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Distribution and abundance of seaweeds on a coral reef at Minicoy Island, Lakshadweep

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ABSTRACT

Macroalgal distribution and abundance in different regions of a coral reef was studied for a period of one year in 1998 at Minicoy Island, Lakshadweep. The biomass distribution of algae on the seaward side of the reef varied from 620.2 g wet wt. / m^2 in September to a maximum of 2800.6 g wet wt / m^2 in August. Reef flat had a minimum in July (251 g wet wt / m^2) and a maximum in December (2074.9 g wet wt / m^2). Significant seasonal differences were noticed in the three regions with maximum biomass during monsoon on the seaward side and in the postmonsoon at reef flat and lagoon side of the reef. *Laurencia ceylanica* formed a continuous mat on the seaward side and *Halimeda gracilis* (56.0%) and *Turbinaria ornata* (32.0%) were major algae of the reef flat and lagoon side of the reef. Minor algae observed on the reef were *Gelidiella acerosa*, *Boergesenia forbesii*, *Sargassum duplicatum* and *Cladophoropsis zollingeri*. Hydrographical parameters such as water temperature, salinity, nutrients, rainfall and hours of exposure of algae were monitored.

Introduction

Macroalgae typically show high pecies diversity and cover on coral reefs. The lgal distribution of coral reefs and atolls of .akshadweep have been reported (Anon, 979; George *et. al.*, 1986; Jagtap, 1987; Kaliaperumal *et. al.*, 1989; Chennubhotla, 1992). Untawale and Jagtap (1984) studied the macrophytes of Minicoy. Kaladharan and Kandan (1997), Gulshad Mohammed *et. al.* (1999) and Hanefakoya *et. al.* (1999) studied the productivity of seaweeds in Minicoy. Coral reef algae exhibit definite seasonal variation that are linked to changes in environmental factors (Hillis-Collinvaux, 1980; Martin-Smith, 1993; Santelices, 1997). The present study reports the seasonal distribution of algae at three sites of a reef in Minicoy. Environmental parameters that influence the distribution is also elucidated.

Materials and Methods

The sutdy site is located on the south-west side of Minicoy Island between the main island and islet of Wiringli (Fig. 1). The total width of the reef at the sample site is 110 m and at the reef flat is 30 m. The seaward side extends from the reef flat to a distance of 30 m and slopes down to 25 m depth contour. The reef is directly exposed to the action of

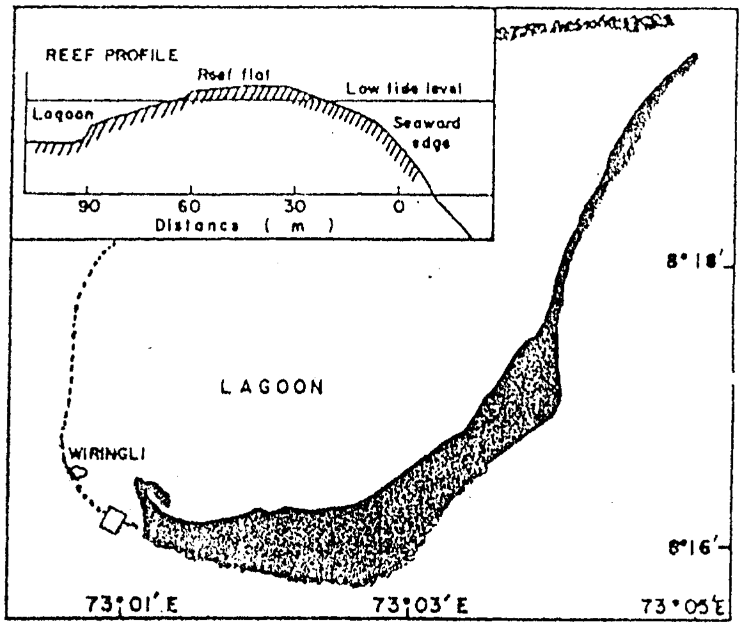

Fig. 1. *Map of Minicoy Island, Lakshadweep showing location and a profile of reef studied.*

incoming waves and the dominant corals noticed are *Pocillipora damicornis* and *Porites* spp. (Pillai, 1972). On the lagoon side, the reef flat edge slopes down gradually forming a protected area behind the reef flat.

Triplicate transects were drawn across the reef and monthly algal samples were collected at random from three sites of the reef for a period of one year using a quadrat of 0.25 sq. m. Water samples were collected from each site for analysis of hydrological parameters. Water movement across the reef was measured using a thermocole piece of size 4.5 x 3.5 x 3.3 cm. Rainfall data for the year was collected from the Materiological Station at Minicoy. Hours of exposure was calculated for each month from the Indian tide table.

In the laboratory, individual species of algae was sorted, washed and weighed. Water temperature was measured at site and salinity estimated by Mohr's titration method. Nutrients were monitored using the method of Strickland and Parsons (1972).

Results

The total biomass of algae varied significantly during the period of study at seaward side with minimum biomass (620.[illegible] g wet wt / m^2) in September to a maximum in August (2800.6 g wet wt/m^2) (Table 1). Reef flat showed minimum biomass in July (251 g wet wt / m^2) and a maximum in December (2074.9 g wet wt / m^2) while on lagoon side a minimum of 552.4 g wet w/m^2 was recorded and a maximum in December (2510.8 g wet wt/m^2) (Table 1). Maximum biomass was observed during monsoon season on the seaward side and in the post monsoon at reef flat and lagoon side of the reef (Table 1).

Table 1. *Monthly average biomass (g wet wt / m²) of algae at the three sites.*

Months	Seaward side	Reef flat	Lagoon side
January	830.2	811.3	900.3
February	880.7	601.7	873.5
March	683.2	604.3	882.4
April	711.5	608.6	1071.3
May	645.3	1143.2	790.7
June	1013.3	901.4	552.4
July	1928.6	251.0	805.6
August	2800.6	304.3	1204.2
September	620.2	601.3	624.7
October	1303.9	1480.4	1935.6
November	1213.2	1671.7	2161.3
December	953.1	2074.9	2316.8

The red alga *Laurencia ceylanica* formed a continuous mat on the seaward side and constituted more than 90% of total biomass from March to October (Table 2). *Halimeda gracilis* was the other major species on the reef flat at lagoon with 83-99% during February to June / July. The alginopyhte *Turbinaria ornata* was about 76% on the reef flat from August to September and in the lagoon side 42% from October to December (Table 2). The relative abundance of minor algae such as *Gelidiella acerosa, Boergesenia forbesii, Sargassum duplicatum* and *Cladophoropsis zollingeri* was low (Table 2).

Hydrological parameters did not show significant variations between sites and therefore the data were averaged to represent the reef as a whole (Table 3). Water movement was comparatively less during premonsoon months while hours of exposure showed an increasing trend from premonsoon to postmonsoon months. Significant correlations were observed between the total biomass, biomass of individual species and environmental variables (Table 4). Nutrients were negatively correlated with biomass. Total biomass and *H. gracilis* of reef flat were positively correlated with water movement. Hours of exposure also showed positive correlation with total biomass and *T. ornata* (Table 4).

Discussion

The algal diversity of the reef is low since only 10 species were recorded in this study. Seaward side was dominated by *Laurencia ceylanica* (Table 2). Calcareous alga *Halimeda gracilis* dominated the reef flat and lagoon side of the reef. Gulshad Mohammed *et. al.* (1998) studied role of *Halimeda* in the reef of Minicoy Island. The macroalgae showed an increase in species number and diversity from seaward side to the lagoon side. However Morrisey (1980) reported an opposite trend on a fringing reef flat of Magnetic Island. The high percentage of some macroalgae on Minicoy reef reflects their ability to successfully colonise the reef even under environmentally unfavourable conditions. Morrisey (1980) attributed the dominance of some species to short generation time, rapid growth rates, oppurtunist life histories and wide tolerence levels.

Seasonal changes in algal populations of reefs have been reported (Tsuda, 1974; Silva *et. al.*, 1987; Price, 1989; Martin-Smith, 1993; Vuki and Price, 1994). A definite seasonality is observed in the present study with maximum biomass during monsoon on the seaward side and in the postmonsoon on reef flat and lagoon side. Major species that contributed to this variation were *Laurencia ceylanica, Halimeda gracilis* and *Turbinaria ornata.*

Seasonal variation in nutrient levels have been suggested as a factor influencing the algal biomass (Prince and O'Neal, 1979; Ang, 1985). Nitrate and phosphate levels at Minicoy are low as expected of oligotrophic waters in coral reefs. The negative relationships observed in the present study seems to

Table 2. *Monthly changes in total biomass (g wet wt / m²) and biomass of percentage distribution of different species of algae at the 3 sites on a reef at Minicoy.*

I. Seaward side :

Species	J	F	M	A	M	J	J	A	S	O	N	D	Biomass
A	61.5	67.8	91.6	97.7	97.6	98.6	99.6	99.0	98.9	90.5	88.3	74.9	12334.1
B	1.1	0.9	1.8	1.8	1.3	0.9	-	0.2	0.1	0.3	0.4	0.5	81.5
C	1.2	0.5	0.5	0.5	1.1	0.3	0.4	0.8	1.0	2.0	2.0	1.6	135.8
D	36.2	30.8	6.1	-	-	-	-	-	-	7.2	9.3	23.0	1032.4
E	-	-	-	-	-	0.2	-	-	-	-	-	-	1.4
Total biomass													13585.2

A - *Laurencia ceylanica;* B - *Gelidiella acerosa;* C - *Boergesenia forbesii;* D - *Halimeda gracilis;* E - *Gelidiopsis variabilis*

II. Reef flat :

Species	J	F	M	A	M	J	J	A	S	O	N	D	Biomass
A	77.6	92.5	91.8	92.7	97.5	95.1	68.1	6.5	1.5	33.5	30.3	34.9	6190.3
B	3.9	7.2	8.2	5.9	1.2	1.2	7.4	0.6	0.6	1.3	1.2	1.1	265.3
C	5.1	-	-	-	0.4	2.0	16.7	21.6	16.0	12.1	12.2	14.8	961.7
D	-	-	-	1.4	0.8	0.5	-	-	-	0.1	-	-	22.1
E	-	-	-	-	0.1	0.3	-	-	-	-	-	-	[illegible]
F	13.1	-	-	-	-	0.8	7.8	71.3	81.7	50.2	55.5	48.8	3537.3
G	0.3	0.3	-	-	-	0.1	-	-	0.1	2.8	0.8	0.4	66.3
H	-	-	-	-	-	-	-	-	0.1	-	-	-	1.1
Total biomass													11047.4

A - *Halimeda gracilis;* B - *Gelidiella acerosa;* C - *Sargassum duplicatum;* D- *Boergesenia forbesii;* E. *Gelidiopsis variabilis;* F - *Turbinaria ornata;* G - *Laurencia ceylanica;* H - *Jania capillacea*

III. Lagoon side :

Species	J	F	M	A	M	J	J	A	S	O	N	D	Biomass
A	53.3	93.7	99.5	96.1	96.5	83.0	93.0	88.2	59.5	59.0	53.5	55.5	10193.8
B	-	-	-	-	-	0.6	0.07	0.07	-	-	-	-	4.2
C	0.03	0.2	-	-	0.5	2.0	-	0.2	1.2	0.2	0.06	0.04	32.5
D	0.1	-	0.02	0.04	-	-	-	0.2	0.05	-	0.06	0.02	5.7
E	46.4	5.8	-	0.1	1.6	7.2	6.9	11.2	38.6	41.8	45.6	44.3	3741.3
F	0.1	0.2	0.2	3.7	1.4	5.4	0.02	0.2	0.6	-	0.6	0.1	165.9
G	-	-	0.01	0.09	-	-	-	-	-	-	-	-	1.4
H	-	-	-	-	-	1.1	-	-	-	-	-	-	5.7
I	0.1	-	0.2	-	-	0.7	-	-	-	-	0.06	0.04	9.9
Total biomass													14160.4

A - *Halimeda gracilis;* B - *Laurencia ceylanica;* C - *Boergesenia forbessii;* D - *Sargassum duplicatum;* E - *Turbinaria ornata;* F - *Gelidiella acerosa;* G - *Ulva rigida;* H - *Struvea* sp.; I - *Cladophoropsis zollingeri*

Table 3. *Seasonal variation in hydrographical parameter in the study area during 1998*

Parameter	Pre monsoon	Monsoon	Postmonsoon
Water temperature (°C)	29.0 ± 0.79	29.4 ± 1.02	28.6 ± 0.43
Salinity (ppt)	33.8 ± 0.35	33.7 ± 1.06	34.3 ± 0.43
Phosphate (μ at/l)	0.60 ± 0.14	0.66 ± 0.14	0.35 ± 0.25
Nitrate (μ at/l)	0.39 ± 0.06	0.58 ± 0.15	0.39 ± 0.24
Water movement (m/s)	0.29 ± 0.14	0.35 ± 0.19	0.35 ± 0.09
Rainfall (mm)	22.4 ± 36.80	111.12 ± 48.84	91.75 ± 66.17
Hours of exposure	43.8 ± 49.6	121.30 ± 113.5	165.0 ± 269.8

Table 4. *Correlation coefficient (P<0.05) for biomass changes of major species of algae correlated with environmental parameters.*

Location	Species	Temp.	Salinity	Phosphate	Nitrate	Water movement	Rainfall	Hours of Exposure
Seaward	A	ns	ns	ns	ns	ns	ns	ns
Reef flat	B	-0.592	ns	ns	-0.478	0.627	ns	ns
Reef flat	C	ns	0.517	-0.523	ns	ns	ns	0.488
Lagoon	B	ns	ns	-0.648	-0.602	ns	ns	ns
Lagoon	C	-0.412	0.476	-0.832	-0.541	ns	ns	0.417
Biomass		ns	ns	-0.658	-0.622	0.487	ns	0.595

A - *Laurencia ceylanica;* B - *Halimeda gracilis;* C - *Turbinaria ornata;* *ns - not significant*

indicate that the nutrients may not influence the biomass changes of algae of the reef of Minicoy.

Santelices (1977) did not find any relation between water movement and total biomass at Hawaii. However Doty (1961) concluded that increased water movement or frequency of storms can reduce frondose algal biomass on the reef. At Minicoy, the water movement is cyclic and predictable and of lesser intensity than reported by Doty (1961). In the present study water movement positively correlated with the biomass and biomass of *H. gracilis* on the reef flat. The intensity of water movement is maximum at the reef flat and the force reduces dreastically as its flows over the lagoon side. The nature of the reef flat and its downward slope on the lagoon side provide a protected zone for the algae. This may probably help in the development of *H. gracilis* and *T. ornata* from reef flat to the inner lagoon areas. Monsoons are important in influencing the algal biomass (Misra, 1960; Tsuda, 1974; Sofiamma *et. al.*, 1991). An increasing trend from premonsoon to postmonsoon in total biomass is observed at Minicoy as reported by Misra (1960) Tsuda (1974) and Sofiamma *et. al.* (1991).

Desiccation is an obvious factor controlling algal biomass when exposed to prolonged low spring tides (Tsuda, 1974; Price, 1989; Martin-Smith, 1993; Vuki and Price, 1994). Hours of exposure surprisingly seems to have a positive effect on biomass in the present investigation. If the low spring tides occur during the noon period, i.e. between 10.00 and 15.00 hrs, the algae will be exposed to great intensity of the sun.

Low spring tides occur only in the early morning hours and late evening hours at Minicoy. So the duration of exposure is only for a period of 1-2 hrs. As shown by Doty (1946) and Lawson (1957), the duration at which algae are exposed is the critical factor.

The above account reveals that the algal biomass of the reef at Minicoy is controlled by environmental factors such as water movement, monsoons and the hours of exposure of algae due to the tides.

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