INTRODUCTION
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The Algae comprise a large and heterogeneous assemblage of relatively simple plants, which have little in common except their characteristic oxygen evolving type of photosynthesis. The most comprehensive definition of the group appears to be that of Fritsch (1935), who writes: ‘Unless purely artificial limits are drawn, the designation alga must include all holophytic organisms (as well as their numerous colourless derivatives) that fail to reach the level of differentiation characteristic of archegoniate plants’. They exhibit great diversity in size and appearance and are found in freshwater of all kinds, barks, soils, rocks and marine habitats. They constitute a group of photosynthetic, eukaryotic organisms ranging from unicellular to multicellular forms, and generally possess chlorophyll but lack true roots, stems and leaves characteristic of terrestrial plants.

Algae are distinguished on a number of different characteristics. The most important ones are:

- The colour of the plastids (more correctly the combination of photosynthetic pigments that are present in the plastid)
- The presence of flagella (and if so how many, how do they insert in the cell and how do they beat).
- Is the cell surrounded by extracellular material? If so, what is that material - organic or inorganic, a continuous wall or a layer of scales).
- Are the cells motile or not?
- Do they occur singly, in colonies, filaments or exhibit differentiation that would allow them to satisfy the criterion of multicellularity?

Algal cells may be naked or may be covered by complete, rigid cell walls; incomplete cell walls (eg, a lorica or theca); or a series of plates, strips or inorganic and sometimes organic scales. Pigments are housed in chloroplasts. A pyrenoid with
associated storage products may be present in a chloroplast. Many unicellular and colonial algae, along with zoospores, possess flagella. Each flagellum is basically an extension of the cell membrane, comprising an internal axoneme of 9 doublet microtubules surrounding 2 doublets. The flagellum may be smooth or possess hairs or even scales. The different algal divisions have different flagella characteristics.

The recent trend among microbiologists and algologists is to separate the prokaryotic group Myxophyceae from algae and call these organisms cyanobacteria (Cyanoprokaryote) in order to emphasize their close relationship with bacteria (Stanier and Cohen-Bazire, 1977, Round, 1981, Allaby, 1992, Nabors, 2004, Losos et al. 2007). The Myxophyceae (Cyanophyta, blue-green algae) differs from other algae in having a prokaryotic cell organization, i.e. it lacks organized double membraned nuclei, chromatophores and mitochondria, and possesses characteristic photosynthetic pigments including billiproteins, myxoxanthin and myxoxanthophyll in addition to chlorophyll-a and β carotene. No flagellated cells are formed and the movement of motile stage is brought about by a characteristic gliding action. Their cell walls contain certain characteristic mucopolymers (or mucopeptides), and muramic acid which is not found in those of Eucaryota. They are susceptible to infection and lysis by viruses of similar morphology. They possess certain specialized cells known as heterocysts. However, the blue-green algae resemble other algae and green plants in their oxygen evolving type of photosynthesis whereas in photosynthetic bacteria no oxygen is evolved. True sexuality, defined as alternating karyogamy and meiosis, does not occur but genetic recombination which fulfills the function of sex is known in some members.

The algae have received lesser attention for the description of their types and most of the species of algae are yet to be described. Out of estimated global species of chromistan algae, only about 44,000 have been described (Hawksworth & Kalin-Arroyo, 1995). Even approximate estimates of global diversity are therefore premature. Urgently needed are extensive and intensive surveys of all groups from a multitude of habitats. In particular, tropical habitats, the meiofauna, deep-sea fauna,
parasites and microorganisms need attention (Lecointre, & Le Guyader. (2001). Among the algae the red and brown algae have received more attention with reported number of species to be 9,671 and 2,849 respectively for the two groups. However, the "green algae" is the most diverse group of algae, with more than 7000 species growing in a variety of habitats.

RANGE OF VEGETATIVE STRUCTURE

The organization of thallus in algae is basically of two types, the unicellular and the multicellular. The wide range of forms that algae exhibit arises from a modification or elaboration of these types. The cells of a multicellular thallus may be loosely held together by a mucilaginous matrix or cemented together through middle lamellae.

UNICELLULAR HABIT

All phyla except the Phaeophyta include unicellular forms which may be motile or non motile. The motile type is of two kinds, the flagellated kind moving by means of flagella (found in all phyla except the Rhodophyta) and the rhizopodial kind having the fine protoplasmic projections (the rhizopodia) and showing an amoeboid movement (Xanthophyta and certain other algae. The flagellated forms may be periplastic, e.g. Euglena or may be provided with a definite cell wall, e.g. Chlamydomonas. External to the periplast, some flagellates have a special envelope, which is provided with pores for the protrusion of the flagella. The calcareous envelope is separated from the cell proper by a space. The non-motile or coccoid type includes forms of diverse shape and size. They are provided with a rigid cell wall and are non-flagellated. A typical example is Chlorella (Chlorophyta).
MULTICELLULAR HABIT

Depending on the manner in which cells are produced and arranged during the vegetative phase, three principal types of habit are recognized – colonial, filamentous and siphoneous.

COLONIAL HABIT

A colony is a group of separate cells generally similar in structure and function and aggregated by a mucilaginous envelope. Main types of colonial organizations are coenobial, palmelloid, dendroid and rhizophodial. A coenobium has a definite number of cells arranged in a particular manner which is determined at the juvenile stage and does not increase during its subsequent growth even though the cells enlarge. The coenobium may be motile or non-motile. In the motile kind, the cells are flagellated, e.g. Volvox. In the non-motile type, the cells are cocoid and more or less fused together, e.g. Hydrodictyon.

Unlike the coenobium, the palmelloid, dendroid and rhizophodial types of colony are not of constant shape and size and their cells divide leading to an increase in the size of the colony. In palmelloid colonies, the cells remain embedded in a mucilaginous matrix of irregular shape and size. The matrix is formed from the walls of individual daughter cells which gelatinize and mix together with the gelatinized walls of daughter cells embedded in the common matrix.

In the dendroid colonies, the cells are united in a branching manner by localized production of mucilage at the base of each cell. The whole colony looks like a tree in habit. Such an organization is found in Ecballocystis (Chlorophyta). The cells of rhizophodial colonies are united through rhizopodia.

FILAMENTOUS HABIT

A uniseriate row of cells joined end to end in a transverse plane through middle lamellae constitutes a filament. The filaments may be unbranched or branched. Branching results from repeated transverse divisions of the lateral
outgrowths produced by a few or many scattered cells of the main filament. The branched thalli are of four types; (1) simple branched filament, e.g. Cladophora (Chlorophyta; (2) heterotrichous in which the thallus is differentiated into an erect and a prostrate system of branched filaments (3) parenchymatous; and (4) Pseudoparenchymatous in which the thalli show uniaxial or multiaxial construction. The heterotrichous habit is the most highly evolved type of filamentous construction in algae.

The parenchymatous habit is a further variant of the filamentous construction and results from vegetative divisions taking place in more than one plane followed by the failure of the division products to separate. The Pseudoparenchymatous habit results from a close juxtaposition of the branched filaments of a single or many axial filaments. If branches from a single filament are involved, as in Batrachospermum, the thallus construction is called as uniaxial. If branches of many axial filaments aggregate, the thallus is multiaxial, e.g. Nemaion.

SIPHONEOUS HABIT

A siphoneous thallus is multinucleate and lacks septation except during the formation of reproductive organs. It ranges from a vesicular, unicellular thallus to branched, siphoneous filament; advanced members show uniaxial and multiaxial forms. Convergence of features in unrelated groups is common. Thus plant body types of algae may be divided in to:

- Unicellular motile
- Unicellular non-motile
- Motile colonial
- Non-motile coenobial
- Filamentous
- Thalloid
- Siphoneous and
- Heterotrichous forms
ALGAL BLOOMS IN FRESH WATER

Dense aquatic accumulation of microscopic organisms produced by an abundance of nutrients in surface water coupled with adequate sunlight for photosynthesis is called water bloom. Such blooms are caused mainly by algae including the cyanobacteria, hence is also called “Algal Bloom”. During bloom development single species of algae, diatoms, or dinoflagellates, reproducing every few hours, may dominate a bloom's population; the number of individuals per litre of water, normally about 1,000, can increase to 60 million.

USES OF ALGAE

Algae are source of Agar, Alginates, Carragreenin, a substance very much like agar, Energy, Fertilizer Pigments and Fodder. They are also used as food and in pollution control. They can also be the source of bio-diesel. More importantly they may act secret weapon in climate change war. However, they have negative importance also. Bloom-forming blue-green algae such as Microcystis aeruginosa, Anabaena flos-aquae and Aphanizomenon flos-aquae have been implicated in poisoning in fish and domestic animals that drink water infested with these algae.

DISTRIBUTION OF ALGAE

Algae have a worldwide distribution, growing wherever light and water are present. The obvious occurrences are along rocky coastlines of all continents (except Antarctica); as conspicuous floating masses (or scums) in particularly productive lakes and ponds; or attached to submerged rocks or larger aquatic plants in lakes, ponds and shallow rivers. Algae are spread mainly by the dispersal of spores. The spores of fresh-water Algae are dispersed mainly by running water and wind, as well as by living carriers (Round, 1981). The bodies of water into which they are transported are chemically selective. To some degree the distribution of Algae is subject to floristic discontinuities caused by geographical features, such as Antarctica, long distances of ocean or general land masses. Mapping is possible for select species
only: "there are many valid examples of confined distribution patterns (Round, 1981). For example, *Clathromorphum* is an arctic genus and is not mapped far south of there. On the other hand, scientists regard the overall data as insufficient due to the "difficulties of undertaking such studies (Round, 1981)."

**Environmental Factors:** Whatever the habitat, algae are dependent upon such factors as light, oxygen, carbon dioxide, proper temperature, water, and suitable mineral salts. Algal growth suffers from the inadequacy of any of these factors, from the presence of chemical wastes and other deleterious substances, from destruction by animals and parasitic fungi, and by the mere limitations of space.

West (1916) is generally credited with the suggestion that a rich desmid flora in Britain is correlated with waters on precarboniferous rocks and poor in electrolytes. This seems to have been confirmed (Fritsch, 1931) by additional evidence from continental Europe, but the relationship does not explain the rich desmid collections occurring along the Gulf States of the United States or elsewhere in North America. Pearsall (1921) amplified West’s suggestion to include such additional factors as waters of rocky shores with little silt, clear soft waters, paucity of calcium and magnesium salts, and abundance of potassium and sodium.

Lakes may be classified, on the basis of such features as oxygen content, form and shape of the basins, electrolytes, transparency and color, into three types: eutrophic, oligotrophic and dystrophic. Summaries of the differences, besides are to be found in Fritsch (1931), Welch (1935) and Prescott (1939). Birge & Juday (1911) emphasized the importance of stratification in lakes, with the hypolimnion deficient in oxygen as compared with the oxygen content of the epilimnion. There is of course no stratification in the shallower ponds, whose ecology is similar in many ways to that of lake margins. Wehrle (1927) found wide variations in the pH tolerance of different algal habitats, although the optimal conditions were somewhat restricted. Rather definite pH ranges, all near neutrality, have been reported for such ubiquitous genera as *Cladophora*, *Oedogonium*, and *Spirogyra*, but when one considers the large number of species included in these genera, such correlations are of dubious validity.
It is quite likely that many, if not most of the filamentous algae, are able to grow within a fairly extensive pH range, but best conditions for each species may reside in much narrower limits. A good amount of data have been collected in relation to the plankton algae (Ketchum 1951), but still it is not possible to formulate very definite principles regarding algal associations, successions, or even direct relationships between algal productivity and specific causal environmental factors.

ALGAL COMMUNITIES OF LAKES, PONDS AND POOLS

Although it is difficult to separate the ecological groups of aquatic algae, the following more or less clearly defined communities may be observed: (a) the plankton; (b) algae of mud or other bottom substrate; (c) algae of shores, including piers, walls and other fairly permanent man-made installations; (d) algae of thermal waters; (e) algae of brine lakes; (f) epiphytes, and (g) algae growing on animals.

Many algae, especially among diatoms, blue-greens and to a lesser extent the greens including the filamentus forms, remain attached to various substrates by mucilage's. The dissolution of these substances frees the plants, and they become part of plankton. The filaments may form mats on the surface of the water. When photosynthesis is occurring at a fairly rapid rate in the plants, the mats float readily as if buoyed up by accumulated gases.

The algae on the bottom of both lotic and lentic habitats bear a very direct relationship to the kind of substrate on which they grow and to the degree of disturbance of the water medium which surrounds them (Tiffany, 1951). The depth below the surface to which algal communities are able to penetrate depends primarily on the availability of the light rays essential to photosynthesis and perhaps other processes. The light intensity may be quite low for all algae living a few inches or better the surface of the water, and thus most algae may be regarded as extremely made-tolerant and possessing a low compensation point. The algal communities of rocky or other stable shores of lakes and larger ponds are easily recognized, but it is
difficult to delimit their exact habitats. Stones may be covered with a semi-slimy substance made up of diatoms and blue-greens.

In artificial troughs, small depressions in rocks and rainy-weather puddles occurs a temporary algal flora few in species but often many in individuals. In small freshwater pools rich in organic matter some of the Euglenophyta occur in such numbers as to colour the water green or red (*Euglena*), green (*Phacus*), or yellowish-brown (*Trachelomonas*).

Algae on the submerged sediments are called epipelic algae; attached to the submerged plants as well as other algae are epiphytic algae; and attached to rocks and sand grains are epilithic and epipsammic algae respectively. However, Most of the algae are found in benthic communities. Algae can also live in aerial habitats provided sufficient moisture is available, A few algae live on (epizoic) or within (endozoic) animals, as well as other organisms. One green alga of the genus *Cephaleuros* is responsible for the red rust disease of tea plants. Diatoms preserve very well in lake sediments because of their resistant siliceous cell wall. As a result they have been used extensively in reconstructing the past historical development of lakes as well as to determine the extent of lake acidification. In terms of lake level fluctuations and paleosalinity changes, diatoms are sensitive proxy indicators of climate changes.

**PHYTOPLANKTON**

Fresh water phytoplankton may contain unicellular, colonial and simple filamentous algae, mostly belonging to the Chlorophyceae, Cynaphyceae and Bacillariophyceae. Two general characteristics of planktonic organisms should be noted; (1) they are small and free-swimming by means of flagella or free-floating; and (2) they have a large surface-volume ratio.

Fresh water phytoplankton, collected from relatively ‘clean’ nutrient-deficient or oligotrophic waters, exhibit a great diversity of algal species, though the concentration of each species or of the algae as a whole is very low, In contrast, polluted ponds and tanks, lakes and rivers, which are rich in dissolved nutrients or are
otherwise eutrophic, may at certain times, especially during the summer, have a luxuriant growth of one or, rarely, a few species of algae, constituting what are known as "water blooms". Such blooms impart their characteristic colour to the water which appears like 'pea-soup'. Indeed the appearance of a bloom of the blue-green alga *Microcystis aeruginosa* in a lake or pond is regarded as indicative of pollution.

The appearance of particular blooms, and the specific composition and proportion of different algae in a plankton sample, often show a marked correlation with physical and chemical factors of the environment such as pH of water, light intensity and availability (visibility), temperature, and nitrate, phosphate, oxygen or silica content.

**CLASSIFICATION OF ALGAE**

Classification of algae is being given only to have idea about some of the older to recent trends in the classification of algae. Classification of algae is changing continuously. One reason of change is the differences in opinion about the status and affinities of different groups but the more important reason of change is due to acquisition of more and more knowledge, particularly at the molecular level. With the different types of classification proposed, it is difficult to agree or disagree with any one system of classification. Following is only a brief account about the current status and taxonomy of the algae. At the end some proposed classifications have been mentioned in brief.

Carolus Linnaeus (1753) distinguished two kingdoms of living things: Animalia for animals and Vegetabilia for plants, where the algae were included in the vegetabilia with higher groups of plants. Later this heterogeneous group of organisms collectively referred to as "algae" were included entirely in the kingdom Plantae. A detailed history of Phycology may be found in West (1951). Without going in to details of status and position of algae among the organisms, following are some of the
latest ideas of dividing the organisms. Whittaker (1969), Whittaker and Margulis (1978) have suggested that organisms should be divided into five kingdoms:

- **Monera or Procaryotae** (prokaryotes, including Bacteria and Archaea)
- **Protista** (eukaryotes with single- or colonial cellular organisation, may be photosynthetic)
- **Fungi** (generally multinucleate eukaryotes with walled syncytia)
- **Animalia** (wall-less eukaryote cells organised into complex organisms)
- **Plantae** (generally autotrophic plants, mostly with photosynthetic plastids, simple multicellular to advanced tissue organisation)

This model includes some "plants" as protists, and makes no distinction between Archaea and Bacteria.

Based on 16s RNA studies, Woese (1977, 1990), Olsen & Woese (1993) have divided the organisms into three domain - six kingdoms. The prokaryotes (Kingdom Monera) has been divided into two kingdoms, called Eubacteria and Archaebacteria. Carl Woese attempted to establish a Three Primary Kingdom (or Urkingdom) system in which Plants, Animals, Protista, and Fungi were lumped into one primary kingdom of all eukaryotes. The Eubacteria and Archaebacteria made up the other two urkingdoms. The initial use of "six Kingdom systems" represents a blending of the classic Five Kingdom system and Woese's Three Domain system.

- Bacteria (Eubacteria),
- Archaea (Archaebacteria) and
- Eukarya (Eukaryotes; further divided into Protista, Plantae, Animalia and Fungi).

Such six Kingdom systems have become standard in many works (Blach et al. 1977). James Lake (1991) and co-workers have lately proposed a radical re-structuring of the "universal" phylogenetic tree, to split Archaea into Halobacteria, Methanogens and Eocytes. This would mean there are three major groupings of prokaryotes (Eubacteria
+ Halobacteria, Methanogens and Eocytes), which could all constitute kingdoms on their own, given each is as unrelated to the others as any are to Eukarya. There is also a 2-empire/8-kingdom scheme (Cavalier-Smith, 1993) with Archaeobacteria and Eubacteria as kingdoms in Empire Bacteria, and 6 kingdoms in Empire Eukaryota:

- Archezoa (primitive eukaryotes without chloroplasts or mitochondria)
- Protozoa (unicellular wall-less eukaryotes with mitochondria)
- Chromista (photosynthetic organisms with chloroplasts within the lumen of the rough ER; e.g., diatoms, brown algae, cryptomonads, oomycetes)
- Plantae (photosynthetic organisms with chloroplasts within cytoplasm; all land plants, many green algae)
- Fungi
- Animalia

Not only is this scheme the most recently proposed, but also the most controversial. Its construction stresses that the term 'algae' wrongly tried to combine organisms with such diversity and differential evolutionary histories into a single group. Under the 8-Kingdom System, algal members are dispersed in vastly different kingdoms that are distinct from each other.

**Recent advances**

Kingdom classification is in flux due to ongoing research and discussion. As new findings and technologies become available they allow the refinement of the model. For example, gene sequencing techniques allow the comparison of the genome of different groups (Phylogenomics). A study published in 2007 by Fabien Burki, et al 2007), proposes four high level groups of eukaryotes based on phylogenomics research.

1. Plantae (green and red algae, and plants)
2. Unikonta (amoebas, fungi, and animals)
3. Excavata (free-living and parasitic protists)
4. SAR (acronym for Stramenopiles, Alveolates, and Rhizaria—the names of some of its members. Burki found that the previously split groups Rhizaria and Chromalveolates were more similar in 123 common genes than once thought.)

Completing this 6 kingdom model would be:
Bacteria
Archaea

Phylogenetic studies may yet again make this model obsolete and expand the kingdom classifications. However, the formal divisional taxon algae is being abandoned, since the component groups are considered sufficiently distinct to warrant divisional status on the basis of comparisons between pigments, assimilatory (storage) products, flagella, cell wall chemistry and structure, as well as aspects of cell ultrastructure.

The classification of algae into taxonomic groups is based upon the same rules that are used for the classification of land plants. However, researches using electron microscope has demonstrated differences in features, such as the flagella - their hairs, swellings, scales; chloroplasts, endoplasmic reticulum, thylakoids, phycobilisomes, external organic and inorganic scales, silica deposition vesicles, theca; nuclear structure and division; and cell division. Simultaneously, biochemists have analyzed the molecular details of pigments, assimilatory products and cell walls. Similarities and differences among algal, fungal, and protozoan groups have led scientists to propose major taxonomic changes, and these changes are continuing. Molecular studies, especially comparative gene sequencing, have supported some of the changes that followed electron microscopic studies, but they have suggested additional changes as well. Since 1960 the number of classes in algae has nearly doubled. Furthermore, the apparent evolutionary scatter of some algae among protozoan and fungal groups implies that a natural classification of algae as a class is impracticable.
Division-level classification is tenuous for algae. For example, some phycologists place the classes Bacillariophyceae, Phaeophyceae, and Xanthophyceae in the division Chromophyta, whereas others place each class in separate divisions: Bacillariophyta, Phaeophyta, and Xanthophyta. Yet, almost all phycologists agree on the definition of the respective classes Bacillariophyceae, Phaeophyceae, and Xanthophyceae. In another example, the number of classes of green algae (Chlorophyta), and the algae placed in those classes, has varied greatly since 1960.

The primary classification of algae is based on five main criteria of a different nature: 1. photosynthetic pigments, 2. the nature of the food reserves, 3. the nature of cell wall components, 4. the types of flagella, and 5. certain details of cell structure. However, it must be emphasized that the final classification of algae depends on a combination of several characters, and not on any single feature.

The foregoing principles are generally accepted as broad guidelines for the primary classification of algae. However, the systems of classification differ widely as regards the rank and status assigned to various taxa. For instance, Fritsch (1935, 1944) divides the algae into 11 classes whereas other classify them into 7-13 phyla (e.g. Round, 1973).

This heterogeneous group of organisms collectively referred to as "algae " were at one time included entirely in the kingdom Plantae. With the present-day 5 kingdom classification, all the eukaryotic (cells having distinct nuclei) algae are now in the kingdom Protista, whereas the Blue-green algae: Cyanobacteria (formerly Cyanophyta) and Prochlorophyta or Chloroxybacteria are in the kingdom Monera with the other prokaryotic (cells having no distinct nuclei) organisms (eg, Bacteria).

Electron microscopy has revealed structural characteristics now employed in algal systematics: flagella - their hairs, swellings, scales; chloroplasts, endoplasmic reticulum, thylakoids, phycobilisomes, external organic and inorganic scales, silica deposition vesicles, theca; nuclear structure and division; and cell division.
Simultaneously, biochemists have analyzed the molecular details of pigments, assimilatory products and cell walls.

Some classification systems of algae are:

Fritsch (1935) has divided algae into 11 classes:

1. Chlorophyceae
2. Xanthophyceae
3. Chrysophyceae
4. Bacillariophyceae
5. Cryptophyceae
6. Dinophyceae
7. Chlomonodineae
8. Euglenophyceae
9. Phaeophyceae
10. Rhodophyceae
11. Myxophyceae

Smith (1938) has divided algae into seven divisions with two groups of uncertain systematic position:

1. Chlorophyta
2. Euglenophyta
3. Pyrrophyta
4. Chrysophyta
5. Phaeophyta
6. Cyanophyta
7. Rhodophyta

Algae of uncertain systematic position:

1. Chloromonadales
2. Cryptophyceae
Round (1971) has, although, indicated the views to separate the Cyanophyta from algae but has, included the group with algae. However, proposing a brief classification, he has excluded the anomalous genera. The following is the proposed classification:

**PROCARYOTA**

Phylum Cyanophyta (Myxophyceae)

**EUCARYOTA**

Caryoyta, Plantae euplastidae. Alage with typical nucleus and pigments localized in Chromatophores. Twelve phyla:

1. Algae with green pigments
   a). Unicellular with a single, obvious flagellum, **EUGLENOPHYTA**
   b). Algae, either unicellular, colonial, coenobial, filamentous or syphonaceous and usually forming starch **CHLOROPHYTA**
   c) Microscopic algae with precise segmentation in to nodal and internodal segments **CHAROPHYTA**
   d) Flagellate or coccoid algae. Four flagella (occasionally fewer) arising from an apical pit and with flagella and body covered by scales **PRASINOPHYTA**
   e) Algae as b, but usually discoid chromatophores and forming oil but not starch **XANTHOPHYTA**
   f) Coccoid algae, separated from the Xanthophyta. With stalked pyrenoids projecting from the inner face of the chloroplasts. Motile cells with a single, emergent flagellum, bearing a proximal swelling. **EUMASTIGOPHYCEAE**

2. Alage with brown pigments
   a) Unicellular, biflagellate with flagella in two different planes, **DINOPHYTA** (= **PYRROPHYTA**)
b) Unicellular or colonial, without flagella, with a bipartite sculptured silica wall. **BACILLARIOPHYTA**.

c) Unicellular or colonial, without flagella, or with one, or two flagella. Often with siliceous scales on the motile cell or cells within loricas **CHrysophyta**

d) Simple or branched filaments or thallloid. Overwhelmingly marine and usually macroscopic **Phaeophyta**

3. Mainly marine algae with red pigments (often somewhat grayish in fresh water). Unicellular, filamentous or thallloid **Rhodophyta**

4. Algae with green, blue, red pigments. Two slightly unequal flagella arising laterally at the apical end **Cryptophyta**

One of the latest classification of algae is given by the Encyclopædia Britannica (Alga, 2009).

**Division Chlorophyta** (green algae)
- Class: Chlorophyceae
- Class: Charophyceae
- Class: Micromonadophyceae
- Class: Pleurastrophyceae
- Class: Ulvophyceae

**Division Chromophyta**
- Class: Bacillariophyceae (diatoms)
- Class: Bicosoecophyceae
- Class: Chrysophyceae (golden algae)
- Class: Dictyochophyceae
- Class: Eustigmatophyceae
- Class: Phaeophyceae (brown algae or brown seaweeds)
- Class: Prymnesiophyceae (Haptophyceae)
- Class: Raphidophyceae (Chloromonadophyceae)
- Class: Synurophyceae
- Class: Xanthophyceae (yellow-green algae)

**Division Cryptophyta**
- Class: Cryptophyceae

**Division Pyrrophyta** (Dinoflagellata)

**Division Euglenophyta**
- Class: Euglenophyceae

**Division Rhodophyta** (red algae or red seaweeds)
Christensen (1962, 64), has proposed a new scheme for the primary classification of algae into procaryota and eucaryota on the basis of the difference between the prokaryotic and eucaryotic cells:

![Diagram of algae classification]

- **Algae**
  - **Procaryota** (Div. Cyanophyta)
  - **Eucaryota** (All other algae)
    - **Aconta** (no flagellate stage) (Div. Rhodophyta)
    - **Contophora** (with flagellate stage)
      - **Divisions**
        - Chlorophyta
        - Charophyta
        - Euglenophyta (Chl. predominate with both chl a & b)
      - **Chromophyta** (carotenoids predominate, contain chl a, but not b)
        - **Divisions**
          - Xanthophyta
          - Chrysophyta
          - Bacillariophyta
          - Pyrrophyta
          - Cryptophyta
          - Phaeophyta
CHHATTISGARH AT A GLANCE

Chhattisgarh state is located almost in the middle of India, surrounded all around by other states of our country.

Location : 17°46' to 24°06' N Latitude and 80°15' to 84°51' E Longitude.


Administrative districts:

One third population of Chhattisgarh is of tribes, mostly in the thickly forested areas in the North and South. The central plains of Chhattisgarh are known as the “Rice Bowl” of Central India. Bastar is known the world over for its unique and distinctive tribal heritage.
Located in Central India, Chhattisgarh state was born, through carving out of about 33% area of eastern part of Madhya Pradesh, on November 1, 2000, to become the 26th state of the Indian Union.

Geography

Chhattisgarh is one of the few landlocked states of the country. Uttar Pradesh and Bihar bind the State in north, in the east it is bound by Orissa, in the south by Andhra Pradesh and in the West by Madhya Pradesh and Maharashtra. A large part of the state comes under Vindhyachal range that divides the Indian subcontinent into two. Mahanadi and Godavari, with their tributaries, are the principal rivers of the state. Physiographically the area of the state is divisible into northern hills, central plain and southern plateau.

Geology

The Archean are oldest rock formations from highland rim encircling the geological Chhattisgarh basin. The patches of Dharwad formation are recognised in the northern part of Sarguja, eastern part of Raigarh, western part of Bilaspur, north-western part of Rajnandgaon, southern part of Durg and south-western part of Bastar district. The iron ore deposit of the region are confined to the Dharwad at Dallirajhara and Bailadila hills. The Purawa rocks or the Cuddapah cover large portions of Durg, Raipur, Bilaspur, Raigarh, Sakti, Rajnanagaon and Khairagarh etc. They also cover considerable parts of Jagdalpur and Kondagaon areas of Bastar district. The Gondwana rocks occupy southern and eastern part of Bilaspur, northern part of Sarguja and central and western part of Raigarh districts. The eastern part of Maiikal range, in Bilaspur and Rajnandgaon districts, is occupied by the Deccan trap. It also extends over Manendragarh area of Sarguja district and parts of raigarh district.

Climate

The state has tropical climate with hot summer and cold winters. Average rainfall of the area is about 160 cm. Most of the precipitation occurs during the monsoon (mid June to mid-September). Day temperature during the summers (mid-April to June end) can touch a high of around 45°C while in the winters the temperature may fall well below 10°C. High amount of rainfall, concentrated in few months are stored in small ponds, all created artificially by the village settlements.
Natural wetlands are also extensive. The area is, thus, dotted with such natural and artificial wetlands. Not a single patch of the state comes under xeric area.

Soil:

Hot and humid climate favour laterisation. The red and yellow soils cover most aprt of Chhattisgarh. The other soil types found in the region are red-loamy, red-sandy, lateritic and black soil, all of them formed in situ. The red and yellow soil of the region are derived from a variety of rocks. Most of Bastar district is covered by the red-loamy and sandy soils. The normal red-loamy soil has the pH around neutrality, while the red-sandy soil shows acidic tendency. Lateritic soils are found over the south of Mainpat plateau of Sarguja, the adjoining parts of Bilaspur and Durg districts and near Jagdalpur area. The soil is derived from residual rocks. It consists of hydrated oxides of aluminium and iron and also of manganese oxide and titanium. The soils are poor in potassium, phosphorus and calcium. A deep balck soil extends over the heartland of Raipur district and the western part of Bilaspur and Rajnandgaon districts. It is derived from the basaltic trap. In parts of Bilaspur and Rajanagaon districts, it is carried down by the rivers from the Satpura or Maikal hills. The soil varies according to the topographical conditions in the region. The common local soil types found in the region are Kanhar, Matasi, Dorsa and Bhata in parts of Chhattisgarh plain, while Gabhar, Tikra, Mal, Marham and Bari are common in parts of the Bastar Plateau. Kanhar is a deep and dark coloured soil derived from the deccan trap or basalt, mostly occupying the low lying situations. Matasi is a light textured yellow sandy soil with more admixture of clay. It occupies relatively higher and well drained areas. Dorsa is intermediate between Kanhar and Matasi, which is considered as loamy soil. It has brown and yellow colour. Bhata soil, poor in fertility, is composed of sand and gravel and occupies mostly the upland tops. Gabhar is a low lying soil, which receives moisture more than its share. It is apparently a clayey soil and is very fertile. Tikra, literally a hill, is a land of uneven surface. Tikra soil is coarser and retains less moisture than Gabhar and is, therefore less fertile. Mal occupies the upland top. It is a coarse, sandy and gravelly soil. It has a very low fertility and moisture retaining capacity. Bari is literally a garden attached to the house. It is generally used for vegetable cultivation and has a fertile soil.
Forests:

The state has about 44% of its area under forest cover making up about 12% of national forest cover. Many parts of the forests are still lying virgin with their utmost wilderness. The forests of the state fall under two major types, i.e., Tropical Moist Deciduous forest and the Tropical Dry Deciduous forest, divisible into about 22 forest sub-types. From the management point of view, there are four types of forests, viz: Teak, Sal, Miscellaneous and Bamboo forests in the state.

Forest area (as per the legal definition of the state):

<table>
<thead>
<tr>
<th>Type of Forest</th>
<th>Area (Sq.Km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reserved Forests</td>
<td>25782.167</td>
</tr>
<tr>
<td>Protected Forests</td>
<td>24036.100</td>
</tr>
<tr>
<td>Undemarkated Protected forests</td>
<td>9954.122</td>
</tr>
<tr>
<td>Total Forests</td>
<td>59772.389</td>
</tr>
</tbody>
</table>

However, according to forest survey of India assessment (1999) the forest cover of the state is 56693 Sq.Km. Out of it, the extent of dense forest is 39557 Sq.Km. and open forest is 17136 Sq.Km.

The state has about 44% of its area under forest cover, accounting for 12% forest cover of the country. Chhattisgarh also has a large concentration of wildlife with national park and wildlife sanctuaries. The forests are of tropical deciduous type. Identified as one of the richest bio-diversity habitats, the Green State of Chhattisgarh has some of the virgin and the densest forests of India, rich in wildlife, yielding over 200 non-timber forest products, with tremendous potential for value addition.

Water bodies:

Source of surface water in the state are both lentic and lotic water bodies. Lentic water bodies include ditches, ponds, tarns and dams while the lotic water bodies include the nalas and rivers. A large size of population of the state, still depend for their nistar on the lentic water bodies. Ponds and tarns are most common surface water bodies in the central, plains of the state. Almost every village, even may be
very small, has at least one pond which may be as numerous as with 126 ponds in Ratanpur village in Bilaspur district and 146 ponds in Bade Dongar village in Kanker district, Raipur, the capital city of the state, historically had as many as 100 ponds, but the number has now reduced to only about 50. Water of most of these ponds have become eutrophic, however the reason for eutrophication of these water bodies is different in city and village areas. Ponds and any other water body including any nearby flowing water body are used as the discharge place for the sewage and domestic and industrial waste water. Ponds in the city area little better than the sewage stabilization ponds. Nevertheless, most of the poor population are dependent on these water bodies, for their nistar purposes including bathing. Ponds in the village areas do not receive sewage but are contaminated through cattle fecal matter as the cattle are in these ponds. Occurrence of cyanobacterial blooms, of Anabaena, Oscillatoria, Raphidiopsis and Spirulina, particularly during early summer months, is a common feature in the ponds of Chhattisgarh. There are only a few dams, all located in the central part of the state. Mahanadi and Indravati with their tributaries are the main lotic water bodies. Rapid industrialization of the state is causing pollution of these water bodies through industrial wastes. Water bodies, with respect to macrophyte growth were of several types. Some of the water bodies were totally free from macrophytic growth. Even the adjoining ponds were found to show the contrast of one pond supporting luxuriant, macrophyte growth while another pond was totally free from them. This difference was not related to pollution of the water bodies as the feature was found with both types of water bodies. Similarly macrophyte growth was found both in water bodies with clear water as well as with turbid water due to pollution. Water bodies with clear water supported growth of submerged macrophytes like species of Chara, Nitella, Salvinia, Azolla, Hydrilla, Potamogeton, Ottelia, Najas, Ceratophyllum etc. Rooted, floating macrophytes like the species of Nelumbo and Lotus were also observed in water bodies with clear water. Water bodies with turbid water supported heavy to very heavy growth of floating macrophyte species of Lemna, Spirodella, Wolffia, Pistia, Eichhornia, Ipomoea etc. Emergent macrophytes like the species of Polygonum, Typha, Scirpus, Cyperus and Panicum were also common. Some of the water bodies were thickly choked with the growth of either the submerged or the free-floating macrophytes but both were never found together. It was also an interesting observation that the Pistia stratiotes outgrows the Eichhornia crassipes. Most of the water bodies have, although, become highly eutrophic but are generally free from toxic contaminants.
However, some of the rivers have become seriously polluted with industrial effluents like the River Kharoon near Raipur city and River Arpa in and around Korba city.

Water bodies in Chhattisgarh state are plenty in numbers, variety and amount of water. However, sufficient studies on algae of these water bodies are still to be made. Hence, the present studies were made to add to the knowledge on the algae of water bodies of Chhattisgarh state, more particularly the phyto-planktons, with the following objectives: