrence and relative abundance of individual algal species. Bonotto (1976) and Leena and Prabha devi (2004) reported that the heavy rainfall followed by tidal flooding can lead to noticeable fluctuations of salinity. Similar variation was noticed in the present study especially in July and August. The present study also reveals that the surface salinity was found high during high tide. A positive correlation ($r = 0.211$) was recorded between seaweed growth and salinity in this study. The phosphate-phosphorus values ranged from 0.15 $\mu g\ at.l^{-1}$ in December to 1.44 $\mu g.at.l^{-1}$ in July were relatively high during high tide. Similar ranges of phosphate-phosphorus level were noticed by Rao and Indusekhar (1987) at Saurashtra coast. Further, the value of phosphate-phosphorus was maximum during monsoon season in the present study. Similar observation was reported by Saji Susan Mathew (1991). The observations on phosphate level by Leena and Prabha Devi (2004) also indicated higher values during pre-monsoon months than monsoon months. The phosphate level in the water showed insignificant positive correlation with abundance of seaweeds ($p<0.4174$). The monsoonal drainages apparently resulted in the highest concentration of nitrite and nitrate in the surface water. Nitrogen availability has

been implicated as a primary limiting factor for marine algae. The nitrate level significantly affects the algal growth (Ryan *et al.,* 1972). Nitrogen enrichment as resulted in enhanced growth in a number of seaweed species in experimental systems (Rosenberg and Ramus 1982). The present result is also indicated that the high level of nitrate during monsoon influences the growth of algae. Chlorophytes occupied most part of the coastal region during monsoon months. However. Rhodophytes (Agarophytes) showed higher density during monsoon and post-monsoon periods. According to Druehl (1981) Rhodophytes were least tolerant to the lower salinities and chlorophytes were most tolerant. Stella Roslin (2001) reported that low temperature and salinity, rise in water level and turbulence caused by the monsoonal winds, increased nutrient content are some of the major factors which favour the growth of algae during the monsoon season. Velkanni and Rengaswamy (1992) recorded that under high and low salinities *Hypnea valentiae* showed negative correlation in their growth. In the present observation the range in salinity variations were very low and did not affect the growth of red algae. A positive correlation (r=0.211) was noticed between salinity and seaweed growth at the study site. Dawes (1981) reported that the composition and texture of rocky substratum greatly influence the plant communities in the shores. Untawale and Dhargalkar (1975) and Jagtap (1987) reported that sandy shores are devoid of macrophytes, because of the presence of loose sandy substratum.The rocky substratum in the intertidal area offers ideal environment for the seaweeds. Besides all the above the temperature, pH and dissolved oxygen level in the sample water were optimum for luxurious growth of both green and red seaweeds. Further, the coastal study area seems to be well suited for the red seaweeds since they were found distributed throughout the year at moderate levels. The Phaeophytes were abundant only during the pre-monsoon when there was high temperature and salinity. Worm *et al*. (2001) also stated that the pattern of seasonal distribution is likely to be related to the life history of the algae, particularly the dispersal ability of spores. Satheesh and Wesley, (2007) have reported that *Gracilaria* sp. *Enteromorpha* sp. and *Ulva* sp., showed dense settlement during pre-monsoon and post monsoon months on test panels.

Table 1. Monthly variations (Mean) in Physico-chemical parameters during December 2007 – November 2008

Fortnights	pH	Dissolved oxygen (mg.l^{-1})	Salinity (%)	Phosphate-Phosphorus (µg.at.l^{-1})	Nitrite-nitrogen (µg.at.l^{-1})	Nitrate-nitrogen (µg.at.l^{-1})
December 2007	8.025	5.28	30.385	0.15	0.605	3.047
January 2008	8.02	5.95	30.11	0.572	0.239	0.925
February	8.04	5.375	30.755	0.325	0.46	2.33
March	8.005	6.34	30.11	0.305	0.46	3.2
April	7.76	8.162	31.49	0.9895	0.255	1.48
May	7.165	9.505	31.76	1.435	0.86	7.0
June	7.547	8.51	30.777	1.07	0.83	4.73
July	7.565	7.2	28.78	1.44	0.86	6.0
August	7.75	5.375	28.85	0.285	2.4	5.86
September	7.88	6.815	30.655	0.685	0.1	4.325
October	7.875	8.93	31.035	0.695	0.085	7.555
November	8.343	6.977	29.703	0.713	0.527	4.067

Table 2. Seasonal (%) distribution of seaweeds at Thirumullavaram during Dec. 2007 to Nov. 2008

Division Season	Premonsoon (%)	Monsoon (%)	Post monsoon (%)
Chlorophytes	45.45	64.29	52.89
Phaeophytes	15.70	Absent	13.0
Rhodophytes	38.84	35.71	34.11

Table 3. Monthly variation in the occurrence (%) of seaweeds

Months	Chlorophytes (%)	Phaeophytes (%)	Rhodophytes (%)
December	47.06	17.65	35.29
January	43.75	18.75	37.5
February	41.18	17.65	41.18
March	42.86	14.29	42.86
April	55.56	11.11	33.33
May	84.17	-	45.83
June	61.90	-	38.1
July	68.42	-	31.58
Aug	85	-	25
September	60	-	40
October	57.69	7.69	34.62
November	50	19.44	30.56

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