GreenariA
Go Green, Learn Green
An Agricultural Monthly e-Magazine

Volume 02, Issue 10, 2024
ISSN: 2584-153X
Article ID: G-24-1034

LICHENS AS BIO-INDICATORS OF ENVIRONMENTAL CHANGES

Vergil Veronica C

B.Sc. (Hons) Agriculture, JSA College of Agriculture and Technology, Avatti, Cuddalore, Tamil Nadu

Corresponding Author Mail ID: vergilveronica1406@gmail.com

Introduction

Lichens are slow-growing, plant-like organisms that have a symbiotic association between algae and fungi. The role of fungi is to provide mass and structure and the role of algae is to synthesize food. This mutual relationship helps lichens to survive in extreme environments. There are about 20,000 known species. They are distributed across a vast area around the globe. They have been used as traditional medicine in Ancient Greece. They have been used for skin disorders, kidney diseases, etc. and also as disinfectants. Lichens produce a large number of secondary metabolites that contain anti-cancer and anti-fungal properties. Some species are being used to make dyes, deodorants, cosmetics, etc. There are a few species of lichens that are edible to animals and humans. They are consumed by humans in the form of bread, porridge, soup, etc. Some species are also used as flavour enhancers. Among all the above-mentioned uses, lichens being used as an bio-indicator is the most impressive one.

About lichens

Lichens are symbiotic association of algae and fungi. The algal part is known as photobiont because of the presence of chlorophyll and can photosynthesize food. The fungal part is known as the mycobiont which contain filamentous cells called hyphae that help in extension and provide structure. They have a wide range of habitat that includes barks of trees, rocks (they can be found inside the rocks too), walls, deserts, slag heaps, rainforests, etc. They can survive as epiphytes. They can be found in high alpine elevations and in low sea levels. Lichens can be broadly classified into the following types based on their morphology, namely:

a) crustose – crust-like appearance
b) foliose – 2-dimensional, leaf-like lobes
c) fruticose – a leafless mini shrub-like appearance
d) squamulose – small leaf-like scales with free tips
e) leprose – powdery
f) gelatinous – jelly-like
g) filamentous – stringy in appearance
h) byssoid – wispy in appearance
i) structureless

They can be found in many colours which is determined by the presence of photosynthetic components. They reproduce vegetatively, asexually and sexually. The three common spores are apothecia, perithecia and pycnidia. They play an important role in nutrient cycling. They are food for a wide range of organisms including nematodes, mites, termites, etc., aquatic organisms and higher animals like reindeer. Lichen is said to be a 'self-sustaining ecosystem'. They can resist extreme temperatures, exposure to UV radiation, drought and dormancy. In the absence of water, the structure completely dries up. However, they are capable of surviving even at low moisture levels. As soon as they absorb water, the structure becomes soft and fleshy. The European Space Agency conducted an experiment in 2005, in which two species of lichens, *Rhizocarpon geographicum* and *Rusavskia elegans* were taken to space and exposed to vacuum in the presence of changing temperature and cosmic radiation. After 15 days, it was brought back to Earth and it was found that there were no changes in its photosynthetic characteristics.


Lichen on barks of trees


Reindeer lichen ***Lichen on rocks***

Uses of lichens

1. Food and fodder – Lichens are consumed as staple food and as delicacy. Examples include *Cladonia* spp., *Laboria* spp., etc. Some lichen species are consumed by insects, mites, nematodes, aquatic animals, reindeer, etc.
2. Traditional medicine – *Lobaria pulmonaria*, *Peltigera leucophlebia Usnea barbata*, *Ramalina* spp., etc were used as medicine in Ancient Greece and Europe. There are recorded medicinal uses of lichens in American and African countries.
3. Dyes – Lichens produce secondary metabolites that are used as dyes. These dyes are used in dyeing the traditional clothes of Scotland. Orchill is a blue dye obtained from *Leconara* used in leather industry.
4. Cosmetics – Some lichens produce aromatic substances that are used in the manufacture of perfumes, deodorants, etc.
5. Lichenometry – Lichens are used to determine the age of rocks, in geomorphology, archeology and paleontology.
6. Biodegradation – Lichens can accumulate heavy metals and pollutants. Some studies have revealed that lichens are capable of degrading polyester resins. Eg: *Parmelia sulcata*, *Lobaria pulmonaria*, *Cladonia* spp., etc.
7. Biomonitoring – Lichens acts as bio-indicators to check the rate of air pollution and heavy metals in the environment.
8. Aesthetic value – In places like the *Yosemite* National Park, *Sequoia* National Park, and the Bay of Fires, the landscape dominated with colourful lichens prove to be a beautiful sight.

Relation between lichens and environmental changes

Ever since the beginning of industrial development, air pollution has become one of its significant by-product. Harmful pollutants like particulate matter, sulphur oxides, nitrogen oxides, and other volatile substances are being released into the atmosphere. This has led to the changes in the ecosystem, climate and human health. These pollutants have detrimental effects on humans that can lead to various diseases and disorders like asthma, skin diseases, lung and eye infections, etc. It has led to the extinction of many sensitive plant and animal species. Air pollution is one of the important reasons for climate change and global warming.

Although lichens can withstand harsh climatic conditions, they are very sensitive to air pollution. Their ability to respond to changing air quality makes them a reliable environmental indicator, along with its unique biology and extreme sensitivity. Lichens are considered as indicators in terms of two metrics, namely, as diversity metric and as bioaccumulation metric. The diversity metric is used to measure the sensitivity of lichens to various environmental changes and the bioaccumulation metric is used to measure its ability to accumulate chemical substances and heavy metals. Lichens cannot survive in polluted areas; the susceptible species disappear and the resistant species can survive

only in less contaminated areas. They are sensitive to sulphur dioxide, an important air pollutant. They have efficient absorption systems that make the organisms accumulate sulphur dioxide and other pollutants rapidly which leads to change in its structure and metabolism. This results in discoloration, reduction of chlorophyll pigments and membrane degradation. Lichens are also used as bio-monitors for measuring physiological responses to atmospheric pollution over time and providing additional information about the amount and intensity of the exposure. Many experiments have been conducted in which lichens are transplanted from a non-polluted area to a polluted area to analyze the pollutants in the air. Heavy metal accumulation also has similar effects to the physiology of the lichens. It leads to chloroplast damage, chlorophyll and protein degradation.

Conclusion

Lichens play an important role in the ecosystem as it exhibits diversity and sustainability. Across the world, they are considered as efficient bio-indicators and bio-monitors. Experiments and research using lichens is one of the most cost-efficient and non-invasive ones. It is necessary to understand the relation between lichens and environmental health. By studying about lichens, we can understand the impact of human activities on environment. This will also help in developing sustainable practices that will help reduce air pollution and heavy metal pollution, which in turn will help conserve the ecosystem.

References

1. Thakur, M., Bhardwaj, S., Kumar, V., & Rodrigo-Comino, J. (2023). Lichens as effective bioindicators for monitoring environmental changes: a comprehensive review. Total Environment Advances, 200085.
2. Crawford, Stuart. (2015). Lichens Used in Traditional Medicine. Pg. No. 5-7.
3. Branquinho, C., Matos, P., & Pinho, P. (2015). Lichens as ecological indicators to track atmospheric changes: future challenges. Indicators and surrogates of biodiversity and environmental change. CSIRO Publishing, Melbourne, CRC Press, London, 77-87.
4. Yang, J., Oh, S. O., & Hur, J. S. (2023). Lichen as bioindicators: assessing their response to heavy metal pollution in their native ecosystem. Mycobiology, 51(5), 343-353.
5. Conti, M. E., & Cecchetti, G. (2001). Biological monitoring: lichens as bioindicators of air pollution assessment—a review. Environmental pollution, 114(3), 471-492.