

Lichens: Natural Sensors for Environmental Change

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Abstract

Lichens, a symbiotic association of algae and fungi, exhibit remarkable physiological adaptations and chemical diversity, enabling them to withstand varied environmental stresses. The phycobiont captures light energy, produces carbohydrates, and in cyanobacterial forms fixes nitrogen, making lichens sensitive to shifts in light, moisture and nutrient availability. The mycobiont shields the photobiont from desiccation, pollutants and UV radiation while regulating water and nutrient exchange, allowing lichens to persist in varied habitats. Their combined functions enable lichens to respond quickly to environmental stress, making them reliable natural sensors of forest health. Their sensitivity to ecological factors makes them valuable bioindicators of air quality and varied land-use pattern. Coupled with remote sensing, lichen diversity assessments can map pollution, track long-range transport of contaminants and model future environmental scenarios. In addition, they serve in lichenometric studies to estimate glacier retreat, offering critical understanding of climate change dynamics. Lichens are proven to be well-established natural sensors of forest ecosystem health, providing insights into species richness, forest type and continuity. Their sensitivity to climatic fluctuations, landscape structure, management practices and land-use change is well documented. Epiphytic lichens, owing to their high substrate specificity, are particularly valuable in assessing forest condition and integrity. Terricolous lichens contribute to soil conservation by forming biological crusts that bind particles, reducing erosion, while erosion-driven shifts in soil properties, especially pH, can result in the loss of soil-inhabiting species. Cyanolichens, containing nitrogen-fixing cyanobacteria, indicate low-nitrogen soils and play an important role in nutrient cycling alongside mosses and other cyanobacteria. Collectively, these functional groups reflect ecological stability, disturbance regimes and nutrient status, making lichens indispensable in long-term environmental monitoring.

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