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# Habitat and Habit (Ecology) of Algae

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## TYPES

Based on their habitat three types of algae can be recognised, viz., 1. Aerial and terrestrial algae; 2. Aquatic algae—(a) freshwater algae; (b) marine algae; 3. Algae of unusual habitat.

### 1. Aerial and Terrestrial Algae

These forms are often found epiphytic on trees like *Trentepohlia* and *Protococcus*. Some forms are found subterranean in soil which can withstand unfavourable conditions.

### 2. Aquatic Algae

Majority of the algae about 90 per cent are aquatic. They may be fresh water algae or marine algae. In the freshwater algae some are still water forms like *Oedogonium*, *Chara*, *Zygnema*, *Rivularia* etc. The running water forms among the freshwater algae include forms like *Cladophora* and *Vaucheria*.

The marine algae are those which live in sea water like *Sargassum*, *Dictyota*, *Ceramium*, *Gracilaria*, *Fucus*, *Laminaria* etc.

### 3. Algae of Unusual Habitat

They are found in different habitats like:

- (a) *Cryophytes* or *snow algae*, like *Haematococcus nivalis*, *Rapidoonema*, *Chlamydomonas yellowstonensis*, *Ancyclonema nordenskioldii*, *Protoderma*, etc. Some of these forms impart their own colour to the snow-fed mountains wherever they occur like red, pink, purple, yellow etc.
- (b) *Thermal algae*, which are found at very high temperatures as high as 85°C especially in hot springs.
- (c) *Halophytic algae* are found in water containing high concentrations like *Dunaliella*, *Stephnoptera*, *Chlamydomonas ehrenbergii* etc.
- (d) *Lithophytes* are found attached to stones and rocky areas, like *Rivularia*, *Gloeocapsa*, *Prasiola*, *Vaucheria*, Diatoms etc.
- (e) *Epiphytes* are algae found attached to other algae or higher plants like *Bulbochaete*, *Oedogonium*, *Coleochaete*, *Cephaleuros*, *Rivularia* etc.
- (f) *Aerophytes* are algae growing on leaves, bark or land animals termed respectively as epiphyllphytes, epiphoeophytes, epizoophytes, like *Phormidium* and *Scytonema*.

**(e) Akinetes.** Akinetes are characteristic of *Cladophora* and *Pithophora* where the entire cell gives rise to a new plant and grows in size with a thick wall.

**(f) Autospores.** In some Scenedesmaceae and Chlorococcales the resting spores develop structures exactly like parent cell except in size and these are called autospores which give rise to adult forms.

**(g) Auxopore.** It is a specialized structure found in all Diatoms. During cell division some of the small cells get enveloped by mucilage which push the valves apart liberating the protoplast. This protoplast later develops into a parent cell.

**(h) Endospores.** Endospores are formed in Rhodophyceae which are also called tetraspores as in *Polysiphonia*.

**(i) Cysts.** Cysts are common in *Vaucheria* which are formed during unfavourable conditions and they are many layered.

## ALGAL ECOLOGY

### Planktonic Algae

The term 'planktonic algae' refers to the forms found floating or freely swimming in water. Among the freshwater planktonic algae, forms such as *Chlorella*, *Scenedesmus*, *Hydrodictyon*, *Chlamydomonas*, *Volvox* and *Eudorina* of Chlorophyceae, *Euglena* and *Phacus* of Eugleninae; *Microcystis*, *Anabaena*, *Aphanotheca*, *Spirulina*, *Arthrospira*, *Anabaenopsis* and *Oscillatoria* of Myxophyceae and *Melosira*, *Cyclotella*, *Pinnularia*, *Navicula*, *Fragilaria* and *Asterionella* of Bacillariophyceae are common while among marine planktonic forms *Phalacroma*, *Dinophysis*, *Exuviaella* and *Prorocentrum* of Desmophyceae; *Gymnodinium*, *Peridinium*, *Gonyaulax* and *Ceratium* of Dinophyceae; *Skeletonema*, *Cyclotella*, *Planktoniella*, *Eucampia*, *Hemidiscus*, *Chaetoceros*, *Biddulphia*, *Fragilaria*, *Asterionella* and *Nitzschia* of Bacillariophyceae; *Trichodesmium*, *Anabaena*, *Oscillatoria* and *Aphanotheca* of Myxophyceae and *Chlamydomonas* of Chlorophyceae are well-known.

### Benthic Algae

The term 'benthic algae' refers to aquatic algae found attached to one or the other substratum. Among the freshwater forms, *Cladophora*, *Pithophora*, *Chara*, *Nitella* etc., and among marine forms most members of Phaeophyceae and Rhodophyceae are the common examples. *Cladophora*, *Enteromorpha*, *Porphyra*, *Polysiphonia*, *Sargassum*, *Laminaria*, *Chondrus*, *Ulva*, *Ectocarpus*, *Sphacelaria*, & *Acetabularia*. The prolific growth of benthic forms are found on rockycoasts such as in the areas of Rameshwaram in South India and Dwarka in Gujarat.

### Thermal Algae

Some algae withstand or tolerate a very high temperature and these are often called thermal algae. Such forms are known to grow upto 85°C, nearly boiling water.

Majority of thermal algae belong to Myxophyceae, e.g., *Synechococcus elongatus*, *Mastigocladus laminosus*, *Phormidium tennue*, *Conferva thermalis* etc. A few forms belong to Chlorophyceae (Zygnematales) and Bacillariophyceae. Thermal algae reproduce by means of cell division and fragmentation and very rarely by spores.

## Soil Algae

Such forms of algae that grow on or in soil are called soil or terrestrial algae or edaphophytes. *Vaucheria*, *Botrydium*, *Zygnema*, *Oedogonium*, *Microcoleus*, *Nostoc*, *Oscillatoria* etc. occur on soils.

## Crybophytes

Certain algae are found growing on snow covered peaks of high mountains imparting attractive colours to snow. Common examples are—*Haematococcus nivalis*, *Chlamydomonas yellowstonensis*, *Raphidonema*, *Cylindrocystis*, *Protoderma*, *Scotiella*. *Ancyclonema nordenskioldii* imparts brownish to purple colour to snow.

## Lithophytes

The algae growing attached to stones and rocky surfaces are called lithophytes. These may be of two types:

- (i) **Epilithic.** These include algae living on surface of rocks, e.g., *Calothrix*, *Rivularia*, *Gloeocapsa*, *Pleurocapsa*, *Ectocarpus*, *Polysiphonia* etc.
- (ii) **Endolithic.** These include algae which live inside the rocks, e.g., *Dalmatella* and *Podocapsa*.

## Epiphytes

Some algae grow attached on the other plants and are called epiphytes. Such algae do not obtain the food from the plants on which they grow rather require support only. *Bulbochaete*, *Oedogonium*, *Ulothrix* etc., grow on other larger algae, besides, *Coleochaete* in association with *Chara* and *Nitella*, *Chaetophora* on leaves of *Vallisneria* and *Nelumbo* and *Oedogonium* on *Hydrilla*.

## Halophytes

Certain algae inhabit in water with high percentage of salt, as *Dunaliella* and *Stephanophora*. However, *Chlamydomonas ehrenbergii* and *Ulothrix flacca* have also been reported to grow in salt water.

## Symbionts

A pretty large number of algae live in association with dissimilar organisms for their mutual advantage and are called symbiotic algae. *Nostoc* in *Anthoceros*, *Anabaena cycadae* in the coralloid root of *Cycas*, *Anabaena* species in *Azolla* etc.

However, lichens are the best examples of symbiosis where the association lies in between algae and fungi. *Trebauxia*, *Calothrix*, *Chlorella*, *Gloeocapsa*, *Nostoc* etc.

## Endozoic Algae

Endozoic algae inhabit the protoplasm of other organisms, e.g., *Euglenomorpha*, *Zoochlorellae*, *Zooxanthellae*, *Carteria* etc. *Chlorella* like algae are found living within *Paramecium*, *Hydra* and certain molluscs and sponges (Cooke, 1975). *Zooxanthellae* live in intimate association with coral community.

## Parasitic Algae

Some algae, for their food, are dependent on other plants and are termed as parasitic forms. The common intercellular parasite *Cephaleuros* (Chlorophyceae) grows on the leaves of angiosperms like *Magnolia*, *Rhododendron*. *Polysiphonia fastigata* is a semiparasite occurring on another algae

*Ascophyllum nodosum* (Phaeophyceae). Some blue green algae *Anabaenium*, *Oscillatoria* and *Simonosilla* are found as parasite on man and in the intestines of animals.

## Algae of East Coast of India

**Chlorophyceae.** *Ulva*, *Cladophora*, *Bryopsis*, *Acetabularia*, *Neomeris*, *Udotea*, *Dictyosphaeria*, *Boodlea*, *Halimeda*, *Caulerpa*, *Chaetomorpha littorea*, *Rhizoclonium kernerii*, *Caulerpa fergusonii*, *C. freycinetii*.

**Phaeophyceae.** *Ectocarpus*, *Giffordia*, *Streblonema*, *Hecatonema*, *Chnoospora*, *Colpomenia*, *Hydroclathrus*, *Iyengaria* and *Rosenvingea*. *Sphacelaria*, *Dictyota*, *Dictyopteris*, *Padina*, *Spatoglossum*, *Stoechospermum*, *Zonaria* and *Procockiella*.

The common species of various forms are—*Ectocarpus breviararticulatus*, *E. filifer*, *E. enhali*, *E. geminifructus*, *Chnoospora minima*, *Sphacelaria tribuloides*, *S. furcigera*, *Dictyota dichotoma*, *Padina gymnospora*, *P. tetrastromatica*, *Turbenaria conoides*, *Zonaria latisima*, *Z. crenata*, *Dictyopteris delicatula*, *D. muelleri*, *Sargassum wightii*, *S. cristaeofolium* etc.

**Rhodophyceae.** *Chondria armata*, *C. transversalis*, *Acanthophora muscoides*, *Polysiphonia unguiformis*, *P. tuticorinensis*, *Rhodymenia dissecta*, *Liagora erecta*, *Porphyra tenera*, *Martensia fragilliss*, *Gracilaria disticha*, *G. lichenoides*, *Ceramium gracillimum* etc.

### ALGAL FLORA OF VISAKHAPATNAM (ANDHRA PRADESH) COAST. (UMAMAHESWARA RAO & SRIRAMULU, 1970)

	<i>Chlorophyceae</i>	<i>Phaeophyceae</i>	<i>Rhodophyceae</i>	<i>Total</i>
Genera	11	13	31	55
Species	20	16	44	80

## Class: Chlorophyceae

Family: Ulvaceae

*Enteromorpha compressa* (L.) Greville

*Ulva fasciata* Delile (—)

Family: Cladophoraceae

*Chaetomorpha antennina* (Bory) Kutzing

*Chaetomorpha brachygona* Harvey

*Chaetomorpha linoides* Kutzing

*Chaetomorpha torta* (Farlow) McClatchie

*Cladophora*

*Cladophora colabense* Borgesen

*Cladophora patentiramea* (Mont.) Kutz.

*Cladophora utriculosa* Kutzing

forma *longiarticulata* Reinbold.

*Spongomorpha*

*Spongomorpha indica* Thivy et Visalakshmi

Family: Valoniaceae

*Boodlea struveiodes* Howe

Family: Derbesiaceae

*Derbesia turbinata* Howe et Hoyt

Family: Bryopsidaceae

*Bryopsis pennata* Lamouroux

*Pseudobryopsis mucronata* Borgesen

Family: Caulerpaceae

*Caulerpa fastigata* Montagne

*Caulerpa racemosa* (Forsk.) J. Agardh var. *macrophyssa* (Kutzing) Taylor

*Caulerpa sertularioides* (Gmelin) Howe

*Caulerpa taxifolia* (Vahl) C. Agardh

Family: Corallinaceae (Melobesieae)

*Fosliella farinosa* (Lamouroux) Howe

*Dermatolithon ascripticum*

(Foslie) Setchell et Mason

Family: Corallinaceae (Corallineae)

*Amphiroa fragilissima* (L) Lamouroux

*Fosliella minutula* (Foslie) Ganesan

*Fania rubens* (L.) Lamouroux

Family: Grateloupiaceae

*Grateloupia flicina* (Wulfen) C. Agardh

*Grateloupia lithophila* Borgesen

Family: Gracilariaceae

*Gracilaria corticata* J. Agardh

*Gracilaria textorii* (Sur.) J. Agardh

*Gracilariopsis sjoestedtii* (Kylin) Dawson

Family: Hypneaceae

*Hypnea musciformis* (Wulfen) Lamouroux

Family: Gigartinaceae

*Gigartina acicularis* (Wulfen) Lamouroux

Family: Ceramiaceae

*Wrangelia argus* Montagne

*Aglaothamnion cordatum* (Borgesen)

Feldmann-Mazoyer

*Spermothamnion speluncarum*

*Spermothamnion* sp.

(Collins et Hervey) Howe

*Ceramium cruciatum* Collins et Hervey

*Ceramium fimbriatum* Setchell et Gardner

*Ceramium gracillimum* (Kitz.) Griff. et Harv.

*Centraceras clavulatum* (C. Agardh) Montagne

var. *bysoideum* (Harvey) Mazoyer

Family: Rhodomelaceae

*Polysiphonia ferulaceae* Subr

*Polysiphonia plactycarpa* Borgesen

*Bryocladia thwaitesii* (Harvey) De Toni

*Herposiphonia secunda* (C. Agardh) Ambronn

*Herposiphonia tenella* (C. Agardh) Ambronn

*Chondria cornuta* Borgesen

*Acanthophora spicifera* (Vahl) Borgesen

## Algae of West Coast of India

**Chlorophyceae.** West coast algal flora is enriched with 28 genera and 72 species of Chlorophyceae. A few characteristic species are *Enteromorpha tubulosa*, *Ulva reticulata*, *Bryopsis hynoides*, *Acetabularia moebii*, *Struvea anastomosans*. *Caulerpa* with its several species is quite common throughout the coast.

**Phaeophyceae.** The common forms are *Ectocarpus arabicus*, *E. enhali*, *Giffordia mitchellae*, *Colpomenia sinuosa*, *Iyengaria stellata*, *Roseningea intilicata*, *Sphacelaria tribuloides*, *S. furcigera*, *Dictyota dichotoma*, *D. divaricata*, *D. cervicornis*, *Dictyopteris australis*, *Padina gymnospora*, *P. tetrastromatica*, *Spatoglossum variable*, *Cystophyllum muricatum*, *Sargassum tenerimum*, *S. cinereum*, *Turbenaria decurrens* etc.

**Rhodophyceae.** West Coast is quite rich as regards to Rhodophyceae being represented by 89 genera and 175 species. A few most characteristic forms are *Scinaia hatei*, *Asparagopsis taxiformis*, *Nitophyllum punctatum*, *Rhodymenia australis*, *Hypoglossum spathulatum* etc.

**ROLE OF ALGAE IN NITROGEN FIXATION**  
**LIST OF ALGAE CAPABLE TO FIX ATMOSPHERIC NITROGEN**

<i>Order</i>	<i>Nitrogen fixing forms</i>
1. Chroococcales	<i>Chlorogloea fritschii</i> , <i>Gloecocapsa</i> , sp.
2. Nostocales	<i>Oscillatoria princeps</i> . <i>Anabaena ambigua</i> A. <i>solicola</i> , A. <i>cylindrica</i> , A. <i>doliolum</i> , A. <i>fertilissima</i> , A. <i>hemicola</i> , A. <i>naviculides</i> , A. <i>oryzoe</i> , A. <i>variabilis</i> , A. <i>ozillii</i> . <i>Anabaenopsis cirularis</i> , <i>Cylindrospermum majus</i> , C. <i>gorakhpurensis</i> , C. <i>licheniforme</i> , C. <i>sphaerica</i> , C. <i>musciola</i> , <i>Nostoc commune</i> , N. <i>sphaericum</i> , N. <i>paludosum</i> , N. <i>callicola</i> , N. <i>punctiforme</i> , N. <i>entophyllum</i> , N. <i>muscorum</i> , <i>Aulosira fertilissima</i> , A. <i>prolifera</i> , A. <i>ambigua</i> , <i>Calothrix brevissima</i> , C. <i>elenkinii</i> , C. <i>parietina</i> , <i>Nodularia harveyana</i> , <i>Fischerella mucicola</i> .
3. Stigonematales	<i>Tolypothrix tenuis</i> , <i>Scytonema oscillatum</i> , S. <i>hofmanii</i> . S. <i>bohneri</i> . S. <i>arcangelii</i> , <i>Stigonema dendroideum</i> , <i>Mastigocladus laminosus</i> , <i>Westeilopsis prolifera</i> .

### Mechanism of Nitrogen Fixation

A fairly large amount of work has been done to establish the structural and functional linkages between N<sub>2</sub>-fixation and photosynthesis and it is now a well-known fact that nitrogen fixing enzyme (nitrogenase) in blue green algae has a definite requirement of light for providing ATP through photophosphorylation. In this process, ferredoxin as a reducing agent is also required which is generated in the light by action of photosystem I of photosynthesis.

The recent findings are still more interesting establishing the fact that nitrogen fixation is controlled by genes. A block of genetic set consisting of nitrogenase complex and heterocystulon complex which contain nitrogen fixing genes (*nif*). Each complex has one operator gene and a few structural genes or *nif* but both are regulated by common regulator gene.

### Heterocyst as Nitrogen Fixing Organ

Fogg (1949) for the first time suggested the role of blue green algae in nitrogen fixation.

Stewart, Haystead and Pearson (1969) have provided further information about the role of heterocysts in N<sub>2</sub>-fixation. Nitrogen fixation is a reductive process and is inhibited in blue green algae by high oxygen levels (Stewart and Pearson, 1970). The heterocysts are unlikely to evolve oxygen and, therefore, it seems reasonable to suppose that nitrogenase should be active in non-oxygen evolving heterocysts rather than in oxygen evolving vegetative cells. They observed that heterocysts were the sites of reducing activity associated with nitrogen fixation.

### CYANOPHAGES OR PHYCOPHAGES

In some recent years a few phages (viruses) have been found infecting blue-green algae. These phages are called cyanophages. The first known isolated cyanophage is LPP-I. The name LPP-I refers to its hosts, *Lyngbya*, *Plectonema* and *Phormidium*.

### EXTRACELLULAR PRODUCTS OF ALGAE

A variety of kinds of organic substances are liberated in extracellular form algae. The amount may be quite high sometimes equal to that of intracellular materials. These extracellular products are liberated from healthy cells of algae belonging to several different groups, viz.

Few fossil blue-green algae have also been found. *Marpolia*, *Gloeocapsomorpha*, *Archothrix oscillatoriformis* (cellular dimensions resembling to Oscillatoria). *Anabaenidium*, *Palaeomicrocoleus* and *Palaeonostoc* etc. *Palaeonostoc indica* has been recently reported from India.

The important fossil forms belonging to Pyrrophyceae are *Eodinia*, *Lithodinia*, *Biecherella*, *Cacisphaerella*, Phaeophyceae and *Lithothamnion*, *Lilkophyllum* *Melobasia* etc.

Myxophyceae—Paleozoic (Archaeozoic)

Chlorophyceae—Paleozoic (Ordovician)

Xanthophyceae—Paleozoic (Mississippian)

Bacillariophyceae—Mesozoic (Triassic)

Dinophyceae—Mesozoic (Triassic)

Phaeophyceae—Paleozoic (Silurian)

Rhodophyceae—Paleozoic (Ordovician)

Charophyceae—Paleozoic (Ordovician)

**Examples.** *Gloeocapsa*, *Gloeotheca*, *Lithothamnium glaciale*, *Halimeda*, *Chlorellopsis*, *Chara*, *Gloeocapsomorpha*, *Epiphyton*, *Palaeoporella*, *Cyclorinus*, *Bornetella*, *Dimorphosiphon*, *Sphaerocodium*, *Solenospora*, *Botryococcus*, *Pyxidicula*, *Conscinodiscus*, *Actinoclava*.