



Seasonal Studies on Marine algae of the Bhimili Coast, East Coast of India

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Abstract

Seasonal data on environmental and hydrographical parameters of surface waters at three different study sites of Bhimili Coast was studied along with occurrence and distribution of marine macro algae for a period of one year from March 2009 to February 2010. Minimum values of salinity, pH and temperature were recorded during winter months and maximum values were observed in the summer months. Turbidity of surface waters was maximum in monsoon seasons during June to August months due to the runoff of material from Gosthani River. Seasonal growth of marine macro algae at Bhimili Coast was studied by using 0.5x0.5M quadrat. A total of 39 marine algal species were recorded in 75 quadrat samples. Maximum number of species was collected during November to February months and minimum number of species (26) was reported during July to October months.

Keywords : Marine algae, Hydrographical, Physico-Chemical Characteristic features, distribution, frequency, Bhimili Coast

Introduction

Seasonal studies on marine macro algae of Indian waters from East and west coast of India and other islands were studied by various authors (Srinivasan, 1946, Gopala Krishnan, 1970; Umamaheswara Rao, 1972; Untawale, 1989; Kalimuthu et al 1995; Jayachandran, 1997; Selvaraj and Selvaraj, 1997; Mohammed et al 1999; Dhargalkar et al 2000; Kerkar, 2004; Venkataraman, 2005; Rath and Adhikary,

2005, 2006; Sulekha and Panikkar 2007). Seasonal studies on marine algae of the Visakhapatnam coast was studied by Umamaheswara Rao and Sreeramulu, (1964 and 1970). Numerical studies on marine algae of Visakhapatnam coast was carried out by Narasimha Rao(1984) and Prasanna Lakshmi(2009). But so far there was no report on the marine macro algae occurring at Bhimili coast, near Visakhapatnam, East Coast of India. In this present study an

attempt was made to investigate the hydrographical parameters of the Bhimili coastal waters and Gosthani estuary, seasonal occurrence and biomass of the marine macro algae at three different stations of Bhimili coast.

Material and methods

Bhimili is small coastal town which located 22 Kms away from the

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Visakhapatnam on the east coast of India between the latitudes $17^{\circ} 45^1$ N and the longitudes $83^{\circ} 16^1$ and $83^{\circ} 21^1$ E.(Fig.1) The River Gosthani opens into the Bay of Bengal in the Bhimili coast. Much of this coastline is sandy with rocky boulders of various sizes, protruding through the sand. Depending upon physical nature and vertical extent of substratum, three stations were selected in the present study.

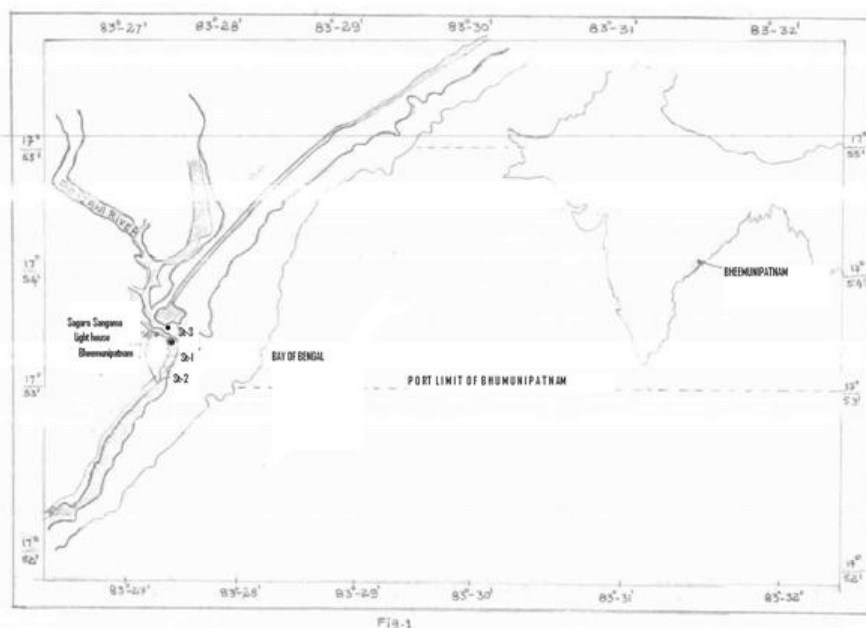


Fig:1. Study area

Hydrographical parameters of the study sites

Hydrographical parameters such as air and water temperature, salinity and pH were collected from all study sites from January 2009 to December 2009. Surface water samples were taken from the centre of the estuary and from seashore.

Temperature, pH and salinity were measured with a thermometer, portable pH meter, and salinometer respectively in all the sampling stations. Water transparency in the estuary and other study sites was determined by Secchi disc. Dissolved oxygen was estimated by the method given by Strickland and Parsons (1972).

Sampling of Intertidal Communities

Plants occurring at different study sites of the intertidal rocky surfaces were sampled at random. An aluminum frame of 0.5 x 0.5 M in size was placed on the rocky surfaces, and the vegetation was sampled, following the procedure described below. The number of species present in the quadrats was noted and cover values were estimated for species present in the entire quadrat. A total of 75 quadrat samples were taken from three stations (25 quadrats in each station) at the Bhimili Coast.

Algal materials from each quadrat was scraped and placed in polythene bag for laboratory study. Algae present in the quadrats were identified with the help of herbarium available in the Department of Botany, Andhra University and the publications of Umamaheswara Rao and Sreeramulu, (1970). The macro algae present in quadrats removed with help of the scalpel and the species were separated. The collections were sundried and then dried to a constant weight in an oven at 60° C temperature. In each station 5 to 6 samples were collected and average values of biomass collected between March 2009 to February 2010 were expressed as g. dry. wt./ m².

Results

Physico-Chemical Characteristic Features

Data on environmental, hydrographical and chemical parameters of the surface waters of three stations of the Bhimili Coastal region were presented in Table-1. Air temperature of the study sites was increased from January and attains maximum temperature in May (30.5°C) and decreased from June onwards with a minimum temperature in the month of November (24.5°C). Temperature of the surface waters in different stations of the Bhimili, shows same trend like air temperature (Table 1 to 3). Salinity values ranges from 28.0 to 32.0 ppt in all three stations. Comparatively, low saline values were reported at Station 3, which is an estuarine region receives fresh water. Maximum salinity values were reported in May and June months and minimum values in December and January months. Secchi disc values were collected including the estuarine region (Station 3). Turbidity of surface waters was maximum in monsoon season during June to August months due to the run off of materials from Gosthani River and nearby areas, and its leads to lower Secchi disc values (Table 1-3). The higher Secchi disc values were recorded in April and May months, when clear water was

observed. Among these stations, in Station-3 turbidity was more when comparing with others stations. pH of the surface waters varied seasonally and showed positive relationship to the seasonal changes in the

salinity (Table 1-3). No seasonal trend was observed in the dissolved oxygen content at the three stations, although seasonally the oxygen content in the surface waters varied from 7.0 to 7.8 ml/l.

Table : 1: Physico-Chemical Characteristics features at Station-I

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Air Temperature ©	26.5	27.5	28.0	28.5	30.5	29.5	28.5	28.5	28.0	26.5	24.5	25.0
Water Temperature ©	22.5	23.5	24.0	25.0	25.5	24.5	23.5	23.0	22.5	22.5	22.0	21.5
Secchi disc(cum)	16.0	17.0	17.0	17.0	18.0	12.0	12.0	14.0	16.0	17.0	17.0	17.0
Salinity (‰)	30.5	31.0	31.0	31.5	32.0	32.0	31.5	32.0	31.5	31.5	31.0	31.0
pH	7.2	7.4	7.7	7.5	7.6	7.3	7.5	7.8	7.5	7.7	7.4	7.4
D.O (ml/L)	7.5	7.1	7.3	7.5	7.1	7.3	7.5	7.1	7.3	7.5	7.1	7.3

Table-2:Physico-Chemical Characteristic features at Station-2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Air Temperature©	26.5	27.5	28.0	28.5	30.5	29.5	28.5	28.5	28.0	26.5	24.5	25.0
Water Temperature ©	22.5	23.5	24.0	25.0	25.5	24.5	23.5	23.0	22.5	22.5	22.0	21.5
Salinity (‰)	30.5	31.0	31.0	31.5	32.0	32.0	31.5	32.0	31.5	31.5	31.0	31.0
Secchi disc (cum)	16	17	17	18	18	14	14	14	16	16	16	17
pH	7.0	7.1	7.2	7.2	7.2	7.1	7.1	7.2	7.1	7.2	7.2	7.1
D.O (ml/L)	7.5	7.5	7.6	7.5	7.4	7.3	7.5	7.4	7.3	7.5	7.6	7.3

Table3: Physico-Chemical Characteristic features at Gosthani Estuary at Station- 3

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Air Temperature©	26.5	27.5	28.0	28.5	30.5	29.5	28.5	28.5	28.0	26.5	24.5	25.0
Water Temperature C	22.0	23.5	24.5	25.5	25.0	24.5	23.0	23.5	22.0	22.5	22.0	22.0
Secchi disc (cm)	15	15	17	18	20	14	12	12	15	16	16	15
Salinity (‰)	28.5	30.0	30.5	31.0	31.0	31.5	29.5	28.0	29.0	30.5	30.0	30.5
pH	7.0	7.2	7.1	7.2	7.2	7.1	7.0	7.0	7.1	7.1	7.2	7.1
D.O (ml/L)	7.2	7.3	7.2	7.4	7.2	7.2	7.4	7.3	7.3	7.4	7.2	7.2

Seasonal distribution of marine macro algae

Data collected on occurrence and distribution of Marine algae in three stations of the Bhimili Coast was presented in Table-4. In each season, 25 quadrats were sampled in all three stations. A total of 75 quadrats were sampled during March 2009 to February 2010. And thirty nine marine algal species were recorded; Table-4 shows the

seasonal occurrence of algae along the Bhimili coast. Species such as *Ectocarpus mithellae*, *Chnoospora minimum* *Dictyota dichotoma*, *Padina tetrastromatica*. *Sargassum species*, *Porphyra vietnamensis*, *Bangiopsis subsimplex* *Gracilaria textorii*, *Liagora visakhapatnamensis* and *Centroceras chavulatum* didn't record during the rainy season from July to October months.

Table-4:Seasonal distribution of marine algae at three stations

S.No.	Name of the Species	March - June	July - Oct.	Nov. - Feb
1	<i>Ulva fasciata</i> Delile	+	+	+
2	<i>Enteromorpha compressa</i> (L) Greville	-	+	+
3	<i>Chaetomorpha antennina</i> (Bory) Kutzing	+	+	+
4	<i>Cladophora socialis</i> Kutzing	+	+	+
5	<i>Spongomorpha indica</i> Thiviy at Visalakshmi	+	+	+
6	<i>Boodlea struveoides</i> Howe	-	+	+
7	<i>Bryopsis pennata</i> Lamouroux	+	+	+

8	<i>Caulerpa fastigata</i> J.Ag.	+	+	+
9	<i>Caulerpa racemosa</i> J.Agardh	+	+	+
10	<i>C.taxifolia</i> (Vahl.) C.Agardh	+	+	+
11	<i>C.sertularioides</i> Howe	+	+	+
12	<i>Ectocarpus mitchellae</i> Hamel	+	-	+
13	<i>Chnoospora minima</i> (papenfuss)	+	-	+
14	<i>Dictyota dichotoma</i>	-	-	+
15	<i>Padina tetrastratica</i> Hauck	+	-	+
16	<i>Sargassum vulgare</i> C.Agardh	+	-	+
17	<i>S.Ilicifolium</i>	+	-	+
18	<i>S.polycestum</i>	+	-	+
19	<i>S.tenerrimum</i>	+	-	+
20	<i>Porphyra vietnamensis</i> , Tanaka et HO	+	-	+
21	<i>Bangiopsis subsimplex</i> Schmitz	+	-	+
22	<i>Gelidiopsis variabilis</i> Schmitz	+	+	+
23	<i>Gelidium pusillum</i> Le Jolis	+	+	+
24	<i>Pterocladia heteroplatos</i> Umamaheswara	+	+	+
25	<i>Amphiroa fragilissima</i> Camouroux	+	+	+
26	<i>Jania rubens</i> Lamouroux	+	+	+
27	<i>Grateloupia lithophila</i> Borgesen	+	+	+
28	<i>Grateloupia filicina</i> C.Agardh	+	+	+
29	<i>Gracilaria corticata</i> J.Agardh	+	+	+
30	<i>G.textori</i>	+	-	+
31	<i>G.edulis</i>	+	+	+
32	<i>Hypnea valentiae</i> Montagne	+	+	+
33	<i>Gigartina acicularis</i> Lamouroux	+	+	+
34	<i>Liagora Visakhapatnamensis</i>	-	-	+
35	<i>Centroceros clavulatum</i>	-	-	+
36	<i>Bryocladia thwaitesii</i>	+	+	+
37	<i>Wrangelia argus</i>	+	+	+
38	<i>Lyngbya majuscula</i>	+	+	+
39	<i>Chara baltica</i>	+	+	+

Maximum numbers of species were reported from November to March /April months only. Seasonal forms occur during the winter season. Data collected on relative frequency of marine algae at three stations of the Bhimili Coast was presented in Table-5. In station-1, the relative frequency of *Ulva fasciata* was highest and value obtained was 81.5% and the lowest value was reported for *Wrangelia argus* with 2.1%, In Station-2, higher relative frequency values were recorded for *Ulva fasciata*, *Enteromorpha compressa*, *Chaetomorpha*

antennina, *Cladophora socialis*, *Spongomorpha indicia*, *Gracilaria corticata*, *Hypnea valentine*, *Amphiroa fragilishma* and *Jania robins*, And lower relative frequency values were reported for *Bangiopsis subsimplex*, *Porphyra vietnamensis*, *Ectocarpus michellae*, *Chnoospora minima*, *Lyngbya majuscula*, *Liagora visakhapatnamensis*, *Dictyota dichotoma* and *Wrangelia argus*. Similarly in Station-3, minimum number of species was reported with relative frequency ranges from 1.2 to 50.5%.

Table-5: Relative frequency of the macro algae at three stations

SL.NO	Name of the Species	Station-1 (%)	Station-2 (%)	Station-3 (%)
1	<i>Ulva fasciata</i>	81.5	72.6	45.4
2	<i>Enteromorpha compressa</i> (V.c.)	61.5	53.8	50.5
3	<i>Chaetomorpha antennina</i>	35.6	42.5	-
4	<i>Cladophora socialis</i>	42.0	41.2	-
5	<i>Cladophora utriculosa</i> Kutzing	-	-	-
6	<i>Spongomorpha indica</i>	56.7	62.8	34.5
7	<i>Boodlea struveoides</i>	-	26.6	-
8	<i>Bryopsis pennata</i>	21.5	18.4	-
9	<i>Caulerpa fastigiata</i>	25.6	31.5	-
10	<i>C. racemosa</i>	18.5	22.4	-
11	<i>C. sertularioides</i>	27.8	26.5	-
12	<i>Gelidiaceae:</i>	24.5	22.4	-
13	<i>Ectocarpus mitchellae</i>	5.5	4.5	-
14	<i>Chnoospora minima</i>	6.2	4.1	1.2
15	<i>Padina tetrastromatica</i>	10.2	8.9	-
16	<i>Sargassum vulgare</i>	21.5	25.6	-
17	<i>Bangiopsis subsimplex</i>	4.2	3.2	-
18	<i>Porphyra vietnamensis</i> Tanaka	5.1	2.8	-

19	<i>Gelidiopsis variabilis</i>	15.5	20.2	6.4
20	<i>Gelidium pusillum</i>	24.5	20.8	5.6
21	<i>Pterocladia heteroplatos</i>	18.5	16.4	-
22	<i>Amphiroa fragilissima</i>	42.5	51.5	-
23	<i>Jania rubens</i>	34.5	42.7	-
24	<i>Grateloupia lithophila</i>	12.4	9.7	-
25	<i>Grateloupia filicina</i>	18.5	11.2	-
26	<i>Gracilaria corticata</i>	71.5	64.3	29.5
27	<i>Hypnea valentiae</i>	67.5	59.4	-
28	<i>Gigartina acicularis</i>	18.5	17.4	-
29	<i>Centroceros clavulatum</i>	21.5	17.6	-
30	<i>Bryocladia thwaitesii</i>	14.2	9.4	-
31	<i>Lyngbya majuscula</i>	4.1	3.4	2.8
32.	<i>Liagora visakhapatnamensis</i>	5.4	4.0	-
33.	<i>Dictyota dichotoma</i>	6.8	3.0	-
34.	<i>Gracilaria edulis</i>	-	-	20.8
35.	<i>Wrangelia argus</i>	2.1	1.8	-
36.	<i>Sargassum ilicifolium</i>	20.4	21.5	-
37.	<i>S.polycystum</i>	15.2	16.7	-
38.	<i>S.tenneramum</i>	8.4	9.6	-

Biomass of the Marine algae at different stations of the Bhimili Coast was estimated and was presented in Table 6 to 8. Table 6 shows the Biomass of the Marine algae in different seasons of the year. Maximum biomass values were reported for the *U.fasciata*, *S.ilicifoliuim* and *Enteromorpha compressa* and seasonally more numbers of species and higher biomass values were reported in winter season from November to February months (Table-6). Biomass in different seasons of the year at station-2, was presented in Table-7. In Station 2,

minimum biomass values (0.3 to 2.0 g/m²) were obtained for the species *Ectocapus mitchellae*, *Chnoospora minima*, *Bangiopsis subsimplex*, *Porphyra vietnamensis*, *C.racemosa*, *G.variabilis*, *G.pusillum*, *G.acicularis*, *Lyngbya majuscula* and *Wrangelia argus*. The highest biomass values were obtained for *U.fasciata*, *Spongomorpha indica* and *Amphiroa fragillissima* (Table-7). In station 3 (Table-8) poor bio-diversity was reported, estuarine species were dominant and occupied the maximum area and higher biomass values

were reported for *Chara baltica* (20.4 g/m²) and *Gracilaria edulis* (16.5 g/m²). These two are the new reports from

Visakhapatnam and Coastal regions of Andhra Pradesh.

Table-6: Marine algal biomass in three seasons at station-1.

S.NO	Name of the Species	March-June (g/m ²)	July-Oct. (g/m ²)	Nov.-Feb. (g/m ²)
1	<i>Ulva fasciata</i>	9.5	6.4	7.8
2	<i>Enteromorpha compressa</i>	5.2	2.8	3.4
3	<i>Chaetomorpha antennina</i>	1.9	2.3	0.4
4	<i>Cladophora socialis</i>	2.5	6.5	1.2
5	<i>Spongomorpha indica</i>	4.2	2.1	3.8
6	<i>Bryopsis pennata</i>	0.9	0.7	1.4
7	<i>Gelidiopsis variabilis</i>	0.5	1.2	1.5
8	<i>Gelidium pusillum</i>	1.4	1.1	1.4
9	<i>Pterocladia heteroplotos</i>	2.1	2.3	1.8
10	<i>Amphiroa fragilissima</i>	0.8	0.6	2.1
11	<i>Grateloupia lithophila</i>	0.6	0.4	0.3
12	<i>Grateloupia filicina</i>	2.4	2.7	1.4
13	<i>Gracilaria corticata</i>	4.5	5.2	8.2
14	<i>Hypnea valentiae</i>	3.9	3.4	7.9
15	<i>Gigartina acicularis</i>	0.2	0.4	2.5
16	<i>Centroceros clavulatum</i>	-	-	-
17	<i>Bryocladia thwaitesii</i>	3.5	2.6	1.0
18	<i>Lyngbya majuscula</i>	0.2	0.3	0.5
19	<i>Caulerpa taxifolia</i>	4.2	3.4	2.1
20	<i>C.racemosa</i>	2.1	2.0	1.5
21	<i>C.fastigiata</i>	3.5	3.2	2.0
22	<i>C.sertularioides</i>	1.4	1.6	1.9
23	<i>Ectocarpus mitchellae</i>	0.1	-	0.4
24	<i>Liagora visakhapatnamensis</i>	-	-	1.8
25	<i>Dictyota dichotoma</i>	-	-	3.1
26	<i>Porphyra vietnamensis</i>	2.1	-	2.3
27	<i>Centroceros clavulatum</i>	-	-	21.2
28	<i>Sargassum ilicifolium</i>	6.1	-	6.7

Table-7 : Marine algae biomass in three seasons at Station-2

S.NO	Name of the Species	March-June (g/m ²)	July-Oct. (g/m ²)	Nov.-Feb. (g/m ²)
1	<i>Ulva fasciata</i>	10.5	6.3	5.4
2	<i>Enteromorpha compressa</i>	8.2	1.4	1.8
3	<i>Chaetomorpha antennina</i>	1.9	2.5	1.9
4	<i>Cladophora socialis</i>	3.0	2.5	4.1
5	<i>Spongomorpha indica</i>	6.7	7.2	7.8
6	<i>Boodlea struveoides</i>	-	2.6	6.2
7	<i>Bryopsis pennata</i>	4.1	2.8	3.4
8	<i>Caulerpa fastigiata</i>	3.2	4.1	4.5
9	<i>C. recemosa</i>	1.2	1.0	1.6
10	<i>C. sertularioides</i>	3.2	2.4	4.1
11	<i>C.taxifolia</i>	4.5	3.4	5.1
12	<i>Ectocarpus mitchellae</i>	-	-	0.6
13	<i>Chnoospora minima</i>	-	-	0.5
14	<i>Bangiopsis subsimplex</i>	-	-	1.6
15	<i>Porphyra vietnamensis</i>	-	-	1.1
16	<i>Gelidiopsis variabilis</i>	0.8	1.5	1.9
17	<i>Gelidium pusillum</i>	1.4	1.2	1.7
18	<i>Pterocladia heteroplotos</i>	3.2	4.1	4.8
19	<i>Amphiroa fragilissima</i>	12.5	11.4	14.6
20	<i>Jania rubens</i>	3.1	2.1	2.6
21	<i>Grateloupia filicina</i>	2.9	2.2	2.6
22	<i>Gracilaria corticata</i>	6.4	7.1	10.5
23	<i>Hypnea valentiae</i>	5.1	4.2	5.8
24	<i>Gigartina acicularis</i>	0.3	0.5	0.7

25	<i>Centroceros clavulatum</i>	-	-	2.6
26	<i>Bryocladia thwaitesii</i>	4.2	3.1	2.9
27	<i>Lyngbya majuscula</i>	0.3	0.3	0.6
28	<i>G.textorii</i>	2.1	-	2.6
29	<i>Wrangelia argus</i>	21	-	2.6
30	<i>Sargossum vulgare</i>	5.4	-	6.9
31	<i>S.polystum</i>	5.0	-	7.2
32	<i>S.tenerrimum</i>	4.3	-	6.0

Table-8_Marine algal biomass in three seasons at Station-3

S.NO	Name of the Species	March-June (g/m ²)	July-Oct. (g/m ²)	Nov.-Feb. (g/m ²)
1	<i>Ulva fasciata</i>	8.4	5.3	7.2
2	<i>Enteromorpha compressa</i>	3.5	4.2	3.1
3	<i>Spongomorpha indica</i>	5.9	7.2	6.8
4	<i>Caulerpa taxifolia</i>	2.3	7.1	1.2
5	<i>Chnoospora minima</i>	-	0.1	-
6	<i>Padina tetrastrumatica</i>	-	-	2.0
7	<i>Gelidiopsis variabilis</i>	0.6	1.1	1.2
8	<i>Gelidium pusillum</i>	1.2	1.0	1.5
9	<i>Grateloupia filicina</i>	2.8	2.0	1.5
10	<i>Gracilaria corticata</i>	5.4	6.1	9.4
11	<i>Gigartina acicularis</i>	0.5	0.3	1.2
12	<i>Centroceros clavulatum</i>	-	-	2.5
13	<i>Gracilaria edulis</i>	15.5	12.8	17.4
14	<i>Chara baltica</i>	20.4	16.5	21.5

Discussion

Hydrographical and chemical studies were conducted at three stations including one estuary at Bhimili coastal region during March 2009 to February 2010. There is no significant variation in air and water temperature among these stations. Lower transparency (Secchi disc) values were reported during June to August months in all stations. Lower transparency values indicate the maximum turbidity in the water. But in summer months clear water was seen both in estuarine and other two stations. p^H of the surface water in all the stations shows the positive correlation with salinity values and dissolved oxygen of the surface water.

Quantitative data was collected on frequency and biomass of marine macro algae along the Bhimili coast for a period of one year. Thirty nine marine algae were reported from the coastal region. Maximum number of species was reported during the winter months from November to February, while minimum numbers of species were reported in rainy season between July to October months. Seasonal studies on marine algae along the Indian shores were studied by several authors. Most of the earlier studies related to inter tidal zonation of flora and fauna based on descriptive and

quantitative work (Srinivasan, 1946; Misra, 1960; Umamaheswara Rao, 1964; Gopala Krishnan, 1970). Untawale *et al* (1989) described the ecology of intertidal benthic algae of northern Karnataka coast and reported 65 species with maximum biomass of algal species during December and February months. Similarly Oza *et al* (1991) studied the growth and phenology of *Gracilaria verrucosa* and observed peak growth period during January February months.

In the present study, maximum numbers of species were reported in winter months from November to February. These observations agree with the findings of Untawale *et al* (1989) at Northern Karnataka coast and Oza *et al* (1991) at west coast of India. Distribution and seasonal studies of marine algae at Visakhapatnam coast was studied by Umamaheswara Rao and Sreeramulu (1964) and have reported 80 algal species. Narasimha Rao (1984) collected the quantitative data on marine algae and reported only 38 marine macro algae from Visakhapatnam coast. Recently, Prasanna Lakshmi (2009) collected the data on some numerical studies on marine algae and reported 31 marine algal species at Visakhapatnam coast.

Present investigation on seasonal studies of marine algae at Bhimili coast indicates that gradual reduction of algal populations from the intertidal regions of Bhimili coast when comparing with the studies of Umamaheswara Rao and Sreeramulu (1964). Species like *Pseudobryopsis mucronata* and *Gracilariopsis sjoestedii* are completely disappearing from this coast. Species like *Chnoospora minima*, *Bangiopsis subsimplex*, *Caulerpa racemosa*, *Gelidiopsis variabilis*, *Gelidium pusillum*, *Gigantina acicularis*, *Lyngbya majuscula* and *Wrangelia argus* shows very low biomass values as reported by Prasanna Lakshmi and Narasimha Rao (2009) at Visakhapatnam coast. Changes in the climatic conditions, pollution from the aqua industries near Gosthani estuary, untreated sewage from town region and indiscriminate collection of algae and human interference may be the reasons for the loss of bio-diversity and disappearing of algal species from Bhimili coast..

References

Dhargalkar, V.K., Untawale a.G. and Jagtap, T.G. 2001. Marine and Macro Algal Diversity along the Maharashtra Coast; Post

Present Status. Indian J. Mar. Sci., Vol.30(1).

Gopalakrishnan, P.1970. Some observations on the Shore Ecology of Okha Coast. J. Mar. bio.Ass. India 12: pp. 15-34.

Jayachandran, V. and Ramaswamy, V. 1997. Algae from Pondicherry Coast. Seaweed Res. Utiln. Vol.19, No.1&2, pp.17-20.

Kalimuthu, S. Kaliperumal, N and ramalingam, J.R. 1995. Distribution of Algae and Sea grasses in the Estuaries and Back Waters of Tamil Nadu. Seaweed Res. Utiln. Vol.17, No.1&2, pp.79-86.

Kerpar, V.2004. Addition to Marine algal Flora of Goa. Seaweed Res. Utiln., Vol.36, No.1- 3, pp.19-21.

Misra, J.C.1960. The Ecology, distribution and Seasonal succession of the Littoral Algae on the West Coast of India. Proc. Symp. Algology (Ed. P.Kachroo) I.C.A.R.New Delhi, pp.187-203.

Mohammed, G., Nasser, A.K.V. and Koya, C.V.H.1999. Distribution and Abundance of Seaweeds on the Coral Reef at Mincoy Island Lakshadweep. Seaweed Res. Utiln. Namakkal, Vol.22, No.1-2pp 7-13.

Narasimha Rao, G.M. 1984. A quantitative study on intertidal zonation at Visakhapatnam. M.Phil, Dissertation. 1-49.

Oza, R.M., Tewari, A. and Rajyaguru, M.R. 1991. Growth and Phenology of Red alga *Gracilaria verrucosa* (Huds.) Papenf. Indian J. Mar. Sci., Vol. 18, No.2, pp. 82-86

Prasanna Lakshmi, K.2009 some numerical studies on marine algae of Visakhapatnam Coast. M.Phil, Dissertation. 1-57.

Prasanna Lakshmi and G.M.Narasimha Rao. 2009. Some numerical studies on Marine algae of Visakhapatnam Coast. *J.Algal Biomass Utiln.* 1(1) 60-85.

Rath, J. and Adhikary, S.P. 2005. Distribution of Marine Macro Algae at Different Salinity Gradients in Chilika Lake India. Indian J. Mar. Sci., Vol.34, No.2, pp.237-241

Rath, J. and Adhikary, S.P. 2006. Marine Macro Algae of Orissa, East Coast of India. *Algae*, Vol.21, No.1, pp.49-59.

Selvaraj, R. and Selvaraj, R. 1997. Distribution and Diversity of Seaweeds In Tiruchendur and Idianthakarai. *Seaweed Res. Utiln.*, Vol.19, No.1 & 2, pp.115-123

Srinivasan, K.S. 1946. Ecology and Seasonal Succession of the Marine Algae Mahabalipuram (Seven pagodas) Near Madras. Indian Bot. Soc. M.O.P. Iyengar Com, Vol. (Ed. B.Sahni) pp.267-278

Sulekha, S. and Panikkar, M.V.N. 2007. Marine Green Algal Flora of Kollam Coast, Kerala, South india *Seaweed Res. Utilin.*, Vol.28 No.1, pp. 5-21

Umamaheswara Rao, M. 1972. Ecological Observations on Some Intertidal Algae of Mandapam Coast. In; Proc. Indian Nat. Sci. Acad., Vol.38, Part-B, pp. 298- 307

Umamaheswara Rao, M. and Sreeramulu, T.1964. An Ecological Study of Some Intertidal Algae of the Visakhapatnam Coast. *J.ecol.*, Vol. 52, pp.595-616.

Umamaheswara Rao, M. and Sreeramulu, T.1970. An Annotated List of The Marine Algae at Visakhapatnam (India). *Bot. J.Linn. Soc.*, Vol.63, pp.23- 45

Untawale, A.G., Reddy, C.R.K. and Deshmukhe, G.V. 1989. Ecology of Intertidal Benthic Algae of Northern Karnataka Coast. Indian J. Mar. Sci., Vol.18, No.2, pp.73- 81

Venkataraman, K.2005. Coastal and Marine biodiversity of India. Indian J. Mar. Sci., Vol.34, No.1, pp.57-75