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BIO102: Plant Diversity

The Algae

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DIVERSITY OF ALGAE





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Topic: Diversity of Algae

Objectives

In this lecture we will learn the followings:

- A clear idea of the features that separate algae from other plants
- Skills in identifying them in our environment
- Importance of the algae
- Contributions to humans lives

Reading Assignment

In addition to the discussion in this lecture read current textbooks in the library and visit: learn.bupoyesiku.net for the online lecture.

Lecture

Algae are one of the simplest photosynthetic aquatic plants. They are important not only to marine habitat, but also for their products that we used in our everyday living, particularly the air we breathe. In our today's discussion, you will be taken to the next level of understanding biodiversity with particular reference to algae. Furthermore, your knowledge of the field (Phycology or Algology) will makes you more conscious of their abundance and important roles to humans.

Introduction

Phycology or algology is the study of algae. Algae (Latin for "seaweed") are primarily producers that trap sun energy directly from the atmosphere and convert it to food. They form the foundation of aquatic or terrestrial food web in typical ecosystems. It is also important for you to know that population explosion of algae (e.g. fresh water algal bloom) contributes to mass mortality of higher aquatic organisms due to lack of sufficient oxygen in the environment. Another explanation for the algal bloom is the breakdown of the floating mechanism of the algal possibly as a result of habitat rich nutrient. Despite the negative impacts, the positive impacts are overemphasized. For your understanding, algae, directly or indirectly, contribute 80% of the world's food



supply. Algae are of important source of food for many aquatic animals, from tiny shrimps to the mighty Whales. Of the world's total oxygen production 75% comes from algae alone. Although it cannot be overemphasize that algae alone produce more oxygen than all the plants in the world.

Main Content

Background of Algae

Algae are found everywhere, worldwide in marine, fresh water, wastewater and moist terrestrial habitats. Larger percent of algae are microscopic (microalgae=*Scenedesmus* spp.) and few large ones, macroscopic (microalgae=*Sargassum* spp.). Algae (singular=Alga) are *eukaryotic* plants and closely related to higher photosynthetic plants. Diversity of algae includes macroalgae and microalgae. Algae can be unicellular or multicellular. Like higher plants all algae do have chlorophyll and accessory pigments for photosynthesis.

Although algae have no roots, stems or leaves except macroalgae (seaweeds) which have false leaves, stems and roots. Body form of macroalgae is generally termed as thalloid or thallus.

Reproduction in Chlamydomonas

Asexual

Algae regenerate by sexual and asexual methods. You have already known that asexual reproduction is by ordinary cell division (mitosis) or by fragmentation and not by union of sex cells. The concept of asexual reproduction with particular reference to *Chlamydomonas* is a process whereby the cell's flagella degenerate and drop off. This is followed by division of nucleus by mitosis. The two daughter cells develop flagella and swims away. This process of mitosis is repeated so that we have multiples of two cells (i.e. 2, 4, 8, 16, 32, and 64...n). It is also important that you note that sometimes flagella may not develop and the cells form a colony, but when growth conditions change (i.e. competition for nutrient), each cell develop flagella and escape. You should not forget that asexual reproduction in algae brings about no changes in the

number of chromosomes in the nucleus and all the cells remain haploid. Hence diversity is not favored by asexual reproduction as in genus of *Chlamydomonas*.

Sexual

This method is characterized by the process of meiosis; in this case a pairs of cells (zoospores) are attracted to each other by their flagella and function as gametes (Fig. 1). The cell walls break down and the protoplasts mate and fused together to form diploid zygote. Under favorable condition, the zygote undergoes meiosis, producing four haploid zoospores. When the zygote wall breaks down the zoospores escape and swims away and grow to adult *Chlamydomonas* cells (Fig 1.1).

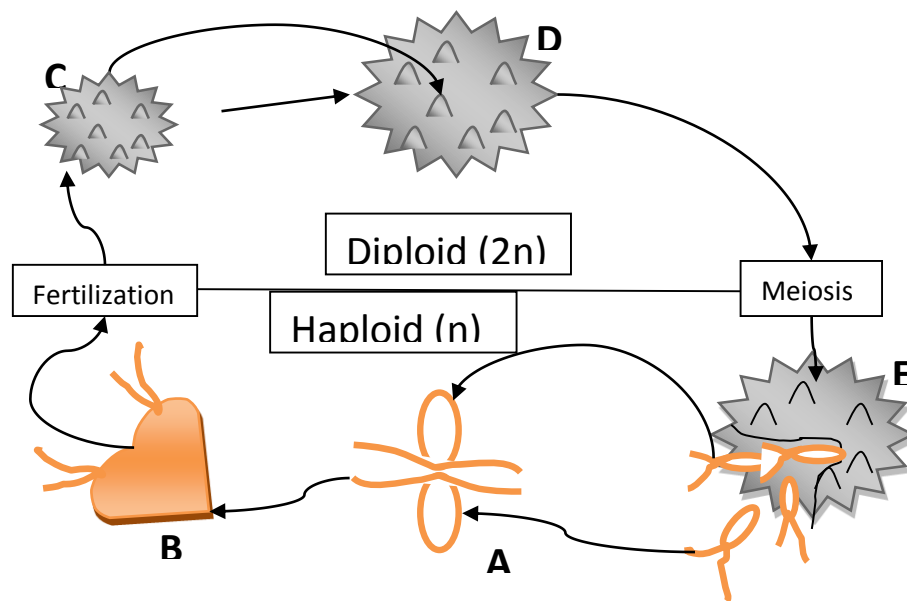


Figure 1.1 Schematic sexual life cycles of *Chlamydomonas*. Mating zoospores (a), fusion and exchange of genetic materials/fertilization (b), formation of zygote (c), matured zygote (d) and escaping zoospores/cells (e).

Two phases are involved in sexual reproduction. In the first phase, each alga cell has a single set of chromosomes called haploid, while in the second stage each alga cell has two set of chromosomes called diploid. You should note that the life cycle of sexually reproducing algae vary, in some the dominant phase is the sporophyte while in others it is the gametophyte, however in few others both are dominant. For example, *Sargassum* (brown macroalgae, seaweed) has a diploid sporophyte as



dominant body and the haploid gametophyte as recessive body) and only known as gametes. In another example, *Ectocarpus*, another brown alga, both diploid and haploid phases are in gametophyte stages, which mean both phases may be dominant. The last example is the genus *Spirogyra*, a green alga has a haploid gametophyte as dominant stage and the zygote as recessive and is the only diploid cell.

Environmental factors commonly the temperature, salinity, inorganic nutrients or day length are limiting indicator for sexual reproduction in algae.

Classification of Algae

Algae can be classified according to their mode of nutrition. The modes are Chemotrophic, heterotrophic (mixotrophic) and photoautotrophic nutrition. At this point it may interest you to know that almost all living organisms obtain their energy through either chemotrophic or phototrophic mode of nutrition. Only a very few exist as heterotrophs.

Phototrophic nutrition

Phototroph is an organism capable of converting light energy into chemical energy. Examples are photosynthetic bacteria (e.g. Cyanobacteria) and algae. As dictate by the prevailing habitat conditions phototrophs may behave as Mixotroph capable of using both light energy and organic carbon to obtain needed energy. Example is Dinoflagelates which exist as either autotroph or heterotroph depending on prevailing conditions.

Chemotrophic nutrition

Chemotroph organism normally feed off chemical and digest chemicals to meet their nutrients need. Given to the prevailing environmental conditions, chemotroph can behave either autotrophic organism using organic molecules- organotroph) or heterotrophic organism using inorganic molecules- lithotroph.



Characteristics of Algae

As already mentioned in the background above you will recollect that all true algae are eukaryotes like all other higher plants. Other characteristics of typical algae are the followings:

- All true algae have a nucleus enclosed in a single membrane and plastids by one or more membranes
- They photosynthesize and produce oxygen as byproduct except for few. For example *Chlamydomonas* is capable of producing oxygen and hydrogen depending on prevailing temperature of its habitat.
- Most algae are phototrophic while some forms are chemotrophic. Others are saprobes and parasites.
- Reproduction in algae is by both asexual and sexual. Examples of asexual method include fragmentation of colonial or filamentous forms, spores formation by mitosis. Sexual forms include alternation of generations of haploid and diploid phases.

Diversity of Forms in Algae

Algae can be conveniently be grouped into several forms of their reproductive cells and combinations of pigments and food reserves. At this level we would divide algae forms into two major groups for your clear comprehension and understanding. The two groups are unicellular and multicellular algae. Each of the two groups has many basic forms, most especially the unicellular algae.

Diversity of unicellular algae

- Capsoid (i.e. separate non-motile cells in mucilage envelope)
- Motile colony (i.e. many small spherical groups of motile cells)
- Coccoid (i.e. single non-motile cells with cell walls)
- Palmelloid (i.e. palm-like non-motile cells in mucilage envelope)
- Dendroid (cell with basal mucilage stalk)



- Filamentous (string of non-motile cells connected straight or branch in one plane)
- Heterotrichous (a branch string of non-motile cells) :
 - Siphonaceous (plant body lack cross wall)
 - Parenchymatous (cells forming thallus with simple differentiation)

Diversity of multicellular algae

Macroalgae include members of the green, red and brown algae that grow under the sea and have their roots attached to the sea bed except for particular floating brown algae *Sargassum natans* and *S. fluitans* (Fig1.2a, b). Few marine types of macroalgae can exceed 50 m in length.

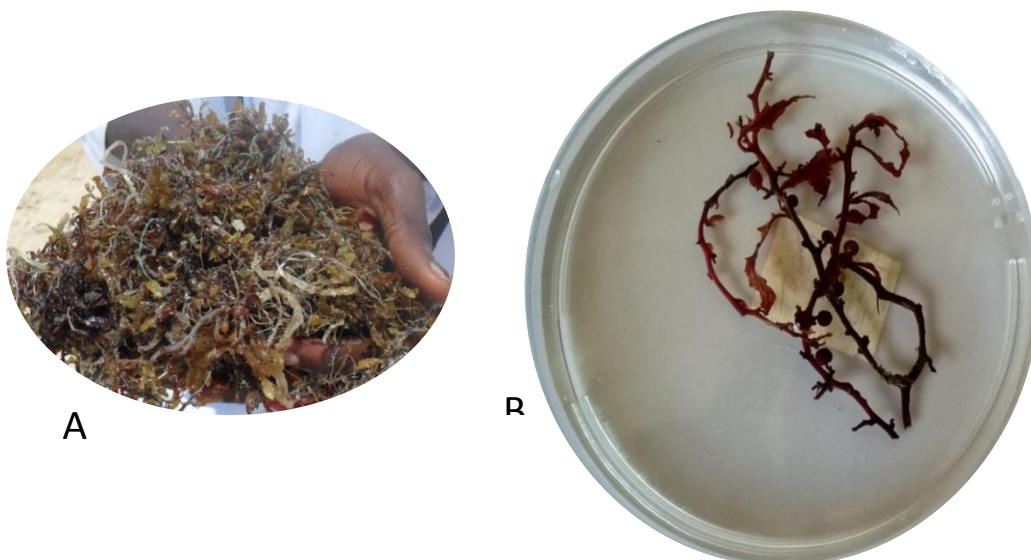


Figure 1.2a *Sargassum* mass found at Ajegunle Erun-Ama Beach, Ondo State Nigeria
A=mixed *S. natans* and *S. fluitans*, B=lateral branches with gas bladders. ©2015
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Habitats of Algae

As you have learnt at the beginning of this lecture, algae are native of the whole world. They are found growing in great diverse habitats. You can find algae diversity from three major habitats of the world. These include terrestrial, fresh water and marine.



Terrestrial Habitats

- Animal fecal including snails, worms, crustacean
- Bryophytes or grasses infusion
- Marshes, swamps, mud, and sand
- Trunk, branch and surface of leaves of tree in shady moist condition
- Rock surfaces in shade moist and humid condition
- Sculptures, glass and metals in moist and humid

Fresh water Habitats

- Aquatic plants: ferns, Lotus, lettuce and other submerge water plants
- Lagoon (abundant micro algal e.g. Desmids)
- River, stream, spring, brook, fish ponds, water reservoirs

Marine Habitats

- Salty lagoon (brackish water)
- Salty lakes and marshes
- Open Ocean

Ecology of Algae

Algae are important key plants occupying the base of ecological food chain (or web). Almost all living organisms depend upon them for their nutritional needs. Algae manufacture organic food molecules from carbon dioxide and water by a process of photosynthesis. To further push your understanding of the role of algae in any ecosystem, nearly 75% of the earth is covered by water and marine algae produced an average of 50% of global oxygen in the past.

Economic uses of Algae

Besides the ecological role, algae have a great economic value. Current trend in the use of algae have step up interest in the field of technology; algae may now be used as source of heat and electricity generation. In today's technology several companies have grown oil-producing algae in high salinity ponds and use it as an



alternative to fossil fuel. Other uses include resource for biofuel (Diesel), bio-cleaner, bio-fertilizer and commercial protein production. Some of these economic values are stated here.

- Bio-cleaner algae remove toxic substances from sewage
- Bio-fertilizer, it traps chemical run-off from the farm and convert it to bio-fertilizer for reuse
- Bio-fuel, they produce crude oil and natural gas. Examples, coccolithophore is a decomposed ancient algae and *Botryococcus*, a green alga, found in much oil covered surface of water.
- Pharmaceutical and cosmetics, algal extracts are used in preparing drugs
- *Spirulina* are source of commercial proteins

Conclusion

In this lecture note, you have learnt how to recognize, and where to find the algae. Current trend in research have shown the commercial uses of algal. If embraced, futuristic use of algae as biofuel can solve the problems of epileptic power supply and fuel scarcity in many countries of the world, particularly in Nigeria.

Summary

Having study this lecture note, you should:

- Have some understanding of types of algae
- Have a better idea of the characteristics that separate them from other groups of plants
- Be ready to look around your environment for the common members
- Better aware of the futuristic biofuel use of algae

References/Further readings/Links



Test Yourself Questions (TYQ)

Matric No	Department	Attendance Code	Session/Student's Level
		AC _____	

Question	TRUE	FALSE
1. Algae are mostly multicellular prokaryotic green plants		
2. No algae no food chain		
3. Mycology is the study of algae		
4. Insufficient nutrients in aquatic habitat cause algae bloom		
5. Inorganic compounds limit sexual reproduction in algae		
6. <i>Sargassum</i> is an example of microalga		
7. <i>Spirogyra</i> is a common lagoon microalga		
8. Chlamydomonas is capable of producing hydrogen only		
9. All algae are sources of biofuel		
10. First world O ₂ was produced by algae		

Comment:

