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ON AUGMENTING SEAWEED RESOURCES OF INDIA*

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ABSTRACT

In recent years, a number of plants have been set up for manufacturing agar-agar from Indian seaweeds. The available resources of seaweeds are scanty and is likely to dwindle further. Hence, it is necessary to augment the resources by cultivation of the economically important species.

Cultivation of seaweeds may be achieved either by vegetative propagation or by collecting and germinating spores in specially designed nurseries and later transplanting the sporelings in the sea. This paper describes the experiments carried out at the Marine Algal Research Station, Mandapam and evaluates the results obtained in these experiments.

INTRODUCTION

IN RECENT YEARS, interest in the utilisation of seaweeds has increased and a number of plants have been set up in various parts of the country for the manufacture of agar-agar and alginic acid and its derivatives. Interest has also been evinced in the extraction of iodine from Indian seaweeds and in the use of seaweeds as food, feed and manure.

In the seaweed based industry, greater attention has been paid to the manufacture of agar-agar than of any other seaweed product. There are as many as seven plants for agar-agar as against only one for aliginates. The total rated capacity of all the agar-agar units exceeds 150 tonnes per annum.

In spite of the interest shown by the manufacturers, there appears to be a set back in the development of the agar industry. The chief difficulty lies in obtaining sufficient raw material for the industry.

Agar manufacturers in India mostly use *Gelidiella acerosa* as the raw material and this alga grows more abundantly on the east coast of South India, especially on the coast of Ramanathapuram District. To a less extent, *Gracilaria edulis* is also used. Other seaweeds which may be used as sources of agar are: *Gracilaria corticata, G. foliifera* and *G. verrucosa. Hypnea musciformis* which is a very common alga, gives an extractive of a low gelling capacity, but this can be improved by suitable treatment (Rama Rao and Krishnamurthy, 1968).

Attempts to assess the quantity of economically important seaweeds on the Indian Coasts have been made from time to time. Some of the earlier accounts do not give a clear statement regarding the methods employed in arriving at the estimates and in those instances where a definite method has been described, the report has been of a limited nature, restricted to a small area or extending over a brief period.

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The most notable reports are those of Varma and Rao (1964), Sreenivasa Rao *et al.* (1964), Chauhan and Krishnamurthy (1968), Krishnamurthy (1969), and Umamaheswara Rao (1968). The data presented by these authors are set forth in Table 1.

TABLE 1. *Estimates of harvestable seaweeds on the Indian Coast*

Author	Area covered	Period of Study	Quantity in tonnes Agaro-phytes	Algino-phytes
Varma and Rao (1964)	Gulf of Mannar	1958	195.3	419.18
	234.25 sq. km	1962-63	353.7	657.94
Sreenivasa Rao *et al.* (1964)	Adatra Reef at Port Okha, 0.015 sq. km	1963	—	60.00
Chauhan and Krishnamurthy (1968)	Eastern Gulf of Kutch, 10.65 sq. km	1967-78	—	4,000.00
Krishnamurthy (1969)	Drifted on the east coast of India	1965-66	50.00	950.00
Umamaheswara Rao (1968)	Pamban	1965	233.15	161.83
	3.58 sq. km	1966	47.92	173.43

The above estimates indicate that the seaweed resources of the country are by no means adequate. With the setting up of more manufacturing units as is likely in the near future, the demand for raw material may soon far exceed the availability. Therefore, there is a vital need for augmenting the seaweed resources of the country.

Thivy (1964) first pointed out the feasibility of cultivating marine algae in India. Krishnamurthy (1967) discussed the necessity for cultivation of seaweeds and the principles and problems involved in such cultivation. Umamaheswara Rao (1968) reported on preliminary culture experiments with fragments of *Gracilaria corticata* and *G. lichenoides (G. edulis)*.

Experiments on growing *Gracilaria edulis* and *Gelidiella acerosa* were conducted by the author and his colleagues at Krusadi Island near Mandapam during the years 1967 to 1970 and these experiments indicate that cultivation of these algae is feasible as well as economically viable.

It has been shown earlier by Humm (1944) and Krishnamurthy (1954) that loose, purely vegetative plants of *Gracilaria confervoides (G. verrucosa)* can continue to grow in a free floating state, provided environmental conditions are favourable. Isaac (1956) cultured two inch fragments of *G. confervoides* in filtered sea water and showed that the fragments themselves did not grow in length but produced new branches at intervals in a characteristic manner. Results similar to those of Isaac were obtained by Thomas (unpublished) at Mandapam for *Gracilaria corticata*. Oza (unpublished) showed that fragments of *G. corticata* as small as 2 mm in length could regenerate and produce branches. Both Thomas and Oza found that the fragments exhibited definite polarity, branches being formed in greater number from the morphologically apical end of the fragment while at the base, haptera like structures are formed. Similar results have been obtained with *Gracilaria edulis.*

Growth under laboratory conditions was very slow and the branches formed slender. But when these fragments were attached to a rope and the rope planted at a suitable depth in the sea, the fragments lengthened rapidly, producing numerous branches, some of the branches adhering firmly to the rope at the base. The following account is that of some preliminary experiments carried out in a lagoon on the southern side of Krusadi Island in June and July, 1967.

Healthy plants of *Gracilaria edulis* were collected from Krusadi Island and, after thorough washing in sea water, fragments, 2.5 cm in length, were removed from the apices of the plants and transferred to a trough containing sea water. The fragments were then inserted between the twists of a rope, one each at intervals of four inches along the length of the rope. The fragment was held firmly by the rope, the two ends projecting out of the rope. Several ropes were prepared in this manner. These ropes were then transferred to the lagoon where they were tied to bamboo posts planted in the sea bottom. The ropes were adjusted at a level of roughly one foot above the bottom, which corresponded to the level at which the alga occurs in nature (0.12 metre above zero of chart datum). Periodical observations were made and the growth was recorded each time. In about five months, the plants attained a length of about 30 cm and were profusely branched and bushy in appearance. The average weight of a plant was about 300 g.

In the first month of growth, it was found necessary to clean the ropes at frequent intervals as a number of other marine algae tended to settle on the ropes as well as on the fragments of *Gracilaria*. But in a month's time, the fragments had grown into plants of about 8 cm length with several branches. Thereafter, some of the lower branches of the alga tended to grow over the surface of the rope, giving out branches of a further order at intervals. The incidence of other weeds on the ropes diminished to some extent, although periodical cleaning at less frequent intervals had to be continued. In the fourth month, the growth on the rope

TABLE 2. *Experiments on cultivation of* Gracilaria edulis *and other results*

Expt. No.	Date of starting	Length of rope used	Date of harvesting and quantity			
			Harv. I	Harv. II	Harv. III	Total Harvest
1.	June, 67	4 m	Dec., 67 5.1 kg.	Mar., 68 4.0 kg.	July, 68 4.0 kg.	13.1 kg.
2.	Nov., 67	6 m	Mar., 68 5.2 kg.	June, 68 3.3 kg.	Oct., 68 3.3 kg.	11.8 kg.
3.	Dec., 67	40 m	May, 68 45 kg.	Aug., 68 51.5 kg.	Nov., 68 36.5 kg.	133.0 kg.
4.	Feb., 68	16 m	July, 68 25 kg.	Oct., 68 18 kg.	Jan., 69 20 kg.	63.0 kg.
5.	June, 68	11 m	Dec., 68 15.5 kg.	May, 69 17 kg.	Aug., 69 17.5 kg.	50.0 kg.
6.	Dec., 68	272 m	May, 69 226 kg.	Sep., 69 367 kg.	Jan., 70 300 kg.	893.0 kg.

had become so dense that the identity of the individual plants was lost. In the fifth month, a harvest was made by clipping the plants close to the rope. The remnants of the plants were left on the rope for further growth. Two more harvests were made at intervals of ten weeks, thus giving three harvests in a period of ten months. Table 2 gives the details of all further experiments conducted and the results obtained in each case.

Preliminary experiments were also conducted in a similar manner on *Gelidiella acerosa* in November–December, 1969. The 2 cm fragments planted in November grew slowly at first and rapidly in the second and third months, giving out numerous branches. In April 1970, the fragments were grown into full sized plants, about 10 cm in length, with 7 to 8 main branches. After April 1970, however, the plants began to lose colour and in May, they were completely bleached. On critically examining the ropes, it was found that the ropes bearing these plants were fixed at a level higher than normal for *Gelidiella*, thus resulting in greater emersion of these plants during low spring tides than could be withstood by them. This, combined with the high intensity of sunlight prevailing in April and May, resulted in the bleaching of the alga.

To verify the above conclusion, an experiment was conducted with three ropes planted with *Gelidiella* fragments fixed at different levels, *viz.*, –0.72 m, +0.12 m and +2.0 m with reference to the zero of chart datum. The plants in the uppermost rope bleached quickly and those in the lowermost rope showed slow growth. Those on the rope at 0.12 metre level showed a good rate of growth, confirming our conclusions on the previous experiment.

Gelidiella also exhibits a comparatively slow rate of growth. Hence, a series of experiments were carried out to find out if the growth rate could be enhanced by pretreatment with growth promoting substances. Fragments were treated for 24 hours with different molar concentrations of indole acetic acid, indole butyric acid, indole-3-aldehyde and asciorbic acid. Then these fragments were planted in ropes and transferred to the sea. It was found that IAA at levels of 10^{-7} to 10^{-9} M concentrations was beneficial in enhancing growth rate measured in terms of fresh weight of the fragments and increase in the number of new branches (Rama Rao and Thomas (unpublished).

Further experiments on the culture of *Gelidiella* are in progress.

From the foregoing, it is clear that massive culture of economic marine algae in Indian coastal waters is quite feasible. Before concluding, it may be mentioned here that it is estimated that production of one tonne of *Gracilaria edulis* (moisture content 15–20%) would cost about Rs. 1,000 with the materials and procedure used in these experiments at the Marine Algal Research Station at Mandapam. It is possible to bring down the cost to about one half of this level and efforts are being made towards this end.

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