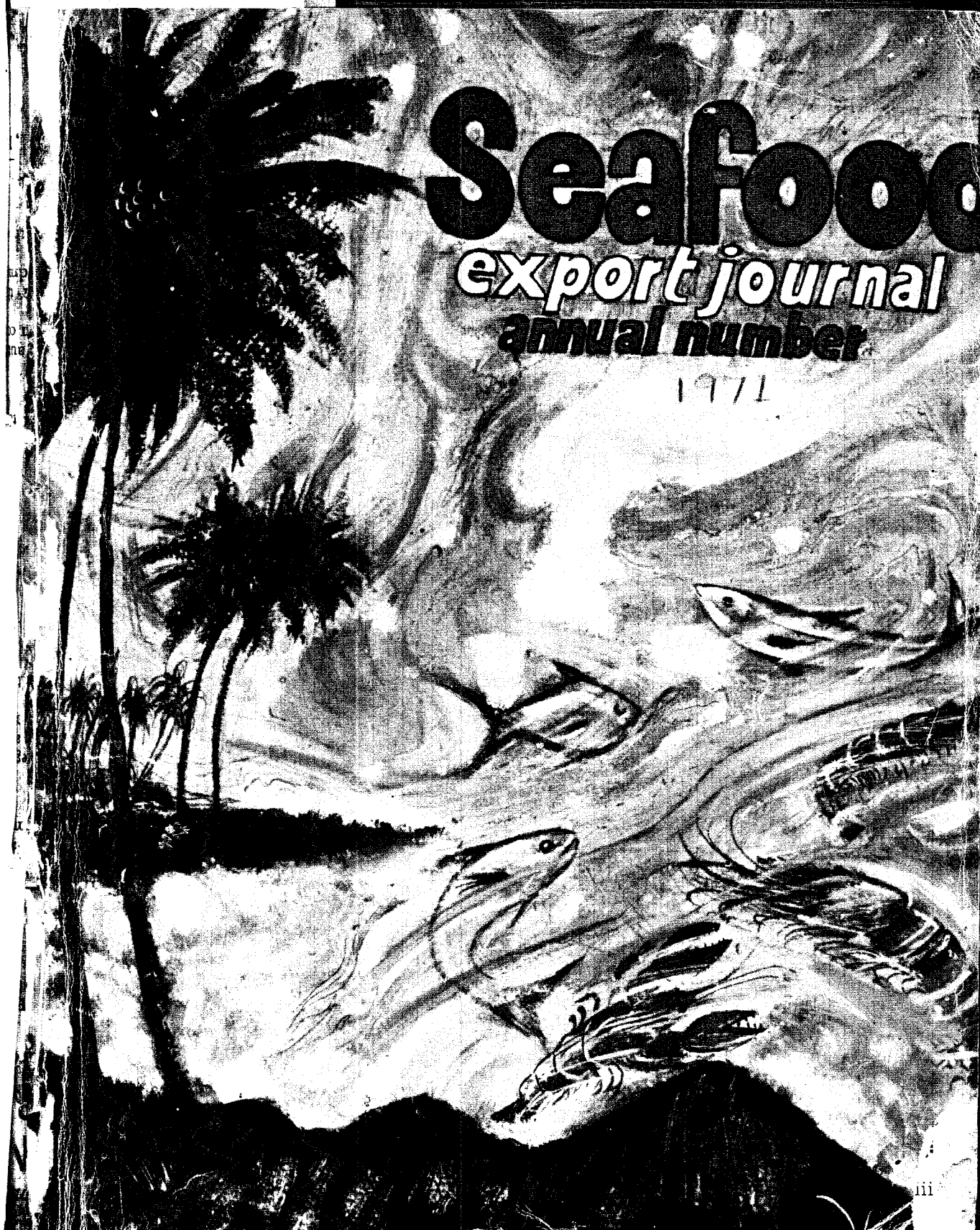
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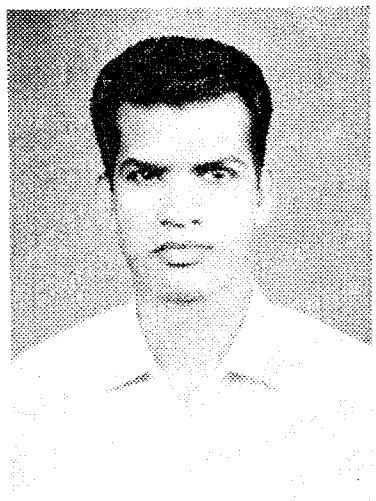


R. Subrahmanyan and C. P. Gopinathan

Dr. Subrahmanyan hails from Pazhayanur in the erstwhile Cochin State. After a brilliant academic career, he graduated from Madras Christian College in 1939 topping the successful candidates with a Ist class and Ist rank. The University of Madras awarded him a Research Studentship and later a Research Fellowship and he worked in the University Botany Laboratory with Prof. M. O. P. Iyengar. In 1943, the University conferred on him the M. Sc. degree for his original researches on the cytology and life history of Diatoms. Subrahmanyan was the first to contribute to a knowledge of the marine Diatoms of India. In 1945, the Govt. of India awarded him an Overseas Scholarship for advanced studies in the U. K. where Subrahmanyan worked with Prof. J. McClean Thompson and Dr. Margery Knight in the University of Liverpool and Marine Biological Station, Port Erin. The University conferred on him the Ph. D. Degree for his researches on the brown sea weeds. Later, he worked with Prof. F. E. Fritsch, F. R. S. in the University of London. He has travelled widely in the U. K. and on the Continent visiting Marine Biological and Botanical Research Institutes.

In 1948, Dr. Subrahmanyan was appointed to the Central Marine Fisheries Res. Inst., where he has been since, except for a period of three years when he was transferred to the Central Rice Res. Inst., Cuttack, to orgonize work on the role of blue green algae in the fixation of atmospheric nitrogen in the rice fields. He has published over 50 original papers covering a wide field of acquatic sciences and Monographs on plankton organisms. A pioneer in phytoplankton studies in the Indian seas which has helped to elucidate many problems of fisheries interest, he was the first to draw attention to the high fertility of the waters of the west coast of India and their fisheries potential. He has evolved a schedule of manuring rice fields using blue green algae to improve the fertility status of the rice soils leading to increased consistent yields. An internationally acknowledged authority on tropical planktology, Dr. Subrahmanyan was elected a

Fellow of the Indian Academy of Sciences in 1956. He is a member of several important bodies in India and abroad.

Dr. Subrahmanyan was heading the Marine Biology and Oceanography Division in the CMFRI until recently and is laying down his office voluntarily to pursue his researches elsewhere.

Mr. C. P. Gopinath, holder of a 1st class M.Sc. from the Kerala University, is a research assistant to Dr. Subrahmanyan.

A student of Prof. A. Raman (Botany Raman) in the St. Albert's College, Ernakulam, Mr. Gopinath had been a scholarship recepient of Burmah-Shell Oil Co., his father's firm, for your years. After his post-graduation with a first class in Botany, he joined the University Botany Laboratory, Karyavattom, Trivandrum for a brief period. Later, he joined the C. M. F. R. I. in 1968 and is persuing his studies on the different aspects of phytoplankton. For the last 3 years, he had been assisting Dr. Subrahmanyan in his various research projects.

The word 'Sea Food' conjures before us such delicacies as prawns, shrimps, lobsters and a host of varieties of fish. In an earlier article entitled 'Pastures of the Sea and Marine resources of India (Sea Food E. J. No. 7, 1969), the author dealt with the role of tiny plants on the fishery resources. While these tiny plants are useful to us in this indirect manner, and constitute the vegetation of the open sea along the shores, particularly where shore is rocky, bouldery but not sandy, one comes across plants attached to the rocks, boulders etc. They are variously coloured green, brown and red chiefly or some hews of these. They are known as seaweeds; plants in every way, though not highly specialised such as common plants we know of on lands. In this article, the uses of these plants and the products from them are described.

The importance of seaweeds came to the fore very much during the last war, not only for India but for other countries also, when the import of seaweed products such as agar agar and alginates came to a halt. Japan had the world monopoly in this trade. In U.S.A. and U.K. a team of algologists took up the challenge and before long, were able to solve the problem from local seaweed resources. Pioneering work towards meeting this paucity in India was initiated mainly in the CMFRI, relating to their resources and manufacture of these products from the raw material. The last war thus gave a great stimulous to research in this field leading to tremendous commercial possibilities utilizing seaweeds.

In the temperate countries, acres of shore are exposed during low tide and one could see the vegetation of seaweeds in all glory (Figs. 1 and 2). Cattle may be seen grazing on them. Farmers lift cartloads of cast up weed to manure the fields,

The high mineral content of seaweeds which contain potash and rare elements, are essential for plant growth. They were the main source of iodine extracted from kelp, the dried up weed. Many seaweeds are also eaten raw or

Figure 1. Vast expanse of seaweed exposed at low tide.

Figure 2. Bed of *Laminaria* exposed at Low Tide.

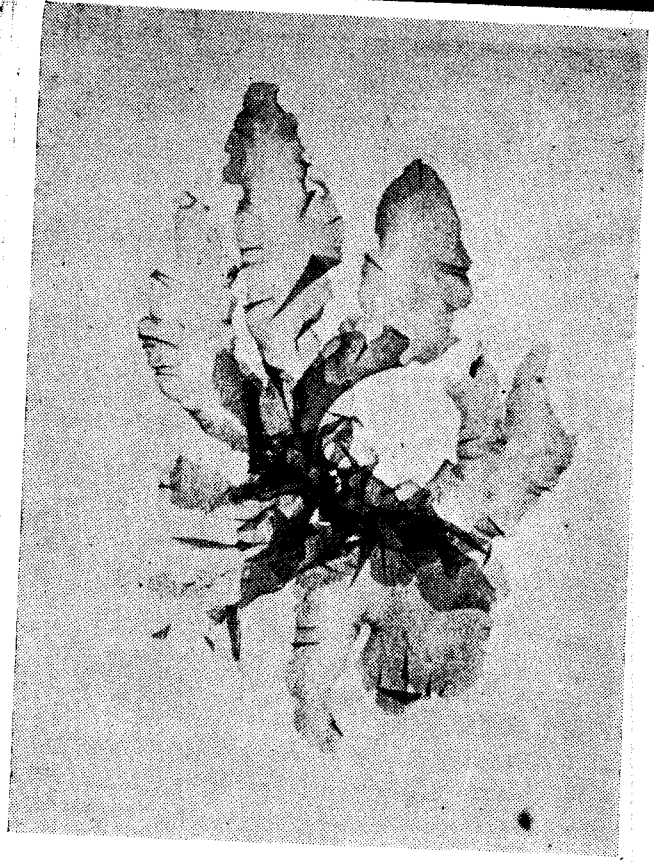


Figure 3. *Dilsia edulis*, red alga eaten raw. Tastes like cucumber.

processed (Figs. 3–6) even now in several parts of the world, Japan, Indonesia, U.K. and Ireland. They are rich in protein and carbohydrates. In Japan several useful seaweeds are cultivated for food and for extracting products useful to various industries.

Seaweeds are the only sources for the two industrially very important phyco-colloides known as agar agar and alginates. Agar agar is obtained from red seaweeds while algin is extracted from brown seaweeds.

AGAR AGAR

Agar agar is an extract derived from certain red seaweeds. It dissolves in hot water and when cooled sets as a gel.

We have in India a number of red seaweeds which yield agar agar (agarophytes) suchas *Gelidium corneum' G. micropterum, G. amansii, Gelidiella* sp., *Gigartina acicularis, G. spinosa, Gracilaria verucosa, G. edulis, G. corticata, G. folifera, Gymnogongrus* sp., *Hypnea muciformis, H. spicifera* etc. (Figs. 7–9).

The agorophytes used for the manufacture of agar in other countries are different. A list of species used in the agar agar industry from the countries bordering the Indian Ocean region are given below:

Aeodes orbitosa	—	S. Africa
Gelidium cartilaginum	—	"
G. corneum	—	"
G. pristoides	—	"
Gigartina acicularis	—	"
G. radula	—	"
Hypnea spicifera	—	"
Suhria vittata	—	"

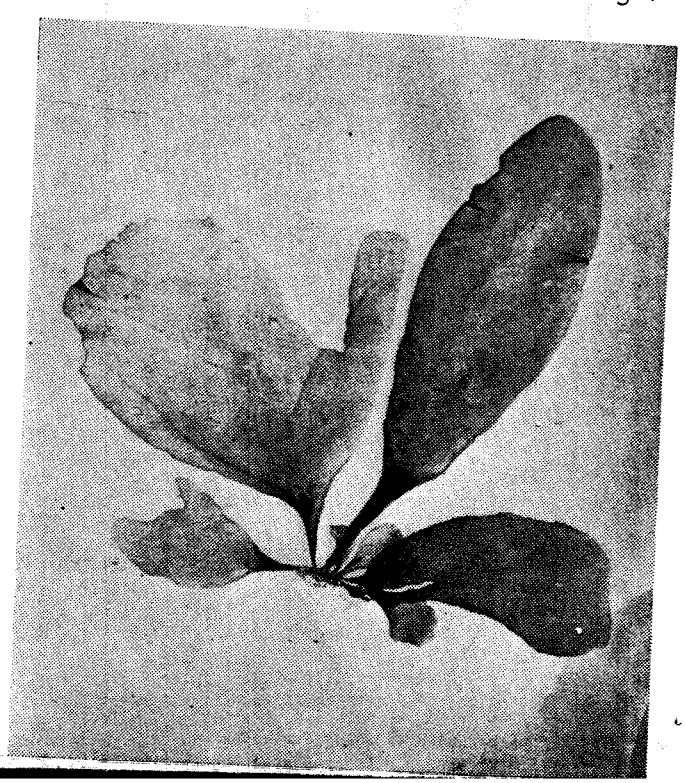


Figure 4. *Ulva lactuca*, a green alga.

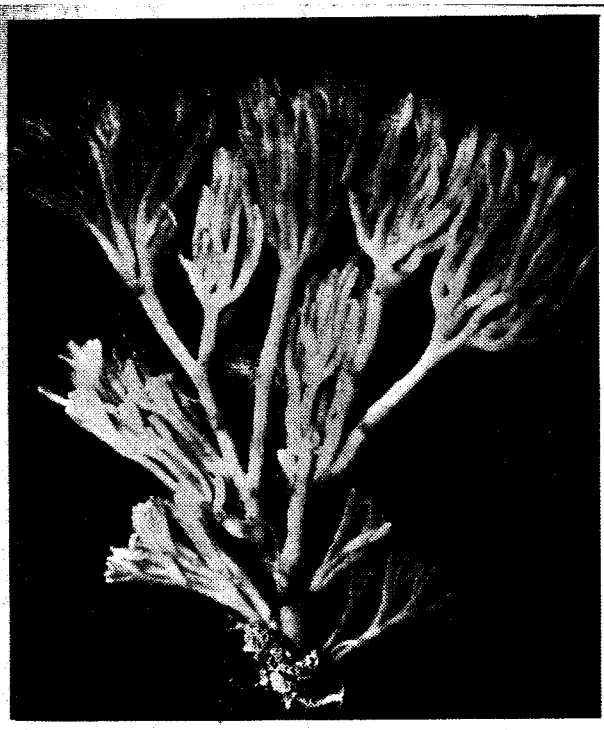


Figure 5. *Codium tomentosum*, green succulent alga.

Gracilaria sp.	—	Ceylon, Malaya, Japan.
Eucheuma denticulatum	—	Indonesia,
E. gelatinosum	—	Indonesia, W. Australia,
Gigartina mamullosa	—	U. K.

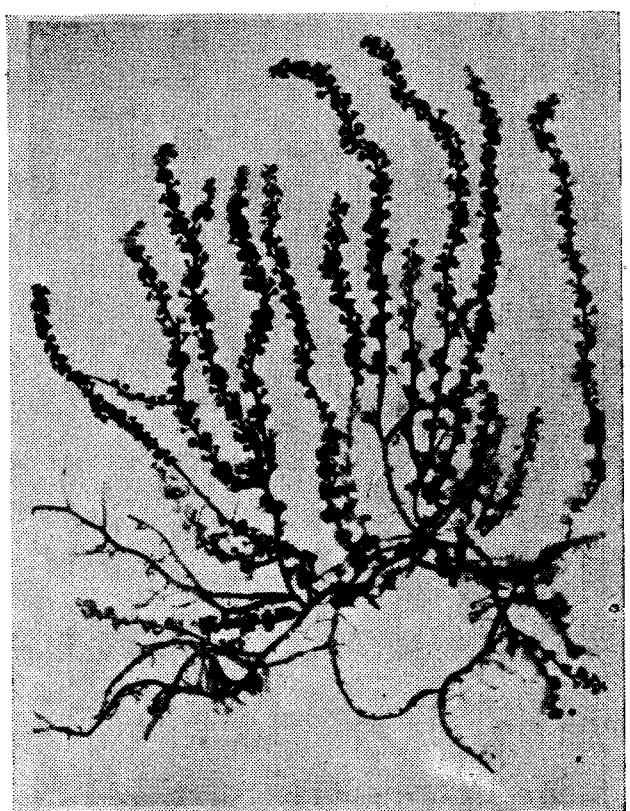
USES OF AGAR

Food value of agar is negligible. It is not affected by any human enzyme. But it has been stated that agar promotes growth of tissues. It is useful in the preparation of food prescribed for diabetic patients. It is used in canning meat and fish; as a thickening agent in cream, pudding, ice cream, fruit salad, soups etc., and in confectionary. It is a cleaning agent for liquors. Agar is important in production of cosmetics, face creams, lotion and even in shoe polish.

In the pharmaceutical industry agar agar occupies an important function viz., in the preparation of culture media for the micro-organisms like bacteria, used in testing efficiency of drugs. It is finding a place in preference to pectin and other colloides. Agar is used as a glycerine substitute, an ointment base, in wound dressing, in blood clotting and in manufacture of plastic materials for dental imprints.

In the textile and leather industry, agar agar forms a sizing medium for fabrics and helps as a thickner for the the dye. In the manufacture of tungston wire for electric bulbs agar agar graphite gel is very useful. Agar is also used as an adhesive in the manufacture of photographic films, in electroplating, sizing of papers etc. Thus it may be seen that agar agar from seaweeds occupies a very role prominent in modern industries.

Figure 6. *Caulerpa* sp. green succulent alga.



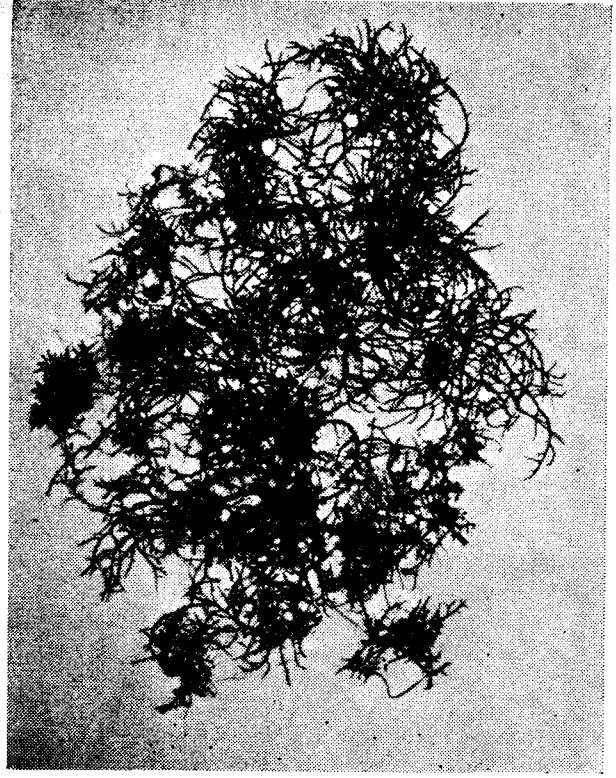


Figure 7. *Gelidium* sp. red alga, agarophyte.

ALGIN

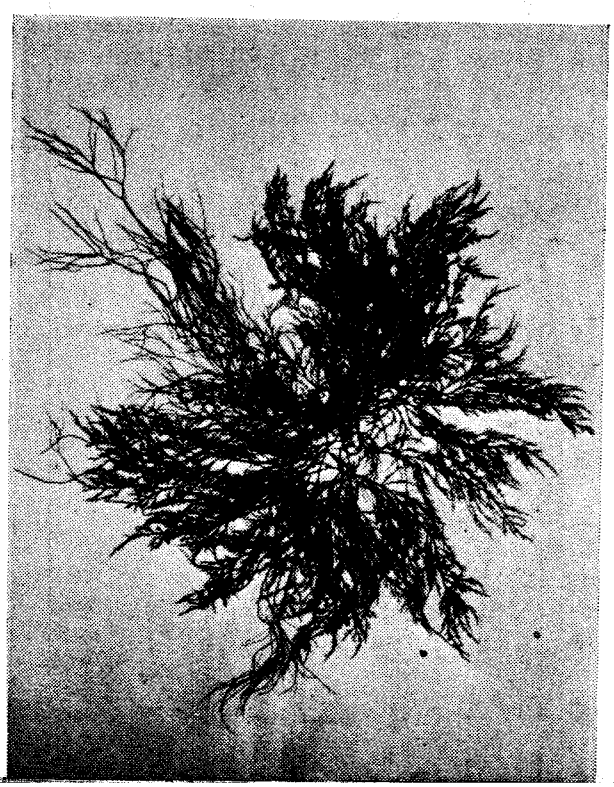
Algin or alginates are hydrophilic colloidal substances in the form of acid extracted from various species of brown algae. The common alginic acid yielding seaweeds in the Indian region are *Dictyota*, *Padina*, *Turbinaria*, *Cystophyllum* and *Sargassum* (Fig. 10). Algin can also be extracted from *Spatoglossum*, *Iyengaria* and *Hydroclathrus*. But due to its low acid content the latter are not commonly used. Most of these seaweeds are found in the same localities mentioned earlier and *Sargassm* spp. is our main source as this is the only one occuring in bulk. The temperate regions have in fact the richest vegetation of brown seaweeds such as *Laminaria*, *Macrocystis*, *Alaria*, *Fucus* and so on (Figs. 1 & 2).

USES OF ALGIN

Alginates (salts of alginic acid) are widely used for making ice cream, candy and soups. Pharmaceutical and cosmetic industries are highly dependent on algin for making tablets, ointments and tooth paste. In the textile industry, it is used as a thickener for printing cotton and synthetic fibres. The latter is widely employed for making parachutes as the fibre is non-inflammable. In the paper industry alginic acid is used for the smoothness of the surface. Algin is a lubricant in welding electrodes.

India has a coast line of about 3600 miles with a variety of habitats in which, numerous species of red and brown seaweeds thrive. Unfortunately

Figure 8. *Hypnea musciformis*, red alga, agarophyte.



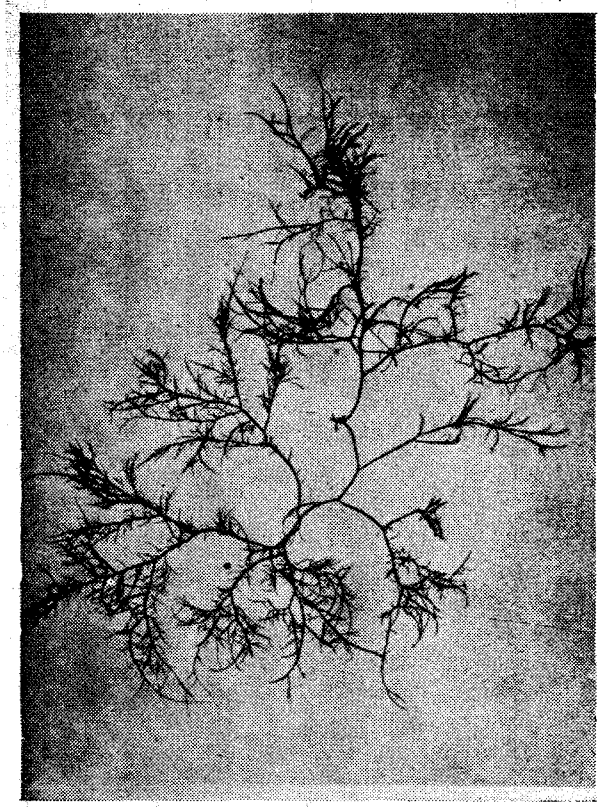


Figure 9. *Gracilaria* sp. red alga, agarophyte.

the richness of our coastal seaweeds cannot stand comparison with those of the temperate countries. Our seaweed vegetation however, is rich in variety but not in quantity. They are restricted only to certain localities: coasts of Gujarat and south east costs (Ramnad District). Chilka Lake is also reported to have a good vegetation of *Gracilaria*.

According to our present knowledge, about 200 tons of seaweeds are harvested from our coasts, most of which is exported to Japan mainly. We are importing agar agar from Japan; very presumably what we import is made out of our exported raw material. It would be advisable to restrict or ban export of the seaweeds so that our needs may be met by utilizing them to make agar agar and save foreign exchange. This would also not starve the few recent industries set up to process seaweed as food under trade name "Sea Grass".

To the extent known, one Kg. of seaweed is exported at the rate of Rs. 2/- or thereabouts. The cost of imported agar agar in the market is between Rs. 76 to 90 per Kg. The enormity of what this country loses may be imagined!

Figure 10. *Sargassum* sp. brown alga, yields algin.

All photographs by R. Subrahmanyan.
1 and 2: views from Isle of Man, U.K.
3 and 5: species from Isle of Man.
4, 6, 7, 8, 9, 10: from Indian coasts.