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# 12. Lichen: A Beauty of Nature

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## 12.1 Information:

A lichen looks like a single organism, but it is actually a symbiotic relationship between different organisms. It is the association of two different organisms such as fungus component is known as mycobiont and algal component is known as phycobiont. Fungus benefits from the algae because fungi, having no chlorophyll, can't photosynthesize their own food. The algae benefit from the association because the fungus is better able to find, soak up, and retain water and nutrients than the algae. This kind of relationship between two or more organisms, where both organisms benefit, is known as mutualism. The photosynthetic partner is generally green algae or cyanobacteria. Lichen is an ecological beauty of nature.

There are about twenty thousand species of lichens of all types in the living world (the current global checklist of lichens and allied fungi lists 18,882 species; (Feuerer & Hawksworth, 2007).

The main bodies of lichens are thallus .i.e. not differentiated into stem, root and leaf. Lichens are widely distributed and found to grow on soil, rocks, trees, marine with variety of habitats like cold to hot, arid to moist climate. They withstand extremes environmental condition. They play several roles in ecosystem, may be dominant vegetation in tundra, primary colonizers in succession of xerosere, involved in weathering of rock and formation of soil, exist where other organisms can’t grow such as surface of desert rocks, alpine, arctic, etc.

Lichen absorbs most of its mineral nutrients from the air and rainfall. Pollution in the atmosphere can be especially dangerous to lichens because they retain, and can accumulate, deadly amounts of heavy metals, sulfur, radioactive elements, $NO_2$, and ozone. Sulfur dioxide ($SO_2$) is especially lethal to lichens because it lowers pH and deteriorates chlorophyll, which causes photosynthesis to cease.

Lichens have been used to monitor the amount of pollutants in an environment. This is done by observing the condition of lichens as well as their chemical composition.

Lichens live in environments where neither fungi nor algae could live alone. While the fungi do not grow alone in the wild, some algal partner of lichen occur as free-living organisms.

They vary in size, shape and colour. Some are flat and firmly attached to the surfaces on which they grow, like those white or yellow-brown disks that are often seen scattered over walls and roofs. But others are scaly, leafy or bushy, or hang in strands from their supports. Several lichen thallus morphologies are recognised, and some are very similar to simple plants in appearance and growth pattern (Figure 12.1).

A. Crustose (a flat crust, commonly seen on walls and other stonework);
B. Foliose (leafy);
C. Fruticose (branched, shrubby);

## A. Crustose Lichens:

The thallus is of insignificant size. It is flat, thin usually without any distinct lobes. It is just like a thin layer or crust closely attached by the whole of its lower surface to stones or rocks, bark and similar hard substrata that the crustose lichen appears to be painted on. Normally it is impossible to dislodge it without breaking it. The surface of the thallus is usually divided into more or less hexagonal areas called the areolae. In many species, the thallus is partly buried in the substratum. *Graphic scripta* and *Haematomma puniceum* are the best examples of crustaceous lichens.

## B. Foliose Lichens:

The foliose thallus is more fascinating. It is flat, broad, and much lobed and twisted leaf-like (but not true leaves). It grows more or less free of the substratum but close to it. It has a distinct upper and a lower surface. The lower surface may be white or sooty. The edges are usually curled up. The foliose thallus is attached to rocks and twigs by rhizoid-like outgrowths called the rhizines. In lichens, rhizines are multicellular root-like structures, arising mostly from the lower surface. . In some foliose lichens, the rhizine consists of a single, simple to branched hypha. The free end of the rhizine broadens to form a flat disc. The disc secretes mucilage and attaches itself firmly to the substratum A lichen consist of rhizines is termed rhizinate, while a lichen lacking rhizines is termed erhizinate. They are dark or dark brown in colour. The thallus, in some species, is attached to the substratum by means of a single rhizine. In others, the thallus is attached by several rhizines. It grows from the centre of the lower surface of the thallus. Rhizines serve only to anchor the lichen to their substrate; they do not absorb nutrients as do plant roots. The common examples of foliose lichens are *Xanthoria* sp, *Physcia* sp, *Peltigera* sp, *Parmelia* sp, *Cetraria* sp and *Cluiudhuria* sp.

## C. Fruticose Lichens:

They are the most conspicuous and have a most complex thallus which is slender and freely branched. The branches may be cylindrical or ribbon-like (flattened) and form thread-like or twig-like tufts.

In many species of *Cladonia* sp, the branches stand stiffy erect making the thallus resemble a tiny bud. There are others (*Usnea* sp) in which the branches are pendant (hanging) and tassel-like. The thallus is attached only at the base by a flattened disc.

The fruticose lichens make extensive and attractive growths standing out from the rocks, foliage and branches of trees. The thallus shows no differentiation into upper and lower surfaces. *Usnea* sp, *Cladonia* sp and *Ramalina* sp are the common examples of fruticose lichens. Lichens reproduce in two main ways:

- Asexually reproduce by isidia and soredia.
- Sexually reproduces by apothecia, and these are basically big cups full of spores (technically ascospores.) and perithecia, and these exist mostly below the surface, with a narrow opening to the top of the thallus.

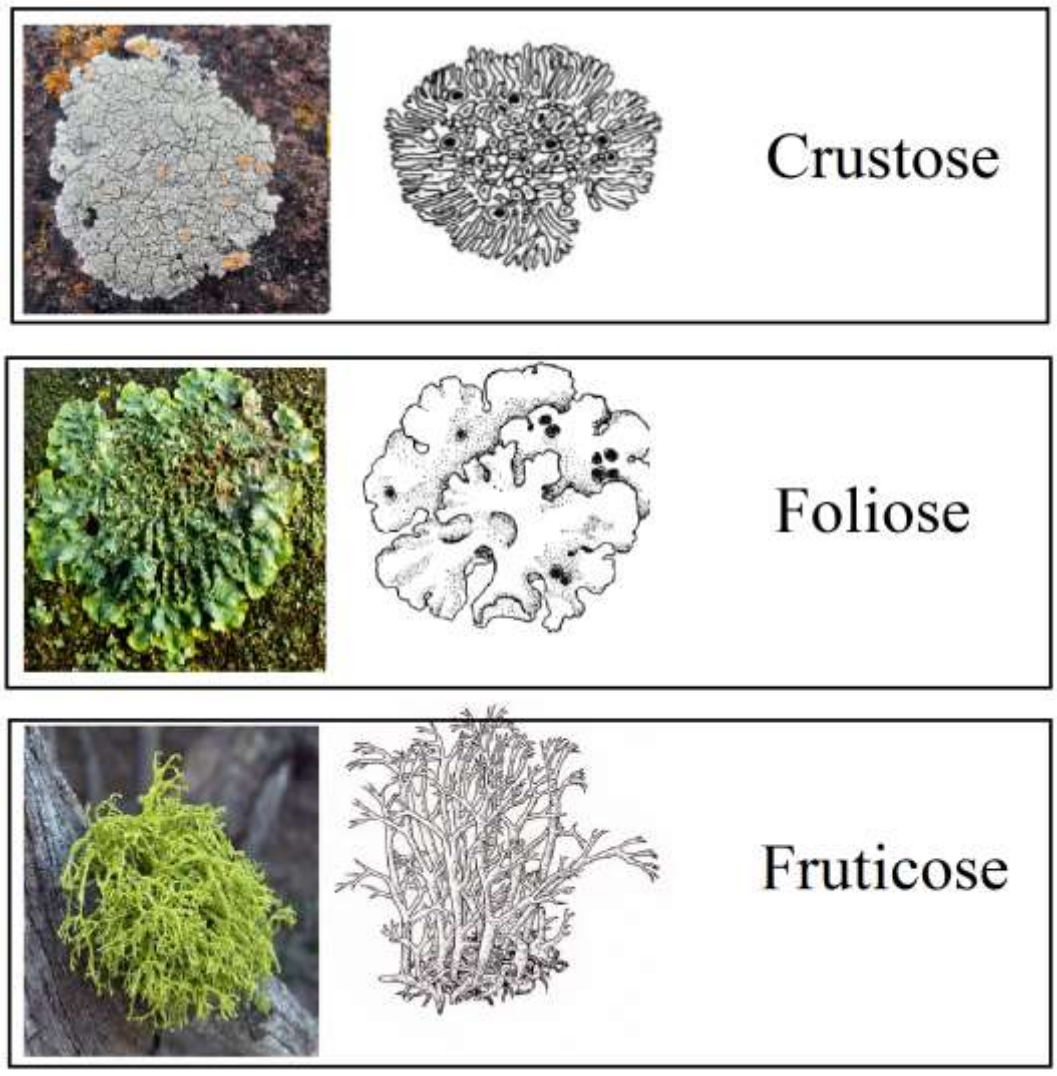


**Figure 12.1: Different lichen thallus**

## 12.2 Current Development:

Using *metatranscriptomics* to examine the lichen symbiosis, it is found that macrolichens are constituted of not two but three symbiotic partners- an *ascomycete fungus, a photosynthetic alga,* and an unexpectedly *yeast* (Spribille *et al*., 2016). The yeast cells are embedded in the cortex of the lichen thallus and may contribute significantly to its morphology.

The yeasts are ubiquitous and essential partners for most lichens and are not casual colonisers or parasites. In addition to nitrogen-fixing cyanobacteria, five bacterial orders are frequently found, providing functions to the overall symbiotic community of the lichen ranging from the provision of vitamins and cofactors to the degradation of phenolic compounds (Cernava *et al*., 2016). Therefore, Hawksworth & Grube (2020) re-defined the lichen symbiosis as *'lichen is a self-sustaining ecosystem formed by the interaction of an exhabitant fungus and an extracellular arrangement of one or more photosynthetic partners and an indeterminate number of other microscopic organisms'*.

## 12.3 Importance of Lichens:

- Lichens are used as food e.g. Cetraria *islandica*, *Dermatocarpon* sp. The 'Bread of Heaven' or the manna of the Israelites is the lichen named *Lecanora esculenia*. The lichen Cetraria or Iceland moss is used as food. *Cladonia*, the Reindeer moss serves as food for reindeer.
- Rosella is a kind of lichen, which yields a dye called *litmus*. It is used in the preparation of litmus paper, which is used as an acid-base indicator to find out the pH in the chemical laboratory.
- Lichens are used for preparation of alcohols e.g. *Cetraria islandica*.
- **Indicator of air pollution:** being sensitive to SO2
- **Bio indicators for Pollution:** One of the most important uses for lichens has to do with their sensitivity to pollution. Some species of lichens are extremely sensitive to specific pollutants. Scientists use these species as indicators in various parts of the world to track the amount of pollution in those areas. In this way, lichens can act much like a canary in a coal mine. They warn when chemicals like heavy metals or sulfur are present at low levels so that steps can be taken to eliminate the pollution before it can reach levels that can affect other organisms. Some species of lichens are more sensitive to pollution and used as indicator of air quality. Most resistant species can also be analyzed for pollutants, including bioaccumulation of heavy metals and radioactive isotopes
- **Fabric Dyes:** Lichens have been used for centuries to create natural dyes for fabrics. The fungal part of lichens makes them a perfect source of pigments with which to create the dyes. Lichens come in a wide variety of colours such as green, yellow, red, brown, even purple etc. The colour of the lichen depends on the species of fungus. Indigenous peoples from around the world have long used lichen to dye yarn for rugs and clothing. In Scotland, lichen-based dyes have been used to dye wool to make sweaters and other products. *Rocella* sp. is used to prepare dye Orcein.
- **Perfumes:** Many lichens contain acids and other essential oils that are useful in making perfumes and scents for various products. Although the formulas for many scents are very tightly held secrets, it is well known that certain types of lichen are widely used. Lichen used for essential oils for cosmetics and perfume are *Evernia* sp, *Ramalina* sp, *Oakmoss* sp.

- **Medicine:** Although lichens have been used in folk medicines for centuries, science is just beginning to investigate the medicinal properties of lichens. Studies have shown that acids from various lichen species may be useful in killing bacteria. Other information suggests that lichens may be helpful in fighting off viral infections and certain types of cancers. Some examples are *Xanthoria parietina* used in jaundice, *Labaria pulmonaria* for lung infection, *Peltigera canina* against hydrophobia. Lichens are used as medicines. *Usnic* acid, obtained from Usnea is used to stop *bleeding. Cladonia, Parmelia* - lichens have medicinal value.
- **Plant Succession:** Lichens are pioneer plants which help in colonisation of bare rocks. They excrete organic acids which disintegrate the rocks forming the soil. The lichen thalli secrete certain organic acids which gradually dissolve and disintegrate the rocks to which they cling. The rock particles together with the decaying and dead lichen thalli form a soil fertile enough for other plants to make appearance through plant succession. So, in rocks lichen is called the pioneer organism for plant succession.

## 12.4 Some Important Features of Lichens:

- The Lichens are dual or composite organism.
- The thallus-like plant body is made up of a fungus and an alga living in closest association. The nature of association between the two partners is the best example of symbiosis in the plant kingdom.
- Fungus provides the body of the organism whereas alga synthesizes carbohydrate food for itself and the fungus.
- The lichen thalli are generally of three kinds, crustose, foliose and fruticose.
- Internally the thallus particularly in the foliose lichens consists of four regions namely, the upper cortex, the algal layer, the medulla and the lower cortex.
- Asexual reproduction by asexual spores and sexual reproduction are entirely the functions of the fungal partner.
- The carpogonium is a coiled, multicellular filament.
- It consists of a coiled, multicellular ascogonium and a straight, multicellular trichogyne.
- There is a pore in the centre of each septum between the cells of the trichogyne.
- The antheridia which are flask-shaped receptacles are sunk in the upper surface of the thallus.
- Male cells or spermatia are non-motile. Each has a cell wall around it.
- The ascus fruit in many species is of apothecium type and in others of perithecium type.
- The contents of each ascus are fashioned into eight haploid ascospores. The ascospores may be simple or septate.
- Each ascospore under suitable conditions germinates to produce fungal hyphae which comes in contact with appropriate alga and develops into new lichen. If the fungal hypha fails to find an appropriate alga, it perishes.

## 12.5 Reference:

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