

III. Lichens

Introduction

By definition, lichens are a symbiotic association between a fungal partner and a population of unicellular or filamentous algae or cyanobacteria. There are approximately 20000 species of lichens worldwide, but less than half of them are macroscopic species that are easily visible to the naked eye.

Currently, lichens are considered as *lichenized fungi* adapted to symbiotic life, with a predominance of fungal components in their morphology and reproduction. They lack stems, leaves, roots, and vascular tissues for transporting sap, which classifies them among non-vascular thallophytes.

Lichens, or lichenized fungi, are slow-growing composite organisms resulting from a stable, durable, and reproducible association (*symbiosis*) between a fungus (*mycobiont* from the Greek *mykes* "fungus" and *bios* "life") most commonly an ascomycete, more rarely a basidiomycete and a photosynthetic partner (*photobiont* from *photo* "light" and *bios* "life"), which is an alga (*Chlorophyceae*, in 80% of cases) or a prokaryotic cyanobacterium (in 10% of cases).

Symbiosis is thus an association between partners with mutual benefits, each organism supplies what the other lacks:

- The fungus receives photosynthetically produced nutrients.
- In return, it provides the alga with water, dissolved substances, and certain organic compounds

1. Morphology

The structure of lichens is highly diverse, but two main types can be distinguished based on their thallus appearance: gelatinous thalli and dry thalli.

1. Gelatinous Thalli

- These contain cyanobacteria distributed throughout the entire thallus.
- In a dry state, they appear black and leathery (hard).
- When hydrated, they swell and form gelatinous masses.
- Example : *Collema*



Figure : Collema sp

2. Dry Thalli

- These are much more common than gelatinous thalli.
- The green algal cells are trapped within the fungal hyphae.

Thallus can take multiple forms: **Crustose thalli** (*crust-like thalli*): Representing more than 4/5 of lichens, they are often called microlichens, form a strongly adherent crust on the substrate. (*Lecanora*), **Foliose thalli** (*leaf-like thalli*: e.g. *Xanthoria*), **Fruticose thalli** (*shrub-like thalli* e.g. *Pseudevernia*), **Composite thalli** (*dual-structure thalli* e.g. *Cladonia*)

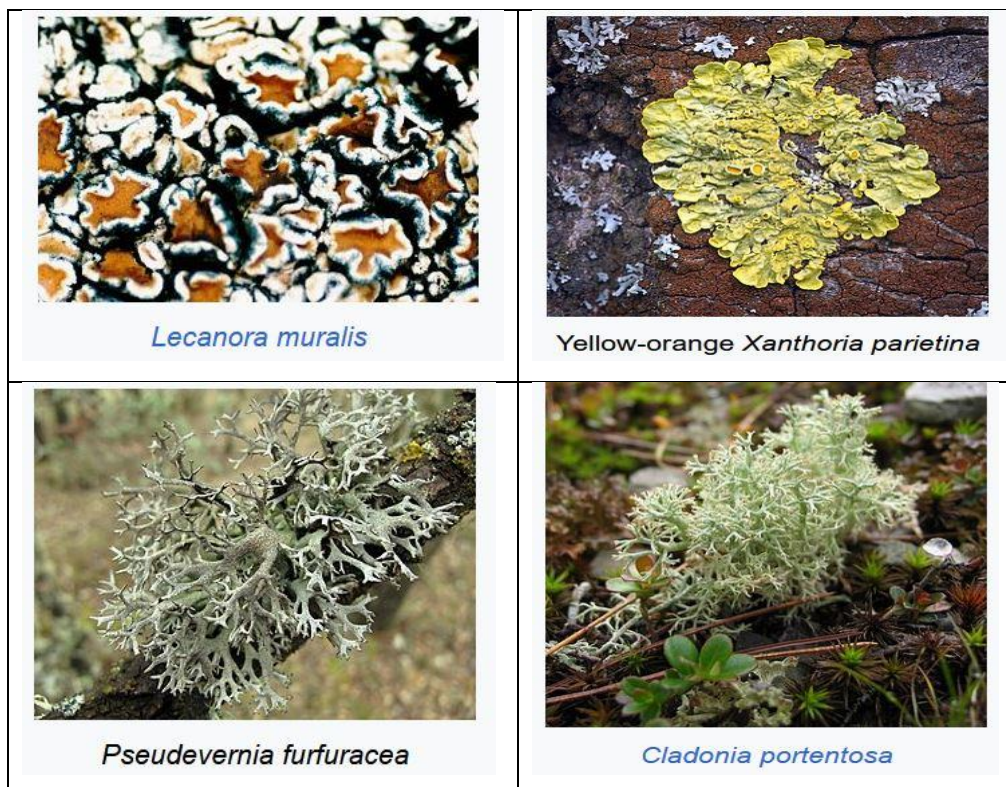


Figure: Lichens forms

2. Anatomical structure

The structure of lichen thalli can be organized in 02 ways:

1. Heteromerous Thallus

- The thallus is organized into distinct layers, with a structured arrangement:
 - Upper cortex (protective layer)
 - Gonidial layer (contains the algal cells)
 - Medulla (loosely arranged fungal hyphae)

- Lower cortex (may include rhizines for anchoring to the substrate)

2. Homoimerous Thallus

- The gonidia (algal cells), either isolated or forming small clusters, are evenly mixed with the fungal hyphae throughout the entire thallus thickness.

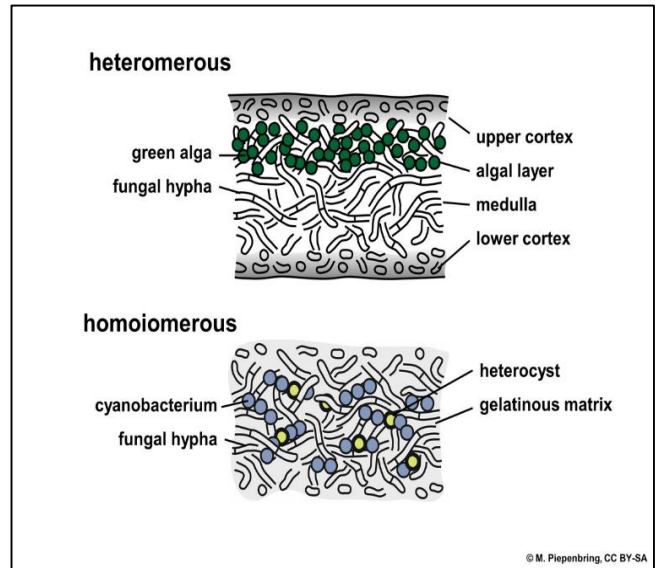


Figure: Structure of lichen thalli

3. Reproduction

Lichens reproduce in two main ways: sexual reproduction (through the fungal partner) and asexual reproduction (by propagules containing both symbiotic partners).

1. Asexual reproduction

Lichens reproduce asexually using special propagules that contain both the fungal and algal partners, ensuring that a new lichen can form directly.

1. Soredia

- Small, powdery structures consisting of a few algal cells surrounded by fungal hyphae.
- Easily dispersed by wind, water, or animals.
- Directly regenerate into a new lichen on a suitable substrate.

2. Isidia

- Small, finger-like outgrowths on the thallus surface, containing both fungal and algal cells.
- They break off and disperse, developing into a new lichen.

3. Thallus Fragmentation

- Pieces of the lichen break off naturally and grow into new individuals.
- Common in harsh environments where lichens experience mechanical stress.

2. Sexual reproduction

- Only the fungal partner (mycobiont) undergoes sexual reproduction, mainly Ascomycetes (in *Ascolichens*) or Basidiomycetes (in *Basidiolichens*).
- The fungal partner produces fruiting bodies (*ascocarps* or *basidiocarps*), which generate spores.

- These spores disperse in the environment but need to find a compatible algal or cyanobacterial partner to form a new lichen.

Types of fruiting bodies (in Ascolichens)

1. **Apothecia:** Cup- or disk-shaped structures containing asci with ascospores.
 - **Lecanorine type:** Apothecia form from the upper thallus layers (e.g., *Lecanora sp.*).
 - **Lecideine type:** Apothecia form from the medulla (e.g., *Lecidea sp.*).
2. **Perithecia:** Flask-shaped structures with a small opening where spores are released (e.g., *Verrucaria sp.*).
3. **Pycnidia:** Small, flask-shaped structures producing asexual conidia (not true sexual spores).

4. Classification

Lichens are classified based on their fungal component, as the fungal partner dominates their structure and reproduction. They are divided into two main subclasses:

1. Ascolichens (Lichens with Ascomycete Fungi)

- The fungal partner is an Ascomycete.
- They represent the vast majority of lichens, with about 98% of all known species.
- This group includes approximately 50 families.
- Examples of Ascolichens: *Lecanora sp.*, *Xanthoria parietina*, *Cladonia sp.*

2. Basidiolichens (Lichens with Basidiomycete Fungi)

- The fungal partner is a Basidiomycete.
- This group is very rare, with only 3 genera and fewer than 20 tropical species.
- Basidiolichens are mainly found in humid tropical regions.
- Examples of Basidiolichens: *Dictyonema*, *Cora*, and *Acantholichen*.

Apart from fungal taxonomy, lichens can also be classified based on their: **growth form** (morphological classification), **photobiont type** and **habitat and ecological adaptation**.