

Seasonal variation in the growth of marine red alga *Asparagopsis delilei* (Rhodophyta/ Bonnemaisoniales) from the Mandapam region, southeast coast of India

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The growth of *Asparagopsis delilei* and other seaweeds have been described from Putty and Valai Islands of Mandapam region from August 1993 to March 1995. At both the islands, plants started appearing on the reef from August, attained maximum growth during November – March and subsequently disappeared gradually from the reef. Antheridial and cystocarpic plants and tetrasporic phase (*Falkenbergia*) of *Asparagopsis delilei* were recognised. A positive correlation was observed between length and fresh weight, whereas, negative correlation was observed between algal biomass and the environmental parameters such as salinity and temperature of seawater. Thirty-two taxa were found in association with *A. delilei* at both the islands. Of these, *Sargassum wightii* and *Chondrococcus hornemanii* were occurring throughout the study period. The results indicated good biomass of *A. delilei* can be harvested from these islands during its peak growth period December and January to meet our iodine requirements partially.

Seaweeds are known to concentrate iodine many times than that present in ambient seawater. Though, some efforts were made for determination and extraction of iodine from the Indian seaweeds¹⁻⁷, not much work has been done to explore the availability of iodine rich seaweed *Asparagopsis delilei* Montagne. However, the recent studies from Hanumandandi reef, Okha coast (west coast of India)⁸ and from different islands of Mandapam region (southeast cost of India)⁹ have revealed some estimable quantities of *Asparagopsis* for exploitation. These studies were confined only to particular season of the year. This alga contains considerable quantity of iodine⁵, but detailed information on the growth of alga is lacking. Therefore, the present study has been carried out from two islands off Mandapam coast, to understand the growth pattern of the alga throughout the year and its relationship with some environmental factors.

Materials and Methods

Putty and Valai islands are located in the Gulf of

Mannar (lat. 9° 14' - 9° 17' N; long. 79° - 79° 13'E). In both islands red alga *Asparagopsis delilei* Montagne (Rhodophyta/Bonnemaisoniales) occurs in subtidal region at 2.0 to 2.5 m depth, below the zero level of the chart datum, attached to the rocky substratum impregnated with coral stones. This study was carried out for 14 months during August 1993 to March 1995. Every month algal growth data were collected following the quadrat method described by Baardseth¹⁰. The entire seaweed population was collected from 5 randomly placed quadrat of 0.25 m² area, after recording percentage cover of *Asparagopsis* and other seaweeds. Fresh weight of *Asparagopsis* plants was recorded after removing their surface moisture and moisture content was also estimated. The plants were sorted out into cystocarpic and antheridial ones and length of 10 plants were measured. To study the distribution of different size groups in the population, erect fronds were divided into 3 groups: Group I (<8 cm), Group II (8-16 cm) and Group III (>16 cm) and their percentage frequency in each month was calculated.

Every month, temperature and salinity of the seawater collected at the study site, were determined. The correlation coefficient ' r ' and significant level (P) between the parameters, biomass vs salinity, biomass vs seawater temperature and individual frond biomass vs length were calculated.

Mean and standard error for length and fresh weight of individual frond, biomass fresh weight, percentage cover and number of plants per quadrat were determined. The Students' t test was performed for length of the plants to know the significance of the plants length at a particular habitat. Extension growth rate and relative growth rate were also calculated. In the present study, the data from April to July / August could not be collected, due to the prevailing rough sea conditions influenced by southwest monsoon.

Results and Discussion

Seasonal growth behavior

Seasonal variation in length and fresh weight of the frond showed more or less a similar pattern (Fig.1). The maximum length of 15.17 ± 0.4 cm and fresh weight of 1.47 ± 0.2 g of the frond were observed during September '93 and March '94 at Putty island, and the maximum length of 15.0 ± 0.1 cm and fresh weight of 1.1 ± 0.1 g of the frond were recorded during February '95 at Valai island. The maximum length and fresh weight recorded in the present study are very much lower when compared to those recorded at the Okha coast¹¹. Length vs fresh weight showed positive correlation (Putty island = 0.812 $P < 0.001$; Valai island = 0.699 $P < 0.01$) unlike those reported in *Gracilaria crassa*¹², where a negative correlation was seen. The extension growth rate (EGR cm/month) varied from 0.38 to 4.23 at Putty island and 0.81 to 2.43 at Valai island (Table 1). The ' t ' value calculated from mean length of frond was found to be non-significant (Putty island = 2.038; Valai island = 0.789).

Data on seasonal abundance of fronds of 3 size classes viz., Group I (< 8 cm), Group II (8-16 cm) and Group III (>16 cm) for the period from August '93 to March '95 are shown in Fig. 2. Group II plants were observed in maximum number (88%) during October '93 / December '94 at Putty island, and (94%) during October '93 at Valai island. While Group I plants showed maximum number (86%) during March '95 at Putty island, and (62.1%) in March '94 at Valai

Table 1—Monthly variation in extension growth rate and relative growth rate of *Asparagopsis delilei* at Putty and Valai islands

Month/ Year	Putty island		Valai island	
	EGR (cm./mon)	RGR g(fr.wt)/ g/d	EGR (cm./mon)	RGR g(fr.wt)/ g/d
Sep'93	0.38	0.005	*	*
Oct	-	-	0.91	-
Nov	*	*	0.81	0.046
Dec	-	-	-	0.056
Jan '94	2.31	0.051	*	*
Feb	4.23	-	1.61	-
Mar	-	0.038	-	-
Oct	0.51	0.042	0.88	0.051
Nov	-	-	2.01	-
Dec	4.12	0.053	1.13	0.031
Jan '95	-	-	2.43	0.004
Feb	-	-	2.06	-
Mar	-	0.017	-	-

* Data not available

- No increase in growth

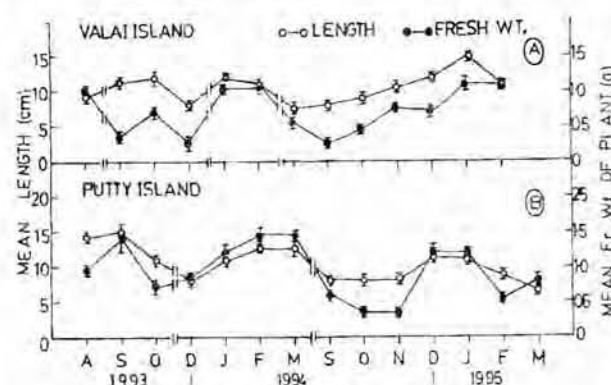


Fig. 1—Monthly variation in length and fresh wt. of individual frond of *Asparagopsis delilei*

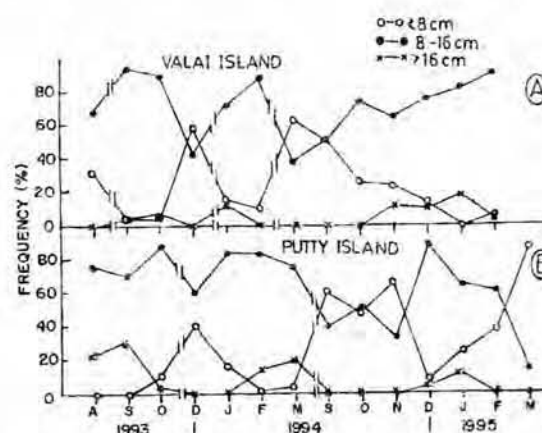


Fig. 2—Monthly variation in % frequency of 3 size classes of frond of *Asparagopsis delilei*

island. Group III fronds occurred in maximum number (30%) during September '93 at Putty island, and (18%) in January '95, at Valai island. Among the three size classes of fronds, Group II, represented the maximum number of the population of *Asparagopsis delilei* followed by Group I and Group III at both the places.

The plants attained maximum growth during November – March at both the islands. The maximum value for percentage cover (76 ± 4.5), biomass (2.12 ± 0.17 kg fresh weight) and moisture content (86.80%) were recorded during January '94, December '94 and February '94 respectively at Putty island. Similarly, maximum value for percentage cover (75 ± 1.4), biomass (1.66 ± 0.32 kg fresh weight) and moisture content (88.67%) were recorded during November '93, January '95 and December '93 respectively at Valai island (Figs. 3-5). The density of plants per quadrat was highest in December '93 at both the islands (Fig. 6). The relative growth rate (RGR) was found to vary from 0.005 to 0.53 g (fr.wt) /d at Putty island and the same varied from 0.004 to 0.56 g (fr.wt) /d at Valai island (Table 1).

Except the percentage moisture content and density of plants, all other parameters were found to be higher at Putty island as compared to Valai island.

In Indian waters, the peak growth of *Asparagopsis taxiformis* was reported earlier^{5,10,13} during December – January. Same trend was observed in the present study. In Japan, peak growth of this alga was recorded during March to June¹⁴. The biomass of the alga obtained from Putty island and Valai island was significantly higher as compared to other region of Indian coasts like Pudumadam¹³.

Reproductive stage

The percentage population of antheridial (male) plants varied from 4 to 95% at Putty island and from 1 to 88% at Valai island. Antheridial plants were found in the population from October onwards (Fig. 7) while cystocarpic plants were found to occur from August. These observations are unlike those found in *Asparagopsis* from Okha coast¹¹ and Mandapam coast¹³, where fertile plants are reported during December to March.

Falkenbergia, the tetrasporic phase of *Asparagopsis*, has been reported earlier from Dwarka¹¹, Kanyakumari and Krusadai island¹⁵ as an epiphyte on *Asparagopsis* during the peak growth season. During present study it was also occurring

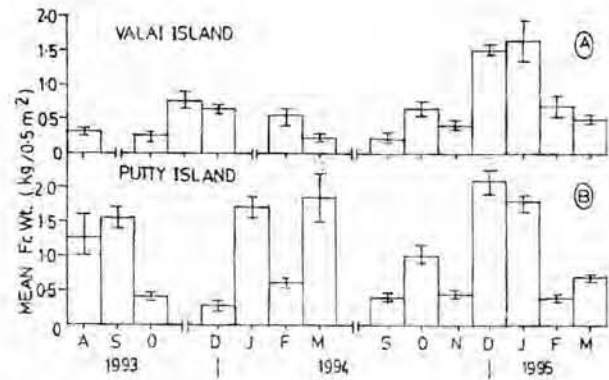


Fig. 3—Monthly variation in biomass (fresh wt.) of *Asparagopsis delilei*

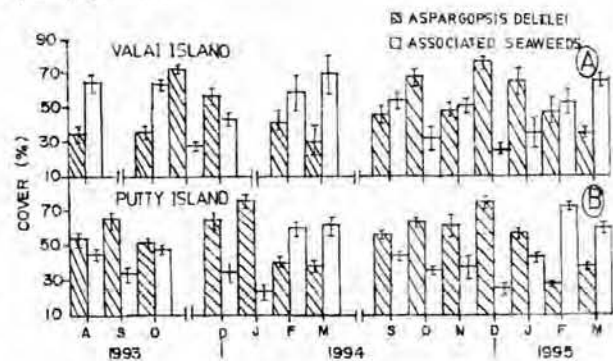


Fig. 4—Monthly variation in percentage cover of *Asparagopsis delilei* and associated seaweeds

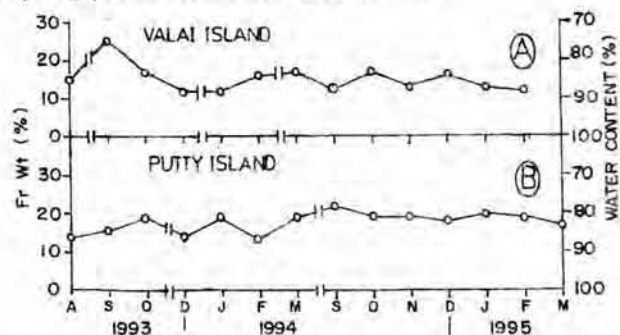


Fig. 5—Monthly variation in total dry matter content expressed as percentage of fresh weight or water content as percentage of fresh weight of *Asparagopsis delilei*

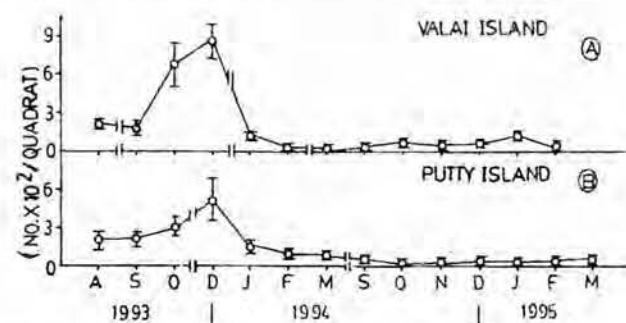


Fig. 6—Monthly variation in number of plants (no. quadrat⁻¹)

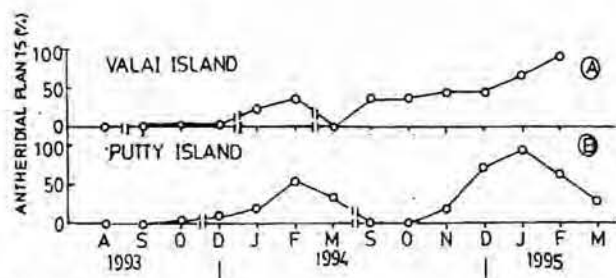


Fig. 7—Monthly variation in percentage occurrence of antheridial plants in *Asparagopsis delilei*

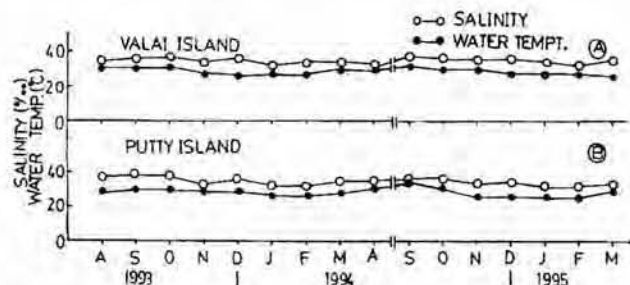


Fig. 8—Monthly variation in salinity (ppt) and temperature (°C)

attached to corals, rocks, shells of molluscs and on other macroalgae. *Asparagopsis* and *Falkenbergia* are annuals, the former giving rise to latter and *vice versa* and these plants are found to occur at the same habitat during October-November (month). *Falkenbergia* produced tetraspores. After defoliation in April onwards, no visible growth of *Asparagopsis* could be observed until August, when plants reappeared.

Environmental parameters

During the study period, the seawater temperature (°C) varied from 27 to 35 at Putty island and from 27 to 31 at Valai island. Similarly the salinity (ppt) varied from 32 to 38.9 ppt at Putty island and from 33 to 38 ppt at Valai island (Fig. 8). Comparatively, more biomass was recorded during November to March than other months, when the seawater temperature and salinity were 27-28°C and 35-35.6 ppt respectively at Putty island and 27°C – 29°C and 33-34 ppt respectively at Valai island (Fig. 8). Biomass of plants correlated negatively with salinity (Putty island $r = -0.037$; Valai island $r = -0.191$; and temperature (Putty island $r = -0.314$; Valai island $r = -0.437$). However, these values are found to be non-significant, similar negative correlation but significant values were recorded in the intertidal populations of *Asparagopsis*¹³ and *Sargassum*¹⁶ on Pudumadam coast of Mandapam area.

Associated seaweeds

The total number of other seaweeds associated with *Asparagopsis* population were 40 at Putty island and 42 at Valai island. Among these 34 seaweeds were common at both the islands. The dominant species occurring throughout the study period (14 months) were *Sargassum wightii* and *Chondrococcus hornemanii* at Putty island and *Sargassum wightii*, *Chondrococcus hornemanii*, *Halymenia floresia* and *Nitophyllum marginale* at Valai island.

The present study clearly revealed that the coral reefs of Putty island and Valai island provide good substratum for growth of *Asparagopsis delilei* during November to March. The entire stretch of coral reefs zone at both the islands were impregnated with good biomass of *A. delilei*. Therefore, it is possible to get few tonnes of *A. delilei* biomass from this coast to meet our iodine requirements partially. For proper crop management harvest can be done during its peak growth period (December and January) by hand picking leaving stolon part on substratum to regenerate vegetatively.

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