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ASSESSMENT OF ENVIRONMENTAL QUALITY IN HARWAN AREA OF SRINAGAR DISTRICT (J&K), USING LICHENS AS BIO-INDICATORS

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ABSTRACT

The present study deals with the monitoring of lichens in a sub-urban area, Harwan, free from any direct polluting source was done with the aim that how air quality of area can be assessed using lichens as indicator and establishing the fact that how cleaner environment supports better diversity and density of lichens. The variety and variability data on Lichen species was collected and correlated with the air analysis data that was obtained using High volume Air Sampler. Analysis of air quality in the air was based on determining fraction of SPM (Suspended Particulate Matter), RSPM (Respirable Suspended Particulate Matter), NRSPM (Non-Respirable Suspended Particulate Matter), SO_2 (Sulphur dioxide) and NO_2 (Nitrogen dioxide) on seasonal basis i.e spring, summer and winter season on six (6) hourly basis. Quadrats of 25cm x 25 cm size, three on each tree, were laid from base to chest height for recording the data on frequency, density and abundance of lichens growing on the selected trees. Chlorophyll analysis, pH of host trees and water holding capacity was determined

The study revealed the occurrence of 14 species of lichens belonging to 11 genera and 5 families. The air quality parameters were generally found within permissible limits with slight variation in different seasons. The data on the quantitative parameters i.e frequency, density and abundance of lichen species showed good values. Analysis of data further revealed that chlorophyll content of species is quite good in the area. The present communication thus serves as baseline record regarding the level of various pollutants including particulate matter and the number of lichen species for conducting biomonitoring studies in future.

Keywords: Lichens, Biomonitoring, Environmental Quality, Harwan, Kashmir.

INTRODUCTION

Lichens comprise a unique group of plant that consists of two unrelated organism, a fungus and an alga, growing together in a close symbiotic association. Lichens, being widespread, perennial, stable, long living organisms and more sensitive species than rest of the plants are nowadays increasingly used as terrestrial biomonitors and bioindicators of air pollution worldwide. They together with mosses form dominant organisms in ecosystem covering over 10% of the earth terrestrial habitats, particularly at higher elevations (Nash and Egan, 1988). Lichens are bio-indicators of air pollution and can be used to test the ecological impacts of emissions from different sources of sources of pollution (Showman, 1975; Will-Wolf, 1980 and Murphy et al. 1999). Lichen diversity is an excellent indicator of pollution by phytotoxic gaseous substances and respond relatively fast to deterioration in air quality, due to lack of cuticle, lichen absorbs both gases and dissolved substances through their surface (Roa and de Blanc, 1965). Lichens with specific biological structures are known as the best bioindicator organisms of air pollution, due to susceptibility

of species to pollutants, especially sulphur dioxide (Saxena *et al*. 2007). Lichens have sensitivity, both physiological and ecological, to pollutants and therefore have been employed almost exclusively to monitor the extent or spread of air pollution particularly SO2 (Gries *et al*., 1997).

Being both physiologically and ecologically sensitive to pollutants these are exclusively employed to monitor the air quality of the area. Lichen diversity is an excellent indicator of pollution and responds fast to deterioration in air quality. Environmental quality assessment using bioindicators approach offers some convincing advantages compared to direct analysis. The use of lichens as biomonitoring studies have gained increased acceptance in recent years. Lichen characters measured for air quality studies include morphological, physiological and population characteristics. Not only this but lichen biodiversity counts can be taken as estimates of environmental quality, with high values corresponding to good situations and low values indicating poor quality (Asta *et al*., 2002).Therefore a survey of lichen community in the area may provide us insight into the existing air quality in the area.

Lichen exploration in the state initiated more exhaustively in fifties of the last century. Awasthi and Singh (1970) published a note on lichens of Jammu and Kashmir. Recently Negi and Upreti (2000); Sheikh *et al*. (2006 a & b, 2009); Charak *et al*. (2009) and Sheikh (2009) have worked on lichens and their phytosociological aspects from the different regions of the state. However, not much has been done on the biomonotiring aspect of the lichens except for Charak *et al*. (2009).

The present study was under taken in Harwan area, with geographical coordinates of 34º 09' 34º 8" N latitude 74º 54' 08º 2" E longitude at an elevation of 1669 meters in Srinagar district of Jammu and Kashmir known for topographic position and weather patterns favoring lichen growth .The site is under *Prunus persica*, *Poplus alba* and *Rubinia pseudocacia* plantation with scattered Pear trees and was apparently not under receipt of any pollution from any direct source.

MATERIALS AND METHODS

To assess the air quality of area, High volume Air Sampler was used .Analysis of air quality in the air was based on determining fraction of SPM, RSPM, NRSPM, SO_2 and NOx on seasonal basis i.e spring , summer and winter season on six (6) hourly basis. The result of air sampling was related to diversity of lichen flora in the area which was in turn determined by collecting lichens from the entire available substratum in the area. Quadrats of 25cm x 25 cm size, three on each tree, were laid from base to chest height for recording the data on frequency, density and abundance of lichens growing on the selected trees. The specimens were identified by studying the morphology, anatomy and chemistry. The recent literature of Awasthi (1988, 1991, 2000 and 2007), Divakar (2001) and Nayaka (2004) was consulted for identification of the lichen taxa. Thin layer chromatography was performed by the methods of Culberson (1972), Walker & James (1980) for lichen substances. Floristic analysis involved carrying out chlorophyll analysis of some lichen species by Arnon's method. pH of host trees was determined by using digital pH meter. Similarly water holding capacity was determined by Billing and Drew (1938) method.

RESULTS AND DISCUSSION

The study revealed the occurrence of 14 species of lichens belonging to 11 genera and 5 families (Table 1). We found only two growth forms of lichens, namely crustose and foliose; fructicose lichens were not found in the study. The air quality parameters SPM, RSPM, NRSPM, SO_2 and NO_2 all were generally found within permissible limits with slight variation in different seasons that could be attributed to

different weather phenomenon. Pollution free, dense and diverse tree species and stream flowing sideways in the area enables the surrounding area to have slightly higher water vapour content as such provides more shady, moist and humid climate which acts as a boon for lichen growth and thus this area shows lichen diversity amounting to total of 14 species. The lichens equally preferred tree substratum represented by 7 corticolous species i,e i.e *Candelaria* sp., *Melanelia* sp., *Parmelia* sp., *Physcia sp*. and *Punctelia sp* and rock substratum, represented by 6 saxicoluos species i.e. *Flavoparmelia caperata* (L.) Hale, *Lecanora muralis* var. *muralis* (schreber) Rabenh., *Phaeophyscia orbicularis* (Necker) Moberg., *Physconia distorta* (With.) Laundon., *Xanthoparmelia sp*., and *Xanthoria elegans* (Link) Th. Fr., while as one species *Xanthoria parietina* (L.) Th. Fr., shared both the habitats. Analysis of the table reveals all the quantitative parameters i.e frequency, density and abundance of species, all showed good values. Smith *et al*. (1993) also reported that by estimating lichen cover, the lichen can be used as bioindicator studies. Analysis of data further revealed that chlorophyll content of species is good is quite good in the area and there seems no apparent damage in them which indicates good air quality in the area (also supported by air analysis data).Variation in bark properties can also be reason for such rich diversity and density of lichen species in the area as is quite evident from pH analysis and water holding capacity of the host trees. These findings though region specific can be extrapolated for periodic monitoring of the lichen communities in relation to ongoing changes of the local land use.

CONCLUSION

Thus it was clear from the study, that the occurrence of 14 lichen species along with higher values for other ecological parameters can be attributed to better environmental conditions available that provide feasible conditions for diverse lichen growth and survival. The present communication thus serves as baseline record regarding the level of various pollutants including particulate matter and the number of lichen species for conducting biomonitoring studies in future

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Table 1: Lichen species collected from the Harwan area of Srinagar district.

S.No.	Lichen taxa.	Family	Substratum	Growth Form
1	Candelaria sp.	Candelariaceae	B	Fo
2	Flavoparmelia carperata (L.) Hale	Parmeliaceae	R	Fo
3	Lecanora muralis var. murali (Schreber) Rabenh.	Lecanoraceae	R	Cr
4	Melanelia sp.	Parmeliaceae	B	Fo
5	Parmelia sp.	Parmeliaceae	B	Fo
6	Phaeophyscia orbicularis (Necker) Moberg.	Physciaceae	R	Fo
7	Phaeophyscia sp.	Physciaceae	B	Fo
8	Punctelia sp.	Parmeliaceae	B	Fo
9	Physcia sp.	Physciaceae	B	Fo
10	Physconia distorta (With.) Laundon	Physciaceae	R	Fo
11	Xanthoria elegans (Link.) Th.Fr.	Telochistaceae	R	Fo
12	Xanthoria parietina (L). Th.Fr.	Telochistaceae	B & R	Fo
13	Xanthoria sp.	Telochistaceae	B	Fo
14	Xanthoparmelia sp.	Physciaceae	R	Fo

Table 2: Seasonal Paticulate NO_2 and SO_2 levels in Harwan area.

S .No.	Season	µg/m³				
		RSPM	NRSPM	SPM	NO_2	SO_2
1.	Spring	114.38	162.12	276.50	32.62	28.78
2.	Summer	122.01	244.01	366.02	34.62	34.97
3.	Winter	108.19	152.82	261.04	41.34	29.48

Table 3: Depicting frequency, density and abundance at Harwan

S.No.	Lichen taxa.	Frequency (%)	Density	Abundance
1	Candelaria sp.	17.59	3.05	23.63
2	Flavoparmelia carperata (L.) Hale	23.94	3.9	6.5
3	Lecanora muralis var. muralis (Schreber) Rabenh.	40.50	7.5	5.5
4	Melanelia sp.	55.09	1.53	5.66
5	Parmelia sp.	10.64	0.25	2.42
6	Phaeophyseia orbicularis (Necker) Moberg.	37.5	3.9	5.3
7	Phaeophyscia sp.	2.77	0.24	8.83
8	Punctelia sp.	28.24	1.87	6.62
9	Physcia sp.	40.27	4.68	11.64
10	Physconia distorta (With.) Laundon	55.00	3.2	7.0
11	Xanthoria elegans (Link.) Th.Fr.	36.05	5.5	12.5
12	Xanthoria parietina (L.) Th.Fr.	68.05	14.55	23.27
13	Xanthoria sp.	2.5	4.6	5.5
14	Xanthoparmelia sp.	35.00	6.5	7.0

Table 4: Pigment analysis of some of the Lichen species found in the area.

S.No.	Lichen taxa.	Pigment content (mg/g)			
		Chl. a	Chl. B	Total Chl.	carotene
1	Candelaria sp.	1.098	0.678	0.221	0.659
2	Flavoparmelia carperata (L.)Hale	0.397	0.230	0.122	0.474
3	Lecanora muralis var. muralis (Schreber)Rabenh.	0.340	0.191	0.051	0.386
4	Melanelia sp.	0.209	0.148	0.058	0.389
5	Parmelia sp.	0.813	0.751	0.374	0.596
6	Phaeophyseia orbicularis (Necker) Moberg.	0.414	0.207	0.067	0.456
7	Punctelia sp.	0.210	0.326	0.276	0.341
8	Physcia sp.	0.564	0.365	0.211	0.472
9	Physconia distorta (With.) Laundon	0.385	0.194	0.040	0.360
10	Xanthoria elegans (Link.) Th.Fr.	0.465	0.182	0.097	0.587
11	Xanthoria parietina (L.) Th.Fr.	0.967	0.707	0.287	0.691
12	Xanthoria sp.	0.437	0.194	0.024	0.511
13	Xanthoparmelia sp.	0.346	0.182	0.071	0.403

Table 5: Average pH and Water holding capacity of specific trees in the area.

S .No.	Plant species	Average pH	Average water holding capacity (%)
1.	Poplus alba	5.70	3.004
2.	Robinia pseudoacacia	5.86	7.538
3.	Prunus persica	5.72	3.277