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Distribution and pH Relationship Studies in Some Mosses Growing in Polluted Sites

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ABSTRACT

Bryophytes (non- vascular land plants) owing to their simple morphological, anatomical structures, worldwide in distribution, and forming an important component of forest ecosystem can be of immense importance in determining the prevailing edaphic conditions (hydrogen ion concentration) by their distribution patterns. Especially, mosses that are highly versatile due to their adaptability to different substrata can be used all the year round in the laboratory and *in situ* to monitor the area in every season, suggesting their wider use as bio-indicators as compared to higher vascular plants which are comparatively difficult to handle.

INTRODUCTION

The mosses are nonvascular land plants. They are worldwide in distribution and form an important component of the forest ecosystem. They inhabit diverse substrata, like rock-surfaces and rock crevices (Saxicolous), soil (Terricolous), tree trunks (Corticolous), branches, and twigs, dead and decomposing wood (Lignicolous), road construction sites, seepage areas, and in lakes. This group is represented by nearly 10,000 species (14,000 estimated by Asakawa, 1990) in 700 genera and 85 families.[1]

Interestingly, some mosses can grow efficiently even in habitats where normal vegetation does not occur as in and around hot springs *(Archidium alternifolium),* hot deserts *(Tortula intermedia, Grimmia laevigata, Bryum caespiticium),* burned sites *(Funaria hygrometrica, Ceratodon purpureus, Bryum argenteum)*, mineral deficient substrata *(Sphagnum, Drepanocladus).* Certain mosses *(Physcomitrella)* can colonise habitats that are available for short durations (bare soil and muddy edges of lakes and rivers). Such taxa have a short life cycle and possess an efficient dispersal mechanism.[2]

Bryophytes resemble green algae, pteridophytes, and seed-bearing plants in respect of their photosynthetic pigments and photosynthetic apparatus, metabolism, and structural the framework of cell wall. These similarities seem to suggest that these plant groups have had a remote common ancestry. Bryophytes resemble green algae, pteridophytes, and seed-bearing plants in respect of their photosynthetic pigments and photosynthetic apparatus, metabolism, and structural framework of the cell wall.[3] These similarities seem to suggest that these plant groups have had a remote common ancestry. Bryophytes posses distinctive features like small size, ability to survive long periods of drought, poikilohydric habit, simple structural, and morphological organization, high regeneration potential, low mineral nutritional requirement, short life cycle, and ability to inhabit diverse substrata. All these features earned them a unique position among other plant groups and also attracted the attention of the bryologists all over the world.[4]

The present study deals with the distribution of mosses, their nitrogen content, and analysis of the pH of their supporting substrate, collected from various polluted sites. All the mosses collected were found to be endohydric and formed short tufts on boundary walls of different industrial units (Table 1).

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MATERIALS AND METHODS

Plant material, along with the substratum, was collected from 17 polluted sites located in Chandigarh, Baddi, and Barotiwala industrial areas (Table 1).

In the laboratory, plant material after separation from the substratum was washed several times with tap water and then checked under binocular to avoid contamination with any other plant material. The purified plant material was then cleaned in water with pressurized air to remove any adhering soil particles.[5-7] It was finally washed with double distilled water and then dried at room temperature between folds of the blotting sheet. Each plant sample was then carefully identified, observing both morphological as well as anatomical features. Nitrogen estimation was done by Linder's Method (1944). The pH of the substratum was also determined using Beckman's pH meter.

RESULTS

Anoectangium clarum Mitt.

This taxon was collected from the upper part of the boundary wall of Vijay Remedies Industry Barotiwala (site I). The pH of the substratum was 7.68. The taxon was characterized by sturdy, short plants, and short excurrent costa. The stem is pale brown, unbranched uniformly covered with erectopatent leaves, with rhizoids in between the leaves, which are slightly curled and incurved.

Table 1: Showing the list of sites, studied taxa, substratum and its pH

Site No	Site	Name of taxon	Substratum	pH
I	Vijay Remedies Industry, Barotiwala	*Anoectangium clarum* Mitt.	On boundary wall (upper part)	7.68
II	Vijay Remedies Industry, Barotiwala	*Gymnostomum calcareum* Nees and Hornsch.	On boundary wall (lower part)	7.47
III	Shivalik Steel Alloy Industry, Barotiwala	-do-	On wall	7.47
IV	Chander Laxmi Glass Factory, Barotiwala	*Hyophila involuta* (Hook.) Jaeg.	On-wall	7.57
V	Transport Depot-I, Chandigarh	*Hyophila spathulata* (Harv.) Jaeg.	On brick wall	7.12
VI	Transport Depot-II, Chandigarh	-do-	On brick wall	6.89
VII	Modern Bread Factory, Chandigarh	-do-	On cemented wall	7.01
VIII	Sanson Pharmaceutical Industry, Baddi	-do-	On wall	7.56
IX	Chhabra Steel Strips Limited, Baddi.	Hydrogonium arcuatum var.*gangeticum* (Griff.) Wijk. and Marg.	On back wall	7.47
X	LML Agency, Chandigarh	- *Hydrogonium consanguineum* (Thw. and Mitt.) Hilp.	On back wall	7.23
XI	Sector-29, Roadside, Chandigarh	-do-	On moist soil	6.93
XII	Sector-30, Roadside, Chandigarh	-do-	On wall	7.06
XIII	Pfizer Industry, Chandigarh	-do-	On wall (outer side)	6.66
XIV	Pawa Chain Industry, Chandigarh	-do-	On wall	7.10
XV	Thread Factory, Baddi	-do-	On boundary wall	7.81
XVI	Rama Steel, Industry, Barotiwala	-do-	On wall	7.14
XVII	Rama Steel, Industry, Barotiwala	-do-	On wall (inner side)	7.43

The nitrogen concentration in plant material was estimated to be 3.27 %.

***Gymnostomum calcareum* Nees and Hornsch**

This taxon was collected from the lower part of the boundary wall of the Vijay Remedies Industry, Barotiwala (site II). The pH of the substratum was 7.47. A bluntly acute leaf tip characterized the taxon. The stem is red-brown, branched with upper longer leaves, and shorter leaves towards lower parts. Leaves are small, broad at base, erectopatent, and apex rounded to subacute.

The nitrogen concentration in plant material was estimated to be 5.62%.

Gymnostomum calcareum

This taxon was collected from the wall of the Shivalik Steel Alloy Industry, Barotiwala (site III). The pH of the substratum was 7.47.

The nitrogen concentration in plant material was estimated to be 2.79%.

***Hyophila involuta* (Hook.) Jaeg.**

This taxon was collected from the wall of Chander Laxmi Glass Factory, Barotiwala (site-IV). The pH of a substratum was 7.57. The taxon was characterized by branched shoots which arise from a long, horizontal, radiculose part below each shoot showed red rhizoids on a stem with uniformly covered erect spreading leaves with serrulate upper leaf margin.

The nitrogen concentration in plant material was estimated to be 3.06%.

***Hyophila spathulata* (Harv.) Jaeg.**

This taxon was collected from the brick wall of Transport Depot-I, Chandigarh (site V). The pH of substratum was 7.12. The taxon was characterized by leaf base narrower than lamina, fertile plants usually unbranched (5 mm) while sterile ones may be much longer (up to 1.5 cm).

The nitrogen concentration in plant material was estimated to be 3.71%.

Hyophila spathulata

This taxon was collected from the wall of Transport Depot-II, Chandigarh (site VI). The pH of substratum was 6.89.

The nitrogen concentration in plant material was estimated to be 2.18%.

Hyophila spathulata

This taxon was collected from the cemented wall of the Modern Bread factory, Chandigarh (site VII). The pH of substratum was 7.01.

The nitrogen concentration in plant material was estimated to be 1.71%.

Hyophila spathulata

This taxon was collected from the wall of Sanson Pharmaceutical Industry, Baddi (site VIII). The pH of substratum was 7.56.

The nitrogen concentration in plant material was estimated to be 2.05%.

***Hydrogonium arcuatum* var. *gangeticum* (Griff.) Wijk. and Marg.**

This taxon was collected from the back wall of Chhabra Steel strips Limited, Baddi (site IX). The pH of substratum was 7.47. The taxon was characterized by yellowish-green, more or less stiff plants. Stem about 1 cm, brown, usually unbranched, uniformly covered with leaves. Leaves are clinging to stem and slightly crispate when dry, broad at the base, margin entire, and usually flat. Leaf acute with prominent costa.

The nitrogen concentration in plant material was estimated to be 5.22%.

***Hydrogonium consanguineum* (Thw. and Mitt.) Hilp.**

This taxon was collected from the back of the wall of LML Agency, Chandigarh (site X). The pH of substratum was 7.23. The taxon was characterized by rounded leaf tip; margin flat above, slightly recurved below. Costa prominent, pale yellow-brown, rough on back, and excurrent.

The nitrogen concentration in plant material was estimated to be 3.79%.

Hydrogonium consanguineum

This taxon was collected from the moist soil along the roadside, Sector 29, Chandigarh (site XI). The pH of substratum was 6.93.

The nitrogen concentration in plant material was estimated to be 1.44%.

Hydrogonium consanguineum

This taxon was collected from the wall along the roadside, Sector-30, Chandigarh (site XII). The pH of substratum was 7.06.

The nitrogen concentration in plant material was estimated to be 5.28%.

Hydrogonium consanguineum

This taxon was collected from the outer side of the wall of Pfizer Industry, Chandigarh (site XIII). The pH of substratum was 6.66.

The Nitrogen concentration in plant material was estimated to be 2.55%.

Hydrogonium consanguineum

This taxon was collected from the wall of the Pawa Chain Industry, Chandigarh (site XIV). The pH of substratum was 7.10.

The nitrogen concentration in plant material was estimated to be 1.78%.

Hydrogonium consanguineum

This taxon was collected from the boundary wall of Thread Factory, Baddi, (site XV). The pH of substratum was 7.81.

The nitrogen concentration in plant material was estimated to be 5.63%.

Hydrogonium consanguineum

This taxon was collected from the wall of Rama Steel Industry, Barotiwala (site XVI). The pH of substratum was 7.14.

The nitrogen concentration in plant material was estimated to be 5.89%.

Hydrogonium consanguineum

This taxon was collected from the inner side of the wall of Rama Steel Industry, Barotiwala (site XVII). The pH of substratum was 7.43.

The nitrogen concentration in plant material was estimated to be 3.79%.

DISCUSSION

Of the 17 sites (I-XVII) studied in the polluted industrial areas located in Chandigarh, Baddi, and Barotiwala showed the pH value of the supporting substrata of mosses between 6.66. and 7.81.

(Table-1). *Hyophila spathulata* was found growing at four sites within pH range of 6.89-7.56. Interestingly, *H. consanguineum* was found to be most commonly occurring at eight sites and at all pH values. *Hyophila involuta* was found growing on substratum with pH 7.57, whereas *Hydrogonium arcuatum* var. *gangeticum* on soil with pH 7.47. The moss taxa collected from substrata with different pH values suggest that mosses have the ability to grow and tolerate a wide range of pH.[8,9] Other ecological factors, mineral status, along with pH, also govern their growth and distribution.[9]

In the 17 sites (I-XVII) studied, the mosses contained 1.71-5.89% nitrogen. The maximum concentration was recorded in *H. consanguineum* growing at site XVI (pH 7.14) and minimum in *Hyophila spathulata,* growing at site VII (pH 7.01).

Moreover, in various polluted sites, six taxa - *Anoectangium clarum, Gymnostomum calcareum, Hyophila involuta, H. spathulata, Hydrogonium arcuatum* var. *gangeticum* and *Hydrogonium consanguineum* were mainly found. The ability of bryophytes to grow in polluted sites may suggest the evolution of tolerant genotypes or the development of pollution tolerant ecotypes as a result of reduced competition there.

CONCLUSION

These plants can be of immense value in pollution monitoring studies. An analysis of such species gives a fair idea about the degree of pollution. We can also develop strains of bryophytes resistant to higher concentrations, and these strains in the ecosystem can act as effective sinks of pollutants.

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