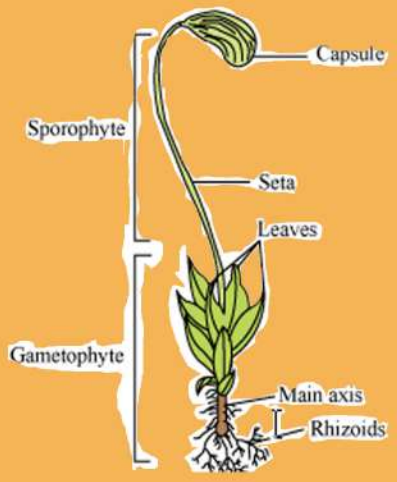
BBOTS-11

தமிழ்நாடு திறந்தநிலைப் பல்கலைக்கழகம்

B.Sc., Botany
First Year - First Semester



PLANT DIVERSITY - I

SCHOOL OF SCIENCE
TAMIL NADU OPEN UNIVERSITY
No.577, Anna Salai, Saidapet, Chennai-15.

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577, ANNA SALAI, SAIDAPET, CHENNAI - 15

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TAMIL NADU OPEN UNIVERSITY

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Date:17.06.2022

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BBOTS 11: PLANT DIVERSITY - I

SYLLABUS

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Unit - 2 General Classification of Algae

Unit - 3 Life Cycle of Algae

Unit - 4 Economic Importance of Algae

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Unit - 11 General Classification of Fungi

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Unit - 13 Type study -Albugo, Aspergillus, Puccinia&Cercospora

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Unit - 18 Type study - Riccia, Anthoceros&Polytrichum

BLOCK V: LICHENS

Unit – 19 Structure in Lichens

Unit – 20 Reproduction of Lichens

Unit – 21 Ecological significance and Economic importance of lichens

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2. Smith, G.M., 1955, Cryptogamic Botany, Vol. I, Tata McGraw Hill book Co., N.Delhi.
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6. Pelczar, Chan and Krieg, 1986, Essentials of Microbiology

Web links

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2. https://naturalhistory.si.edu/research/botany/research/algae/algae-classification
3. https://organismalbio.biosci.gatech.edu/biodiversity/fungi-2/
4. https://www.britannica.com/science/lichen
5. https://www.worldatlas.com/articles/what-is-the-economic-importance-of-algae.html

BBOTS 11: PLANT DIVERSITY - I

SCHEME OF LESSONS

Block I

ALGAE

Unit - 1 Algae General Introduction

Unit - 2 General Classification of Algae

Unit - 3 Life Cycle of Algae

Unit - 4 Economic Importance of Algae

UNIT – I

ALGAE - GENERAL INTRODUCTION

STRUCTURE

OVERVIEW

A group of organisms able to produces its own food materials, inhabits various altitudes and landscapes are said to be algae. The basi characteristic features are discussed in this unit.

LEARNING OBJECTIVES

To understand the characteristic features of algae

1.1 INTRODUCTION

Algae are autotrophs, and grow in a wide range of habitats. Majority of them are aquatic, marine (*Gracilaria,* and *Sargassum*) and freshwater, (*Ulothrix*) and also found in soils (*Fritschiella,* and *Vaucheria*). *Chlorella* lead an endozoic life in hydra and sponges whereas *Cladophora crispata* grow on the shells of molluscs. Algae are adapted to thrive in harsh environment too. *Dunaliella salina* grows in

salt pans (**Halophytic alga**). Algae growing in snow are called **Cryophytic algae**. *Chlamydomonas nivalis* grow in snow covered mountains and impart red colour to the snow (**Red snow**).

A few algae grow on the surface of aquatic plants and are called **epiphytic algae** (*Coleochaete,* and *Rhodymenia*). The study of algae is called **algology** or **phycology**. Some of the eminent algologists include F.E. Fritsch, F.E. Round, R.E. Lee, M.O.Parthasarathy Iyengar, M.S. Randhawa, Y. Bharadwaja, V.S. Sundaralingam and T.V.Desikachary. The term Algae is derived from a Latin word Alga (means sea weed). The study of algae is called algology or phycology which in itself consists of two greek words – Phykos- sea weeds (algae) and logos= discourse (study).

Definition: A simple, non-flowering, and typically aquatic plant of a large group that includes the seaweeds, and many single celled forms. Algae contain chlorophyll but lack true stems, roots, leaves, and vascular tissues.

Examples:*Chlamydomonas, Diatoms, Oedogonium, Nostoc, Volvox, Sargassum, Ulva* ect.,

1.2 GENERAL CHARACTERISTIC FEATURES

1. The algae show a great diversity in size, shape and structure. A wide range of thallus organisation is found in algae. Unicellular motile (*Chlamydomonas*), unicellular non-motile (*Chlorella*), Colonial motile (*Volvox*), Colonial non motile (*Hydrodictyon*), siphonous (*Vaucheria*), unbranched filamentous (*Spirogyra*), branched filamentous (*Cladophora*), discoid (*Coleochaete*) heterotrichous (*Fritschiella*), Foliaceous (*Ulva*) to Giant Kelps (*Laminaria* and *Macrocystis*).
2. **Pant body:** known as Thallus and they are avascular
3. **Habitat:** Algae are usually aquatic and marine (*Sargassum)*, freshwater (*Oedogonium*) or and some are terresterial(*Vaucheria*).
4. Algae are photoautotrophs.
5. Algae are Eukaryotes except blue green algae.
6. The cell wall of algae is made up of cellulose and hemicellulose. Siliceous walls are present in diatoms.
7. **Storage form of food:** Starch

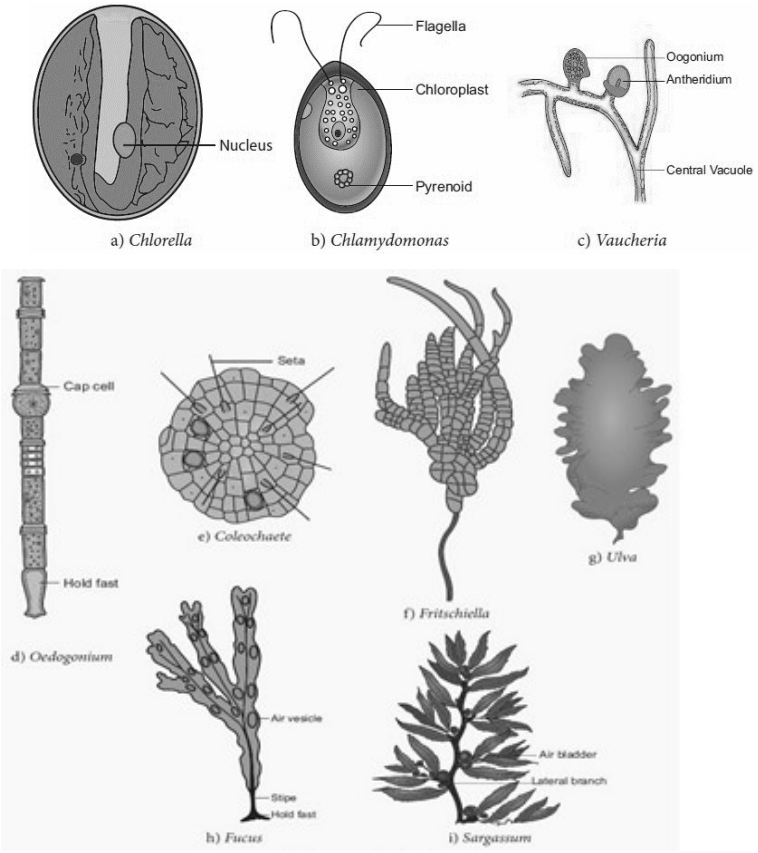

Fig. 1.1 Thallus organization of Alage

8. **Reproduction:** Algae reproduces by vegetative, asexual and sexual methods
9. **Vevetative method:** fission (Eg. *Chlamydomonas*); fragmentation (Eg. *Ulothrix*)
10. **Asexual spore:** zoospores (*Ulothrix, Oedogonium*), aplanospores(*Vaucheria*); hypnospores(*Chlamydomonas nivalis*), akinetes(*Pithophora*), azygospore
11. **Sexual method:** isogamous, anisogamous, and oogamous gametic fusion

a) Isogamy (Fusion of morphologically and physiologically similar gametes Example: *Ulothrix*)

b) Anisogamy (Fusion of either morphologically or physiologically dissimilar gametes Example: *Pandorina*)

c) Oogamy (Fusion of both morphologically and physiologically dissimilar gametes Example: *Sargassum*).

d) .The life cycle shows distinct alternation of generation.

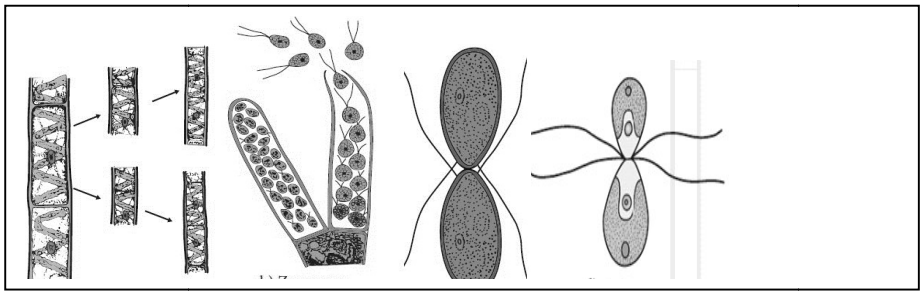

Fig.1.2 Reproduction in Algae

LET US SUM UP

In this unit General introduction of Algae discussed and the charecterestic features of alage is also discussed.

CHECK YOUR PROGRESS

1. Algae are ----------
2. Fusion of morphological and pysiologial dissimilar gametes is ---------

GLOSSARY

Zoospore - Asexual spore

Isogamy - Fusion of morphologically and physiologically similar gametes

SUGGESTED READINGS

1. Manual of Phycology by G.M. Smith

ANSWERS TO CHECK YOUR PROGRESS

1. Autotrophs
2. Oogamy

MODEL QUESTIONS

1. Write about general Characteristic features of Algae

WEB SOURCES

1. https://www.britannica.com/science/algae
2. https://www.toppr.com/guides/evs/a-treat-for-mosquito/algae/
3. https://www.dcceew.gov.au/science-research/abrs/publications/algae-of-australia/introduction
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UNIT – 2

CLASSIFICATIONS OF ALGAE

STRUCTURE

OVERVIEW

A set of organisms placed according to its shape size, habit physical and chemical properties is said to be classification. Algae were classified by many scientists among those we can see some classification.

LEARNING OBJECTIVES

To understand the groups of algae

To identify algae from varous environment

2.1 BASIC CRITERIA FOR CLASSIFICATION

Classification is defined as the systematic arrangement of the organisms in groups or categories distinguished by structure, origin, etc.

The usual series of categories is phylum (or, especially in botany, division), class, order, family, genus, species, and variety.

The classification of algae into taxonomic groups is based upon the same rules that are used for the classification of land plants. The land (terrestrial) plant classification came before algal classification. Since, many microscopic algae are revealed only the discovery of advanced microscopes. The major algal classifications are characterized based on some criteria.

They are:

1. Photosynthetic pigments (e.g. Chlorophyll, xanthophyll & carotenoids)
2. Morphological features (size, shape and structure).
3. Chemical composition of cell wall.
4. Structure, type, number and positionof flagella.
5. Chemical nature of reserve food or materials (e.g. Starch and oil globules).
6. Method reproductions.
7. Presence or absence of a definite nucleus.

The major algal divisions can be distinguished based on the appearance of predominant pigment colours. On the basis of their colour the following four groups were recognised.

1. *Myxophyceae* or *Cyanophyceae* – Otherwise called blue-green algae, due to presence of dominant pigment *c*-phycocyanin.

e.g. *Ocillatoria,Nostoc,* and *Spirulina*.

2. *Chlorophyceae* – These are called green algae, due to the presence of pigments chlorophyll a and b.

e.g. *Chlamydomonas, Spirogyra*, and *Chara*.

3. *Phaeophyceae* – Also called as brown algae, they are predominantly marine. They have chlorophyll a, c, carotenoids and xanthophyll pigments.

e.g. *Dictyota, Laminaria,* and *Sargassum*.

4. *Rhodophyceae* – They are the red algae because of the presence of the red pigment, r-phycoerythrin.

e.g. Examples are *Porphyra, Gracilaria,* and *Gelidium*.

Many algologists gave classification of algae but most authentic and

comprehensive classification was proposed by F. E. Fritsch (1935) who published his voluminous work in the form of a book entitled “Structure and Reproduction of Algae” in two volumes. He classified algae into 11 classes. The most common classification of algae was proposed by F.E Fritsch (1938, 1948) in his book The Structure and Reproduction of the Algae’. Classificationwas based on pigmentation, types of flagella, assimilatory products, thallusstructureand methods ofreproduction.

2.2 CLASSIFIATION BY F.E. FRITSCH.

ClassificationofAlgae by F.E Fritsch (1938, 1948)					
Classes - 11	Characteristic features of different classes				Number of orders
	Pigments	Flagella	Reserv efood	Reproductio n	
1.Chloroph yceae (Green algae) Eg. *Volvox*	Chlorophy llaandb, Carotenoid s& Xathophyll	1, 2,4ormoree qual anteriorwhipl ashflagella	Starch	vegetative, asexual and sexual methods	11
2.Xanthop hyceae (Yellow-green algae) eg. *Heterochl oris*	Chlorophy llaandb Carotenoid s &Xanthop hyll	2,unequala nterior1 tinseland1w hiplash	Fatsand leucosin	vegetative, asexual and sexual methods	4
3.Chrysop hyceae eg.	Chlorophy llaandb & Carotenoi	1or2 unequalore qualanterior	Oilsand leucosi n	Sexualreprod uctionrare(iso gamous)	3

Chrysosphaera	ds	bothwhiplashor1whiplashand1tinsel			
4.Bacillariophyceae eg *Pinnularia*	Chlorophylla andc & Carotenoids	1anterior (onlyinmalegametes)tinsel	LeucosinandFats	Sexual	2
5.Cryptophyceae eg *Cryptomonas*	Chlorophyllaandc,carotenoids & xanthophyll	unequalanteriorbothtinselflagella	Starch	Sexualreproductionrare	2
6.Dinophyceae (Dinoflagellates) eg *Desmocapsa*	xanthophyll	2unequal(whiplash) lateralflagellain different plane	Starchandoil	Sexualreproductionrare	6
7.Chloromonadineae eg *Trentonia,*	Chlorophyllaandb, Carotenoids & Xathophyll	2equalflagella	oil		1
8.Euglenophyceae eg *Euglena*	Chlorophyllaandb	1or 2 anteriortinsel flagella	Fatsand paramylon		-
9.Phaeophyceae	Chlorophyllaandc &	2 unequalwhip	Laminarinstarch	Sexual	9

(Brown algae) eg *Ectocarpus*	Xanthophyll	lashand tinsel lateralflagella	andfats		
10.Rhodophyceae (Red algae) eg *Gelidium*	Chlorophylla & r-Phycoerythrin	absent	Floridean starch	Sexual (oogamoustype)	7
11.Cyanophyceae (Blue green algae) e.g. *Nostoc,*	Chlorophylla, carotenoids, c-Phycocyanin, Allophycocyanin	absent	Cyanophycean starch	asexual	5

2.3CLASSIFIATION BY G. M. SMITH

G. M. Smith Classification (1955)classified algae into seven divisions. These divisions include one or more classes. He included certain algae of uncertain position into Chloromonadales & Cryptophyceae.

Divisions	**Classes**		
	Class I	**Class II**	**Class III**
1.Chlorophyta	Chlorophyceae (grass-green)	Charophyceae	-
2.Eunglenophyta	Euglenophyceae	--	-

3.Pyrrophyta	Desmophyceae (dinophysids)	Dinophyceae (dimoflagelloids)	-
4.Chrysophyta	chrysophyceae (golden brown)	Xanthophyceae (Yellow green)	-
5. Phaeophyta (brown algae)	Isogenerateae	Heterogenerateae	Cyclosporeae
6.Cyanophyta (Blue - Green algae)	Myxophyceae	-	-
7.Rhodophyta (Red Algae)	Rhodophyceae	-	-

2.4CLASSIFIATION BY CHAPMAN AND CHAPMAN

Chapman and Chapman (1973) Classification

He classified algae into 2 groups. These groups are divided into divisions and further divisions are categorized to one or more classes.

Groups	Divisions	Classes		
		Class I	**Class II**	**Class III**
1.PROKARYOTA	**1. Cyanophyta**	Cyanophyceae		
2. EUKARYOTA It is further divided into 10 divisions. Divisions are further divided into one or more classes.	**1. Rhodophyta**	Rhodophyceae		
	2. Chlorophyta	Chlorophyceae	Prasinophyceae	Charophyceae
	3. Euglenophyta	Euglenophyceae		
	4. Chloromonadophyta	Chloromonadophyceae		
	5. Xanth	Xanthophyc		

	ophyta	eae		
	6. Bacill ariophyta	Bacillarioph yceae		
	7. Chrysoph yta	Chrysophyc eae	Haptophycea e	
	8. Phaeophy ta	Phaeophyce ae		
	9. Pyrrophyt a	Dinophycea e	Desmophyce ae	
	10. Crypt ophyta	Crptophyce ae		

LET US SUM UP

Many authors classified Algae in various groups according to its shape size physical chemical properties. In this chapter we dealt four classification for easy understanding.

CHECK YOUR PROGRESS

1. Systematic arrangement of the organisms in goups is said to be ----------
2. G.M. Smith Classified Algae in the year ----------

GLOSSARY

Chlorophyceae – Green algae

Phaeophyceae – Blue green algae

SUGGESTED READINGS

1. Manual of Phycology by GM Smith

ANSWERS TO CHECK YOUR PROGRESS

1. Classification
2. 1955

MODEL QUESTIONS

1. Write notes on blue green algae

WEB SOURCES

1. https://www.britannica.com/science/algae/Classification-of-algae
2. https://www.toppr.com/guides/biology/plant-kingdom/algae/
3. https://old.amu.ac.in/emp/studym/99993037.pdf
4. https://www.vedantu.com/question-answer/basis-of-classification-of-algae-class-11-biology-cbse-5fc47a8d287b0f7a38255ae1

UNIT – 3

LIFE CYCLE IN ALGAE

STRUCTURE

OVERVIEW

A life cycle of algae explained in a different phases and stages. Every group of algae follows certain similar stages some different phases. In this unit we can study the life cycle of Algae

LEARNING OBJECTIVES

To know the stages of an algae

To understand the stages of algae in its life.

3.1 INTRODUCTION

Life cycle is the cyclic sequence of events occurring in the life of an organism. The different types of life cycles of algae are,

- **Haplontic type**
- **Diplontic type**
- **Haplodiplontic type**
- **Diplohaplontic type**
- **Haplobiontic.**
- **Diplobiontic type**

3.2 .**Haplontic Life cycle**:

- It is the most common, primitive and simplest type of life cycle.
- It is diphasic (two phases), but the prominent phase is haploid gametophyte (n)
- Plants are haploid.
- The main vegetative plant body is gametophytic (n).
- Diploid phase is only represented by zygote (2n)

e.g. Chlamydomonas, Ulothrix, Oedogonium, Spirogyra

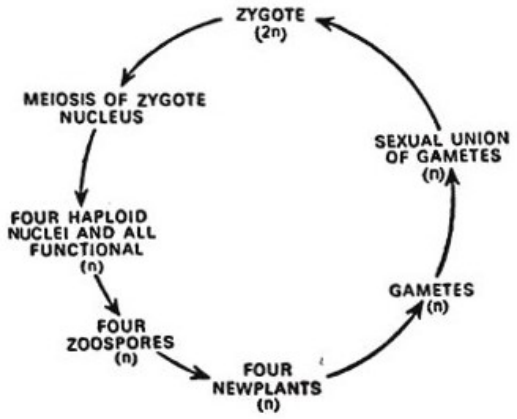


Fig. 3.1 Haplontic lifecycle

3.3.DIPLONTIC LIFE CYCLE:

- It is just a reversal of the haplontic type of life cycle
- It is diphasic (two phases), but the prominent phase is diploid sporophyte (2n)

- Plants are diploid.
- Plant body is diploid (2n) and sporophytic sex organs are also 2n. By meiosis forms gametes.
- Haploid stage represented only during gamete formation.
- E.g. *Sargassum, Fucus*

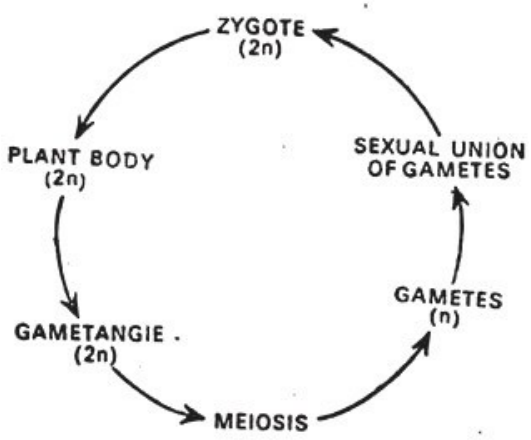


Fig. 3.2 Diplontic lifecycle

3.4 HAPLODIPLONTIC LIFE CYCLE:

- It is diphasic
- One phase is haploid gametophyte and the other is diploid sporophyte
- Diploid zygote develops into diploid sporophytic generation
- The two generations are equally prominent and multicellular. e.g., *Laminaria*

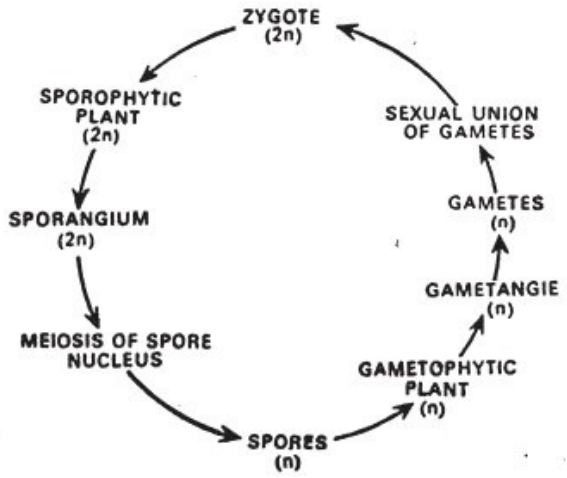


Fig. 3.3 Haplodiplontic lifecycle

3.5 Diplohaplontic Life cycle:

- Both haploid (n) and diploid (2n) plants are present. It is of two types.
- A) Isomorphic alternations of generation: If both are morphologically similar and shows alternation of generation.eg: *Cladophora, Ectocarpus, Ulva*
- B) Heteromorphic alternations of generation: Here 2n plant is large and macroscopic and in plant is microscopic Eg : *Laminaria*

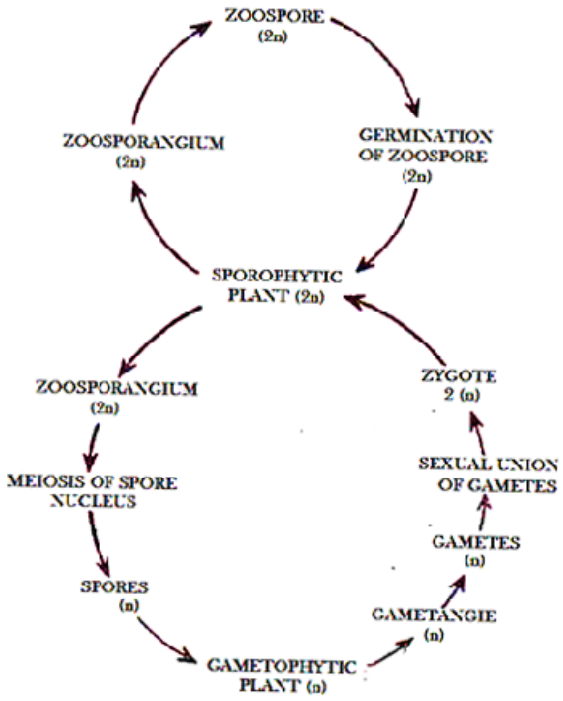


Fig. 3.4 Diplohaplontic lifecycle

3.6. Haplobiontic life cycle:

- It is triphasic (three phases)
- Two well developed haploid phases are present. Diploid phase represented only by zygote.

threy are

(a). Gametophyte phase (n):

haploid phase 1

(b). Zygote (2n): diploid phase

(c). Carposporophyte phase (n): haploid phase 2

- First haploid phase represented by gametophytic plant body, sex organs and gametes.
- Second haploid phase represented by gonimoblast filaments, carposporangia, carpospores and chantransia stage
- E.g. *Batrachospermum, Nemalion*

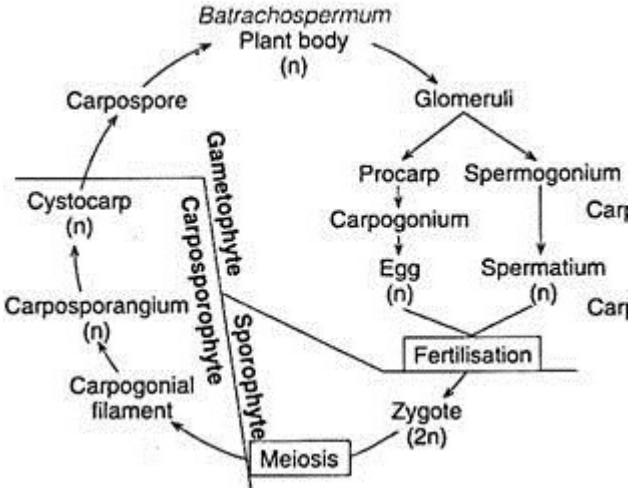


Fig. 3.5 Haplobiontic lifecycle

3.7. DIPLOBIONTIC LIFE CYCLE (TRIPHASIC LIFE CYCLE):

- Most complex and advanced type of life cycle in algae
- Life cycle is triphasic with one haploid phase and two diploid phases.
- They are

  a) Carposporophyte – diploid (2n)

  (b).Gametophyte – haploid (n)

  (c). Tetrasporophyte – diploid (2n)
- First haploid phase represented by male and female gemetophytic plant body, sex organs and gametes
- First diploid phase is represented by zygote, gonimoblast filament, carposporangia and carpospores. All these together represent carposporophyte which depends on the gametophyte
- Second diploid phase represented by tetrasporophytic plant bearing tetrasporangia.

- E.g., *Polysiphonia*

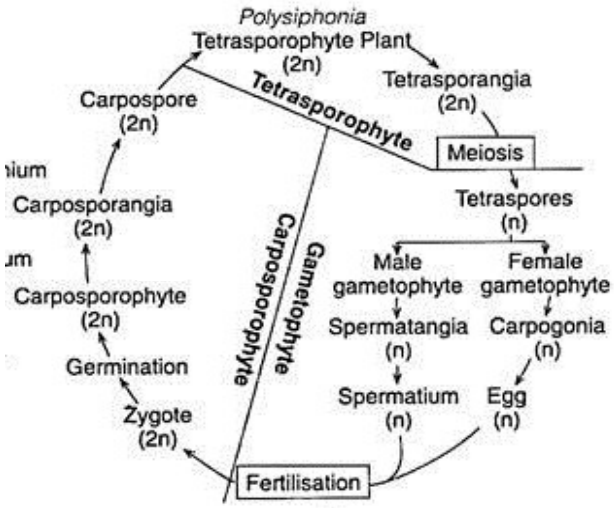


Fig. 3.6 Diplobiontic lifecycle

LET US SUM UP

In this unit we elaborately studied te life cycle of algae. Every stages of different lice cycles ave been discussed in this chapter.

CHECK YOUR PROGRESS

1. Haploid plants produced in ---------- life cycle
2. The life cycle possess two phases is called ----------

GLOSSARY

1. Haplobiontic – Triphasic life cycle

SUGGESTED READINGS

1. Manual of Phycology by GM Smith

ANSWERS TO CHECK YOUR PROGRESS

1. Haplontic
2. Diphasic

MODEL QUESTIONS

1. Write sort notes on Diplontic Life cycle

WEB SOURCES

1. **https://microbiologynote.com/life-cycle-of-algae/**
2. **https://www.vedantu.com/biology/algae**
3. https://www.vcbio.science.ru.nl/en/virtuallessons/lifecycle/
4. https://sciencing.com/life-cycle-of-algae-13406659.html
5. https://www.plantscience4u.com/2014/05/life-cycle-in-algae.html

UNIT – 4

ECONOMIC IMPORTANCE OF ALGAE

STRUCTURE

OVERVIEW

Many plant species of Algae are playing very important role in human kind. They are useful in te forms of Medicine, Food, Fodder, Environment, Ornamental and etc. Many of those discussed in this unit

LEARNING OBJECTIVES

To know the importance of Algae

The species of algae are a source food, medicine and other uses. Algae are taking an active role in human beings.

4.1.ALGAE AS PRIMARY PRODUCERS:

Algae are the main Oxygen producers in aquatic areas. They are also useful in decreasing water pollution by realizing Oxygen.

4.2. ALGAE AS FOOD:

Algae species have proteins, vitamins (A, B, C and E), lipids, and minerals. *Laminaria*species is the important edible seaweed in Japan and the food item 'Kombu' is prepared from it. 'Aonori' from *Monostroma*; 'Asakusa Nori' from *Porphyra*are prepared in different countries

a. *Chlorella*
b. *Chondrus crispus* (Irish moss) – popular dish Blancmanges
c. *Codium* and *Ulva* – salad in japan
d. *Porphyra* – use as food having 30-35% protein and vitamin B &C
e. *Laminaria*- kombu food in japan (57-60% carbohydrate rich)
f. *Rhodymenia*- dulse food
g. *Monostroma* – use as aonori in Japan
h. *Spirulina*- having 60% protein
i. *Scenedesmus*- equivalent to skimmed milk
j. *Nostoc* – soup for China
k. *Spirogyra*- in south India
l. *Spirulina* and *Chlorella* are used as Single cell protein (SCP).

4.3. ALGAE AS FODDER FOR CATTLE:

Rhodymenia palmate is used as food for sheeps in Narvey. *Laminaria saccharina, Pelvitia, Ascophyllum*, etc. species are used as food for cattles.

4.4. ALGAE AS FERTILIZERS:

Blue-green algae like *Nostoc, Oscillatoria, Scytonema, Spirulina,* etc. are used as fertilizers to rice fields. All these algae are fixed the atmosphere Nitrogen in to ground.

4.5. ALGAE IN PISI CULTURE:

Some green-algae, *Diatoms*, some blue-green algae are used as food material to fishes. These are also making the water clean, by realizing Oxygen.

4.6.ALGEA IN INDUSTRY:

Iodine industry is mainly depended upon algae. *Laminaria, Ecklonia, Eisenia*, etc. are used in the industry to prepare Iodine in industries.

Alginates:

Alginates are extracted from *Fucus, Laminaria, Macrocystis and Ecklonia*. Alginates are used in the preparation of flame-proof fibrics, plastics, paints, gauze material in surgical dressing, soups, ice creams etc

Agar-Agar:

Agar-agar is a jelly like substance of great economic value. It is obtained from certain red algae like *Gelidium, Graciliaria, and Gigartina*. Agar is used as a culture medium for in tissue culture.

Carragheen or Carragheenin:

It is extracted from cell walls of red algae like *Chondrus* and *Gigartina*. It is used as emulsifier in pharmaceutical industry and also in textile, leather, cosmetics and brewing industries.

Diatomite:

Diatoms are used in different industries like glass, metal polishing, paints, tooth pasts, soups, etc.

4.7.MINERALS:

The brown sea weeds popularly called as kelps yield potash, soda, and iodine. Some sea weeds are rich source of iron, zinc, copper, manganese and boron.

Antibiotics and Medicines:

Antibiotic Chlorellin, obtained from *Chlorella* is effective against a number of pathogenic bacteria. Extracts from *Cladophora, Lyngbya* can kill pathogenic *Pseudomonas* and *Mycobacterium*. *Laminaria* is used as one of

the modern tools for abortion. Seaweeds have beneficial effect on gall bladders, pancreas, kidneys, uterus and thyroid glands.

4.8. ROLE OF ALGAE IN SEWAGE DISPOSAL:

Some species like *Chlamydomonas, Scenedesmus, Chlorella, Pondorhina, Euridina*, etc are living in sewage water. They are mainly useful to clean the water by realizing Oxygen.

4.9.ALGAE AS RESEARCH MATERIAL:

In biological research algae are useful because of their rapid growth, brief life span and easy mode of cultivation. *Chlorella*, *Scenedesmus* and *Anacystis* are used in investigations in photosynthesis.

LET US SUM UP

Algae plays an important role in Economic values, Medicinal values food values for human and fodder for cattles.

CHECK YOUR PROGRESS

1. Important edible seaweed in Japan is ----------
2. Algae used as fertilizer is ----------

GLOSSARY

1. Agar agar - Agar is used as a culture medium for in tissue culture.
2. Carrageen - is extracted from cell wall of Chondrus

SUGGESTED READINGS

1. Algae by OP Sharma

ANSWERS TO CHECK YOUR PROGRESS

1. Laminaria
2. Nostoc

MODEL QUESTIONS

1. Write about medicinal importance of Algae

WEB SOURCES

1. https://www.toppr.com/ask/content/concept/economic-importance-of-algae-202041/
2. http://www.lscollege.ac.in/sites/default/files/e-content/Economic%20imp.%20of%20Algae.pdf
3. https://www.jagranjosh.com/general-knowledge/economic-importance-of-algae-1555399986-1
4. https://gclambathach.in/lms/Economic%20importance%20of%20Algae.pdf

Block II

Unit - 5 Oscillatoria

Unit - 6 Volvox

Unit - 7 Chara

Unit - 8.Sargassam

Unit - 9 Polysiphonia

UNIT – 5

OSCILLATORIA

STRUCTURE

OVERVIEW

Each and every individual species of algae have peculiar characteristic feature and posses different behaviour. In this unit we can see the features by single genus Oscillatoria and its life cycle.

LEARNING OBJECTIVES

To learn the charecterstics of Oscillatoria

To understand the life cycle of Oscillatoria

5.1 SYSTEMATIC POSITION OF *OSCILLATORIA*

Class: Cyanophyceae

Order: Oscillatoriales

Family: Oscillatoriaceae

Genus: *Oscillatoria*

5..2CHARACTERISTICS AND MORPHOLOGY

Oscillatoria (oscillare, to swing) is one of the simplest, a fresh water, filamentous blue green algae. It is commonly occurred in fresh and polluted water of ponds, pools, drains, streams, and also in damp soils and rocks, which are rich in decaying organic matter. These forms thin blue green mucilaginous coating on water surface. It is represented by 100 species. Some common species are *Oscillatoria formosa*, *O. splendida*, *O. lomosa*, *O. prolifica*.

5.3 Structure

- *Oscillatoria* is a free floating blue green alga.
- The plant body is simple, unbranched and filamentous thallus.
- It is composed of single row of cells
- They are arranged in one above the another.

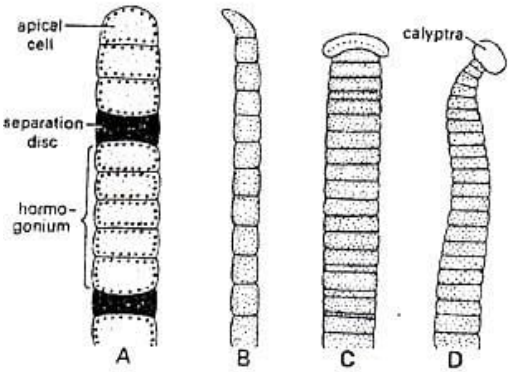


Fig. 1 (A–D) : *Oscillatoria* : Trichomes.

Fig. 5.1 Oscillatoria Trichomes

- These cells form trichomes.
- Trichomes are unbranched filaments and covered by very thin mucilaginous sheath.
- The anterior end of trichomes (i.e. apical cell) shows mostly rounded or convex (*O. annae*), acuminate (*O. acuminata*), and discoid (*O. princeps*).
- Calyptra (the apical cell has thickened membrane) is present in some species e.g., *O. proboscidea.*

Cell Structure:

- All cells of a trichome are similar in shape except apical cells.
- **It consists of outer cell wall and inner protoplasm.**
- Cell wall is made of mucopeptide.

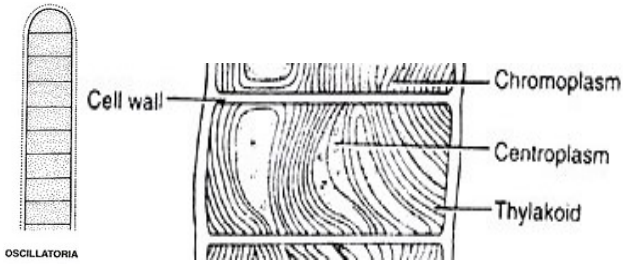


Fig.5.2 Oscillatoria – Cell wall

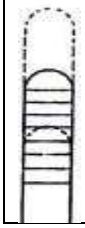
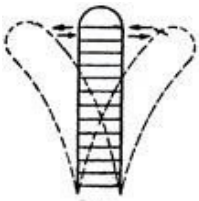
- Protoplasm is composed of peripheral coloured chromoplasm and a central colourless centroplasm.
- Thylakoids are present in chromoplasm.
- It contains photosynthetic pigments such as chlorophyll a, carotenes, xanthophyll and phycobilins.
- The reserve food is cyanophycean starch, lipid, globules and cyanophycin.

Growth

- The growth of trichome is intercalary.
- The division is right angle to the longitudinal axis.
- As result, the increase in the length of trichome.
- The cell divides by amitotically

Movement

Oscillatoria shows two types movements. They are gliding movement and Oscillatory movement.

Gliding movement	Oscillatory movement.
The trichome moves forward and backward along its long axis. 	The trichome moves right and left side of the axis is called **oscillatory movement**. These are the jerky, pendulum- 

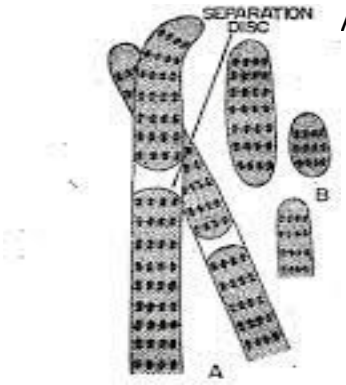
	like movements of the apical region of the trichome.

5.4 REPRODUCTION IN *OSCILLATORIA*

- The reproduction takes place by vegetative method.
- The vegetative reproduction is takes place by means of **hormogonia** and **fragmentation**.

Hormogonia x

- Hormogonium is produced in mature filaments.
- In filaments, some cells are filled with mucilage and become dead.
- These cells are biconvex and called necridia.
- The cells present in the trichome between two adjacent necredia is called hormogonium.



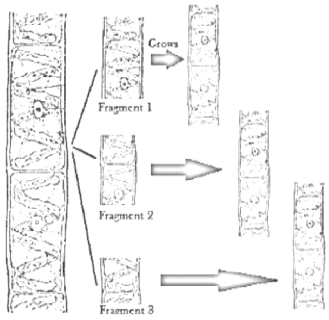
A- filament with separation disc; B- hormogonia

Fig. 5.3 Filament

- These hormogonia separate from the trichome.
- Each hormogonium is develop into a new filament by repeated division.

Fragmentation

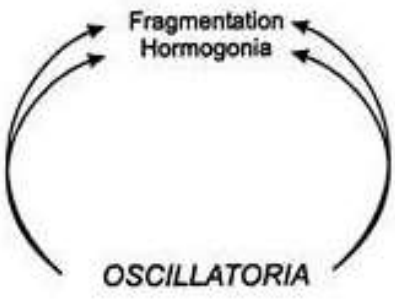
- It occurs due to accidental breakage or biting of insects in the filament.
- So, filament divides into small pieces or fragments.
- Each of these fragments is capable of developing into new individual filament.



Fragmentation

Fig. 5.4 Fragmentation

Graphic life cycle of *Oscillatoria*



LET US SUM UP

In this unit we experienced the detailed information about distribution structure, reproduction and life cycle of Oscillatoria

CHECK YOUR PROGRESS

1. Oscillatoria is a ---------- algae
2. The cells present in the trichome between two adjacent necredia is called ----------

GLOSSARY

1. Trichomes – Unbranched filaments
2. Cyanophycean – Starch and lipid food storage grains

Suggested Readings

SUGGESTED READINGS

1. A Text Book of Algae by A.V..S.S. Sambamurthy

ANSWERS TO CHECK YOUR PROGRESS

1. Fresweter
2. hormogonium

MODEL QUESTIONS

1. Write about reproduction in Oscillatoria

WEB SOURCES

1. **https://www.britannica.com/science/Oscillatoria**
2. **https://www.itis.gov/servlet/SingleRpt/SingleRpt?search_topic=TSN&search_value=917#null**
3. http://oceandatacenter.ucsc.edu/PhytoGallery/Freshwater/Oscillatoria.html
4. https://www.marinespecies.org/aphia.php?p=taxdetails&id=146549
5. https://www.montclair.edu/water-science/freshwater-cyanobacteria-of-new-jersey/visual-guide-to-cyanobacteria-in-new-jersey/filamentous/non-heterocyte-forming/oscillatoria/

UNIT – 6

VOLVOX

STRUCTURE

OVERVIEW

In this unit we can study the systematic position habit, habitat, and life cycle of Volvox. This unit mainly covers Volvox reproduction in detail.

LEARNING OBJECTIVES

To understand the lifecycle of Volvox

6.1 SYSTEMATIC POSITION

Class – Chlorophyceae

Order – Volvocales

Family – Volvocaceae

Genus – Volvox

Volvox is a fresh water planktonic (free-floating) alga. There are about 20 species belongs to these genera. In the plant kingdom it appears as the most beautiful and attractive object. It is found in fresh water as green balls of pin head size. They are just visible to the naked eyes, about 0.5 mm. in diameter.Some common Indian species are—*Volvox globator*, *V. aureus*, *V. prolificus, V. africanus* and *V. rousseletii*.

6.2 STRUCTURE:

- *Volvox*thallus forms motile colony with definite shape and number of cells.
- The colony of *Volvox* is called **coenobium.**
- It is **spherical or oval** in shape. Each colony has ranging from 500 to 50,000 number of cells.
- The interior of the colony is filled with **mucilage.**
- The colony moves with the collective action of the **flagella.**
- The end directed forward is called **anterior end**.
- The end directed backward is called **posterior** end of the colony.
- The cells of anterior end possess bigger eye spots than those of posterior end cells.
- The cells of *Volvox* colony are *Chlamydomonas* type.
- Every cell has its own mucilage sheath. It is connected with the sheath of other cell by a series of cytoplasmic strands called plasmodesmata.
- Each cells are biflagellate, two flagella are equal, whiplash type and project outwards.
- Each cell contains one nucleus, a cup shaped chloroplast with one or more pyrenoids, an eye spot and 2-6 contractile vacuoles.
- The cells of colony are independent and performs its own function of photosynthesis, respiration and excretion.
- The movement of colony takes place by co-ordinated flagella.
- The cells of the posterior ends take part in reproduction at maturity.

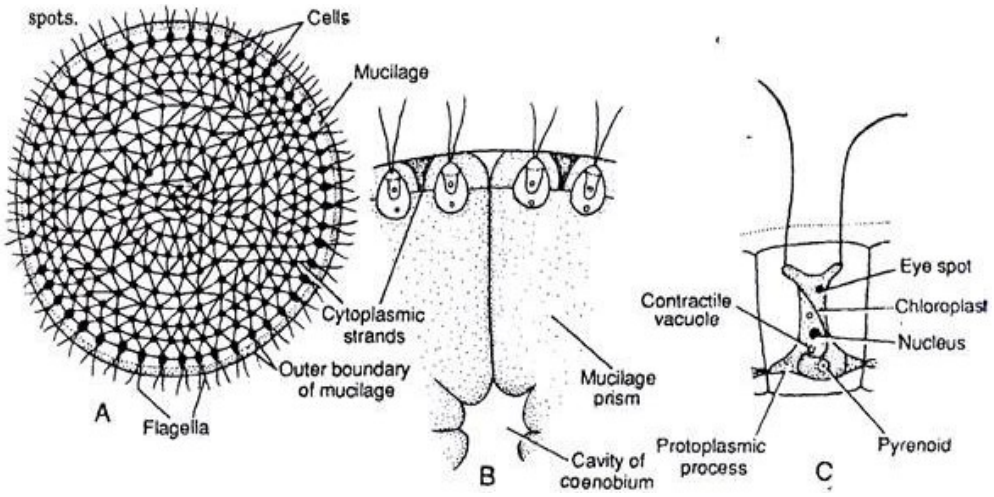


Fig. 6.1 **A - Colony; B - A part of colony; C - Single cell**

6.3 REPRODUCTION:

- *Volvox* can reproduce both asexually and sexually.
- Asexual reproduction in *Volvox* takes place by the formation of autocolonies.
- These autocolonies or special cells are located at the posterior end of the colony.
- These cells are called gonidia.
- The cells of the gonidia are divide to form daughter colonies.
- These colonies are part of the parent but with flagella and facing inwards.
- When the cells have divided into the same number of cells as the parent colony, the hollow colonies invert through a special pore so that the flagella face outwards. The parent colony splits open to release the newly formed autocolonies.

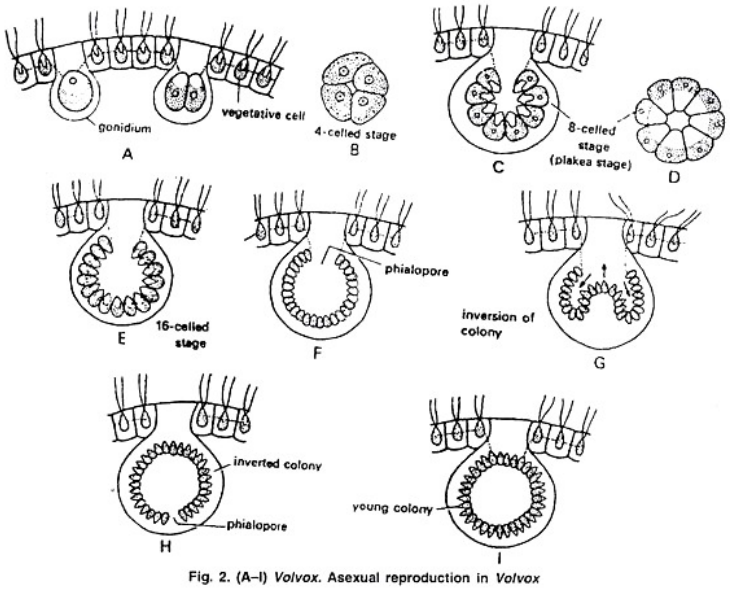


Fig. 2. (A–I) *Volvox*. Asexual reproduction in *Volvox*

Fig. 6.2 Asexual reproduction

Sexual Reproduction in *Volvox*

- Sexual reproduction in *Volvox* is oogamous type.
- The male sex organ is called antheridia and female sex organ is called oogonia.
- They are produced posterior half of the coenobium in few numbers.
- The coenobium may be monoecious or dioecious.
- In the monoecious species, antheridia and oogonia are formed on the same coenobium *eg.Volvox globator and* dioecious species, antheridia and oogonia are formed on different coenobium eg. *Volvox aureus.*

Antheridium

- It is an enlarged structure similar to gonidia.
- The protoplast of an antheridium undergoes repeated divisions to form biflagellate antherozoids.
- Each antherozoid contains a single nucleus and a chloroplast.

Oogonium

- It is a unicellular, enlarged, semi flask-shaped cell, with a gelatinous sheath-like wall.
- The protoplast of each oogonium forms a beak-like protrusion towards one side.

- Antherozoid enters through this end.
- The oosphere contains a chloroplast, pyrenoids, and a central nucleus.

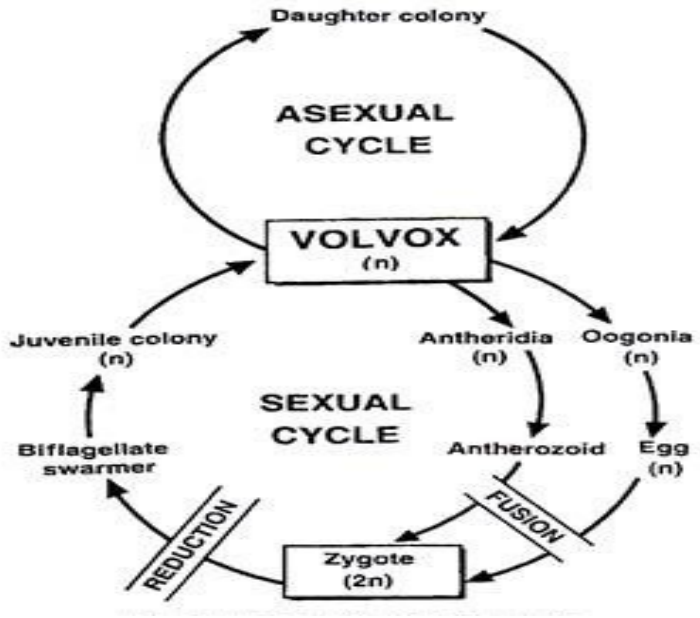
Fertilization

- During the fertilization, the antherozoids is liberated out from antheridium and swim to reach the egg.
- One of the antherozoid is fuse with the egg as a result to form a zygote or oospore.
- After that, the zygote develops a thick wall around it.
- The zygote comes out from the parent coenobium by the disintegration of the gelatinous matrix and sinks to the bottom of the water for a period of rest.

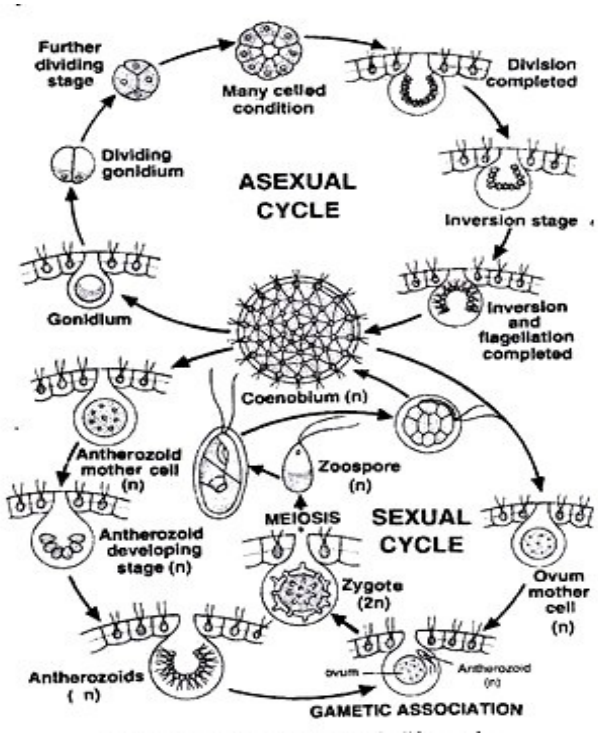
Germination of Zygote

- The diploid zygote divides meiotically into four haploid nuclei.
- One of the four nuclei survive with cytoplasmic contents escapes from the vesicle.
- The remaining three nucleus are degenerated.
- At this stage, is known as a swarmer who swims freely and forms a zoospore and develops into a new coenobium (colony).

Graphic life cycle of *Volvox*



Diagrammatic life cycle of *Volvox*



LET US SUM UP

In this unit we learned the detailed information about distribution structure, reproduction and life cycle of Volvox

CHECK YOUR PROGRESS

1. Volvox is a ---------- algae.
2. The colony of Volvox is called ----------

GLOSSARY

1. Anterior end - end directed forward
2. Gonidia - cells are located at the posterior end of the colony.

SUGGESTED READINGS

1. Algae By O.P. Sharma

ANSWERS TO CHECK YOUR PROGRESS

1. Freswater planktonic
2. coenobium

MODEL QUESTIONS

1. Write about life cycle of Volvox

WEB SOURCE

1. https://evodevojournal.biomedcentral.com/articles/10.1186/s13227-020-00158-7
2. https://www.algaebase.org/search/genus/detail/?genus_id=Qd0bc6cdd9739f7fd
3. https://fmp.conncoll.edu/silicasecchidisk/LucidKeys3.5/Keys_v3.5/Carolina35_Key/Media/Html/Volvox_Main.html
4. https://micro.magnet.fsu.edu/featuredmicroscopist/vanegmond/volvoxgroupsmall.html

UNIT – 7

CHARA

STRUCTURE

OVERVIEW

Chara belongs to Chlorophyceae family, its common name is stone wort. This unit describes the structure reproduction and lifecycle of Chara.

LEARNING OBJECTIVES

To know the reproduction and life cycle of Chara

7.1 SYSTEMATIC POSITION

Class: Chlorophyceae

Order: Charale

Family: Characea

Genus: *Chara*

Chara is commonly called as ‘stone wort’ It is a submerged aquatic

freshwater alga growing attached to the mud of the lakes and slow running streams. *Chara baltica* grows in saline water. The thallus is often encrusted with calcium and magnesium carbonate.

7.2 THALLUS STRUCTURE

The plant body is multicellular, macroscopic and is differentiated into main axis and rhizoids. The rhizoids are thread-like, multicellular structures arise from the lower part of the thallus or peripheral cells of the lower node. They are characterized by the presence of oblique septa. The rhizoids fix the main axis on the substratum and helps in the absorption of salts and solutes.

Structure of thallus *Chara*

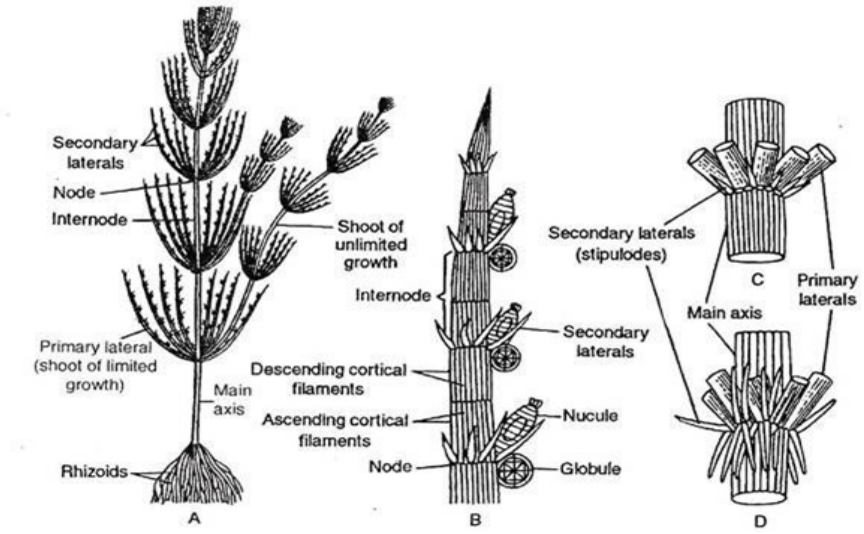


Fig.7.1 A-external morphology; B- Branch of limited growth: C& D- Appendages on node (C-haplostephanous & D- Diplostephanous)

The main axis is branched, long and is differentiated into nodes and internodes. The internode is made up of an elongated cell in the centre called axial cell or internodal cell. The axial cell is surrounded by vertically elongated small cells which originate from the node. They are called cortical

cells. In *C. wallichii* and *C. corallina* the cortical cells are absent.

Three types of appendages arise from the node. They are

1. Branches of limited growth 2. Branches of unlimited growth 3.Stipuloides.

The growth of the main axis and its branching takes place by the apical cell.

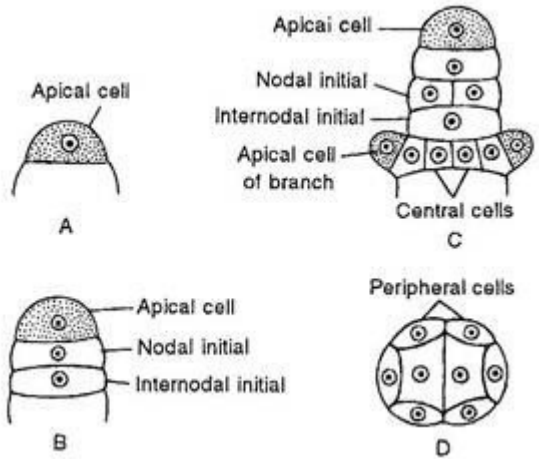


Fig. 7.2 A-C: stages of growth; D- T.S. of node

7.3 REPRODUCTION

Chara reproduces by vegetative and sexual methods. Vegetative reproduction takes place by Amylum stars, Root bulbils, Amorphous bulbils and secondary protonema.

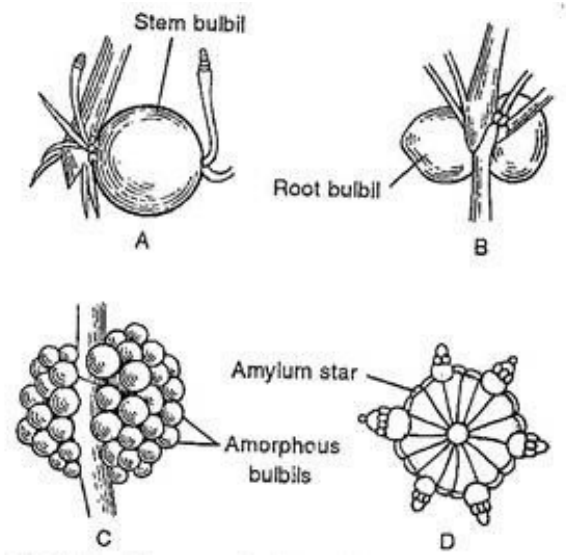


Fig.7.3 Bulbil

Sexual reproduction:

Sexual reproduction is Oogamous. Sex organs are macroscopic and are produced on the branches of limited growth. The male sex organ is called Antheridium or Globule. The female sex organ is called Oogonium or Nucule .The Nucule is located above the Globule. The antheridium is spherical, macroscopic and its wall is made up of eight cells called shield cells.The antheridium has spermatogenous filaments. These filaments produce antherozoids.

The nucule is covered by five spirally twisted tube cells and five coronal cells are present at the top of the nucule (Figure 7.4). The centre of the nucule possesses a single egg.

***Chara* sex organs**

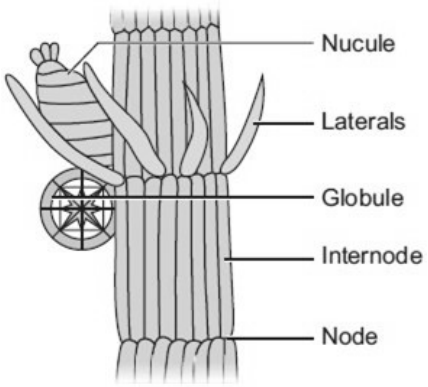
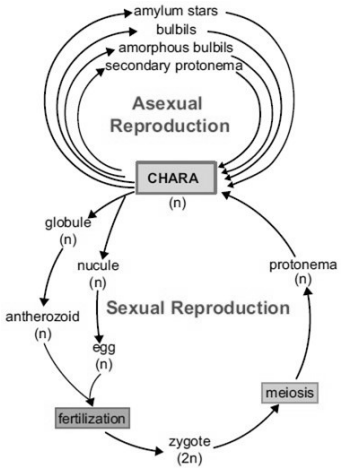


Fig. 7.4 Nucule

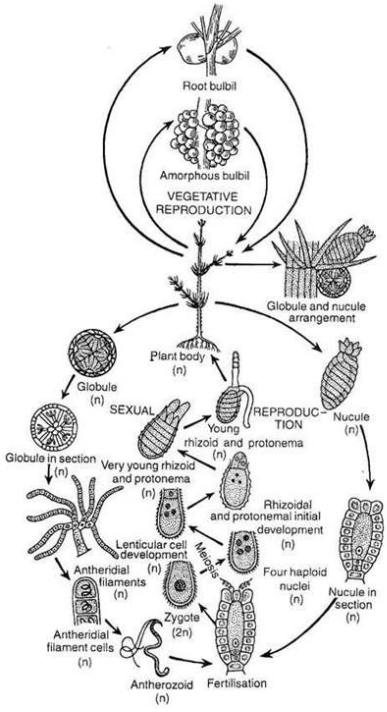
Fertilization:

At maturity the tube cells separate and a narrow slit is formed. The antherozoids penetrate the oogonium and one of them fuses with the egg to form a diploid oospore. The oospore secretes a thick wall around and germinates after the resting period. The nucleus of the oospore divides to form 4 haploid daughter nuclei of which, three degenerate. The oospore or zygote germinates to produce haploid protonema. The plant body of *Chara* is haploid. The oospore is the only diploid phase in the life cycle. Therefore, the life cycle is of haplontic type. Alternation of generations is present.

Graphic life cycle *Chara*



Diagrammatic life cycle of *Chara*



LET US SUM UP

In this unit we learned the detailed information about distribution structure, reproduction and life cycle of *Chara*

CHECK YOUR PROGRESS

1. Chara can grow in----------.
2. The female sex organ of Chara is called ----------

GLOSSARY

1. Anterior end - end directed forward
2. Gonidia - cells are located at the posterior end of the colony.

SUGGESTED READINGS

1. The Algae World by Dinabandhu Sahoo and Joseph Sackbach

ANSWERS TO CHECK YOUR PROGRESS

1. Saline water
2. Nucule

MODEL QUESTIONS

1. Explain sexual reproduction in Chara

WEB SOURCES

1. **https://aquaplant.tamu.edu/plant-identification/alphabetical-index/muskgrass/**
2. **https://www.aquaticbiologists.com/branched-algae-chara/**
3. **https://www.merriam-webster.com/dictionary/chara**
4. **https://www.algaebase.org/search/genus/detail/?genus_id=43352**

UNIT – 8

POLYSIPHONIA

STRUCTURE

OVERVIEW

Polysiphonia is a very important member of the class Rhodophyceae commonly called red alagae. In this unit we can study elaborately about Polysiphonia, from systematic positionto lifecycle.

LEARNING OBJECTIVES

To understand the life cycle of polysiphonia

8.1 SYSTEMATIC POSITION

Class: Rhodophyceae

Order: Ceramiales

Family: Rhodomelaceae

Genus: Polysiphonia

8.2 OCCURRENCE

Polysiphonia is a large genus with about 150 species. The genus is represented in India by about 16 species found is southern and western coasts of India (e.g., *P. ferulacea, P. urceolata* and *P. variegata*). Most of the species are lithophytes i.e., growing on rocks. Some species are epiphytic, i.e., growing on other plants and algae e.g., *P. ferulacea* grows on *Gelidium pusillum*. Some species are semi parasitic e.g., *P. fastigiata* is semiparasiite on *Ascophyllum nodosum* and *Fucus*.

8.3 THALLUS STRUCTURE

The thallus is filamentous, red or purple red in colour. The thallus is multi-axial and all cells are connected by pit connections hence, the name given is *Polysiphonia*.

- The thallus is heterotrichous and is differentiated into a basal prostrate system (creeping filament) and erect aerial system (erect filament).
- Basal prostrate system grows over the substratum horizontally.
- It is attached to the substratum by rhizoids
- Rhizoids are anchorage in function.
- Erect aerial system is branched and multiaxial filament.
- It consists of central siphon surrounded by several pericentral siphons.
- The erect system has two of branches namely long and erect branches.
- The short branches or trichoblasts are branches of limited growth.
- These are uni-axial in structure and lack pericentral siphons.
- The cells are connected to each other by pit connections.
- The long lateral branches are branches of unlimited growth are polysiphonous at the base and monosiphonous in terminal parts.

Cell structure

- The cells of central and pericentral siphons are cylindrical and elongated.
- The cell is bound by a cell-wall.
- Inner to this is a plasma membrane which surrounds the protoplasm.
- The cells are interconnected by pit.
- The cytoplasm contains a nucleus, vacuole, chromatophores
- Floridean starch is the reserve food.

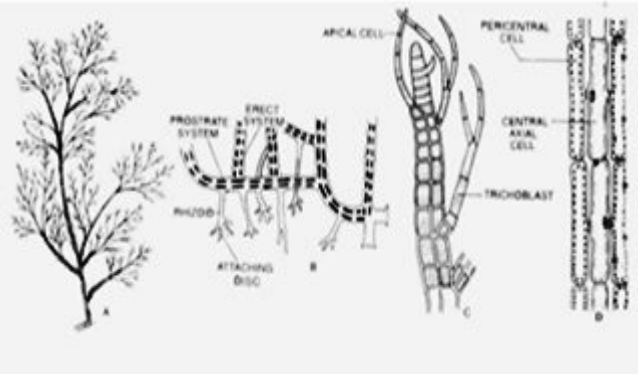


Fig. 8.1 Polysiphonia

8.4 REPRODUCTION IN *POLYSIPHONIA*

Polysiphonia is mainly heterothallic. In the life cycle of *Polysiphonia* three kinds of thalli are found. These are:

(a) **Gametophyte: it is** haploid free living and dioecious. The male sex organs spermatangia are formed on male gametophytic plant and the female sex organs carpogonia are formed on female gametophytic plant.

(b)**Carposporophyte**: It is diploid and depend upon the female gametophyte. They develop after fertilization from zygote and later bear carposporangia. The carposporangia form diploid carpospores.

(c) Tetrasporophyte: It is formed by germination of diploid carpospores and bears tetrasporangia in which non-motile tetraspores are formed.

*Polysiphonia*reproduces bysexual and asexual methods.

Sexual reproduction is oogamous type and plants are dioecious (i.e., male and female sex organs are produced on different male and female gametophytic plants).

Spermatangia:

It is a male sex organ. They are produced in clusters on fertile branches. Each fertile branch has a central row of cells. This row of cells is surrounded by pericentral cells. Each pericentral cell cuts off one or more spermatangial mother cells. Each spermatangial mother cell produces1 to 4 spermatangia.Each spermatangium develops into a single spermatium.

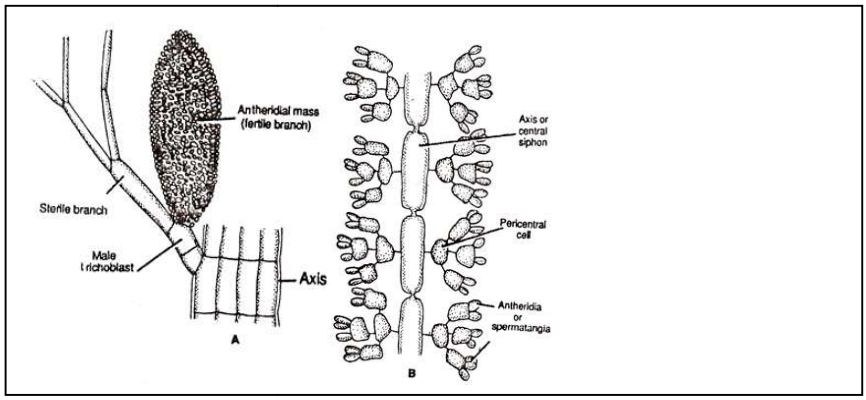


Fig. 8,2 Reproductive organs

Carpogonia: it is afemale sex organ. They are produced singly on the female fertile branches. They are short and about five to seven cells in length. The apical cell of this carpogonial filament is changed into carpogonium. Carpogonium is flask shaped. its basal portion has single egg or oosphere. Its upper elongated neck is called trichogyne.

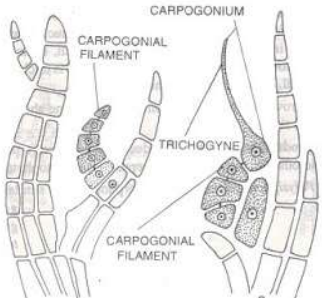


Fig. 8.3 Carpogonium

Fertilization: Spermatia is released are carried to the carpogonium. The male and female nucleus fuse and form zygote. It soon divides into two nuclei.

Basal sterile cell of carpogonium filament

produces two cells called basal sterile.

↓

Supporting cell produces an auxillary cell

↓

A tubular connection develops between auxillary and carpogonium filament

↓

Diploid nucleus divides into two and enter through auxillary cell.

↓

Now auxillary, carpogonium filament and basal sterile cell fuse and form central cells.

↓

Now, diploid nucleus divides mitotic and form two nucleus.

↓

Now, goniomoblast initials develop from central cell.

↓

The terminal cell of the goniomoblast enlarges and form carposporangium

↓

Inside carposporangium, carpospores is formed.

↓

Then, sterile filaments grow around the goniomoblast and central cell.

↓

It covers and form pericarp.

↓

The entire body thus formed is known as cystocarp.

↓

The opening is called ostiole.

↓

The carpospores germinate into tetrasporophytes plant and form 4 tetraspores.

↓

Two sporophytes give rise to male gamtophytes and other two give female gametophytes.

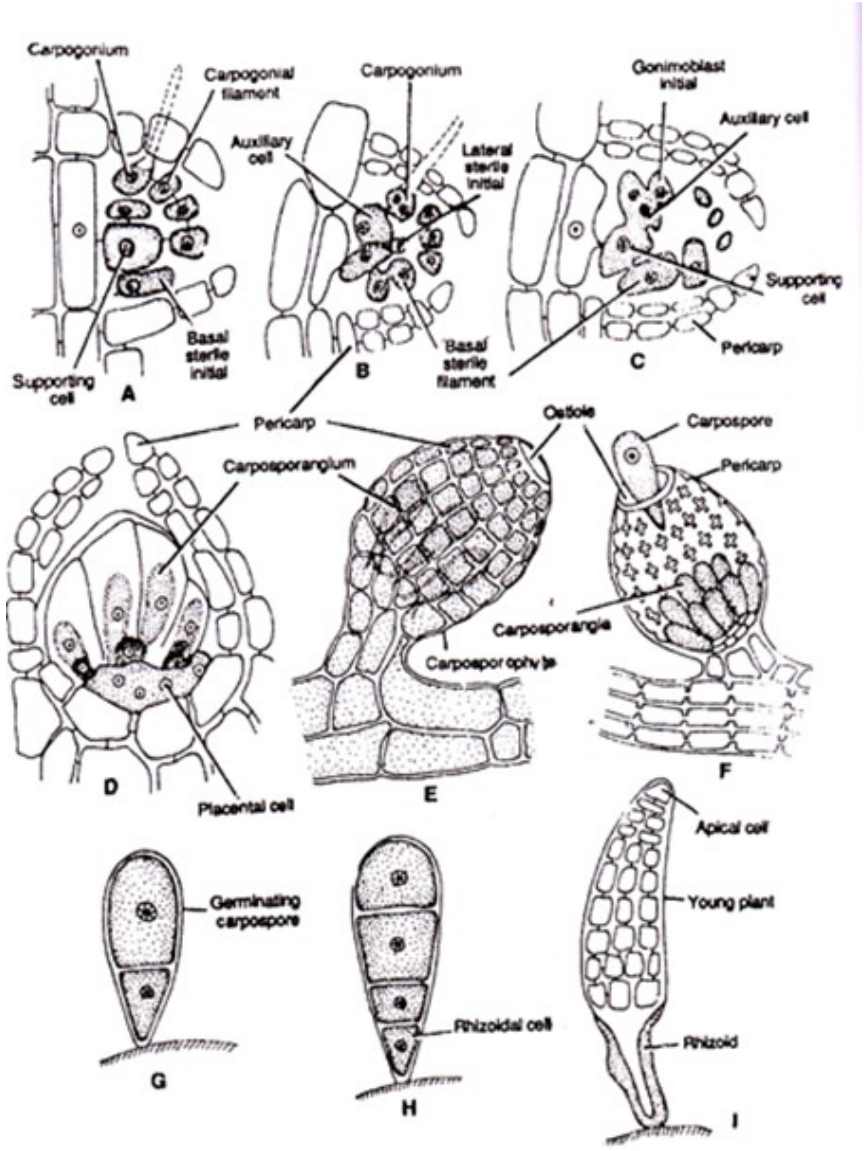


Fig. 8.4 Post fertilization changes

Asexual reproduction

It occurs in sporophyte. It produces tetraspores in terasporangium. Tetrasporangia are produced from the fertile pericentral cells. Only one pericentral cell in each tier is fertile. The fertile pericentral cell cut off a small

peripheral cell and one or two cover cells. The pericentral cell itself divides transversely. It forms two unequal cells. The lower smaller cell becomes the stalk cell. The upper larger cell becomes tetrasporangium. The nucleus of tetrasporangium undergoes meiosis. It produces four haploid tetraspores. The haploid tetraspores germinate to form gametophyte.

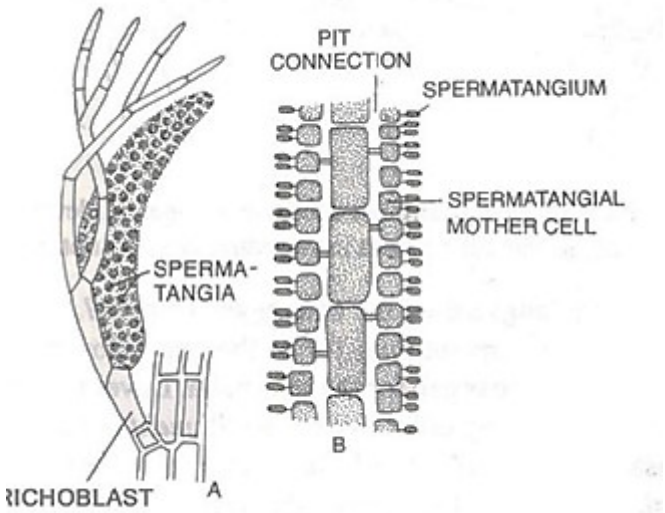


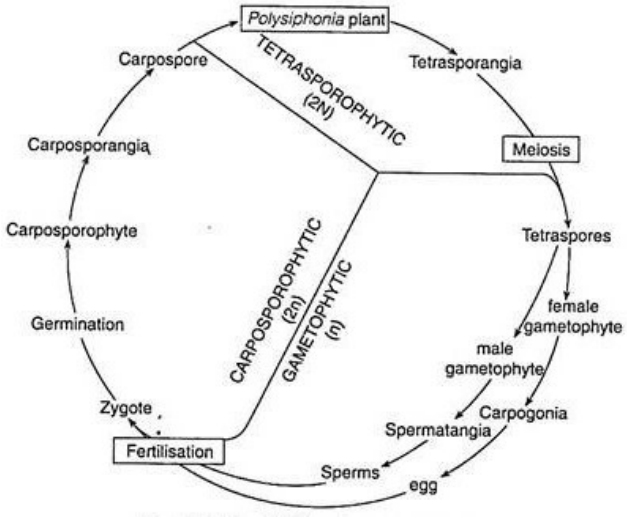
Fig.8.5 Spermatangial changes

8.5 LIFE CYCLE OF *POLYSIPHONIA:*

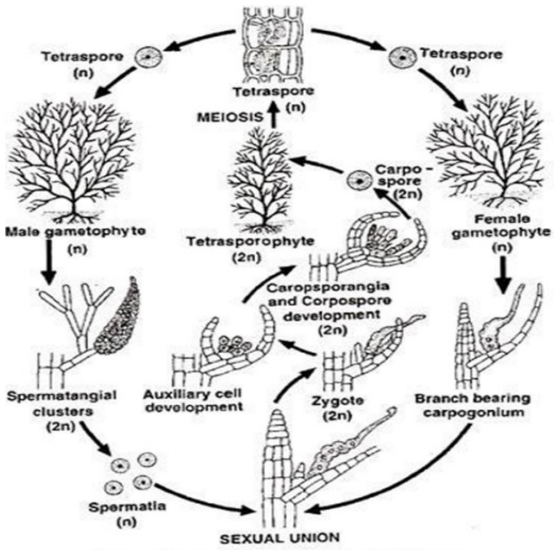
The life cycle of *Polysiphonia* is triphasic alternation of generation. In the life cycle three distinct phases occur.Tetrasporophyte which produces four haploid tetraspores. These tetraspores grow by mitosis into haploid gametophytes, either "male" or "female". The male gametophyte produces spermatangia at the tips of its branches and these spermatangia produce haploid spermatia by mitosis. The female gametophyte produces carpogonial branches, which have an egg at the base and a long filament called a trichogyne that extends from the egg chamber. A spermatium fuses with a trichogyne and its nucleus travels down the trichogyne to fertilize the egg, making a diploid zygote. The zygote grows, still attached to the gametophyte, within a structure called the cystocarp. The cystocarp has an external layer called the pericarp that is formed from the female gametophyte's tissue (haploid). Within the pericarp, the zygote has grown by

mitosis into a carposporophyte making elongated carposporangia. Inside each carposporangium, diploid carpospores are produced by mitosis. Carpospores are released and grow by mitosis into tetrasporophytes. Within the branches of the tetrasporophyte, tetrasporangia are formed and undergo meiosis to produce four haploid tetraspores each. These tetraspores are released and we arrive back where we started.

Graphic life cycle of *Polysiphonia*



Diagramaticlife life cycle of *Polysiphonia*



LET US SUM UP

In this Unit we discussed about the detailed information of red algae-Polysiphonia. The details includes systematic position, occurrence, structure, reproduction and lifecycle.

CHECK YOUR PROGRESS

1. ---------- is epiphytic algae
2. The name Polysiphonia is given due to ----------

GLOSSARY

1. Floridea - starch food reserve

SUGGESTED READINGS

1. The structure and reproduction of Alga by FE Fritsch

ANSWERS TO CHECK YOUR PROGRESS

1. *P. ferulaceae*
2. pit connection of cells

MODEL QUESTIONS

1. Write detailed notes on Polysiphonia

WEB SOURCES

1. https://www.marinespecies.org/aphia.php?p=taxdetails&id=143853
2. https://micro.magnet.fsu.edu/optics/olympusmicd/galleries/brightfield/polysiphonia.html
3. https://www.itis.gov/servlet/SingleRpt/SingleRpt?search_topic=TSN&search_value=13440#null
4. https://www.cabi.org/isc/datasheet/107751

UNIT – 9

SARGASSUM

STRUCTURE

OVERVIEW

This unit deals with member of Bluegreen algae Sargassum. This genus posses nearly 150 specie, it is widely distributed mainly in tropical places. Thallus is normal with holdfast. Reproduction takes place by vegetative and sexual reproduction.

LEARNING OBJECTIVES

To understand te life cycle of BGA Sargassum

9.1 SYSTEMATIC POSITION

Class: Phaeophyceae

Order: Fucales

Family: Sargassaceae

Genus: *Sargassum*

9.2 OCCURRENCE OF *SARGASSUM*:

The genus Sargassum is represented by about 150 species. The genus is widely distribute; specially in warmer regions mainly in tropical and subtropical seas of the southern hemisphere. The plants form large floating masses in the Atlantic Ocean of the African continent between 20° and 35° north latitude. This part of Atlantic ocean is called the Sargasso Sea.

The alga grows abundantly both in east and west coasts of India, Australia and Ceylon. In India Sargassum is represented by about 16 species. Some common Indian species are: *S. carpophyllu, S. christifolium, S. cinereum, S. duplicatum, S. ilicifolium, S. myriocystwn, S. plagiophyllum* and *S. wightii.* The alga grows attached to the rocks in little bushes in the intertidal zone or in the shallow puddles of the zone.

9.3 THALLUS STRUCTURE OF *SARGASSUM*:

- The thallus of *Sargassum* is diploid and sporophytic.
- The thallus is differentiated into holdfast and the main axis.
- The holdfast is discoid structure, it helps in attachment of thallus to substratum.
- The main axis bears large number of primary laterals.
- The main axis and primary laterals bear flat leaf-like branches known as secondary laterals or **"leaves"**
- The leaf-like laterals are flat and simple with blade, veins and petiole like structure.
- The air bladders are modifications of secondary laterals.
- These are spherical, air filled structures. They help in floating of plants.

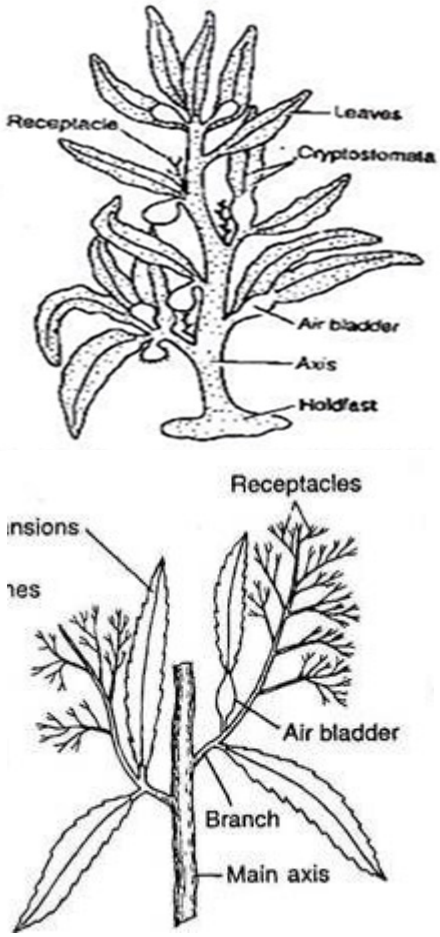


Fig.9.1 Sargassum

- Another modification of these laterals is in the form of highly branched structures bearing reproductive bodies called receptacles.
- The receptacles bear reproductive structure in special flask shaped cavities called as conceptacles.

Internal structures of main axis:

The main axis is circular in outline and internally it is differentiated into three regions:

(i) Meristoderm, (ii) Cortex (iii) Medulla.

The meristoderm is single cell thick outer-most layer and compactly arranged columnar cells.

The meristoderm functions as protective layer.

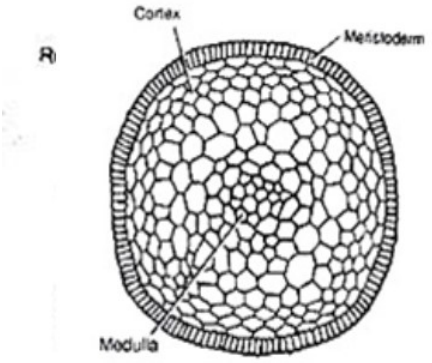


Fig.9.2 TS of Sargassum

- The meristoderm is covered with thin layer of mucilaginous cuticle.
- The cortex zone is present between meristoderm and the medulla, is a multilayered and parenchymatous cells.
- The ain function is storage of reserve food material.
- The medulla is present in the central part and made of thick walled cells.
- The function of medulla is transport of water- and metabolites.

Internal structures of Secondary laterals:

- The internal structure of leaf is differentiated into meristoderm, cortex and medulla.
- The meristoderm is the outermost layer and functions as epidermis.
- It is made of radially elongated meristematic cells.
- The cells contain chromatophores and reserve food.
- The cortex is present between meristoderm and medulla.
- It is made of thin walled parenchymatous cells.

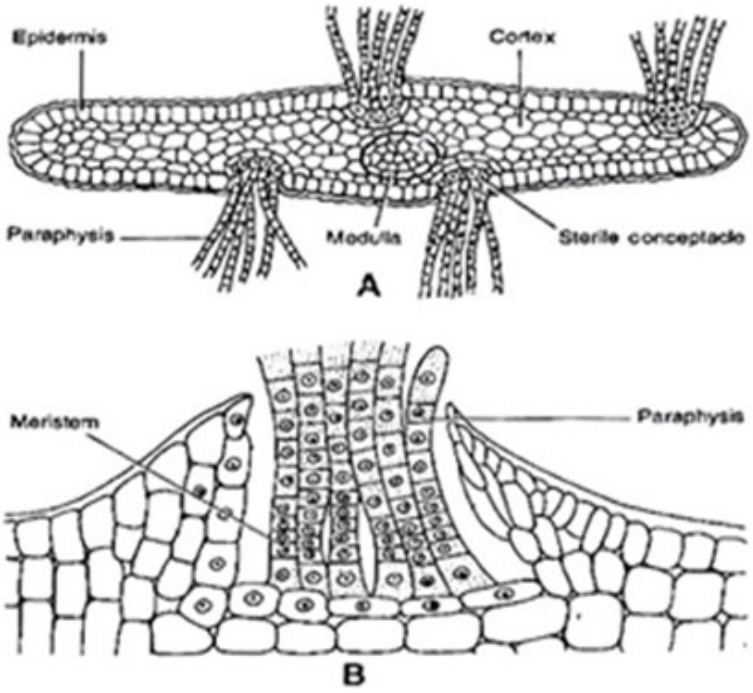


Fig.9.3 Internal structure of Sargassum

- The function of cortex is mostly storage.
- The medulla is made of thick walled cells.
- The function of medulla is conduction.
- On the margins of leaves and on surface are present many sterile cavities called sterile conceptacles, crypto stomata or crypto blasts.

9.4 REPRODUCTION:

The reproduction takes place by vegetative and sexual methods. The asexual reproduction is absent.

(A) Vegetative Reproduction in Sargassum:

Sargassum multiplies profusely by vegetative fragmentation.

The thallus breaks into fragments due to mechanical injury or death and decay of older parts.

(B) Sexual Reproduction in Sargassum:

- Sexual reproduction in Sargassum is oogamous.
- The male sex organs are called antheridia and the female sex organs are oogonia.

- The sex organs develop in special flask shaped cavity called conceptacle and present in receptacles.
- The male and female sex organs develop in separate conceptacles.
- The male conceptacles bearing antheridia and female conceptacles bearing oogonia.
- In homothallic or monoecious species the male conceptacle and female conceptacles are produced on same receptacle, but antheridia and oogonia are not produced in same conceptacles. Sargassum species are mostly monoecious.

Antheridium

- The antheridium has one diploid nucleus which undergoes meiotic divisions and later by mitotic divisions.
- This results in formation of number of antherozoid.
- The antherozoid is pear shaped structure with two lateral flagella.

Oogonia

- The diploid oogonial nucleus undergoes meiotic and mitotic divisions to form 8 nuclei.
- Of these one is functional and others are degenerated.
- This nucleus with protoplasm forms single ovum.

Fertilization

- The antherozoids are released in water and the oogonia remain attached to the conceptacle base by mucilaginous stalk.
- The male and female nuclei fuse to form a diploid zygote.

Germination of Zygote

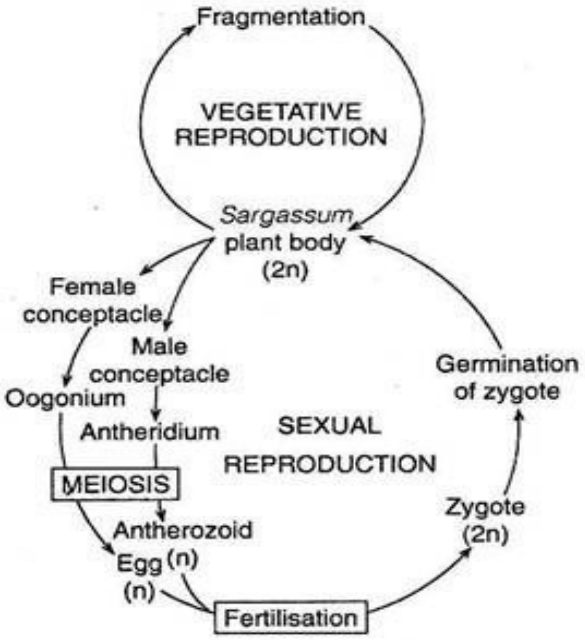
- The zygote germinates immediately after fertilization.
- The zygote first divides by transverse division to make a lower cell and upper cell.
- The lower cell forms the hold fast and upper cell forms the main axis.

Life Cycle of Sargassum:

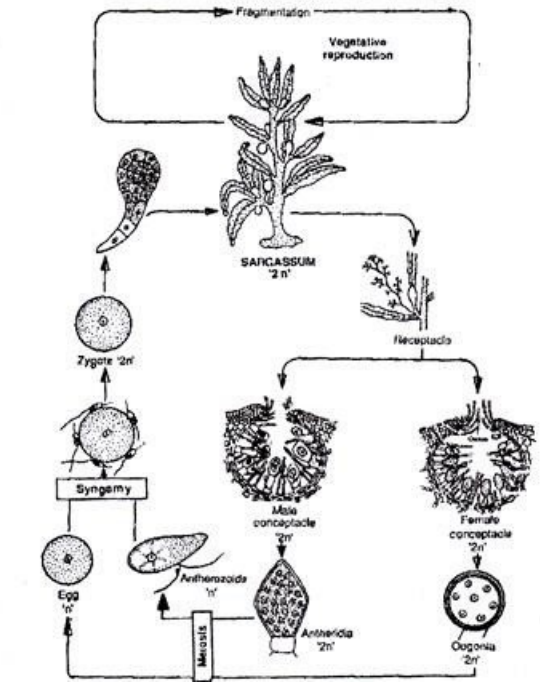
The life cycle of Sargassum is diplontic type and there is no alternation of generation. The thallus is diploid sporophytic. It forms diploid antheridia and oogonia. The reduction division in antheridia and oogonia

forms haploid antherozoid and oognial nuclecus. The gametes only are haploid structure in the life cycle. After fertilization a diploid zygote is formed which divides to make a diploid sporophytic thallus.

Graphic llife cycle of *Sargassum*



Dagramatic llife cycle of *Sargassum*



LET US SUM UP

This unit elaborates from the systematic position of Sagassum from the Cass Phaeophyceae and further explains the structure, reproduction and lifecycle of Sargassum. Sargassum appears I simple thallus structure and reproduces by means of vegetative and sexual reproduction.

CHECK YOUR PROGRESS

1. Secondary laterals modified into ----------
2. Anthrozoids possess ----------lateral flagella

GLOSSARY

1. Holdfast – Discoid structure helps in the attachment of thallus to the substratum.

SUGGESTED READINGS

1. The Algae by Chapman and Chapman

ANSWERS TO CHECK YOUR PROGRESS

1. air bladders
2. two

MODEL QUESTIONS

1. Write about the life cycle of Sargassum

WEB SOURCES

1. https://www.britannica.com/science/Sargassum
2. https://oceanexplorer.noaa.gov/facts/sargassum.html
3. https://www.floridamuseum.ufl.edu/earth-systems/blog/sargassum-seaweed-or-brown-algae/
4. https://cen.acs.org/environment/sustainability/Sargassum-strangling-tourism-Caribbean-scientists/97/i34

Block III

FUNGI

Unit - 10 Introduction to Fungi

Unit - 11 General Classification of Fungi

Unit - 12 Economic Importance of Fungi

Unit - 13 Type study -Albugo, Aspergillus, Puccinia & Cercospora

UNIT – 10

INTRODUCTION TO FUNGI

STRUCTURE

OVERVIEW

Fungi are most common organism in living environment. They spread all over the earth. The most common feature of the fungi is they can't prepare their food material, the depend upon other organisms.

LEARNING OBJECTIVES

To understand the habit and distribution of fungi

To know the charetersti feature of fungi

10.1 INTRODUCTION

Fungus, plural **fungi**, any of about 144,000 known species of organisms of the kingdom Mycology (Mykes-mushroom,logos-study) is the study of fungi and the concerned scientists are called mycologists. Fungi (singular fungus- meaning mushroom) are achlorophyllous thallophytic plant. Due to absence of chlorophyll, they are heterophytes.

Fungi, which includes the yeasts, rusts, smuts, mildews, molds, and mushrooms. There are also many fungus-like organisms, including slime molds and Oomycetes (water molds), that do not belong to kingdom fungi but are often called fungi. Many of these funguslike organisms are included in the kingdom *Chromista*.

Alexopoulos and Mims defined fungi as “eukaryotic spore bearing achlorophyllous organisms that generally reproduce sexually and asexually, and whose usually filamentous, branched somatic structures are typically sorrounded by cell walls containing chitin or cellulose or both of these substances, together with many other complex molecules.”

10.2 GENERAL CHARACTERISTICS OF FUNGI

1. Fungi are eukaryotic organisms; i.e., their cells contain membrane-bound organelles and clearly defined nuclei.
2. They are cosmopolitan in distribution.
3. They are found in aquatic (water), terrestrial (soil) or aerial (air) habitats.
4. They are heteromorphic in nature (i.e.parasite- eg. *Puccinia*, saprophyte – eg. *Mucor* or symbionts).
5. They are unicellular (eg. *Synchytrium*) or filamrntous (eg. *Mucor, Aspergillus*).
6. The plant body is known as mycelium (i.e., filamentous hypha in plural hyphae)
7. The hypha maybe aseptate (i.e. without septa and containing many nuclei) or septate (i.e., mycelium in its cell may contain uninucleate (one nucleus) or multinucleate (many nucleus).
8. The cells are sorrounded by distinct cell wall (except slime molds).
9. The cell wall is composed of fungal chitin or glucan.
10. Glycogen or oil is the common reserve food material in fungi
11. They reproduce by three methods: 1. Vegetative; 2. asexual and 3. sexual.
12. Vegetative reproduction is takes place by fragmentation (Mucor), budding (Saccharomyces), and fission (Sachharomyces).
13. Asexual reroduction takes place by different types of spores.

14. These are zoospores (*Synchytrium*), conidia (*Aspergilus*), oidia (*Rhizopus*), chlamydospore (*Fusarium*). The spores maybe unicellular (*Aspergillus*) or multicellular (*Alternaria*).
15. Sexual reproduction occurs in all group of fungi except Deuteromycetes.
16. It takes place by the Gametic copulation (*Synchytrium*), gametangial contact (*Pythium*), Gametangial copulation (*Rhizopus*), Spermatization (*Puccinia*), and Somatogamy (*Polyporus*).

LET US SUM UP

In this Unit Discussed about the general charecterestic features of Fungi and also its habit.

CHECK YOUR PROGRESS

1. In this group ----------there is no sexual reproduction
2. Common reserve foo material in fungi is ----------

GLOSSARY

1. Mycology – study of fungi
2. Fragmentation – vegetative reproduction

SUGGESTED READINGS

1. Intoductionr to Mycology by Chelin Rani Gnanam
2. Introduction to Fungi by John Webster and W S Weber

ANSWERS TO CHECK YOUR PROGRESS

1. Deuteromycetes
2. Glycogen

MODEL QUESTIONS

1. Sketch Classification of Fungi by Alexapoulos and Mims

WEB SOURCES

1, https://www.britannica.com/science/fungus

2. https://microbiologysociety.org/why-microbiology-matters/what-is-microbiology/fungi.html

3. https://ucmp.berkeley.edu/fungi/fungi.html

4. https://www.news-medical.net/life-sciences/What-are-Fungi.aspx

5.https://www.cdc.gov/fungal/diseases/index.html

UNIT – 11

CLASSIFICATION OF FUNGI

STRUCTURE

OVERVIEW

Many scientists classified fungibased on may charecterestic features like, shape, size, habit, colour byproduct, storage materials host organism, etc. In tis unit we can disuss te classification made by two eminent groups.

LEARNING OBJECTIVES

To understand the fungi by its position

11.1 CLASSIFICATION - CONCEPT

Many mycologists have attempted to classify fungi based on vegetative and reproductive characters. Traditional classifications categorise fungi into 4 classes – Phycomycetes, Ascomycetes, Basidiomycetes and Deuteromycetes. Among these 'Phycomycetes' include fungal species of Oomycetes, Chytridiomycetes and Zygomycetes which are considered as

lower fungi indicating algal origin of fungi.

The classification of fungi is designed mainly for practical application but it also bears some relation to phylogenetic considerations. The division of mycota, or fungi and moulds, includes the true slime moulds (Myxomycetes), the lower fungi (Phycomycetes), and the higher fungi (Eumycetes).

The fungi can be classified according to the various parameters including;

- Classification based on taxonomy hierarchy
- Classification based on spore Production
- Classification of medically important fungi
- Classification based on route of acquisition
- Classification based on virulence
- Classification based on taxonomy hierarchy:

11.2 CLASSIFICATION Of FUNGI BY CONSTANTINE J. ALEXOPOULOS AND CHARLES W. MIMS (1979)

Constantine J. Alexopoulos and Charles W. Mims in the year 1979 proposed the classification of fungi in the book entitled 'Introductory Mycology'. They classified fungi into three divisions namely Gymnomycota, Mastigomycota and Amastigomycota. There are 8 subdivisions, 11 classes, 1 form class and 3 form subclasses in the classification proposed by them.

<table>
<tr><td colspan="3">Kingdom: Mycetae
(Further divided into 3 divisions)</td></tr>
<tr><td>Division I</td><td>Division II</td><td>Division III</td></tr>
<tr><td>Gymnomycota</td><td>Mastigomycota</td><td>Amastigomycota</td></tr>
<tr><td colspan="3">(These divisions are further divided into sub divisions, classes, sub classes and orders)</td></tr>
<tr><td>Subdivision I
Acrasiogymnomycotina
Class</td><td>Subdivision I
Haplomastigomycotina
Classes</td><td>Sub division I
Zygomycotina
Classes
1. Zygomycetes
2. Trichomycetes</td></tr>
</table>

1.Acrasiomycetes **Sub division II:** Plasmodiogymnomycotina **Classes** 1. Protosteliomycetes 2. Mycomycetes (Further divided into 3 sub classes and orders) **Sub classes** 1.Ceratiomyxomycomycetidae One order 2.Mycogasteomycetidae Four orders 3. Stemonitomycetidae One order:	1.Chytridiomycetes 2.Hyphochytridiomycetes 3.Plasmodiophoromycetes **Sub division II:** Diplomastigomycotina **Class** 1.Oomycetes four orders	**Sub division II** Ascomycotina **Class** 1.Ascomycetes (Further divided into 5 sub classes and orders) **Sub classes** 1.Hemiascomycetidae Three orders. 2. Plectomycetidae Five orders 3. Hymenoascomycetidae Ten orders 4. Laboulbeniomycetidae Two orders 5. Lowloascomycetidae Five orders **Sub division III** Basidiomycotina **Class** 1: Basidiomycetes (Further divided into 3 sub classes) Sub classes 1. Holobasidiomycetidae 2.Phragmobasidiomycetidae 3. Teliomycetidae **Sub division IV** Deuteromycotina **Class** Deuteromycetes (Further divided into 3 sub classes) **Sub classes** 1. Blastomycetidae

		2. Coelomycetidae 3. Hyphomycetidae

11.3 Classification of Fungi by Ainsworth (1973)

A more natural system of classification of fungi was proposed by Ainsworth (1973) which has been accepted by many mycologists today like Webster (1980), Bilgrami (1985 and Dube (1987).

Kingdom: Mycota

(Further divided into 2 divisions)

Division I: Myxomycota (Wall-less organisms possess either a Plasmodium or a pseudoplasmodium)	**Division II: Eumycota** (True fungi, all with walls):

(These divisions are further divided into sub divisions and classes)

Classes	**Subdivision I**
1.Acrasiomycetes 2. Hydromyxomycetes 3. Myxomycetes 4. Plasmodiophoromycetes	Mastigomycotina (Motile cells – zoospores present, perfect state spore-oospore) **Classes** 1. Chitridiomycetes 2. Hyphochytridiomycetes 3. Oomycetes **Subdivision II** Zygomycotina (Mycelium aseptate, perfect state spore-zygospore). 1. Zygomycetes 2. Trichomycetes **Subdivision III** Ascomycotina (Yeasts or septate mycelium, perfect state spore- ascospores

	formed in ascus, usually within ascocarp). **Classes** 1. Hemiascomycetes 2. Loculoascomycetes 3. Plectomycetes 4. Laboulbeniomycetes 5. Pyrenomycetes **Subdivision IV** Basidiomycotina (Yeast or septate mycelium, perfect state spore – basidiospore formed on a basidium). **Classes** 1. Teliomycetes 2. Hymenomycetes. 3. Casteromycetes. **Subdivision V** Deuteromycotina or Fungi imperfecti. (Yeast or septate mycelium. Perfect state unknown) **Classes** 1. Blastomycetes. 2. Hyphomycetes 3. Coelomycetes

LET US SUM UP

In this unit we clearly understood te fungi by its position and its classification concept.

CHECK YOUR PROGRESS

1. Ainsworth classified fungi in the year ----------

GLOSSARY

1. Eumycetes – Higher fungi

SUGGESTED READINGS

1. The Kingdom Fungi by SL Stephenson

ANSWERS TO CHECK YOUR PROGRESS

1. 1973

MODEL QUESTIONS

1. Sketch the Classification of Fungi by Alexapoulos and Mims

WEB SOURCES

1. **https://pressbooks-dev.oer.hawaii.edu/biology/chapter/classifications-of-fungi/**
2. **https://www.toppr.com/guides/biology/biological-classification/kingdom-fungi/**
3. **https://www.geeksforgeeks.org/kingdom-fungi/**
4. **https://microbenotes.com/classification-of-fungi/**
5. **https://ucmp.berkeley.edu/fungi/fungisy.html**

UNIT – 12

ECONOMIC IMPORTANCE OF FUNGI

STRUCTURE

OVERVIEW

Each and every organism in tis world is important. Many organisms are useful for mankind oneway or the other. In this unit we can discuss the importance of Fungi at many angles.

LEARNING OBJECTIVES

To know various importance and useful products fro fungi.

12.1 FOOD:

Edible mushrooms are contains rich source of 30-40% of proteins, 2-5% of fibers, fats, minerals, nutrients and vitamins. Eg.*Agaricus bisporus, Morchella esculenta, Lentinus edodes, Clavatia gigantia, Volvariella volvacea* are edible. The yeast *Saccharomyces cerevisiae* is used for making '**yeast cake**'.

Single Cell Protein (SCP) are used as substitute of protein food. It has high

protein contents. Eg. Yeasts, *Penicillium, Fusarium* etc.

Flavoring of food: *Penicillium roquefortii* and *P. camemberti* are employed for flavouring cheese.

Brewing and baking: Yeasts are generally used in bakeries and breweries. *e.g., Saccharomyces cerevisiae*.

12.2 INDUSTRIAL IMPORTANCE

Organic acids: Several organic acids are commercially produced by fungi

Fungi as a source of organic acids

Organic acids	Source
Citric acid	*Aspergillus niger*
Gallic acid	*Penicillium glaucum*
Gluconic acid	*Aspergillus niger, Penicillum purpurogenum*
Fumaric acid	*Rhizopus stolonifer, Mucor sp.*
Lactic acid	*Rhizopus nodosus*
Kojic acid	*Aspergillus flavus*
Oxalic acid	*Aspergillus niger*

Antibiotics: The antibiotics are chemicals produced by living organisms that kill other living organisms. The first known antibiotic is penicillin that was extracted from Penicillium notatum by A. Flemming, (1944). Raper (1952) also extracted the same antibiotic from *P. chrysogenum.* Besides, several other antibiotics have been extracted since then.

Fungi as a source of antibiotics

Antibiotics	Source
Griseofulvin	*Penicillium griseofulvum*
Cephalosporin	*Acremonium sp.*
Ramycin	*Mucor ramannianus*
Jawaharin	*Aspergillus niger*
Patulin/Clavicin	*A. patulum/ A. clavatus*
Fumigallin	*Aspergillus fumigatus*
Frequentin	*Aspergillus cyclopium*

Other chemicals: Various chemicals have been obtained from different

kinds of fungi. Yeast is good source of glycerol and enzymes like zymase, invertase and lipase. Cellulases are obtained from *Aspergillus*. Some alkaloids are also obtained from fungi e.g., Ergotinine, Ergotetrine and Ergobasine from *Cleviceps purpurea*. Gibberellins (plant hormones) are obtained from *Gibberella fujikuroi*. Another hormone, trisporic acid is obtained from *Mucor mucedo*.

Biological assays : The fungi can detect the presence of certain chemicals present in the medium even in traces e.g., Aspergillus niger for Mn, Pb, Zn, Cu, Mo etc.

Vitamins : Various vitamins have been obtained from different kind of fungi.

Fungi as source of vitamins

Vitamins	Source
Vitamin A	Rhodotorula gracilis
Vitamin B2	Eremothcium ashbyii
Thiamine B1	Saccharomyces cerevisiae
Riboflavin B2	Saccharomyces cerevisiae

12.3 HARMFUL ASPECTS

Crop diseases: Several important crop plants are destroyed by fungal diseases. Some important ones are listed here under:

Fungal disease in plants

Disease	**Causal organism**
White rust of crucifers	*Albugo candida or Cystopus condidus*
Early blight of potato	*Alternaria solani*
Tikka disease of groundnut	*Cercospora personata*
Ergot disease of rye	*Claviceps purpurea*
Red rot of sugarcane	*Colletotrichum falcatum*
Powdery mildew of wheat	*Erysiphe graminis*
Powdery mildew of pea	*Erysiphe polygoni*
Leaf spot of oats	*Helminthosporium avenae*
Brown leaf spot of rice	*Helminthosporium oryzae*
Covered smut of barley	*Ustilago hordei*

Loose smut of wheat	*Ustilago tritici*
Late blight of potato	*Phytophthora infestans*
Downy mildew of grapes	*Plasmopara viticola*
Black rust of wheat	*Puccinia graminis-tritici*
Brown rust of wheat	*Puccinia recondita*
Yellow rust of wheat	*Puccinia striformis*
Damping off of seedlings	*Pythium sp.*
Wart disease of potato	*Synchytrium endobioticum*

Diseases in human beings: Several diseases in human beings are found to be caused by fungi, infecting different parts of the body. Some of them are given here under as:

Fungal disease in human

Disease	Causal organism	Place of infection
Athletes foot	*Epidermophyton floccosum*	Foot
Ring worm	*Trichophyton* sp., *Microsporum* sp.	Skin
Moniliasis	*Candida albicans*	Nails
Aspergillosis	Aspergillus *niger*, *A. flavus, A. terrus*	Lungs
Torulosis	*Cryptococcus neoformans*	Lungs, CNS

Spoilage of food: Some forms like *Rhizopus, Mucor, Aspergillus, Cladosporium*grow on food articles and spoil them. *Cladosporium* grows even at a temperature of – 6°*C*.

Aflatoxins: They are produced mainly by *Aspergillus flavus* and *A. parasiticus*. They are well known for their carcinogenic effect.*e.g.*, Aflatoxin B_1, B_2, M_1, M_2, G_1, G_2.

Poisonous fungi: Some fungi are extremely poisonous *e.g., Amanita phalloides* ('death cup'), *A. verna*and *Boletus satanus*. Forms like *Coprinus, Psilocybe* are less poisonous. The fungus *Amanita phalloides*

Rotting of wood: Rotting of wood is caused due to degradation of lignin and cellulose. It is brought about fungi like *Polyporus* sp., *Fomes* sp. and

Ganoderma sp., Forms like *Fusarium, Penicillium* leave stains on the wood.

Allergies: Spores of *Mucor, Aspergillus, Penicillium, Puccinia* etc., present in the atmosphere cause allergies.

Deterioration of articles: Forms like *Aspergillus, Cladosporium, Rhizopus, Chaetomium, Alternaria*deteriorate cork, rubber, leather, textile and even plastics.

LET US SUM UP

We discussed about the economic importance of fungi, most valuable such as food, medicine, industrial uses of fungi.

CHECK YOUR PROGRESS

1. Tikka disease in groundnut developed by ----------
2. Pennicillin derived from----------

GLOSSARY

1. Rotting – degradation of wood by fungi

SUGGESTED READINGS

1. Textbook of Fungi by Ramachandra Kushwaha

ANSWERS TO CHECK YOUR PROGRESS

1. Cercospora
2. Penicillium notatum

MODEL QUESTIONS

1. Give an account on Economic importance of Fungi

WEB SOURCES

1. https://collegedunia.com/exams/economic-importance-of-fungi-definition-examples-sample-question-biology-articleid-2389
2. https://uomustansiriyah.edu.iq/media/lectures/6/6_2021_11_27!08_24_20_PM.pdf
3. https://marwaricollege.ac.in/study-

material/2012507854Economic%20importance%20of%20Fungi.pdf
4. https://microbiologynote.com/economic-importance-of-fungi-in-medicine-industry-agriculture-and-food/

UNIT – 13

TYPE STUDY

STRUCTURE

OVERVIEW

In this unit we can elaborately study the detailed features of specific types like Albugo, Aspergillus, Puccinia and cecospora.

LEARNING OBJECTIVES

To learn specific details od some important fungi.

13.1 ALBUGO

Systematic position:

Division : Eumycophyta

Class : Phycomycetes

Order : Pernosporales

Family : Albuginaceae

Genus :*Albugo* or *Cystopus*

Introduction:

Albuginaceae is a monotypic family. It includes only single genera *Albugo*. It is an obligate, inter cellular parasite. It cannot be grown on culture medium.

Etiology:

- It causes "White-rust disease in the plants of family Cruciferae or Brassicaceae.
- It shows specificity towards the host.
- It appears in the form of shiny, white, smooth irregular patches (pustules) or blisters.
- They are usually present on lower surface of leaves which may also spread on the upper surface of the leaves & stems.
- Hypertrophy (increase in size of the cells and organs) is also a symptom of the disease.

Structure:

- Mycelium is branched, aseptate, coenocytic. (Septa are only formed in mycelium during reproduction).
- The hyphal wall is made up of cellulose.
- Reserve food material is present in the form of glycogen and oil globules.
- Hyphal network is found in the inter cellular spaces of the host.
- Round, button shaped or knob like and stalked haustoria are found in *Albugo*.

Reproduction in *Albugo*

The fungus reproduces both by asexual and sexual methods.

Asexual Reproduction of Albugo:

- It takes place by conidia or conidiosporangia.
- They develop on conidiophore or conidiosporangiophore.
- Mycelium below the epidermis gives off many erect, short, unbranched, club-shaped hyphae called conidiophores or sporangiophore

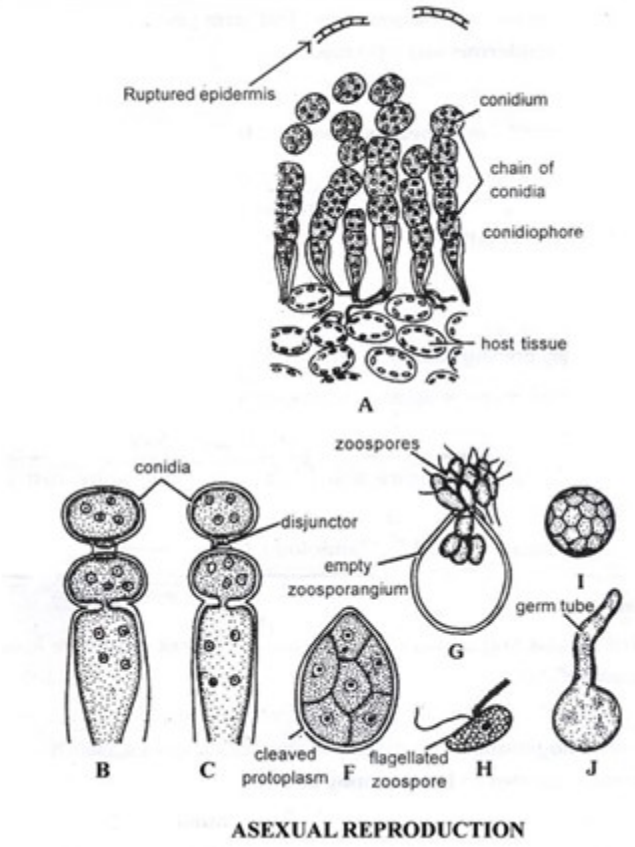


Fig.13.1 Conidium

- Conidiophores lie parallel to one another and perpendicular to the surface of the host, and form a palisade-like layer.
- On the thin-walled apical end of the thick-walled conidiophore are present four to six or more spherical, smooth and hyaline bodies called conidia.
- Conidia are arranged in basipetal succession on the conidiophore, i.e., youngest at the base and oldest at the top. (Figure).
- In between two conidia are present a disc of gelatinous material called mucilaginous disc or disjunctor.
- Each conidium and conidiophore is a multinucleate structure.
- In the later stages, the epidermis of the host gets ruptured and conidia disseminate.
- They germinate either directly by forming a germ tube or form biflagellate zoospores.

Sexual Reproduction:

- The sexual reproduction is oogamous type.
- The male sex organ is called antheridium and female sex organ is called oogonium.
- Two sex organs develop near each other but on different male and female hyphae.

Antheridium:

- It is elongated and club shaped structure.
- It is multinucleate, in some cases, only one nucleus remains functional.
- Mostly many nuclei can remain functional.

Oogonium:

- It is spherical and multinucleate (65 to 115 nuclei).
- All nuclei are evenly distributed throughout the cytoplasm.
- As the oogonium reaches towards the maturity.
- The contents of the oogonium get organised into an outer peripheral region of periplasm and the inner dense central region of ooplasm or oosphere or the egg.
- However, at the time of maturity, all nuclei disintegrate, except single functional nucleus.

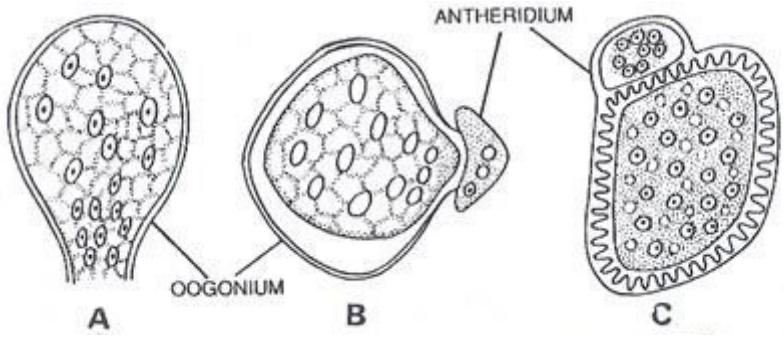


Fig.13.2 Oogonium

A. Oogonium with many nuclei; B. formation of the receptive spot towards attached antheridium; C. nuclei in antheridium and oogonium.

Fertilization:

- In centre of the ooplasm a deeply staining mass of cytoplasm appears is called coenocentrum.
- The functional female nucleus attached to a point near it.
- The oogonium produces a papilla like outgrowth for the contact of antheridium is called receptive papilla.
- It is disappeared soon after.
- Antheridium produces a fertilization tube.
- It penetrates and carries a single male nucleus through receptive papilla, oogonial wall and periplasm and finally reaches the ooplasm.
- The tip ruptures to discharge the male nucleus and fuses with the female nucleus (karyogamy) to form an oospore.

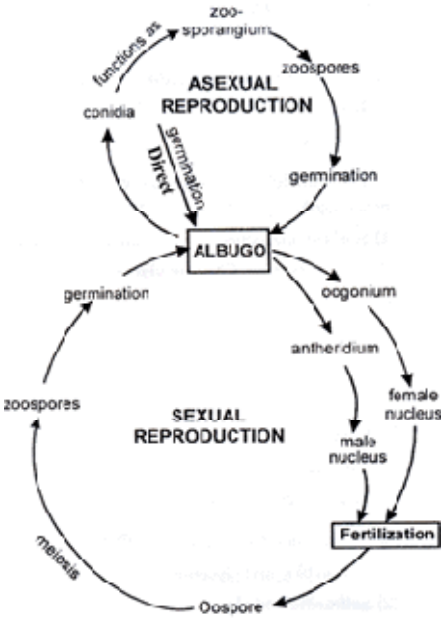
Oospore:

- It is a globular body.
- It is surrounded by outer thick and spiny exosporium and inner thin and smooth endosporium.

Germination of oospore:

- Before germination the oospore divides mitotically to form a number of diploid nuclei.
- Then theoospore produces germ tube and the tip of the germ tube ultimately develops into a sporangium.
- It undergoes first a meiotic division, followed by many mitotic divisions to form haploid nucleus.
- Each haploid nucleus ultimately metamorphoses into a reniform, biflagellate, and haploid zoospores or zoomeiospores.
- The zoospores are motile and encysted.
- It is germinated by a germ tube.
- It is again infecting the host plant.

Life cycle:



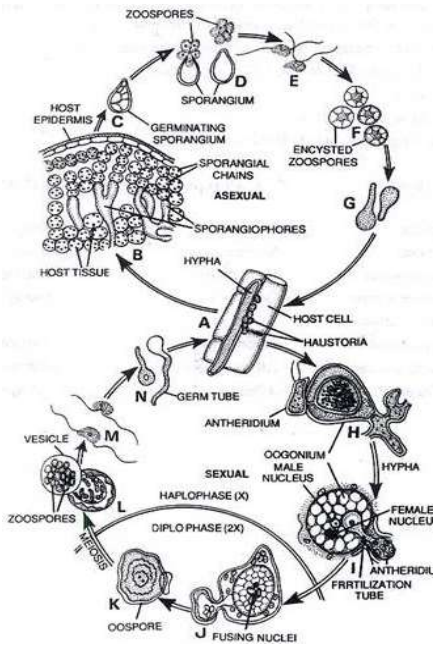


Fig.13.3 Life Cycle of Abugo

13.2 *ASPERGILLUS*

Division	: Ascomycota
Class	: Eurotiomycetes
Order	: Eurotiales
Family	: Trichocomaceae
Genus	: Aspergillus

Introduction:

Aspergillus is a common fungus.

It is ubiquitous in nature.

It is commonly known as black mold

It is represented by about 100 species.

Among which some are economically important, and some are pathogenic.

It was named in 1729, by a scientist named Antonio Micheli.

Structure:

Aspergillus has a filamentous fungus.

It consists of foot cell, conidiophore, vesicle, conidia, mycelium and cytoplasm.

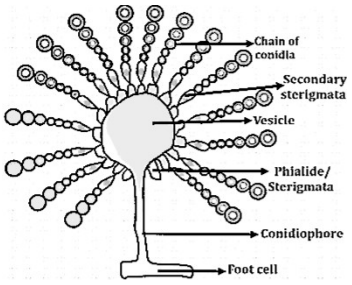


Fig. 13.4 Aspergillus

Foot cell: It is vegetative hyphae and used to attach to the substratum. Foot cell is generally L or T shaped. When it grows, it gives rise to the conidiophore.

Conidiophore: Conidiophore is the long, slender and erect hyphal branch, which gives rise to the vesicle.

Vesicle: It is rounded or club-shaped, which develops a layer of cells called phialides or sterigmata.

Conidia: it is the reproductive structure developed from the sterigmata. The conidia appear in chains and are having a basipetal arrangement.

Mycelium: It is hyaline, septate, branched, multicellular, multinucleated and tubular in structure.

The cell consists of cytoplasm, mitochondria, endoplasmic reticulum, ribosomes, vacuoles etc.

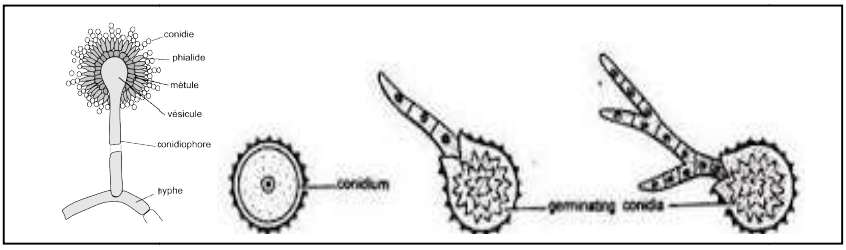
Reproduction:

Aspergillus reproduces by vegetative, asexual and sexual methods.

Vegetative reproduction occurs by the fragmentation method, in which a vegetative hypha breaks into few fragments which then develops into a new vegetative body.

Asexual Reproduction

It takes place by the formation of conidia on conidiophores.



13.5 Aspergillus reproduction

1. It takes place by the formation of conidia on conidiophores.
2. The foot cell gives rise to the long and slender hyphae called conidiophore.
3. The tip or apex of the conidiophore becomes swollen is known as vesicle.
4. Vesicle gives rise to many sterigmata or phialides.
5. Sterigmata are uninucleate, which produces the secondary sterigmata.
6. Each secondary sterigmata gives rise to many, rounded and multinucleate conidia arranged basipetally.
7. After that, conidiospores gets detached from the hyphae by accidentally.

8. It remains in the soil at dormant state. During favorable conditions it germinates by producing a germ tube.

Sexual Reproduction:

The sexual reproduction rarely occurs only in the **heterothallic species** those contain both male (**Anthredium**) and female hyphae (**Ascogonium**). **Ascogonium** possesses three parts (Basal, middle and apical) and it is multinucleate, septate and loosely coiled. **Antheridium** possesses two parts (Upper and lower), and it is unicellular, multinucleate and septate.

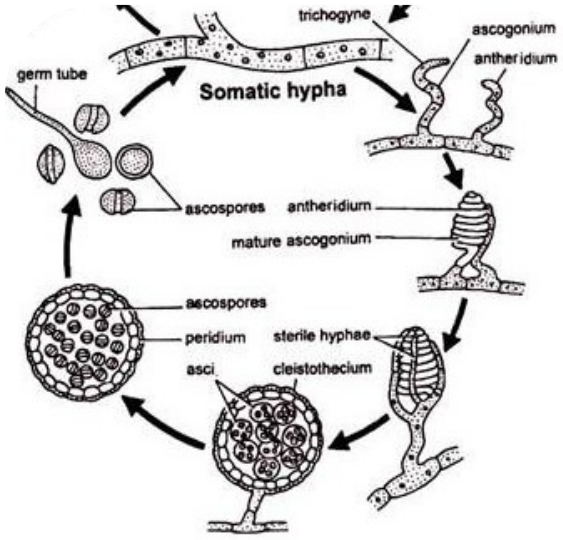


Fig. 13.6 Sexual reproduction

Fertilization:

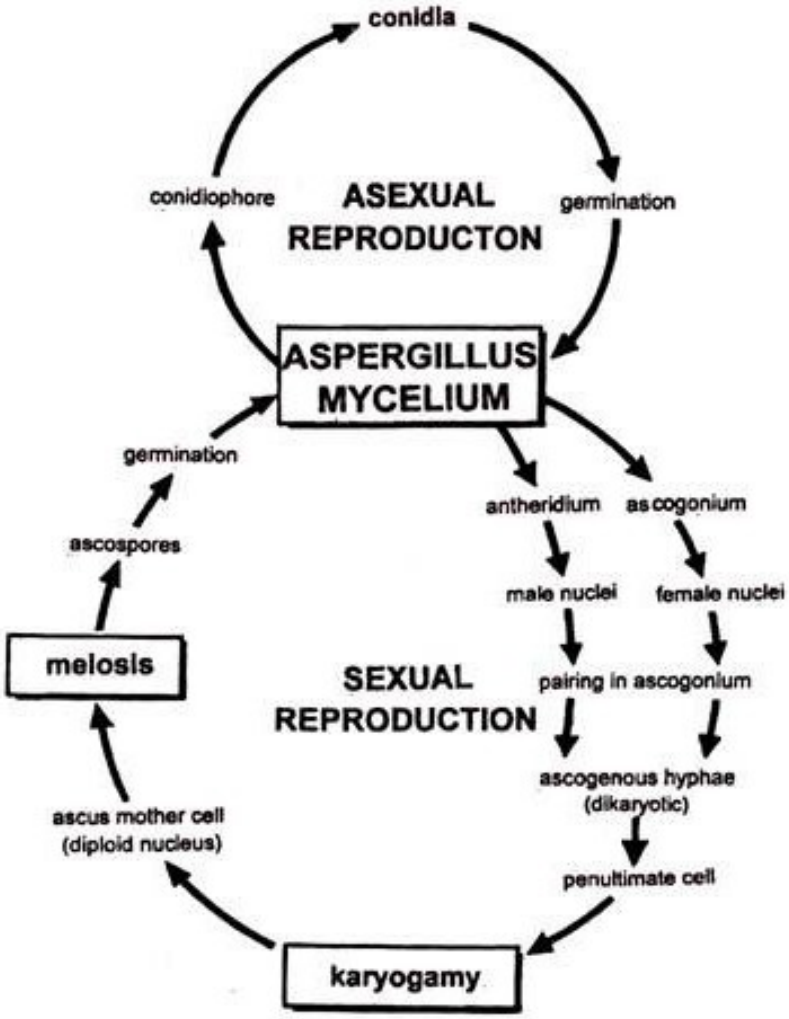
The female and the male hyphae contact and fuse each other. The wall at the point of contact dissolves, thus making a continuous passage. It is plasmogamy. The contents of the antheridium pass into the ascogonium. The pairing of male and female nuclei takes place in ascogonium. The ascogonium develops into the fruiting body called Ascocarp, where the karyogamy occurs. Then, 8 haploid ascospores form inside the asci (saclike structure). It is pear-shaped.

After the maturation of ascocarp, a protective layer (peridium) eventually forms.Then by the maturation of the asci, the ascospores release out by the lysis of asci and then through the ascocarp wall.

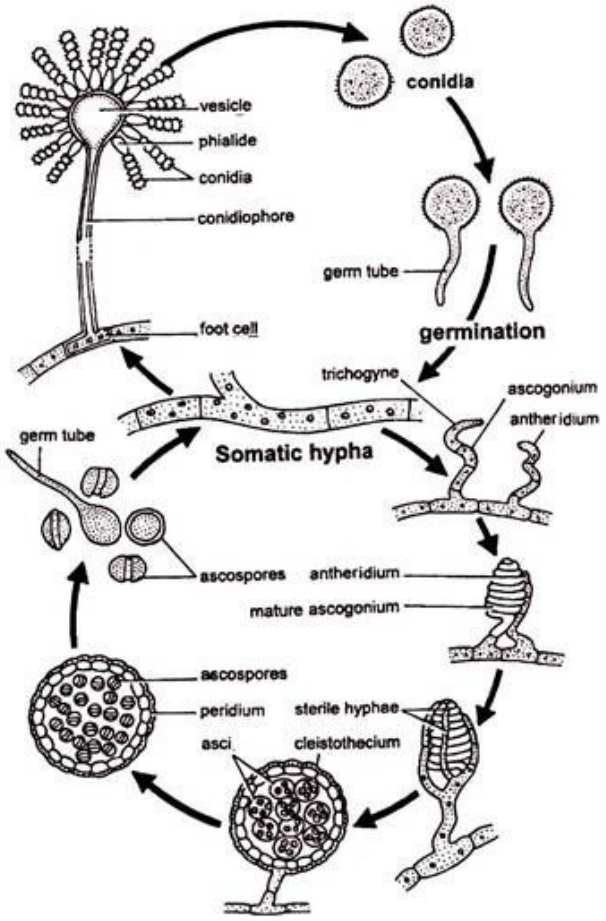
The ascospores remain dormant in the environment and are

unicellular, wheel-shaped and 5µm in diameter. Its wall differentiates into three layers, namely an outer layer (thick), a middle layer or epispore and an inner layer (thin).On favorable conditions, they germinate new vegetative hyphae by the formation of a germ tube.

Graphic life cycle of *Aspergillus*



Diagrammatic life cycle of *Aspergillus*



13.3 *PUCCINIA*

Division- Basidiomycota

Class- Pucciniomycetes

Order- Pucciniales

Family- Pucciniaceae

Genus- *Puccinia*

Introduction:

Puccinia is a very large genus with about 1800 species, distributed in all parts of the world. The genus is represented by more than 147 species in

india. They cause serious rust disease in cereal crops like wheat, barley, oats and maize. The species of *Puccinia* are internal obligate parasites. The species of Puccinia are either autoecious (complete life cycle on single host) or heteroecious (they complete life cycle on two different host).

Major pathogen, *P. graminis* – (Black rust or stem rust) affects cereal crops such as wheat, barley etc.

Some other species *P. recondita* - Brown rust or leaf rust; *P. striigormis* - yellow rust or stripe rust affects cereal crops.

Puccinia graminis:

P. graminis is the casual organism for black rust or stem rust disease of wheat and other cereal crops.

It is an internal obligate parasite.

It is heteroecious fungus.

There are two phases in its life cycle – dikaryophase and haplophase.

Dikaryophase occurs in its primary host that is wheat plant (*Triticum aestivum*), whereas the haplophase in its alternate host that is *Berberis vulgaris*. Although *P. graminis* can survive in the absense of alternate host but its life cycle completed only when both hosts are avilable.

Physiological specialization:

P. graminis has shown physiological specificity towards their host.

It causes rust disease in crops like wheat, barley or oats.

Once the strain which infects wheat plant it does not infect barley or oats.

Vegetative structure:

There are two types of mycelia

Dikaryotic mycelium (two nucleus): Occurs in primary host (wheat plant)

Monokaryotic mycelium (single nucleus): occur in the alternate host (Barberry plant).

Both these mycelia are intercellular, septate and branched.

They maintain protoplasmic connections between the adjacent cells through pores in septum.

Each cell of the dikaryotic mycelium have two nucleus and monokaryotic mycelium have.

Spherical haustoria is present.

It is used for taking food from the host cells.

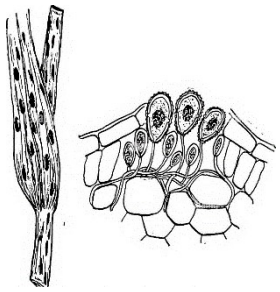


Fig. 13, 7 Puccinia

Reproduction:

P. graminis is reproduces by formation of different type of spores in the life cycle.

They are

1. Uredospores
2. Teleutospores
3. Basidiospores

} Wheat plant

4. Pycnidiospores
5. Aecidiospores

} Barberry Plant

It completes its life cycle in two hosts, namely wheat and barberry plant.

Life cycle of *P. graminis* is macrocyclic because it produces several types of spores.

Stages of *Puccinia graminis*:

- Wheat Plant is the primary host.
- The dikaryotic mycelium found in the plant is branched.
- The dikaryotic hyphae are formed by the germination of aecidiospores.

- The life cycle of *Puccinia graminis* is divided into five stages.

1. **Uredospores stage**
2. **Teleutospores stage**
3. **Basidiospores stage**
4. **Pycnidiospores stage**
5. **Aecidiospores stage**

Uredospore stage:

- During early summer, aecidiospores infect wheat plant and produce a number of reddish-brown mycelia.
- Pustules are formed on surface of the leaves.

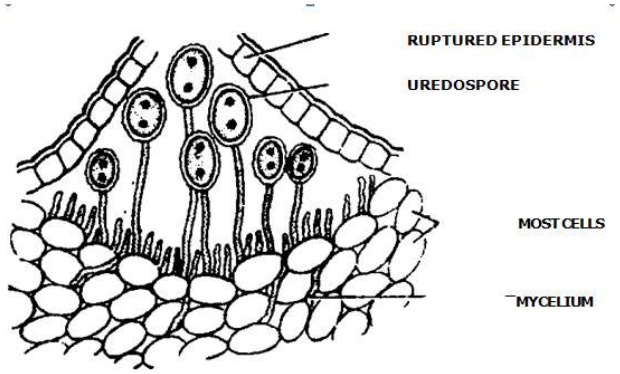


Fig. 13.8 Uredospores

- This pustule is known as Uredospores.
- The uredospores are stalked, unicellular, ovoid, binucleate spores.
- The uredospore enters through the stoma and produce within 6-10 days.

Teleutospore stage:

- This stage is found on wheat plant.
- uredospores now give rise to new spores called teleutospores

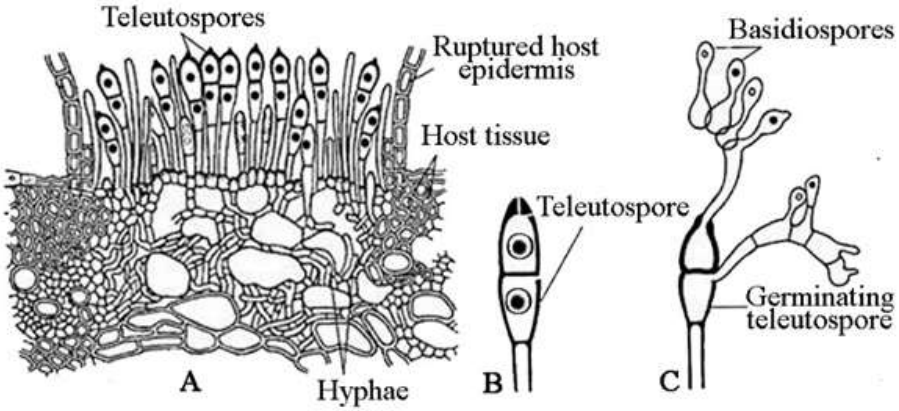


Fig. 13.9 Teleutospores

- They produce black streaks in leaf sheaths and stems.
- It is bicelled, stalked and binucleate.
- The teleutospores are liberated out by the breaking the epidermis.
- They remain dormant in the soil.

Basidiospore stage:

- The teleutospore produces one germ tube from each cell.
- From each cell, promycelium arises a sterigma.

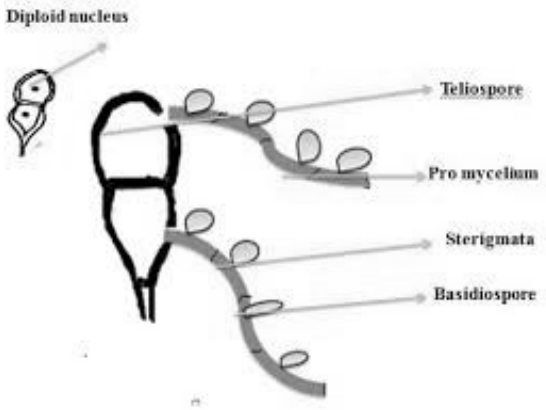


Fig.13.10 Basidiospores

- At the tip of the sterigma, a basidiospore is formed.
- each cell produces four types of basidiospores.
- Two are positive strain and other two are of negative strain.
- The basidiospores are haploid.
- It can germinate only on the leaves of alternate host, Barberry plant.

Pycnidiospore stage:

- This stage is found on the barberry plant.
- The spore germinates on the leaves of berberry plant.

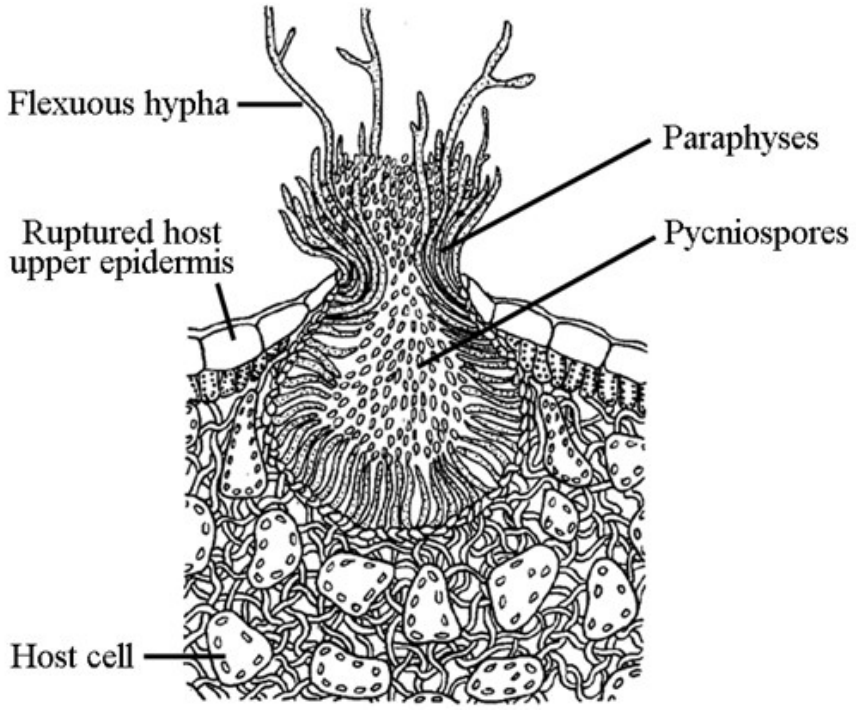


Fig.13.11 Pycnidiospores

- They produce flask shaped structures called the pycnidium or spermagonium.
- The opening is seed in the pycnidium is called ostiole.
- In ostiole, there are sterile hairs which is called periphyses.
- At the lower portion, there are long filaments which is called as spermatiophores.
- From this spermatiophores, pycnidiospores are produced.
- The pycinidiospores (+) received in the receptive hyphae fuse with the other strain (-).
- This is known as spermatization.

Aecidiospore stage:

- This stage is formed on the berberry plant.
- The mycelium accumulates and produces aecidiospores on lower surface of the leaf.

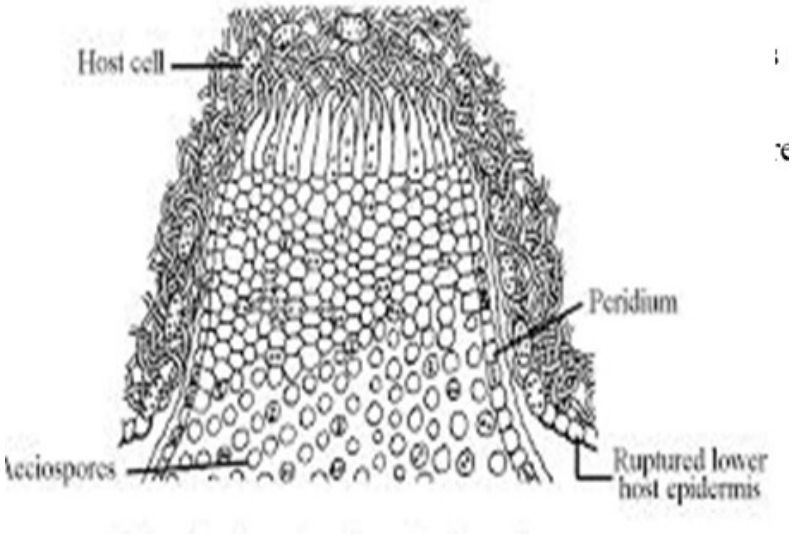
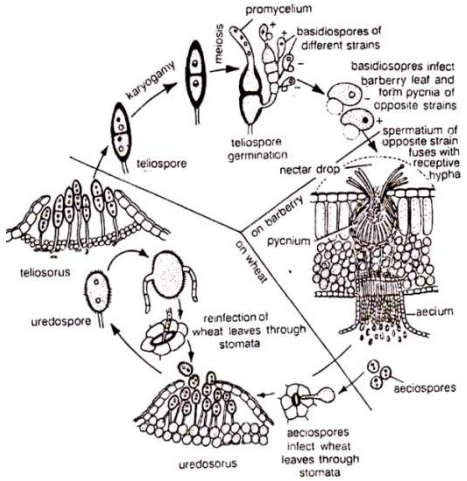


Fig.13.12 Ascidiospores

- There is sterile covering called Peridium.
- The peridium produces sterile hyphae called sporophores.
- Each sporophores produce a number of aecidiospores.
- The aecidiospores are liberated out and germinate on wheat plant.
- Then, after 10-15 days, uredospores are produced.

Diagrammatic life cycle of



13.4 *CERCOSPORA*

Systematic position:

Division : Eumycophyta
Sub-division : Deuteromycotina
Class : Hypomycetes
Order : Moniliales
Family : Dematiaceae
Genus : *Cercospora*

Habit and Habitat:

Cercospora is a very large genus of family Dematiaceae. It is represented by over 2,000 saprophytic or parasitic form - species. Most of the species are plant pathogen and cause leaf spot or tikka disease. The fungus usually infects the host plant leaves. economically important plants. C. apii is a human pathogen and may cause several lesions on the face.

Symptoms:

The infection begins as pale green spots on the upper surface of the leaf. These spots gradually enlarge, turn brown in colour and ultimately entire leaf dries and crumbles down. One of the important plant diseases caused by *Cercospora* is the tikka disease in ground nut plant. It is caused by *C. personata* and *C. arachidicola*.

Fig.13.12 Groundnut plant leaf (Infected)

Vegetative structure*:*

The Mycelium is well-developed, branched, septate, slender, intercellular and brown coloured. Branched haustoria are present and used for derive food materials from the host plants.

Reproduction:

- Sexual reproduction is absent.
- It reproduces only asexually by means of conidia.
- Conidia are developed on the conidiophores
- A tuft of conidiophores are septate, dark-coloured structures emerge either through stomata or ruptured epidermis.
- Each conidiophore produces single conidium at its apex.

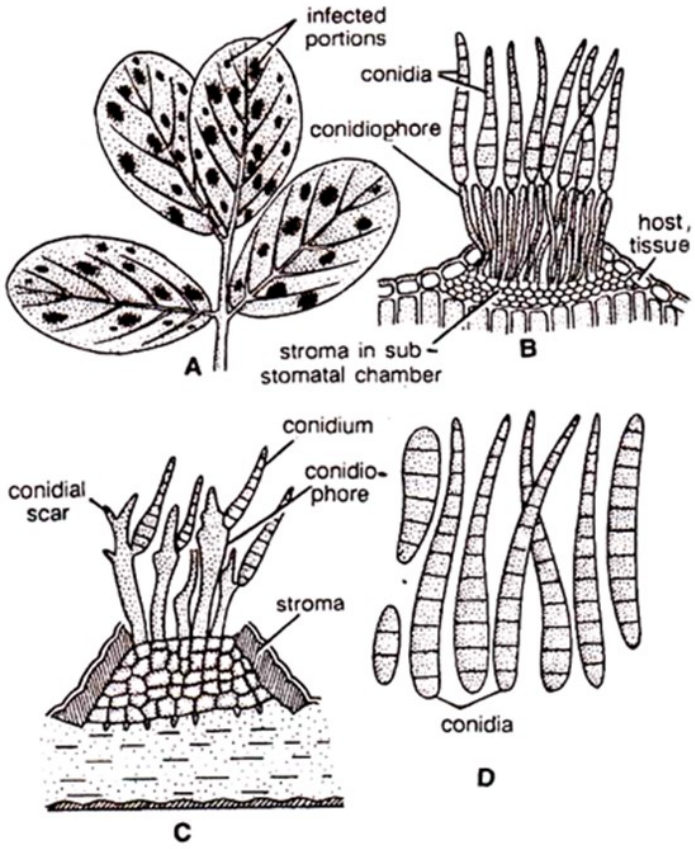


Fig.13.14 Cercospora

- The growth of the conidiophore is renewed after the formation of first conidium.
- The mature conidium is pushed to one side and another conidium is formed at the apex.

- This process is repeated and formed conidia on the conidiophore.
- On detachment each conidium leaves a geniculate scar or conidial scar on the conidiophore at the place of its attachment.
- Conidia are long cylindrical, obclavate, multi-septate (tranverse septa), hyaline or brownish in colour.
- The conidia are disseminated by wind or rain splash.
- Under suitable conditions (24-28°C temperature) conidia germinate by giving rise to one or more germ tubes.
- Each germ tube develops into a new mycelium.
- The perfect stages of *C. arachidicola* and *C. personata* are *Mycosphaerella arachidicola* and *M. berkeleyii* respectively.

LET US SUM UP

The detailed study about Albugo, Aspergillus, Puccinia and Cercospora has been discussed in this unit. Tis unit completely dedicated to individual species study.

CHECK YOUR PROGRESS

1. White rust disease caused by -------
2. Black rust of wheat caused by ----------

GLOSSARY

1. Mycelium - It is hyaline, septate, branched, multicellular, multinucleated and tubular in structure

SUGGESTED READINGS

1. Textbook of Fungi by O.P. Sharma

ANSWERS TO CHECK YOUR PROGRESS

1. Albugo
2. Puccinia

MODEL QUESTIONS

1. Give detailed account on cercospora

WEB SOURCES

1, https://www.magadhuniversity.ac.in/download/econtent/pdf/Albugo-%20Introduction%20and%20life%20history.pdf

2. https://www.mayoclinic.org/diseases-conditions/aspergillosis/symptoms-causes/syc-20369619

3. https://www.cabi.org/isc/datasheet/12178

Block IV

BRYOPHYTES

Unit - 14 Introduction to Bryophytes

Unit - 15 General Classification - Reimers, 1954

Unit - 16 Reproduction and Dispersal

Unit - 17 Economic Importance of Bryophytes

Unit - 18 Type study - Riccia, Anthoceros & Polytrichum

UNIT – 14

INTRODUCTION TO BRYOPHYTES

STRUCTURE

OVERVIEW

Bryophytes placed between two groups Fungi and Pteridophytes in the plant Kingdom. In this unit we can know the General characteristic features of Bryophytes.

LEARNING OBJECTIVES

To understand the basics of Bryophytes

14.1 INTRODUCTION

The word Bryophyta is derived from a Greek word Bryon- Moss; phyton- plants.Bryophytes occupy intermediate position between Algae and Pteridophytes. Bryophyta includes embryophytes like mosses, hornworts, and liverworts. There are 25,000 species of liverworts and mosses. They are widely distributed throughout the world (moist forest of Tropics, Sub- tropics and Antarctic).

In India most of the species are confined to the Northern Himalayas, Southern Himalayas, Nilgiri Hills and Western Himalayas (**known as gold**

mines of liverworts). Some species also occur in the plains of South India, M.P., U.P., Rajasthan and Gujarat.

- Bryophytes are **small, non-vascular land plants** that **require water for reproduction.**
- The study of bryophytes is called bryology.
- The term bryophyta was coined by **Robert Braun (1864).**
- The study of Bryophytes is called **Bryology.**
- **Father of Bryology – Hedwig.**
- Father of Indian Bryology – S.R.Kashyap.

Example of bryophytes:*Riccia, Marchantia, Anthoceros, Sphagum, Pellia, Polytricum, Funaria*

Why bryophytes are called amphibians of plants?

Bryophytes are called “amphibians of the plant kingdom” because they are terrestrial plants, but require water to complete their life cycle at the time of sexual reproduction.

General Characteristics of Bryophytes:

- Plants occur in moist and shaded areas
- The plant body is thallus like, i.e. prostrate or erect
- It is attached to the substratum by rhizoids, which are unicellular or multicellular
- They lack true vegetative structure and have a root-like, stem-like and leaf-like structure
- Plants lack the vascular system (xylem, phloem)
- Bryophytes show **alternation of generation** between independent gametophyte with sex organs, which produces sperm and eggs and dependent sporophyte which contains spores
- The dominant part of the plant body is gametophyte which is haploid
- The thalloid gametophyte is differentiated into rhizoids, axis and leaves
- The gametophyte bears multicellular sex organs and is photosynthetic

- The male sex organ is antheridium produces antherozoids, which are biflagellated
- The female sex organ is archegonium produces one egg.
- The antherozoids fuse with egg to form a zygote
- The zygote develops into a multicellular sporophyte
- The sporophyte is semi-parasitic and dependent on the gametophyte for its nutrition
- The sporophyte is differentiated into foot, seta and capsule
- Cells of sporophyte undergo meiosis to form haploid gametes which form a gametophyte
- The juvenile gametophyte is known as protonema

ClassificationofBryophytes:

AccordingtothelatestrecommendationsofICBN(InternationalCodeofBotanicalNomenclature),bryophytes havebeendivided into**threeclasses**.

1. Hepaticopsida (Liverworts) (thallusleaflikeandlobed)
2. Anthocertopsida (Hornworts)(sporophytecylindricalandhorn-like)
3. Bryopsida (Mosses)(plantsgrowingverydensely, formingcushion likegrowth)

LET US SUM UP

The general characteristic features of Bryophytes have been studied in this unit. The highlights of this unit are, alternation of generation showed by Bryophytes.

CHECK YOUR PROGRESS

1. Gold mines of liverworts ----------
2. Father of Bryology ----------

GLOSSARY

1. Bryology – study of Bryophytes

SUGGESTED READINGS

1. Bryophyte biology by Bernard Goffinet

ANSWERS TO CHECK YOUR PROGRESS

1. Eastern Himalayas
2. Hedwig

MODEL QUESTIONS

1. Write about general characteristics of Bryophytes

WEB SOURCES

1. https://www.britannica.com/plant/bryophyte
2. https://stri.si.edu/story/bryophytes
3. https://nhpbs.org/natureworks/nwep14c.htm
4. https://pressbooks-dev.oer.hawaii.edu/biology/chapter/bryophytes/
5. https://www.vedantu.com/biology/bryophytes

UNIT – 15

CLASSIFICATION OF BRYOPHYTES

STRUCTURE

OVERVIEW

In this Unit we supposed to know the classification of fungi recommended by ICBN. It is Classified into a three major classes such as Hepaticopsida, Anthocertopsida and Bryopsida. This Bryopytes covers three major classes called Liverworts, Hornworts and Mosses.

LEARNING OBJECTIVES

To know the systematic position of members in Bryophytes

15.1 CLASSIFICATIONOFBRYOPHYTES (ICBN)

Accordingtothelatestrecommendationsof**ICBN**(InternationalCodeof Botanical Nomenclature),bryophytes havebeendivided into**threeclasses**.

Class I: Hepaticopsida (Liverworts)	**Class II:** Anthocertopsida (Hornworts)	**Class III:** Bryopsida- (Mosses)

Hepaticopsidaisfurther dividedinto**4orders**: 1. Marchantiales (e.g.Riccia,Marchantia) 2. Sphaerocarpales (e.g.Sphaerocarpos) 3. Calobryales (e.g.Calobryum) 4. Jungermanniales (e.g.Pellia)	It has only **one order** i.e. 1. **Anthocerotales** (e.g.Anthoceros,Megaceros, Notothylas)	Bryopsida is divided into 5**orders**: 1. Bryales 2. Andriales 3. Sphagnales 4. Polytrichales 5. Buxbaumiales

Themaincharacteristicsoftheclasses.

Class I: Hepaticopsida(Liverworts):

Thenamehepaticopsidacomesfromtheword "hepatic"meaningliver. Liverwortscomeunderthisclass.

- Gametophyteplantiseither**thalloidorfoliose**
- In**folioseforms**,leavesarewithoutmidriband **dorsiventral**
- **Thalloidforms**aredorsiventral,lobedand**dichotomouslybranched**
- Eachcellofthalluscontainsmanychloroplastswithoutpyrenoids
- Rhizoidsareunicellular,branchedandaseptate
- Sexorgansarebornedorsallyembeddedingametophytictissues
- The sporophyte is made up of **only capsule (in Riccia**) or **foot, seta andcapsule(in Marchantia)**
- The**columellaisabsent** inthecapsule
- Sporogenoustissuesdevelopfromendothecium
- Reproduction is takes place by **asexually (fragmentation** or**gemmae) and sexual reproduction**

Class II: Anthocerotopsida(Hornworts):

Therearearound300speciespresentinthisclass.They are commonly known as hornworts.

Themainfeaturesare:

- Thegametophyticbodyisflat,dorsiventral,simplethalloidwit houtinternaldifferentiation
- Rhizoidsaresmooth-walled
- Eachcellhasonechloroplastwithapyrenoid
- Sexorgansarepresent dorsallyembeddedinthethallus
- Thesporophyteisdifferentiatedintofoot,meristematiczoneandcapsule
- **Sporogenoustissues**developfrom**amphithecium**
- **Pseudoelaters** arepresentinthe**capsule**
- The**columella ispresent**inthecapsule,whichoriginatesfromendothecium
- Reproduction is takes place by asexual (fragmentation andtubers) and sexual methods.

Class III: Bryopsida (Mosses):

It is the largest class of Bryophyta with around 1400 species. Theyare commonly called mosses.

- The**gametophyte**isdifferentiatedinto **protonema**and**foliosegametophore.**
- Folioseismadeupofstem asanaxis andleaveswithout midrib.
- Rhizoidsaremulticellularwithobliquesepta.
- Sexorgansareborneapicallyon stem.
- Elatersareabsent.
- Thesporophyteisdifferentiatedinto foot,setaandcapsule.
- Sporogenoustissuesdevelopfromendothecium.
- Columellaispresent.
- Dehiscence of the capsule takes place by separation of the lid.
- Reproduction is takes place by asexual (budding and fragmentation of secondaryprotonema) and sexual methods.

Reimers (1954) divided the class Bryopsida into 5 sub-classes and he used suffix-idae for the sub-class:

Sub-class I Sphagnidae-1 order. Sphagnales-1 family.

Sub-class II Andreaeidae-1 order. Andreaeales-1 family.

Sub-class III Bryidae-12 orders

Sub-class IV Buxbaumiidae-1 order. Buxbaumilaes-2 families.

Sub-class V Polytrichidae-2 orders. Polytrichales and Dawsoniales-2 families.

Vegetative reproduction in bryophytes:

Bryophytes possess a characteristic feature and that is their tendency towards extensive vegetative reproduction. The vegetative reproduction takes place in favourable season for vegetative growth. Majority of the Bryophytes propagate vegetatively and it is brought about in many ways.

LET US SUM UP

The Classification recommended by ICBN for Bryophytes explained elaborately in this unit. Bryophytes classified into three major Classes namely, Hepaticopsida, Anthocetopsida and Bryopsida.

CHECK YOUR PROGRESS

1. Hepaticopsida or otherwise called ----------
2. Largest Class of Bryophyta is ----------

GLOSSARY

1. Foliose – Leaves without midrib

SUGGESTED READINGS

1. Text Book of Bryophyta by Afroz Alam

ANSWERS TO CHECK YOUR PROGRESS

1. Liverworts
2. Bryopsida

MODEL QUESTIONS

1. Write the classification of Bryophytes recommended ICBN

WEB SOURCES

1. https://www.geeksforgeeks.org/bryophyta/
2. https://www.vedantu.com/biology/bryophytes
3. https://plantlet.org/bryophyta-classification-and-identification-of-bryophytes/
4. https://www.britannica.com/plant/bryophyte/Annotated-classification

UNIT – 16

REPRODUCTION OF BRYOPHYTES

STRUCTURE

OVERVIEW

Lower organisms produce its next generation by various methods such as Vegetative reproduction sexual and asexual reproduction. In this unit we can see how they reproduce to next generation.

LEARNING OBJECTIVES

To understand the reproduction of Bryophytes

16.1 VEGETATIVE REPRODUCTION

1. Fragmentation

In Bryophytes the growing point is situated at the tip of the thallus. The older portion of the thallus are detached by death or decay. These detached fragments develop into independent plants by apical growth. This is the most common method.

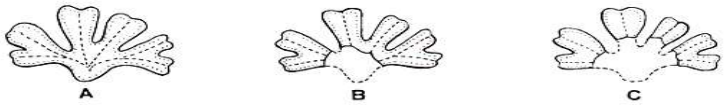


Fig. 16.1 Marchantia fragmentation

E.g. Marchantia, Anthoceros

2. By tubers

Tubers are perennating structures found in apices of the thallus lobes. During the unfavorable conditions the thallus dies out but the tubers are remained dormant. On the favourable conditions each tuber germinates to form a new plant.

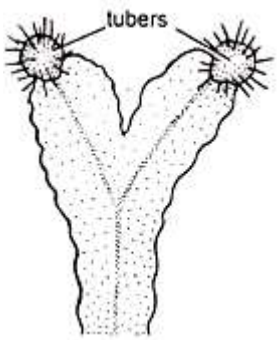


Fig.16.2 Tuber

e.g., *Riccia, Anthoceros, Conocephalum, Conicum, Fossombronia* etc.

By Gemmae:

Gemmae are green, multicellular asexual reproductive bodies. They are produced in gemma cups, on the surface of the thallus in midrib region. They get detached from the parent plant and gemmae give rise to a new individual directly (e.g., *Marchantia*) or indirectly (e.g., *Mosses*).

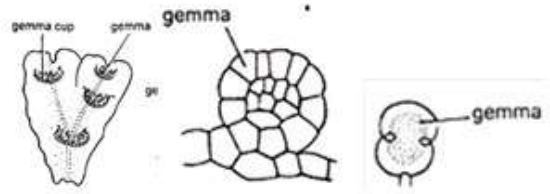
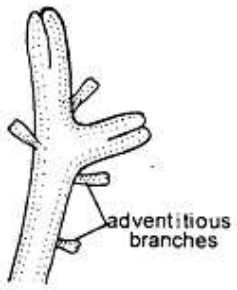


Fig.16.3 Gemmae

By adventitious branches

In some species (*Riccia fluitans, Anthoceros*) the adventitious branches develop from the ventral surface the thallus. These branches detached from the parent plant and develop into new thalli.



By secondary protonema

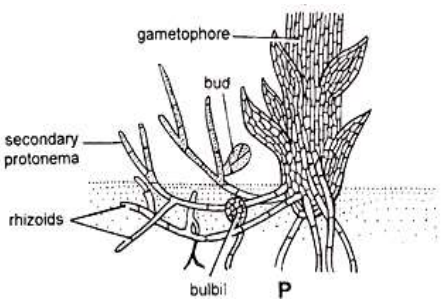


Fig.16.4 Adventitious branc hes

The secondary protonema may develop from the exposed rhizoid or any other detached living part of the gametophyte. These protonema also produce buds which develop into gametophytes. This method of vegetative reproduction is very common in *Funaria hygrometrica*.

16.2 SEXUAL REPRODUCTION

It is Oogamous type. Sex organs are multicellular and jacketed. Male and female sex organs are known as antheridia (Singular-antheridium) and archegonia (Singular-archegonium), respectively.

Antheridium

- Antheridium is a male sex organ.
- They are stalked, and globose or elliptical in shape.
- It is covered by sterile jacket layer.
- The fertile Androcytes are present in it.
- These androcytes metamorphoses into motile biflagellate Antherozoids.
- Boththeflagellaarewhiplash.

Archegonium

- Archegonium is a femalesexorgan. They are flaskshapedstructure and consists of basal swollen, venter cells and elongated upper part neck cells.
- The venter and neck cells aresurroundedbysterilejacket.
- Eggispresentin venter cells.

Fertilization:

Water is necessary for fertilization. Many antherozoids may enter the neck but onlyone fusewitheggandformthezygote. It is single cell and diploid.

Sporophyte:

- After fertilization, zygote divides immediately. The first division is always transverseandoutercellformembryo(**Exoscopic**mode ofdevelopment).
- Embryoformsporophytewhichcompletelydependongametophyte.
- Sporophyte is represented by capsule or capsule and foot or capsule, foot and seta.Sporogenouscell(soremothercell,S.M.C.)presentinthecapsuleun dergo meiotic divisionandformhaploidspores(Meiospores).
- All spores are similar in shape and size (**Homosporous**).Sporesare non-motile anddisseminate bywind.
- Sporesgerminate infavorableconditionsand formyounggametophyteorprotonemasinmosses.

Dispersal of spores in bryophytes

The sporophyte generation is short-lived. It comprises a capsule which produces spores by meiosis and a stalk which holds this aloft the gametophyte. The spores once released they are dispersed. Many bryophyte spores are very small and easily wind-dispersed for long distances. Water is another dispersal agent and one group of mosses even attracts insects to carry away the spores.

Although there is no special mechanism of spore dispersal in bryophyte, but this spore dispersal mechanism continues by different methods in different

species of bryophyte.

In *Riccia* the wall of capsule disintegrate before the spores are mature and the later remain enclosed in the outer layer of calyptras inside tissue of thallus.

In the Hepaticopsida the seta elongates rapidly after the spores are formed, and the calyptra is ruptured.

In the bryopsida the seta elongates after the capsule has been pushed through above the calyptra in dehisces.

In a jungermaniales the mature capsule splits from the apex to the base into four valves along predetermined longitudinal lines of dehiscence which usually backwards.

In marchantiales, specially these have ring like thickening on the cells of the wall, the dehiscence of the capsule starts at the periphery of the apical cap, which is marked by more or less zig zag line. In some marchantiales which have no ring like thickening in the cell wall egreboulia, Mania, cryptomitrium, the upper part of the wall of the capsule comes off as a lid and the lower part remains in intact cap.

In Liverworts spores are attached to specialized cells known as elaters. The elater is tubular in shape and are helically oriented along the long axis of the cell. These helical thickenings are hydroscopic, in that they readily absorb water. As the liverwort capsule dries, it opens up. Then the helical cell wall thickenings of the elater dry out and the elater changes its shape. As this happens, the elater releases the bound spores which are then dispersed by wind

In *Anthoceros* the capsule dehisces by 1to 4 slits along predetermined longitudinal lines of dehiscence. v. In mosses like *Sphagnum, Braunia aulacopilum*, the capsule is covered by an operculum which simply falls off when the spores are mature and thus liberated. In moss capsule, dispersal of spores takes place through peristome teeth. When the mature capsule begins to dry up the thin-walled cells of the annulus break and the operculum is thrown away. Dropping off the operculum is assisted by the outward hygroscopic movement of the underlying peristomial teeth. Due to this movement, slits between the inner thin walled peristomial teeth become wider

and spores escape gradually through these slits. In a wet atmosphere, the wet peristomial teeth bend inwards and thus closing the slits and prevent the escape of spores. The seta of the mature sporophyte also exhibits hygroscopic movements. In dry weather, by losing water, it twists and bents, thus helping in dispersal of spores.

LET US SUM UP

Reproduction in Bryophytes carriedout by many ways, like Fragmentation, tubers, Gemmae and sexual reproduction. Sexual reproduction done by Antheridium and archegonium prosuxws cells fertilized eventually and forms zygote and the zygote further divides for form a sporophyte.

CHECK YOUR PROGRESS

1. Where Gemmae produced in Bryophytes - ---------- \
2. Protonema produced in ----------

GLOSSARY

1. Homosporous - All spores are similar in shape and size

SUGGESTED READINGS

1. Bryophyta by O.P. Sharma

ANSWERS TO CHECK YOUR PROGRESS

1. Gemma cup
2. Mosses

MODEL QUESTIONS

1. Write about sexual reproduction in Bryophytes

WEB SOURCES

2. https://acikders.ankara.edu.tr/pluginfile.php/130464/mod_resource/co

ntent/0/week%202.pdf#:~:text=Reproduction-,Bryophytes%20reproduce%20both%20sexually%20and%20vegetatively.,from%20just%20one%20parent%20plant.

3. https://www.anbg.gov.au/bryophyte/reproduction-dispersal.html
4. https://www.biologydiscussion.com/bryophyta/reproduction-in-bryophytes-with-diagram-botany/53844

UNIT – 17

ECONOMIC IMPORTANCE OF BRYOPHYTES

STRUCTURE

OVERVIEW

Bryophytes can be used in many ways by human. Sphagnum used in medical industry for the production of surgical dressing. Polytricum dissolves te stone in kidney and gall bladder. Marchantia has the ability to cure TB. Bryophytes decays te rock and act as soilbinder, it is a maor ecological importance of Bryophytes.

LEARNING OBJECTIVES

To know the ecological importance of Bryophytes

17.1 MEDICINAL USES:

Plant names	Medicinal uses
Sphagnum	1.Surgical dressing due to its high

	absorptive power and some antiseptic property. 2.Decoction of dried sphagnum is used in the treatment of acute haemorrhage and eye infections
Marchantia	Cure pulmonary tuberculosis and affliction of liver
Polytrichium	Dissolve stone in kidney and gall bladder
Marchantia polymorpha, M. stellata and Polytrichum commune	Anti-tumour properties.

In research: Mosses and liverworts are used in research in the field of genetics. The mechanism of sex determination in the plant is discovered in liverworts.

Packing material: Dried mosses make an excellent packing material for fragile goods like glassware, bulbs

Food: Some mosses provide food for herbaceous mammals, birds and other mammals

As Indicator plants: Some bryophytes grow in a specialised area and can be used as an indicator for acidity and basicity of the soil.

E.g. ***Polytrichum*** indicated the acidity of the soil, ***Tortella*** species grow well in the soil rich in lime

In seedbeds: Because of its water retention capacity, it is used in seedbeds, greenhouses, nurseries to root cuttings.

Peat formation: ***Sphagnum*** is also known as peat moss. Peat is formed by slowing down the decaying process.

- It is used as a fuel
- Lower layers of peat form coal
- Peat is also used in the production of ethyl alcohol, ammonium sulphate, ammonia, dye, paraffin, tannins etc.
- It improves soil texture in horticulture

17.2 ECOLOGICAL IMPORTANCE

1. Bryophytes have great ecological importance. Mosses and lichens are the first organisms to colonize rocks.
2. They decompose the rock making it suitable for the growth of higher plants. The acid secreted by lichens, death and decay of mosses helps in soil formation
3. Bryophytes grow densely so act as soil binders
4. Mosses play an important role in bog succession.
5. Mosses can change the landscape from open soil to climax forest.
6. The thick mat formed of mosses forms suitable substratum for germination of hydrophilic seeds due to the presence of water and humus.
7. They prevent soil erosion by reducing the impact of the falling rain
8. They reduce the amount of run-off water due to their water holding capacity
9. They help in recycling of the nutrients
10. They act as a rock builder.

LET US SUM UP

The members of Bryophytes used in many ways for human kind and the environment. The use of bryophyte in medicinal industry is important, because it used to cure TB, Kidney stone, haemorrhage and anti tumor.

CHECK YOUR PROGRESS

1. Anti tumor property present in ----------
2. ----------can change the landscape from open soil to climax forest.

GLOSSARY

1. Peat moss - Sphagnum

SUGGESTED READINGS

1. Text Book of Bryophyta by K. P. Singh

ANSWERS TO CHECK YOUR PROGRESS

1. M.polymorpha
2. Mosses

MODEL QUESTIONS

1. Write about te ecological importance of Bryophytes

WEB SOURCES

1. https://www.britannica.com/plant/bryophyte/Importance-to-humans-and-ecology
2. https://www.geeksforgeeks.org/ecological-and-economic-importance-of-bryophytes/
3. https://littleflowercollege.edu.in/upload/e_contents/files/7a9f309e74309ea2f13e7a138f44b709.pdf

UNIT – 18

TYPE STUDY

STRUCTURE

OVERVIEW

In this unit we can discuss about the detailed study of selected members in Bryophytes suc as Ricia, Anthoceros and Polytrichum. This unit comprises Systematic position, Habit, habitat, Reproduction and all things.

LEARNING OBJECTIVES

To know the specific details of Riia , Antoceros and Polytrichum.

18.1 *RICCIA*

Systematic Position

Division : Bryophyta

Class : Hepaticopsida

Order : Marchantiales

Family : Ricciaceae

Genus : *Riccia*

Gametophytic generation

The plant body is thallus. It is small, flat and dorsiventral. It is dichotomously branched. The dorsal surface shows prominent midrib. The growing point is situated in the apical notch• ventral surface shows the presence of a large number of rhizoids and scales.

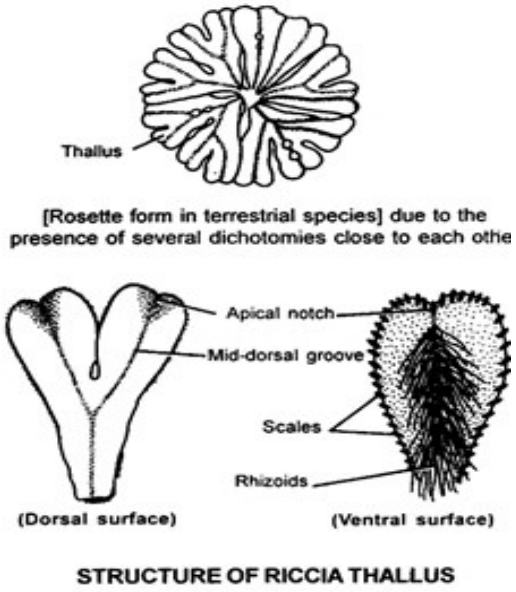


Fig. 18.1 Riccia

Rhizoids:

There are two types of rhizoids.

1.Smooth walled: it is smooth inner walls, living cells, main function is absorption

2. Tuberculate: it is peg like projections in inner wall, devoid of protoplasm, main function is mechanical support.

Scales:

- It is present on the ventral surface of thallus.
- It is simple and ligulate type.
- It is used to help to protect the growing point.
- In each scale is simple, multicellular and one cell in thickness.

Occurrence

- The genus was named after an Italian botanist F. F. Ricci

- All the species grow as terrestrial plants on damp soils except *Riccia fluitans* which grows in water
- The common Indian species are: *R. discolor*, *R. gangetica*, *R. frostii*, *R. melanospora*, *R. crystallina*, *R. fluitans*

Internal structure

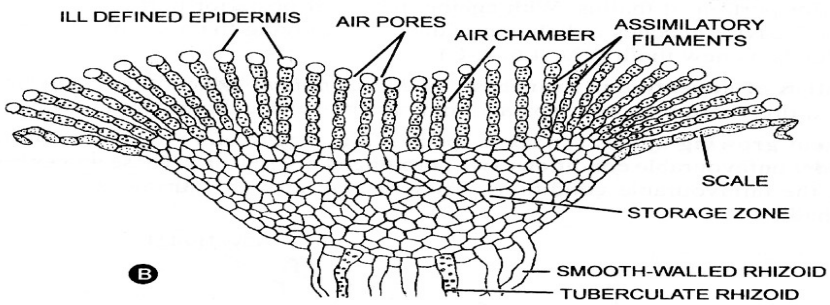


Fig. 18.2 Riccia Internal Structure

Photosynthetic Zone

- It consists of compactly arranged vertical rows of chlorenchymatous cells (assimilatory filaments) separated by narrow vertical air chambers.
- The cells possess chloroplasts and perform photosynthesis.

Storage zone:

It consists of compact, colorless parenchymatous tissue without intercellular spaces.

The cells are contained abundant starch grains.

A few cells of lower epidermis elongated and to produce rhizoids.

Reproduction:

Riccia reproduces by sexually and vegetatively.

Vegetative reproduction

The vegetative reproduction is takes place by following methods

1) Fragmentation

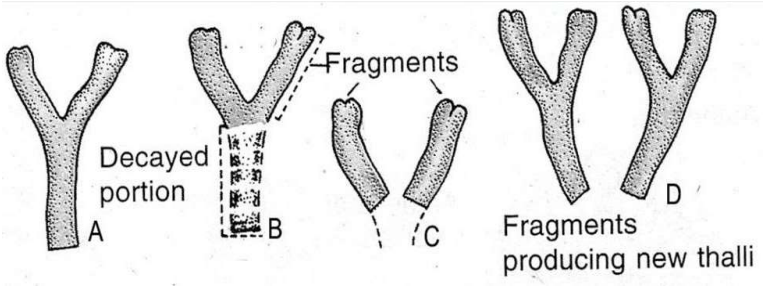


Fig. 18.3 Fragmentation

2) Formation of adventitious branches

i. The adventitious branches are formed from mid rib region of ventral surface of the thallus.

ii. Due to decaying of these branches are detached from the parent thallus to form new thallus of Riccia.

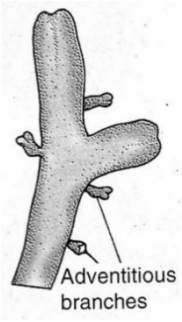


Fig. 18.3 Thallus

3) Persistent growing apices

4) Formation of tubers

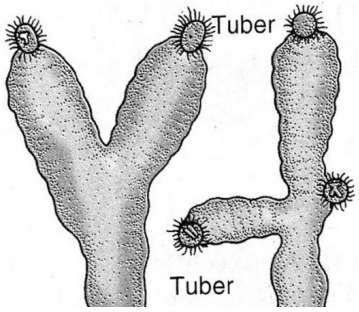


Fig. 18.3 Tubers

Sexual reproduction:

- It is oogamous type.

- The male sex organs are antheridia (borne in antheridial chambers).
- The female sex organs are archegonia (borne in archgonial chambers).

Antheridium:

- It is differentiated into two parts namely stalk and body of antheridium.
- The body of antheridium consists of single layered jacket enclosing a mass of androcytes
- Each androcyte differentiates to produce single biflagellated antherozoid

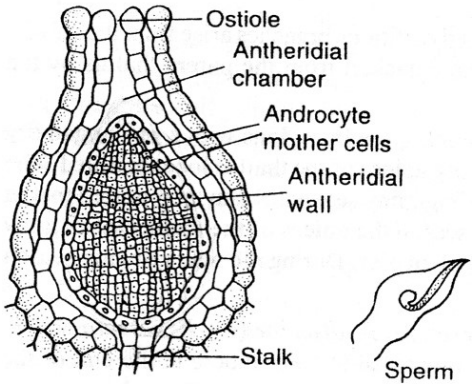


Fig.18.4 A mature antheridium

Archegonium:

- A mature archegonium is flask shaped structure and enclosed in archegonial chamber.
- The archegonium consists of stalk, basal swollen Venter and long neck (sterile cell) portions.
- It is attached with the base of archegonial chamber with the stalk.
- The archegonium has a single layered jacket.
- The jacket in the neck region is composed of six vertical rows of cells.
- In each vertical row 6 to 9 (mainly 6) neck cells are present.
- The neck region has 4 (mainly) – 6 neck canal cells.

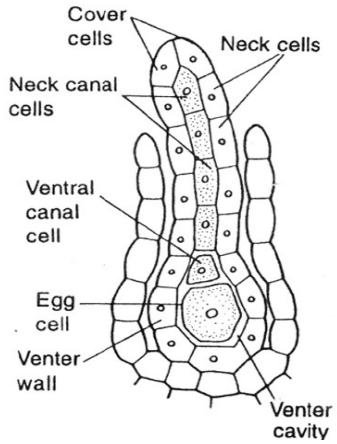


Fig.18.5 Archegonium

- Venter region contains a large cell which is termed egg or oosphere and above the oosphere is a small venter canal cell.
- Swollen Venter : Consists of single layered wall. It encloses a venter canal cell and a large naked egg.
- Long neck : consists of 6 - 9 tiers of cells arranged in six vertical rows, surrounding a narrow neck canal.

Fertilization

- Water is needed for dehiscence of antheridia, liberation of antherozoids, opening of archegonial neck, movement of antherozoids to archegonia.
- At maturity, the neck canal cells and venter canal cell disintegrates and become mucilaginous.
- Tthe mucilaginous substance, when hydrated, exerts a pressure so that the cover cells spread apart.
- A passage is created at the opening of archegonial neck through which some of the mucilaginous substance oozes out.
- Antherozoids are attracted chemotactically towards some chemical substances present in mucilage.
- Some of them enter into the neck canal.
- A single antherozoid which reaches first, fuses with the egg.
- The fusion results, in the formation of diploid zygote.
- The gametophytic phase of the life cycle ends with the formation of zygote.

- It is first cell of sporophytic generation, It is diploid
- The zygote is retained inside the venter and starts germinating

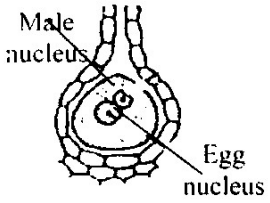


Fig.18.6 Zygote

Sporophytic generation:

- Zygote is develop into diploid sporophytic plant body (i.e. the sporogonium) which is dependent on gametophytic plant body.
- It is embedded centrally in the tissue of gametophyte plant body
- It is represented only by the capsule (spore sac), foot and seta are absent
- It consists of mass of spores enclosed within the outer layer of calyptra.
- The spores are generally attached in tetrads
- spores are haploid and are the first cells of sporophytic generation
- The calyptra layer is a part of gametophyte.
- The spores are enclosed within the gametophytic thalli untill the thallus dies and decays.
- After that spores are set free in the soil and dispersed by the wind or rain

Spore:

- It is first cell of gametophytic generation
- It consists of a mass of cytoplasm with a small haploid nucleus
- The spore wall differentiated intoexine is hard, thick and intine is thin, translucent.

Germination of spores

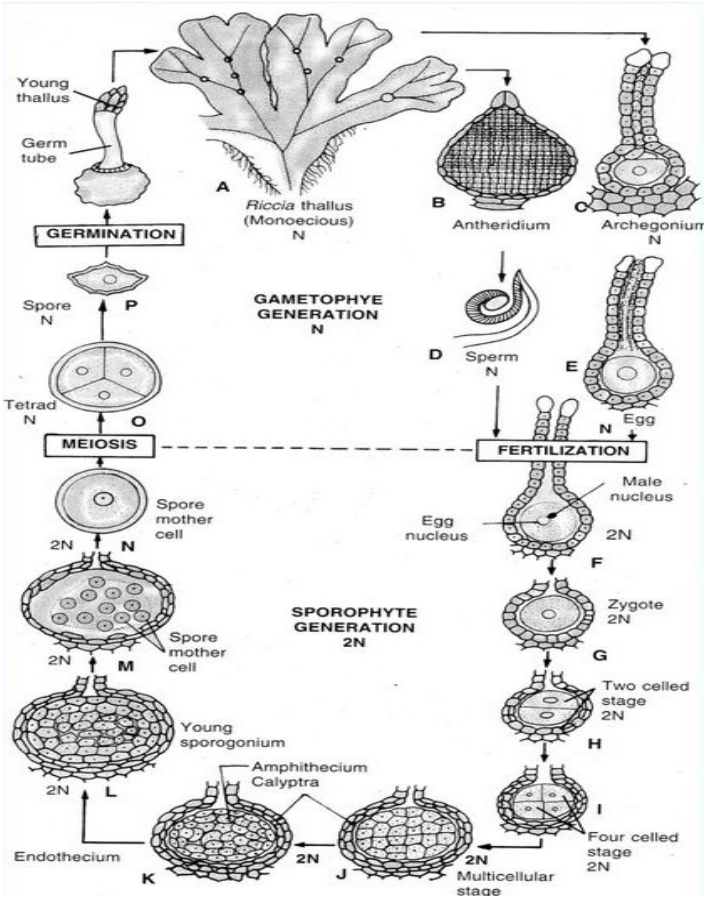
- Spore is the first cell of gametophytic generation. T
- The germination requires presence of light, low temperature and moisture
- The spores absorb moisture and swell
- A germ tube emerges out through a germ pore

- The dense protoplasm flows through the germ tube to its distal end which cuts a large terminal cell.
- First rhizoid is formed near the base of tube
- The terminal cell divides in to form two tiers of four cells each.
- Further growth results in the formation of a young flat thallus

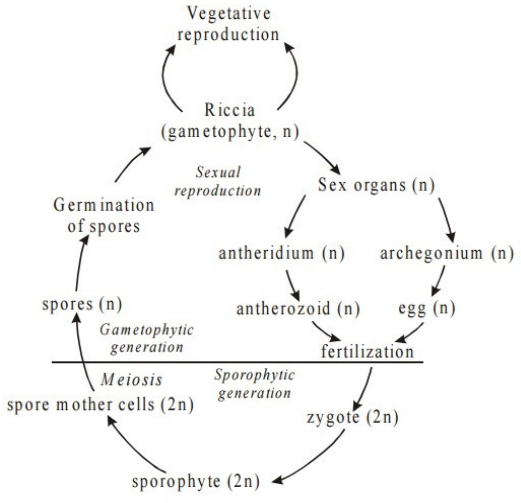
Life cycle

- Life cycle showing alternation of generations
- Life cycle is diplohaplontic.
- Alternation of generations is heteromorphic type since the plant bodies of two generations are morphologically dissimilar.

Diagramatic life cycle of *Riccia*



Graphic life cycle of *Riccia*



18.2 ANTHOCEROS

Systematic position

Division – Bryophyta

Class – Anthocerotopsida

Order – Anthocerotales

Family – Anthocerotaceae

Genus – *Anthoceros*

The genus *Anthoceros* comprises about 200 species and is widely distributed all over the world. It occurs mainly in temperate and tropical regions. It grows mostly in moist and shady places on ditches, rocks, etc. the species of Anthoceros may be annual or perennial.

About 25 species of *Anthoceros* have been reported from India.

Example - *A. erectus, A. himalayansis, A. khandalensis*, *A. crispulus,A. longii* etc.

External and internal structure of Anthoceros

The Anthoceros thallus composed of gametophyte and sporophyte.

External structure

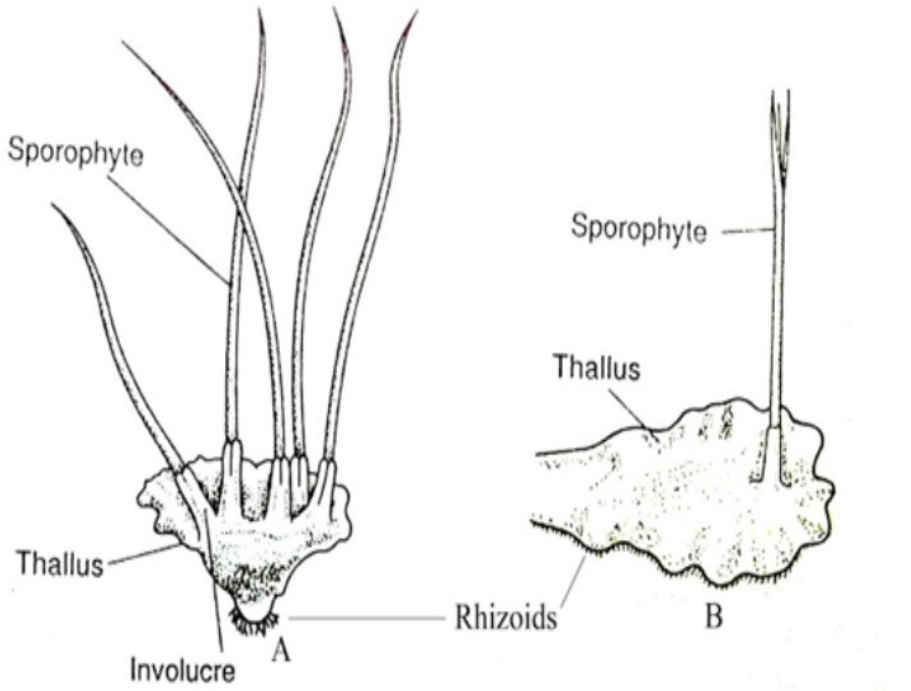


Fig. 18.7 Anthoceros

- The plant body is gametophyte.
- It is a small, dark-green dorsiventrally flattened lobed thallus.
- The lobes with divided margins overlap.
- The lobes are thick and fleshy.
- The *Anthoceros* species exhibit in different habits (prostrate - *A. laevis* or slightly raised - *A. erectus* above the substratum)
- The upper surface of the thallus is smooth (*A. laevis*), rough (*A. fusiformis*) and velvety (*A. crispulus*).
- The lower surface of the thallus has numerous unicellular, smooth-walled rhizoids.
- The mature thallus has erect, elongated and cylindrical sporophytes.

Internal structure

- Internally the thallus is simple without any cellular differentiation.
- The upper and lower epidermis is distinct and continuous.
- The thallus composed of soft parenchyma cells.
- The cells are uniform and compact.

- There are no intercellular spaces.
- Each cell of the thallus contains a single chloroplast.
- Each chloroplast encloses a single, large, conspicuous body called pyrenoid, a characteristic feature of class Anthocerotopsida.
- 25-300 disc to spindle shaped bodies aggregate to form pyrenoid.
- In some species, a stomata-like pores open towards the lower epidermis (ventral surface) which are known as **slime pores**.
- The slime pores lead towards a large cavity, filled with mucilage which is known as **mucilage cavity**.
- These mucilage cavities are invaded by *Nostoc* colonies.

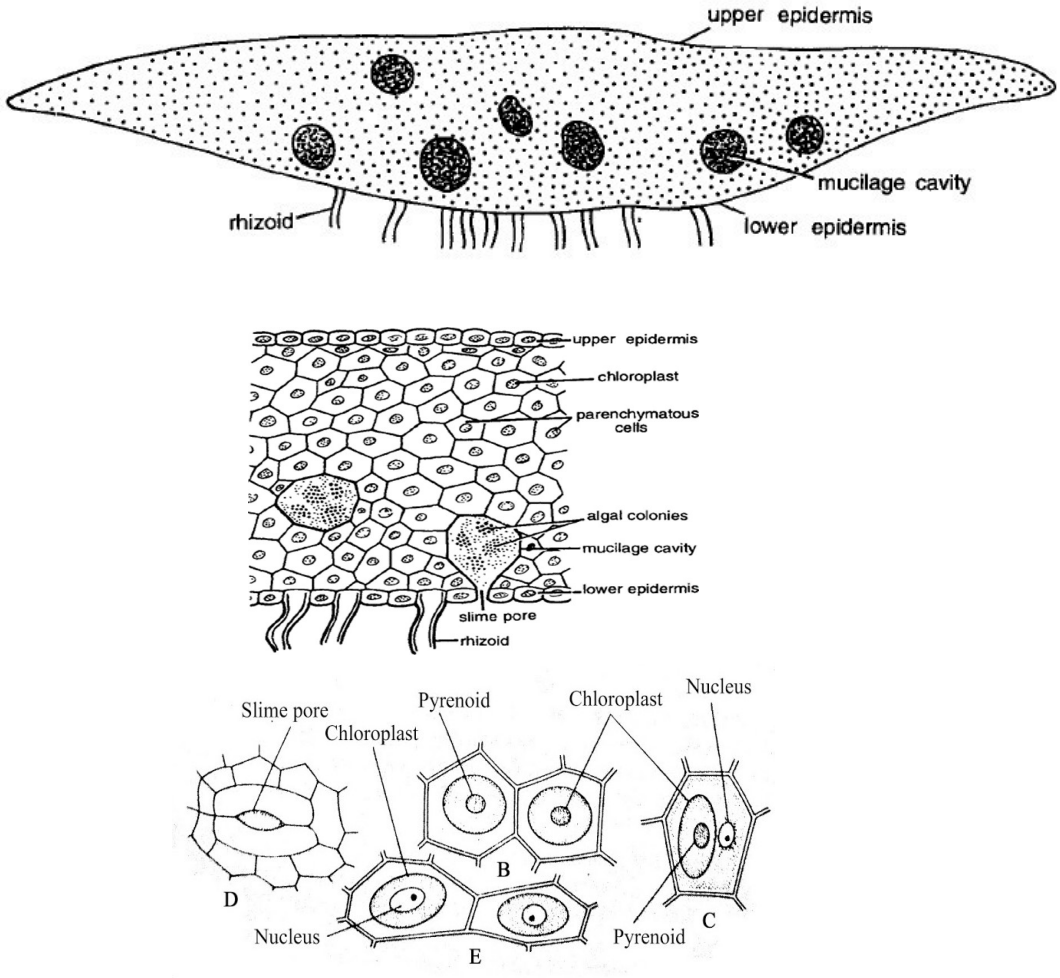


Fig.18.8 Internal Structure of Antoceros

REPRODUCTION

Anthoceros reproduces both by asexual and sexual reproduction methods.

Vegetative Reproduction

Vegetative reproduction takes place by the following methods.

Fragmentation

- The progressive death and decay of the older portions of the thallus.
- As it reaches up to the place of dichotomy, the lobes of the thallus get separated.
- Each separated lobe by continuous apical growth grows into new thallus.

Gemmae

- Gemmae is formed on the upper surface and along the margin of the thallus in *A. glandulosus, A. formosae* and *A. propaguliferus.*
- The detached gemma grows into a new plant.

Tubers

- In certain species of *Anthoceros* (*A. himalayensis, A. tuberosus, A. pearsoni, A. hallii, etc.*) tubers develop on the margins of thallus, during dry and unfavourable conditions.
- Each tuber develops into a new plant with the return of favourable conditions.

Persistent Growth Apices

- In A. *pearsoni* and *A. fusiformis*, the whole thallus dries and gets destroyed except the growing point due to long summer draught except persistent apices.
- Later it grows deep into the soil and becomes thick under unfavorable conditions.
- It develops into new thallus.

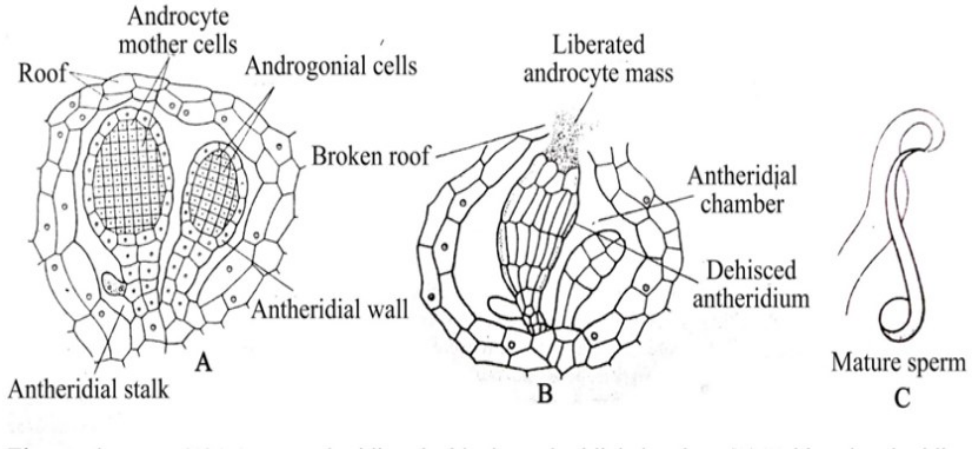
Sexual Reproduction

- Sexual reproduction is oogamous type.
- *Anthoceros* may be monoecious or dioecious.

- In monoecious species, antheridia develop much earlier to archegonia (Protandrous condition).
- Sex organs are deeply embedded and develop inside the gametophytic thallus.

Antheredia

- Antheredia (male sex organ) are developed in clusters from the upper region of the thallus.
- They are enclosed in and roofed over by antheridial chamber.
- Each mature antheridium has an ovoid body and a multicellular, slender stalk.
- The body is covered by a single layered antheridial jacket wall.
- Inside the body, a mass of androcytes or spermatocytes are present.
- Each spermatocyte is a bi-flagellate 'coma' shaped structure with a single haploid nucleus



Fir.18.9 Structure of Anthoceros

Structure of archegonia

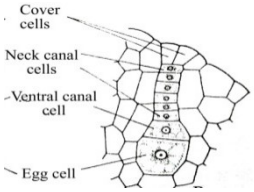


Fig.18.10 Archegonium

- Archegonia (female sex organ) develop singly from the upper side of the thallus and are produced in an acropetal order.
- There is no stalk and they are embedded in the thallus.
- The vegetative cells of the thallus provide protection to the archegonium.
- Cover cells or lid cells are found at the tip of the archegonium.
- The mature archegonium consists of vertical row of 4-6 neck canal cells, a ventral canal cell and an egg cell.
- At maturity, the neck canal cells and the ventral canal cell disorganize.

Fertilization:

- At the time of fertilization one of the antherozoid enters through the neck and fertilizes the egg. As a result, a *zygote* i.e., *oospore* is formed.
- Zygote is a single cell and diploid.
- Sporophytic generation begins from the zygote.

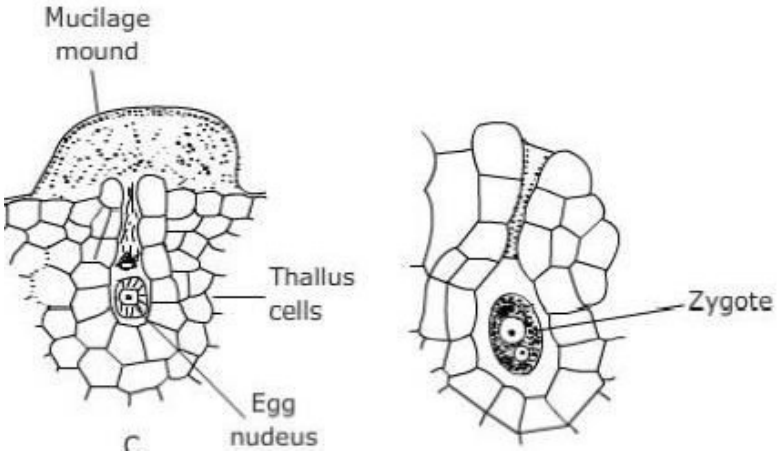


Fig.18.11 Zygote

SPOROPHYTIC PHASE:

- Zygote is the first cell of the sporophyte.
- By repeated division it develops into an elongated **embryo**.
- Then embryo grows into **sporangium** or **sporophyte**.

- The sporophyte of *Anthoceros* is differentiated into two regions – **foot** and **capsule.** Each sporophyte is surrounded at its base by a tubular **involucre**.

Foot

- It is a rounded bulbous parenchymatous structure deeply embedded in the tissue of the gametophytic thallus.
- It helps in attaching the sporophyte to gametophyte and in absorption of water and nutrients from it.

Intermediate or intercalary zone

- A narrow zone of meristematic cells located between the basal foot and the upper capsule.
- These cells help in the continuous growth of the sporophyte.

Capsule

- It forms the major and conspicuous part of the sporophyte.
- It is a long, slender, smooth, upright and cylindrical structure.
- Internally, capsule is a complex structure and shows differentiation of tissues.

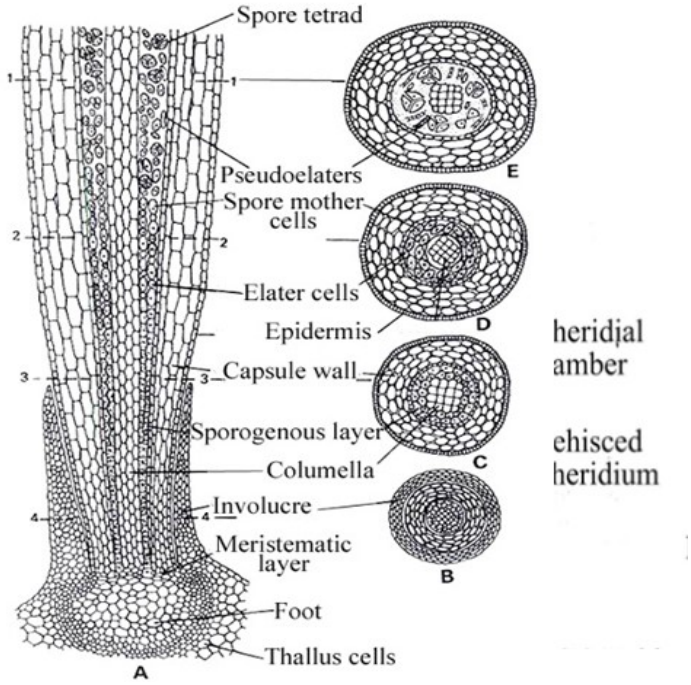


Fig.18.12 Anthoceros Sporangium

- **columella** is present in the centre of the capsule.
- It is a sterile mass of tissue.
- A narrow region encircles the columella.
- This region contains spores and multicellular elaters.
- The uppermost layer consists of the **capsule wall**.
- It is multilayered consisting of 4 – 6 layers of cells.
- The outermost layer forms the epidermis with distinct stomata.
- The cells of the capsule wall contain chloroplasts.
- So, they can perform photosynthesis.
- In dry condition, capsule dehisces by splitting into two halves exposing spores.
- Dispersal of the spores takes place by air current.
- Spores after liberation from the sporangium undergo a resting period of few weeks or months – then each germinates through germ tube and forms a new *Anthoceros* thallus.

Alternation of Generation:

The life cycle of Anthoceros show regular alternation of two morphologically distinct phases. One of these generations is haplophase **or gametophytic phase** and the other is diplophase **or sporophytic phase**.

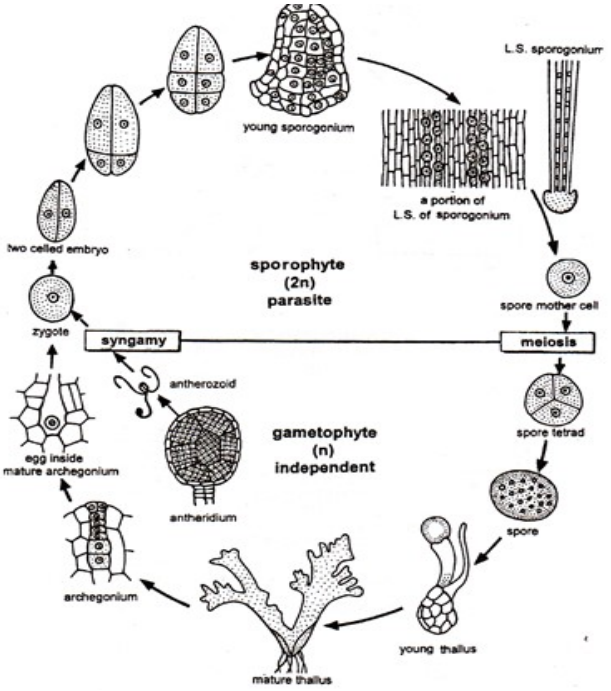
Haplophase or gametophytic phase:

In Anthoceros this phase is dominant and produces the sex organs. Sex organs produce gametes to form a diploid zygote.

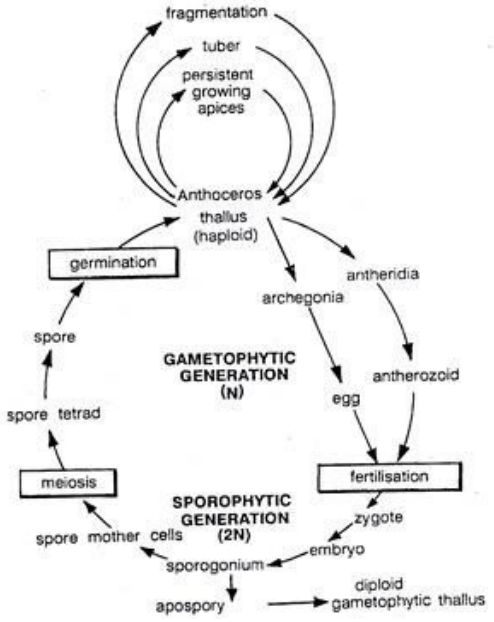
Diplophase or sporophytic phase:

Zygote develops into sporophyte. In Anthoceros sporophyte is represented by foot, meristematic zone and capsule. The sporophyte produces the spores in the capsule. The spores on germination produce the gametophyte.So, in Anthoceros, two morphologically distinct phases (haplophase and diplophase) constitute the life cycle. The life cycle of this type which is characterised by alternation of generation and sporogenic meiosis is known as heteromorphic and diplohaplontic.

Diagramatic life cycle of *Anthoceros*



Graphic life cycle of *Anthoceros*



18.3 *POLYTRICHUM*

Systematic Position

Class: Bryopsida

Sub-class: Eubrya

Order: Polytrichales

Family: Polytrichaceae

Genus: *Polytrichum*

Occurrence and distribution

- **Polytrichum** is cosmopolitan in distribution.
- They are found in tropical regions.
- Plants live in cool and shady places.

General Structure

- The main plant body is gametophyte.
- The adult gametophytic plant is differentiated into rhizoids, the underground rhizome, the erect stem and leaves.

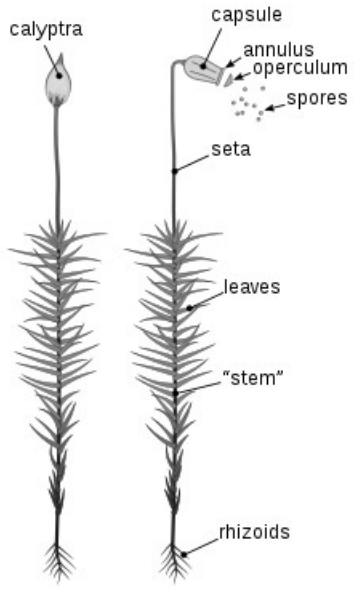


Fig.18.13 Polytrichum

1. Rhizome:

- It is horizontal portion and grows underground.

- It bears three rows of small brown or colourless leaves.
- It also bears rhizoids.
- The cells are rich in protoplasm and oil globules.

2. The erect stem:

- The leafy shoots are much longer.
- It is the most conspicuous part of the plant.
- It arises from rhizome. These branches consist of central axis.
- These branches bear large leaves arranged spirally.
- The T.S. of stem shows three regions: medulla, cortex and epidermis.
- The medulla is again differentiated into two zones: central zone and peripheral zone. The cortex consists of thick-walled cells.
- The innermost layer of cortex around the conducting strands is known as a **mantle.**
- Its cells contain starch grain. Epidermis is present over the cortex.

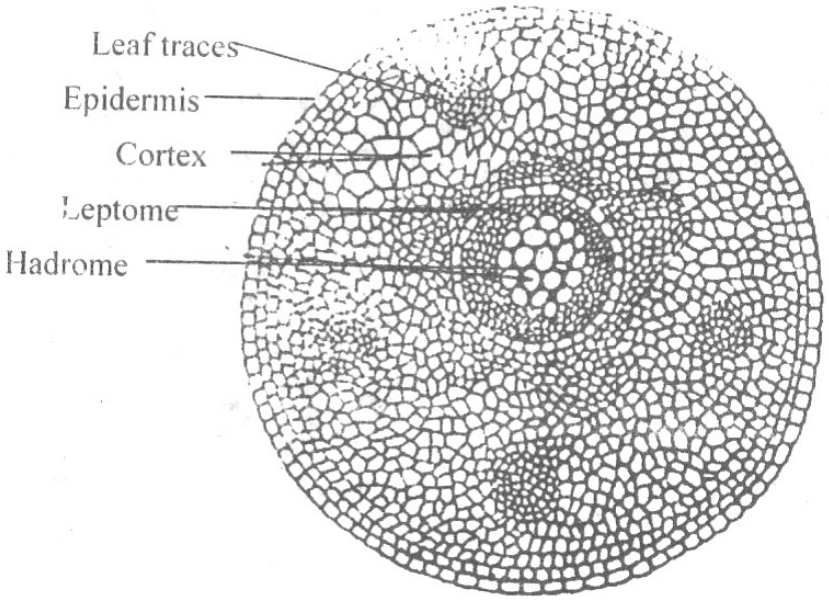


Fig.18.14 Internal Structure of Polytrichum

3. Leaves:

- Leaves have broad bases. Leaves in the upper portion are green.
- Each leaf has a broad. colourless sheathing leaf base and narrow distal limb.
- The mid-rib is thick and forms the major part of the leaf.
- These leaves possess extra photosynthetic tissue in the form of closely set vertical plates of green cells.
- These are known as lamellae. Green lamellae act as additional photosynthetic tissue.
- The lower surface is bounded by epidermis.
- One or two layers of sclerenchymatous tissues are present above the epidermis. The central tissue of leaf is composed of thin-walled parenchymatous tissues.
- The upper surface is formed of a layer of large cells from which arise numerous lamellae. This upper portion is the main photosynthetic region of the leaf.

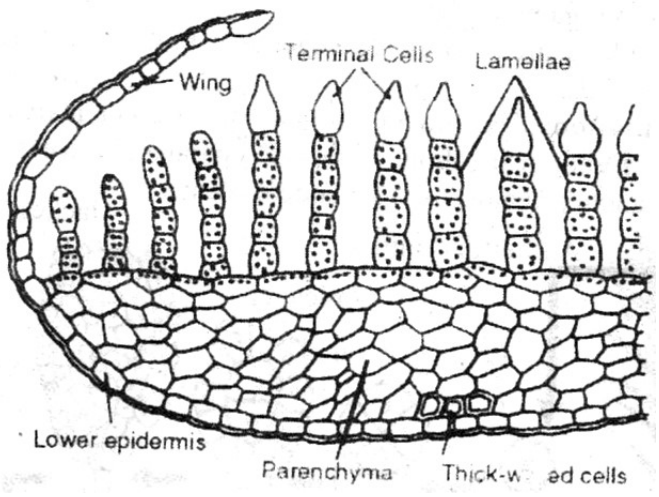


Fig.18.15 Leaf Internal

Vegetative Reproduction

Vegetative reproduction takes place by following methods:

I. Protonema:

- The spores germinate to form protonema.
- Several buds grow on the protonema.
- Each bud by of its apical cell develops into gametophyte.
- These are also called vegetative buds. They are formed on the rhizoids.

2. Fragmentation:

- The rhizome gives rise to erect lea& shoots at intervals.
- Death or breaking of shoots separates the erect branches.
- These branches behave as independent plants.

Sexual Reproduction

Polytrichum is dioecious (antheridia and archegonia occur on separate plants).

Antheridia

- The antheridia are borne in the axillary clusters at the tips of leafy stems.
- They are surrounded by a rosette of leaves called **perigonial leaves.**
- These leaves are different from the ordinary vegetative leaves.
- The antheridia are produced in groups in the axils of these leaves.
- **Paraphyses** also occur among the antheridia.
- Mature antheridium is club-shaped. It is composed of a short stalk and a club-shaped body.
- Jacket is present around the capsule. Inside the jacket are present androcyte mother cells.

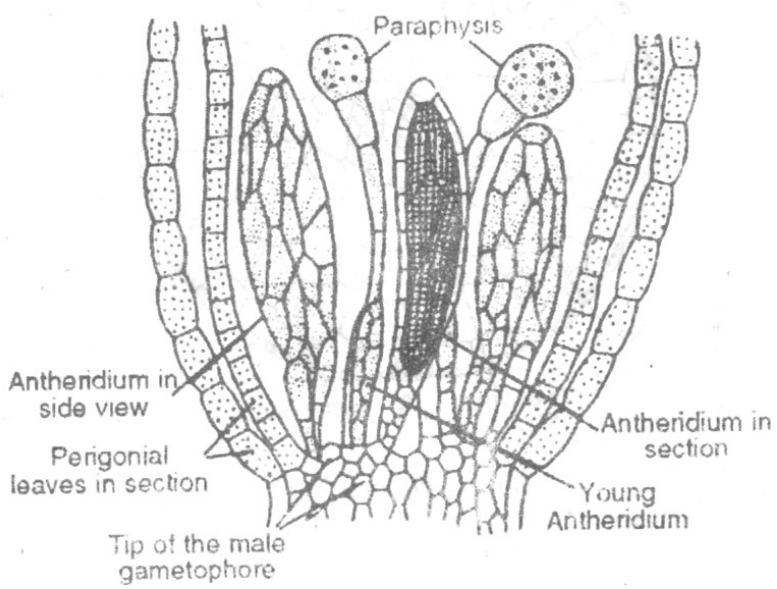


Fig.18.16 Antheridia

Development of antheridium

- The antheridia arise from the embryonic cells at the tip of male shoot.
- The embryonic superficial cell forming antheridium is called **antheridial initial.** It increases in size.
- It undergoes transverse division to form lower primary stalk cell and the upper **antheridial mother cell.**
- The apical cell cut off 3-4 segments. Now this apical cell functions as the **operculum cell.**
- The last segment divides by two vertical divisions. It forms peripheral **jacket initials** and central **primary androgonial cells.**
- The primary androgonial cells divide to form **androgonial cells.**
- The primary androgonial cells is called the androcyte mother cells cell gives rise to two coiled biflagellate sperms. Sperm mass contained in mucilage comes out.

Archegonial head

- The flask-shaped archegonia *are* borne at the apices of leafy stems.
- Archegonitim is surrounded by **perichaerial leaves.**

- The archegonia occur in cluster of 3 to 6.
- Mature archegonium is flask-shaped and has a thick multicellular stalk.
- The neck is long and twisted. It contains neck canal cells. The neck consists of 6-vertical rows of cells. Neck gradually merges into venter.
- Venter contains upper small venter canal cell and lower large egg cell. Paraphyses are absent.

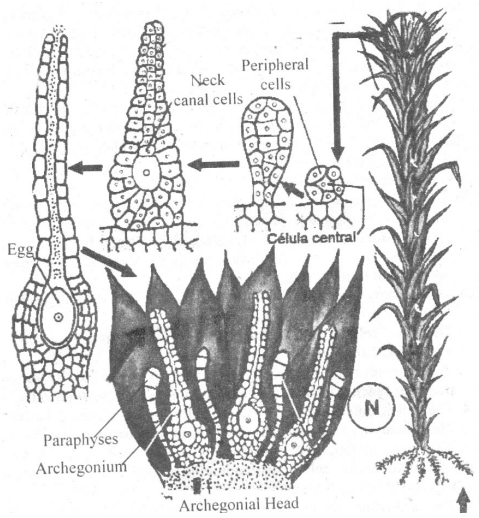


Fig.18.17 Archegonia

Development of archegonium

- Any apical cell in the apical region acts an **archegonial initial. The** archegonial initial enlarge and divides by a transverse division to form lower **primary stalk cells** and upper **archegonial mother cell.**
- The primary stalk cell forms a massive stalk. The archegonial mother cell forms the main body of archegonium. It undergoes three vertical division s to form three peripheral cells surrounding an axial cell.
- Three peripheral cells divide to form 2-3-layered jacket around the venter. The axial cell divides transversely to form inner central cell and outer apical cell.

- Central cell forms upper small venter canal cell and lover large egg cell. Apical cell divides to form long neck which consists of 6 vertical rows of cells.

Fertilization:

The sex organs dehisce in the presence of water. The venter canal cell and the neck canal cells dissolve to form mucilage. This mucilage exerts pressure and the neck opens out. The mucilage comes out of the neck. The sperms reached the archegonial heads by rain water. They are attracted towards the archegonia. One of the sperm swims down the open neck and reaches the base. It fuses with the egg to form oospore. Oospore is the first stage of sporophytic generation.

Structure of Mature Sporogonium (Sporophyte)

The mature sporogonium is differentiated into foot, seta and capsule. Foot: The foot is buried deep in the tissue of gametophyte. It is absorptive in function. It consists of thin-walled narrow cells containing dense cytoplasm.

Seta: The seta is several inches long. It carries the capsule high into the air. It also conducts water and food. It consists of epidermis, cortex and central conducting strands.

Capsule: The upper part is capsule. It is differentiated into three regions: apophysis, theca and operculum.

1. Apophysis: It is the lower part of capsule. It is continuous with the seta. It is in the form of a swollen ring-like protuberance. Its cells are thin-walled, green and loosely arranged. The apophysis is the main photosynthetic region of the capsule.

2. Theca: It is the middle part of the capsule. It is four-lobed. Its wall is several layered. The outermost layer is epidermis. Trabecular air spaces are present inside the wall layers. These spaces have filaments of thin-walled elongated cells containing chloroplasts. Outer spore sac **wall** is present internal to outer trabecular spaces. This is followed by spore-sac proper. Then 2-layered inner spore-sac wall is present. Then inner trabecular air space is present. The centre is occupied by solid **columella.** All the sporogenous cells are fertile and form spores after reduction division.

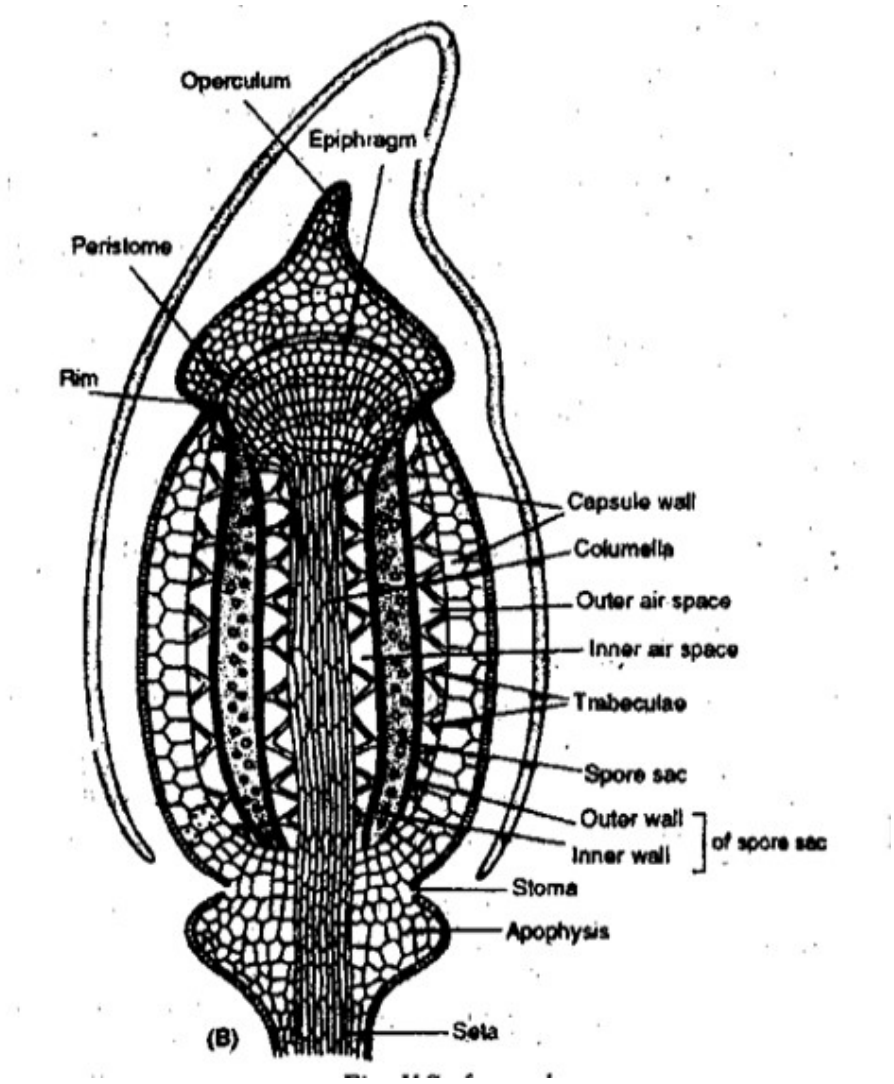


Fig.18.18 Capsule

3. Operculum: This is the uppermost part of the capsule. It is conical. The operculum is covered by **calyptra.** The calyptra forms a hairy structure. So Polytrichum is also known as **hair moss.** A constriction is present between operculum and theta. **A rim or diaphragm** is present at the base of this constriction. The celumella of the theca is continuous into the operculum. It expands into a fan-shaped **epiphragm.Peristome** is present in the form of a thick rim. It bears a number of rigid teeth. The epiphragm fills the space inside the ring of peristome teeth and is attached to their tips. Peristome teeth arise from the rim or diaphragm.

Dispersal of spores

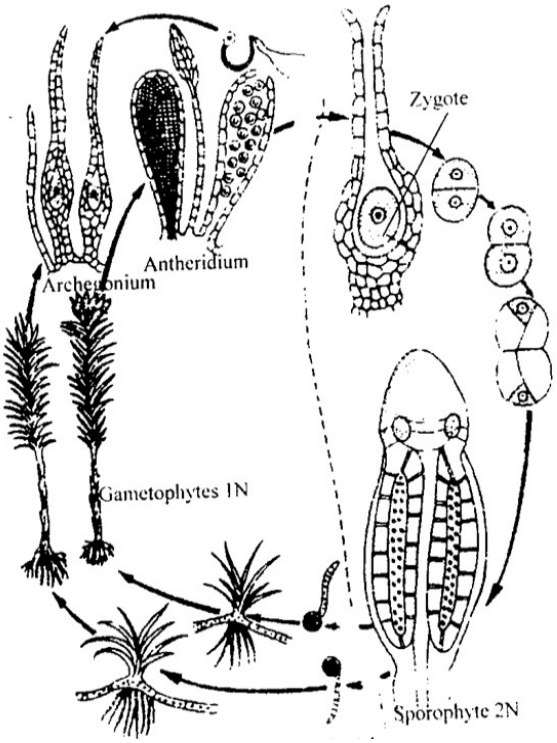
Cells of the epiphragm dry up during dry conditions. It separates the operculum. The calyptra falls. Epiphragm also dries up between the peristome pores. The central tissue of theca region except the spores degenerates. Thus the spores lie free in the centre of the capsule at maturity. Spores come out through pores. They are dispersed by wind.

Structure and germination of spores

Sopres are uninucleate and two walled. The spores are yellow. Each spore is uninucleate and has two wall laye:s. The outer layer is **exosporium** (exine). The inner layer is **endosporium.** The spore germinates under favourable conditions. Exosporium ruptures and endosporium comes out. It forms prntonema. Protonema develops many buds. These buds produce new moss plants.

Altrnation of generation

Polytrichum shows heteromorphic alternation of generation.



Gametophyte:

- The plant body is a gametophyte and it is haploid.
- It develops antheridia and archegonia.
- Antheridia produce antherozoids and archegonium produces egg.
- Antherozoids fuse with egg to produce diploid oospore.

Sporophyte:

- The oospore is the first stage of sporophyte generation.
- It is diploid generation. Sporophyte has three parts: foot, seta and capsule.
- Haploid spores are produced in the capsule by meiosis.
- Spore is the first stage of gametophyte.
- Spores germinate to produce protonema stage. It gives rise to mature gametophyte completing the life cycle.

LET US SUM UP

In Bryophytes three major classes and one member from each class has been discussed. These three are Riccia, Marchantia and Polytrichum.

CHECK YOUR PROGRESS

1. Tuberculae present in ----------
2. Members of Antocerotopsida posses ----------

SUGGESTED READINGS

1. Pteridophytes by N. S. Parihar

GLOSSARY

1. Zygote: Diploid single cell

ANSWERS TO CHECK YOUR PROGRESS

1. Riccia
2. pyrenoids

MODEL QUESTIONS

1. Describe detailed life cycle of Polytrichum

WEB SOURCES

1. https://www.britannica.com/plant/Riccia
2. https://istudy.pk/anthoceros/
3. https://www.britannica.com/plant/moss-plant

Block V

LICHENS

Unit – 19 Structure in Lichens

Unit – 20 Reproduction of Lichens

Unit – 21 Ecological significance and Economic Importance of ichens

UNIT – 19

STRUCTURE OF LICHEN

STRUCTURE

OVERVIEW

The internal and external morphology of Lichens are described in this unit. Types of special structures and tissues present in lichens are specific to this group of vegetation only. For example Leprose Lichen it is a simple thallus, looks like a powdery appearance. Apart from this special structure like breathing pore cyphellae also discussed.

LEARNING OBJECTIVES

To understand the structure and life cycle of Lichens

19.1 INTRODUCTION

Lichens are unusual creatures. A lichen is not a single organism the way most other living things are, but rather it is adual organisms formed by the symbiotic association of a fungus and alga or cynobacteria. The algal

component is known as phycobiont or photobiont (Greek, phykos - alga, bios-life) and fungal component known as mycobiant (Greek, mykos – fungus, bios - life). This true nature of lichens was first identified by **Simon Schwendener**. He named the algal component as Phycobiont and the fungal component as Mycobiont.

The term Lichen was first introduced by **Theophrastus** (371-284 B.C.). There is about 400 genera and 15,000 species of lichens, widely found in almost all parts of the terrestrial world. The plant body is thalloid and self-reproducing functional unit. They are generally growing on bark of trees, leaves, dead logs, bare rocks etc., in different habitat. They grow mostly in the forest areas with free or less pollution and with abundant moisture.

Hawksworth et al. (1983) defined lichen as **'As stable self-supporting association of a mycobiont and a photobiont".**

19.2 EXTERNAL MORPHOLOGY

1.The plant body is thalloid and irregular in shape.

2. It has no root, stem and leaves.

3. They are usually grey /greyish in colour but some species are yellow, red, orange or brown in colour.

4. Based on external structure Lichens are divided into five types

i. Leprose lichen:

ii. Crustose lichen

iii. Foliose lichen

iv. Fruticose lichen

v. Filamentous Lichen

Leprose lichen:

- This is the simple thallus and looks like a powdery appearance.
- Single or small cluster of algal cells are enveloped by fungal hyphae.
- No distinct fungal layer.

Fig.19.1 :*Leprasia incana*

Crustose lichen:

- These are encrusting lichens with thin, flattened and leathery in texture.
- Thallus is very closely attached to the substratum.
- So, it is looks crust like appearance.

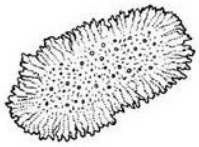


Fig. 19.2: *Graphis,*

Foliose lichen:

- These are flat, leaf like and lobed thallus.
- It is attached to the substratum with the help of rhizoid like structure called rhizines.

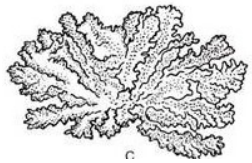


Fig. 19.3: *Parmelia, Physcia, Peltigera,*

FruticoseLichen:

- These lichens are well developed, shrub like, cylindrical and branched thallus.
- They grow erect or hang from the substratum.
- It is attached to the substratum by a basal mucilaginous disc.

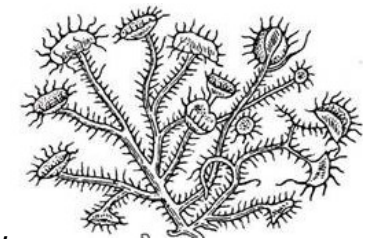


Fig. 19.4: *Usnea, Bryoria*

Filamentous Lichen:

- The algal partner is filamentous and well developed.
- The algal filaments are covered by only a few hyphae.

Example: *Coenogonium, Racodium, Cystocoleus*

19.3 INTERNAL STRUCTURE

1.**Homoiomerous type**:

The fungal hyphae and the algal cells are more or less uniformly distributed throughout the thallus.Example: *Collema, Leptogium*

2.Heteromerous type

Cross-section of the thallus consists of upper cortex, algal layer, medulla and lower cortex.

Upper Cortex

- It is outer most thick and protective zone of the thallus composed of fungal hyphae.
- There is no inter cellular spaces between hyphae.

Algal Layer

- It is found below upper cortex.
- It is consisting of network of hyphae in which algal cells are found in groups.

Medulla

- This is the central part of the thallus with spaces in between them

Lower Cortex

- It is the lowermost layer of the thallus.
- This layer is composed of compactly arranged hyphae.

- Some of the hyphae in the lower surface may extend downwards is known as rhizines.
- The main function of the rhizines is anchorage.

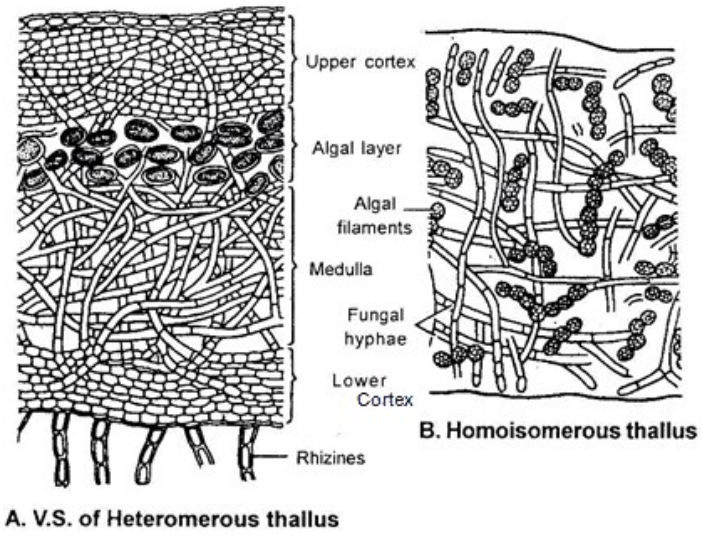


Fig. 19.5: Thallus structrure

19.4 SPECIALISED STRUCTURES IN THALLUS

Breathing pore

- In some foliose lichen, the upper cortex is interrupted by some opening, called breathing pores (e.g., *Parmelia*).
- It is used for gaseous exchange.

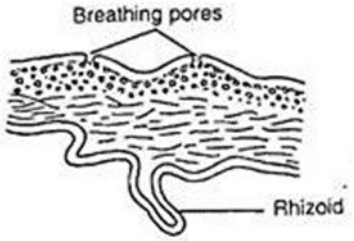


Fig. 19.6 Breathing pores

Cyphellae

- In some foliose lichen, a small develop, which appears as cup-like (depressions) white spots known as Cyphellae (e.g., *Sticta*).

Cephalodium:

- They are small warty outgrowths on the upper surface of the thallus.
- They contain fungal hyphae and algal elements.
- It is used for retaining the moisture.

LET US SUM UP

This unit completely discussed the internal and external structures present in Lichens. The special features of lichens such as breathing pore, Cyphellae and cephalodium are also explained.

CHECK YOUR PROGRESS

1. Well developed shrub like cylindrical branched thallus is called ----------
2. This Lichen structure ---------- able to retain the moisture -

GLOSSARY

1. Foliose – flat leaf like lobed thallus.

SUGGESTED READINGS

1. The Lichens by Vernon Amedijian 1974

ANSWERS TO CHECK YOUR PROGRESS

1. Fruticose
2. Cephalodium

MODEL QUESTIONS

Model Questions

1. Write detailed account on Internal structure of Lichens

WEB SOURCES

1. **https://www.britannica.com/science/lichen**
2. **https://www.anbg.gov.au/lichen/what-is-lichen.html**
3. **https://njaes.rutgers.edu/fs1205/**

UNIT – 20

REPRODUCTION IN LICHENS

STRUCTURE

OVERVIEW

Lichens are reproducing by means of asexual and sexual methods. In asexual reproduction they follow three methods Fragmentation, Isidia and Soredia. In sexual reproduction it produces male and female reproductive organs and forms zygote.

LEARNING OBJECTIVES

To understand the reproductive organs and its fuctions and also reproduction methods.

20.1 ASEXUAL REPRODUCTION:

It is most method of reproduction in lichens. It reproduces by following ways

- Fragmentation.
- Isidia.

- Soredia.

Fragmentation:

The older parts of thallus break into smaller pieces by wind or by death. Each fragment, which give rise to new thallus. It contains both algal and fungal components.

Soredia

These are small rounded asexual bodies, produced on the upper surface of the thallus.

They are grayish -black in colour.

Each soredium consists of a few algae cells surrounded by a mass of fungal hyphae.

They are detached from the thallus and develop into new thalli.

This is the most common method of vegetative reproduction in lichens.

e.g., *Parmelia, Bryoria* etc.

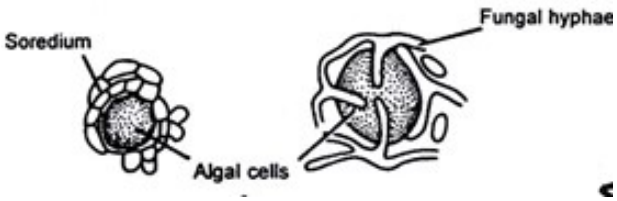


Fig. 20.1 Fungal Hypha

Isidia:

These are the stalked, un-detachable outgrowths produced by the thallus on its upper surface.

They contain algal and fungal cells.

The Isidia break from the thallus and develop into new lichen thalli.

e.g., *Usnea comosa*

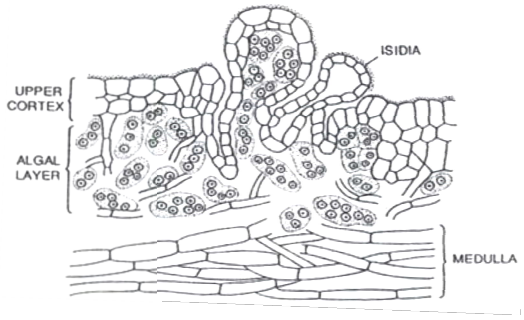


Fig. 20.2 Isidia

Oidia

It is very rare occurrence in lichen. But certain lichens may also reproduce asexually by means of spores (oidia and Pycniospores).

In some cases, hyphae break down into small pieces known as oidia.

In some cases, pycniospores are produced with in the flask shaped structures known as pycnidia.

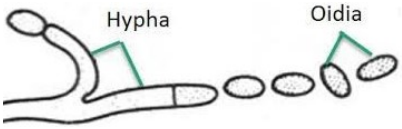


Fig. 20.3. Oidia

20.2 SEXUAL REPRODUCTION

The sexual reproduction in lichens takes place by process of spermatisation. The male reproductive organ is called the spermogonium and the female is known as carpogonium. As a result of the sexual reproduction is formation of apothecia or perithecia.

Carpogonium

It takes place by process known as Carpogonium is a female sex organ.

It consists of basal coiled filament, ascogonium and elongated trichogyne.

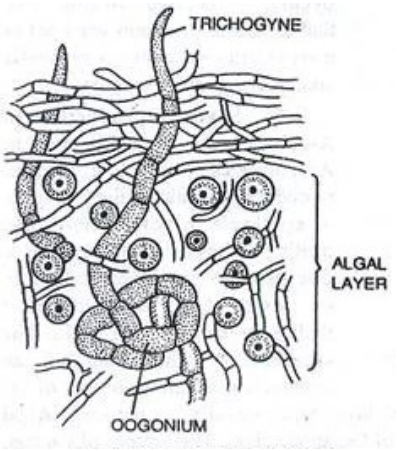


Fig. 20.4. Carpogonium

Spermogonium

The male sex organ is the spermagonium.

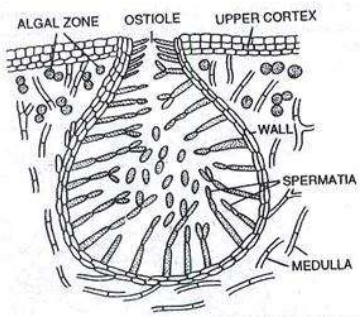


Fig. 20.5 Spermogonium

The spermogonia are flask shaped structures embedded in the upper surface of the thallus.

They open outside by a small pore known as ostiole.

It produces large number of male gametes minute at its tip called spermatia.

Fertilization:

- The spermatia are liberated and carried to the trichogyne by wind.
- The spermatium attaches in the trichogyne.
- The male nucleus pairs enter and reaches the egg.
- Now, it fertilizes with the egg.
- After fertilization, asci, ascogenous hyphae and ascogonium are formed.
- In each ascogenous hyphae, ascus is formed. It results in the formation of fruiting body which is either a apothecium o rperithecium type.
- In each ascus, 8 ascospores are produced.

Apothecium:

- Apothecia are fruit bodies which are produced after sexual reproduction or spermatization.

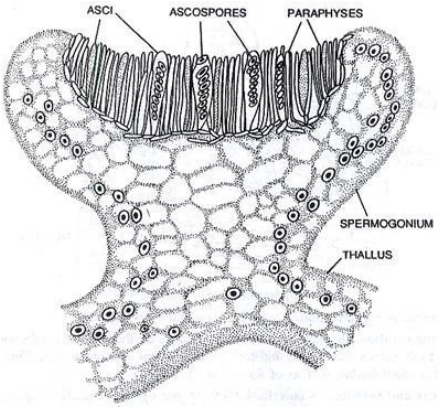


Fig. 20.6 Apothecium

- They are cup shaped or disc shaped.
- Inside the apothecium, there is peridium, algal zone and hymenium.
- Peridium is the outer covering of the apothecium
- In the algal zone, algal cells and fungal hyphae are present.
- On the upper surface of the apothecium, hymenium is present.
- It contains ascus and paraphysis.
- The ascus has eight ascospores.
- The ascospores are liberated out and reaches the substratum.
- Then, a new lichen thallus is formed.

LET US SUM UP

In this unit we have observed the reproductive organs and functions of Lichens. Lichens produced some special features for reproduction like soredia, isidia and Oidia as an asexual reproduction method.

CHECK YOUR PROGRESS

1. ----------contains algal and fungal cells
2. Male sex organ of Lichen is ----------

GLOSSARY

1. Carpogonium – Female sex organ

SUGGESTED READINGS

1. The Lichen by Vernon Ahmedijian

ANSWERS TO CHECK YOUR PROGRESS

1. Isidia
2. spermogonium

MODEL QUESTIONS

1. Describe Sexual reproduction in Lichens

WEB SOURCES

1. **https://study.com/academy/lesson/lichen-reproduction-life-cycle.html**
2. **https://www.anbg.gov.au/lichen/reproduction-dispersal.html**
3. **https://www.pieninypn.pl/en/1160/0/lichen-reproduction.html**

UNIT 21

ECOLOGICAL SIGNIFICANCES AND ECONOMIC IMPORTANCE OF LICHEN

STRUCTURE

OVERVIEW

Lichens posses ecological significance because they are pioneer of vegetation in lithosere. It also serves ecological indicator of air pollution, because tey are very sensitive to SO_2

LEARNING OBJECTIVES

To understand the importance of Lichen

21.1 PIONEER OF COLONIZERS

- The lichens are pioneer of vegetation in lithosere (succession on rocky surface).
- Lichen initiates biological weathering of rocks by forming acids like Carbonic acid, Oxalic acid leads to the formation of soil i.e. helpful in pedogenesis.

Indicator of air pollution:

- Lichens are very sensitive to SO2 and die at higher level of SO2. So lichens are not found in industrial areas where atmosphere is polluted by smoke (especially SO2), so lichens are biological indicator of air pollution.

21.2 ECONOMIC IMPORTANCE OF LICHEN

1. As Food & Fodder: -

- *Cladonia rangiferina* (reindeer moss) in tundra region (adapted to low temperature habitat).
- *Cetraria icelandica* (iceland moss) used in iceland.
- *Umbillicaria* is used as food in Japan.
- *Endocarpon miniatum* is used as vegetable in Japan.
- *Lecanora esculenta* is used as delicious food in Israel
- *Evernia* used in bakery products by Egypt.
- Species of parmelia are called "rock flower" and used as food in South India.

2. Lichen as a source of dye:

- Litmus (acid-base indicator) is obtained from *Rochella montagnei, R. tinctoria* and *Lasallia pustulata.*
- An orchil (blue dye) is obtained from Rochella and Lecanora and Purified form of orchil is "orcein" and used as biological stain (Histological studies).

3. Lichen as source of medicine:

- "Usnic acid" is important broad specturm antibiotic and it is obtained from *Usnea* and *Cladonia*.
- *Parmelia saxatilis* is used against curing epilepsy.
- *Peltigera canina* is used aganist hydrophobia.
- *Xanthoria parientina* is used aganist jaundice.
- *Loberia pulmonaria* is used against lung infection.
- *Cetraria* is used as Laxative.

4. In cosmetics and perfumes:

- Some lichens have aromatic substance like *Evernia, Ramalina* are used for manufacturing soap.

LET US SUM UP

In this unit we studied the ecological significance of Lichen and economic importance of Lichens.

CHECK YOUR PROGRESS

1. Lichens are very sensitive to ----------
2. ---------- used for soap manufacturing

GLOSSARY

1. Usnic acid – Antibiotic obtained from Usnea

SUGGESTED READINGS

1. Lichen Biology Edited by ThomasH Nash

ANSWERS TO CHECK YOUR PROGRESS

1. SO2
2. Evernia

MODEL QUESTIONS

1. Write about Ecological and economic importance of Lichen

WEB SOURCES

1. https://unacademy.com/content/neet-ug/study-material/biology/economic-importance-of-lichens/
2. https://www.biologydiscussion.com/lichens-2/importance-of-lichens-8-importance-with-diagram/69689
3. https://study.com/academy/lesson/lichen-environmental-importance-symbiosis-facts.html
4. http://tnenvis.nic.in/tnenvis_old/Lichens/Economic%20Importance.pdf

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