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Impact of Brick Kiln and Vehicular Emissions on Lichen Diversity in Khanabal Area of Anantnag District (J&K), India

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Abstract

The aim of this work was to find out the impact of pollutants emitted from brick kiln and vehicles, on lichen density and diversity, as such the site was chosen accordingly in the vicinity of highway where the impact of both was clearly visible. Only three (3) species of lichens of foliose growth form were recorded. The analysis of air quality in the Khanabal area which was based on determining fraction of RSPM, NRSPM, SPM, SO_2 and NO_2 revealed that all these parameters showed values higher than the prescribed norms.Potential sources of pollutants were evaluated ; the Brick kiln ,its fuelling material ,the huge brunt from exhaust pipes of vehicles ,use of adulterated fuel, unpaved road used for loading and unloading of materials, soil extraction process all these added pressure to local environment which reflected on lichens in area causing grave and irreparable damage to them. The data on frequency, density and abundance of different lichen species was also recorded and correlated with the qualitative and quantitative aspect of lichens. The tree species showed variation in bark chemistry (pH, water holding capacity) along the pollution gradient. The study thus allowed us to monitor the extent of pollution and determine its quantity through lichen species in the area

Keywords: Brick Kiln, vehicular emissions, lichen diversity, Jammu and Kashmir, biominitoring.

Introduction

Lichens are some of the most amazing living organisms on this planet that are able to survive economically in the harshest of environment and their peculiar structure and physiology enables them to inhabit diverse geographical regions of the world. They are amongst most frequently used biomonitors of atmospheric pollution[1]. The ability of lichens to accumulate levels of elements in the excess of physiological requirements in close correlation with atmospheric elemental levels has led to their wide scale application as practical biomonitors of atmospheric contamination. Lichen biomonitoring is especially useful in urban areas, where high density of different emitting sources makes monitoring of air pollution with conventional chemical-physical gauge an extremely difficult task. Moreover lichens have more advantages over them. Urban environments are highly complex and air pollutants from different emitting sources have been shown to have both direct and indirect effects on these lichens. Some of the major pollutants that harm lichens are SO_x, No_X ,H_2SO_4, HNO_3, F, O_3 and metals like Cu, Pb and Zn.

Lichens are a major section of species that are sensitive to changes in atmospheric nutrient conditions[2] and have been used as bioindicators of pollution over a long period of time, especially SO_2. Fruticose lichens are known to be the most sensitive to airpollution, followed by foliose and crustose forms. The vanishing of sensitive lichen species due to changes in microclimatic conditions and air pollution has been reported from Indian cities of Bangalore[3] and Kolkata[4]. Hazarika*et al.*[5] reported that highways receive loads of SO_2 from the diesel-powered automobiles in Guwahati city whichhave resulted in the depletion foliose growth form. They further reported that some areas in Guwahati city, experience less air pollution and hence support good lichen growth.Lichen exploration in the state initiated more exhaustively in fifties of the last century, Awasthi and Singh[6] published a note on lichens of Jammu and Kashmir. Recently, Sheikh*et al.*[7-9], Charak*et al.*[10] and Sheikh[11] 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.*[10].

Both quantitative and qualitative aspects of lichens are very important as these help in understanding the impact and extent of pollutants in any area. Keeping these points under consideration, the present study was carried out in Khanabal area of Anantnag district with elevation of 1606m and graticulesof 33°42’ 02° 06’ N and 75° 06’ 31° 05’E (figure-1). The area around the kiln and along the highway were marked by the presence of only two tree species i.e*Poplus alba* and *Robiniapseudoacacia.*

Material 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 NO_2 on operational basis of brick kilns i.e. pre-operational phase, operational phase and Post-operational phase on six (6) hourly basis. The result of air sampling was related to diversity of lichen flora in the area determined by collecting lichens from all the 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 different lichen species, along a few km downwind and upwind from brick kiln on north, south, east and west side of the trunks of the available tree species. Sampling was carried out in total of six rings, at different distances from the brick kiln. The specimens were identified by studying the morphology, anatomy and chemistry. The recent literature of Awasthi[12-15], Divakar[16] and Nayaka[17] was consulted for identification of the lichen taxa. Thin layer chromatography was performed by the methods of Culberson[18] for lichen substances. Floristic analysis involved carrying out chlorophyll analysis of available lichen species by Arnon's method. pH of host trees was determined by Kousinen's method using digital pH meter. Similarly water holding capacity was determined by Billing and Drew[19] method.

Results and Discussion

The study revealed the occurrence of only three (3) species of lichens of foliose growth form belonging to 3 genera and 2 families (table-1). The analysis of air quality in the Khanabal area which was based on determining fraction of RSPM, NRSPM, SPM, SO_2 and NO_2revealed that all these parameters showed values higher than the prescribed norms (table-2). This data was then correlated with the qualitative and quantitative aspect of lichens in terms of diversity, with observation of population changes and other morphological and floristic parameters serving as indication of extent of pollution in the area. The marked decline in lichen population was attributed to higher pollutant levels in the area which overlaid the pattern of species extirpation both qualitatively and quantitatively. Along the gradients of increasing pollutants lichen communities on both tree species exhibited marked decline in species diversity, density as well as their health and pigment content (table-3, 4 and 5). The pollutants emitted from kiln and vehicles which includes smoke, dust, SO_2, NO_2. Flourides, photochemical toxins and metallic pollutants all have taken their toll on lichens, as bleached and dust and smoke impregnated thallus is quite a visible phenomenon. Bleaching occurs as a result of decomposition of chlorophyll which is also supported by our chlorophyll analysis results, the damage being more near the source itself and decreases as one moves away from source. Same species of tree species showed variation in bark chemistry (pH, water holding capacity) along the pollution gradient (table-6 and 7). In general the high brunt of pollutants has contributed not only to complete absence of sensitive lichen species in the area but also poorly developed population characteristics of the existing ones. Not only this but these pollutants also serve as a threat for further survival and spread of species.

The fast growth of urbanization, the rate of deforestation and vehicular activities have increased tremendously in the state. Lichens have a long history of use as biological indicators of air quality[20]. The tolerance oflichens to most of the heavy metals and their slowgrowth rate, are among the main factors that makethem good indicators of both organic and inorganicmetal pollution. The members of lichen family Physciaceae are well known for their toxi-tolerantnature and are growing frequently in the differentregion of the state can be used for pollutionmonitoring[21]. The lichens along with higher plants act as minor sinks of air pollution by accumulating pollutants at the cost of their life, increase in air pollution in future will further affect lichen composition and diversity in this area. The present communication will act as a baseline record for conducting biomonitoring studies in future in the area.

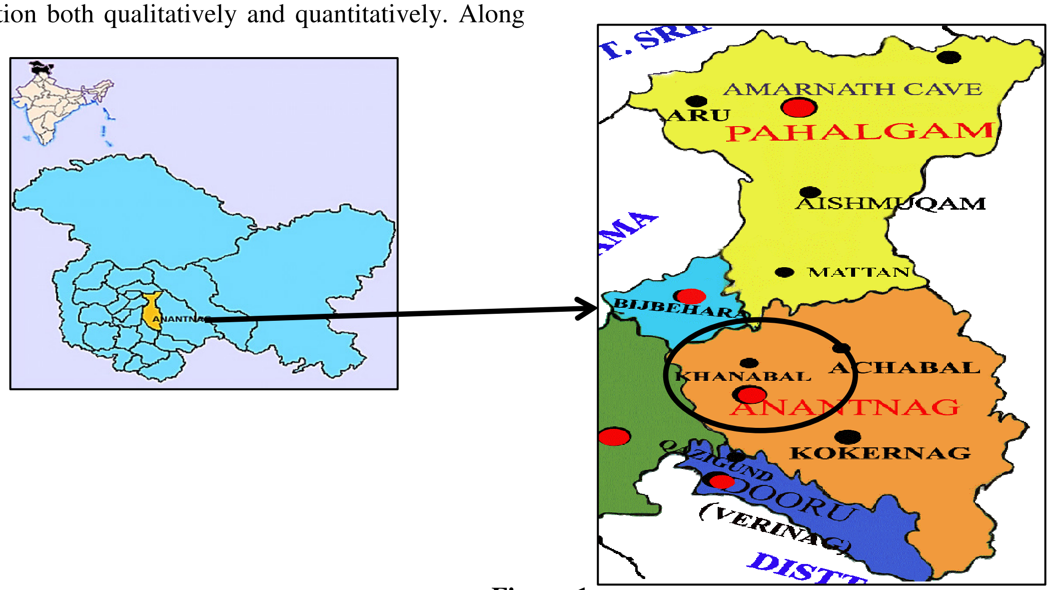

Figure-1
Map of the study area

Table-1
Lichen Diversity in the area

S.No	Lichen taxa.	Family	Substratum	Growth Form
1	*Phaeophyscia*sp.	Physciaceae	B	Fo
2	*Physcia*sp.	Physciaceae	B	Fo
3	*Xanthoriaparietina*(L.)Th.Fr.	Telochistaceae	B&R	Fo

Table- 2
Particulate, SO_2 and NO_2 levels at Khanabal during different phases

S .No	Parameters	Phases		
		Pre-operational phase (µg/m³)	Operational phase (µg/m³)	Post- operational phase µg/m³
1.	RSPM	216.46	241.30	213.83
2.	NRSPM	271.93	312.26	257.02
3.	SPM	488.39	553.56	470.85
4.	NO_2	84.17	116.34	120.31
5.	SO_2	113. 17	130.95	109.27

Table- 3
Table showing Frequency, Density and abundance of lichen species on *Poplusalba*

Lichen taxa.	Frequency						Density						Abundance					
	Rings						Rings						Rings					
	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
*Physcia*sp.	Ab	25.00	25.00	33.33	33.33	Ab	Ab	1.00	1.41	1.41	1.08	Ab	Ab	4.00	5.66	4.25	3.25	Ab
Xanthoriaparietina (L.)Th.Fr.	Ab	41.66	58.33	58.33	50.00	66.66	Ab	4.33	6.83	9.41	5.41	10.33	Ab	10.40	11.71	16.14	10.83	15.50

Table- 4
Table showing Frequency, Density and abundance of lichen species on *Robiniapseudoacacia*

Lichen Taxa	Frequency						Density						Abundance					
	Rings						Rings						Rings					
	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
*Physcia*sp.	Ab	33.33	33.33	16.66	41.66	33.33	Ab	1.83	2.16	2.41	3.66	4.25	Ab	5.5	6.5	14.4	8.8	12.75
Xanthoriaparietina (L.) Th.Fr.	Ab	41.66	58.33	50.00	50.00	58.33	Ab	55.75	9.66	10.41	9.91	7.75	Ab	71.50	71.82	59.12	69.26	50.01

Table-5
Pigment analysis of the two Lichen species collected from the area

Rings	Lichen Taxa.	Pigments(mg/g)			
		Chl. a	Chl. b	Total Chl.	Carotene.
1	*Physcia*sp.	Species Absent			
	Xanthoriaparietina(L.)Th.Fr.				
2	*Physcia*sp.	0.199	0.161	0.072	0.407
	Xanthoriaparietina(L.)Th.Fr.	0.180	0.168	0.082	0.443
3	*Physcia*sp.	0.272	0.209	0.097	0.465
	Xanthoriaparietina(L.)Th.Fr.	0.285	0.236	0.108	0.443
4	*Physcia*sp.	0.368	0.219	0.109	0.486
	Xanthoriaparietina(L.)Th.Fr.	0.344	0.155	0.141	0.437
5	*Physcia*sp.	0.397	0.304	0.108	0.636
	*Xanthoriaparietina (*L.)Th.Fr.	0.586	0.203	0.016	0.609
6	*Physcia*sp.	0.417	0.365	0.141	0.663
	Xanthoriaparietina(L.)Th.Fr.	0.654	0.299	0.043	0.569

Table- 6
pH of the bark of two common tree species in the area

Plant sps.	Rings						
	1	2	3	4	5	6	Average pH
Poplus alba	4.67	6.34	9.63	9.78	6.16	8.44	7.50
Rubiniapseudocacia	5.31	7.56	10.73	12.92	12.19	10.49	7.81

Table- 7
Water Holding Capacity of the bark of two common tree species found in the area

Plant sps.	Rings					
	1	2	3	4	5	6
Poplus alba	7.327	6.348	9.631	9.783	6.168	8.443
Rubiniapseudocacia	11.230	7.546	10.732	12.928	12.192	10.495

Conclusion

The present investigation revealed that decline in lichens can be attributed to higher pollutant levels in the area which overlaid the pattern of species extirpation both qualitatively and quantitatively as well their health and pigment content. 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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