

**STUDIES ON THE GROWTH AND REPRODUCTION OF *GRACILARIA*  
*CORTICATA* NEAR MANDAPAM IN THE GULF OF MANNAR**

M. UMAMAHESWARA RAO\*

*Central Marine Fisheries Research Institute, Cochin-682 018*

ABSTRACT

Studies on the growth and reproductive behaviour of *Gracilaria corticata* carried out at Mandapam and Pudumadam in the Gulf of Mannar, over a period of three years from 1968 to 1970 have been presented, along with some observations on the distribution and harvest of the crop. The growth of the species appears to be irregular and the peak growth occurs during June to August/September and December to February/March. Seasonal changes have not been observed in the abundance of reproductive plants which occurred throughout the year. Tetrasporic plants have predominant in the populations examined at Mandapam and Pudumadam than the sexual plants. Harvesting experiment conducted at Pudumadam showed that the time of harvest and periodic collection of plants influence the rate of production and density of the alga in the natural habitats and that it is profitable to harvest *G. corticata* twice in a year, during June to August/September and December to February/March.

INTRODUCTION

*GRACILARIA CORTICATA* J. AGARDH has been reported from many localities along the Indian Coast and it forms dense mats on rocky surfaces of the infralittoral fringe. On the east coast of India some preliminary observations on seasonal changes in the growth of *G. corticata* were made from Mahabalipuram (Sreenivasan, 1946) and Visakhapatnam (Umamaheswara Rao and Sreeramulu, 1964). While working on the biology of agarophytes of Mandapam area studies were initiated on *G. corticata* occurring abundantly along the Gulf of Mannar side of the coastline. Seasonal growth behaviour observed at a station selected in Mandapam from August 1965 to January 1968 was reported earlier by the author (Umamaheswara Rao, 1972). In the present communication data on the growth and reproductive behaviour of *G. corticata* collected from the same station in Mandapam and another station at Pudumadam during January 1968 to December 1970 are presented, together with some information obtained on the vertical distribution and a harvesting experiment conducted at Pudumadam.

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MATERIAL AND METHODS

*G. corticata* grows on sand stones in Mandapam and Pudumadam. Plants are well developed in Pudumadam where the coastline is open and more exposed to wave action than at Mandapam. The distribution of *G. corticata* was studied at Pudumadam on a belt transect with a width of 0.25 m. The profile of the transect from high water level to low water level was surveyed following the method described by LaFond and Prasada Rao (1954). The alga occurring along the transect was

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\*Present address: Botany Department, Andhra University, Waltair.

collected using a brass frame of 0.25 m<sup>2</sup> and the fresh weight of the standing crop per 0.25 m<sup>2</sup> was determined.

As *G. corticata* occurs as pure bands with erect fronds in different stages of development, its growth behaviour was studied by marking permanent quadrats and also by estimating the proportion of different size groups of erect fronds in the population. Three quadrats (with a side of 25 cm) were marked in Mandapam and seven in Pudumadam on rocks covered with *G. corticata* at different levels. The basal cover of the alga within these permanent quadrats was estimated at monthly intervals. For size frequency analysis 50 to 150 erect fronds were measured, collecting samples of *G. corticata* each month from the same area in Mandapam and Pudumadam. Depending upon the size of the fronds in each locality they were separated into the following three size groups and the percentage frequency of each of these size groups was estimated:

	Mandapam	Pudumadam
Group I	Below 5 cm	Below 5 cm
Group II	6 cm and above	6 to 10 cm
Group III	—	11 cm and above

Another sample consisting of 25 to 30 plants of tufts were collected every month from January 1969 onwards and the percentage of sexual, asexual and sterile plants in the samples was estimated to study the annual fruiting behaviour in *G. corticata*.

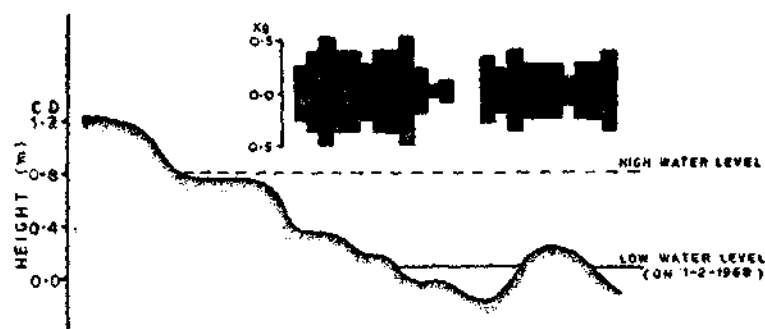


Fig. 1. Distribution and density of *Gracilaria corticata* on an intertidal transect.

A harvesting experiment was conducted in Pudumadam to test the effect of harvesting on the density of standing crop and to assess the rate of production and replenishment of *G. corticata* in the natural environment. A permanent quadrat of 0.5 m<sup>2</sup> area was marked in June 1970 on a horizontal rocky surface completely covered with *G. corticata*.

Standing crop occurring in this half metre square area was harvested at bi-monthly intervals from June 1970 to April 1971 by hand-picking. Fresh and dry weights of the algal mass were determined after washing and drying the weed.

## RESULTS AND DISCUSSION

*Distribution*

Distribution and density of *G. corticata* observed along the transect are shown in Fig. 1. As already mentioned (Umamaheswara Rao, 1972), *G. corticata* is confined to the infralittoral fringe extending roughly from 0.4 m CD to extreme low water of spring tide. The width of *G. corticata* band and also density of the alga varied with the topography of the coastline. In the area selected (Fig. 1) the density of the crop was more in the upper half of *G. corticata* belt than in the lower half. In the deep depression found between the two rocks along the transect, the density decreased and the alga was not seen in two quadrats (Fig. 1).

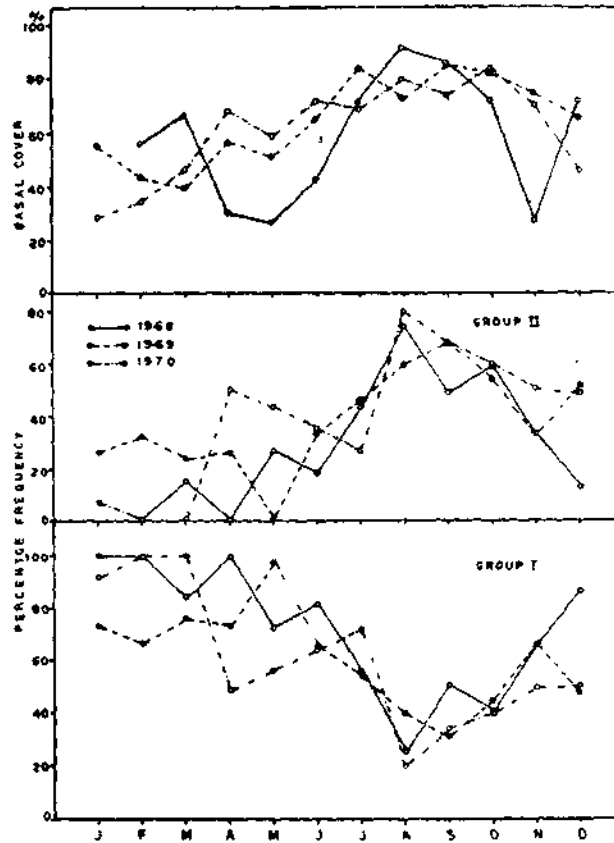


Fig. 2. Monthly changes in the basal cover and abundance of young and fully grown fronds of *G. corticata* observed from 1968 to 1970 at Mandapam.

*Growth behaviour*

Monthly changes in the growth of *G. corticata* observed from 1968 to 1970 in Mandapam and Pudumadam are shown in Figs. 2 and 3. In Mandapam two peaks

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in the percentage cover were noticed in 1968 during August–September and December–April, agreeing with the earlier studies (Umamaheswara Rao, 1972). But in 1969 and 1970 maximum cover was found in the quadrats between July and October (Fig. 2) and the second peak in growth was not prominent. In the open coast at Pudumadam the basal area covered by the alga did not alter much in different months of the year, except from April to June 1968. (Fig. 3).

The proportion of young (Group I) and fully grown fronds (Group II or III) varied in different months of the year and two peaks can be seen in the populations analysed in both the localities, particularly in Pudumadam (Fig. 3). In Mandapam maximum number of Group II fronds occurred in the samples during August to September/October in all the three years. Another peak was observed between

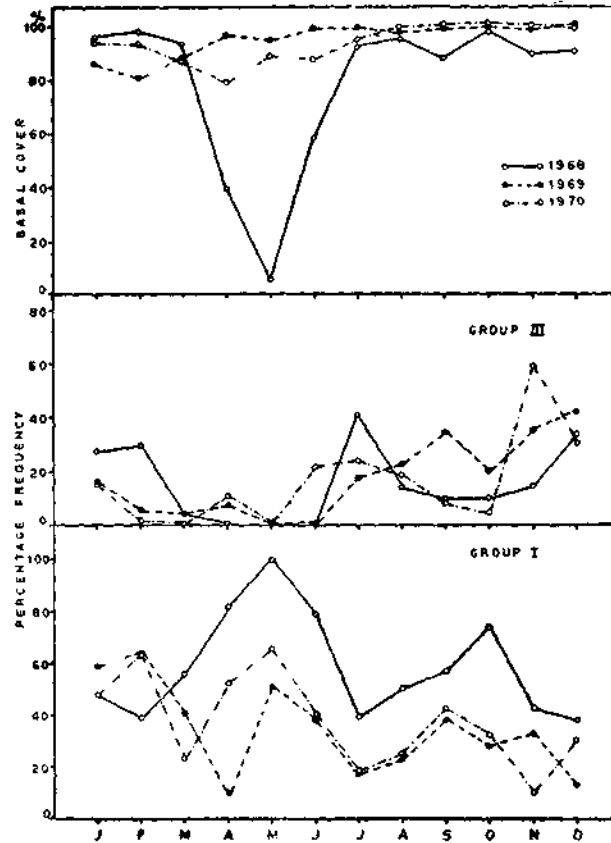


Fig. 3. Monthly changes in the basal cover and abundance of young and fully grown fronds of *G. corticata* observed from 1968 to 1970 at Pudumadam.

December and March, but the abundance of fully grown fronds varied in different years. In 1969, 32.9% of Group II fronds were found in February and in 1970, 51.3% of the fronds were observed in April. Due to luxuriant growth of *G. corti-*

*cata* in Pudumadam, fronds above 11.0 cm were seen in the population and maximum number of Group III fronds occurred from July to August/September and again from November to January/February. The second peak in growth observed in this locality from November to January/February was more marked than in Mandapam in all the three years of study and this might be due to variations in the habitats of these two localities.

Above findings clearly indicate that two peak growth periods occur in *G. corticata* growing in the natural habitats, though the changes in growth are not regular in different years, as reported in sublittoral species of *G. edulis* and *G. folifera* during the two halfyearly growth seasons of the year (Umamaheswara Rao, 1973 a). Similar irregular behaviour in growth was seen in *G. acerosa* growing in the intertidal region (Umamaheswara Rao, 1973 b). The monthly and yearly changes in the environmental conditions were found to be responsible for the differences observed in the growth cycles of certain algae (Umamaheswara Rao, 1972) and these details would be discussed elsewhere.

#### Fruiting behaviour

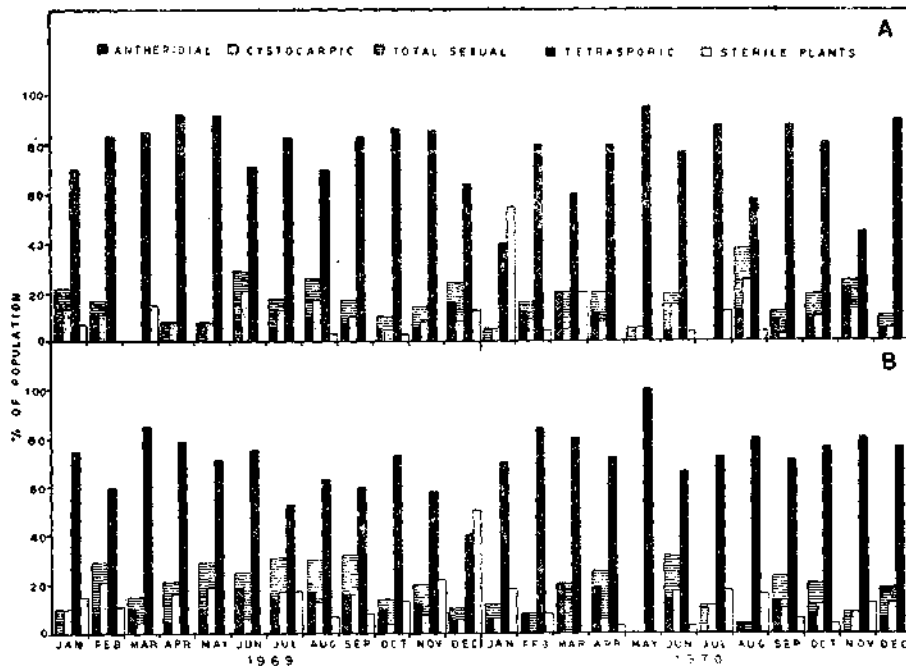


Fig. 4. Monthly changes in the abundance of fruiting and sterile plants of *G. corticata* growing at Mandapam (A) and Pudumadam (B).

Plants with reproductive structures were found throughout the year in the populations of *G. corticata*. Data on the percentage frequency of tetrasporic, antherial, cystocarpic, total sexual and sterile plants collected in 1969 and 1970 are shown in Fig. 4. Yearly means of sexual, tetrasporic and sterile plants are given in Table 1. The fruiting behaviour of *G. corticata* was similar to that observed in *G. folifera* (Umamaheswara Rao, 1973 a) and the abundance of fruiting plants did not vary

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markedly in different seasons of the year as also in the two localities (Fig. 4). There was, however, slight increase in the abundance of sexual plants from July to September and from November to February as compared with other months of the year.

TABLE 1. Abundance of sexual, asexual and sterile plants in *Gracilaria corticata* growing in Mandapam and Pudumadam

Locality	Year	Yearly means (%)				
		Asexual	Female	Male	Total sexual	Sterile
Mandapam	1969	80.4	10.4	5.7	16.1	3.5
	1970	75.3	7.6	8.6	16.2	8.5
Pudumadam	1969	66.1	27.2	5.5	32.7	1.2
	1970	77.3	6.8	8.1	14.9	7.8

As reported in *G. edulis* and *G. folifera* (Umamaheswara Rao, 1973 a) tetrasporophytes were most abundant in *G. corticata* and the yearly means estimated for the two years ranged from 66.1 to 80.4% (Table 1). Sexual plants were very few in the population and varied between 14.9 to 16.2%, except in 1969 at Pudumadam. A small number of plants (1.2 to 8.5%) was found to be sterile in both the localities.

Harvesting experiment

The fresh and dry weights of the standing crop of *G. corticata* collected at the time of starting the experiment in June 1970 and the densities of the repopulated alga harvested from the same quadrat are shown in Fig. 5. During this one year, increase in the algal mass was observed till October 1970 due to rapid development of the plants and the area was completely covered by fully grown plants within two months. But after three harvests, scattered growth of *G. corticata* was seen in

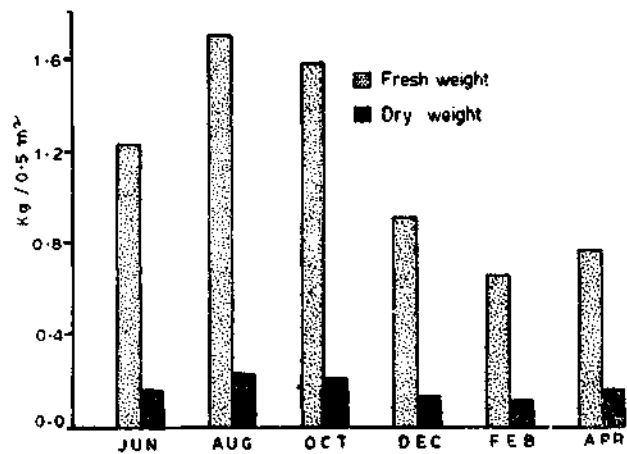


Fig. 5. Fresh and dry weights of *G. corticata* harvested from 0.5 m area at Pudumadam.

the quadrat and weight of the crop decreased to a large extent between December 1970 and April 1971 (Fig. 5). In June 1971 many other algae were found in the half metre square area marked for this experiment.

Based on the increase in fresh and dry weights obtained between the two harvests and the time allowed for regrowth, the rate of production of *G. corticata* per day per unit area was estimated and the results on fresh and dry weight basis are shown in Table 2. It was evident from the estimates that the rate of growth as well as production in *G. corticata* were high between June and October and the values obtained during this period were similar (26.4 and 27.5 gm Fr. wt/day). After October, the rate of production per day varied between 11 and 13 gm Fr. wt/day (Table 5), which was 50% less than that observed in the period from June to October. These differences in the rate of production in two seasons of the year indicated that the time of harvest and collection of alga three or four times in a year might influence the growth rate and density of *G. corticata* in the natural environment. The data also showed that the period between June and October was the main growth season for *G. corticata* growing on the Gulf of Mannar side, as maximum production was observed in this period.

TABLE 2. Rate of production of *Gracilaria corticata* in different months of the year

Period	Days	Increase in fresh weight 0.5 m area (gm)	Increase in dry weight 0.5 m area (gm)	Rate of Production	
				gm fr.wt/day	gm dry wt/day
June-August	62	1705	229	27.5	3.7
August-October	60	1585	207	26.4	3.5
October-December	70	910	134	13.0	1.9
December-February	59	654	108	11.1	1.8
February-April	58	770	155	13.3	2.7

From the field observations on growth and reproduction and from harvesting experiments it may be pointed out that *G. corticata* is a rapidly growing alga with a production rate ranging from 44.4 to 110.0 gm Fr. wt/m<sup>2</sup>/day and that its growth behaviour changes markedly in relation to variable factors of the intertidal environment. Though *G. corticata* grows rapidly by vegetative means and fruiting plants occur in all months of the year, continuous harvesting at bi-monthly intervals reduces the density of the crop and helps in the colonisation of other algae of the intertidal region. Collection of *G. corticata* in two seasons of the year would, therefore, give good yield without destroying the populations in the natural habitats. Best yield of *G. corticata* can be obtained in the peak growth periods from June to August/September and December to February/March.

#### REFERENCES

- LA FOND, E. C. AND R. PRASAD RAO 1954. Beach erosion cycles near Waltair on Bay of Bengal. *Andh. Univ. Memo. Oceanogr.*, **1**: 61-77.
- SREENIVASAN, K. S. 1946. Ecology and seasonal succession of the marine algae at Mahabalipuram (seven Pagodas) near Madras. *Indian bot. Soc. M.O.P. Iyengar commem. vol.* pp. 267-278.
- UMAMAHESWARA RAO, M. 1972. Ecological observations on some intertidal algae of Mandapam coast. *Proc. Indian natl. Sci. Acad.*, B **38**: 298-307 (1974).
- 1973 a. Growth and reproduction in some species of *Gracilaria* and *Gracilariopsis* in the Palk Bay. *Indian J. Fish.*, **20**: 182-192.
- 1973 b. Growth and reproduction of *Gelidiella acerosa* in the Palk Bay and Gulf of Mannar near Mandapam. *Ibid.*, **20**: 411-416.
- AND T. SREERAMULU 1964. An ecological study of some intertidal algae of the Visakhapatnam coast. *J. Ecol.*, **52**: 595-616.