UNIT 6 ALGAL HABITATS AND DISTRIBUTION

Structure

6.1 Introduction
Objectives
Study Guide
6.2 Aquatic Algae
Fresh Water Habitats
Marine Habitats
Special Habitats
6.3 Soil and Subaerial Algae
Soil Algae
Subaerial Algae
6.4 Algal Associations
Algal-Plant Associations
Algal-Animal Associations
Algal-Symbiotic Associations
6.5 Summary
6.6 Terminal Questions
6.7 Answers

6.1 INTRODUCTION

You are familiar with the general features of algae, and their position among the other groups. You have also learnt about the classification of algae into various divisions and the characteristic of each. By now it must have been clear to you that they are very diverse in their structure and characters, and are quite distinct from plants as a group.

Algae range from unicellular (microscopic) to large (macroscopic) thalloid forms growing in variety of habitats almost all over the surface of earth. A brief account of various habitats where algae grow in nature is included in this unit. This is to familiarise you so that you may recognise and identify some common algae if you happen to see them in their natural surroundings.

When we say algae are found everywhere it is no exaggeration. Wherever there is water, a little moisture or water vapours, and light, however feeble, they are sure to appear as green, yellow, or brown patches, which in course of time cover the whole surface. Their occurrence and growth is controlled by several factors and is the subject of science, ecology. When several types of algae grow together under similar natural conditions we call them as communities. The composition of a community is determined by the physical and chemical nature of the habitat. In many cases the algal community indicates to us about the nature of the habitat, whether it is rich or poor in nutrients or polluted etc., in other words it serves as an ecological indicator.

In this unit you will also learn how algae have adapted to the environment in which they are found growing by having special morphological and physiological features. We list below some important algal habitats found in nature.

Objectives

After studying this unit you should be able to:

- describe the various types of habitats of algae,
- give examples of algae that are of common occurrence in fresh water, marine and harsh habitats,
- recognise some classes of algae when you happen to come across them in their natural surrounding,

- describe algal association with plants and animals and
- give examples of algae that live in symbiotic association with other algae, other protists, plants and animals.

Study Guide

We have given several examples of algae in this unit but you are expected to remember at least two for each habitat.

6.2 AQUATIC ALGAE

Salt pan-a vessel, or a depression near the sea, used for getting salt by evaporation.

Most of the algae grow in water in the absence of which they quickly dry up and die; however, there are also subaerial algae, which are described in section 6.3.2 of this unit. Depending on the concentration of salts there are various kinds of water bodies, such as fresh water, brackish water, sea water, brine-salt lakes and salt pans. Further, these habitats nowadays may contain many types of pollutants, like excessive organic matter, heavy metals, pesticides, industrial effluents which are produced and dumped into them by man. This greatly affects algae and other organisms present in the water.

6.2.1 Fresh Water Habitats

Fresh water habitats comprise of rivers, mountain streams, lakes, ponds, tanks, and temporary rainwater puddles. In our country, rice fields where standing water is present for several months, are rich in nitrogen-fixing cyanobacteria such as *Aulosira, Rivularia, Gloeotrichia, Cylindrospermum, Nostoc, Anabaena, Aphanothece* and some green algae *Oedogonium, Draparnaldiopsis,, Chaetophora* and *Coleochaete*, and desmids and diatoms.

In slow flowing rivers with rocky shores one may find many filamentous algae like *Spirogyra, Oedogonium* and *Cladophora* as extensive floating mats generally attached to the under water rock boulders. The surface of submerged rocks also shows various types of attached epiphytic algae like diatoms, desmids and cyanobacteria. Algal flora also shows seasonal variation depending on the turbidity and rate of flow of water and other seasonal factors.

The algal flora in a lake shows different communities at different regions. Near the shores and at the bottom (benthos) thick mats of *Spirogyra, Oedogonium, Chara, Nitella* and a number of epiphytic algae like *Chaetophora, Coleochaete*, desmids, diatoms colonial cyanobacteria, *Cladophora* growing as tufts on the shells of animals are frequently found. Suspended in the upper layers of water, unicellular and colonial algae *Chlamydomonas, Volvox, Pandorina, Scenedesmus, Euglena,* diatoms, *Microcystis, Anabaena, Anabaenopsis* occur as - phytoplankton. These algae are generally small, phototactic - moving up and down depending on the light conditions - floating during the day and sinking at the night. At times, when the water is rich in nutrients with optimum temperature and sunshine, one particular algal type (*Microcystis, Euglena*) multiplies very rapidly to dominate the other algae, resulting in water blooms (flowering of water). Such blooms can be harmful to the fish and other animals that grow in the water because they may consume all the oxygen in the water during the night. While seasonal water blooms are more common in temperate countries, in India and other tropical countries, permanent blooms of colonial cyanobacterium *Microcystis* is most frequent. It forms thick, bluish-green suspension in many temple tanks and lakes making the water unfit for human needs.

6.2.2 Marine Habitats

Sea inhabits largest number of algae collectively known as seaweed. Although India has a very long shore line, it is only the rocky areas as found in Gujarat, Tamil Nadu, Andhra Pradesh, and in the islands of Andamans and Laksha Dweep that have rich marine flora.

Seacoast is periodically flooded and exposed to sun because of the tides. The area between the high tide and low tide level is known as intertidal zone. The seaweed that grow in the intertidal zone face alternate drying and wetting. They are also firmly attached to the underlying rocks by means of holdfasts. At times they may get detached and found floating in the open sea as in the case of Sargasso Sea. On the coasts of India, like Gulf of Mannar (Tamil Nadu) one can collect manually several seaweed such as *Gracilaria edulis* (red alga), *Gelidiella acerosa* (red alga), *G. folifera, G.crassa, Hypnea musciformis* (red alga) *H. valentiae, H. pannosa, Sargassum wightii* (brown algae) and *Turbinaria* (brown algae), which are of commercial importance.

Sargasso Sea

A sea in North Atlantic, named because of huge accumulation of *Sargassum* fronds found floating in island like masses.

Benthic algae constitute the seaweed that are attached to the bottom away from the shore in deeper waters and are never out of water. Their distribution depends on the depth of the sea to which enough light can penetrate. Beds of seaweed may be found in very deep waters, 100-200 meters, mostly containing red algae because only these algae can utilise the blue wavelengths of light that can be absorbed by the red pigment, phycoerythrin.

Table 6.1: Some Important Littoral Seaweed Found on Indian Coast.

East Coast	
Chlorophyta (green algae)	*Ulva, Cladophora, Bryopsis, Acetabularia, Neomeris, Udotea Halimeda, Boodlea, Dictyosphaeria.*
Phaeophyta (brown algae)	*Ectocarpus, Pedina, Dictyopteris, Dictyota, Turbinaria, Zonaria, Hormophysa, Sargassum.*
Rhodophyta (red algae)	*Acrochaetium, Laurencia, Chondria, Polysiphonia, Gelidiopsis, Grateloupia, Rhodymenia, Liagora, Porphyra, Gelidiella, Gracilaria, Ceramium.*
West Coast	
Chlorophyta (green algae)	*Chamaedoris, Enteromorpha, Ulva, Bryopsis, Acetabularia, Struvea, Pseudobryopsis.*
Phaeophyta (brown algae)	*Dictyopteris, Dictyota, Nemacystis.*
Rhodophyta (red algae)	*Scinaia, Halymenia, Caloglossa, Rhodymenia, Dasya, Laurencia, Helminthocladia.*

The intertidal zone also known as littoral zone can be differentiated sometimes into three belts, supralittoral, middle littoral and infralittoral belts, each consisting of associations of different but characteristic algae. The algae found in different zones vary according to the geographical location, nature of the substratum and other factors. Important seaweed found in the littoral zones of coastal India are listed in the table 6.1(for reference).

Open sea away from the coast is rich in planktonic algae. Marine phytoplankton is rich in variety and its composition depends on the geographical location and seasons. Diatoms form the main bulk of phytoplankton, Dinophyta, Cyanophyta, silicoflagellates and other groups also occur but in less quantities. Sometimes, the sea water becomes coloured due to thick pink blooms of *Noctiluca* and some other algae. A cyanobacterial bloom of *Trichodesmium* may cover large area of the sea giving a red colour as in Red Sea. Occasionally, some dinoflagellates (toxic) multiply very fast and form blooms generally known as **red tides**. Phytoplanktons of the sea play an important role in the primary production of organic matter, photosynthetic carbon

fixation and serves as food for crustaceans, fingerlings of many fishes and even whales. All marine living organisms are directly or indirectly dependent on the growth and activities of the phytoplankton.

In recent years very minute organisms collectively known as **picoplankton** including *Chlorella nana, Micromonas, Nannochloris, Dolichomastix* and *Hilba* have been found to play a very important role in the biological productivity of oceans.

6.2.3 Special Habitats

Algae are also found in special habitats where environmental conditions are in extreme.

Brines and Salt Lakes

Inland lakes like Sambhar Salt Lake in Rajasthan contain sodium chloride and other salts in saturating concentrations (brines). One can see in them thick floating blue-green scums of permanently growing cyanobacteria *Anabaena, Anabaenopsis* and unicellular green alga *Dunaliella*. The metabolism of these halophilic organisms is active only at high salt concentration.

Thermal Regions

Among the lower Himalayas and other mountains (Himachal Pradesh, Bihar, Orissa and Maharastra) are found hot water thermal springs with temperatures ranging from 40° to 70°C which inhabit quite a number of algae, mainly cyanobacteria, *Mastigocladus laminosus, Synechococcus lividus, Oscillatoria* and *Phormidium*. Unlike in other algae, the growth and metabolism of the thermal algae are most active only at high temperatures.

Polar Regions

Algae can also grow under extremely cold climate conditions that prevail at Arctic and Antarctic regions. Among cyanobacteria-*Nostoc* is most common, besides *Schizothrix, Oscillatoria, Lyngbya, Phormidium* and *Stigonema*. Lichens with algal symbionts (*Collema*) are of common occurrence. Cyanobacteria and lichens grow and fix nitrogen under polar conditions. Indian expeditions to Antarctic have collected several types of algae mostly diatoms and cyanobacteria.

On permanent snow fields where the surface is stable atleast for a few weeks, abundant growth of algae is found giving red, brown or yellow colour to the snow. Red snow is caused by green algae *Chlamydomonas nivalis* and *C. flavo-virens*.

SAQ 6.1

a) Tick mark the correct answer in the following:

i) Most of the fresh water algae belong to the Division

1) Cyanophyta
2) Chlorophyta
3) Phaeophyta
4) Rhodophyta

ii) Which of the following algae is found in the rice fields?

1) *Sargassum*
2) *Porphyra*
3) *Aulosira*
4) *Ulva*

b) Which group of algae are found in deep sea waters and why?

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c) Name the two seaweed that can be collected from Gulf of Manner in India.

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d) In the following sentences fill in the blank spaces with appropriate words.

i) The algae that cause permanent blooms in temple tanks and lakes belong to the Division .....

ii) ..... form the main bulk of marine phytoplanktons.

iii) The colour of Red Sea water is due to .....

iv) The name of Sargasso Sea is due to floating of huge islands of .....

v) The most common algae of arctic and antarctic region is .....

vi) The species of *Chlamydomans* that give red colour to the snow are .....

vii) The algae that inhabit sea are called .....

6.3 SOIL AND SUBAERIAL ALGAE

6.3.1 Soil Algae

Surface layers of soils all over the world provide a favourable substratum when wet for the growth of several types of algae. Terrestrial algae play a major role as primary colonizers on newly exposed areas and help in the establishment of other plants in the accumulation of humus. After the destruction of all life by the eruption of a volcano on the island of Krakatoa in 1883, the first organisms that appeared were cyanobacteria like *Anabaena, Tolypothrix, Symploca* and *Lyngbya.*

Soil algae grow profusely on damp or moist soil, although many of them can withstand prolonged and severe dry conditions. Many cyanobacteria (*Nostoc, Cylindrospermum, Porphyrosiphon, Scytonema, Tolypothrix, Stigonema, Aphanocapsa, Lyngbya, Phormidium)* green algae (*Oedogonium, Oedocladium, Uronema,* and other algae (*Botrydium, Vaucheria,* diatoms) grow on the surface of the soil, which is temporarily moist at least for brief time during the seasons. They form a crust over the surface of the soil, particularly cyanobacteria which have mucilagenous sheaths and prevent erosion of the top soil.

6.3.2 Subaerial Algae

Subaerial algae obtain their water from the moisture in air and grow if moisture is available. They are capable of enduring drought like the soil algae. In our country one can see dark brown patches, sometimes with a velvety carpet like cushions

covering extensively the exposed surfaces of buildings, walls, terraces, asbestos roofs, rock surfaces,and also tree trunks. Ancient archeological monuments, temples and in fact, any lime coated or lime plastered surfaces form excellent habitat for the growth of cyanobacterial cushions on which seeds of higher plants colonize and ultimately bring out ruin and destruction of the structures. The algal growth is mainly cyanobacterial in nature consisting of *Chroococcus, Myxosarcina, Scytonema, Tolypothrix, Lyngbya, Porphyrosiphon, Synechococcus.* All forms show thick layers of mucilagenous sheath deep brown in colour. Bark of many tree trunks also harbours not only the above algae but also a few green algae like *Trentepohlia, Physolinum* (orange tufts) and *Chlorococcum.*

6.4 ALGAL ASSOCIATIONS

Algae live associated with other plants and inside animals as described below.

6.4.1 Algal -Plant Associations

Algae are known to be associated with other plants, some as epiphytes attached to the outer surface and some inside the tissues as endophytes. Epiphytes are common in all the groups of aquatic algae. One interesting case is a green endophytic alga *Cephaleuros* which grows just below the cuticle of leaves of tea (red rust disease of tea) coffee, mango, guava and other fruit bearing trees, as rusty red coloured patches.

Another endophytic alga *Chlorochytrium* is found in the intercellular spaces of water plants *Lemna, Ceratophyllum* and *Elodea. Coleochaete nitellarum* occurs inside the cuticle of another alga *Nitella.* Several species of brown algae *Ectocarpus* and *Sphacelaria* grow as endophytes in larger kelps - *Laminaria* and *Cystoseira.*

6.4.2 Algal-Animal Associations

There are number of instances where algae are found growing inside the animals (endozoic). Green alga *Chlorella* is found inside the unicellular *Paramaecium*, in the tentacles of *Hydra* and in sponges. In marine habitats, sea anemones, and some corals contain unicellular algae-zooxanthellae (Cryptophyta) and also some Dinophyta members. *Platymonas* (green alga) is found inside a marine worm *Convoluta.* In unit 1 you learnt that recently discovered prokaryotic alga *Prochloron didemni* (which contains chlorophyll *b* also) exists as a symbiont in the gut of sea squirts.

6.4.3 Algal -Symbiotic Associations

When an alga lives in close association with a non-photosynthetic organism (fungus or an animal), because of its ability to fix carbon photosynthetically some of the carbon fixation products like sugars may be absorbed by the nonphotosynthetic host, while the alga in turn may get some sort of protection. This kind of mutually beneficial association is known as **symbiosis**. Where the alga is also a nitrogen-fixer as in some cyanobacteria, nitrogenous compounds are also available to the host organism along with carbon compounds.

Several cyanobacteria and also some green algae occur in symbiotic association with fungi as distinct group known as lichens (refer to Block 2, Unit 12, for more information on lichens). Nitrogen-fixing cyanobacteria are found in symbiotic association with photosynthetically active plants, bryophytes, pteridophytes, gymnosperms and angiosperms (see table 6.2).

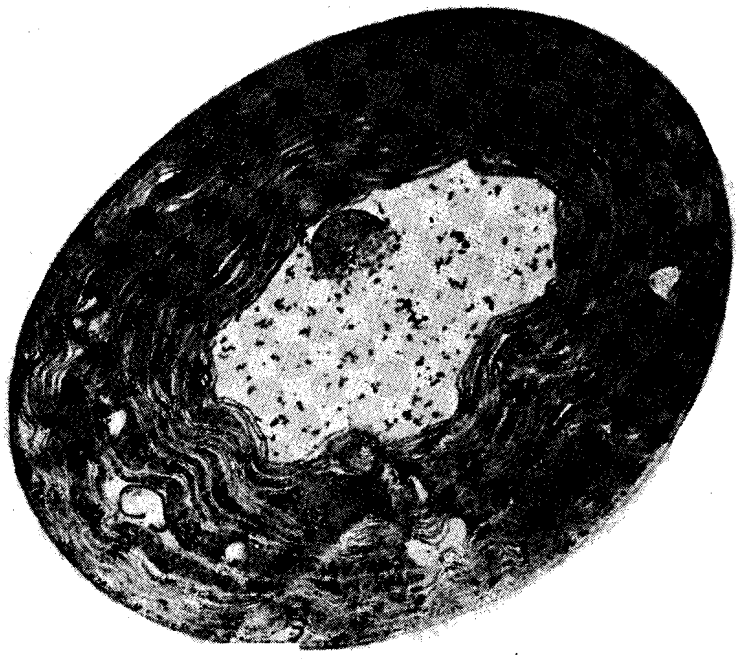

Fig. 6.1 : Detailed structure of *Prochloron*.

They are mostly found in intercellular spaces forming coralloid (calcarious) nodules as in *Cycas*. *Azolla*, a water fern has packets of *Anabaena* in the leaf cavities. In the case of a marine diatom –*Rhizosolenia* (unicellular) , a single filament of cyanobacterium *Richelia intracellularis*, probably a nitrogen-fixer is found. Such intracellular existance has been observed also in unicellular flagellate *Paulinia* and *Oocystis*, where cyanobacteria-like bodies have been discovered. *Cyanophora* (cryptophyte) also shows such cyanobacteria-like intracellular inclusions. These are known as cyanelles and under electron microscope they appear to have prokaryotic structure but without proper cell walls.

Table 6.2 : Symbiotic Associations of Cyanobacteria with Plants and Animals.

Partner Organism	Cyanobacteria
Fungi	
ascomycetes in lichens	*Calothrix, Nostoc, Scytonema, Stigonema*
Bryophytes	
Anthoceros	*Nostoc, Anabaena*
Blasia	
Ferns	
Azolla	*Anabaena-azollae*
Gymnosperms	
Cycas, Macrozamia	*Nostoc*
Angiosperms	
Gunnera	*Nostoc*
Protozoa	
Cyanophora paradoxa, Glaucocystis, Paulinella	various "cyanelles"

As has been mentioned earlier that a prokaryotic alga *Prochloron didemni* exists as a symbiont in the gut of sea squirts. (This alga as well as another

Prochlorothrix hollandica show prokaryotic structure like cyanobacteria in all respects except that they contain chlorophyll *b* also but no phycobilins).
In some phytoflagellates (green alga or cryptomonad) cyanobacterial cells exist in symbiotic association. "The host cell is called **cyanomes,** the cyanobacterial cell **cyanelles** and the association is called **syncyanosis**.

Intracellular existance of one alga inside another is also found in Dinophyta. The unicellular, colourless alga *Peridinium balticum* and *Glenodinium* contain in their cytoplasm a unicellular chrysophyte as an endosymbiont. In all the above cases it is to be noted that the host cell being colourless depends on the photosynthetic endosymbiont for organic carbon compounds.

An extreme case of symbiotic state is the presence of chloroplasts (not complete cells) in tissues of marine animals. A marine slug -*Saccoglossa* feeds on marine green algae like *Codium*. The chloroplasts of the alga instead of being digested are incorporated into the epithelial cells of the digestive tract of the animal. The animal appears green in colour and the chloroplasts actively photosynthesize in light like normal cells.

The existance today of such diverse symbiotic associations, specially those instances where a colourless eukaryotic cell is inhabited by a prokaryotic cyanobacteria-like organism, strongly supports the assumption that the chloroplasts of higher plants evolved from the ancestral cyanobacteria- like endosymbionts (ref. unit 1, section 1.6, p 18; unit 2 section 2.2, p 36).

SAQ 6.2

In the following statements fill in the blank spaces with appropriate words.

i) The algae that are primary colonizers on volcanic soils belong to the Division .....

ii) Thick layers of cyanobacteria on the soil prevent soil erosion because of the presence of .....

iii) The alga ..... lives inside *Paramecium*.

iv) The existence of functional chloroplasts is observed in a marine .....

v) The cyanobacterial cells found in some phytoflagellates are called .....

vi) The red rust of tea is due to an alga of Division .....

vii) *Prochloron didemni* exists as an endosymbiont in the gut of.....

6.5 SUMMARY

In this unit you have learnt that

- Algae are distributed in all habitats on the surface of the earth wherever water or water vapours and sunlight are reasonably available. They show astounding ability to adapt themselves to the environmental conditions where they grow.
- Green algae are found in fresh water bodies, polluted water, flowing rivers and mountain streams. The flora varies according to seasons.
- Different regions of the sea show characteristic algal flora.

- Cyanobacteria and some algae can be found under extremely cold and hot conditions.

- Cyanobacteria, green algae, diatoms and some other algae grow on damp soil if sunshine is available. Many of them can withstand prolonged desiccation. Cyanobacteria play a major role as primary colonizer on newly exposed area. Blue green and green algae are subaerial in habitat also.

- Certain algae live associated with plants as epiphytes or endophytes. Some of them are parasitic in nature also,

- Algae are found growing inside animals, for example in *Paramecium,* sponges, *Hydra*, sea anemone, corals and marine worms.

- Cyanelles of cyanobacteria are observed in animals, plants and protists. This observation along with the presence of functional chloroplasts in marine animals support the endosymbiont theory of evolution of chloroplasts.

6.6 TERMINAL QUESTIONS

1. Choose the correct answers:

a) Common algae found in thermal springs belong to
   i) Cyanophyta
   ii) Phaeophyta
   iii) Dinophyta
   iv) Rhodophyta

b) Algae found in salt lakes belong to
   i) Dinophyta
   ii) Cyanophyta
   iii) Rhodophyta

c) *Ectocarpus*, a brown alga is found in
   i) open sea
   ii) fresh water;
   iii) littoral areas of sea.

2. Which of the following statements are true and which are false? Write T for true and F for false in the given boxes.

   a) Kelps like *Laminaria* are found in west coast of India. ☐

   b) Cyanelles are symbiotic, eukaryotic algae. ☐

   c) *Prochloron* is a prokaryotic alga which contains -chlorophyll *b*, also. ☐

   d) *Microcystis* forms water-blooms in the sea. ☐

3. Prepare a list of fresh water and marine algae.

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6.7 ANSWERS

Self-assessment Questions

6.1 a) i) 1 and 2
ii) 3.
b) Mostly red-algae because they contain red pigment-phycoerythrin that absorbs blue wavelength of light available in deep waters of the sea.
c) *Gelidiella*
Gracilaria
d) i) Cyanophyta
ii) Diatoms
iii) *Trichodesmium*
iv) *Sargassum*
v) *Nostoc*
vi) *C.nivalis* and *C. flavo-virens*
vii) seaweed

6.2 a) i) Cyanophyta
ii) mucilagenous sheath
iii) *Chlorella*
iv) slug
v) cyanelle
vi) Chlorophyta
vii) sea squirts

Terminal Questions

1. (a) Cyanophyta, (b) Cyanophyta, (c) in littoral areas of sea.

2. (a) F (b) F (c) T (d) F