Current Botany 2013, 4(3): 63-66
ISSN: 2220-4822
Available Online: http://currentbotany.org/

Evaluation of various Lichen species for monitoring pollution

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Abstract

Lichens are small, non-vascular plants consisting of a fungus and an alga growing together in one tissue. The most commonly known lichens are those that are found on the bark of trees, or the reindeer lichens growing on the ground, but many other species grow on rocks, fences, roofs, tombstones, and other man-made objects. Even though some lichens are extremely tough and grow in very inhospitable habitats, they are also notoriously sensitive to air pollutants, primarily sulfur dioxide and heavy metals. Lichen deserts, a phenomenon where lichens disappear from cities, were described over a hundred years ago and determined to be caused by sulfur pollution. Lichens are especially sensitive to air pollutants because they have no outer impermeable layer of tissue to exclude gases and particles that impair their metabolism. Consequently, accumulation of pollutants is greater than it is in the foliage of vascular plants, which have impermeable cuticles. Lichens accumulate unusually large amounts of deposits, including heavy metals, which eventually reach toxic concentrations.

Lichens are therefore excellent bioindicators and biomonitors or ecological indicators As bioindicators, the presence/absence of sensitive species is used to look for distribution patterns that reflect pollutant deposition. Voids in distributions may indicate whether lichens have died out due to heavy metals and/or sulfur oxide pollution. Lichens that do not die out, but are still present and are known to accumulate trace elements are used to indicate patterns of deposition.This review aims for highlighting the potential of lichens as an important,year round easily available bio-monitoring agent.[brief conclusion; one or two sentence as what was need of introducing this review in publication and uses to draft out]

Keywords : Bioindicators ,Biomonitors, Ecological indicators, Lichens,

INTRODUCTION

The exponential growth of the human population, the overuse & exploitation of natural resources and the growth in technology has changed the major biogeochemical cycles, and also resulted in the extinction of many species of genetically distinct populations from the Earth's ecosystems .Many of these changes are important and reasonably well quantified by driving global climatic changes and also are responsible for causing irreversible losses of biological diversity. Lichens are unique organisms because they consist of fungal hyphae and microscopic algae living together and functioning as a single organism. The main body of lichen is called a thallus and does not resemble either the fungal or algal parts. Both partners receive some benefit from this symbiotic association.The algae within the thallus manufactures food & supplies to the fungus and in return, the fungus provides protection for the alga. Lichens do not have roots,stems and leaves so they must receive their nutrients from atmosphere/environment. Lichens are the most studied bioindicators of air quality.As bioindicators, the presence/absence of sensitive species is used to look for distribution patterns that reflect pollutant deposition. They grow slowly, & they are totally dependent upon the environment for their nutrition needs, and – uniquely– they do not shed parts during growth. Particles of various elements become embedded in the lichen thallus. Lichens accumulate substances from their environment by a variety of mechanisms, including particulate trapping, ion exchange, extracellular electrolyte sorption, hydrolysis, and intracellular uptake. Lichens are supplied with mineral nutrients and heavy metals from rainfall, dustfall, and the underlying substrate from both natural and man made sources. Natural sources of metals include marine aerosols, leachates from foliage and bark, volatile metals,volcanoes and suspended particulates derived from local and remote soils and rock. Lichens show varying sensitivity to metals, are good accumulators, and have been used to indicate deposition levels. Epiphytic lichens (or epiphytes),i.e.lichens growing on bark of trees, are characterized with the most sensitivity among all ecological groups of lichens. Study of these species in large cities of the world show a number of general patterns: the more industrialized the city is, the fewer

Received: Aug, 2013; Revised: Sep., 2013 ; Accepted: Oct, 2013

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species of lichens are found; the less the total area of the tree trunk is covered with lichens, the lower the vitality of the lichens.It has been discovered that when the level of air pollution increases, first fruticose lichens disappear,then foliaceous lichens, and the last ones to disappear are crustose (cork-forming) forms of lichens.

Modernization & use of technology has led to socio-economic development. However, they have also led to variety of harmful side effects. Many harmful pollutants are liberated into the atmosphere from different sources in the form of nitrogen oxides, sulphur oxides, pesticides, herbicides, suspended particulates and heavy metals. Out of these, the heavy metals are emitted into the atmosphere from industrial and many other man made sources. These pollutants threaten human health, disturb animal, insect & bird reproduction, cause diseases to plants & also disturb the structure of the ecosystem. Pollutants emitted from a source fall either in the area immediately surrounding the source or are carried to remote areas.

Biomonitoring studies provide important primary information about the diversity,quantity, and quality of pollutants in the atmosphere and can be very useful as an early warning system to detect changes in the environment. Many studies have been devoted to show the distribution of atmospheric air pollutants . Different bioindicator organisms have been used for the monitoring of atmospheric air pollution , among them moss and lichens occupy first place showing local and regional variations in heavy metal pollution. They have no real root system but accumulate heavy metal cations supplied by dry and wet deposition . Several studies have shown that, lichens are among first organisms used as bioindicators for assessment of different types of pollution . Many studies have demonstrated their ability to absorb and accumulate persistent contaminants and hence lichens are routinely employed to monitor radionuclides metals, nonmetals and other Compounds present in the atmosphere . Lichen flora have been used as indicators for monitoring sources of pollution at industrial levels and from vast areas or by transplantation from uncontaminated areas to places devoid of spontaneous colonization.various workers have monitored the heavy metals using different growth forms of lichen in different geographical area with varied climate .

Lichens or mosses for biomonitoring

lichens	mosses
Accumulate more heavy metals	Accumulate less heavy metals
Accumulate more volatile metals	Accumulate less volatile metals
More porous surface	Less porous surface
Accumulate less dust	Accumulate more dust
lichens are mainly used as bioindicators of air quality in forest ecosystems.	Mosses are used as indicators of heavy metal contamination from the volcanic emissions

Both lichens andn mosses are good Biomonitors,but lichens are better biomonitors.

lichens used as biomonitors

For Highly Polluted areas	*For Moderately Polluted areas*
Hypogymnia physodes	Evernia prunastri
Xanthoria parietina	Foraminella ambigua
Lecanora dispersa	Lecanora chlarotera
Diploicia canescens	Ramalina farinacea
Lepraria incana	Lecidella elaeochroma
Lecanora expallens	Hypogymnia physodes
Lecanora conizaeoides	Parmelia glabratula
Cladonia macilenta	Parmelia saxatilis
Buellia punctata	Plastimatia glauca

lichens used as biomonitors

For Slightly Polluted areas	For Minimal or no pollution areas
Parmelia caperata	Usnea subfloridana
Graphis scripta	Parmelia perlata
Bryoria fucescens	Degelia plumbea
Physconia distorta	Ramalina fraxinea
Opegrapha varia	Teleoschistes flavicans
Anaptychia ciliaris	Lobaria pulmonaria
Parmelia acetabulum	Lobaria scrobiculata
Physcia aipolia	Pannaria rubiginosa

The advantages of lichens as biomonitors are as follows

1] Communities of lichens (arboreal especially) are available for sampling year round, are ubiquitous and widespread throughout most sampling areas.
2] Sampling is usually simple, requiring a minimum of equipment.

The disadvantages of the use of lichen as biomonitors/ indices of pollution are as follows

1] Lichen communities can be severely impacted to the point of removal from large areas in high pollution areas, making the diagnosis of air quality concentrations using indicator species very difficult
2] Lichen indices require biologists to learn the lichen species that are commonly us indicators. While there are abundant manuals, keys and courses available, there is

sometimes a resistance to working on this group.
3]Percent cover and species richness of lichens are not as effective for showing edge effects as biochemistry of lichens , and there is always the concern that previous fire , wind effects, past logging history, excess moisture and other climatic constraints, etc. has over-ridden the effect of ambient sulphur dioxide dioxide on species percent cover and distribution.
5] Air quality improvements result in increased diversity and known sensitive bioindicator recovery.

CONCLUSION

Using lichens as bioindicators/biomonitors has the clear advantage of permitting short, medium and long term monitoring without widespread establishment and maintenance of costly, sophisticated equipment. Furthermore, physicochemical surveys do not necessarily measure those air pollutants harmful to biological materials; measuring devices on-site and analytical equipment in laboratory back-up are generally restricted to a limited number of quickly and easily determined pollutants. The dramatic reduction in the number of volumetric gauges to monitor SO_2 and the very limited number of gauges established to monitor other pollutants makes it all the more important to use biomonitors to extend spatially restricted data. Furthermore, the development of more efficient mechanisms for the dispersal of pollutants from their sources to implement clean air policy has resulted in widespread 'blanket pollution'. The use of corroborative information derived from bioindication surveys to support the limited data available from rural sites is strongly recommended. Wide geographical areas can be monitored by such means, particularly remote regions where no electricity supply is available for physico-chemical equipment. An obvious advantage of using lichens as bioindicators is that they show the results of the action of pollutants on living material - a relevant approach to determining technological impact on the biosphere. The use of bioindicators will never completely replace direct physico-chemical measurements of air pollutant concentrations; nevertheless, both approaches are necessary for making detailed or large-scale surveys of the distribution of air pollutants, where the extensive use of technical equipment is costly or impractical. Furthermore, biomonitors can act as early warning indicators, prompting where necessary a detailed survey using both types of approach.

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