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Bio-Indicator Lichens of Sikandra Hills of North West Himalaya

Monika Thakur[1] and Hem Chander[2*]

[1 & 2] *Division Botany, Department of Bio-Sciences, Career Point University Hamirpur, (H.P.), INDIA*

[*] *Correspondence: E-mail: hemchander78@gmail.com*

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ABSTRACT: During the lichen floristic studies, three hundred specimens of lichens were collected from Sikandra hill, which is situated in Shivalik zone of North West Himalaya. These specimens were then investigated morpho-chemo-taxonomically and thirty species of lichens have been identified. Out of these, ten species of lichens (viz. *Candelaria concolor* (Dicks.) Arnold, *Heterodermia pseudospeciosa* (Kurok.) W.L. Culb, *Lecanora chlarotera* Nyl, *Parmotrema praesorediosum* (Nyl.) Hale, *Parmotrema tinctorum* (Despr. ex Nyl.) Hale, *Phaeophyscia hispidula* (Ach.) Essl, *Physcia stellaris* (L.) Nyl., *Punctelia subrudecta* (Nyl.) Krog, *Pyxine subcinerea* Stirt) act as bio-indicator. *Candelaria concolor*is a nitrophile and act as indicator of nitrogen pollution, whereas, *Punctelia subrudecta* is nitrogen tolerant. *Heterodermia pseudospeciosa* belong to physcioid lichen community and is toxi-tolerant species. The other seven lichen speciesact as bio-indicator of heavy metal air pollutants (iron, chromium, copper, zinc, lead and nickel. These potential bio-indicator lichen species can be used for monitoring of environmental quality in the study area.

Keywords: Bio-indicator; Heavy metal; Nitrophile; Pollutant and Toxi-tolerant.

INTRODUCTION: Lichens are bio-indicators of air pollution, especially sulfur dioxide pollution. They are inexpensive to use in evaluating air pollution and are able to react to wide range of air pollutants over a period of time as compared with other physical/chemical monitors. The quality of environment in a particular area can be assessed either by monitoring changes in lichen community or through monitoring their physiological changes. The toxic elemental pollutants and radioactive metals bind with mycobiont and concentrate over time. Lichens were recognized as potential indicators of air pollution as early as the 1860's in Britain and Europe[1]. Since then, lichens have played prominent role in air pollution studies throughout the world because of their sensitivity to different gaseous pollutants, particularly sulfur dioxide. They have also been found to act as accumulators of elements, such as trace metals, sulfur, and radioactive elements[2-3]. The lichen species best suited as bio-monitors are foliose (having a lobed, leaf-like shape) and fruticose (having upright or pendulous branches) epiphytic lichens. The properties that make them suitable for monitoring purposes are the weakly developed cuticle and vascular bundles, absence of real roots, their slow growing nature and prolonged life cycle and their broad distribution [4]. Indicators are required to monitor ecological conditions of habitats. Lichens have been found to be very much sensitive to environmental parameters like temperature, humidity, wind and air pollutants because they don't have any vascular system and thus absorb water and nutrients passively from their surrounding environment. Lichen species composition and changes in composition is a very powerful tool to get information about changes in climate, air quality and biological processes. The lichens respond to the environmental changes by reflecting changes in their diversity, abundance, morphology, physiology, accumulation of pollutants etc. The main threats such as habitat degradation and loss, habitat fragmentation, overexploitation, air pollution, and climate change which affect biodiversity in general are also applicable for lichens[5]. Lichens are also measurable. Due to these unique features, lichens may be used as relevant indicators for ecosystem productivity and biodiversity. Biological monitoring using lichen as indicator may be considered a very effective tool for early warning system to monitor and detect climate change and air pollution[6.] The unregulated harvesting of lichens has become a serious hazard to biodiversity in Himalayas and Western Ghats[7]. Lichens are very important for nutrient cycling[8.] Lichens absorb air and rain-borne nutrients for their use and thus contribute in ecosystems cycling. Some lichen species help in fixing nitrogen through a symbiotic relationship with cyanobacteria which contribute good amount of nitrogen to forest ecosystems[9-12].

MATERIALS AND METHODS: During the present study, lichen specimens were collected from in and around Sikandra Dhar. Sikandra Dhar is situated in Shivalik hill zone of North Western Himalaya and is located in district Mandi of Himachal Pradesh (India).

The study area spreads in Suket, Bhambla and Nagrota forests. The specimens were collected from various habitats and substrates. The field data such as texture, size, colour, macroscopic features and form have been noted in the field book during the excursions [13]. All the specimens have been preserved in CPUH (The Herbarium, Department of Bio-Sciences, Career Point University, Hamirpur). The collected lichen specimens were initially segregated according to their growth forms. Within the growth forms the specimens were further grouped according to the type of fruiting bodies (apothecia, perithecia, sterile). The lichens were identified by studying their morphology, anatomy and chemistry. Authenticated taxonomic keys were referred for identification of lichen specimens [14-16]. The chemicals used for the chemical spot tests of the lichens were prepared using standard method [17].

RESULTS AND DISCUSSION: On the basis of morpho-chemo-taxonomic investigations, a total of twenty five species of lichens were identified.[18] Out of these, ten species of lichens (viz. *Candelaria concolor* (Dicks.) Arnold, *Heterodermia pseudospeciosa* (Kurok.) W.L. Culb, *Lecanora chlarotera* Nyl, *Parmotrema praesorediosum* (Nyl.) Hale, *Parmotrema tinctorum* (Despr. ex Nyl.) Hale, *Phaeophyscia hispidula* (Ach.) Essl, *Physcia stellaris* (L.) Nyl., *Punctelia subrudecta* (Nyl.) Krog, *Pyxine subcinerea* Stirt) act as bio-indicator. *Candelaria concolor*is a nitrophile and act as indicator of nitrogen pollution, whereas, *Punctelia subrudecta* is nitrogen tolerant. *Heterodermia pseudospeciosa* belong to physcioid lichen community and is toxi-tolerant species. The other seven lichen speciesact as bio-indicator of heavy metal air pollutants (iron, chromium, copper, zinc, lead and nickel (Table 1).

Table 1: Bio-Indicator Lichens of Sikandra Hill.

Sr. No.	Species	Family	Indicator & functional group	Remarks
1	*Candelaria concolor* (Dicks.) Arnold	Candelariaceae	Nitrophilous	Nitrophiles-- these species thrive in nutrient-enriched areas receiving N inputs from fertilizer application in agricultural areas or N emissions from power plants, automobile exhaust or industry (van Herk 1999). Among the most common in the NCR are *Candelaria concolor*, *Flavoparmelia caperata*, *Flavopunctelia flaventior*, *Parmelia sulcata*, *Phaeophyscia orbicularis*, *Physcia aipolia*, *Physcia millegrana*, *Punctelia rudecta* and *P. subrudecta*. These are the most common lichens in the NCR plots, and can be found even in park units nearest the center of Washington, D.C. (NAMA, NACE).
2	*Dermatocarpon vellereum* Zschacke	Verrucariaceae	Bio-indicator	Air pollution monitoring
3	*Heterodermia pseudospeciosa* (Kurok.) W.L. Culb	Physciaceae	Bio-indicator	Physcioid lichen community, Physcioid lichens are well known toxitolerant species employed for biomonitoring studies mostly in tropical regions.
4	*Lecanora chlarotera* Nyl	Lecanoraceae	Bio-indicator	Air pollution monitoring
5	*Parmotrema praesorediosum* (Nyl.) Hale	Parmeliaceae	Bio-indicator	Air pollution monitoring
6	*Parmotrema tinctorum* (Despr. ex Nyl.) Hale	Parmeliaceae	Bio-indicator	It is a bio-indicator of air pollution. It is especially sensitive to sulphur dioxide (SO_2) and has been threatened or even extinct in urban areas where the annual mean concentration of SO_2 is more than 20 ppb (Sugiyama et al., 1976).
7	*Phaeophyscia hispidula* (Ach.) Essl	Physciaceae	Bio-indicator	Heavy metals were significantly increased due to exposure of pollutants

8	*Physcia stellaris* (L.) Nyl.	Physciaceae	Bio-indicator	Bio-indicator of air pollution
9	*Punctelia subrudecta* (Nyl.) Krog	Parmeliaceae	Nitrophilous tolerant	Bio-indicator of air pollution

CONCLUSION: During the present study, thirty species of lichen have been recorded from Skindra dhar of district Mandi. Out of these ten species of lichens act as bio-indicator. The result of this work will be useful for future studies of lichens to determine atmospheric pollution in the study area and other area as well.

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