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EXPERIMENTAL CULTURE OF *GRACILARIA* AT THE MARICULTURE CENTRE, MUTTUKADU, TAMIL NADU

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ABSTRACT

Experimental culture of *Gracilaria* was done in the Kovalam Backwaters at the Mariculture Centre, Muttukadu, Tamil Nadu. The study, conducted over two years, revealed that the period June to March was condusive to growth. The rate of growth was better in the open, unenclosed area than in ponds. Growth was best during the period June to September. The potential yield in the different growing seasons has been estimated for the open area as well as ponds. The relation between the growth of seaweeds and some environmental conditions in the farm is discussed. A strategy is suggested for the continuous culture and domestication of this species in the area.

INTRODUCTION

FIELD CULTURE of *Gracilaria* is an established practice in Taiwan (Shang, 1976) and experimental culture has been done in several countries (Chennubhotla *et al.*, 1978 ; Kim, 1970 ; Ren *et al.*, 1983 ; Raju and Thomas, 1967 ; Rao 1974 ; Saunders and Lindsay, 1978). Culture is done in ponds in Taiwan, but this method has not been adopted in India. This paper evaluates the potential for culture of *Gracilaria* in ponds located in the coastal lagoons on the east coast of India. This is based on the results of experimental culture of *Gracilaria* sp. done at the Mariculture Centre of CMFRI, Muttukadu, situated in the Kovalam Backwaters 36 km south of Madras City.

MATERIAL AND METHODS

The seaweed studied was *Gracilaria* sp. occurring in rolling entangled masses in the Kovalam Backwaters. One form, reddish in colour and dichotomously branched, was cultured during 1984-85 and another form, brown-green coloured and variably branched was cultured through 1985-86. The algae were found only in the vegetative state and could not be characterised further. Both showed similar patterns of growth, however, and the results are therefore considered together. The agar yield of both was on an average 30.4%.

The culture site, 93 ha in area, is the northern wing of the Kovalam Backwater which runs parallel to the coast and is separated from the main body of the backwater by an earthen bund with steel sluice gates (Fig. 1). Fish culture ponds have been constructed in the southeastern part of the farm, leaving a large portion open.

Environmental conditions in the farm are quite different in the open area and ponds (Bharathan *et al.*, MS). The substratum varied from sandy to muddy. Extensive beds of *Halophila ovalis* cover various parts of the farm, including some ponds.

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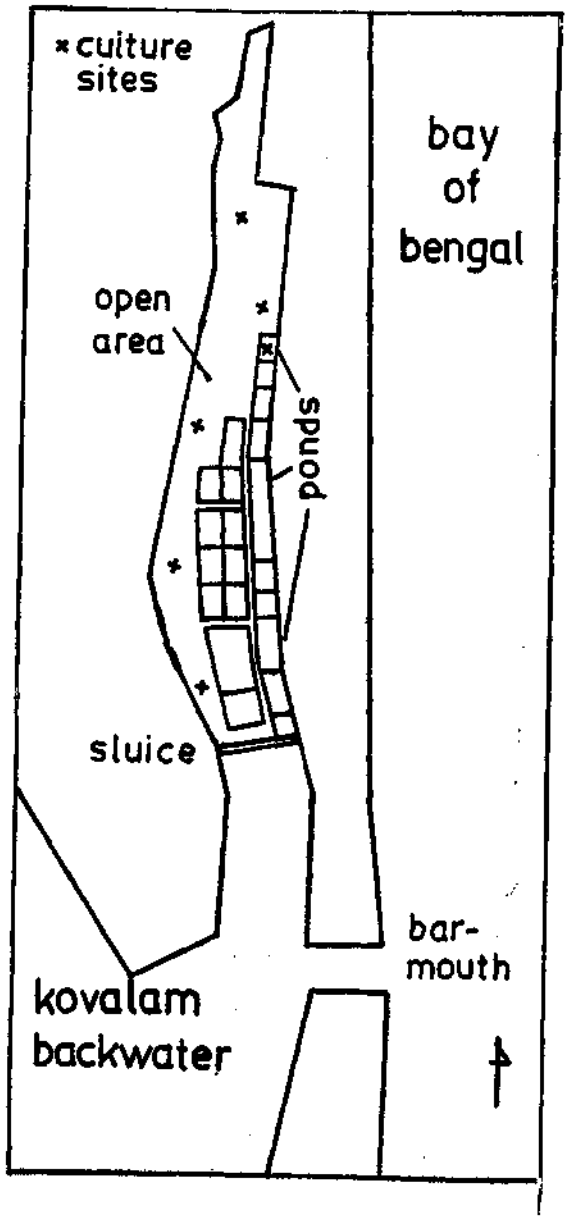

FIG. 1. A diagrammatic map showing location of cage culture and pond culture of *Gracilaria* at Mariculture Centre of CMFRI, Muttukadu.

Cage culture

Experimental culture was done in cages to study seasonal variations in growth. Cages, $2 \times 2 \times 2$ m in size were constructed from casuarina poles covered on the sides with old fishing nets. Cages (3-6 in number) were placed in different parts of the farm (open area as well as pond) at a depth of 0.5-0.8 m. The area (4 m^2) under each cage was cleared of all vegetation except *Halophila*, if any. Seeding was done at the rate of 0.5 kg/m^2. The seaweed was harvested after 2 weeks and weighed. The original quantity (2 kg) was then returned to each cage for the next round of harvesting. This periodic seeding and harvesting was done throughout the period of 2 years.

Mass culture in pond

One pond (0.1 ha in area) was seeded by broadcasting in December 1985. The total amount seeded was 18 kg, at a seeding rate of only 0.02 kg/m^2. This low rate of seeding was due to a shortage of seed material. Harvesting was done in March 1986, by netting and dragging several times.

Growth

The specific growth rate (SGR) was calculated from the observation as follows:

$$SGR = \log_2 \frac{W_2}{W_1} \div T$$

where W_1 and W_2 are initial and final weights respectively, and T the period of observation. The reciprocal of this expression gives, directly, doubling time (Stein, 1973). Fortnightly values for SGR were obtained thus. Monthly means calculated from these were plotted on a graph to display the seasonal variation in growth (Fig. 2). The annual mean value for SGR was calculated. Total potential yield was calculated as the product of annual mean SGR and seeding rate (Table 1).

RESULTS AND DISCUSSION

Growth rate

Growth in the open area was, on the whole, better than in the ponds. Mean annual SGR

was 5.2% per day in the open area and 2.5% per day in the ponds (Table 1).

The growing season was found to be June-March during both years of observations, with some difference between the open area and ponds (Fig. 2). Growth was nil or negative during the summer months April-May.

In the open area the best season for growth was June-September (SGR = 6.8% per day), with another season, November-January (SGR = 4.1% per day). In the ponds, on the other hand, growth was poor during June-November (SGR = 1.3% per day) and good during the period December-March (SGR = 3.6% per day).

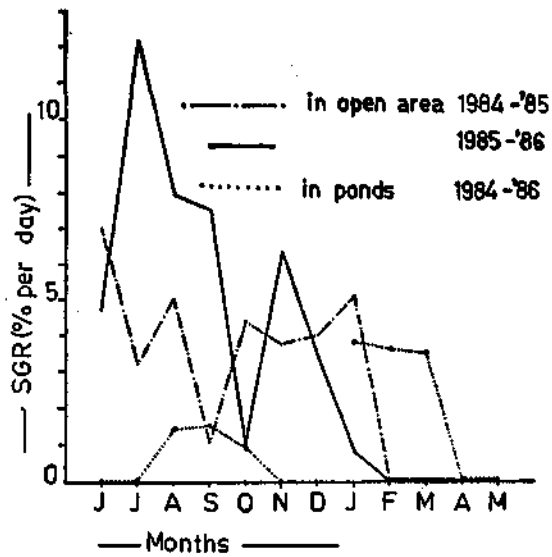

FIG. 2. Seasonal variation in growth of *Gracilaria*.

Yield

Results of the mass culture in a pond was very encouraging (Table 2). From an initial weight of 1.94 kg (dry weight) a total amount of 27.0 kg (dry wt) was obtained. This represented an SGR of 3.85% per day. Yield was rather low, 0.08 gm dry wt/m² per day. A higher seeding rate, say 0.5 kg/m² would give a yield of 2.08 gm dry weight/m²/day.

The potential yield calculated from seasonal mean SGR observed in this study (Table 1) shows that, at seeding rates of 0.5% kg/day the potential annual production is higher in the open area (640 gm dry wt/m²) than in ponds (305 gm dry wt/m²).

The rates of growth observed here compare favourably with rates computed from published data. Thus, *G. edulis* on long lines in Mandapam (Raju and Thomas, 1971) showed an increase in length with an SGR of 2.5%/day. When increase in weight is taken, this value

TABLE 1. *Observed growth rate and total estimated production of* Gracilaria *in open area and ponds of farm at Mariculture Centre, Mutukadu*

	Outer Area		Ponds	
	June-Sep. (120 days)	Nov.-Jan. (90 days)	June-Oct. (150 days)	Dec.-Mar. (100 days)
SGR (%/day)	6.8 ± 2.9	4.1 ± .53	1.3 ± 0.21	3.6 ± 0.20
Seeding density (kg/m²) (wet wt)	0.5	0.5	0.5	0.5
Potential yield (gm/m²/day) (dry wt.)	3.64	2.25	0.75	1.93
Estimated total production season per (gm/m²) (dry wt)	437	203	112	193
Estimated total production per annum (gm/m²) (dry wt)	640		305	

goes up, to 5.52%/day, as in the case of *G. edulis* grown on nets (Chennubhotla *et al.*, 1978). *G. Verrucosa* in Taiwan (Shang, 1976) had an annual mean SGR of 1.8%/day, probably an underestimate ; in China (Ren *et al.*, 1983) rates observed ranged between 4 and 10%/day and in Chile (Kim, 1970) reports are 4 to 8%/day. Rates in intensive culture systems in North America were reported to be 4 to 14%/day (Hansen *et al.*, 1981). In our observations here, while the annual average was 5.2%/day, the monthly range was wide—from 2.0 to 12.1%/day.

When the potential yield in the open area, 2.81 gm dry wt/m²/day is compared with that of *G. edulis*, 3.68 gm dry wt/m²/day, it is seen that *G. edulis* yields more. However, it should be noted that whereas the annual average is taken in the case of *Gracilaria* results of one trial only of *G. edulis* has been taken, from the paper of Chennubhotla *et al.* (1978). The maximum yield that could be obtained in *Gracilaria* sp. can be as high as 6.53 gm dry wt/m²/day.

Growth in relation to environment

Growth was good in sandy areas as well as in those muddy areas which were covered with *Halophila*. The latter apparently prevented *Gracilaria* from being covered by the mud.

Growth was stimulated during periods when large scale ingress of water relieved stressed conditions in the farm, bringing down salinity and temperature (Table 2) and increasing water exchange. This happens in the open area during the month of June when the southwest monsoon sets in in other parts of the south. The steep drop in growth in September-October was due to large scale rains or drainage and heavy silting during these months. Growth after the month of January was poor due to a combination of increasing temperature (which rose from 27.8 to 29.32°C) and salinity (from 19 to 26-31 ppt) and decreasing water level. While these conditions may not be directly harmful for *Gracilaria*, they caused the extensive decay of *Halophila* beds which developed during the year. This, combined with reduced water exchange invariably led to deterioration of the substratum which became clayey and de-oxygenated and caused the decay of the algae growing there.

Conditions for growth in the ponds were best after the northeast monsoon. During the period December-March water-exchange was much improved and temperature (28-31°C)

TABLE 2. *Monthly Variations in some Environmental Features of Water at The Mariculture Centre, Muttukadu, Tamil Nadu*

	1985											
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
	Temperature (°C)											
Open Area ..	27.8	29.0	30.8	32.0	32.0	29.7	28.5	29.5	31.2	29.0	27.2	27.7
Pond ..	29.4	30.2	31.6	32.9	32.8	31.0	29.5	29.8	32.2	31.1	28.1	28.1
	Salinity (ppt)											
Open Area ..	17.5	18.9	20.8	26.2	31.4	26.4	27.4	20.3	22.1	21.5	9.9	20.5
Pond ..	18.9	21.9	24.9	29.9	33.8	27.8	27.4	26.6	25.6	23.5	12.6	16.8
	pH											
Open Area ..	8.1	8.6	8.4	8.4	8.6	8.3	8.5	8.6	7.8	8.4	8.3	8.1
Pond ..	7.9	8.3	8.3	8.1	8.4	8.4	8.3	8.4	8.0	8.4	8.6	8.4

and salinity (17-25 ppt) were conducive for growth. The deterioration observed in the open area during February was absent in those ponds where there was no *Halophila* and growth in such ponds could continue until the middle or end of May. Cessation of growth in ponds was mainly due to decrease in the water level leading to lack of water-exchange and exposure of the plants.

The above points suggest a strategy for round the year cultivation of *Gracilaria* in this area (Fig. 3). As we have seen the growing season in the open area terminated by the beginning of February and it was not possible to continue culture operations beyond that. Natural populations of the species also dwindle during this period. Production can be carried on for two more months, until the end of March, by stocking suitable ponds during December or January. This leaves the summer months of April and May when neither the open area nor the ponds appear to support growth of the alga. This is mainly because of sub-optimal conditions in the shallow substrata brought about by curtailed water exchange.

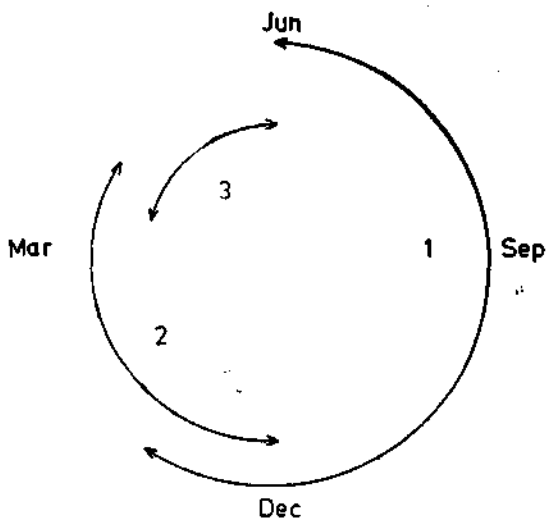

FIG. 3. Scheme for year-round cultivation and domestication of *Gracilaria* at Mariculture Centre of CMFRI, Muttukadu.

This behaviour of *Gracilaria* leads to the problem of shortage of seed material during June when stocking could be done. Methods of maintaining seed material are required. This could be done in two ways : (i) by shifting cages with seed stocks to deeper areas where substratum conditions could be better and (ii) stocks could be maintained in large bags or floating cages in mid-water. This may not permit much growth, but decay would be prevented. Culture on ropes may appear to be the solution to this problem but it was found in earlier trials that the brittle nature of the alga and lack of firm attachment causes the seeded material to be washed away easily during wave or wind action. Another alternative is of course, maintenance in an aquarium, which is entirely possible, although more expensive.

If this problem of maintaining the material through the summer months (April-May) is solved, depletion of stock and consequent shortage of seed material during the onset of the growing season (June) could be avoided and the production would increase. This would result in the optimum utilization and the eventual domestication of this crop.

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