BACILLARIOPHYTA
Class: Bacillariophyceae

1. This class is represented by approximately 200 genera and 600 species.

2. Members are commonly known as diatoms and are commonly found in fresh water, water, in air or on soil.

3. Thallus is unicellular, uninucleate diploid and show radial or bilateral symmetry.

4. Cell wall is silicified. It shows characteristic secondary structures. It is often called the she or frustule.

5. Frustule is made up of two overlapping halves.

The upper larger half is called as the epitheca, and the lower smaller overlapped half is called hypotheca.

6. Cells generally possess many discoid or two plate like chromatophores.

7. Members of this class are also called as golden brown algae because of their characteristic pigments which include carotenoids, fucoxanthin, diatomin (diatoxanthin, diadinoxanthin), beside chlorophyll a and chlorophyll C.

8. The stored food products are in the form of oil, volutin chrysolaminarin.

9. Cell shows gliding movement.

10. Reproduction occurs by cell division and auxospore formation.

11. Motile stages possess a single, anterior pantonematic flagellum.

Classification of Bacillariophyta:
Class Bacillariophyceae has been divided into two orders. Pennales and Centrales.

Order: Centrales:
1. Thallus radially symmetrical.

2. Gliding movement absent.

3. Sexual reproduction anisogamous or oogamous.

Order Pennales is further divided into:

Araphideae

Fragilarioideae

Raphidioideal

Eunotioideae

Monoraphideae

Achnanthoideae

Braphideae

Naviculoideae e.g., Navicula

Epithemioideae

Nitzschioideae

Surirelloideae.

Family: Naviculoideae:
(i) Members are fresh water in habitat.

(ii) Valve view is boat shaped.

iii) Raphe is present in both the valves.

Navicula:
Systematic Position:
Class: Bacillariophyceae
Order: Pennales
Family: Naviculoideae
Genus: Navicula

Occurrence:

Navicula (Latin for smallness), commonly known as pinnate diatom, is a fresh water genera. A few species may be terrestrial. The most common Indian species is N. halophila.

Thallus Structure:

Thallus is represented by a iso-bilaterally symmetrical diploid unicells.

Structurally, it can be differentiated into two parts:

A siliceous cell wall (called frustule) and the protoplast. The cell wall is made of pectic substances which are impregnated with silica (SiO_2). Cell wall consists of two overlapping halves called epitheca and hypotheca. Epitheca remains fitted over the hypotheca as a lid over the box.

Each theca is further divided into two parts:

The main surface called valve and the incurved margin known as connecting band or cingulum. The two connecting bands of the two thecas are fitted together. The connecting band of the epitheca overlaps that of the hypotheca and the two bands remain united in the overlapping region (called girdle) by a connecting cement present between the (Fig. 1).

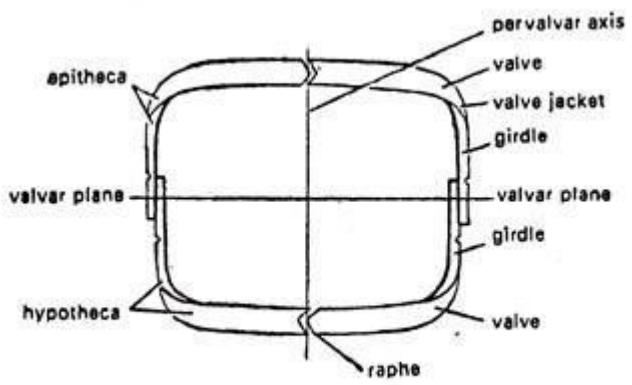

Fig. 1. Structure of *Navicula* (diagrammatic) in a section.

A frustule can be seen in two views:
Valve view and girdle view. In top view or valve view it appears as boat shaped (Fig. 2A) and in girdle view or side view more or less rectangular (Fig. 2B). The valve view shows marking or striations which spread out laterally in two parallel series, one on either side of the axial strip. The axial strip pears a longitudinal cleft known as raphe (Fig. 2B)

The raphe extends from one end of the valve to the other. It also bears three enlargements or rounded nodules, one central nodule and two polar nodules. Due to presence of raphe Navicula shows gliding movement. This movement is caused **"by streaming cytoplasm by circulation within the raphe, and by the extrusion of the mucilage."**

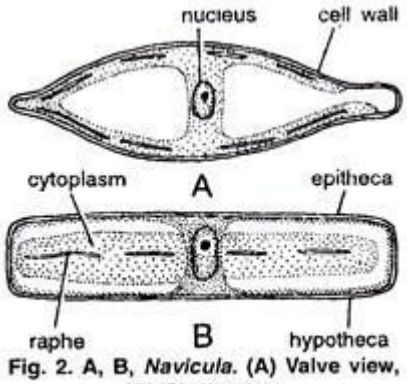

Fig. 2. A, B, *Navicula*. (A) Valve view, (B) Girdle view.

Just inner to the cell wall is present a plasma membrane which encloses the cell protoplast It is differentiated into a single nucleus and cytoplasm. The cytoplasm forms a thick layer just below the cell wall and encloses a large central vacuole.

The cytoplasm includes mitochondria, Golgi bodies, and two large parietal brownish yellow chromatophores. Pyrenoids are absent. The photosynthetic pigments are chlorophyll-a, Chlorophyll-c, p-carotene, fucoxanths, diatoxanthin and diadinoxanthin. Reserve food material is in the form of chrysolaminarin and oil droplets.

Reproduction:

Navicula reproduces by two methods:
Vegetative and sexually.

Vegetative Reproduction:

It takes place by the mitotic cell division or fission. Successive cell division takes place very rapidly at night. Presence of aluminium-silicate in water is essential for cell division to occur. As the cell division starts, the cell protoplast increases in diameter. The cell also increases in size.

The diploid nucleus divides mitotically and produces two daughter nuclei (Fig. 3A-C). Two chromatophores divide. The single chromatophore spits longitudinary in such a manner that one chromatophore comes to lie in each half. Now the protoplasm cleaves into two uninucleate portions by division in longitudinal plane parallel to valve surface (Fig. 3C).

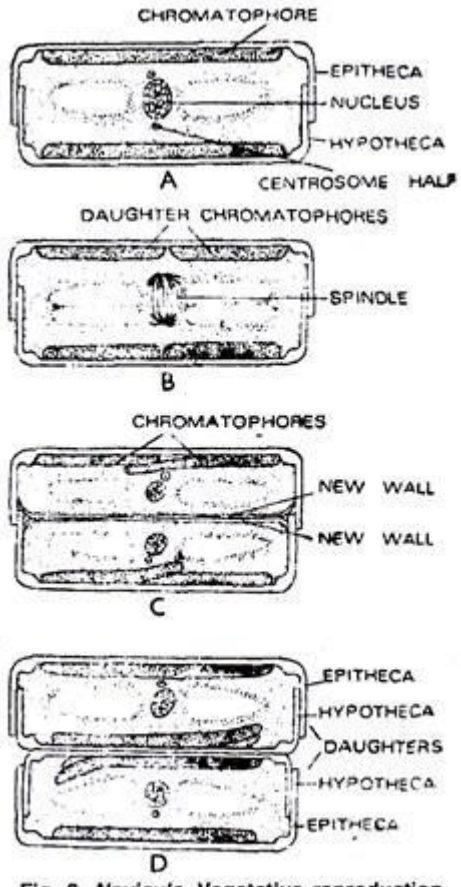

Fig. 3. *Navicula*. Vegetative reproduction.

One daughter protoplast now lies in epitheca and the other in hypotheca.

Now both the daughter protoplasts with one daughter nucleus secrete the new siliceous wall on the two fresh protoplasmic

surfaces exposed along the cleavage plane. The new valves developed always become hypotheca while the older theca (which may be epitheca or hypotheca of the parent cell) becomes the epitheca of the new or daughter cell.

When this cell again divides, it produces a daughter ceil which is again smaller than the present parent. Thus, in a population of diatom cells during successive divisions there is normally a progressive decrease in the average cell size (Fig. 4). It is called Macdonald-Pfitzer law. The smaller cells of later series of division loose their vitality and capacity of division.

Sexual Reproduction:

It takes place by the formation of auxospores. The successive decrease of cell size in vegetative reproduction is prevented by the auxospore formation. The auxospore formation is actually a **'restorative process'** because the reduction in the original size of the cells, during the cell division is restored. During the process only those cells which have diminished sufficiently in size can act as **'sex cells'** or conjugating cells.

Those cells which do not decrease in size by cell division apparently do not show sexual reproduction. Majority of the species of Navicula are monoecious but, N. haplophila is dioecious. Two sex cells come together, pair up longitudinally (called gamontogamy) and secrete a common mucilaginous envelope (Fig. 5A, B).

The diploid nucleous of each cell undergoes meiosis to form 4 haploid nuclei. Out of these two nuclei degenerate and only two remain functional (Fig. 5C). The protoplasm of each cell now cleaves into two portions each obtaining one haploid nucleus. The functional nuclei ultimately metamorphose into gametes (Fig. 5B-D).

The parent cell fuses (cytogamy) and the fusion of gametes occurs in a copulatory jelly. In N. haplophila the two gametes formed in one cell (conjugant) are amoeboid and the two gametes formed in the other are passive or immobile. The amoeboid gametes emerge through the open valves of the parent frustule and dip into open

shell of the other to fuse with opposite gametes to form two zygotes (Fig. 5 E. F) in one shell.

The other is empty. Thus, N. haplopila shows physiological anisogamy. Two diploid fusion cells or zygotes escape from the enclosing pustules. They remain doranant for some time. Later the zygote elongates (more in the longitudinal plane) and functions as auxospore (Fig. 5G-I), which develops a silicified membrane called perizonium around its protoplasm.

It may be secreted by the auxospore or by the remains of the zygotic membrane. The auxospore secretes new pustules around itself around the perizonium. The reconstituted new cell is of normal size and after sometime begins to divide vegetatively to form new generations. The valves of the old pustules are often seen attached to the newly formed pustules (Fig. 5G).

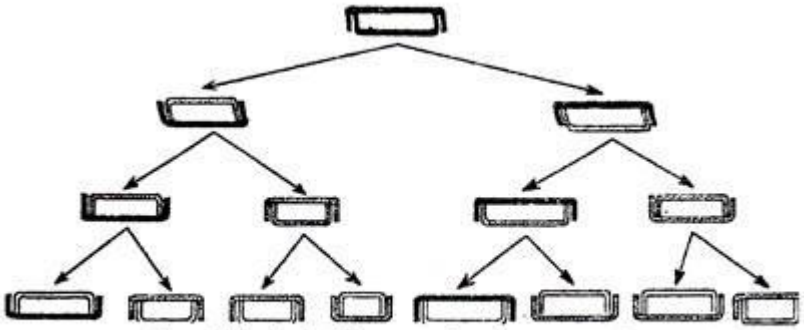

Fig. 4. *Navicula*. Diagrams showing successive decrease in cell size.

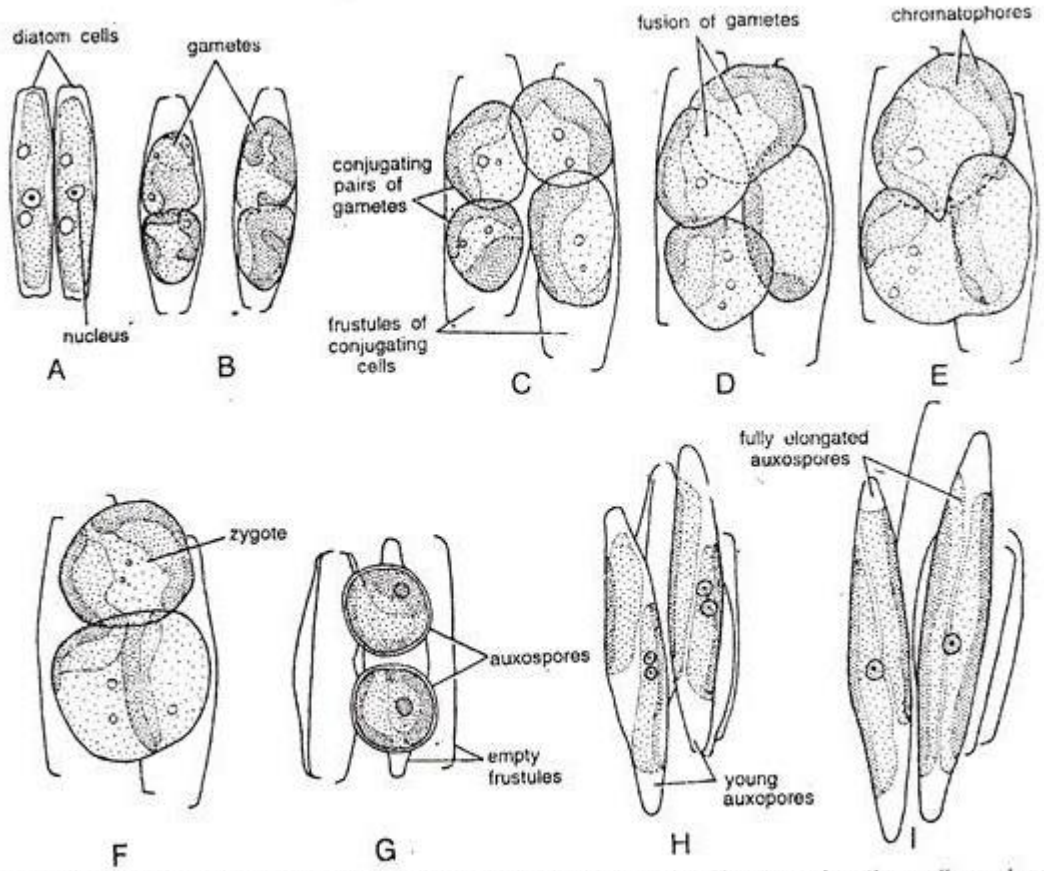

Fig. 5. (A-I). *Navicula*. Sexual reproduction by auxospore formation. (A, B) two conjugating cells enclosed in a common mucilaginous envelope (C) After meiosis two nuclei degenerate in each conjugating cell; (D) Formation of two gametes, (E, F) Fusion occurs between (+) and (-) gametes and two diploid zygotes are formed; (G) Auxospores with old frustules (H–I) Auxospores.

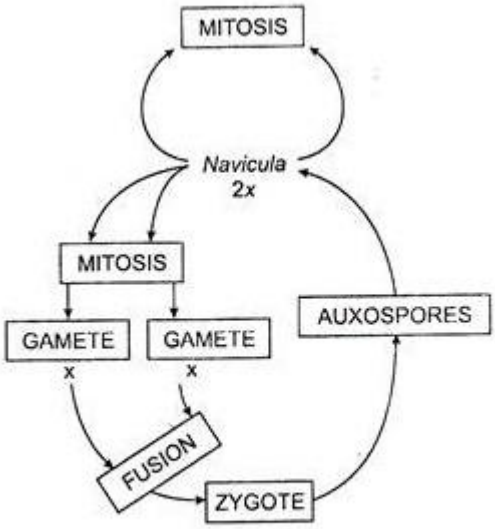

Fig. 6. *Navicula*. Graphic life cycle.

PHAEOPHYCEAE

Description of Phaeophyceae (Brown Algae)

It is a large group of algae consisting of 240 genera and over 1,500 species out of which 32 genera and 93 species are reported from India. They are commonly known as brown algae, due to the presence of a golden brown xanthophyll pigment, fucoxanthin ($C_{40}H_{54}O_6$) in the chromatophores.

About 99.7% members are marine and a few grow in fresh water. The fresh water members are Pleurocladia, Heribaudiella, Pseudobodanella, Lithoderma and Sphacelaria. Members like Pleurocladia lacustris grow both in fresh water and marine habitats.

Important Characteristics of Phaeophyceae (Brown Algae):

The important characteristics of the class Phaeophyceae are given below:

1. Plant body is immobile, multicellular and highly differentiated both externally and internally. [Unicellular, colonial (motile and non-motile) and unbranched filamentous forms are completely absent).

2. They range from simple microscopic heterotrichous filament (Ectocarpus) to largest alga (Macrocystis pyrifera), which attains a length of 60-90 meters. (The largest forms are known as kelps or rockweeds. Lessonia davicans reachs a length of 4 meters and looks like a miniature tree. Nereocystis luelkeana, the bladder kelp which attains a length of 25-30 meters. Postelsia palmae- formis appears like a palm tree and commonly known as Sea Palm) (Fig. 3.109).

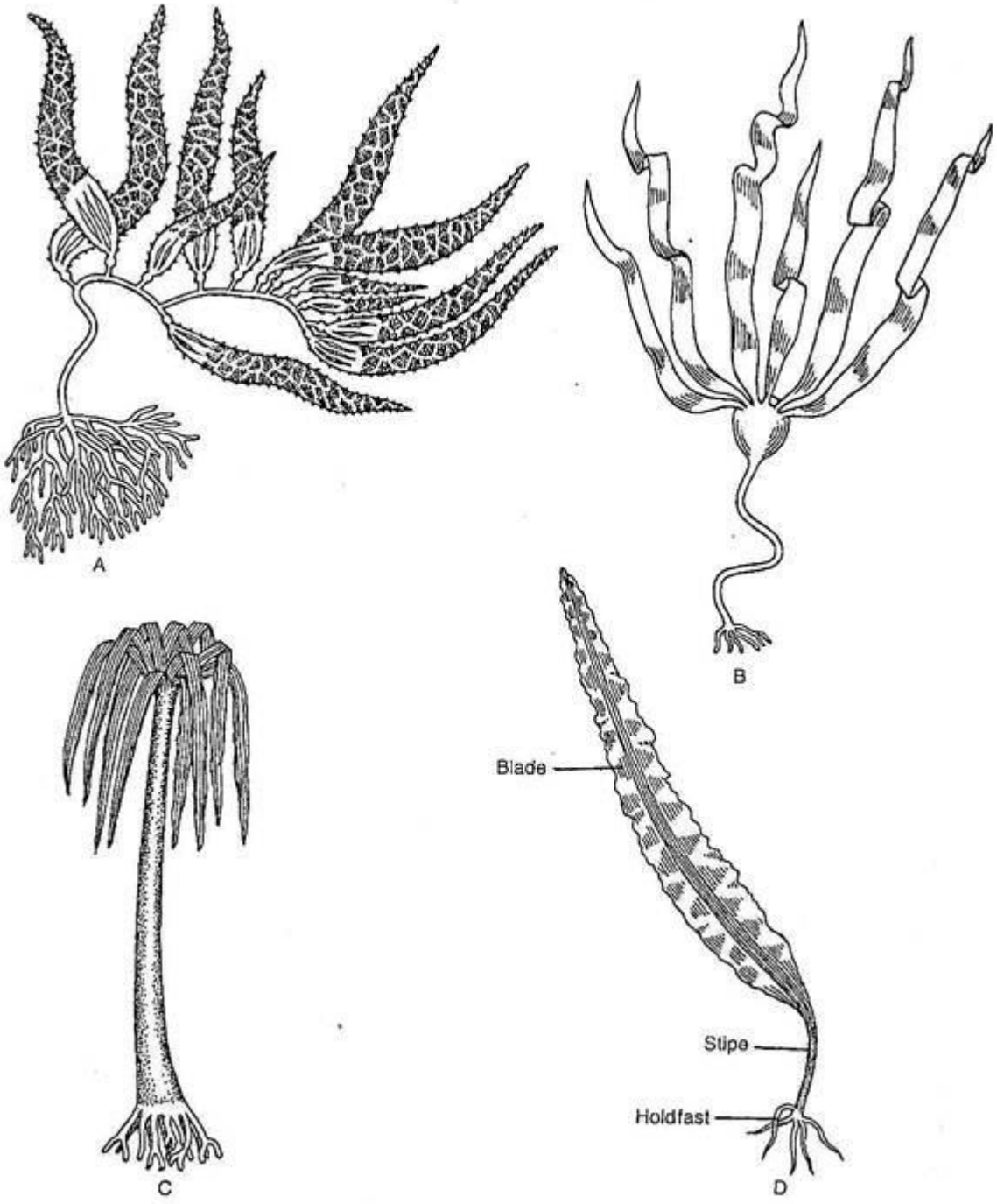

Fig. 3.109 : Some marine members of Phaeophyceae : A. *Macrocystis pyrifera* (largest alga), B. *Nereocystis luelkeana* (bladder-kelp), C. *Postelsia palmaeformis* (sea-palm) and D. *Laminaria saccharina* (Devil's apron)

3. Commonly the plant body is differentiated into hold fast, a short or elongated stipe and an expanded blade. The blade performs photosynthesis and bears reproductive structures. Many species remain afloat by having air bladders.

. The photosynthetic pigments include chlorophyll a, chlorophyll c, β-carotene and xanthophylls like lutein, fucoxanthin, flavoxanthin

and violaxanthin. The fucoxanthin is however present sufficiently which partially mask the chlorophyll and carotenoid, thereby giving the characteristic brown colouration.

5. The growth of the plant body may be apical (Fucales, Dictyotales), intercalary (Laminariales) or trichothallic (Ectocarpales).

6. The cell wall is differentiated into outer and inner layers. The outer mucilaginous layer has fucinic and alginic acid, but the inner layer is mainly cellulosic. [The alginic acid is used to manufacture artificial silk and adhesive, obtained commercially from Sargassum, Laminaria etc].

7. The cells usually have many small vesicles and white granules. The granules are called fucosan vesicles.

8. Pyrenoides are usually absent, but, if present, is of single stalk type.

9. Motile structures (zoospores and gametes) have two laterally inserted unequal flagella, of which larger one is tinsel or pantonema- tic and the smaller one is whiplash or acronematic type.

10. The reserve foods are commonly laminarin and mannitol. Sucrose and glycerol are also present in some members.

11. They reproduce by all the three means: vegetative, asexual and sexual.

Vegetative reproduction takes place by fragmentation. Special reproductive branches, the propagules, are developed in some members of Sphacelariales; those develop to new plants after detachment.

b. Asexual reproduction takes place by zoospores except Tilopteridales, Dictyotales and Fucales. The zoospores produced in unilocular sporangia are haploid, while in pleurilocular sporangia they are diploid.

c. Sexual reproduction ranges from isogamy (Ectocarpales and Sphacelariales) to oogamy (Fucales, Dictyotales and Laminariales) through anisogamy (Cutleriales and Tilopteridales).

12. In most of the members fertilisation is external. Zygote does not undergo meiotic division and on germination it develops diploid thallus.

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13. The members show various types of alternation of generations i.e., isomorphic (Ectocarpus), heteromorphic (Laminaria) or diplontic (Sargassum).

The members of Phaeophyceae show two types of life cycle:
1. Diplontic life cycle e.g., Sargassum.

2. Diplohaplontic life cycle.

Characters of Brown Algae:

Brown algae are eukaryotic marine algae which possess chlorophyll a, chlorophyll c, abundant fucoxanthin, phycocolloid algin and reserve food in the form of laminarin.

1. Brown algae comprise about 2000 species.

2. Majority of the brown algae are marine.

3. Brown algae generally occur in both tidal and sub tidal regions of colder seas.

4. Unicellular forms are absent.

5. The body consists of a branched filamentous structure in lower forms (e.g., Ectoearpus) and parenchymatous structure in higher forms (e.g., Sargassum, Laminaria, Fucus, Macrocystis).

6. Brown algae include the largest algae. The giant brown algae are called kelps. The largest kelps are Macrocystis (40-100m) and Nereocystis (20—30m).

7. The plant body is often differentiated into holdfast, stipe and lamina (frond).

9. Lamina may be simple or divided variously. Despite its size and complexity of form, lamina of kelp is annual. Lamina (frond) is photosynthetic.

10. The large forms often possess air vesicles or bladders for providing buoyancy.

11. Cell wall contains cellulose, nonglucan saccharides and phycocolloids.

12. Phycocolloids of brown algae are non-sulphated monosaccharide's. The common ones are alginic acid, fucoidin and fucin. They are copious in species dwelling tidal areas.

Phycocolloids protect the algae from desiccation during low-tide, freezing under low temperature and injury when beaten against rocks.

13. Photosynthetic organelles or chromatophores possess 3-thylakoid lamellae.
14. Photosynthetic pigments include chlorophyll a, chlorophyll c and carotenoids (carotenes and xanthophylls). The brown colour of algae is due to the presence of large amount of xanthophyll called fucoxanthin.

15. Food reserve is laminarin (carbohydrate) and lipid.

16. Cells possess refractile vesicles called fucosan vesicles. The vesicles contain a phenolic chemical named fucosan. Fucosan is colourless inside water but becomes brown or black on exposure to air.

17. Conducting tubes or trumpet hyphae are present in larger brown algae or kelps. The tubes possess sieve septa. They take part in conduction of food materials. The rate is 38- 78cm/hr.

18. Asexual reproduction occurs with the help of both motile and non-motile spores (e.g., neutral spores, tetra spores, mono-spores). The motile spores or zoospores are bi-flagellated and have heterokont flagellation with one smaller whip like smooth flagellum and other larger of tinsel type.

19. Sexual reproduction varies from isogamy, anisogamy to oogamy. In isogamy and anisogamy both the gametes are motile with heterokont flagellation. In oogamy, only the male gametes are motile or flagellate. The female gametes are non-motile.

20. Isomorphic alternation of generations is found in some brown algae, e.g., Ectocarpus, Dictyota. Here both the haploid and diploid generations are present and are similar in structure. In many brown algae, the diploid generation or phase is dominant. The haploid generation or phase is either microscopic or represented by gametes only (e.g. Fucus).

Types of Common Brown Algae:
Some of the common brown algae are:
1. Laminaria:
It is a wide spread kelp or large-sized brown alga popularly called devil's apron. The size is 1-3 metres. Plant body is sporophyte. It is differentiated into basal holdfast, a near cylindrical stipe and a flattened blade or lamina. Alternation of generations is heteromorphic. Laminaria is a source of food, manure, algin and iodine.

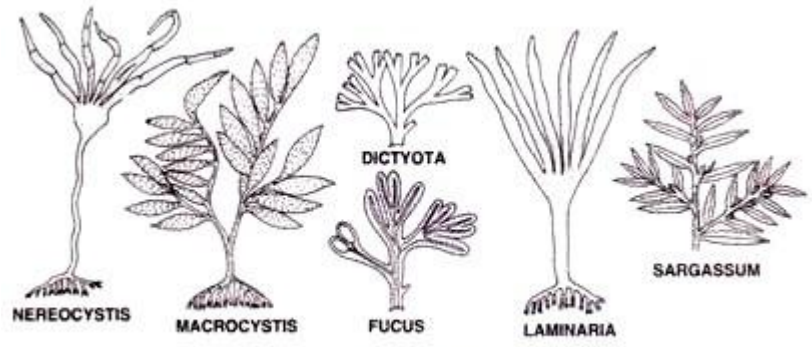

Fig. 3.2. Some Brown Algae.

2. Dictyota:

It is a ribbon shaped dichotomously branched marine brown alga that grows in shallow waters. Frond is flat, dichotomously branched. The surface of the frond bears hair and unilocular sporangia. Unilocular sporangia produce haploid tetra spores.

Each tetraspore produces haploid gametophytic thallus that is similar in morphology to sporophytic tha**ll**us. Sex organs are borne in clusters or sori. Male sex organs or antheridia produce uniflagellate sperms. Fert**ili**zation produces diploid zygote which germinates to produce diploid plant body.

3. Fucus:

It is a leathery flat branched perennial brown alga of small size which has been a source of fodder, manure and algin. Frond is flat and branched both dichotomously and monopodially. A pair of pneumocysts or air bladders occurs in the region of branching. At places the branches contain flask-shaped cavities called conceptacles. Meiosis occurs during gamete formation.

4. Sargassum:

Sargassum is popularly called gulf weed which is used both as fodder and manure. Sarganine is an antibacterial and antifungal extract obtained from it. Both free floating and attached forms occur. Floating forms are common in part of North Atlantic ocean called Sargasso sea where these are menace to shipping. In attached forms, the plant has three parts— holdfast, main axis and laterals.

Main axis bears long laterals on which are borne short laterals or leaves. Pneumocysts or air bladders occur at places in the axils of

leaves. In free floating forms, pneumocysts provide buoyancy tor floating while in attached forms they provide buoyancy for keeping the plants upright. Sex organs are borne in two different types of conceptacles.

5. Ectocarpus:

It is a filamentous marine brown alga which has both upright and prostrate regions. Such a growth is called heterotrichous. Upright branches show evection (pushing of parent branch) to give an appearance of dichotomy. Fixation to solid substratum occurs through prostate portion and rhizoids.

Reproduction occurs by fragmentation. The plants can also multiply asexually through the formation of diploid biflagellate zoospores in plurilocular (= neutral) sporangia.

The sporophytic plant body also bears unilocular sporangia in which sporic meiosis occurs and haploid biflagellate meiozoospores are formed. The latter germinate to produce gametophytic thalli. The gametophytes liberate biflagellate gametes from their plurilocular gametangia. The gametes fuse to form diploid zygote that germinates to produce diploid plant.

RHODOPHYCEAE

Description of Rhodophyceae (Red Algae):

It is a large group of algae consisting of about 831 genera and over 5;250 species. They are commonly known as red algae due to the presence of a water soluble red pigment, r- phycoerythrin. The r-phycoerythrin is, however, present sufficiently and completely to mask the chlorophyll a, giving the characteristic red colouration. More than 98% members are marine and the rest grow in fresh water.

The fresh water members grow in stagnant water (e.g., Asterocystis, Compsopogon etc.) as well as in flowing water (e.g., Lamanea, Thorea, Batrachospermum etc.). The marine species have the ability to live at greater depth (even at 30-90 meters) than the other members of different classes. They also exhibit a high degree of parasitism and epiphytism. The parasitic members show great reduction in their size and pigmentation.

Some parasitic members are Ceramium condicola on Codium fragile, Polysiphonia lanosa on Ascophyllum nodosum etc. The epi-phytic members like Rhodochorton, Ceratocolax etc. grow on other members of Rhodophyceae. Porphyridium, a unicellular member, is terrestrial and grow on damp soil. Marine members commonly grow in sublittorial zone, but a few members like Rhodocorton, Corallina and Bostrychia grow in intertidal zone.

Characteristics of Rhodophyceae (Red Algae):

1. Most of the members (more than 98%) are marine and 20 species (as per report) grow in fresh water. The members may grow either as saprophytes, parasites and also as epiphytes.

2. The plant body may be unicellular (Porphyridium) or multicellular. The multicellular form may be filamentous (Gonio-trichum), parenchymatous (Porphyra, Crinellia), pseudoparenchymatous (Helmin- thocladia), feathery (Polysiphonia) or ribbon like (Chondrus) (Fig. 3.130).

3. They do not attain the size like that of the brown algae (Phaeophyceae), but may reach up to 2 meters in Schizymenia (Abbott, 1967).

4. The flagellated motile stages are totally absent.

5. The cell wall consists of outer pectic and inner cellulosic layer. The mucilaginous material of the outer layer mainly consists of agar-agar and carrageenans and constitute major portion of dry weight of the cell wall.

6. In multicellular forms, the cell walls have pits, through which cytoplasmic connections are maintained. These cytoplasmic threads are the so-called plasmodesmata. (E.M. studies have not confirmed it.)

7. The members of Rhodophyceae show much variation in the number of nuclei in a cell. In the subclass Bangioideae, cells are uni-nucleate, but in the subclass Florideae most of the members are multinucleate and the number of nuclei is 3,000-4,000 in Griffithsia.

8. The cells may have one chromatophore with a central pyrenoid (Bangioideae) or many discoid and parietal chromatophores with pyrenoids (Florideae).

9. The photosynthetic pigments are chlorophyll a, chlorophyll b; α- and β-carotene; xantho- phylls like teraxanthin, lutein, violaxanthin, zeaxanthin, flavoxanthin and biliproteins such as r-phycoerythrin and r-phycocyanin. The characteristic red colouration of the algae is due to the sufficient presence of r-phycoerythrin which completely masks the chlorophyll a. [The chief Xanthcphyll is teraxanthin and chlorophyll b is absent.]

10. The reserve food is floridean starch, floridi- side and mannoglycerate.

11. Reproduction takes place by all the three means: vegetative, asexual and sexual.

a. Vegetative reproduction takes place only in unicellular form

b. Asexual reproduction takes place by monospore, neutral spore, carpospore, bispore, and tetraspore.

c. Sexual reproduction is of advanced oogamous types.

i. The male sex organs are known as spermatangium. Single non-flagellate male gamete is produced in each spermatangium, called spermatium.

ii. The female sex organs are called carpogonia or procarp. Carpogonia are flask-shaped with a long neck, the trichogyne.

2. During fertilisation, the spermatium comes in contact with the trichogyne with the help of water current.

13. In Rhodophyceae the post-fertilization changes are highly elaborate. They develop carposporophyte. Carposporangia are developed from each carposporophyte and each carposporangium produces single carpospore.

14. Most of the Rhodophycean members show biphasic or triphasic life cycle patterns.

Classification of Rhodophyceae (Red Algae):
Fritsch (1935, 45) classified the Class. Rhodophyceae into two sub-classes and seven orders.

The outline of the classification is given:
Class. Rhodophyceae

Sub-class Bangioideae

Order.

1. Bangiales

Sub-class Florideae

Order.

1. Nemalionales

2. Gelidiales

3. Cryptonemiales

4. Gigartinales

5. Rhodymeniales

6. Ceramiales

Thallus organisation :

(i) All members of Rhodophyceae except twenty fresh water species are marine and about two hundred species inhabit land waters. The fresh water species either grow in fast flowing water (e.g., Batrachospermum, Lamanea) or grow in stagnant water with sufficient aeration (e.g.. Asterocystis, Compsopogon).

(ii) Algae of Rhodophyceae are most abundant in the lower intertidal and sub-littoral zones at a depth of 60 meter or more. A few are adapted to a considerable exposure living at or above the high tide level. Some are terrestrial (Porphyridium). Apart from some being epiphytes, several species are distinctly parasites (Ceratocolax, Calleocolax, Pterocladiophila). Some algae have deposit of calcareous substances in their wall.

(iii) Most of the members of Rhodophyceae are red, soft and slimy, the thallus ranges from unicellular to complex multi-axial forms.

(iv) The thallus is unicellular in Porphyridium, filamentous in Goniotrichum, palmelloid in Asterocytis or parenchymatous in Porphyra, Gelidium, Gracillaria. Thallus in Batrachospermum has uniaxial structure and in Polysiphonia it is multi-axial.

(v) The growth is by apical cell in sub-class Florideae and diffused in sub-class Bangioideae.

(vi) The cell wall is differentiated into an outer pectic layer and inner cellulosic layer. The mucilaginous matter of the outer pectic

layer consists of agars and carrageenan's. Cells are generally uninucleate and in some genera they may be multinucleate (e.g., Griffithsia). The shape of centrally situated nucleus is spherical and the peripheral nuclei are elliptical.

(vii) In Bangiodeae the chromatophore is single, star shaped with central pyrenoid, in Florideae the chromatophores are many, discoid and parietal chromatophores without any pyrenoid.

(viii) The main pigments are chlorophyll a and b, α and β carotene, xanthophyll's and biliproteins. The pigments r-phycoerythrin and r-phycocyanin are responsible for red colour of the thallus.

(iv) The thallus is unicellular in Porphyridium, filamentous in Goniotrichum, palmelloid in Asterocytis or parenchymatous in Porphyra, Gelidium, Gracillaria. Thallus in Batrachospermum has uniaxial structure and in Polysiphonia it is multi-axial.

(v) The growth is by apical cell in sub-class Florideae and diffused in sub-class Bangioideae.

(vi) The cell wall is differentiated into an outer pectic layer and inner cellulosic layer. The mucilaginous matter of the outer pectic layer consists of agars and carrageenan's. Cells are generally uninucleate and in some genera they may be multinucleate (e.g., Griffithsia). The shape of centrally situated nucleus is spherical and the peripheral nuclei are elliptical.

(vii) In Bangiodeae the chromatophore is single, star shaped with central pyrenoid, in Florideae the chromatophores are many, discoid and parietal chromatophores without any pyrenoid.

(viii) The main pigments are chlorophyll a and b, α and β carotene, xanthophyll's and biliproteins. The pigments r-phycoerythrin and r-phycocyanin are responsible for red colour of the thallus.

(ix)The algae of sub-class Florideae have uniaxial or multi-axial thallus. The cells are connected by pit connections and the growth of thallus is by apical cell. The reproductive structures are relatively more complex.

(X)The algae of family Rhodomelaceae are polysiphonous. The thallus consists of central siphon and pericentral siphons. The cells of central siphon are uninucleate. The male and female reproductive structures develop on special reproductive branches called as trichoblasts.