Discipline Courses-I

Semester-I

Paper: Phycology and Microbiology

Unit-IX

Lesson: Xanthophyceae

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Introduction

The class Xanthophyceae comprises of members with yellow green color, due to excess of xanthophylls. Hence, the members are commonly referred to as “yellow green algae”.

The class includes around 75 genera and 375 species. The majority of members are fresh water forms, very few are marine.

General Characteristics

1. The plant body is unicellular or multicellular. In the latter case, it consists of a simple filament.
2. The cell wall is often absent, but when present, it is composed of mainly pectic substances, with smaller amounts of cellulose. The cell wall is silicified in a few species and appears to consist of two equal overlapping halves.
3. The plastids are yellow green, with carotenoids usually in excess over the chlorophylls. Photosynthetic pigments include chlorophyll ‘a’, with very little of chlorophyll ‘e’. Chlorophyll ‘b’ is absent. Xanthophylls are predominant, especially ß-carotene which is present in fairly high concentrations. There is no lutein or fucoxanthin.
4. Chromatophores are discoid and many in each cell. Pyrenoids are absent.
5. Starch is not found. Oil, fat (lipid) and a glucose polymer known as leucosin or chrysolaminarin are the normal food reserves.
6. Sexual reproduction is rare, if present it is isogamous. In *Vaucheria*, sexual reproduction is typically oogamous.
7. Motile bodies contain more than one chromatophore and are flagellated. Usually two flagella are present, which are of unequal length and are inserted at the anterior end. The longer flagellum is of tinsel or pantonematic type. It bears numerous fine flimmer hairs in two rows. The shorter flagellum is of whiplash or acronematic type, having a smooth surface.

Classification

The class Xanthophyceae is classified based on thallus structure of its members. The class exhibits morphological diversity and includes motile and coccoid forms, as well as palmelloid, filamentous and siphonaceous forms. However, parenchymatous and heterotrichous forms are conspicuously absent.

Fritsch classified Xanthophyceae into four orders:

1. Heterochloridales
2. Heterococcales
3. Heterotrichales
4. Heterosiphonales (Vaucheriales)

Later Smith added two more orders, namely Heterocapsales and Rhizochloridales. Of the above mentioned 6 orders, order Heterosiphonales is described as below:-

Order Heterosiphonales (Vaucheriaceae)

This order includes coenocytic siphoneous forms and in this respect, it is somewhat analogous to the order Siphonales of Chlorophyceae. The multinucleate thallus is not partitioned into cells. Hence, such forms are called 'acellular', rather than unicellular. The multinucleate thallus is tubular and can be of diverse forms.

The order Heterosiphonales comprises of two families, namely Botrydiaceae and Vaucheriaceae.

(a) **Family Botrydiaceae** – This includes the most primitive siphoneous bladder-like coenocytic forms anchored to the substratum by a rhizoidal system. Asexual reproduction occurs by biflagellate zoospores. Sexual reproduction is either isogamous or anisogamous. The family includes a monotype genus – *Botrydium.*

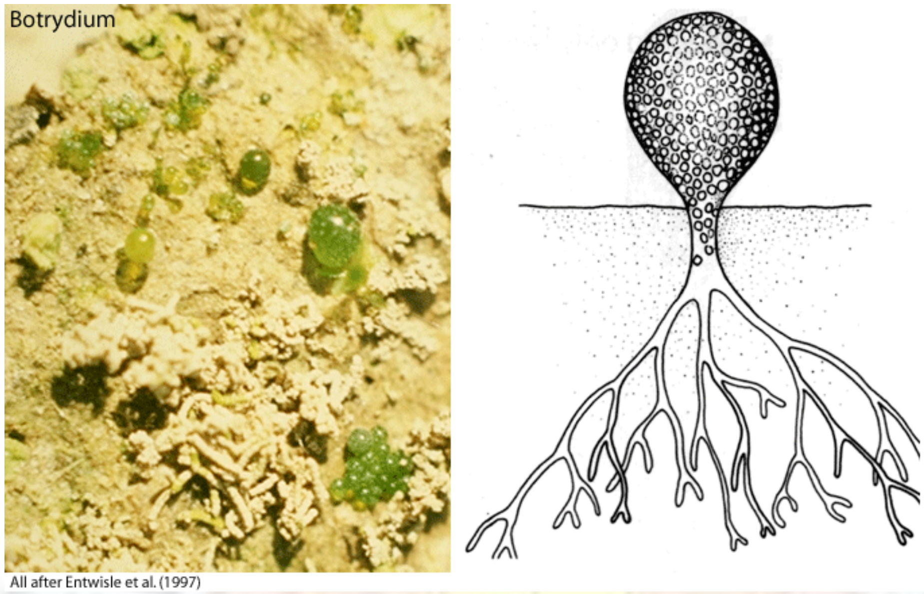


Figure: *Botrydium*

A- Several individuals showing habit and habitat ;B- Thallus showing differentiation into balloon shaped above ground part and colorless, dichotomously branched underground part

Source:http://www.rbgsyd.nsw.gov.au/__data/assets/image/0008/47897/Botrydium2.gif

(b) **Family Vaucheriaceae**- The thallus consists of a branched, aseptate, coenocytic filament with apical growth. The thallus is usually anchored to the substratum by means of branched rhizoids. Chloroplasts are numerous, oval or elliptical in shape and lack pyrenoids. The reserve food material is oil or fat (lipid). Starch is absent. Asexual reproduction takes place by the formation of multiflagellate zoospores (synzoospores), aplanospores or akinetes. Sexual reproduction is typically oogamous. The family includes a single genus – *Vaucheria.*

The genus *Vaucheria* is described in detail below:-

Vaucheria

Occurrence

The genus *Vaucheria* comprises more than 40 species, of which 9 species are reported from India. The species are predominantly terrestrial or fresh water forms, very few are marine. Terrestrial forms occur on damp soil or mud-flats exposed on drying up of ponds and puddles. Aquatic forms occur in very shallow water of ponds and ditches or near the bank of slow flowing streams.

Vaucheria sessilis and *V. geminata* are two widely distributed species in India. *V.sessilis* occurs both on land and in water. *V. amphibia* is amphibious. *V. piloboloides* is confined to marine waters.

Figure: *Vaucheria* – thallus in natural habitat.
Source: http://www.whitchurchmeadow.org.uk/wp-content/uploads/2009/01/vaucheriawhitchurch1-300x225.jpg

Thallus

The thallus of *Vaucheria* is sparingly branched, cylindrical tube lacking cross walls or septa, except during reproduction. The terrestrial species are anchored to the substratum with the help of rhizoid-like branches.

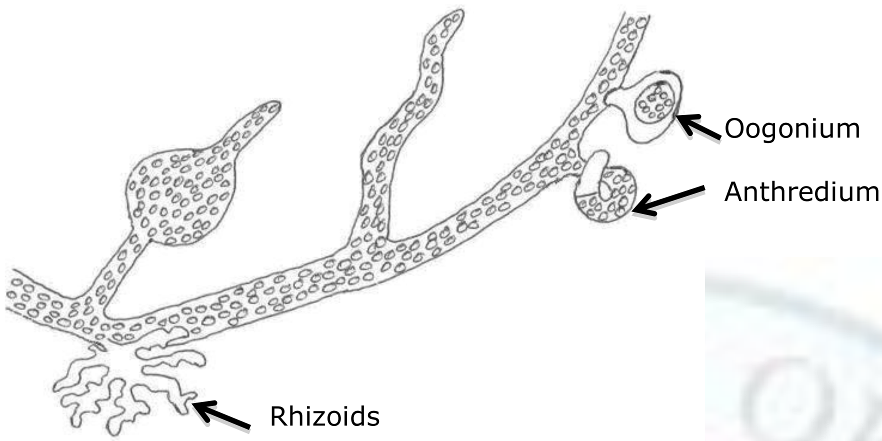


Figure: *Vaucheria* – Coenocytic filamentous thallus with rhizoids and sex-organs (diagrammatic).

Source: http://commons.wikimedia.org/wiki/File:Vaucheria_sesselis.JPG

The thallus contains an outer wall, a central vacuole which runs continuously from one end of the thallus to the other, and a continuous layer of protoplast, with the peripheral region containing many discoid chromatophores, devoid of pyrenoids. Septa or cross walls are lacking.

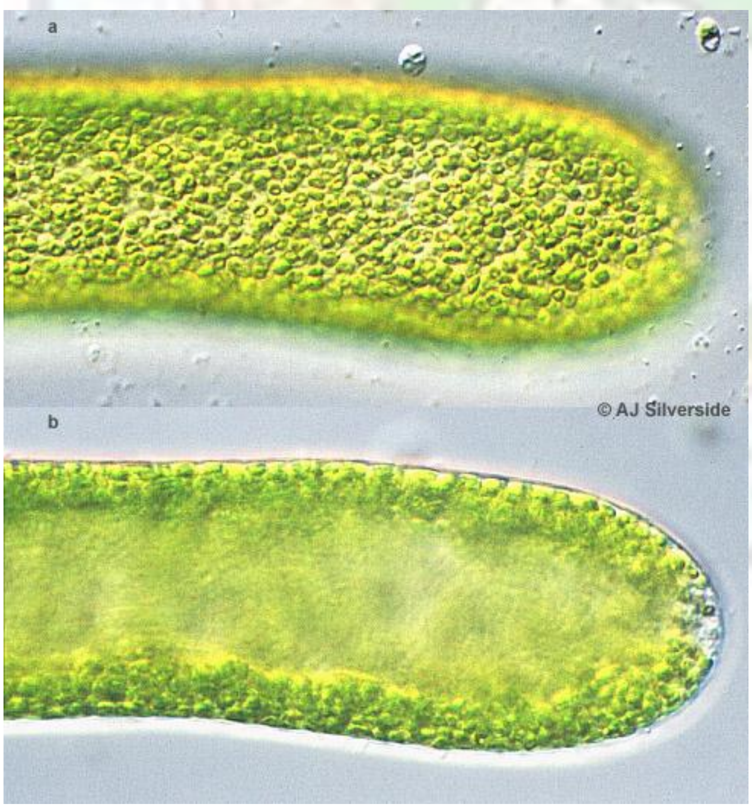


Figure: *Vaucheria*
Tubular filament a. focus on surface view and b. focus through central plane showing central vacuole and peripheral chloroplasts. There are no cross walls.

Source: Displayed with permission. Copyright Alan Silverside

http://bioref.lastdragon.org/Xanthophyta/Vaucheria3c.jpg

The thallus is coenocytic as the cytoplasm and nuclei are not partitioned into distinct cells. Such filaments, with protoplasm that is continuous, multinuclear and not partitioned into separate protoplasts, are called 'coenocytes'.
Truly speaking, *Vaucheria* is a neither a unicellular nor a multicellular form. It is a coenocyte and possesses all the essentials of a multicellular organism, but the cytoplasm and the numerous nuclei are not partitioned into distinct cells. Septa formation occurs only during the formation of reproductive structures or when filaments get injured. Hence, *Vaucheria* is 'acellular' coenocytic form and unique among all algae.

The thallus grows in length by a simple elongation of the terminal portions of the branches.

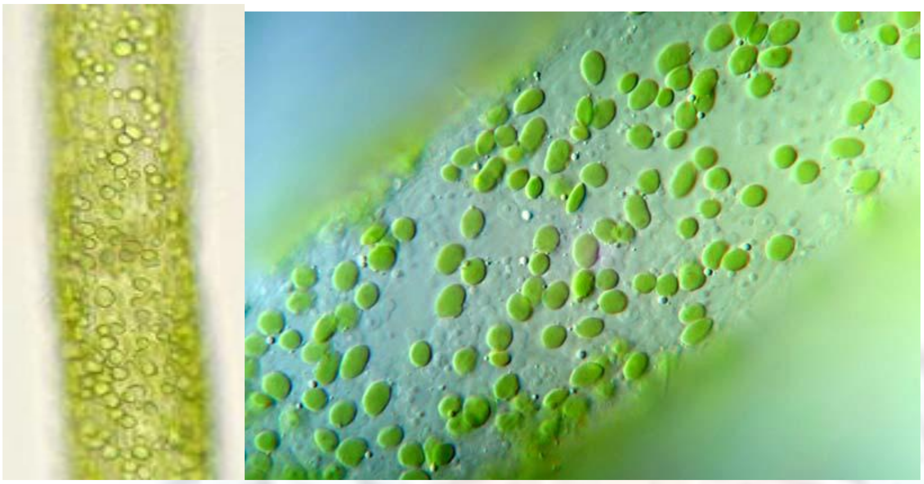
Structure

The filament wall is thin, weak and lacks elasticity. The cell wall is two layered – outer layer is made up of pectic substances and inner layer is cellulosic in nature.

The principal food reserve occurs in the form of countless oil droplets. Starch is not formed.

The cytoplasm has usual membrane bound organelles such as mitochondria, chromatophores, small vesicles, etc. Several minute nuclei are present in close proximity to the central vacuole.

The chromatophores are discoid and localized towards the peripheral region of the cytoplasm. They contain photosynthetic pigments- namely chlorophyll 'a', chlorophyll 'e', abundant carotenoid pigments and one known Xanthophyll. Chlorophyll 'b', typical of green algae, is lacking. Also, there are no pyrenoids.



A. **B.**

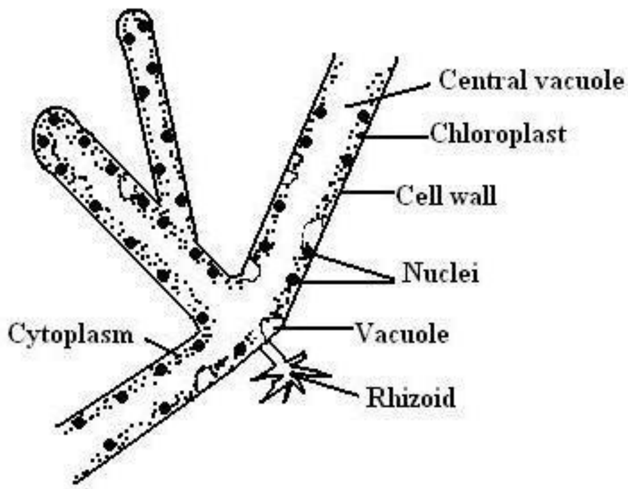
Figure: *Vaucheria*

A: Filament showing chromatophores.

B: Discoid chromatophores.

Source: http://www.bioimages.org.uk/html/p5/p55613.php, http://cfb.unh.edu/phycokey/Choices/Tribophyceae/VAUCHERIA/Vaucheria_09_600x450.jpg

The relative position of the internal components in the thallus is interesting. The thallus shows a definite arrangement of chloroplasts, oil droplets and nuclei around the central vacuole. Numerous minute nuclei lie internal to the chromatophores. Nuclei are in close proximity to the tonoplast of the central vacuole, where as chloroplasts and lipid droplets are restricted to the peripheral portion of the cytoplasm, just beneath the cell wall. Nuclei are much smaller in size, as compared to the large discoid chloroplasts.



Vaucheria has siphonaceous, coenocytic filaments that can form feltlike mats, commonly known as "water felt". Cytokinesis does not usually follow mitosis, so the cells retain multiple nuclei. The thallus has cross walls only where gametes or zoospores were produced, and may be branched.
The cytoplasm of Vaucheria is pushed to the cell periphery by large vacuoles, and contains many nuclei and discoid plastids. The plastids can change their orientation in response to changes in light levels. The large cells rely on cytoplasmic streaming to move materials around as needed.

Figure: *Vaucheria* -Portion of thallus (diagrammatic).

Source: http://www.peoi.org/Courses/Coursesen/bot/bot15.html

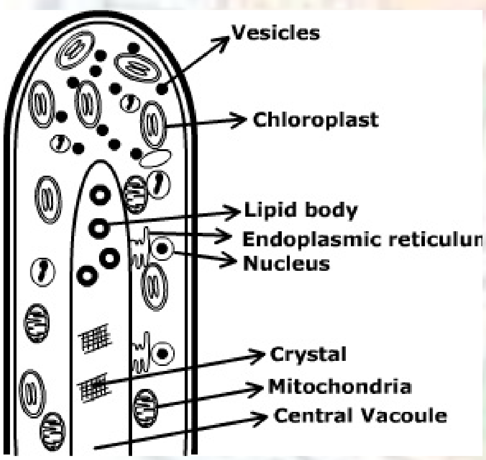


Figure: Portion of filament showing relative position of the internal contents (diagrammatic). Nuclei lie internal, close to the central vacuole. Chloroplasts are restricted to the outer peripheral portion just beneath the cell wall.

Source: ILLL Inhouse

Cytoplasmic Streaming

The thallus of *Vaucheria* exhibits cytoplasmic streaming.

The chloroplasts move, accompanied by small vesicles and mitochondria, with the streaming of cytoplasm along the longitudinal axis of the filament in the dark.

Video: *Vaucheria*

Cytoplasmic streaming

Source: https://www.youtube.com/watch?v=r65eslhbdlg

The mechanism of streaming in *Vaucheria* remained a mystery for sometime. However, later it was understood that longitudinally oriented cytoplasmic fibrils are associated with the chloroplasts, mitochondria and vesicles and these fibrils appear to guide the streaming of these organelles. The fibrils are composed of bundles of F-actin microfilaments and cytoplasmic myosin is linked with streaming organelles. The active shearing force responsible for cytoplasmic streaming in *Vaucheria* results from the interaction between organelle-linked myosin and F-actin microfilaments.

Further, the streaming organelles aggregate in the region of the filament illuminated with low intensity blue light. In fact, blue light induces organelle aggregation, which is accompanied by the formation of cortical fibre reticulation, with photo-receptor located at the plasma membrane (see Blatt & Briggs, 1980).

Photo-tactic Response

The chromatophores exhibit photo-tactic response – i.e. back and forth movement in response to weak, unilateral illumination (see Haupt, 1962). In dark conditions, chromatophores are uniformly distributed. When light intensity is weak, the chromatophores cluster towards the source of dim light. However, when the light intensity is strong, the chromatophores show a lateral movement away from the light source. Thus, photo-tactic response is regulated in such a manner so as to permit maximum absorption of photosynthetic light by the chromatophores during weak light conditions, simultaneously protecting them from excessive photo-damage when light intensity is intense.

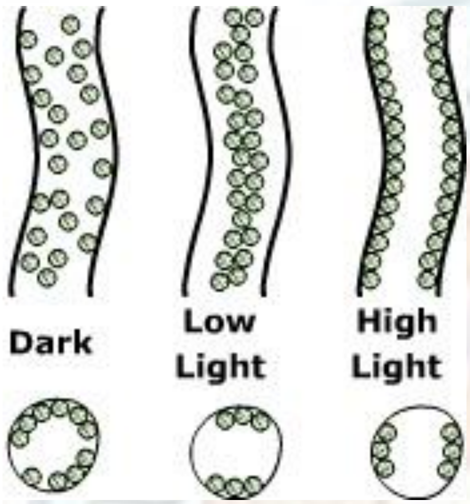


Figure: *Vaucheria* – exihibits chromatophore orientation movements under the influence of light. In dark the chromatophores are uniformly distributed in the peripheral cytoplasm. Under low light the chromatophores are oriented at the top and bottom of the coenocytic thallus to trap maximum light. In high light intensities they orient along the sides of the filament therefore receiving less light.

Source: ILLL Inhouse

Reproduction

Vaucheria reproduces by all the methods – vegetative, asexual and sexual.

(a) **Vegetative Reproduction** – This is rare, and occurs by fragmentation, in which the thallus accidentally breaks into short segments, each of which subsequently becomes thick-walled and grows into a new filament.

(b) **Asexual Reproduction** – This is very common and involves the formation of spores of several types- zoospores, aplanospores and occassionally akinetes/ cysts/ hypnospores.

Aquatic species commonly reproduce through zoospores, while terrestrial forms show formation of aplanospores.

- **Zoospores** – Low light intensity, change of medium from running to still water and complete darkness are factors which enhance zoospore formation in *Vaucheria*.

In *Vaucheria*, the zoospores are formed singly within elongate club-shaped zoosporangia. Each zoosporangium forms one zoospore. Zoospores in *Vaucheria* are unique structures. They are large multiflagellate and multinucleate, and thus each such zoospore is referred to as a compound zoospore or 'synzoospore'.

The zoosporangium develops at the end of a branch which gets swollen into a club-shaped structure. A large number of nuclei and chloroplasts, along with the cytoplasm, stream into and accumulate in the swollen tip, before it is separated from the rest of the filament by a transverse septum.

Once the zoosporangium is clearly differentiated and separated from the rest of the filament through a transverse wall, the process of zoospore formation begins. The nuclei and chromatophores exchange their position so that the nuclei, which were originally placed internal to the chromatophores, now come to lie external to the chromatophores. Pairs of centrioles appear *de novo* in the colorless peripheral cytoplasm just within the plasma membrane. Each pair becomes associated with a nucleus. The sporangial protoplast shrinks and a pair of flagella, of somewhat unequal length, develops opposite each nucleus.

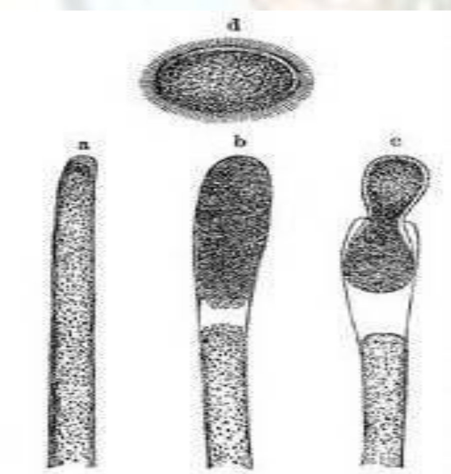


Figure: *Vaucheria*- Stages in the differentiation of zoosporangium and release of synzoospore

Source: http://commons.wikimedia.org/wiki/File:Vaucheria_sesselis.JPG

Since the sporangial protoplast does not segment into smaller compartments, the zoospore formed in every zoosporangium of *Vaucheria* is large in size, multiflagellate and multinucleate structure. It is commonly called 'compound' zoospore or 'synzoospore'.

A mature synzoospore is large, yellowish green, ovoid structure. It has a superficial hyaline layer of cytoplasm containing numerous nuclei. Internal to this are numerous chromatophores embedded in the cytoplasm which also contains the contractile vacuoles. In the centre is the sap vacuole, which may be traversed by strands of cytoplasm. The surface of the synzoospore is covered with numerous flagella, a pair opposite to each nucleus. At the base of each pair of flagella are two blepharoplasts (centrioles). The flagella are somewhat unequal in length, but are of whiplash type.

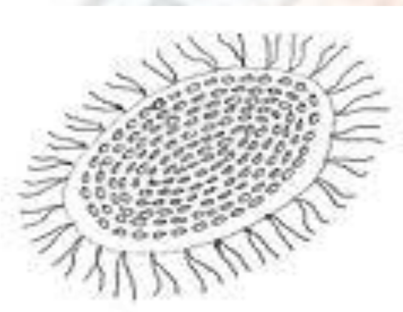


Figure: *Vaucheria* synzoospore (diagrammatic)

Source: http://commons.wikimedia.org/wiki/File:Vaucheria_sesselis-zoospora.JPG

Unlike *Vaucheria*, other members of Xanthophyceae form biflagellate, uninucleate zoospores, which are small in size and formed in large numbers in each zoosporangium.

In *Vaucheria*, the release of synzoospore is a very interesting phenomenon. Once the synzoospore is mature and ready for release, an apical pore is formed by gelatinization of the zoosporangial wall and through this opening, the multiflagellate, multinucleate zoospore (synzoospore) slowly and gently slides out.

Video: *Vaucheria*-Zoospore release from a zoosporangium

Source: http://www.youtube.com/watch?v=7aNk1Ip028c&feature=related

The synzoospore shows a sluggish motility for a short period and then comes to rest on a suitable substratum. Subsequently, it discards flagella and secretes a new wall and germinates to form one or more germ tubes, which over a period of time, develop into *Vaucheria* plant.

- **Aplanospores** – These are non-motile asexual spores, formed in the terrestrial species of *Vaucheria.* The ends of short filaments or lateral branches differentiate into club-shaped or round aplanosporangia, which get isolated from the rest of the thallus by septum formation at the base.

The aplanospores are non-motile and relatively thick-walled structures. Each aplanosporangium finally gets converted into a single round to oval, thin walled, non-flagellated aplanospore, which is liberated by the irregular rupture of the sporangial wall. Occasionally, aplanospore release occurs through formation of an apical pore in the sporangial wall. The aplanospore, after liberation, germinates to give rise to a new thallus.

- **Akinetes/ Cysts/ Hypnospores** – Akinete formation is common in aquatic and terrestrial species which get exposed to greater desiccation or low temperature.

The branched filament divides into rows of short segments by thick, gelatinous cross walls. Their protoplasts become laden with oil droplets. These resting, multinucleate thick walled segments are called the akinetes/ cysts or hypnospores. Akinetes may remain connected in a chain and in its appearance, the *Vaucheria* filament may resemble another alga called *Gongrosira*. This stage, in the life-cycle of *Vaucheria*, has thus come to be known as Gongrosira stage.

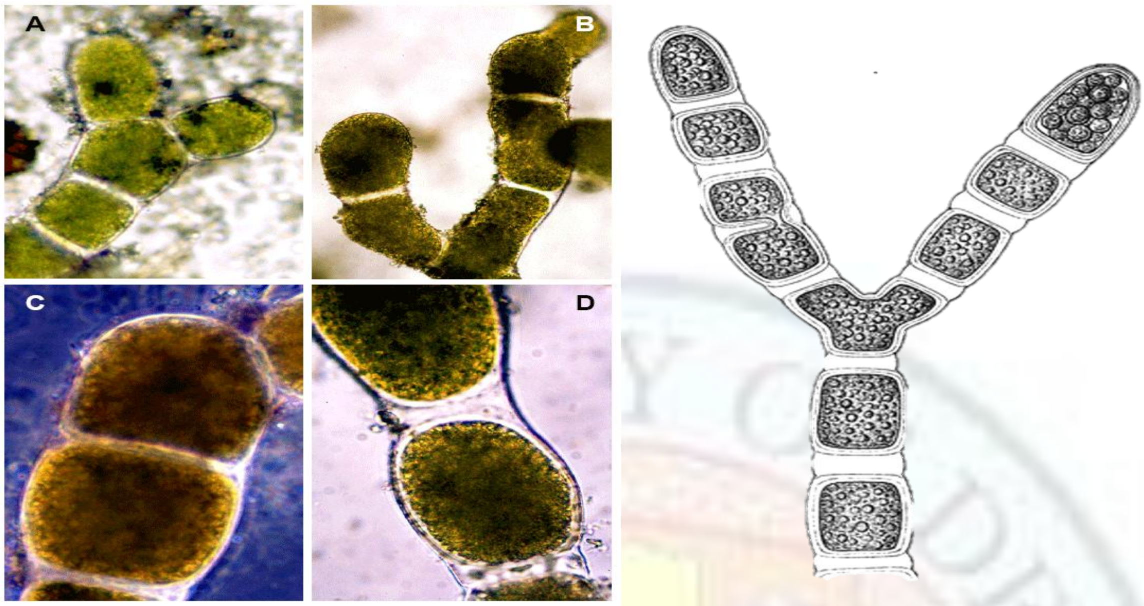


Figure: *Vaucheria*-A-D: Stages in akinete formation;E: Gongrosira stage (diagrammatic)

Source: http://www.scielo.cl/fbpe/img/gbot/v67n1/art15-f2.jpg

When conditions become favorable, each akinete divides into small protoplasmic bits, which emerge like small amoebae from the akinete wall and after a while, come to rest on a substratum. They become spherical, secrete a cell wall and develop into a new plant.

Sexual Reproduction

Vaucheria species may be either homothallic or heterothallic. In homothallic species, an antheridium lies in close proximity to an oogonium, or an antheridium may have oogonia on either sides, on the same filament. In heterothallic species, filaments bear only antheridia or oogonia.

Antheridia and oogonia may be sessile or stalked and originate as protuberances which gradually grow in size and accumulate a large number of nuclei and chromatophores.

When antheridia and oogonia are fully differentiated, transverse septa formation occurs at their bases, thereby isolating them from the rest of the thallus.

The antheridia are generally tubular, with their apices slightly curved or coiled. Generally a mature antheridium appears as a curved, hook- like structure.

The oogonia are commonly large, spherical or oval, with a broad base.

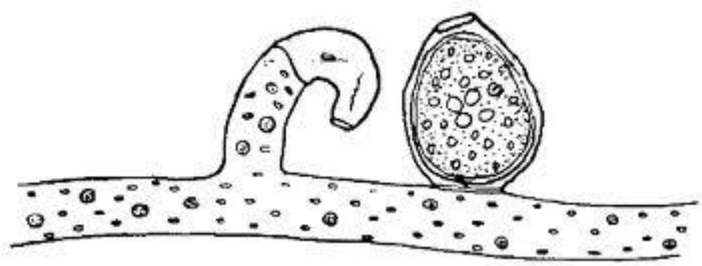


Figure: *Vaucheria*

Filament showing mature antheridium and oogonium. Note septa formation at the base of antheridium and oogonium.

Source: author

A. **B.** **C.**

Figure: *Vaucheria*

A- Early stage of differentiation of antheridia and oogonia as protruberances on the filament.

B- Filament showing antheridia and oogonia lying in pairs on the same filament.

C- Filament showing a mature antheridium, flanked on either sides by oogonia.

Source: http://www.hccfl.edu/media/192368/11_vaucheria_sessilis.gif ;http://farm9.staticflickr.com/8208/8220852373_a5748a311a_o.jpg; http://media-1.web.britannica.com/eb-media/87/76187-004-3D869F07.jpg

A mature antheridium is hook-shaped and its coenocytic protoplast divides into a large number of uninucleate, biflagellate sperms/ antherozoids. Each sperm functions as a male gamete. It is motile, with two laterally inserted flagella- one acronematic and the other pantonematic. The sperms are liberated from the antheridium after rupture of the antheridial wall at the terminal end. Sperms are liberated from the antheridium simultaneously, in large numbers.

A mature oogonium is large, spherical or oval, with a broad base. It has large number of nuclei, chromatophores and is loaded with oil droplets. A mature oogonium forms a single egg, which functions as the female gamete. A transverse septum is formed at the base of the oogonium and subsequently, it develops a receptive region called the 'beak', which has an opening at the top, through which sperms enter the oogonium at the time of fertilization.

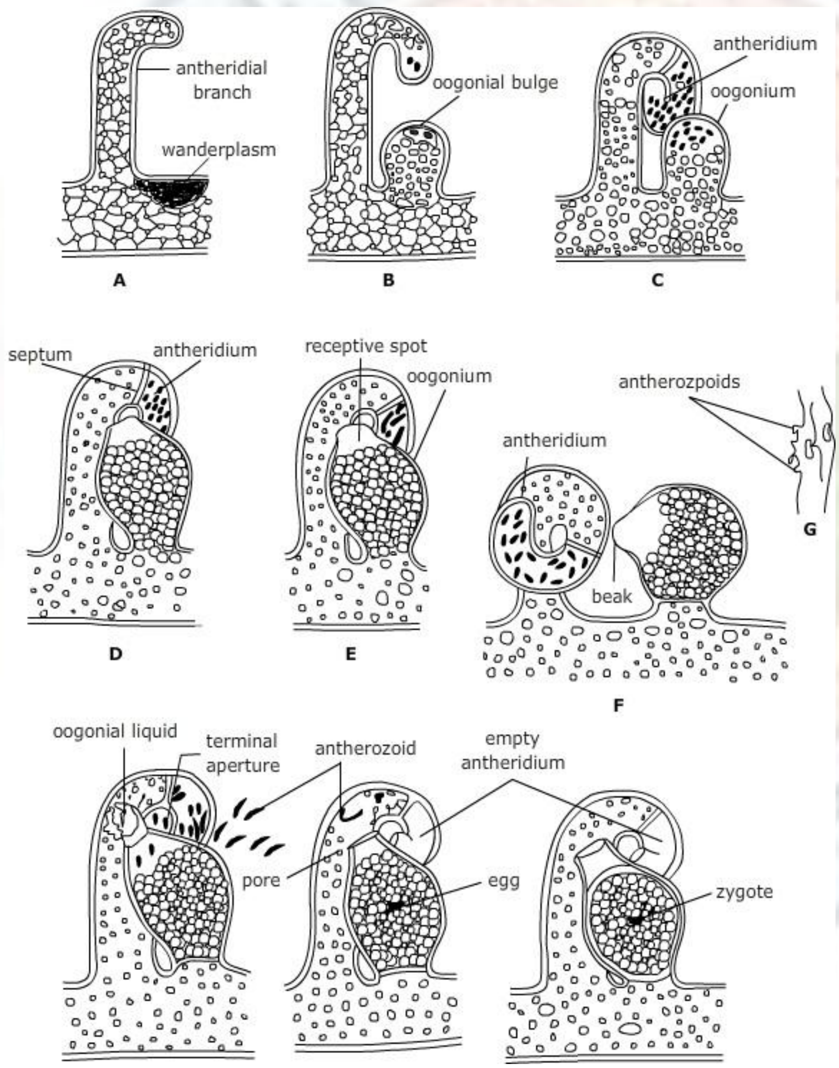
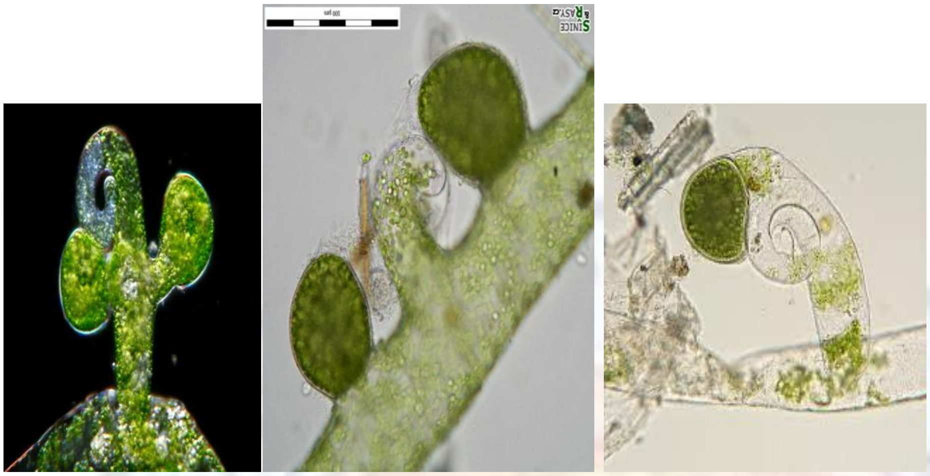


Figure: *Vaucheria* -Stages in sexual reproduction resulting in the formation of zygote.

Source: ILLL Inhouse



A. **B.** **C.**

Figure: *Vaucheria*

A-Filament with a mature hook-shaped antheridium, flanked on either side by dense oval oogonia.

B-Filament showing a mature antheridium and two oogonia, prior to the release of antherozoids.

B-Filament showing an empty antheridium (after release of spermatozoids), lying in close proximity to an oogonium. The oogonium develops a thick wall and forms a zygote.

Source:http://cfb.unh.edu/phycokey/Choices/Tribophyceae/VAUCHERIA/Vaucheria_03_600x450_plingfactory.de.jpg,http://cfb.unh.edu/phycokey/Choices/Tribophyceae/VAUCHERIA/Vaucheria_06_600x572.jpg ; http://www.bioimages.org.uk/html/p5/p55609.php

Sexual reproduction, in other members of Xanthophyceae, is either isogamous or anisogamous. However, sexual reproduction in *Vaucheria* is typically oogamous.

In *Vaucheria*, a large number of small, motile sperms are released from each antheridium, while each oogonium bears one single large, non-motile egg (female gamete). The sperms enter the oogonium through the beak (receptive region).

Generally, one male gamete succeeds to fuse the egg cell, while the other sperms gradually degenerate. Water plays a critical role as a medium for fertilization between the gametes. Fertilization results in the formation of diploid zygote.

Interestingly, in homothallic species, generally antheridia and oogonia do not mature simultaneously. Thus, self-fertilization is prevented.

The zygote subsequently becomes thick-walled and accumulates abundant reserves of oil.

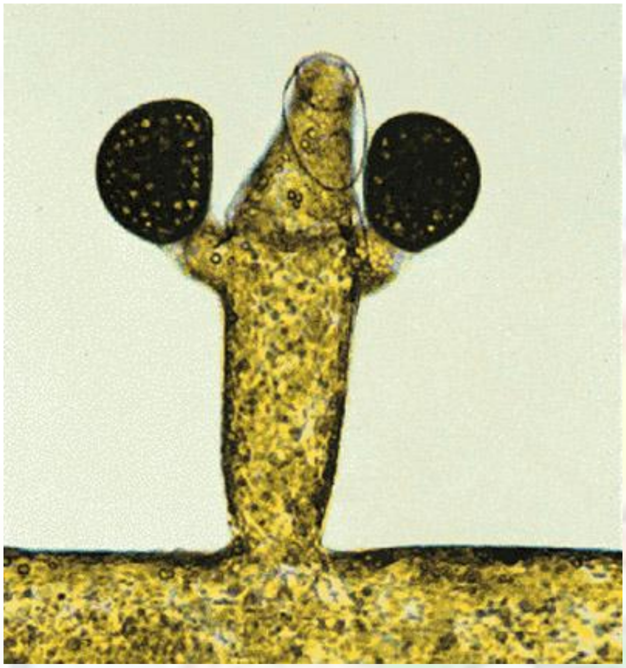


Figure: *Vaucheria* - Filament showing two zygotes, with thick walls and dense cytoplasm loaded with food reserves.

Source:http://cfb.unh.edu/phycokey/Choices/Tribophyceae/VAUCHERIA/Vaucheria_05_400x427_sp.jpg

Subsequently, the zygote gets detached from the parent plant and after meiosis, directly gives rise to a new haploid plant. Meiospores are not formed.

Life-cycle

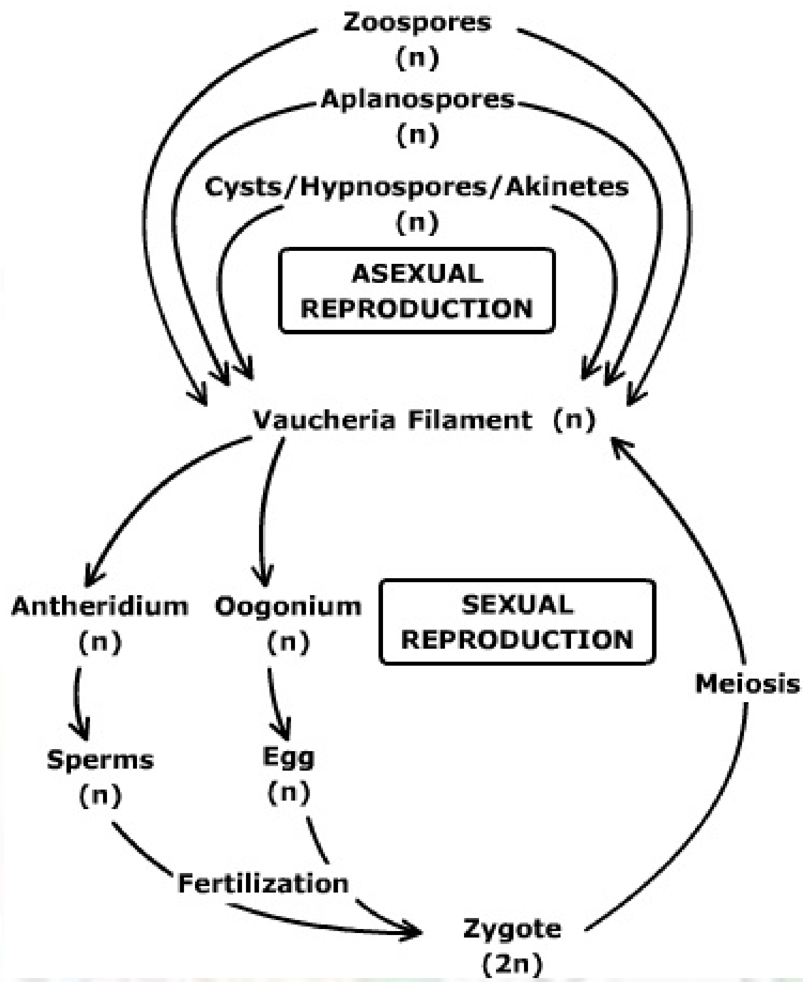


Figure: *Vaucheria* -Diagrammatic representation of life-cycle

Source: Author

Life-cycle in *Vaucheria* involves reproduction through asexual or sexual methods.

Asexual reproduction occurs through the formation of zoospores (synzoospores), aplanospores and akinetes/ cysts/ hypnospores. Gongrosira stage is seen when akinetes occur in chains in the filament.

Sexual reproduction is oogamous and involves the formation of antheridia and oogonia. The haploid phase is predominant and zygote is the only diploid structure formed during the life-cycle. Thus, *Vaucheria* is haplont.

Image: http://diatomeae.narod.ru/pictures/LifecycleVaucheria.JPG

Taxonomic Position

The taxonomic position of *Vaucheria* has been a matter of controversy for many years.

Earlier, *Vaucheria* was placed in the order Siphonales of the class Chlorophyceae, on the basis of multinucleate, aseptate thallus and oogamous sexual reproduction. These are features in which *Vaucheria* approaches the green algae (Chlorophyceae).

However, later *Vaucheria* was removed from Chlorophyceae and placed in a separate new Class Xanthophyceae, in Order Heterosiphonales. This transfer was due to its unique features, such as absence of chlorophyll 'b', presence of chlorophyll 'e', excess of carotenoids over chlorophylls, food reserves in the form of oil, absence of starch and unequal length of paired flagella of compound zoospores/ synzoospores.

The classification of *Vaucheria* is as follows:-

Division: Xanthophyta

Class: Xanthophyceae

Order: Heterosiphonales

Family: Vaucheriaceae

Genus: *Vaucheria*

Affinities

1. *Vaucheria* approaches green algae (Chlorophyceae) with respect to features such as multinucleate, a septate thallus and oogamous sexual reproduction.

2. *Vaucheria* indicates relationships with other members of the Xanthophyceae, with respect to features such as siphoneous, coenocytic, acellular organization of the thallus, photosynthetic pigments, discoid chloroplasts, cell wall composition, flagellar morphology of motile cells and principal food reserves.
   At the same time, *Vaucheria* is unique within the Class Xanthophyceae itself, with respect to formation of compound zoospores/ synzoospores and oogamous type of sexual reproduction.

3. *Vaucheria* resembles Class Oomycetes of the Fungi, with respect to coenocytic nature of the thallus, chemical composition of cell wall and oogamy in the sexual phase. The

resemblance is so great that the Saprolegniaceae are believed to have close affinities with the Vaucheriaceae (*Vaucheria*).

4. *Vaucheria* is indicative of the Class Phycomycetes of the Fungi, with respect to the discovery of tinsel and whiplash type of flagella in its motile stages.

Summary

1. The thallus of *Vaucheria* is 'acellular'. Plant body consists of an aseptate tubular, irregularly branched siphoneous coenocytic filament. Normally, a branched, colorless holdfast anchors the plant body onto a substratum.
2. The protoplast has numerous nuclei, chromatophores and oil droplets. These show a typical arrangement around a central vacuole.
3. Transverse septa are formed only at the base of reproductive structures.
4. Chromatophores in *Vaucheria* exhibit photo-tactic response.
5. *Vaucheria* exhibits cytoplasmic streaming.
6. Asexual reproduction occurs by sporulation. In aquatic species, zoospores are formed. These are multiflagellate, multinucleate structures called synzoospore. Each zoosporangium forms one synzoospore. In terrestrial species, non-motile aplanospores or thick-walled akinetes/ cysts/ hypnospores are formed.
7. Gongrosira stage is a typical stage in the life-cycle of *Vaucheria*, during which akinetes are formed in long chains.
8. Sexual reproduction is typically oogamous. Antheridia are curved or hook-shaped, while oogonia are spherical. Each antheridium produces large number of motile sperms, while only one, non-motile egg is formed per oogonium. Homothallic as well as heterothallic species are reported.
9. Zygote, after a short resting period, undergoes zygotic meiosis and germinates to give rise directly to a new haploid *Vaucheria* filament, without the intervention of meiospores.
10. *Vaucheria* is haplont. The haploid phase is the dominant phase and zygote is the only diploid structure formed during the life-cycle.

Exercises

Long Questions

Q1 With the help of suitable diagrams, describe the life-cycle of *Vaucheria*.

Q2 Discuss the systematic position and affinities of *Vaucheria*.

Q3 Describe the structure of *Vaucheria* filament.

Q4 Discuss the different modes of reproduction in *Vaucheria*.

Q5 With the help of suitable diagrams, describe asexual reproduction in *Vaucheria*.

Q6 With the help of suitable diagrams, describe sexual reproduction in *Vaucheria*.

Q7 With the help of labelled diagrams, describe the formation, structure and release of synzoospore in *Vaucheria*.

Q8 List the salient features of *Vaucheria* and give a graphical representation of its life-cycle.

Short Questions

Q1 Describe the cytoplasmic streaming in *Vaucheria*.

Q2 Chromatophores in *Vaucheria* exhibit phototaxis. Briefly explain the process and mention its significance.

Q3 What is synzoospore? With the help of a labelled diagram, discuss its structure.

Q4 What is Gongrosira stage? Why is it called so? Give diagram.

Q5 *Vaucheria* is haplont. Explain.

Q6 Compare the structure of antheridium and oogonium in *Vaucheria*.

Q7 Briefly describe thallus structure and organization in *Vaucheria*.

Q8 Discuss zoospore formation and release in *Vaucheria*.

Q9. Describe sexual reproduction in *Vaucheria*.

Q10. How does *Vaucheria* resemble and differ with green algae?

Differentiate between

1. Homothallic vs Heterothallic

2. Synzoospore vs Aplanospore

3. Aplanospore vs Akinete

4. Acellular vs Unicellular

5. Isogamy vs Oogamy

6. Antheridium of *Vaucheria* vs Oogonium of *Vaucheria*

7. Pantonematic vs Acronematic

8. Gamete vs Spore

9. Meiospore vs Zoospore

10. Coenocytic vs Multicellular

Define the terms

1. Coenocytic

2. Siphoneous

3. Akinete

4. Aplanospore

5. Zoospore

6. Synzoospore

7. Cytoplasmic streaming

8. Phototaxis

9. Gongrosira stage

10. Haplont

11. Meiospore

12. Zygote

13. Gamete

14. Flagella

15. Cyst

16. Blepharoplast

17. Isogamy

18. Anisogamy

19. Oogamy

20. Thallus

Glossary

Acronematic : Flagellum with slender and smooth surface and ending in thin hair.

Akinete: Vegetative cell that becomes converted into a thick-walled, non-motile resting spore; wall of cell becomes wall of spore.

Anisogamy : Union between two morphologically dissimilar gametes.

Aplanospore: Non-motile spore in which spore wall is not derived from wall of its parent cell.

Blepharoplast: Granule lying at base of flagellum; gives rise to one flagellum.

Carotenoids: General name for pigments of carotene and xanthophyll type; yellow, orange or red pigments composed of eight linearly joined isoprenoid units, widespread among all organisms.

Chromatophore: Plastid containing chlorophyll 'a' and other pigments, but not chlorophyll 'b'.

Coenocytic: Multinucleate cell, lacking septa or cross walls.

Cytoplasmic Streaming: Streaming of the cytoplasm along the longitudinal axis of the filament of *Vaucheria* in the dark. The chromatophores move, accompanied by small vesicles and mitochondria.

Cyst: Resting cell with thick envelope.

Flagella: Fine, thread-like structures by activity of which cells move.

Gamete: Sex cell; two gametes of opposite sex unite to form zygote.

Gongrosira stage: Stage in the life-cycle of *Vaucheria* during asexual reproduction, characterized by the formation of akinetes, which remain connected in chains in the filament and resemble the alga *Gongrosira*.

Haplont: Haploid plant in which the only diploid stage is confined to zygote.

Heterothallic: Self-incompatible; sexual fusion occurs only between gametes of different parentage or plants.

Holdfast: Single sell or group of cells that acts as an organ for attachment.

Homothallic: Self-compatible; fusion can occur between gametes derived from the same plant.

Isogamy: Fusion between morphologically and physiologically similar gametes.

Meiospores: Spores formed after meiosis in zygote.

Oogamy: Fusion of small motile sperm, with large passive non-motile egg.

Pantonematic: Flagellum in which surface is covered with hair-like appendages.

Photo-taxis: Movement oriented in response to light.

Siphoneous: Tubular thallus in algae, lacking septa or cross walls during vegetative phase of growth.

Synzoospore: Compound, multiflagellate and multinucleate asexual spore found in *Vaucheria*.

Thallus: Relatively undifferentiated plant body that is not divided into roots, stem and leaves.

Vacuole: Small, usually spherical space within cell, surrounded by membrane and containing fluid sap.

Zoospore: Motile flagellated asexual cell.

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