LICHEN AND MYCORRHIZA

A - Lichen

- Lichens are composite thalloid structure containing algae and fungi.
- Algal component of lichen synthesize carbohydrates by photosynthesis and provides nutrition to fungi and themselves while fungal component helps is water absorp0tion and water retention. Hence lichen is an example **symbiosis.**
- Lichens are distinct group of plant having to components i.e. algal component called **Phycobiont** and fungal component called **Mycobiont.**
- The term **"Lichen"** was first given by **Theophrastus** for superficial growth on barck of **olea europea** (olive) tree. Study of lichen called as **Lichenology.**
- **Erik Acharius -** father of Lichenology.
- **Morrison -** called lichen as **"Musco-fungus".**
- Initially linches were considered to be individual plants and were included in mosses but **Schwendiner** gave **dual hypothesis** i.e. there are two components in lichen and defined as **fungi parasitizing algae.**
- **Reininke -** gave the term **consortium** (marriage) for this association i.e. mutual growth and interdependence.
- **De Bary** -gave this association the name **Symbiosis.**
- **It Crombie -** gabe the **master slave hypothesis** for this association (also called **husband-wife** relationship). It is also called **helotism** (Most accepted association now a days).
- In this association, the fungal component shows predominance over algal component and the latter is a suborinate partner. Such type of association is known as **helotism.**

HABIT & HABITAT

- The lichen are mostly perennial, aerial, **slow growing** and **long lives** plant.
- Lichen are **cosmopolitan.** Lichens grow even in areas which appear unsuitable for normal plant like **bare hard rock** and **cold arctic region.**
- Lichens are most sensitive to air pollution specially **SO_2-pollution**
- In India lichen are most common in **eastern Himalaya** as compare to **western Himalaya Lichens** are **absent** in **planes.**

On the basis of habitat, lichen are of following type :

1. **Saxicolous -** Lichens growing on rocks. eg. - ***Dermatocarpon , Pornia***
2. **Corticolous -** Lichens growing on tree barck. e.g. - ***Parmelia, Usnea***
3. **Terricolous -** Lichens growing on soil eg. ***Cladonia, Collema.***
4. **Lignicolous -** Lichens growing on wodd eg. ***Chyphelium.***

- The lichen may also occur in fresh water eg. ***- "Hymenelia lacustris"***
- Few marine species eg. ***"Caloplaca marina"***

CLASSIFICATION

- Major part of lichens thalli are composed of fungal component.

I. ON THE BASIS OF THEIR FUNGAL COMPONENT -

A. Ascolichen :

- In Ascolichen fungal partner is the member of **ascomycetes**
- **Most of the lichens are Ascolichen**

***** Ascolichens are further divided into two types.

a. Gymnocarpae - Where fruiting body is **apothecium** type. Apothecium is a plate like fruiting body. These are called **discolichen** eg. **parmelia**

b. Pyrenocarpae - Where fruiting body is peitheium type Flask shaped fruiting body is called **perithecium.** These are called **pyrenolichen** eg. **Dermatocarpon.**

- In basidiolichen, fungal partner belongs to basidiomycetes. There are only **three genera** in this group.
- In basidiolichen, alogal partner is always a member of **Myxophyceae** (B.G.A.)

Note :

1. In **80% cases** of lichen algal partner is member of green algae or **clorophyceae** and in 20% cases blue green algae.

2. Important member of green algae in lichens is **Trebo uxia** [most common **unicellular** green alga], **Pleurococcus, Cladophora.**

Blue green algae - **Nostoc, Scytonema, Anabaena, Gloeocapsa, Rivularia etc.**

II CLASSIFICATION ON THE BASIS OF TYPES OF THALLUS -

Lichens are of three types -

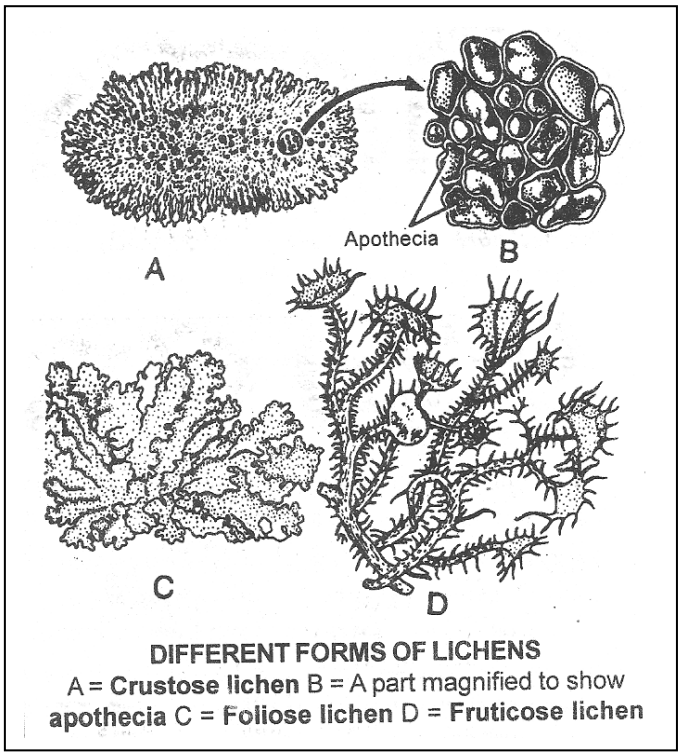
1. Crustose lichen - These lichen thallus are flat. The thallus is closely adhered to the substratum and provides a crust like appearacne.

- These lichens are partially or com pletely embedded in to substratum.
- These can't be separated from the substratum without breaking them.
- Fruiting bodies are visible above the surface o the substratum.

e.g. - **Rhizocarpon, Graphis, Lecanor, Verrucaria Haemotomma**

2. Folise Lichen - These lichens are flant, leaf like and lobed. They are attached to the substrum with the help of rhizoid like **rhizines.** These hairy structuresare developed from lower side of thallus

eg. **Parmelia, Peltigera, physcia and collema.**



DIFFERENT FORMS OF LICHENS
A = **Crustose lichen** B = A part magnified to show **apothecia** C = **Foliose lichen** D = **Fruticose lichen**

3. **Fruticose lichen -** These lichens are well developed, shurb like, cylindricl and brunched thallus. They grow erect (Ex. ***Cladonia***) or hang from substrum (Ex. ***Usnea***). They are attached to the substratum by their **basl mucilagenous disc.**

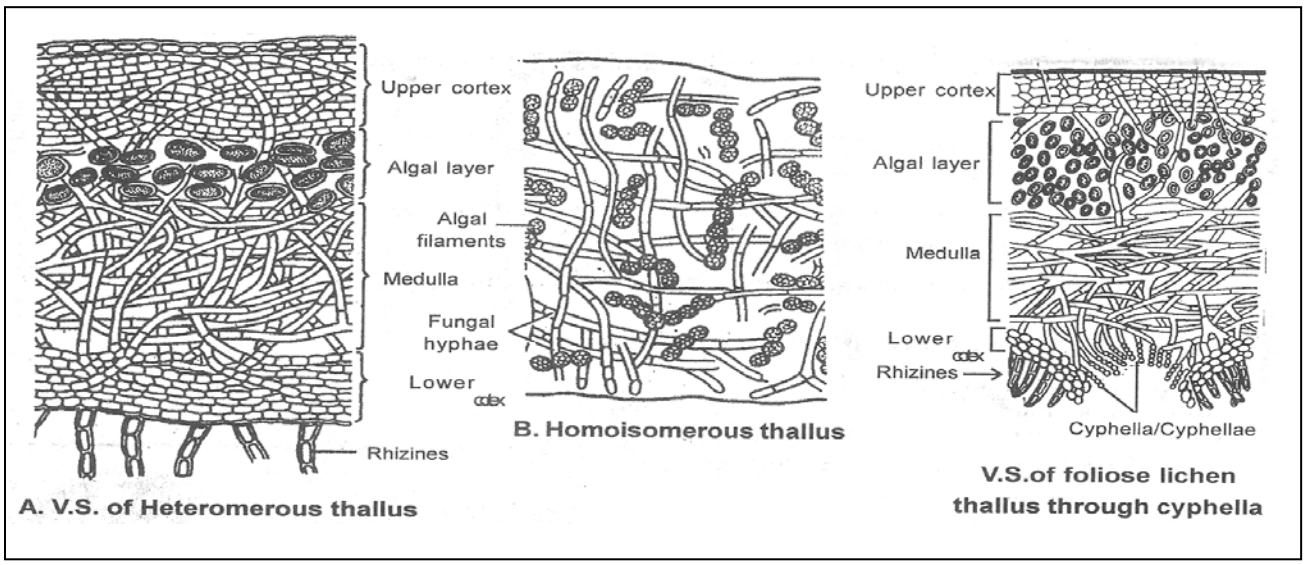
III CLASSIFICATIIN OF LICHEN ON THE BASIS OF DISTRIBUTION OF ALGAL COMPONENT IN THALLUS

a. Homoisomerous thalli -

- In this type of Lichan thallus algal and fungal partners are **uniformly distributed** throughout the lichen thallus. These lichen thallum are **rare**. eg. **Collema** and **Leptogium.**

b. Heteromerous thalli -

- In this type of Lichen thallus algal cells are **restricted** to from a **distinct layer** generally on the upper side of thallus.
- In these form, fungal component is dominant. The algal component usually a member of **chlorophyceae eg. *Prmelia***
- Most of the lichens are of these types



INTERNAL STRUCURES OF LICHEN -

- V.S. of foliose lichen -

a. Upper cortex - It is made up of compactly interwoven fungal hypae Intercellular spaces are absent. If present then filled with **gelatinous substance.**

- In some lichens **(*Prmelia*) breathing pores** are present on upper cortex.

b. Algal layer - It occurs just below the upper cortex. This layer forms photosynthetic zone of thallus.

- In this layer algal cells are present and some fungal hyphae are randomly oriented. This layer also called **"gonidial layer".**

c. Medulla - Beneath the algal zone there occurs medulla. It is made up of **llosely interwoven** fungal hyphae with l arge spaces between then which are randomly oriented.

d. Lowre cortex - it is made up of compactly interwoven fungal hyphae some of these hypae become specialized and extend down ward from the lower surface of the cortex and helps in the attachment of thallus to the substratum. These **specialized hyphae** are known as **rhizines.**

***** Internal structure of crustose lichens is also **more or less similar** to **foliose lichens.** The **lower cortex does not occur in fruticose lichens** due to their **cylindrical structure** and medulla forms the central part of the axis.

Special points :

(i) Breathing pores : The upper surface of some lichen have loosely arranged areas called breathing pores . They helps in gaseous exchange. ***e.g. Parmelia***

(ii) Cyphellae - These are small, almost circular depression on the lower side of thallus (In foliose lichen). they are meant for exchange of gases.

- Cyphellae are **analogous** to **stomata** of higher plants.

REPRODUCTION :

I. VEGETATIVE REPRODUCTION

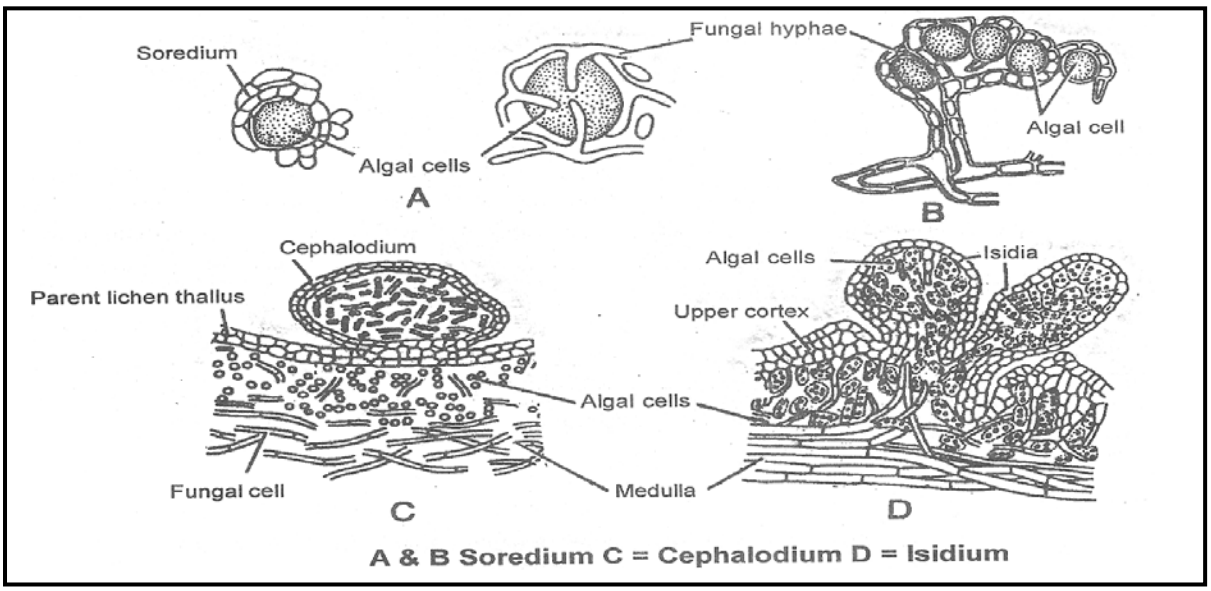
(a) Fragmentation : The main thallus breaks into small pieces and each piece grows to form new lichen thallus. Each fragment develops into a new thallus, provided it contains both algal and fungal components.

(b) Soredium : Some small **bud-like** outgrowths known as soredia, develop on the surface of the thallus. A soredium contains one or few algal cells closely envoloped by a **weft** of fungal hyphae. The **soredia** form a granular layer of greyish-white colour on the surface of the thallus, They are detached from the thallus by the impact of **wind** o **rain.** The soredia germiante on suitable subtratum and form new thalli.

(c) Isidium : Isidia are small, stalked, **greyish-black** coral like outgrowths which develop on the **upper surface** of the thallus. The isidium h as an **outer cortical layer** enclosing the algal and fungal components. It is usually constricted at the base and is **easily detachable** from the parent thallus. It germinates under favourable conditions and forms new thallus.

- In addition to **propagation** insidia also help in increasing the **photosynthetic** surface of the thallus. They vary in shape nd may be rod life (e.g. ***Parmelia***), coral like (e.g. Pelitigera) scale-like (e.g. Collema) or cigar like (e.g. Usnea).

Note : Cephalodium : These are small **wart like structures** formed on the surface or inside of the thallus. One of the characteristic feature of the cephalodium is that its algal and fungal components differ from that of the thallus. It is due to the fact that cephalodia develop on the younger parts of the thallus from soredia of some other species. Hence, **the cephalodium may be regarded as sterile thallus of some other lichen.** They **retain moisture.** In some species, the cephalodium contains the same fungal hyphae as in thallus but the algal component is always different.



II ASEXUAL REPRODUCTION :

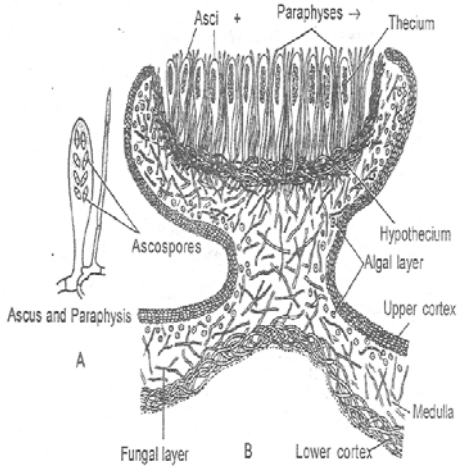
(a) Oidia : The fungal hyphae form small **thin walled** bodies called **oidia.** They form mycelium. On coming in contact with suitable algal component they form new lichen thallus.

(b) Conidia : In several lichnes, the fungal component form **conidia**. conidia produced on **conidiophores.** They form fungal mycelium and mycelium on coming in contact with suitable algal component form new lichen thallus.

(c) Pycnidiospores : These spores are formed in flask shaped structures, called **Pycnidium**. Pycnidiospores form new fungal mycelium and Mycelium for m new lichen on coming in contact with suitable algal component.

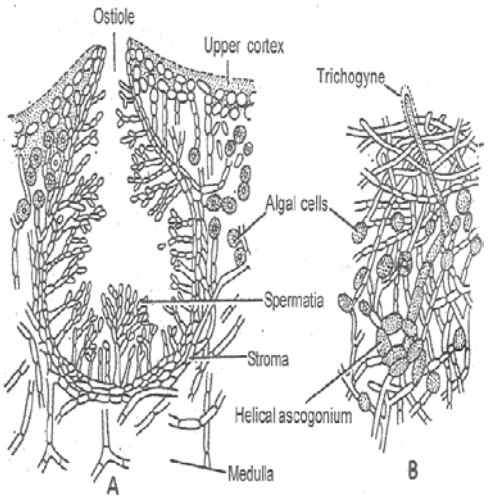
III SEXUAL REPRODUCTION

- Sexual reproduction is the function of fungal component. The fungal component of most of the lichens belongs to the calss **.** Carpogonium **ascomycetes.**
- Female sex organ is called **"Carpogonium".** Carpogonium differentiated into **two parts-** lower coiled part is called **"ascogonium"** and upper straight is called **"trichogyne".** The ascogonium remains embedded with in the **algal layer** of the thallus, whereas the **trichogyne projects** over the surface of the thalus
- Male sex organ is called **"Spermogonium"= (Pycnidium).** It is flask shaped. It open **out side** by **ostiole**. Inside spermogonium **non motile** sperms of **spermatia** are formed.
- The spermatia are ooze out through **ostiole** in the form of slimy mass and attach with the **trichogyne** and wall of **two** soon **dissolves.**
- Nucleus of spermatia reaches in **ascogonium.** Many **"Ascogenous hypae"** arises from the fertilized ascogonium. These cells are **uni** or **binucleated** and the terminal or penultimate (sub-terminal) binucleaste cell of the ascogenous hyphe develops into as ascus. In ascus both nuclei fuse to form a **diploid** nucleus.



Lichen - V.S. of fruiting body

A. Showing ascus and paraphyses
B. V.S. of apothecium



Lichen A. spermogonium, B. Carpogonium

- In ascus **one meiosis** and **one mitotic** division take place and **8-ascospoores** are formed in each ascus. Ascicovered by paraphysis.
- **Asci** (Ascogenous hyphae, ascus motther, cells, ascospores) and some sterile hyphae form furiting body called **"apothecium** eg. ***Parmelia*** or ***Perithecium*** eg. ***Dermatocarpon, Verrucaria.***
- Ascospores are libereated from ascus and on coming in contact with suitable algae form new lichen thallus.

ECONOMIC IMPORTANCE OF LICHEN :

1. Ecological importance :

The lichens are pioneer of vegetation in a **lithosere** (succession on rocky surface).

Crustone being first followed by Foliose and finally fruticose.

- Lichen initiates biological weathering of rocks by forming acids like **Carbonic acid, Oxalic acid.**
- Biological weathering of rocks leads to the formation of soil ie. helpful in **pedogenesis.**

In **Lithosere** - sequence of different strage is -

Crustose lichen (Pioneer) → Foliose lichen → fruticose lichen → Moss stage

Tree(climax) → Shrub stage → Herb stage

2. As Food & Fooder :

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

3. Lichen as a source of dye :

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

4. LIchen as source of medicine :

- **"Usnic acid"** is important broad spectrum antibiotic and it is obtained from **Usnea** and **Cladonia.**
- **Parmelia saxatilis** is used against curing epilepsy.
- **Peltigera canina** is used against **hydrophobia.**
- **Xanthoria parietia** is used against **jaundice.**
- **Loberia pulmonaria** is used against lung infection
- ***Cetraria*** is used as **Laxative**
- The **"protolichesterinic acid"** obtained from some lichen. This acid have **anticarcinogenic** properties.

5. Brewing and distillation :

- The lichen contains carbohydrate in the form of **"lichenin".** So some lichen like **Cetraria** and **Lecanora** are used for **alcoholic fermentation.**

6. In cosmetics and perfumes :

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

7. Poisonous lichen :

- ***Cetraria juniperina*** and ***Letharia vulpina*** (wolf moss) are used **as poison.**

8. Indicator of air pollution :

- Lichens are very sensitive to SO_2 and die at higher level of SO_2
- so lichens are not found in industrial areas where atmosphere is polluted by smoke (specially SO_2) So lichens are ***biological indicator*** of air pollution.

9. Forest fire :

- **Usnea,** popularly known as **"old man's beard"** is of **inflammable** nature. They are responsible for fires in the forests during sumer season

B-MYCORRHIZA

- Mycorrhiza is the symbiotic relationship between roots of higher plants and fungi. Mycorrhiza name was given by **"Frank"** (1885).
- Mycorrhiza are of two types

(a) Ectomycorrhiza -

- In this type of mycorrhiza surface of root completely covered by **pseudo parenchymatous sheath** formed by fungal hyphae.
- Fungal hypae enter intercellularly in cortical cell of root.
- Fungal hypae which arises from **pseudo parenchymatous sheath** limited up to outer cortical cell and form a net called **"Hrting net".**
- Ectomycorrhiza occurs in **Pinus, Fagus, Abies, Oak, Eucalyptus etc.**
- fungus mainly members of class **basidiomycetes** e.g. **Clavatia, Amanita,** etc.
- **Root hair** are **absent** on root.
- Fungus helpful in absorpiton of water and minerals. Due to presence of fungus absorptie surface of root increases. In return fungus gets carbohydrates from the root.

Note : Amanita is found in **Pinus** roots where as **Russula** is found in **Fagus** roots.

(b) Endomycorrhiza :

- In this type of mycorrhiza fungus does not form **pseudo parenchymatous sheath.**
- Fungal haphae enter intracellulary in cortical cell of root.
- Intracellular **fungal hyphae** form branched structures in cells of roots called ***"arbuscule".*** Due to same reason endomycorrhiza is called **Vesicular arbuscular mycorrhiza (**VAM**)**
- VAM increases **fertility of soil.**
- **VAM** is important in **phosphate nutrition** of plant.
- Endomycorrhiza occurs in **orchid.**
- Fungus mainly member of class **"zygomycetes". Corticium Rhizoctonia etc.**
- Mycorrhiza is an example of **symbiosis.** Fungus obtain food and shelter from root and it helps to root in **absorpition of water** & **minerals.**

  Note : The angiospermic saprophytes in which root systems are poorly developed, survive only because of their mycorrhiza fungi **(Armillaria** fungi mainly found in orchid's roots**).**

  Special point : Ectomycorrhizal genera → **Hebeloma, Laccaria, Pisolithus**
  Endomycorrhizal genera : **Glomus, Gigaspora, Sclerocystis.**