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INDIAN SEAWEED RESOURCES AND THEIR MANAGEMENT

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ABSTRACT

During the last three decades detailed information was obtained on the occurrence of economically useful seaweeds on the Indian shores and their utilisation as sources of phycocolloids, food, fodder and fertilizer. Many ecological and biological investigations have also been undertaken on agarophytes, alginophytes and other seaweeds to understand their growth and reproductive behaviours in the natural habitats. Systematic resources surveys were made in some maritime States and manufacturing of agar-agar and algin was started from the sources available in different parts of the country. The work done on Indian seaweeds is reviewed in this paper to get an idea of the present status of the seaweed industry and resources position in the country. From the data available on productive seaweed areas and harvesting seasons, steps to be taken for proper mangement and rational exdloitation of the existing natural resources are suggested.

INTRODUCTION

DURING the last two decades information was collected on the potential of Indian seaweeds and their utilisation as sources of phycocolloids, human food, animal fodder and fertilizer (Thivy, 1960 ; Umamaheswara Rao, 1969, 1970 ; Untawle *et al.*, 1981). Though industrial units have started production of agar-agar and alginates from the indigenous resources, no attempts seem to have been made to manage the natural seaweed beds of our country and to harvest the useful plants in a proper way. Various aspects relating to the seaweed industry, present level of exploitation, ecology and harvesting of seaweeds of our country are dealt within this paper. Measures to be taken up for proper harvesting and management of natural seaweed populations are also discussed.

COMPOSITION AND DISTRIBUTION OF SEAWEEDS

Mixed populations of different kinds of seaweeds occur in the intertidal and shallow subtidal environments of our shores. Among the seaweeds reported from different localities on the east and west coasts of India, Lakshadweep and Andaman and Nicobar Islands, a few red and brown algal taxa are useful as sources of phycocolloids. For, instance, *Gelidiella acerosa*, *Gracilaria edulis*, *G. verrucosa* and other *Gracilaria* spp. yield agar-agar and *Hypnea* species yield Carrageenan. Species of *Sargassum* and *Turbinaria* are the important raw materials for algin production. Many other seaweeds reported from Indian waters can be used as food, fodder and fertilizer. The distribution of these useful seaweed populations in different maritime States is given by Thivy (1960) and Umamaheswara Rao (1969, 1970).

SEAWEED RESOURCES

Data available on seaweed resources and area or length of the coastline surveyed are presented in Table 1. So far systematic assessment of resources was made in three maritime States namely Tamil Nadu, U.T. of Lakshadweep and Andhra Pradesh. Some details are available on the resources of

Gujarat, Maharashtra, Goa and Orissa States and coastal areas of Kerala, Andaman and Nicobar Islands have not yet been surveyed. As shown in Table 1, the total standing crop of all seaweeds is about 39,790 tonnes wet weight and the dry weight of these seaweeds is about 11,937.2 tonnes (based on 70% water content). On an average basis, agar and algin yelding seaweeds constitute one fourth of the total seaweed crop (about 9947 and 2484 tonnes wet and dry weights respectively). From the survey data available it is evident that the densities of total standing crop of useful seaweeds vary in different areas (Table 1) and attempts have not been made to identfy and classify the seaweed beds according to the biomass values. From the information existing in the literature, some rich and more productive seaweed beds are shown in Table 2. Species of *Sargassum*, *Turbinaria*, *Gracilaria*, *Hypnea*, *Ulva* and *Chaetomorpha* are the major components of these beds. Another intersting feature emerged from these surveys is that the important Indian agarophyte *Gelidiella acerosa* is a less abundant and rare plant in Gujarat and Tamil Nadu, when compared with other agarophytes and its density is slightly more in some islands of Lakshadweep (Subbaramiah *et al.*, 1979).

Present Level of Exploitation

Though *Gelidiella*, *Gracilaria* and *Sargassum* species are extensively used for the extraction of seaweed polysaccharides in our country, total quantities of seaweeds harvested and utilised by the industry each year are not available to understand the present level of exploitation, annual changes in the seaweed production and the damage caused to the natural beds. Industrial units available in the country, their installed capacity and present production of agar-agar are shown in Table 3. The total production of phycocolloids in these units is about 791 tonnes, which is far less than the installed capacity. These production figures clearly show that the quantities of raw material used by the seaweed industry are more than the seaweed stocks estimated (Table 1), since 791 tonnes of phycocolloid is equivalent to 3956 and 13,186.7 tonnes of dry and wet weights of agar and algin-yielding seaweeds (based on 20% yield and 70% water content). These calculations clearly emphasize the fact that the pressure of exploitation is more on the seaweed beds occurring in the inshore waters of our country. Though most of the agar and algin-yielding plants take a minimum period of 4 to 9 months for regrowth

Table 1. *Seaweed resources estimated from different maritime States*

Maritime State	Area/length of the coast line surveyed	Standing crop (Tonnes wet wt.)	Author(s)
Gujarat	548 ha	446.2	Chauhan, 1978 b
Maharashtra	563 km	278.3	Chauhan, 1978 a
Goa	—	2,000.0	Dargalkar, 1981
Tamil Nadu	9,892 ha	22,044.0	Anonymous, 1977
Andhra Pradesh	1,876 ha	7,493.0	Subbaramiah *et al.*, 1987
Orissa (Chilka)	—	5.0	Mitra, 1946
Lakshadweep	1,334 ha	7,524.0	Subbaramiah *et al.*, 1979

Total wet wt. = 39,790.5, Dry wt. = 11,937.2 tonnes.

TABLE 2. *Some rich and more productive seaweed beds along the Indian shores*

Maritime State	Localities	Dominant seaweeds in the beds	Author(s)
Andhra Pradesh	Rambilli—Bhimunipatnam	*Hypnea, Gracilaria Sargassum*	Subbaramiah *et al.*, 1987
	Pulicat Lake	*Gracilaria, Chaetomorpha*	Report of CSMCRI, 1984
Lakshadweep	Kavarathi, Agatti Kadamat, Kalpeni	*Gelidiella, Gracilaria*	Subbaramiah *et al.*, 1979 Report of CSMCRI, 1979
Tamil Nadu	Rameswaram—Athankarai (Palla Bay)	*Gracilaria, Hypnea*	Anonymous, 1977
	Thonithorai-Mukkaiyur and Coral Islands (Gulf of Mannar)	*Sargassum, Turbinaria*	
Maharashtra	Malvan area	*Sargassum*	Chauhan, 1978
Gujarat (Saurashtra)	Vadodra, Porbandar Harshad, Armada Adtra	*Sargassum Gracilaria*	Chauhan, 1978

and maximum development (Table 4), continuous exploitation may not only decreases the biomass and regenerating capacity of plants, but modifies the distribution and cover of seaweeds of a particular locality.

TABLE 3. *Present production of phycocolloids and capacity of existing units in the country*

Phycocolloid	No. of units	Present production (Tonnes)	Installed capacity (Tonnes/ year)
Agar-agar ..	20	55.7	198
Sodium alginate	12	735.5	1623
Total ..	32	791.2	1821

(*Source :* Venkatesh Kumar, 1980)

HARVESTING AND MANAGEMENT

Commercial harvesting of seaweeds was commenced from 1964 onwards in our country. At present seaweeds are harvested by hand picking especially from the maritime States

TABLE 4. *Harvesting seasons and time required for regrowth of some Indian seaweeds*

Seaweed	Harvests/ Year	Harvesting season(s)	Interval between two harvests
*Enteromorpha compressa** *Ulva fasciata** *Gracilaria edulis* *G. foliifera* *G. corticata* *Hypnea valentiae*	Two	June-July and November-January	4 months
Gelidiella acerosa	One	July-August or February-March	2 years
Prophyra vietnamensis	One	January-March	9 months
Sargassum spp. *Turbinaria ornata*	One	October-December	9 months
T. conoides *T. decurrens*	One	December-February	9 months

* Seasonal growth peaks vary in green algae.

of Tamil Nadu, Gujarat and Andhra Pradesh. The biology and ecology of agar and algin-yielding seaweeds and other algae have been investigated by different workers in certain coastal areas with an objective to suggest suitable seasons for harvesting and to maintain and conserve the natural seaweed resources. Information available on growth cycles, fruiting behaviour and spore producing capacity of important algae growing at Visakhapatnam and Mandapam has been summarised recently by Umamaheswara Rao (1987). Table 4 gives some details of harvesting seasons, number of harvests per year and minimum time required for regrowth and maximum development of useful Indian seaweeds. In general, species of *Gracilaria*, *Gelidiella*, *Ulva* and *Enteromorpha* have two maximum growth seasons, whereas species of *Porphyra*, *Sargassum* and *Turbinaria* have a single peak growth season. Following the growth pattern and regenerating capacity (as in the case of *Gelidiella acerosa*), seaweeds must be harvested once or twice a year, allowing sufficient time for the development of plants between the two harvests (Table 4).

Seaweeds are harvested in different parts of the world by hand picking; using trawls and rakes of different types or by diving. Hand picking or cutting with hand tools is the suitable method in our country since seaweeds grow mainly on rocky boulders in the intertidal areas and in the shallow sublittoral, coral reefs and lagoons and rakes can not be operated in these habitats. Seaweeds are less abundant in the deep waters of our shores to gather them by trawling with mechanised boats.

Plants like *Sargassum*, *Turbinaria*, *Gracilaria* and *Hypnea* regenerate quickly from the basal hold-fasts and/or cut ends of the thalli, rather than from the reproductive elements liberated from fertile plants. On the other hand, taxa like *Ulva*, *Enteromorpha* and *Porphyra* develop mainly from the swarmers liberated. Because of these variations in the regeneration and development of seaweeds, the basal part should not be disturbed, while hand picking or cutting the seaweeds and some mature plants must be left in the seaweed beds for subsequent growth and development of plants from the reproductive elements.

Indiscriminate harvesting without understanding the growth and reproductive cycles of seaweeds gradually destroy the natural populations. For example, in the beds of *Gelidiella acerosa*, harvested by hand picking, population density decreased in three years (1973 to 1976) from 416 to 140 g Fr. Wt/m^2 (Subbaramiah, 1977). Rama Rao and Subbaramiah (1977) reported less growth in population of *G. acerosa* harvested and left for regeneration. Based on these studies Subbaramiah (1977) suggested that *Gelidiella* beds be allowed to grow at least for two years between the two harvests and the period of harvesting must be limited to three months each year. Proper harvesting and management of seaweed beds are therefore, very important for the development of seaweed industry and the following measures have to be taken up for maintaining and conserving the natural seaweed populations of our country;

1. Selection of rich or productive seaweed beds.
2. Regulation on harvesting seasons.
3. Regulation on harvesting methods and implements.
4. Weeding of less desirable species and removal of predators.
5. Formation of seaweed co-operatives or other Government agencies.

More (> 2 Kg biomass/m^2) and less (< 2 Kg biomass/m^2) productive grounds must be identified for different seaweeds in Tamil Nadu, Andhra Pradesh, Lakshadweep and other seaweed growing areas to regulate harvesting and carry out post-harvest management in the selected grounds. Local seaweed cooperatives or other Government agencies formed must sallot grounds to harvesters, announce the

periods of harvesting seasons, supervise the harvest management practices such as weeding of less desirable species, removal of grazers, etc., maintain records of seaweeds harvested from different beds and provide marketing facilities to the seaweed collectors. These measures would not only prevent over harvesting, but give an uninterrupted supply of raw-material to the seaweed industry.

Conclusions

In conclusion it may be mentioned that emphasis must be given in the coming years to classify the seaweed beds of our country based on the density of standing crop. Detailed investigations must be carried out on harvest management and effects of prolonged harvesting in seaweed grounds to conserve and ensure continuous supply of seaweeds to the industry. Seaweed grounds must be given to harvesters selected by the cooperative societies, on lease basis and this would generate employment opportunities to coastal people.

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