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RESEARCH ARTICLE

Corticolous Lichen Diversity of Gulmarg Forest Area

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ABSTRACT

An assessment has been carried out in Gulmarg forest ecosystem Baramulla, to explore the Corticolous lichen diversity of the region. A total of 26 Corticolous lichen species were found during the study period in the site belonging to the 11 families. Among the growth forms foliose (12 species)was the most frequenty encountered lichen, followed by Crustose with 10 species and Fruticose with 4 species. The family Physciaceae was found as dominating family with 8 species followed by Parmeliaceae (4 species),Sterocaulaceae (3 species) Teloschistaceae, Collemataceae,Pertusariaceae, Lecanoraceae), Candelariaceae,, Acarosporaceae, Psilolechiaceae, Crysothriaceae (1 each). The mean lichen diversity value were generated based on the record for five sites to be 1195.7246.

Keywords: Gulmarg, Corticolous Lichen, Cyanobacteria.

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INTRODUCTION

The term `lichen` was introduced 300 B.C. by Theophrastus, the father of Botany, primarily to represent the superficial growth of lichens on the bark of olive trees (Hawksworth and Hill, 1984). Lichen is an organism that is composed of a mycobiont (fungal partner) and a photobiont (alga or cyanobacteria) growing together in a symbiotic relationship, where the two organisms growing together rely on each other for their survival (Silva *et al*, 2015). Algae and cyanobacteria produce food for fungus, converting co2 gas into sugars via photosynthesis. Cyanobacteria also convert nitrogen gas into forms used to build proteins, nucleic acids and other essential molecules. The fungus, in turn, serves as a home for the food producing partner and provides water, minerals and other nutrients absorbed from the air, rains and substrates. This unique association probably evolved as an adaptation to the varied microhabitats withstanding extreme microclimatic conditions is unfavourable for fungi and algae in isolation (Negi and Upreti, 2000). The photobiont is sensitive to a wide range of environmental conditions which determine the distribution pattern of the lichen. The mycobiont contains a diversity of chemical substances for the protection of the photobiont which extend their ecological range (Silva *et al*, 2015) Various factors govern the growth and development of lichens on tree trunks in different habitats. Variation of macroclimatic factors; rainfall and temperature affect lichen development pattern in different geographical regions. Microclimatic factors such as light, humidity and temperature are the most vital factors that cause variation within the site. Site factors such as age, composition, management practices and pollution of the forest also affect lichen development. Substrate characteristics of tree species such as bark type, surface corrugation, moisture retention, pH and nutrient status of the bark influence the growth of lichens on a tree. But the influence of above factors on lichen development in a given ecosystem considerably varies (Mulligan L, 2009). On the basis of substratum lichens grow upon, they are grouped as, corticolous/epiphytic lichens (lichens growing on tree trunks and barks), lignicolous (growing on dead wood), ramicolous (lichens inhabiting twigs), terricolous (lichens growing on soil), humicolous (lichens growing on humus), saxicolous (lichens growing on rocks) and folicolous (lichens growing on evergreen leaves) (D.K.Upreti, 1998). By their appearance the lichens can be grouped into three main categories of growth forms (S. Nayaka, 2005). Crustose Lichens: the thallus in the lichen is closely attached to the substratum without leaving free margin. The thallus usually lacks lower cortex and rhizines (root like structures). Such lichens are collected along with the substratum for the detailed study. Foliose Lichens: they are also called leafy lichens. The thallus in this case is loosely attached to the substratum at least at the margin. They are collected by scrapping them from substratum. Fruticose

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Lichens: here the lichen thallus is attached to the substratum at one point and remaining major portion is either growing erect or hanging. India constitutes a rich biodiversity, contributing nearly 15% of the 13,500 species of lichens recorded in the world (Groombridge, 1992). In India, Jammu and Kashmir is one of the lichen rich regions, oftenly known as 'Hot Spot' of lichen diversity (Sheikh, *et al* 2006). The unique anatomical and physiological peculiarities allow lichens to grow in all sort of terrestrial habitat domains. Lichens are of great significance. In nature, lichens play an important role as pioneer organisms. Lichens have bio-accumulator capacity and high sensitivity towards specific pollutants. Pollution effects in lichens are shown in the decrease of sorts of lichens number due to the break-up of symbiotic association. Therefore, lichens are used as bioindicators according to the presence/absence of kinds of lichens in the environment. They are used to identify PAHs (Polycyclic aromatic hydrocarbons), phenols and trace metals (PawlikSkowron'ska *et al*., 2008). Combustion processes from road traffic, industrial sector and home heating are the main responsible for the generation of PAHs (Samanta *et al*., 2002; Grynkiewicz *et al*., 2002). These toxic compounds are present largely in air, water, aerosols, soils and sediments (Kipopoulou *et al*., 1999; Haawthorne *et al*., 2000 Aims of the study:

- Survey collection and identification of lichens in the study area.
- Study distribution of different growth forms of lichens growing on diverse substrates.

METHODOLOGY

Study Area

Jammu and Kashmir is a state in northern India. It is located in the Himalayan mountains and shares borders with the state of Himachal Pradesh and Punjab to the South. The Kashmir Valley, called as 'the paradise on earth', is a beautiful valley enclosed in a magnificent amphitheater of mountains. It extends between latitudes 33o 20′ N to 34o 54′ N and longitudes 73o 55′ E to 75o 35′ E, covering an area of 15,948 km2. (Figure 1)

The present study is conducted on Gulmarg forest area, a hill station and a notified area committee in the Baramulla district of Jammu and Kashmir present at an elevation of 2650m.

It lies between the geographical coordinates of 34°3'N latitude and 74°22'48'' E longitude and has a total area of about 5,737.50 Ha. Gulmarg accentuates a humid continental climate where the wet winter season sees heavy snowfall, especially for its latitude. Summers are moderate in temperature and length, whereas shoulder seasons are relatively cool. The town is situated in the Pir-Panjal Range in the western Himalayas. The town receives an average annual precipitation of 1049mm (41.3 inch). The average annual temperature for the town is recorded to be 7.6°C. A lot of research work had been conducted on the forest ecosystem of Gulmarg from time to time under which numerous documentation had been carried out on various ecosystem properties for maintaining the health of ecosystem. The major focus was given on phytosociology of the hill station, land use, land scaping, ecotourism, etc however lichens of the

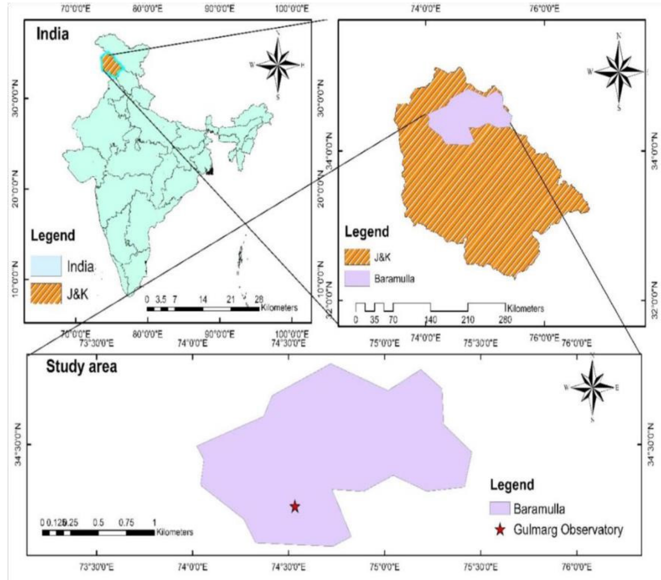

Figure 1: Location map of Gulmarg

region despite of their pivotal role in stabilizing the ecosystem has not been studied yet. In this backdrop the present 7 study has been carried out as a part of major project for studying chen diversity of Gulmarg forest ecosystem.

The study was carried out from February 2023 to October with the gap of 9 months. The study area was divided into 5 plots according to the area of the forest. The samples were collected from all the plots in 15 visits. For each plot three trees were taken for surveying lichens

Corticolous (epiphytic)

Lichen diversity was surveyed on selected trees using surveying grids consisting of four quadrat segments of 50cm in height and 10cm in width.Surveying quadrat was attached vertically to the trunk placing the quadrat segments on the North,East,South and West side of the trunk and 1-2 meter above the ground. Each quadrat segment was subdivided into five quadrat squares 10 x10cm and the presence of species were recorded in each quadrat square. In case of lignicolous lichens, the grids were placed linearly on the wood log and were counted from I to IV.

Calculation of Lichen diversity Values (LDV)

The European guideline developed by Astaet.al, (2002a, b) was used to assess the lichen diversity In Gulmarg forest area. LDV for each sample plot was calculated following procedures of Asta *et al* (2002a, b). Within each sample plot; a sum of frequencies of lichen species at aspect of each tree (1) / dead wood / treemoss was calculated.Thus for each tree /dead wood / treemoss there were four sum of frequencies (SF1) on North (SF1n), East (SF1e), South(SF1s)and West(S1w) side of the trunk.Then the mean of the sums of the frequencies (MSF) for each aspect (North East South West) in each sample plot was calculated according to following equation:

$$\text{MSFn} = \frac{SF1n+SF2n+SF3n+SF4n}{N}$$

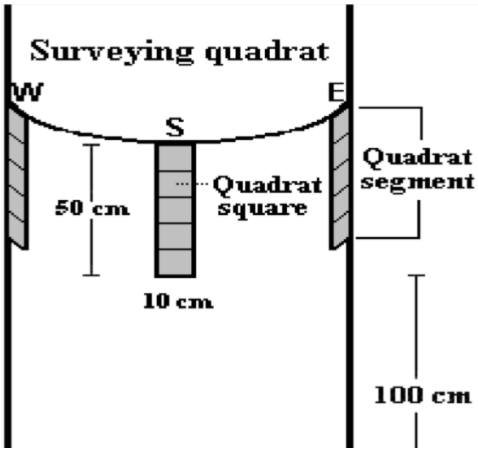

Figure 2: Calculation of Lichen diversity Values

Where;

MSFn = Mean of the sums of the frequencies of all trees/ dead woods /tree mosses of sample plot at a given aspect (e.g. North)

SF1n = sum of frequencies of all the species found at one aspect tree1/dead wood1/treemoss1

Figure 3: Location of placing the quadrat on the tree trunk during the study

(e.g. North) n, e, s, w = North, East, South, West,

N = number of trees/dead woods/tree mosses surveyed in sample plot

Then the Lichen Diversity Value (LDV) of a sample plot was calculated as the sum of the MSF of all the aspects (Figure 2):

LDV=MSFe + MSFw + MSFn + MSFs

Tools for sampling (Figure 3)

Various tools that were used during sampling include:

Table 1: Corticolous Species of lichens collected during the study

S. No.	*Species*	*Family*	*Growth form*	*Substrate type*
01	Lepraria finkii	Stereocaulaceae	Crustose	Epiphytic, Lignicolous, Saxicolous, Tericolous, Muscicolous
02	*Lecanora hybocarpa*	Lecanoraceae	Crustose	Corticolous
03	*Buellia punctata*	Physciaceae	Crustose	Corticolous
04	Lepraria incana	Stereocaulaceae	Crustose	Lignicolous, Saxicolous, Corticolous, Muscicolous
05	*Candelariella reflexa*	Candelariaceae	Crustose	Corticolous, Lignicolous
06	Phaeophyscia orbicularis	Physciaceae	Foliose	Corticolous,Lignicolous
07	Pertusaria albescens	Pertusariaceae	Crustose	Corticolous, Saxicolous, Muscicolous
08	*Physcia tribacia*	Physciaceae	Foliose	Saxicolous, Corticolous
09	*Chrysothrix xanthina*	Arthoniaceae	Crustose	Lignicolous, Corticolous, Saxicolous
10	Hyperphyscia adglutinata	Physciaceae	Foliose	Corticolous
11	*Usnea filipendula*	Parmeliaceae	Fruticose	Corticolous
12	Psilolechia lucida	Psilolechiaceae	Crustose	Tericolous, Corticolous, Muscicolous
13	*Usnea hirta*	Parmeliaceae	Fruticose	Corticolous
14	*Mylochroa aurulenta*	Parmeliaceae	Foliose	Corticolous, Saxicolous, Lignicolous
15	*Candelariella vitellina*	Candelariaceae	Crustose	Saxicolous, Lignicolous, Corticolous
16	*Physconia detersa*	Physciaceae	Foliose	Corticolous, Saxicolous, Muscicolous
17	*Physcia dimidiata*	Physciaceae	Foliose	Corticolous, Saxicolous
18	*Rusavskia elegance*	Teloschistaceae	Crustose	Corticolous, Saxicolous
19	Paemotrema perlatum	Parmeliaceae	Foliose	Corticolous, Saxicolous
20	Leptogium azureum	Collemataceae	Foliose	Corticolous, Saxicolous
21	*Ramalina dilacerata*	Ramalinaceae	Fruticose	Corticolous, Saxicolous, Muscicolous, Lignicolous
22	*Leptogium cyanescens*	Collemataceae	Foliose	Corticolous, Saxicolous Muscicolous
23	Lepraria neglecta	Stereocaulaceae	Fruticose	Saxicolous, Corticolous
24	Physcia orbicularis	Physciaceae	Foliose	Corticolous, Saxicolous
25	*Crysothrix candelaris*	Crysothriaceae	Foliose	Corticolous, Saxicolous
26	Physcia tribacia	Physciaceae	Foliose	Corticolous, Saxicolous

Figure 4: Corticolous Species of lichens collected during the study

- Grid with the size 50 cm x10 cm
- Locking -blade or fixed- blade knife
- (Figure 1) Hand held lens
- Specimen packets (poly bags)
- Permanent ink pen for recording data on specimen packets
- White chalk

RESULTS

Species composition

A total of 26 Corticolous lichen species were found during the study period in the site (Table 1) belonging to the 11 families dominated by growth form foliose (12 species), followed by Crustose (10 species) and Fruticose (4 species). The family Physciaceae was found as dominating family with 8 species followed by Parmeliaceae(4 species),Sterocaulaceae (3 species) Teloschistaceae, Collemataceae,, Pertusariaceae, Lecanoraceae), Candelariaceae,, Acarosporaceae, Psilolechiaceae, Crysothriaceae (1 each)

It was recorded in the present investigation that among the five plots, MSF values for epiphytic lichens were highest in site II followed by site IV then by site I, site V and site III. Further, it was recorded that MSF value in plot II was highest for the lichens on north side (406.666), followed by west (333.333), south (286.666) and east (240).

In the present investigation, among the five plots of the study site, the highest LDV of Epiphytic lichens was recorded for the plot II. Mean LDV of the Epiphytic lichens in the site was recorded to be 1195.7246.

DISCUSSIONS

A total of 26 Corticolous lichen species were found during the study period in the site (Table 1 and Figure 4) belonging to the 11 families dominated by growth form foliose (12 species), followed by Crustose (10 species) and Fruticose (4 species). The family Physciaceae was found as dominating family with 8 species followed by Parmeliaceae (4 species), Sterocaulaceae (3 species) Teloschistaceae, Collemataceae,, Pertusariaceae, Lecanoraceae), Candelariaceae,, Acarosporaceae, Psilolechiaceae, Crysothriaceae (1 each) The present investigation revealed that among all the epiphytic lichens found in plot I, *Ramalina dilacerata* and *Physconia detersa* were the that were found dominant on all the selected trees. The occurrence of *Ramalina dilacerata* and *Physconia detersa* on all the trees is due to its habit of growing on tree barks all over the world.

Mean sum of frequencies of epiphytic lichens in plot I was recorded highest on east side indicating that the tree is located at a point where its east side is facing sunlight for short period of the day and retains moisture due to which the bark of the tree rarely dries off which is an essential factor for lichen growth. It was observed during the present study that among the epiphytic lichens found on tree 1 in plot II (Table 2, *Leptogium azureum* showed the highest frequency while *Lecanora hybocarpa*, *Buellia punctata* and *Physcia orbicularis* were entirely absent on tree 1. On tree 2 (*Ailanthus altissima*) in plot II, *Candelariella vitellina* showed the highest frequency in comparison to that *Leptogium azureum* showed the least frequency while Rusavskia elegance was entirely absent on tree 2. On tree 3 in plot II, *Candelariella vitellina* showed the highest frequency while *Leptogium azureum* was entirely absent.

Table 2: Mean LDV of epiphytic lichens of five plots

Lichen type			*Epiphytic lichen*		
Plot	*I*	*II*	*III*	*IV*	*V*
LDV	1013.334	1931.999	999.99	1079.98	953.32
Mean LDV			1195.7246		

During the present investigation it was recorded that among the epiphytic lichens found on plot III, the frequency of *Ramalina dilacerata* was found to be highest on tree 1 (*Abies pindrow*) while least frequency was shown by *Usnea hirta,*which showed highest frequency on tree 3 (*Abies spectabilis*), on tree 2 (*Abies pindrow*) the frequency of *Lepraria neglecta* was found to be highest. It was observed that MSF was highest for the east side and lowest for the north side. During the present investigation it was recorded that among the epiphytic lichens found on plot IV, the frequency of *Rusavskia elegance* was again found to be highest on all the selected trees. It was observed that MSF was highest for the east side and lowest for the south side indicating that the former side is facing sunlight for short period of the day hence retaining good amount of moisture enhancing the lichen growth,(Lange and Tenhunin,1981)while as the same thing was reverse for the latter.

In the present investigation, it was found that among the lichen species recorded on the selected trees in plot V, that *Usnea filipendula* showed highest frequency on tree 1 and tree 2 while *Ramalina dilacerata* and *Usnea hirta* showed the highest frequency. Among the 4 lignicolous lichens found in plot IV

CONCLUSIONS

A good diversity of lichens is present in the Gulmarg forest area growing on different substrates dominated by corticolous / epiphytic lichens which is supported by floristic diversity of trees in the forest, including Ailanthus altissima,salix alba, Populas tremula, Abies spectabilis, Abies pindrow,, Pinus griffithii, Pinus wallichiana, Acer caesium etc. In addition to the floristic diversity and other substrata present in the forest, lichen growth is also influenced by sulphur emissions from tourist vehicles as the site is a famous tourist spot.

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