

Chapter 1: Algae

Algae are photosynthetic autotrophic living organisms that always contain chlorophyll a and various other supernumerary pigments. They can be unicellular or multicellular. Algae are cryptogams (plants with a hidden reproductive system) and thallophytes (the vegetative system is a thallus). Their habitats are varied, but their reproductive cycle absolutely requires water (for reproduction). Their morphology is highly diverse.

The classification of algae is also based on :

1. The ultrastructure of the plastids
2. The presence of pigments: chlorophylls a, b, c and supernumerary pigments,
3. The morphology of the thallus
4. Type and location of reserves
5. Sexual reproduction

1. Classification of algae

The classification of algae can be complex. From a systematic point of view, algae are divided into 11 groups, 10 of which are eukaryotes, which are themselves divided into six or seven major evolutionary lineages. This can be simplified by considering four groups: blue algae, red algae, brown algae and green algae.

1.1. Blue algae

Cyanobacteria, or cyanophyceae, or blue-green algae, are prokaryotes in the kingdom Eubacteria.

1.2. Green algae

Green algae produce intraplastidial starch and contain chlorophylls a and b, carotene (red pigment) and xanthophylls (yellow pigments). They belong to the vast group of green organisms known as the *Chlorobionta*. Examples: *Ulva* and *Caulerpa*.



1.3. Red algae

A related taxon, red algae contain only chlorophyll a and pigments such as phycoerythrins and phycocyanins. There is also an extraplasmidial starch called rhodamylon. Examples: *Porphyra* (Asia), *Palmaria* (Europe and Canada).



1.4. Brown algae

Pheophytes, or brown algae, contain chlorophyll a and c, many other pigments and various cytoplasmic and vacuolar reserves. They are generally marine. Examples of macroscopic brown algae: *Fucus*, *Laminaria*.



2. Ecology of algae :

Depending on their habitat, there are three types of algae:

1. Pelagic algae: move through the water (sargassum, diatoms)
2. Symbiotic algae: develop with and by helping a host. They produce matter and oxygen from the host's waste mineral salts (Zooxanthellae).
3. Benthic algae: attached to the substrate. Grouped into three families according to the pigments and types of chlorophyll held by the algae:

Green algae (chlorophyceae): chlorophyll A and B

Brown algae (pheophyceae): chlorophyll A and C

Red algae (rhodophyceae): chlorophyll A and D

The type of chlorophyll determines the range of light absorption possible, and therefore the depth at which algae can be found.

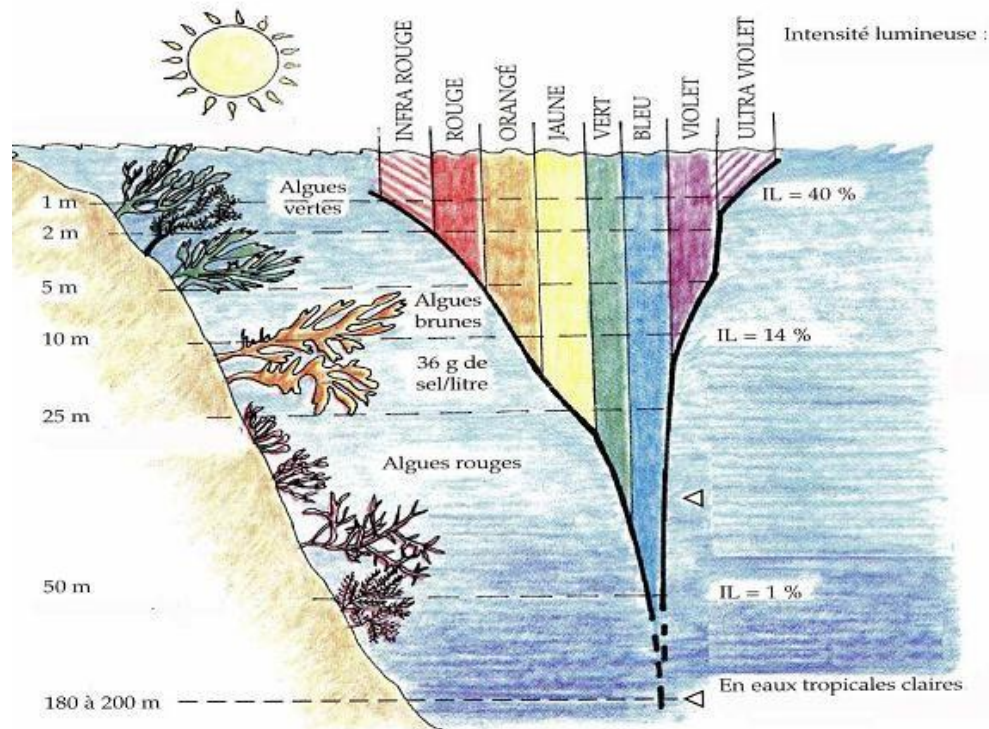


Figure - Distribution of algae in the aquatic environment according to light radiation.

3. Prokaryotic algae (Cyanophytes / Cyanobacteria)*

Cyanophytes or cyanobacteria "blue algae" are a primitive group of algae and the oldest chlorophyll plants. They comprise 150 genera and 2000 species. They are the only prokaryotic algae. They contain chlorophyll a. They contain phycobilisomes (supernumerary pigments). They never have flagella. Cyanobacteria are organisms made up of microscopic cells or filaments that often develop simultaneously to form colonies visible to the naked eye (clusters or filaments).

Cyanobacteria have an ecological interest: they reduce CO₂ to organic matter (C sequestration), carry out photosynthesis (O₂ production) and fix atmospheric nitrogen (good nitrogen fertiliser) and an economic interest: production of proteins, vitamins, fatty acids, pigments and food supplements (spirulina, for example).

4. Eukaryotic algae

Eukaryotic algae (unicellular or multicellular) can be green, brown or red.

4.1. General characteristics

4.1.1 Morphology of the vegetative apparatus

The vegetative apparatus (thallus) of Phycophyta varies greatly in form, from unicellular to branched filaments. Thallus are classified according to their degree of complexity. A distinction can be made between them:

- Archaethallus

This type of thallus is found in the simplest forms. It is found in unicellular algae (Chlamydomonas, Euglena) and certain simple filamentous green algae (Spirogyra).

4.1.2. Reproduction

a. Asexual reproduction

This occurs either by :

- Fragmentation of thalli: each fragment regenerates a whole thallus.
- Spores form inside the sporocyst, giving rise to an identical individual with the same number of chromosomes.

b. Sexual reproduction

Sexual reproduction in phycophytes involves meiosis and fertilisation. It involves the formation of gametes. The fusion of a male gamete and a female gamete (= fertilisation or gamie) gives rise to a diploid egg (=zygote).

4.2. Brown algae (Chromophycophyte)

These are algae that mainly contain chlorophylls A and C and other pigments. They are generally marine algae. Their size and abundance give them an important role in marine vegetation and in tidal rocking zones. These algae are also home to a varied fauna of fish and crustaceans, which find abundant food in them (the seashore food chain).

The Chromophyta phylum, or Chromophycophyta phylum, groups together brown, yellow and golden-coloured algae in five classes:

Chrysophyceae

Diatomophyceae

Xanthophyceae

Eustigmatophyceae

Phaeophyceae

4.3. Red algae or Rhodophytes

The oldest multicellular eukaryotic fossil discovered to date is a filamentous red alga 1.7 billion years old. Rhodophytes thus appeared after cyanobacteria (formerly known as blue-green algae).

Rhodophytes comprise around 500 genera and 5,000 species, almost all of which are multicellular. They are most often marine algae, and their presence in freshwater is limited to around thirty uncommon genera. In freshwater, Rhodophytes are blue-green, violet-red, very often dirty green or blackish green.

They can be found at great depths because they are often able to develop in conditions of low light, living attached to rocks or mollusc shells.

Red algae are small marine algae (1 to 4 cm), living on rocks and growing on the coasts of the English Channel, the North Atlantic and the Mediterranean. It is an annual algae that fructifies from spring to autumn.

Taxonomy:

The Rhodophycophyta phylum comprises a single class: the Rhodophyceae, which includes two subclasses:

Subclass1 : Bangiophycidae

Includes species with a simple structure

Cells often with a plastid

A unicellular or filamentous thallus.

Presence of star-shaped chloroplasts.

Reproduction is solely by sexual means, except for the Porphyra and Bangia genera. There are three orders:

Order of Bangiales

Order Goniotrichales

Order Porphyridiales

Subclass 2: Florideophycidae

4.4. Green algae (Chlorophycophytes)

Green algae include between 6,000 and 7,000 species and are the largest group of algae. They are generally freshwater species. There are marine and terrestrial species. They are widespread throughout the world. Green algae are thought to be the origin of higher plants.

Like higher plants, they have two chlorophylls (a and b) as well as carotenes and xanthophyll.

Their shapes and sizes vary widely: they can be microscopic and unicellular, like chlorella (*Chlorella vulgaris*), used as a food supplement; or large and multicellular, in the shape of flat blades, like sea lettuce (*Ulva lactuca*), well-known to fishermen on foot and eaten as a salad in Nordic countries. Others are filamentous and take the form of a tube (*Enteromorpha intestinalis*).

These algae, which live in shallow waters, are highly sensitive to organic or nitrate pollution, and multiply to the point of causing veritable green tides. Green algae are therefore known to be good indicators of nitrate pollution (algae blooms, *Ulva* green tides, etc.).

Taxonomy: The Chlorophycophyta phylum comprises four classes:

Chlorophyceae

Zygothryceae

Charophyceae

Prasinophyceae