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ON

LIVING RESOURCES *of* THE SEAS AROUND INDIA

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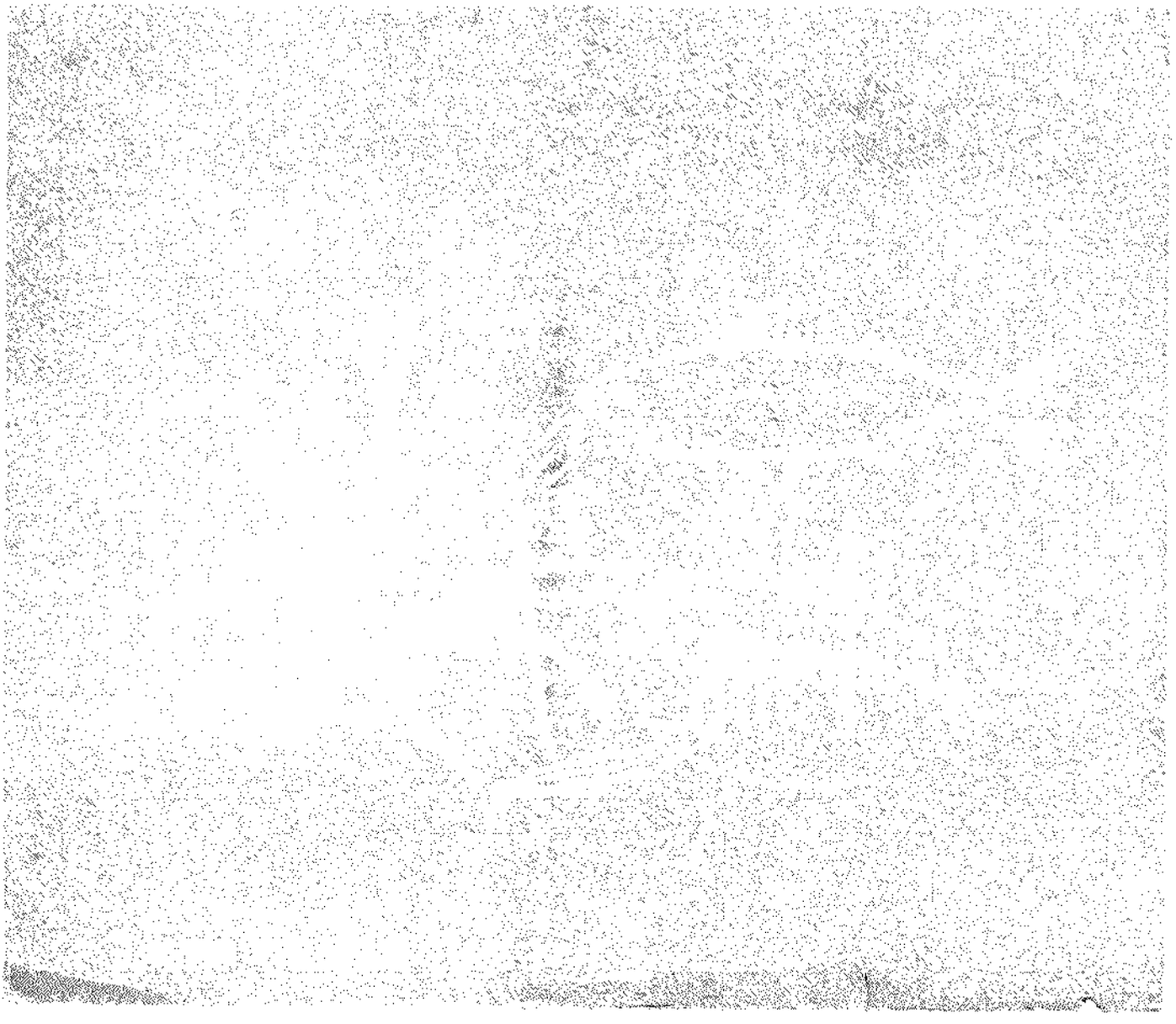

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THE SEAWEED POTENTIAL OF THE SEAS AROUND INDIA

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ABSTRACT

The present paper deals with the Indian seaweeds of economic value and the potential resources available in the inshore waters of the country. Results of the sample surveys carried out to estimate the standing crops of all marine plants growing in the Palk Bay area are given. Possibilities of cultivating the commercially valuable species in sheltered and calm areas of the coastline are indicated based on the culture experiments conducted with *Gracilaria lichenoides* and *G. corticata*.

SEAWEEDS are economically important as sources of agar and algin and they are often used directly as food, fodder and manure. In India the value of seaweeds, particularly the agar- and algin-producing plants has been well realised and a seaweed industry has been developed in recent years based on the present limited exploitation that is carried out only in a few centres. However, vast areas of the coastline are yet to be surveyed to assess the full potentialities of this valuable marine resource.

The present paper gives a brief account of the important Indian seaweeds of commercial value and their potential resources in the Indian waters. Information obtained from two sample surveys made in the Palk Bay area near Mandapam and some culture experiments carried out on two species of *Gracilaria* are also presented in this paper.

Indian seaweeds of economic value

Different kinds of green, brown and red seaweeds available in the inshore waters of the country and the way in which they are utilised have been given in the earlier papers published from this Institute (Thivy, 1958, 1960; Umamaheswara Rao, 1967). The important species which deserve special attention for further development of the seaweed industry in the country are listed in Table I along with their economic uses. Recent studies on the chemical composition of certain species of *Ulva* and *Porphyra* (Table I) have indicated that these algae are rich sources for proteins, minerals and trace elements which are essential for proper growth and development of the body tissues (Sitakara Rao and Tipnis, 1965; Lewis, 1965; Tiwari *et al.*, 1968). A process has been developed by Parekh and Visweswara Rao (1964) for preparing protein concentrates from the species of *Ulva*. Many of the Indian agarophytes and alginophytes given in Table I have been studied in detail.

Resources

The major seaweed growing regions in India are the coastal areas of the Gujarat State from Veraval to Okha and Dwarka and of the Madras State from Mandapam to Cape Comorin where many of the economically important seaweeds occur in harvestable quantities. In addition to these places, the littoral and sublittoral rocky stretches in the vicinity of Bombay, Karwar, Cannanore, Kovalam, Madras and Visakhapatnam are populated with useful varieties of seaweeds. *Ulva fasciata*, *Sargassum* spp. and *Gracilaria corticata* are abundant in many of these localities. *Porphyra* was reported from the Visakhapatnam area (Umamaheswara Rao and Sreeramulu, 1963). Examination of the seaweed collections of this Institute has revealed the presence of *Porphyra* in the intertidal region of Cape Comorin. The occurrence of this species from this area has not been reported so far. The salt water lakes on the east coast of India, such as Chilka and Pulicat Lakes,

support a good growth of *Gracilaria* species, especially *G. verrucosa*. Large beds of seaweeds are also known to be present around Laccadives, Andamans and Nicobar Islands. However, the quantities of seaweeds available in these areas have not been assessed in a systematic way. The surveys so far have been restricted to Chilka Lake (Mitra, 1946), Cape Comorin area (Koshy and John, 1948) and some places in the Gulf of Mannar (Varma and Krishna Rao, 1964; Desai, 1965) and Gujarat coast (Sreenivasa Rao *et al.*, 1964; Desai, 1965). Some attempts were also made to estimate the drift weeds (Krishnamurthy *et al.*, 1965).

The areas exploited at present for this marine resource are limited, localities like Pamban, Periyapatnam and Kilakarai on the south-east coast of India being the chief centres for harvesting seaweeds. Large-scale harvesting of seaweeds has been started here since 1966 and the available data on the quantities of seaweeds collected from these three places are shown in Table II. *Gelidiella acerosa, Gracilaria lichenoides* and *Sargassum* species are the main weeds harvested here now. The data on the dry and fresh weeds presented in Table II indicate the luxuriance of the economic seaweeds in a limited area of the Madras coast. It seems evident that the annual yield of seaweeds in the country can be increased substantially if the resources of the other maritime states are surveyed and exploited. In addition to the intensive surveys in all seaweed growing areas, detailed ecological and experimental studies have to be made as suggested by Subrahmanyan (1965) for a more effective exploitation and maintenance of the resources occurring along the east and west coasts of India.

TABLE I

Important economic seaweeds of India and their uses

Class	Species	Uses			
		as whole Food	as source of Protein	as source of Agar	as source of Algin
Chlorophyceae	*Ulva lactuca* ..	+	−	−	−
	Ulva fasciata ..	+	+	−	−
	Ulva reticulata ..	+	−	−	−
	Ulva rigida ..	+	+	−	−
Phaeophyceae	*Sargassum* spp. ..	−	−	−	+
	Turbinaria spp. ..	−	−	−	+
Rhodophyceae	*Porphyra vietnamensis* ..	+	−	−	−
	Gelidiella acerosa ..	−	−	+	−
	Gracilaria lichenoides ..	+	−	+	−
	G. verrucosa ..	−	−	+	−
	G. crassa ..	−	−	+	−
	G. corticata ..	−	−	+	−

Sample surveys conducted in the Palk Bay

In many earlier surveys emphasis was given to the agar- and algin-yielding seaweeds. Edible species and other plants growing in the inshore coastal waters have not received attention, except *Ulva rigida* recently reported from Sourashtra coast (Parekh and Visveswara Rao, 1964). In order to know the overall abundance of the utilisable seaweeds, sample surveys were conducted by the author

TABLE II

Quantities of seaweeds harvested from three localities around Mandapam (Metric tons)

Year	Pamban	Periyapatnam	Kilakarai	Total dry weight	Total fresh weight†
1966	15·19	..	..	15·19	75·95
1967	18·35	65·55	58·07	141·97	709·85
1968*	16·59	8·00	304·65	329·24	1,646·20

* till October 1968.

† assuming that the weeds contain 80% water.

in a 3·58 sq. km area in Palk Bay (Fig. 1) during the calm seasons of 1965 and 1966. Sampling was done with 1·0 sq.m quadrat on eight survey lines or traverses selected opposite to beacons and other land marks (Fig. 1). Samples were taken on the survey lines at five metre intervals with the help of a diver, moving from one spot to the other in a small boat. To measure the distances between the sampling spots and the traverses accurately, about 300 metres of long rope, marked with cloth bands at five metre intervals, was used. While sampling the vegetation on the traverses the rope was laid on the bottom and the free ends of the rope were tied to anchors. Buoys were used to indicate the position of the anchors.

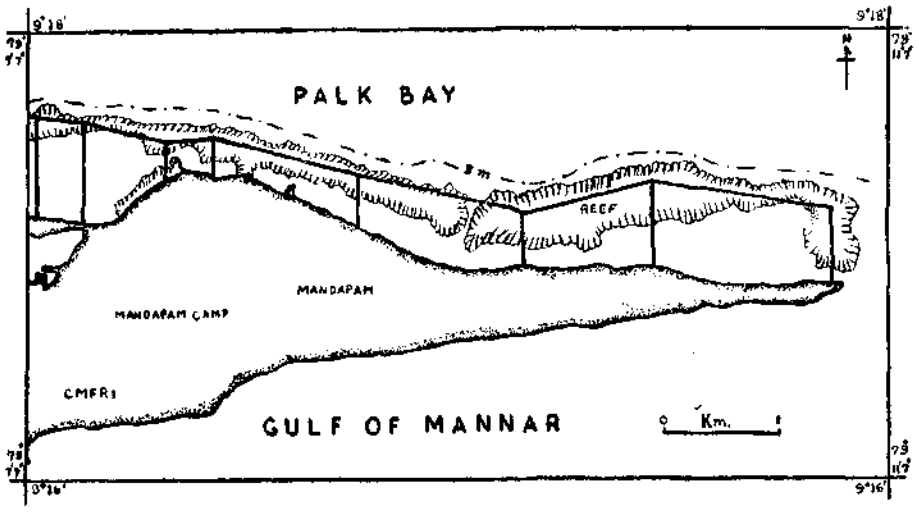

FIG. 1. Map showing the traverses and the area surveyed in the Palk Bay.

A total number of 860 quadrat samples were taken in the first survey and 751 samples in the second survey. All *Gracilaria* species, brown algae and edible species like *Ulva, Caulerpa, Acanthophora,* present in the samples, were sorted and weighed separately. From the length of the traverse and distance between the traverses the area surveyed was estimated using the formula given by Walker (1947). The standing crop of the different seaweeds was estimated from the fresh weight of the weeds collected in all the samples and the total area surveyed. For the estimation of seagrass growing in the area surveyed, data were collected on the area occupied by the seagrass in all the spots sampled and its density (Fresh weight/m^2) was determined in certain places. The standing crop was then calculated from the total area covered by seagrass beds and the mean density of the crop.

Quantitative data obtained on marine algae are shown in Table III. From the data (Table III) it may be seen that 53 to 56% of the total marine algae are economically useful. Among the different groups of weeds sorted, edible species account for the 18·12 and 28·49% of the total seaweeds estimated in 1965 and 1966 respectively. Further, within the two sample surveys significant variation was not observed in the standing crops of different types of seaweeds, except in agarophytes (Table III).

TABLE III

Standing crop of seaweeds in a 3·58 sq.km area in Palk Bay

	Fresh weight in metric tons (in 1965)	(in 1966)
Agarophytes	233·15	47·92
Alginophytes ..	161·83	172·43
Edible algae ..	188·84	245·91
Other algae ..	457·87	398·51
TOTAL ..	1,041·69	864·77

Among the seagrasses *Cymodocea* was predominant in the area surveyed and it occurred as dense beds on sandy bottom of the lagoon like area. Data obtained on the area occupied by the seagrass beds and the standing crop in the two surveys are given below:

Year	Area covered by seagrass (sq. km.)	Fresh weight (metric tons)
1965	0.75	1,916.19
1966	0.88	2,170.81

It is evident from these figures that about one-fourth of the total area surveyed was covered with seagrass and the standing crop was higher than that of marine algae. The present estimate of about 2,000 tons of seagrass in 3·58 sq.km area also suggests that considerable quantities of these marine flowering plants occur around Mandapam, which can be utilised as manure and packing or insulating materials.

Seaweed cultivation

In addition to the exploitation of the natural resources, cultivation or farming of seaweeds on a large scale would increase the annual production of this raw material. High yielding and commercially valuable species can be cultivated by (1) placing boulders or concrete structures in the natural habitats where useful species grow, (2) using artificial substrata such as bamboo frames, coir or synthetic fibre nets in protected areas and (3) transplanting the important varieties to other coastal areas of the country.

To study the possibilities of cultivating *Gracilaria* species by vegetative propagation preliminary experiments have been conducted by the author with *Gracilaria corticata* and *G. lichenoides*. Fragments of *G. corticata* were kept in the twist of a small rope at intervals and the rope was suspended in an aquarium tank. Increase in growth from the cut ends of the plant bits was measured at

fifteen-day intervals. The average growth rate of the experimental plants is shown in Fig. 2. Slow growth was observed for a period of 45 days and thereafter rapid increase in length from 1·8 to 5·5 cm was recorded during the next 45 days (Fig. 2). Experiments with *G. lichenoides* were conducted in the sea using coir net frames of about 0·5m² size. Small pieces of *G. lichenoides* were kept on each frame and they were suspended horizontally in the sea in the first week of July 1967. As the growth increased many shoots developed from the plant bits and after a two-month period the entire frame was covered with profusely branched plants of *G. lichenoides* (Fig. 3). The average height of these

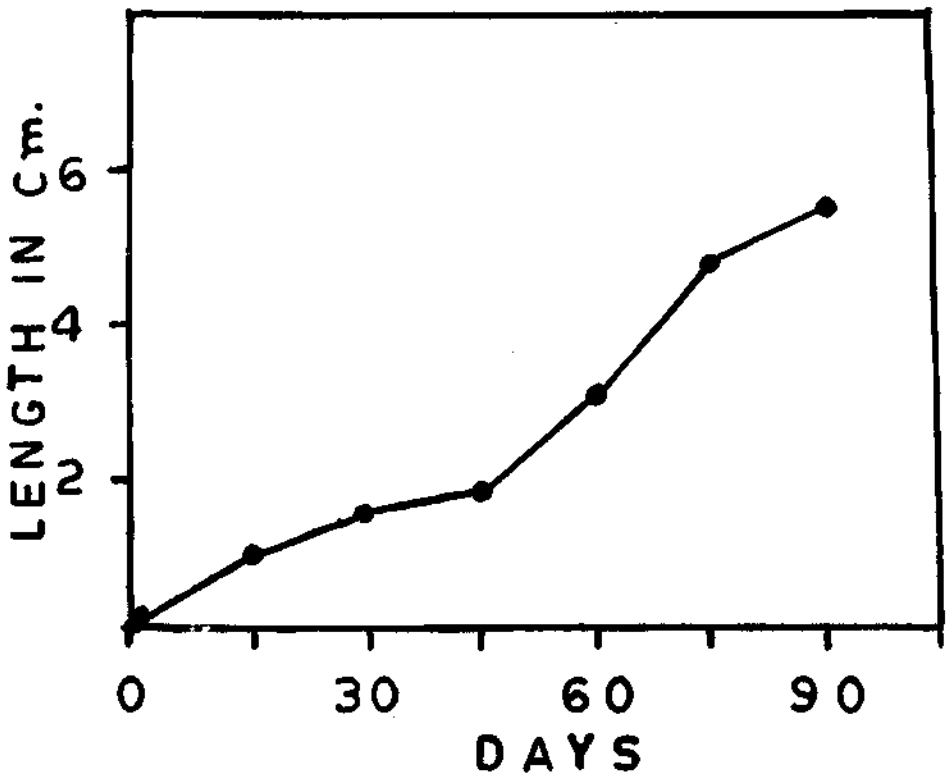

FIG. 2. Growth rate in the experimental plants of *Gracilaria corticata*.

plants varied from 14 to 16 cm and at the end of two months plant bits kept on the two frames gained a weight of 213 gm and 275 gm respectively. Results obtained in these experiments suggest that the regenerating power is high in the two *Gracilaria* species studied and that they grow rapidly to harvestable size within three or four months. In the experiments carried out in culture ponds at Porbandar (Thivy, 1964) small plants of *Sargassum cinctum* had grown to a height of 37 to 52 cm within 40 days. Studies on the growth behaviour of *Ulva fasciata, Enteromorpha compressa, Porphyra vietnamensis* and *Gracilaria* growing on the Visakhapatnam coast (Umameheswara Rao and Sreeramulu, 1964) and *Ulva lactuca, Gracilaria* spp. and other algae of Mandapam coast (Umamaheswara Rao, unpublished) have also shown that these algae attain their maximum size in one or two months in the natural habitats. Because of this sudden increase in growth and overall abundance it would even be possible to harvest two or more crops in a year, provided the environmental conditions of the area are favourable for cultivating them throughout the year. Attempts should therefore be made to cultivate the species of *Ulva, Porphyra, Gelidiella, Gracilaria* and *Sargassum* in the protected areas of the Palk Bay and Gulf of Mannar, in the backwaters or shallow bays near Cochin, Visakhapatnam, Kakinada and in the Chilka and Pulicat Lakes to augment the seaweed resources of the country.

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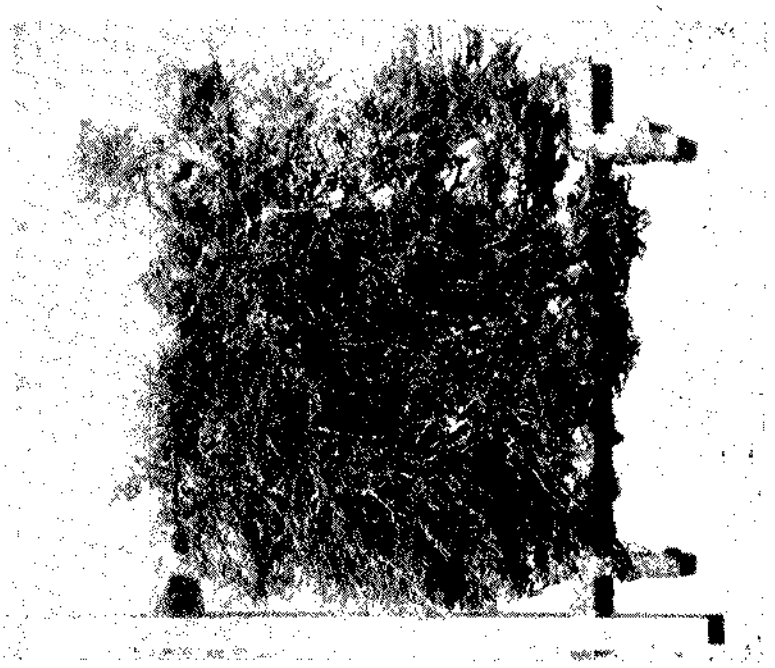

FIG. 3. Growth of *Gracilaria lichenoides* on the coir net frame suspended in the sea (Photographed on 11-9-1967).