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Project Title :- Economic Importance of Algae

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Contents

Acknowledgement:-

I have immense pleasure in presenting this project on Economic Importance of Algae.

Thank You our principal Sir Dr. Sukriti Ghoshal and Moumita Basu (Department of Botany) for give this Dissertation topic (Economic Importance of Algae).

The subject is an interesting one. It gave me an opportunity to have detailed study on this subject and showed how thing work in Practical world. I came to understand and analyze the importance and the role of algae in our environment. I had a great time working on the project and I have provided information to the fullest of knowledge and finding.

Economic Importances of Algae

1. Introduction:-

(a) Defination of Algae:-

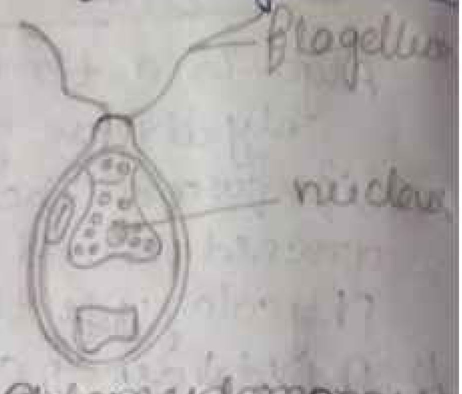
Alga is a term that describes a large and incredibly diverse group of eukaryotic, photosynthetic life forms. These organisms do not share a common ancestor and hence, are not related to each other. Phycology is the branch of science that deals with the study of algae. It also includes the study of various other prokaryotic organisms like blue-green algae and cynobacteria. It also known as algology. The algae normally have chlorophyll and autrophic mode of nutrition. It's body is thallus like. They lack true roots, leaves and stem and donot produce flowers. Algae are usually green, but they can be found in a variety of different colours. Most algae require a moist or watery environment, hence, they are ubiquitous near or inside waterbodies. They also donot have vascular tissues to circulate essential nutrients and water throughout their body. Most of algae have chlorophyll-a.

(b) Various types of structural features:-

The body structure of algae is thallus i.e., they doesnot have well differentiated body structure and exhibit numerous range of thallus organisation, from microscopic to macroscopic structure unicellular to multicellular, motile to non-motile and many more. This huge range of thallus organisation of algae are discussed below:-

(i) Unicellular motile:-

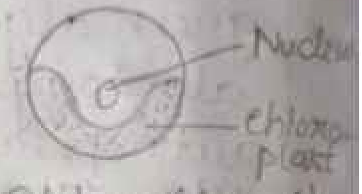
This is the simplest form of algae. They are unicellular with a round, pear-shaped body structure and two flagella at their anterior region. They are motile i.e. they are capable of changing their position. Example: Chlamydomonas (Chlorophyceae)



Chlamydomonas sp.

(ii) Unicellular non-motile:-

Algae of this type are unicellular, small, more or less spherical, non-flagellate and are non-motile. Example: Chlorella, Chlorococcum. (Chlorophyceae)



Chlorella sp.

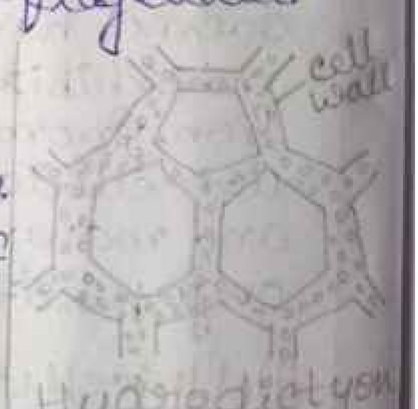
(iii) Multicellular motile:-

In this type, a large number of flagellated unicellular algae are embedded together in the gelatinous sheath forming a rounded motile colony. Example: Volvox, ~~Pandori~~ Pandorina.

Pandorina sp.

(iv) Multicellular non-motile:-

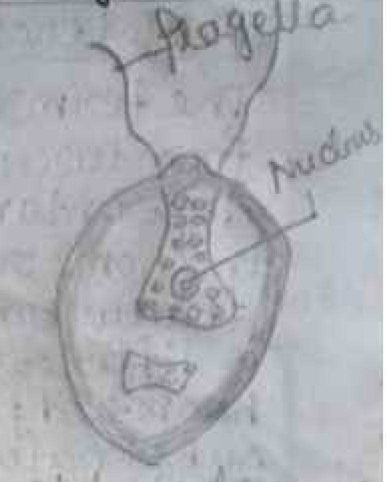
In this type a large number of non-flagellated unicellular algae are arranged in a single layer along the long axis and thus they are non-motile. Example: Hydrodictyon, Pediastrum



Hydrodictyon sp.

(v) Palmelloid :-

It is a temporary stage that are formed in some alga where the daughter cells are embedded within a common gelatinous envelope formed by the gelatinisation of the parent cell wall. This daughter cells then divide further forming numerous cells within the matrix which later on become motile by the formation of flagella. Example: Chlamydomonas and Chromulina



Chlamydomonas sp.

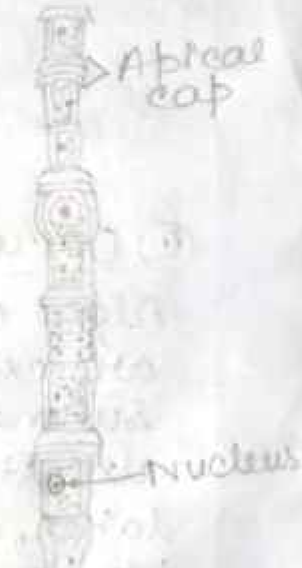
(vi) Dendroid :-

Dendroid means tree-shaped. In this type, the algal body looks like a microscopic tree. Example: Prasinocladus, Ecballocystis.

Prasinocladus sp.

(vii) Filamentous :-

In this type of thallus organisation cells are arranged upon one another in a row or in several rows to form a filamentous appearance. This filamentous type may be branched or unbranched. Example: Oedogonium.



Oedogonium sp.

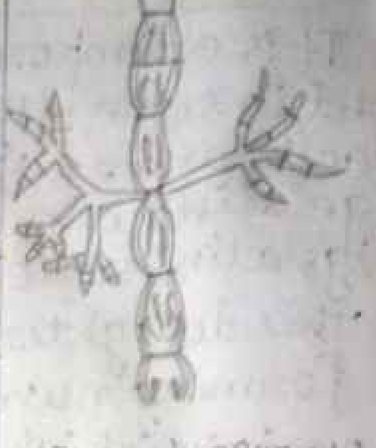
(viii) Siphonaceous :-

This type of thallus organisation is made up of long, hollow tube-like structure called coenocyte. Such coenocytic filament have many nuclei and is branched. Example: Vacheria, Botrydium.

Vacheria sp.

(ix) Heterotrichous:-

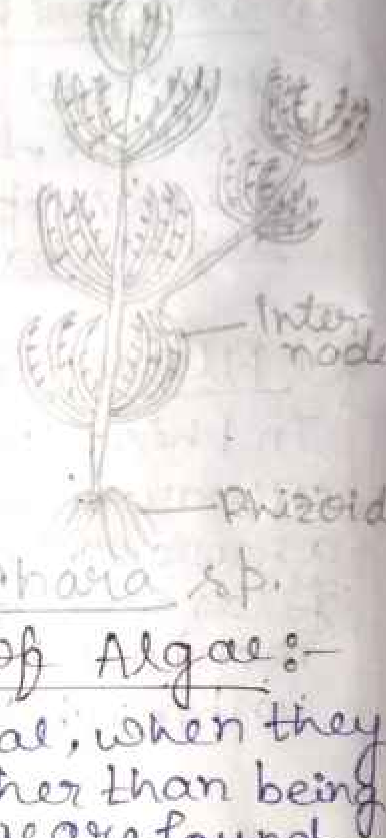
The term 'heterotrichous' is derived from two words 'hetero' which means different and 'trichous' which means trichome or filament. In this type of thallus organisation the algal body is differentiated into a prostrate branched filaments growing along the substratum and erect branched filaments growing away from the substratum. Example: Stigeoclonium, Draparnaldia.



Draparnaldia sp.

(x) Parenchymatous:-

In this type, repeated septation of algal filaments and cell division occours in two or more planes which results in the formation of parenchymatous thallus like body. Example: Chara, Fucus.



Chara sp.

(c) Occurrence and Distribution of Algae:-

Algae can be aquatic or subaerial, when they are exposed to the atmosphere rather than being submerged in water. Aquatic algae are found almost anywhere from fresh water spring to salt lakes, with tolerence for a broad range of pH, temperature, turbidity, O_2 and CO_2 concentration.

They can be planktonic, like most unicellular species, living suspended throughout the lighted regions of all water bodies including under ice in polar areas. They can be also benthic, attached to the bottom or living within sediments, limited to shallow areas because of the rapid attenuation of light with deph Benthic algae can grow attached on stones (epilithic), or mud or sand (epipelic), on other on plants (epiphytic) or on animals (epizoic). In case of marine algae, various terms can be used to describe their growth habits, such as supralittoral, when they grow above the high-tide level, within the reach of waves and spray intertidal, when they grow on shores exposed to tidal cycles; or sublittoral when they grow in the benthic environment from the extreme low-water level to around 200 m deep, in the case of very clear water.

A considerable number of subaerial algae have adapted to life on land. They can occur in surprising places such as tree trunks, animal fur, snow banks, hot springs, or even embedded within desert rocks. The activities of land algae are thought to convert rock into soil to minimize soil erason and to increase water retention and nutrient availability for plants growing nearby.

Algae also frow mutually beneficial partnership with other organisms. They live with fungi to from lichens or inside the cells of reef building corals, in both cases providing oxygen and complex nutrients to their partner and in return receiving protection and simple nutrients. This arrangement enables both partners to survive in conditions that they could not endure alone.

Dirision	Common Name	Habitat			
		Marine	Fresh Water	Terrestrial	Symbiotic
Cyanophyta	Blue-green algae	Yes	Yes	Yes	Yes
Prochlorophyta	n.a.	Yes	n.d	n.d	Yes
Glaucophyta	n.a	n.d	Yes	Yes	Yes
Rhodophyta	Red algae	Yes	Yes	Yes	Yes
Heterokontophyta	Golden algae, Yellow-green algae	Yes	Yes	Yes	Yes
Haptophyta	Coccolithophorids	Yes	Yes	Yes	Yes
Cryptophyta	cryptomonads	Yes	Yes	n.d	Yes
Chlorarachiophyta	n.a	Yes	n.d	n.d	Yes
Dinophyta	Dinoflagellates	Yes	Yes	n.d	Yes
Euglenophyta	Euglenoids	Yes	Yes	Yes	Yes
Chlorophyta	Green algae	Yes	Yes	Yes	Yes

n.a. ⇒ not avaiblable; n.d. ⇒ not detected.

(d) Algal Pigments:-

All algae contain photosynthetic pigments. These are usually an integral part of the structure of the chloroplast lamellae, but sometimes, as in blue green algae, they are homogeneously distributed throughout that part of the protoplasm called the "chromatoplasm". Pigments are molecules, which are absorp light. The most efficient organic pigments have a molecular absorption which is one on two orders of magnitude greater than that of the organic pigments (such as cobalt blue, cinnabar and chrome yellow), which are used as prints. Many pigments have a characteristic molecular structure of long, carbon chains on closed rings linked by so called "conjugated" double bonds. These bonds are particularily stable because they involve "resonance", a situation where two or more molecular configuration can exist simultaneously. The chemical properties of the pigments determine the methods used to extract them. Phycobilins have no phytol chains and are covantly band to water-soluble proteins. There fore, they are easily extractable with pure water. chlorophyll extraction require organic solvents such as methanol, ethanol or acetone. Most carotenoids are soluble in organic dissolve in fats and oils.

Division	Common Name	Botanical Name	Major Pigments
Chlorophyta	Green algae	Chlorella sp.	Chl. b
Charophyta	Charophytes	Spirogyra sp.	Chl. b
Euglenophyta	Euglenoids	Euglena gracilis	Chl. b
Phaeophyta	Brown algae	Fucus vesiculosus	Chl. C_1+C_2, Fucoxanthin
Chrysophyta	Yellow Brown or Golden Brown algae	Dunaliella salina	Chl. C_1+C_2, Fucoxan-thin
Pyrrhophyta	Dinoflagelletes	Amphidinium carterae	Chl. C_2, peridinin
Cryptophyta	Cryptomonads	Cryptomonas sp.	Chl. C_2, Phycobilins
Rhodophyta	Red algae	Porphyridium Cruentum	Phycoerythin, phycocyanin
Cyanophyta	Blue-green algae	Spirulina platensis	Phycoerythin, phycocyanin

2. Economic importance :- (Positive aspect)

(a) Algae as primary producer of the food Chain:-

Microscopic algae are arguably the source of more than half of the world's oxygen though photo-synthesis. They ture carbon-di-oxide into biomass and release oxygen. Ecologycally, algae are at the bass of food chain. They are beginning of the transfer of solar energy to biomass that transfers up trophic levels to the top predators.

Phytoplankton, are largely responsible for this primary production. Phytoplanktons are mostly single called type of algaes that are in twin eaten by small animals called zooplankton (mostly crustaceans such as copepods) that drift near the surface of the sea. The zooplankton are in twin fed upon by larger zooplanktons, small fish and fliter feeding whales (think Krill). Energy transfer happens and larger fish eat the smaller ones. At the top of the open water ones. At the top of the open water food web may be fish eating birds, seals, whales, very large fish such as sharks or bluefin tuna and humans.

The large algae provide a habitat for fish and other invertebrate animals. A great example of this is Macrocystis, which is a Keystone species in a giant kelp forest.

As algae die, they are consumed by organisms called decomposars (mostly fungi and bacteria). The decomposers feed on decaying plants and consume the high energy molecules essentially remineralizing the biomass into lower-energy molecules that are used by other organisms in the food web.

(b) Algae used in fish Culture :-

Algae are at the base of the aquatic food chain, producing the food resources that fish are adapted to consume. Previous studies have proven that the inclusion of small amounts (<10% of the diet) of algae in fish feed (aqua feed) resulted in positive effects in growth performance and feed utilisation efficiency. Marine algae have also been shown to possess functional activities, helping in the mediation of lipid metabolism and therefore are increasingly studied in human and animal nutrition. The aim of this study was to assess the potentials of two commercially available algae derived products (dry algae meal), verdemin (derived from Ulva ohnoi) and Rosamin (derived from diatom Entomoneis spp.) for their possible inclusion into diet of Atlantic Salmon (Salmo salar). Fish performances, feed efficiency, lipid metabolism and final product quality were assessed to investigated the potential of the two algae products (in isolation at two inclusion levels, 2.5% and 5%, or in combination), in experimental diets specifically formulated with low fish meal and fish oil content. The results indicate that inclusion of algae product verdemin Rosamin at level of 2.5% and 5% did not cause any major positive, nor negative, effect in ~~alt~~ atlantic Salmon growth and feed effiency. An increase in the omega-3 long chain polyun saturated fatty acid (n-3-LC-PUFA) content in whole body of fish fed 5% Rosamin was observed.

(c) Algae used in sewage treatment:-
Species of Chlamydomonas, Scenedesmus, Chlorella and Euglena are used in sewage treatment plants for providing through photosynthesis the oxygen necessary for rapid decomposition of the sewage by bacteria.

(d) Algae as the origin of petroleum ang gas:-
Algal biofuel is an alternative to fossil fuel, which is generated by specific algae species from carbondioxide. These algae species are primarily unicellular ordiatom microalgae that produce high carbohydrate compositions suitable for ethanol production, high lipid compositions suitable for biodiesel production or high hydrocarbon compositions that are suitable for producing renewable distillates.

The plankton of the seas was probably of the greatest importance as a source of this organic matter. Minute marine algae captured the energy of sunlight, which was in turn transferred to the animals that fed upon them. Organic compounds derived from the plankton, both plant and animal, accumulated in mud deposist in shallow waters of the ocen floor. In the source, materials were buried by sedimentary action and, in an oxygen-free environment gradually converted into oil and gas.
Natural gas is largely methane (CH_4) which can be produced by certain kinds of anaerobic bacteria. Gas in generally associated with oil and can result from the action of methane producing bacteria up on organic compounds.

(e) Algal and limestone formation :-

Many species of algae withdraw calcium from water, both fresh and salt, and deposit it, in the from of Calcium carbonate in their cell walls or gelatinous sheaths. The most significant forms in this category are the blue-greens and reds, but certain green algae and flagellates are also concerned.

The blue-greens are chiefly important in fresh waters; they are responsible, for example, for the formation of extensive limestone deposits around hot springs and glaciers. The red algae are the most important calcareous algae of the seas: in particular, they play a significant role in the construction of coral reefs and islands. Although true coral results from the activities of minutes sedentary animals, it is recognized that time secreting red algae are almost as important in the formation of coral reefs as the coral organisms themselves. The calcareous red algae are best developed in the warmer seas, but certain species also flourish in temperate and polar regions, where they from extensive banks of limestone in coastal areas.

The algae are not only important in the present age in the formation of calcareous deposists, both in the seas and fresh water, but also they have played a significant part in the production of beds of limestone rocks, which may be 1000 feet thick.

(7) Algae used as food :-

Large number of algae have entered into the diets of human beings from ancient times. The earliest records are those of the chinese, who mentioned such food plants as Laminaria and Gracilaria in their materia medica several thousand years ago.

The ancient inhabitants of Japan ate Porphyra as a healthful supplement to their rice diet, It use became widespread, not only in Japan, but in china in course of time kompu, a Japanese food is prepared from stipes of species of Laminaria. Ulva and Codium are used as salad in Japan. Chlorella is mostly used as a space food. It has 30% of protein, 30% of carbohydrates and 15% of lipids. The cell wall of chlorella is very hard to digest for humans. however work is underway to solve this problem. Rhodymenia is used to make salty food like dulse. Sea algae are too much produce than other foods in Japan. Chlorella, chondrus, Codium, Porphyra, Rhodymenia, Ulva are mostly used as food Nostoc commune is used for soup in china.

(g) Algae used in space research and other fundamental studies:-

In recent years Chlorella is being used in space research. Chlorella has been found very suitable for keeping the air in space vehicles pure on long interplanetary flights. The stale air in which the CO_2 has been concentrated is fed into a flood-lit container containing a mixture of water and nutrient chemicals and chlorella.
The algo restore oxygen into the space vehicle by its photosynthesis. Again species of Chlorella chlamydomonas and Acetabularia are used as tools for solving fundamental biochemical and genetical problems.

(h) Algae used as fodder:-
The orients developed wide human uses for marine algae, but Europeans profited by extensive use of these plants for stock feed. In Iceland and Scandinavia, in the British Isles, and along the coast of France, stock has long been driven or allowed to wonder to the seashore at low tide to feed on seaweeds.

Some kinds of Algae, such as Rhodymenia palmata and Alaria esculenta, are favourable food of goats, cows and sheep and in Scotland and Ireland the stock actively hunt the shores a low tide for particular algae, especially the former.

The milk does not have any taste of algae, nor is the meat inferior because of the seaweed diet. Such animals, that have for several generations been nourished on algae, show better ability to digest it than those not so habituated.

The shortage of grain in many parts of Europe during World War I led to considerable experimentation with the use of seaweeds as food for cows and horses. Stock feed factories were established in France, Norway, Denmark and Germany, and various methods of treating and reducing seaweeds to meal or powder were developed.

The favourable results in animal husbandry in Europe led to the industrial processing of the great Pacific-Coast kelp for animal rations. Seaweed-meal factories have been operating in the United States for several decades, providing supplementary feeds for poultry, cattle and hogs.

The high mineral and vit G content of kelp meal has made possible its use in various poultry and other animal rations.

(i) Algae used as Medicine :-

Medicinal applications of plants are almost as old as their food uses. From earliestest times the chinese used Sargassum and various Lamenariales for treatment of goiter and other glandular troubles. Gelidium very early became employed for stomach disorders and for heat induced illness.

The gental swelling of dried Laminaria stipes upon exposure to moisture make them surgical tool in the opening of wounds. Similarly, the orientals have empolyed the same technique in child-birth for expansion of the cervix.

Perhaps the algae used most widely and for the longest time for medicinal purposes and from which agar is extracted are the agarphytes, including Gelidium, Pterocladia, Gracilaria, Ahnfeltia. The name 'agar-agar' is of Malay origin and means 'Jelly'. This jelly was obtained by boiling up seaweeds and cooling the resulting liquid.

Agar early became useful for stomach disorders and as a laxative, and was once empolyed as a dietetic. It was originally produced and marketed in China, but the Japanese took over production in about 1662 and maintained a world monopoly till 1940.

The most significant date in the ulilization of agarphytes was 1881, when Robert Koch proved the value of agar in the cultivation of bacteria. Since that time is has became essential to the work of hospitals and medical research laboratories throughout the world: Besides these, Chlorella is used for preparation of antibiotic chlorellin.

(i) Algae used as fertilizer:-

The value of seaweeds in fertilizing the soil was discovered early in the history of agriculture in Coastal Asia, and by the ancient colonizers of the coasts and islands of North-Western Europe. In some areas of Britain and along the coast North-West France the cutting of rockweeds for manure has been so intensively practiced that it became necessary to regulate it by laws that have now been in effect for nearly 100 years.

In the United States, long before the recognition of their potash content, seaweeds were employed for fertilizers by the thrifty farmers. Not only the chemical fertilization but also the water-holding capacity of fragments of the algae in the soil proved effective. These provided valuable small reservoirs of water in close contact with the roots of the cultivated plants.

Further more, the bulky organic substances decay slowly in the soil and from humus. Again yield of paddy is increased substancially when paddy field is inoculated with nitrogen fixing blue-green algae. Some of them are Tolypothrix tenius, Aulosira fertilissima, Anabaena Oryzae, Anabaenopsis arnoldii, Calothrix confervicola, Nostoc commune and cylindrospermum bengalensis.

(K) Industrial Utilization of Algae :-

(i) Kelp industry :-

Industrial utilization of sea weeds in Europe had its principal early development in the production of 'Kelp', a name that originally reffered to the ash, rich in soda and potash, derived from burning marine plants. Kelp production was begun sometimes in the seventeenth, century by French peasants and spread to other parts of North-West Europe.

Drift weeds were first used, but cutting was later resorted to Laminaria and Saccorhiza in North Britain as of Major importance.

But Fucus and Ascophyllum were also widely used, and in some are as Himanthalia and chorda. The Kelp ash from these plants was widely bought by early industrialists for use in manufacture of soap, glass and alum. During the eighteenth and early nineteenth centuries the demands became considerable and enormous quantities of seaweeds were handled in areas of rich algal growth.

Kelp extract contains a number of chemical elements, notably potassium and iodine. About 25 percent, of the dry weight of kelp is potassium chloride. Many species of kelp are used as food for man, especially in the orient. In Northern Europe they also serve as food for domestic animals, such as sheep and cattle.

(ii) Algin Industry :-

Algin is the general term designating the hydrophilic, or water-loving derivatives of alginic acid. The most commonly known algin is sodium alginate, but other commercially important compounds are the potassium, ammonium, calcium and propylene glycol alginates, as well as alginic acid itself.

Algin occurs generally throughout the brown algae (Laminaria, Macrocystis, Fucus and Sargassum) as a cellwall constituent.

Thus algin provides ice cream with a smooth texture by preventing the formation of ice crystals. In automobile polishes it suspends to abrasive; in paints, the pigments; also in pharmaceuticals, the drugs and antibiotics. As a stabilizing agent it serves in the processing of rubber latex and in the printing textiles.

The algin industry has become so important to such a wide variety of industry that extensive servey of kelp-bed ecology is an effort to guard against loss of this important resource. Harvesting methods are now carefully regulated, and a huge amount of money is being spent on kelp-bed research throughout the world.

Experimental studies are continuing on the relation of pollution to kelp survival and on kelp bed grazing organisms.

(iii) Agar industry :-

The outstanding use of the red algae, however, is in the production of agar. This is a dried and bleached gelatinous extract obtained from red algae - Gelidium nudefrons, Gelidium pusillum, Gelidium robustum and Gracilaria verrucosa. Agar is used extensively in medicine, chiefly as laxative since it is not digested and increases greatly in bulk with the absorption of water.

Since the introduction of Agar into bacteriology in 1881, the agarphytes have become increasingly industrialized and the technical uses of Agar enormously expanded. Large quantities of agar are used as a food adjunct.

Early industrial uses of agar in the orient included sizing fabric, water proofing paper and cloth and making rice paper more durable. Modern industry has refined and expanded these uses to meet new needs in the manufacturing of such items as photographic film, shoe polish, dental impression molds, shaving soaps, and hand lotions.

The increasing applications have called for wide expansion of the collection of agarphytes and since Japan supplied most of the world's markets before World War II, when those supplies were cut off, a great amount of hurried research was conducted in only in the United States, but in South Africa, Australia, New Zealand and Russia.

(iv) Diatomaceous Earth Industry :-

The Diatoms are equally important in comparison with other algae that have industrial utilization. Most species of Diatoms are marine and when these minute plants die, they fall to the sea bottom and because of their siliceous nature the cell walls are preserved indefinitely. Great deposits of this material, known as diatomaceous earth, are found in many parts of the world.

The largest beds in the United States, some 1400 feet thick, are in California. The beds are sedimentary deposits originally laid down on the floor of the ocean and later raised above the level of the sea. It has become an important and valuable material in industry. It makes an excellent filtering agent, which is widely used to remove colouring matters from products as diverse as petrol and sugar.

As a poor conductor of heat it is used in sound proofing. It is used in the manufacture of paints and varnishes of phenograph records, and as a filter for battery boxes. Because of its hardness, it is used as an abrasive in scouring and polishing powders.

Harmful aspect

(i) Parasitic algae :-

The well known disease 'red rust of tea' is not caused by any parasitic fungus but an algal form cephaleuros virescens. This causes havoc to tea plants in Assam tea gardens. Besides, this parasitic from attacks several other plants, e.g. Mangifera, coffee and Rhododendron etc. The heavy losses are cause to tea and coffee by this parasitic algae form.

(ii) Algae in spoilage of water supply :-

Many blue-green, green and other algae contaminate the water of city reservoirs. This contamination develops a foul odour in the water and makes the water unhygienic. The algae also form some mucilaginous secrations which are the seats of harmful bacteria and other pathogens causing several human and animal diseases.

Conclusion:-

We always focus on angiosperm and gymnosperm plants. But also algae are most important in our environment. Green algae are arguably the source of more than half of the world's oxygen through photosynthesis. Algae are very important in food chain as a producer. Algae are used as food mostly China and Japan. Chlorella sp. is mostly used as space food. Algae like Laminaria, Fucus are used in fodder. Algae like Spirulina used in medicine. Algae are also used in sewage system, fertilizer, industry etc. In some case algae can causes harmful effects like algal bloom and a common disease 'Red rust of tea'.

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