

SEAWEED POTENTIAL AND ITS EXPLOITATION IN INDIA

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Abstract

The potential areas in India for luxuriant growth of seaweeds are south Tamil Nadu coast, Gujarat coast, Lakshadweep and Andaman Nicobar Islands. The total standing crop of seaweeds from Intertidal and shallow waters of all maritime states and Lakshadweep Islands was estimated as 91339 tons (wet wt.) The quantity of seaweeds growing in deep waters of Tamil Nadu was estimated as 75372 tons (wet wt) in an area of 1863 sq km from Dhanushkodi to Kanyakumari. Data were collected every month from 1978 to 1995 from the seaweed landing centres in Tamil Nadu on the quantity of seaweeds exploited from the natural seaweed beds. During this period the quantity of agar yielding seaweeds *Gelidiella acerosa*, *Gracilaria edulis*, *G. crassa* and *G. foliifera* exploited in a year varied from 248 to 1289 tons (dry wt.); algin yielding seaweeds *Sargassum* spp and *Turbinaria* spp from 651 5537 tons (dry wt) and all the above seaweeds from 1177 to 6420 tons (dry wt). Since several years, agar yielding red algae are over exploited in Tamil Nadu. The need for conservation of commercially important seaweeds of Tamil Nadu and time - table for their commercial exploitation are given. The harvesting of underexploited and unexploited seaweeds from Tamil Nadu and unexploited seaweeds from other parts of Indian coast are suggested.

Introduction

Seaweeds or marine algae constitute one of the commercially important renewable marine living resources. They are the only source for the production of phytochemicals such as agar, carrageenan and sodium alginate which are widely used as gelling, stabilizing and thickening agents in food, confectionary, pharmaceutical, dairy, textile, paper, paint and varnish industries. Many protein rich seaweeds such as *Ulva*, *Enteromorpha*, *Caulerpa*, *Codium* and *Monostroma* (green algae); *Sargassum*, *Hydroclathrus*, *Laminaria*, *Undaria*, *Macrocystis* (brown algae); *Porphyra*, *Gracilaria Eucheuma*, *Laurencia* and *Acanthophora* (red algae) are used for human consumption in the form of soup, salad, curry etc. Jelly, jam, chocolate, pickle and wafer can be prepared from certain seaweeds. Marine algae are also used in different parts of the world as animal feed and fertilizer for land crops as they contain more than 60 trace elements, carbohydrate, iodine, bromine, vitamin and some bioactive substances (Silas, *et al* 1986 and Kaliaperumal 1993). In India seaweeds are used only for the production of agar and sodium alginate. The seaweed industries offer employment to hundreds of people living in the coastal villages. Seaweed is exported in the form of raw material or finished product like agar and it earns good foreign exchange.

Seaweed distribution and resources

The potential areas in India for luxuriant growth of several species of green, brown and red algae are the southeast coast of Tamil Nadu from Mandapam to Kanyakumari covering 21 islands in the Gulf of Mannar, Gujarat coast, Lakshadweep and Andaman-Nicobar Islands. The other places in the east and west coast where rich seaweed beds occur are Bombay, Karwar, Ratnagiri, Goa, Varkala, Vizhinjam, Pulicat and Chilka (Kaliaperumal *et al* 1987). The agar yielding seaweeds *Gracilaria arcuata* and *G. verrucosa* and carrageenan yielding seaweed *Hypnea valentiae* also occur in harvestable quantities in some estuaries and backwaters of Tamil Nadu and Pondicherry (Kalimuthu *et al* 1995).

The important and commonly occurring agar yielding seaweeds in different localities of Indian coast are species of *Gelidiella*, *Gracilaria*, *Gelidium* and *Pterocladia*. Among these red algae, only *Gelidiella acerosa*, *Gracilaria edulis*, *G. corticata* var. *corticata* *G. foliifera* and *G. verrucosa* are available in exploit-

Table 1: Standing crop of seaweeds in different maritime states of India

State	Quantity of Seaweeds (wet wt in tons)	
	Shallow waters	Deep waters
Gujarat	19445	Not surveyed
Maharashtra	20000	Not surveyed
Goa	2000	Not surveyed
Karnataka	Negligible	Not surveyed
Kerala	1000	Not surveyed
Tamil Nadu	22044	75373
Andhra Pradesh	7500	Not surveyed
Orissa	5	Not surveyed
Lakshadweep	19345	Not surveyed
Andaman - Nicobar	Not surveyed	Not surveyed
Total	91339	75373

able quantities. Species of *Sargassum*, *Turbinaria*, *Cystoseira*, *Hormophysa*, *Spatoglossum*, *Rosenvingea* and *Chnoospora* are the important algin yielding seaweeds in Indian waters. Among these brown algae, *Sargassum Turbinaria* and *Hormophysa* grow in harvestable quantities. The carrageenan yielding red alga *Hypnea* also occurs in exploitable quantity at various parts of the coastline.

The quantitative seaweed resources survey in the intertidal and shallow waters of all maritime states (Mitra, 1946; Chauhan and Krishnamurthy, 1969; Chauhan and Mairh, 1978; Anon, 1978; Untawale *et al* 1979; Untawale and Agadi, 1981; Dhargalkar, 1981; Anon, 1984 and 1988 and Chennubhotla *et al.*, 1988) and Lakshadweep Island (Kaliaperumal *et al* 1989) and in deep waters (5 to 22 m depths) of Tamil Nadu from Dhanushkodi to Kanyakumari (Anon, 1989, 1990, 1993 and 1993 b) was conducted by various research organisations. From these surveys the total standing crop of seaweeds in the intertidal and shallow waters was estimated as 91339 tons (wet wt) and 75372 tons (wet wt) in deep waters (Table 1).

Seaweed exploitation and industry

In India the seaweeds are used at present only as raw material for the production of agar and sodium alginate. About 25 actively functioning agar and algin industries are situated in different places in Tamil Nadu, Kerala, Karnataka, Pondicherry, Andhra Pradesh and Gujarat (Silas and Kalimuthu, 1987). Now the red algae *Gelidiella acerosa*, *Gracilaria edulis*, *G. crassa* and *G. foliifera* are used for agar manufacture and brown algae *Sargassum wightii*, *S. ilicifolium*, *S. myriocystum*, *Turbinaria conoides*, *T. ornata*, *T. decurrens* and *Cystoseira trinodis* for sodium alginate.

Table 2 Algae Associated with Fauna

Macrofauna	Algae
<i>Trochus stellatus</i>	<i>Chaetomorpha antennina</i> ; <i>Cladophoropsis zollingeri</i> , <i>Centroceras clavulatum</i>
<i>Turbo</i> sp.	<i>Cladophora</i> sp., <i>Centroceras clavulatum</i> , <i>Chaetomorpha antennina</i>
<i>Astraea stellare</i>	<i>Amphiroa anceps</i> , <i>Amphiroa</i> sp.
<i>Triton</i> sp.	<i>Centroceras clavulatum</i>
<i>Perna indica</i>	<i>Laurencia poitei</i>

Among the 19 species of green algae reported *Valoniopsis pachynema* dominated in all the three months. Other dominant species of green algae which occurred in exploitable quantities were *Caulerpa scalpelliformis*, *Ulva lactuca* and *U. fasciata*.

The study also showed 15 species of brown algae representing 8 genera. Among 15 species 13 of them occurred in all the three months. *Dictyopteris delicatula* was not observed in September and *Chnoospora bicanaliculata* disappeared completely in November. The brown algae which occurred in harvestable quantities during September 1995 were *Chnoospora bicanaliculata*, *Padina boergesenii* and *Stoechospermum marginatum*. Species of *Sargassum* namely *S. ilicifolium*, *S. wightii*, *S. longifolium* occurred in harvestable quantities throughout the study period. *Dictyota bartayresiana* showed maximum occurrence in November forming cushion like outgrowth on rock and on other seaweeds.

Forty eight species of red algae representing 31 genera were observed during the study period. Among these 29 species occurred in all the three months. Few of them were very rare and were noticed only once that too in minimum numbers. They were *Dictyurus purpureus*, *Botryocladia* sp., *Cryptonemia coriacea*, *Halymenia venusta*, *H. porphyroides* and *Rhodomenia palmata*. Some species occurred in harvestable quantities in different months. *Amphiroa anceps*, *Gracilaria corticata* var. *corticata* occurred abundantly in all the three months in harvestable quantity. *Chondrococcus hornemanii* showed its maximum occurrence in October and November. *Cheilosporum spectabile*, *Hypnea musciformis*, *H. valentiae* and *Laurencia flagelliformis* occurred more in September and *L. poitei*, *Gracilaria fergusonii* in November.

Only 4 species of blue green algae belonging to 2 genera were noticed in all the three months but in negligible quantities.

The sea grasses noticed in the locality were *Syringodium isoetifolium* and *Cymodocea rotundata* and were found in all the three months of observation.

Some members of seaweeds, apart from living as independent organisms on the surface of rocks and sandy bottoms, also showed epiphytic and epizoid associations. The members which exhibited epiphytic relationship with other species of algae were: 1. *Polysiphonia* sp. growing on *Sargassum wightii*, *Gracilaria corticata*, *C. fergusonii*, *Laurencia flagelliformis*, *Cheilosporum spectabile* and *Hypnea* sp. 2. *Ulva lactuca* was noticed growing on *Cheilosporum spectabile* and *Sargassum wightii*. 3. *Rhodomenia dissecta* on *Cheilosporum spectabile*, *Laurencia flagelliformis* and *Enantiocladia prolifera*. 4. *Champia parvula* on *Laurencia flagelliformis* and *Enantiocladia prolifera*. 5. *Chaetomorpha* on *Sargassum wightii* and *S. vulgare*. 6. *Ectocarpus* sp. on *Laurencia flagelliformis* and *Gracilaria fergusonii*.

The members which exhibited epizoid association were: 1. *Chaetomorpha antennina*, *Cladophoropsis zollingeri* and *Centroceras clavulatum* growing on *Trochus stellatus* and *Turbo* sp. 2. *Amphiroa anceps* and *Amphiroa* sp. were attached to the shell surface of *Astraea stellare*. 3. *Centroceras clavulatum* showed its luxuriant growth on *Triton* sp. 4. *Laurencia poitei* was seen associated with *Perna indica*, the common brown mussel (Table 2).

The macro fauna that formed the remaining part of the community are some species of sea anemones, tubeworms, decapods, gastropods, and bivalves. The sedentary forms like *Zoanthus* sp. and *Crossostrea* sp. occupy the rock regions where there is no algae growth. All the 26 species of Gastropods and 3 species of Decapods were found to be common throughout the period of study. The tubeworm *Vermetus* sp. is a sedentary form and that was found distributed along with the algae substratum and on the adjacent rocky surface.

The different species of polychaetes, like Nerid worms. Terebellid worms, *Eurythoe* sp. and *Eurice* sp., barnacles, decapods like small hermit crab and spider crabs, gastropods namely, *Thasis granulata*,

S.No.	Name of the Algae	Sep.95	Oct.95	Nov.95
27.	<i>G. corticata</i> var. <i>puthumadensis</i>	-	+	+
28.	<i>G. edulis</i> (Gmel.) Silva	+	+	+
29.	<i>G. fergusonii</i> J.Ag.	+	+	+
30.	<i>Gelidiopsis variabilis</i> (Grev.) Schmitz.	+	+	+
31.	<i>Ahnfeltia plicata</i> (Huds.) Fricis	+	+	+
32.	<i>Gymnogongrus pygmaeus</i> (Grev.) J.Ag.	+	+	+
33.	<i>Botryocladia</i> sp.	-	+	-
34.	<i>Rhodymenia dissecta</i> Boergs	-	+	+
35.	<i>R. palmata</i> (L) Grev.	-	-	+
36.	<i>Champia parvula</i> (C.Ag.) Harv.	+	+	+
37.	<i>Centroceras clavulatum</i> (C.Ag.) Mont.	+	+	+
38.	<i>Ceramium</i> sp.	+	+	+
39.	<i>Spyridia aculeata</i> J.Ag.	-	+	+
40.	<i>Dictyurus purpurescens</i> Bory	-	+	-
41.	<i>Polysiphonia</i> sp.	+	+	+
42.	<i>Herposiphonia</i> sp.	+	+	+
43.	<i>Laurencia flagelliformis</i> J.ag.	+	+	+
44.	<i>L.indica</i> Hauck	+	+	+
45.	<i>L. poitei</i> (Lamour.) Howe.	+	+	+
46.	<i>Acan thophora</i> sp.	+	+	+
47.	<i>Enatiocladia prolifera</i> (Grev.)falk	+	+	+
48.	<i>Leveillea jungermanniodes</i> (Mart) et.Her.Harv.	-	+	+
CYANOPHYTA				
1.	<i>Lyngbya majuscula</i> Harvey et Gomont	+	+	+
2.	<i>Lyngbya</i> sp.	+	+	+
3.	<i>Phormidium retzii</i> (Ag) Gomont	+	+	+
4.	<i>Phormidium</i> sp.	+	+	+
SEA GRASSES				
1.	<i>Syringodium isoetifolium</i>	+	+	+
2.	<i>Cymodocea rutundate</i> Ezrene Hempr. ex. Aschens	+	+	+

S.No.	Name of the Algae	Sep.95	Oct.95	Nov.95
RHODOPHYTA				
1.	<i>Porphyra</i> sp.	-	+	+
2.	<i>Gelidium micropterum</i> Kutz.	-	+	+
3.	<i>G. pusillum</i> (Stackh.) Le Jolis	-	+	+
4.	<i>C hondrococcus hornemanii</i> (Mert.) Schmitz	+	+	+
5.	<i>Amphiroa anceps</i> (Lamk.) Decsne	+	+	+
6.	<i>A. anastomosans</i> Weber v. Bosse	+	+	+
7.	<i>A. fragilissima</i> (L.) Lamour	+	+	+
8.	<i>Amphiroa</i> sp.	+	+	+
9.	<i>Cheilosporum spectabile</i> Harvey	+	+	+
10.	<i>Jania rubens</i> (L.) Lamouroux	+	+	+
11.	<i>Grateloupia lithophila</i> Boergesen	+	+	+
12.	<i>Halymenia floresia</i> (Clem.) C.Ag.	-	+	+
13.	<i>H. porphyroides</i> Boergs	-	-	+
14.	<i>H. venusta</i> Boergs	-	+	-
15.	<i>Cryptonemia coriacea</i> Schmitz	-	-	+
16.	<i>C. lomation</i> (Bartel) J. Ag.	-	+	-
17.	<i>Corynomorpha prismatica</i> J.Ag.	-	+	+
18.	<i>Solieria robusta</i> (Grev.) Kylin	+	+	+
19.	<i>Sarconema filiforme</i> (Sonder) Kylin	+	+	+
20.	<i>S. furcellatum</i> Zam	+	+	+
21.	<i>Hypnea musciformis</i> (Wulf) Lamour	+	+	+
22.	<i>H. valentiae</i> (Turn) Mont.	+	+	+
23.	<i>Hypnea</i> sp.1	+	+	+
24.	<i>Hypnea</i> sp.2	+	+	-
25.	<i>Griffithsia flabelliformis</i> Harv.	-	+	+
26.	<i>Gracilaria corticata</i> J.Ag. var. <i>corticata</i> Umamaheswara Rao	+	+	+

Table 1 List of Marine Algae collected from Arockiapuram Coast, Tamilnadu

S.No.	Name of the Algae	Sep.95	Oct.95	Nov.95
CHLOROPHYTA				
1.	<i>Ulva fasciata</i> Delile	+	+	+
2.	<i>U. lactuca</i> (Linn.) Le Jollis	+	+	+
3.	<i>Chaetomorpha aerea</i> (Dillw.) Kuetz	+	+	+
4.	<i>C. antennina</i> (Bory.) Kuetz.	+	+	+
5.	<i>Cladophora</i> sp. 1	+	+	-
6.	<i>Cladophora</i> sp. 2	+	+	-
7.	<i>Cladophoropsis zollingeri</i> (Kuetzing) Boergs	-	+	+
8.	<i>Bryopsis plumosa</i> (Huds.) Ag.	+	+	+
9.	<i>Caulerpa chemnitzia</i> (Esper) Web. v. Bosse	+	-	-
10.	<i>C. cupressoides</i> (Vahl.) Ag.	+	-	-
11.	<i>C. microphysa</i>	+	+	+
12.	<i>C. peltata</i> Lamour	+	-	-
13.	<i>C. scalpelliformis</i> (R.Br.) Web.v. Bosse	+	+	+
14.	<i>C. taxifolia</i> (Vahl.) Ag.	+	+	+
15.	<i>Codium tomentosum</i> (Huds.) Stackh	-	+	+
16.	<i>Halimeda macroloba</i> Decaisne	+	+	+
17.	<i>Halimeda</i> sp.	+	-	-
18.	<i>Valoniopsis pachynema</i> (Martns) Boergs	+	+	+
PHAEOPHYTA				
1.	<i>Ectocarpus</i> sp.	+	+	+
2.	<i>Colpomenia sinuosa</i> (Roth) Derb.et. sol.	+	+	+
3.	<i>Chnoospora bicanaliculata</i> Krishnamurthy & Thomas sp. nov.	+	+	-
4.	<i>C. minima</i> (Herring) Papenfuss	+	+	+
5.	<i>Dictyopteris delicatula</i> Lamour	-	+	+
6.	<i>Dictyota bartayresiana</i> Lamour	+	+	+
7.	<i>Dictyota dichotoma</i> (Huds.) Lamour	+	+	+
8.	<i>Padina boergesenii</i> Allender & Kraft	+	+	+
9.	<i>P. tetrastromatica</i> Hauck	+	+	+
10.	<i>Stoechospermum marginatum</i> (Ag) Kuetz.	+	+	+
11.	<i>Sargassum ilicifolium</i> (Turn) J. Ag.	+	+	+
12.	<i>S. longifolium</i> Ag.	+	+	+
13.	<i>S. vulgare</i> C.Ag.	+	+	+
14.	<i>S. wightii</i> Grev.	+	+	+
15.	<i>Sargassum</i> sp	+	+	+