- University Roll No: 170611610011
- University Reg No: 201701010522 of 2017-18

- Project Title:

Economic Importance of Algae

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Acknowledgement

I, would like to express my special thanks of gratitude to my teacher Dr. Moumita Basu madam and as well as our principal sir Mr. Sukmiti Ghosal who gave me the golden opportunity to do this wonderful project on the topic 'Economic Importance of Algae', which also helped me in doing a lot of Research and I came to know about so many new things.

Secondly, I would also like to thank all of my departmental sir's and Librarian of MUC WOMENS COLLEGE, who helped me a lot in finishing this project within the limited time.

Economic Importance of Algae

Introduction

The term 'Algae' (Latin-Seaweeds) was first introduced by Linnaeus in 1753, meaning the Hepaticeae. The algae comprise of a large heterogeneous assemblage of plants which are diverse in habitat, size, organisation, physiology, biochemistry and reproduction.

Ⓐ Depination of Algae :

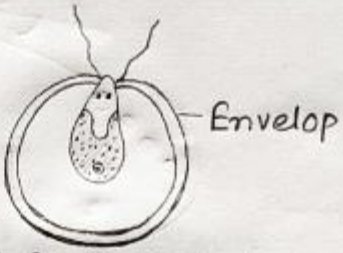
'Algae' is an informal term for a large diverse group of photosynthetic eukaryotic organisms that are not necessarily closely related, and is thus polyphyletic.

Alge are protists with plant like characteristics, are found in aquatic environments. Like plants, algae are eukaryotic organisms that contain chloroplasts and are capable of photosynthesis. Like animals, some possess flagella, centrioles and are capable of feeding organic material. Algae range in size from a single cell to very large multicellular species. They can live in various environments including salt water, fresh water, wet soil, or in moist rocks. As primary producers, algae are the foundation of the food chain in aquatic environment.

Algae can reproduce sexually, asexually or by a combination of both processes through alternation of generations. The types which reproduce asexually divide naturally or release spores which can be motile or non-motile. Unlike angiosperms and higher plants, algae lack vascular tissue and do not possess roots, stems, leaves or flowers. Algae reproduce sexually are generally induced to produce gamets when certain environmental stimuli — including temparature, salinity and nutrients — become unfavourable. These algae species will produce a fertilized egg or zygote to create a new organism or a dormant zygospore.

1) Unicellular motile algae:

1.A Chrysamoeba



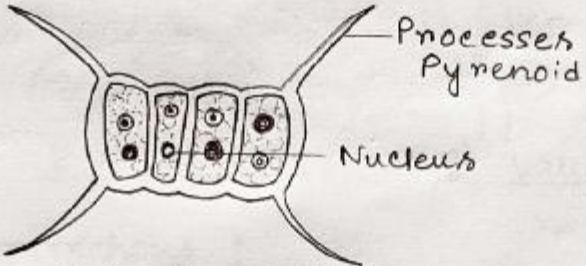
1.B Phacotus

2) Unicellular non-motile algae:

2.A. Spirulina

2.B Chlorella

3) Colonial algae:



3.A Scenedesmus

4) Palmelloid

4.A) Tetraspora

5) Dendroid

5.A) Chrysodendron

(B) Various types of Structural features :

▨ **Unicellular Algae** » Unicellular forms of algae are also called acellular algae as they function as complete living organisms. These are common in all groups except Rhodophyceae, phaeophyceae and chanophyceae. The unicells may be motile or non-motile.

(a) The motile unicells are either rhizopodial or flagellated. The rhizopodial unicells are found in many groups of algae. e.g, Chrysamoeba (1.A) Rhizochloris (xantho-phyceae).
The flagellated unicells are in different groups. e.g, Phacotus (1.B), chlamydomonas etc.

(b) The non-motile cells may be spiral filament as found in Spirulina (Cyanophyceae). The coccoid unicellular algae are the simplest forms of algae found in cyanophyceae, chlorophyceae etc. e.g- Chlorella (2.B)

▨ **Multicellular Algae** »

- **Colonial** : The colonial habit is achieved by loose aggregation of cells within a common mucilaginous investment. The cells remain connected by cytoplasmic threads.

(a) **Coenobium** : when a colony has a definite number of cells with a definite shape and arrangement. It may be motile or non-motile.

(i) In motile form, it can move by organised beating action of flagella. e.g- volvox, Pandorina

(ii) In non-motile form, the cells are without flagella, thus the coenobium is non-motile e.g- Hydro-dictyon, Scenedesmus. (3.A)

(b) **Aggregated Form** : irregularly showing a colonial mass of various size and shape.
It is three types.

6) **Rhizopodial :**

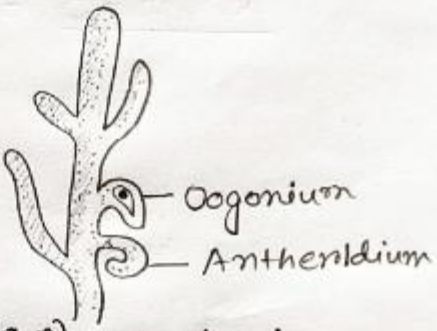
6.A) Chrysidiastrum

7) **Parenchymatous :**

7). A Ulva

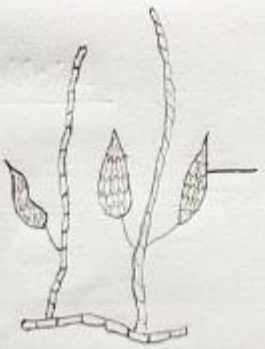
8) **Siphonaceous :**

8.A Botrydium



8.B) Vaucheria

9) **Heterotrichous :**



Ectocarpus

▨ **Palmelloid:** In this type the non-motile cells remain embedded in an amorphous gelatinous or mucilaginous matrix. chlamydomas and chromulina represent it as a temporoorary feature. In chrysodendron and chrysidiastrum palmelloid is permant feature. Another one is Tetraspora (A.A)

▨ **Dendroid:** In this type the number, shape, size of the cell is variable.

Ex: chrysodendron (5.A), Eeballocystis etc.

▨ **Rhizopodial:** In this type cells are united through rhizopodia.

e.g - chrysidiastrum (chrysophyceae) (6.A)

▨ **Parenchymatous:** when the cells of filament divide in multidirectional planes, it results the formation of a parenchymatous thallus and ultimately becoming foliose and flat, tubular or complex structure.

e.g - Ulva (7.A), Enteromorpha, sargassum.

▨ **Siphonaceous:**

In this form the thallus is aseptate and multinucleate. It may be simple branched or may be very elaborate with clear division of labour, differentiated into aerial and subterranean portions.

E.g - Vaucheria, Botrydium. (8.A)

▨ **Filamentous:** (i) unbranched filamentous e.g - Ulothrix

(ii) branched filamentous, e.g - Scytonema

© Occurrence And Distributions

Algae are commonly presumed to be occuring in water. Most of the algae are aquatic either fresh water or marine. Very few are terrestrial. A few genera grow even in extreme condition like thermal springs, glaciers and snow. Algae are almost ubiquitous throughout the world and can be categorized ecologically by their habitats.

- **Planktonic algae:** They are microscopic and grow suspended in water.
- **Neustonic algae:** Grow on the water surface and can be micro or macroscopic.
- **Cryophilic algae:** Occur in snow and ice.
- **Thermophilic algae:** Live in hot springs.
- **Edaphic algae:** Live in soil.
- **Epizoic algae:** Grow on animals such as turtles and sloths.
- **Corticolous algae:** Grow on the bark of trees.
- **Epiphytic algae:** Grow on fungi, land plants or other algae.
- **Epilithic algae:** Lives in rocks.
- **Endolithic algae:** Lives in porus rocks or coral.
- **Chasmolithic algae:** These grow in rock fissures.
- **Halophytic algae:** Algae growing in water of high concentration of salts as in salt lakes.
- **Terrestrial algae:** Algae growing in moist soil surface, stones and rocks.
- **Symbiotic algae:** Some algae of chlorophyceae and cyanophyceae are found in symbiotic association with other plants.

Distributions:

Algal abundance and divesity vary form one environment to the next, just as land plant abundance and diversity vary from tropical forests to deserts. Terrestrial vegetation (plants and algae) is influenced most by precipitation and temparature. where as aquatic vegetation is influenced most by light and nutrients. when nutrients are abundant as in some polluted waters, algal cell numbers can become great enough to produce obvious patches of algae called 'Blooms' or 'Red tides'. which can deplete the oxygen content in the water and poison aqatic animals and waterfowl.

Distribution of Algal Divisions

Division	Common name	Habitat			
		Marine	fresh water	Terrestrial	Symbiotic
Chlorophyta	Green algae	yes	yes	yes	yes
Cyanophyta	Blue green algde	yes	yes	yes	yes
Glaucophyta	n.a	n.d	yes	yes	yes
Rhodophyta	Red algae	yes	yes	yes	yes
Euglenophyta	Euglenoids	yes	yes	yes	yes
Cryptophyta	Cryptomonads	yes	yes	n.d	yes
prochlorophyta	n.a	yes	n.d	n.d	yes
Dinophyta	Dinoflagellates	yes	yes	n.d	yes
Heterokontophyta	Golden algae.	yes	yes	yes	yes
Chlorarachniophyta	n.a	yes	n.d	n.d	yes

Note: n.a → not available, n.d → not detected.

⑮ Algal Pigments

Three major classes of photosynthetic pigments occur among the algae: chlorophylls, carotenoids (carotenes and xanthophylls) and phycobilins. The pigments are characteristic of certain algal groups as indicated below.

chlorophylls and carotens are generally fat soluble molecules and can be extracted from thylakoid membranes with organic solvents such as acetone, methanol or DMSO. The phycobilins and peridinin, in contrast, are water soluble and can be extracted from algal tissues after the organic solvent extraction of chlorophyll in those tissues.

Chlorophylls are greenish pigments which contain a porphyrin ring. There are several kind of chlorophyll, most important is chlorophyll 'a'. It makes photosynthesis possible by passing its energized electrons to manufactur sugar. Chlorophyll 'b' occurs in green algae. And chlorophyll 'c' is only found in photosynthetic membrane of chromista as well as dinoflagellates.

Carotenoids are usually red, yellow or orange pigments. It must pass their absorb energy to chlorophyll. For this reason it called 'accessory pigments'. Very visible accessory pigment is fucoxanthin, the brown pigment which colours kelps and other brown algae as well as diatoms. Phycobilins found in red algae. It act as light absorbing antenna for photo synthesis, they are able to efficiently absorb light in the green and orange spectral religion where chlorophylls absorb poorly.

CHART

DIVISION	COMMON NAME	MAJOR ACCESSORY PIGMENT
Chlorophyta	Green Algae	Chlorophyll b
Charophyta	Charophytes	chlorophyll b
Euglenophyta	Euglenoids	chlorophyll b
Phaeophyta	Brown Algae	chlorophyll $C_1 + C_2$, fucoxanthin
Chrysophyta	Yellow-brown or, golden-brown Algae	chlorophyll $C_1 + C_2$, fucoxanthin
Pyrrhophyta	Dinoflagellates	Chlorophyll C_2, phycobilins.
Cryptophyta	Cryptomonads	chlorophyll C_2, phycobilins.
Rhodophyta	Red Algae	Phycoerythrin, Phycocyanin
Cyanophyta	Blue-Green Algae	Phycocyanin, Phycoerythrin.

(ii) # Economic Importance

(Positive Aspect)

① Algae as primary producer of the food chain:

Both fresh and salt waters contain an enormus variety of algae which constitute the fundamental or primary link of many diverse food chains. Algae synthesize organic food stuffs, just as do the plants of the Land. As the flesh of the land is dependent upon the activities of the green leaf so the fish and other aquatic forms of animal life are dependent, directly or indirectly, upon algae and fish in turn are important item in the daily diet of larger sea animals and man.

A number of aquatic algae from the food of fish either directly or indirectly. Diatoms, filamentous and some planktonic green algae, and a number of blue green algae are very often found in the guts of various species of fresh and brackish water fish and they appear to be directly utilized as fish food. The reserve food materials in these algae, e.g fats and volutin in the diatoms, starch, often accompanid by oil in the green algae, Sugars and glycogen in the blue green algae, and polysaccharides in Euglena are utilized by fish.

② Algae used in fish culture:

That algae are fruitfully utilized in fish culture can very well be indicated from the successful culture of the Siamesh fish, Tilapia mossambica which is voracious feeder of filamentous algae.

This particular fish has been successfully introduced in different parts of India

A culture of Scenedesmus is often exclusively used, as a daily dose of fish meal for the culture Tilapia massambica.

③. Algae used in Sewage treatment plant:

Water borne wastes of industry and domestic house are called 'sewage'. It is rich in sulphur, nitrogen, phosphorus and potassium. The anaerobic breakdown of sewage, gives out bad odour. So the aerobic breakdown is preferred, which does not give out bad odour and the products can also serve as fertilizer. Bacteria and carried out in a container and the required oxygen is collected from algae. Unicellar algae like Chlamydomonas, Chlorella, Scenedesmus, Euglena etc. are used in this process. In turn, ammonia and nitrogen compounds become available to the algae as nutrient.

④ Algae as the origin of Petroleum and Gas:

The origin of oil and Gas has been a matter of controversy, but it is now generally believed that like coal, these fuels owe their energy to photosynthesis in ancient plants. Unlike coal, however, which was laid down in inland swamps, oil and gas were formed from organic matter in marine environments. The plankton of the seas was probably of the greatest importance as a source of this 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 deposits in shallow waters of the ocean 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 largly CH_4, which can be produce by certain kinds of anaerobic bacteria. Gas is generally associated with oil and can result from the action of methane-producing bacteria upon organic compounds.

⑤ 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 carbon dioxide has been concentrated is fed in to a flood-lit container containing a mixture of water and nutrient chemicals and chlorella.

The alga restores 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.

⑥ Algae and Limestone formation:

Many species of algae withdraw calcium from water, both fresh and salt, and deposit it, in the form of calcium carbonate, in their cell walls or gelatinous sheaths.

The blue green algae are chiefly important in fresh waters, 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 the construction of coral reefs and islands.

Although true coral results from the activities of minute sedentary animals, it is recognized that lime-secreting red algae are almost as important in formation of coral reefs.

The algae are not only important in the present age in the formation of calcareous deposits, both in the seas and fresh waters, 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 chinese, who mentioned such food plants as Laminaria and Gracilaria in their 'materia medica' several thousand year ago. The ancient inhabitants of japan ate porphyra as a healthful supplement to their rice diet.

Perhaps the best known and most widely used food alga in western Europe in recent centuries was Irish moss.

Man, thus obtains carbohydrates, vitamins (especially rich in vit A and E) and inorganic substances, e.g, iodine, not to mention the benifits of the mild laxative action.

Chlorella is an alternative source of animal feed and of human vegetable food.

⑧ Algae used as fodder:

Brown algae (kelps) are used as fodder for cattle and chopped for sheep and chickens in Great Briten. Macrocystis species are food source of vitamin A and E. Rhodymenia is used for cattle food in France. The Brown algae Ascophyllum, Laminaria and fucus as stock feed for sheep and cattle.

Some kinds of algae, such as Rhodymenia, Palmata and Alaria esculenta are favourable food for goats, cows and sheep.

The favourable results in animal husbandry in Europe led to the industrial processing

of the great pacific-coast kelp (Macrocystis) for animal rations.

The high mineral and vitamin C content of Kelp meal has made possible its use in various poultry and other animal rations.

⑨ Algae used as fertilizer:

Algae can be used as a fertilizer because it is a living organism. When algae is used as fertilizer, it quickly begins to breakdown releasing its abundant nitrogen source. As a result algae can act as an excellent fertilizer that can be used to help grow crop efficiently.

Not only chemical fertilization but also the water holding capacity of fragments of the algae in the soil proved effective.

Furthermore, the bulky organic substances decay slowly in the soil and form humus. Again yield of paddy is increased substantially when paddy field is inoculated with nitrogen fixing blue-green algae. Some of them are- Tolypothrix tenius, Aulosira fertilissima, Anabaena oryzae, Nostoc, cylindrospermum bengalense.

⑩ Algae used as Medicine:

From earliest times the Chinese used Sargassum and various Laminariales for treatment of goiter and other glandular troubles. Gelidium very early became employed for stomach disorders and for heat induced illness.

Chlorella is used for the preparation of antibiotic chlorellin.

Perhaps the algae used most widely and for the most widely longest time for medicinal purpose. and from which agar is extracted are the agarphytes, including Gelidium, pterocladia, Gracilaria and Ahnfeltia.

(11) Industrial Utilization of Algae:

(i) **Kelp Industry** » Industrial utilization of seeweeds in Europe had its principal early development in the production of 'kelp', a name that originally referred to the ash, rich in soda and potash, derived from burning marine plants. Fucus and Ascophyllum were widely used in some areas 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.

Kelp extract contains a number of chemical elements, notably pottassium and iodine. About 25%. of the dry weight of kelp is potassium chloride. Many species of kelp are used as food for man. especially in the orient. In Northan 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, Sargassum)

as well as cell wall constituent. It has remarkable water absorbing qualities that make it useful in numerous industries in which a thickening, suspending, stabilizing, emulsifying, gel-forming, or film-forming colloid is required.

Thus algin provides icecream with a smooth texture by preventing the formation of ice crystals. In automobile polishes it suspends the 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 of textiles. As an emulsifier it is widely used in such products as water based paints, French dressings, and cosmetics.

The algin industry has become so important to such a wide variety of industries that extensive survey of Kelp-bed ecology is an effort to guard against loss of this important resource. 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 rudifrons, G. pusillum, G. robustum, 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.

More important than, this medicinal utilization is its use as an essential ingredient in the preparation of medium for the growth of bacteria and fungi. As such it is indispensable in bacteriological laboratories, because no adequate substitute for agar is known.

Agar has proved effective as a temporary preventive for meat and fish in tropical regions, due to the inability of most purifying bacteria to attack it.

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.

(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 indenfinately. It has a chemical properties, because of this it is a 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 photograph records, and as a filter for battery boxes. Because of its hardness, it is used as an abrasive in scouring and polishing powders. The largest beds in the united states some 1400 feet thick, are in california. The beds are sedimentary deposits originally.

Negative Aspects

(i) Parasitic Algae:

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

(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 secretions which are the seats of harmful bacteria and other pathogens causing several human and animal disease.

Not algal blooms are harmful, however when there is fast growth of algae and cyanobacteria that can harm environment. HABs can produce toxic chemical. It reduce the levels of O_2 in water, and when they decompose, these lower O_2 levels may kill other plants and animals in the water.

Conclusion

Through this assignment I aquired immense knowledge about Algae and its variations. I deeply understood its variations which were predominantly based on its various structures and functions.

I also gathered knowledge about the influence which algae has in the ecosystem. while some of its influences are benifi ial, some are also non-benificial and might have harmful consequences. But by analyzing the entire project one can easily understood that the good aspects of it are associated with our lives. India along with other countries such as Africa, chili, America, Japan get economically benifited of its impact on modern humankind.

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