

SEaweEDS

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Marine plants are divided into algae and seagrasses. Among the algae the microscopic suspended drifting forms are called the phytoplankton and the larger attached forms are the macrophytes or popularly know as seaweeds. Algae are the primitive group of plants capable of synthesizing the complex organic substances with the help of solar energy and nutrient salts present in the seawater. They are simple in structure with no leaves, stems, roots and made up of similar cells with little or no difference. Algae are the ancient organisms. Fossil record indicates that most ancient organism that contain chlorophyll a were probably blue-green algae way back to 3.1 billion years into Precambrian times. It is considered that the remaining members of the plant kingdom are involved from the green algae.

Classification : On the basis of morphological, anatomical characters and pigments present in them they are divided into four main classes namely chlorophyta (green), phaeophyta (brown), rhodophyta (red) and cyanophyta (blue-green). The primary classification of the algae aims to express the fundamental evolutionary or phylogenetic relationship between different species. It is clear that the substantial amount of parallel evolution must have occurred within the different groups of algae, since most of the morphological types are represented by algae from several different groups.

Distribution and Habitat : The distribution of seaweed species depends on various factors such as topography, geological features, environmental parameters and biological factors. Substrate also plays an important part in the distribution and the growth of the seaweeds. The geographical distribution of seaweeds depends on the capacity of algal (seaweed) species to withstand minimum and maximum temperature of the locality. Depending on their tolerance and temperature range, seaweeds are considered as tropical (e.g. Caulerpa, Sargassum, Turbinaria), Temperate (Macrosystis, Laminaria) and cold region (Himantothallus, Desmeratia).

The fluctuation in tide level influence vertical distribution of intertidal seaweeds. It also affects the temperature, light and osmotic pressure to a significant degree.

Seaweeds grow attached to various substrate and are classified as epilithic (living on stones), epipellic (attached to mud and sand), epiphytic (attached to other plants) and epizoic (attached to animals). This type of substrate are found in the open water, sheltered bays and coves, estuaries, coral reefs and lagoon .

Ecological features : Growth of the seaweed species deped on water temperature, light, salinity, nutrients, dissolved oxygen and biotic factors. Effect

of all these parameters vary depending on the seaweed species and the locality where they grow. The water temperature of the intertidal area change markedly with season and tide. Seaweed species growing in the tide pools situated at different levels in the intertidal areas are subjected to the high water temperature and light. Only those seaweed species that can tolerate these fluctuations can grow in this area. e.g. Bryopsis, Ulva, Chaetomorpha, Enteromorpha, Centroceros, Sphacilaria, etc.

Salinity also plays an important role in the distribution of seaweed. It influences all the metabolic processes in the plant which is responsible for the intertidal as well as geographical distribution. Species like Ulva, Enteromorpha, Gracilaria, Sargassum show optimum growth in salinities 30% to 35%. Out of these species Ulva and Enteromorpha grow in upper littoral region where salinity fluctuation occur due to evaporation while Gracilaria and Sargassum occupies sublittoral region where there is not much salinity fluctuation.

Dissolved oxygen and pH do not show much variation in the intertidal area except in the tide pools where fluctuation in these parameters occur due to high photosynthesis.

Nutrients in the coastal waters are comparatively higher than open waters. Accordingly, seaweeds growing in these areas get sufficient nutrients to grow and carry out other living processes. In the polluted areas, nutrients are found in higher concentration where seaweed species like Ulva and Enteromorpha grow luxuriently.

Seaweeds are grazed up on by various organisms from the intertidal and subtidal areas. Sometimes the grazing is so extensive that it affects the productivity of the region.

Production estimates : Recently, world over much attention is gained to study and evaluate seaweed resources of the coast for qualitative and quantitative estimation.

For qualitative estimates, seaweeds are hand picked from the intertidal area. Collected seaweeds are separated, labelled, identified and listed. From Indian coastline of 7860 km including two groups of islands 646 seaweed species have been reported. Maximum number of seaweed species were reported from the Tamil Nadu coast (302 species) followed by Gujarat (202 species).

Quantitative estimation of seaweed is by line transect method. A transect in the intertidal area from high tide level to low tide level is marked and a quadrant having an area of $1 \times 1 \text{ m}^2$ is randomly placed along the transect. Seaweed species present inside the quadrant are collected, separated and weighed to calculate average weight of the quadrant (kg/m^2). Then the average weight of the quadrant is multiplied by the area of the coast

where seaweeds are present as tonnes/km². This methodology is normally used for the estimation of economically important agar and alginate yielding species such as Gracilaria, Gelidiella, Sargassum, Turbinaria, etc.

Seaweed utilization : Seaweeds are being used from time immemorial by the coastal inhabitants to feed cattle, poultry, piggery and as manure. Some of the green seaweeds are used as fish food in aquaculture. Brown seaweeds have nitrogen content similar to the farm yard manure. Seaweed meal is used for making soda and potash for glass, soap factories and iodine. Seaweed as organic fertilizer has shown encouraging results on the crop plants. Countries like U.K. and Norway are manufacturing organic fertilizer under the brand of Maxicrop and Algifert respectively, as foliar spray. Uses of seaweeds as human food is being practiced in South East Asian countries. However, it is not being practiced in India. Porphyra, Monostroma, Caulerpa, Ulva, Gracilaria are some of the species used as food.

Some seaweeds are the source of agar and alginates. During second world war, alginates, soda ash and iodine were extracted from brown seaweeds. In India agar is extracted from Gracilaria spp., Gelidiella, spp., Gelidium spp. and alginate from Sargassum spp. and Turbinaria spp. However, raw material available along the Indian coast is not sufficient to meet the present demand of agar and alginate hence about 60 tonnes of agar and 600 tonnes of alginates are being imported every year. It has been estimated that demand of phycocolloid and their raw material will increase by 10% every year. In order to meet this future demand seaweed cultivation is required to be undertaken.

Seaweed cultivation :

Various seaweed species have been successfully cultivated for industrial purpose in Japan, Norway, Korea, China and other countries. With this technique, Japan has become self-sufficient to fulfill the demand and contribute about 62.28% to the total world seaweed harvest. In India, Technical know-how has been developed for Gracilaria, Gelidiella, Hypnea, Sargassum, Monostroma and Enteromorpha by CMFRI, Mandapam, NIO, Goa and CSMCRI, Bhavnagar. This cultivation technique could be further augmented by using tissue culture, genetic engineering, molecular biology to give high yield and desired strain. These techniques could also be used to produce kelp species like Macrosystis and Laminaria which can be grown in the Indian waters.

Introduction of new seaweed species

Another important aspect of future development of seaweed industry will be introduction of new economically important species in Indian waters. Species like Eucheuma is a good source of Kappa Carrageenan and ideal seaweed for Indian waters. It is being cultivated in the South East Asian countries. However, more research work is required in this field so that species introduced will not outrage existing species upsetting the ecological balance.

Energy from seaweed biomass

Seaweeds have been used as the potential source of fuel through anaerobic digestion of methane. Biogas from seaweed through biotechnology has been identified. It has also been proved to develop and cultivate a particular clone with specific characteristics through tissue culture, e.g. clone of Gracilaria tikvahiae has a capacity to propagate vegetatively for long period without genetic changes.