International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 2, 2025
https://www.theaspd.com/ijes.php

Assessing Lichen Diversity In The Himalayan Region Of Reasi, Jammu And Kashmir

Priya Darshni[1(a,b)],Pihu Gupta[2], Anamika Shrivastava*,Mamta Bhat[3],Renu Dhupper[4] and Lal Singh[5]
[1(a)] *Research scholar, Amity Institute of Environmental Sciences,Amity University,Noida,U.P*
[1(b)]*Associate Professor,Department of Environmental Sciences,Govt.Degree College,R.S.Pura, Jammu.*
[2] *Ph.D Scholar,Department of Environmental Sciences,University of Jammu*
[*]*Assistant Professor, Amity Institute of Environmental Sciences,Amity University,Noida,U.P(Corresponding author)*
[3]*Assistant Professor,School of Biosciences and Biotechnology,BGSB University,Rajouri-185234,Jammu and Kashmir,India.*
[4] *Associate Professor and Coordinator, Amity Institute of Environmental Sciences,Amity University,Noida,U.P*
[5] *Principal Scientist/Associate Professor,Environmental Biotechnology and Genomic Division,CSIR-National Environmental Engineering Research Institute,Nagpur*
***Corresponding Author:** *Anamika Shrivastava*
**E-mail: shrivastavanamika012@gmail.com*

ABSTRACT
This study investigates the lichen diversity in District Reasi, Jammu and Kashmir, an area previously unexplored for lichen flora. The research, conducted between 2021 and 2023, employed a comprehensive sampling methodology across nine sites within the district.A total of 50 lichen species from 33 genera and 15 families were identified. Physciaceae was the most prevalent family (7 genera), followed by Verrucariaceae (5 genera) and Parmeliaceae (4 genera). Crustose and foliose growth forms were equally represented, each with 22 species.The primary substrate for lichen growth was identified as corticolous (27 species), followed by saxicolous (20 species) and terricolous (3 species). Ecological assessments using diversity indices revealed differences among the various study sites, with Site 2 (Thuru) demonstrating the highest level of biodiversity. This study significantly enhances the understanding of lichen diversity in the Himalayan region and provides a foundational reference for future ecological research in the Reasi District.
KEY WORDS
Lichens, biodiversity, Reasi, Physciaceae, Verrucariaceae, Lecanoraceae

INTRODUCTION

Lichens represent a symbiotic relationship between fungi and algae and/or cyanobacteria (Ahmedjian, 1993). Their evolutionary lineage extends back to periods when neither algae nor fungi could thrive independently. This symbiotic relationship developed as a strategy for survival in challenging environmental conditions. Lichens are ubiquitous, capable of colonizing a variety of surfaces, including rocks, trees, and various human-made structures. The growth of lichens on different substrates is affected by several factors, such as microclimatic conditions like temperature, moisture levels, and light availability, in addition to broader climatic influences such as average temperature and precipitation. The characteristics of the substrate, including rock composition, bark type, pH, surface roughness, and moisture retention properties, also play a crucial role in their development (Hawksworth and Rose, 1976; James *et al*., 1977; Hawksworth and Hill, 1984; Woseley and Aguirre-Hudson, 1997; Mulligan, 2009).One of India's hotspots for lichen diversity, the union territory of Jammu and Kashmir is mostly a Himalayan terrain, with coordinates between 32.733 and 36.666 N latitude and 73.433 and 73.433-80.5 E longitude (Sheikh *et al* , 2006). Owing to significant altitude variance, distinct topography, a vast variety of vegetation, and a fluctuating climate, J & K provides lichens with a broad range of habitats for growth and colonization.Limited research on lichens was conducted in the 20th century by Smith (1931), Schubert and Klement (1966), and Awasthi and Singh (1970). However, comprehensive studies commenced in the early 21st century, with numerous researchers, including Sheikh *et al.* (2006, 2009), Khan *et al.* (2010), Solan *et al.* (2010), Kumar *et al.* (2012), Khare *et al.* (2020),Kumar and Sharma (2020) ,Kumar *et al*, 2021 ,Gupta,2025, etc., making substantial contributions to the understanding of the lichen mycota in the region.Although lichen diversity surveys have been carried out in other areas of Jammu and Kashmir, such as Doda, Kishtwar, Rajouri, Anantnag, and Pahalgam, there has been no similar research conducted in District Reasi. This study seeks to address this deficiency by exploring the lichen diversity in this previously unexamined region.

International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 2, 2025
https://www.theaspd.com/ijes.php

STUDY AREA

The proposed study area is located primarily within the Reasi (Fig.1) and Udhampur tehsils of the former Udhampur district, with a small portion extending into the Rajouri district. Geographically, it lies between 32°53' and 33°20' North latitude and 74°35' and 72°10' East longitude. The region is bordered to the west by the Nowshera Forest Division, to the north by the Mahore Forest Division, to the east by the Udhampur Forest Division, and to the south by the Jammu Forest Division. The study area falls within the catchment of the River Chenab, with the Reasi range being primarily drained by the Anji Nallah, which joins the Chenab River near Reasi town. Several smaller streams and nallahs also drain directly into the Chenab. The region benefits from both winter and monsoon precipitation, with the majority of rainfall occurring during the summer months, particularly in July and August. The climate at lower altitudes, including Pouni, Reasi, and Katra, is very hot during the summer, while higher elevations experience cooler temperatures. Winter temperatures in the lower regions can become quite cold, while the higher zones receive snowfall from November to February.

District Reasi's diverse topography and climatic conditions foster a wide variety of vegetation. Notable plant species include *Acacia catechu* (L.f.) Willd., *Cassia fistula* L., *Terminalia bellerica* (Gaertn.) Roxb., *Anogeissus latifolia* Wall. ex Guill. & Perr., *Mallotus philippensis* A. Müll.-Arg., *Lannea coromandelica* (Houtt.) Merr., *Toona ciliata* M.Roem., *Bombax ceiba* L., *and Syzygium cumini* (L.) Skeels. Pure stands of *Dalbergia sissoo* Roxb. ex DC. are found in Dehra Baba, while other species such as *Quercus leucotrichophora* A. Camus, *Pyrus pashia* Buch.-Ham. ex D. Don., *Indigofera tinctoria L.*, ,*Phyllanthus emblica* L.,*Grewia tiliaefolia* Vahl., *Bauhinia spp.*, *Acacia modesta* Wall. Pl. Asiat. Rar. (Wallich). , *Ficus spp.*, *Pinus roxburghii* Sarg., *and Pinus wallichiana* A.B.Jacks. also occur in the area. The undergrowth primarily consists of *Adhatoda vasica* (L.) Nees *and Dodonaea viscosa* Jacq., while the ground flora includes a variety of grasses and ferns.District Reasi is comprised of 259 villages and 147 panchayat halqas, organized into 9 tehsils and 12 rural development blocks. The data for this study was gathered on a tehsil-by-tehsil basis, with the coordinates and altitudes of the various study sites detailed in Table 1.

Table 1: Altitude and coordinates of the study sites

S.No	Site	Coordinates	Altitude(m asl)
1	Mahore(site1)	33.5110N 75.0794E	1667-2586
2	Thuru(Site 2)	33.2629 N 74.9834 E	2000-2567
3	Katra(Site3)	32.9915 N 74.9318E	572-847
4	Reasi (Site4)	33.0828 N 74.8331 E	420-637
5	Chasana(Site5)	33.3506 N 74.8240 E	801-1282
6	Bhomag (Site6)	33.0966 N 74.9135 E	873-1172
7	Thakarakote (Site7)	33.1688 N 74.7956 E	511-934
8	Arnas(Site8)	33.2070 N 74.8166 E	524-578
9	Pouni(Site9)	33.0527 N 74.6304 E	573-677

Fig. 1: General Map of the study area

MATERIALS AND METHODS

Sampling Methodology

The collection of lichen samples from the study area was carried out tehsil-wise. Repeated visits were made between 2021 and 2023, during which lichens were collected from all available substrates, including rocks, trees, and soil.The lichen samples were dried using folds of newspaper or blotting paper. After drying, the samples were securely placed in lichen herbarium packets. Important details such as locality, collection date, collector's name, and other ecological information were recorded for each sample.

Examination and Identification of Lichens

The examination and identification of the collected lichen samples were conducted at the Centre for Biodiversity Studies, Baba Ghulam Shah Badshah University, Rajouri. A stereomicroscope and light microscope were used for the morpho-anatomical analysis of the samples .Chemical analysis of the lichens was carried out using standardized thin layer chromatography (TLC), UV tests, and spot tests (Elix *et al.*, 1993). For accurate identification of lichen taxa, the study consulted various lichenological literature from renowned authors such as Awasthi (1988, 1991, 2000), Upreti (1998), Singh and Sinha (2010), Nayaka and Upreti (2011), Kumar *et al.* (2012), Bhat *et al.* (2014), and Goni *et al.* (2015).

Ecological Studies,Data analysis and interpretation

For ecological studies, a stratified random sampling technique was adopted. A total of 120 quadrats were laid at each study site.Each quadrat selected for the study had a size of 25 cm × 25 cm.Lichen communities were subjected to a quantitative analysis focusing on their density and frequency. The IVI calculated here is the sum of relative density and relative frequency (Pinokiyo,2008). The determination of relative density and relative frequency has been calculated by the methodology established by Phillips (1959).The IVI can be calculated as

$$Relative Frequency = \frac{Frequency of the particular species}{Sum of frequency of all the species} \times 100$$

$$Relative Density = \frac{Density of the particular species}{Sum of densities of all the species} \times 100$$

Therefore, Importance Value Index (IVI) = Relative Frequency + Relative Density

Numerous indices have been created to integrate both species richness and evenness into a single metric, with the Simpson Index (Simpson, 1949) and the Shannon-Weiner Index (Shannon & Weiner, 1949) being two of the most frequently employed.

Simpson's index (1949):

$$\boldsymbol{D = \sum_{i=0}^{s} \left(\frac{ni(ni-1}{N(N-1)}\right)}$$

Where,

ni =number of individual in the i^{th}species

N= total number of individual of all species

D= index value

Shannon-Wiener Index (H') (1949):

$$H' = -\sum [(ni/N) \ln (ni/N)]$$

Where,

ni= number of individual of i^{th}species

N = total number of individual of all species

H'= index value

Similarity Index Calculation

To determine the ecological similarity among the nine sampling sites, the similarity index based on the presence-absence data of lichen species has been computed. The similarity index values were calculated using the Sørensen similarity coefficient (Sørensen, 1948), expressed as:

Similarity Index (SI)=2C/A+B

where C is the number of species common to both sites, *A* is the total number of species in site A, and *B* is the total number of species in site B. This index ranges from 0 (no similarity) to 1 (complete similarity) and helps in identifying ecological affinities and differences across study sites. The method is widely used in ecological studies to assess compositional similarity (Magurran, 2004; Krebs, 1999; Whittaker, 1972).

RESULTS AND DISCUSSSION

Diversity,Distribution and Ecological studies of lichens for whole of the study area

The present investigation has identified a total of 50 lichen species distributed across 33 genera and 15 families. A comprehensive list of these species, including their growth forms and the substrates on which they were observed, has been provided in Table 2 and few representatives species of the study area has been shown in Fig 2. An examination of this table indicates that Physciaceae has been the most prevalent family, comprising of 7 genera, followed by Verrucariaceae with 5 genera and Parmeliaceae with 4 genera (see Fig 3). Other families such as Acarosporaceae, Candellariaceae, Chrysotrichaceae, Pertusariaceae, and Psoraceae have been represented by a single species each. A comparative analysis of the dominant lichen families found in the present study area was conducted against those documented in the neighboring regions. The present findings align with those of Bhat (2018), who also identified Physciaceae as the predominant family in District Rajouri. Similarly, Mishra and Upreti (2016) reported that Physciaceae was the leading family in the Kumaon Himalayas. Kumar *et al.* (2012) corroborated these results, noting Physciaceae as the most dominant family in their research on the Ladakh region. Conversely, Sharma *et al.* (2019) recognized Parmeliaceae as the dominant family in Padder Valley, Jammu and Kashmir, with Physciaceae following closely. Additionally, Goni *et al.* (2015) reported Parmeliaceae as the leading family in certain areas of Jammu and Kashmir.

Table 2 also presents the computed values for Frequency, Density, Abundance, and Important Value Index (IVI). The analysis reveals that *Dermatocarpon vellereum* exhibits the highest values in Frequency (5.278), Density (0.072%), and IVI (26.431), signifying its extensive distribution, substantial population, and overall ecological dominance. In contrast, *Biatora* spp. demonstrates the greatest Abundance (2.133). Additionally, *Hyperphyscia adglutinata* holds a notable position, ranking second in Frequency (3.889), third in Density (0.056), second in Abundance (1.429), and second in IVI (19.861), which suggests its significant presence despite a comparatively lower density. Conversely, *Rhizoplaca chrysoleuca* is identified as having the lowest Density (0.003), Frequency (0.093), Abundance (1.5), and IVI (0.712). This analysis underscores the complexity of the lichen community, highlighting various species that contribute to the ecosystem in distinct manners, ranging from widespread occurrence to ecological prominence.

Table 2: Lichen species identified in the study area, along with their respective families, growth forms, substrata, and Importance Value Index (IVI)

S.No	Name Of the Species	Family	Growth Form	Substrate	Density	Frequency	Abundance	IVI
1	*Bacidia arnoldiana* Korber	Ramalinaceae	Crustose	Bark	0.00	0.19	2.00	1.12
2	*Bacidia incongruens* (Stirt.) Zahlbr.	Ramalinaceae	Crustose	Bark	0.00	0.09	3.00	0.71
3	*Bacidia* spp	Ramalinaceae	Crustose	Bark	0.01	0.28	1.67	1.53
4	*Biatora* spp.	Ramalinaceae	Crustose	Rock	0.03	1.39	2.13	8.71
5	*Buellia disjecta* Zahlbr.	Physciaceae	Crustose	Rock	0.00	0.19	2.00	1.12
6	*Caloplaca ahmediana* Poelt & Hinteregger	Teloschistaceae	Crustose	Rock	0.01	0.28	1.67	1.53
7	*Caloplaca subsoluta* (Nyl.) Zahlbr.	Teloschistaceae	Crustose	Rock	0.02	1.02	1.91	6.01
8	*Candellaria concolor* (Dicks.) Arnold	Candellariaceae	Foliose	Bark	0.02	1.30	1.86	7.54
9	*Chrysothrix chlorina* (Ach.)	Chrysotrichaceae	Leprose	Bark	0.00	0.19	1.50	0.97
10	*Collema limosum* (Ach.)	Collemataceae	Foliose	Rock	0.00	0.09	4.00	0.87
11	*Collema pulcellum* var. *pulcellum* Ach.	Collemataceae	Foliose	Bark	0.00	0.19	2.00	1.12
12	*Collema subflaccidum*(Degel.)	Collemataceae	Foliose	Bark	0.01	0.19	3.00	1.43
13	*Dermatocarpella squamulosum*	Verrucariaceae	Foliose	Rock	0.01	0.19	2.50	1.27
14	*Dermatocarpon miniatum* (L.) Mann	Verrucariaceae	Foliose	Rock	0.02	0.93	1.90	5.45
15	*Dermatocarpon vellereum* Zschacke	Verrucariaceae	Foliose	Rock	0.07	5.28	1.37	26.43
16	*Diploschistes euganeus* (A. Massal.)	Graphidaceae	Crustose	Rock	0.01	0.65	1.71	3.62
17	*Diploschistes scruposus* (Schreb.)	Graphidaceae	Crustose	Rock	0.02	1.02	1.91	6.01
18	*Dirinaria aegialita* (Afz. in Ach.) Moore	Physciaceae	Crustose	Rock	0.01	0.28	2.00	1.68
19	*Endocarpon rosettum* A. Singh & Upreti	Verrucariaceae	Squamulose	Rock	0.01	0.28	1.67	1.53
20	*Endocarpon* spp	Verrucariaceae	Squamulose	Rock	0.01	0.28	2.00	1.68
21	*Graphis* spp	Graphidaceae	Crustose	Bark	0.02	1.02	1.46	5.25
22	*Hyperphyscia adglutinata* (Florke) Mayerh.And Poelt	Physciaceae	Foliose	Bark	0.06	3.89	1.43	19.86
23	*Hyperphyscia granulata* (Poelt) Moberg	Physciaceae	Foliose	Bark	0.01	0.28	2.00	1.68
24	*Hyperphyscia syncolla* (Tuck.Ex Nyl.) Kalb	Physciaceae	Foliose	Bark	0.01	0.83	1.67	4.58
25	*Lecanora achroa* Nyl.	Lecanoraceae	Crustose	Rock	0.01	0.37	1.50	1.94
26	*Lecanora albescens* (Hoffm.) Flk	Lecanoraceae	Crustose	Rock	0.01	0.19	2.50	1.27
27	*Lecanora muralis var.muralis* (Schreb.) Rabenh. Em. Poelt	Lecanoraceae	Crustose	Rock	0.01	0.46	1.80	2.65

28	*Lecanora perplexa* Brodo	Lecanoraceae	Crustose	Rock	0.01	0.28	1.67	1.53
29	*Lepraria lobificiens* Nyl.	Stereocaulaceae	Leprose	Soil/rock/bark	0.04	2.96	1.44	15.18
30	*Lepraria* spp	Stereocaulaceae	Leprose	Soil/rock/bark	0.01	0.28	2.67	1.99
31	*Leptogium denticulatum* Nyl.	Collemataceae	Foliose	Rock	0.00	0.19	2.00	1.12
32	*Parmelia* spp	Parmeliaceae	Foliose	Rock	0.01	0.28	1.67	1.53
33	*Parmotrema praesoredium* (Nyl.) Hale	Parmeliaceae	Foliose	Bark	0.00	0.19	2.00	1.12
34	*Pertusaria melastornella* Nyl.	Pertusariaceae	Crustose	Rock	0.00	0.19	2.00	1.12
35	*Phaeophyscia hispidula* (Ach.) Moberg	Physciaceae	Foliose	Bark	0.03	1.76	1.53	9.27
36	*Phaeophyscia orbicularis* (Neck.) Moberg	Physciaceae	Foliose	Bark	0.00	0.19	2.00	1.12
37	*Phaeophyscia pyrrhophora* (Poelt) D.D.Awasthi & M.Joshi	Physciaceae	Foliose	Bark	0.01	0.56	1.67	3.06
38	*Phylliscum indicum* Upreti	Lichinaceae	Crustose	Rock	0.04	2.50	1.56	13.29
39	*Phylliscum* spp	Lichinaceae	Crustose	Rock	0.00	0.28	1.33	1.38
40	*Physcia dilatata* Nyl.	Physciaceae	Foliose	Bark	0.02	1.30	1.79	7.38
41	*Physconia distorta* (With.) J.R. Laundon	Physciaceae	Foliose	Bark	0.01	0.74	1.75	4.18
42	*Pleopsidium flavum f. flavum* (Schaer.)	Acarosporaceae	Crustose	Rock	0.01	0.37	1.50	1.94
43	*Psora decipiens* (Hedw.) Hoffm.	Psoraceae	Crustose	Soil/Rock	0.01	0.37	1.50	1.94
44	*Punctelia subrudecta* (Nyl.)	Parmeliaceae	Foliose	Rock	0.00	0.19	1.50	0.97
45	*Pyxine cocoes* (Swartz.) Nyl.	Physciaceae	Foliose	Bark	0.01	0.46	2.20	2.95
46	*Rhizoplaca chrysoleuca* (Sm.)	Lecanoraceae	Squamulose	Rock	0.00	0.09	3.00	0.71
47	*Staurothele fissa* (Taylor) Zwackh	Verrucariaceae	Crustose	Rock	0.00	0.19	1.50	0.97
48	*Verrucaria coerulea* DC.	Verrucariaceae	Crustose	Rock	0.01	0.28	2.67	1.99
49	*Xanthoparmelia congenesis* (J.Steiner) Hale	Parmeliaceae	Foliose	Bark	0.02	1.20	1.69	6.67
50	*Xanthoria parietina* (L.) Th. Fr.	Teloschistaceae	Foliose	Bark	0.00	0.19	2.00	1.12

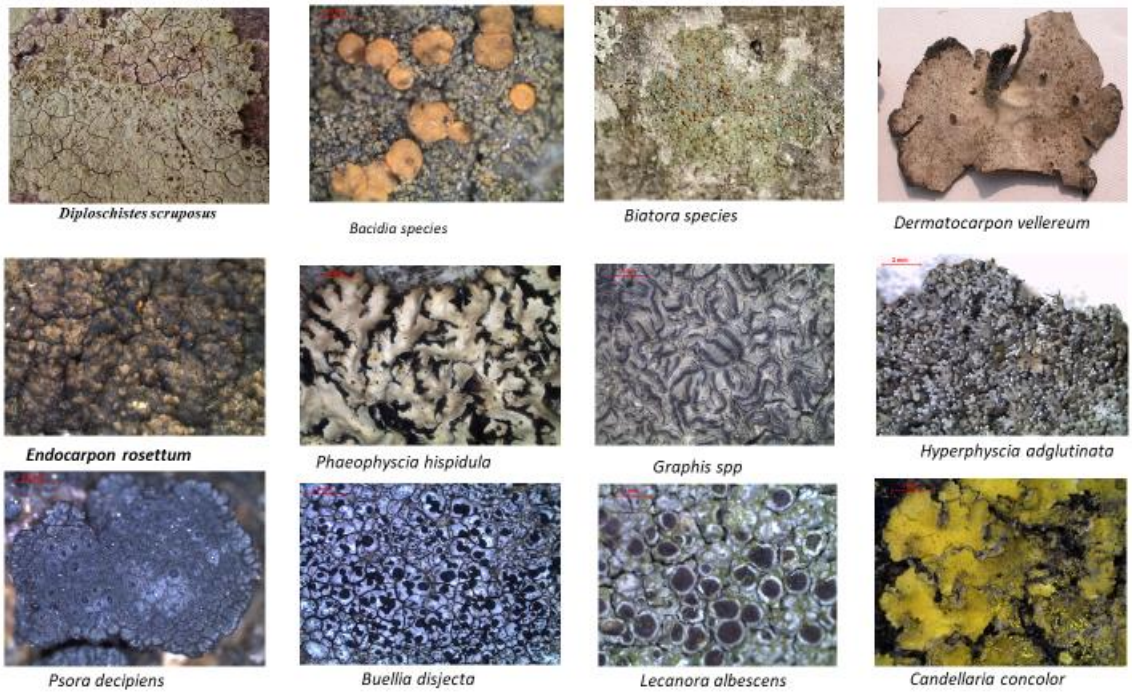


Fig 2: Few representative lichen species of the study area

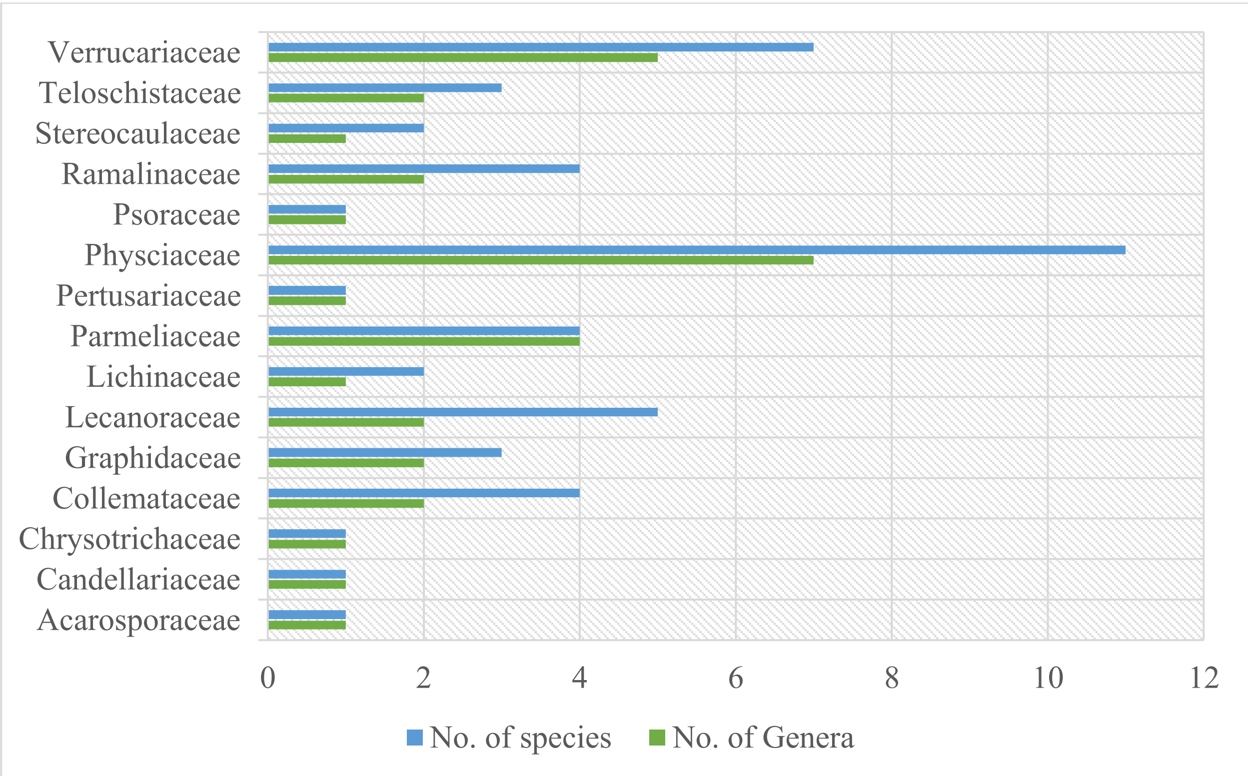
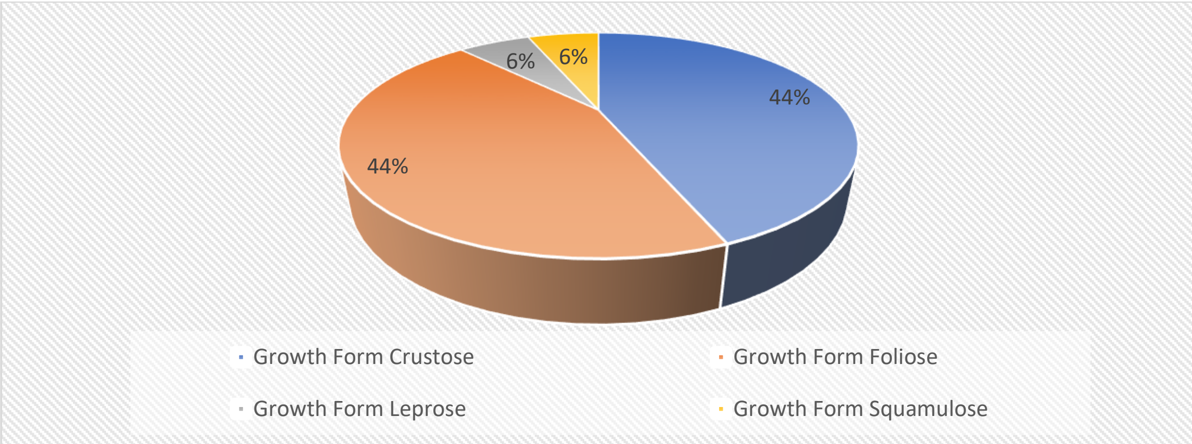


Fig3: Showing distribution of genera and species in various families

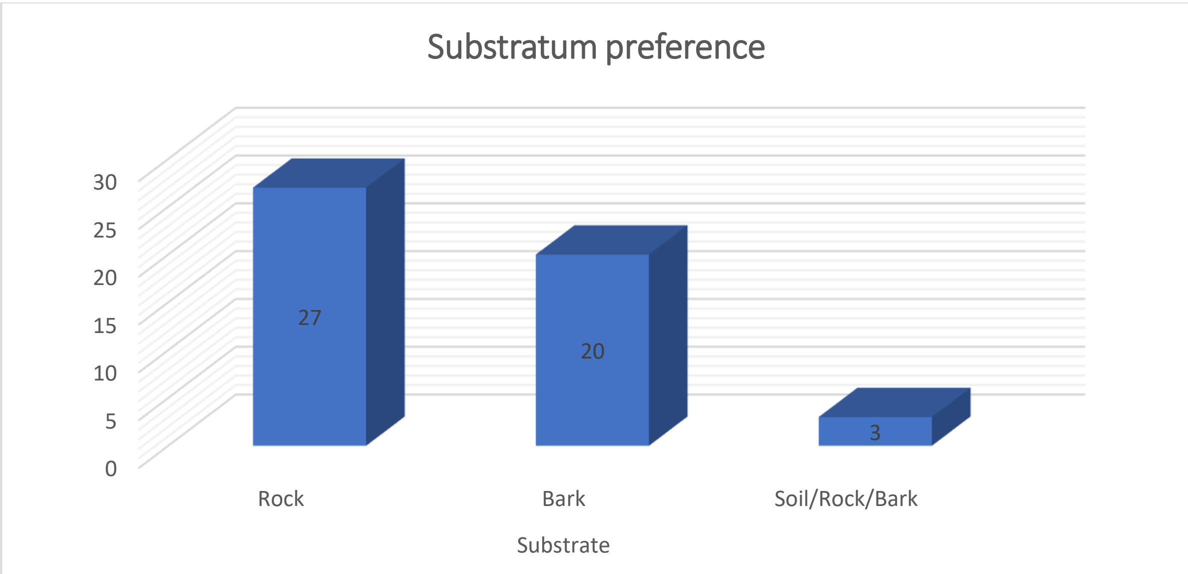
The examination of Fig 4(A) indicates that both crustose and foliose growth forms consist of 22 species each, while leprose and squamulose forms are represented by three species each. According to Sharma *et al.* (2019), the foliose form was the most prevalent in Padder Valley, followed by crustose and fruticose forms. In a similar way, Bhat (2018) noted that the crustose lichens in District Rajouri were dominant. Furthermore, Mishra and Upreti

International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 2, 2025
https://www.theaspd.com/ijes.php

(2016) reported that the foliose form was the most dominant lichen type in the Kumaon Himalayas. In contrast, Sheikh *et al.* (2013) found that crustose forms were the most abundant in Jammu and Kashmir, with foliose and fruticose forms following in lesser numbers. A closer analysis of Fig 4(B) reveals that the preferred substrate for lichen growth in the study area has been found to be corticolous, with 27 species followed by saxicolous species (20 species), and only three species classified as terricolous. Notably, some soil-dwelling species were also observed growing on rock and bark substrates. These findings are consistent with earlier studies, including Sharma *et al.* (2019) in the Padder Valley, Sheikh *et al.* (2013) in Jammu and Kashmir, and Mishra and Upreti (2016) in the Kumaon Himalayas, who reported a predominance of corticolous lichens across different Himalayan regions.However, Bhat (2018) indicated that saxicolous substrates were the most favored by lichens in District Rajouri.



(A)



(B)

Fig 4(A)&(B): Distribution of species according to their growth form and the substrate

Diversity And Ecological Analysis Of Lichens Across Different Study Locations:
A total of 50 species belonging to 33 genera and 15 families are reported from the study area. Highest number of species are reported from site 2 Thuru (23 species), followed by Mahore site 2, (17 species),Pouni site 9 (15 species)(Table 3). Both Bhomag,site 6 and Arnas, site 8 host 12 species. Reasi , site 4 and Thakarakote site 7,

each feature 11 species.Chasana ,site 5 also records 11 species . Lastly, Katra shows the least number with 9 species.

Table 3: Distribution of Lichen Species Across Multiple Sites

S.no.	Name of Species	Site-1	Site-2	Site-3	Site-4	Site-5	Site-6	Site-7	Site-8	Site-9
1	*Bacidia arnoldiana*	-	-	-	-	-	+	-	-	-
2	*Bacidia incongruens*	-	-	-	-	-	-	-	-	+
3	*Bacidia spp*	+	-	-	-	-	-	-	-	-
4	*Biatora spp.*	+	+	+	+	+	+	+	-	+
5	*Buellia disjecta*	-	+	-	-	-	-	-	-	+
6	*Caloplaca ahmediana*	-	-	-	-	-	-	-	+	-
7	*Caloplaca subsoluta*	+	+	-	-	-	+	-	+	-
8	*Candellaria concolor*	+	+	-	+	-	-	-	+	-
9	*Chrysothrix chlorina*		+	-	-	-	-	-	-	-
10	*Collema limosum*	-	+	-	-	-	-	-	-	-
11	*Collema pulcellum*	-	-	-	-	-	-	-	+	-
12	*Collema subflaccidum*	-	-	-	-	-	-	+	-	-
13	*Dermatocarpella squamulosum*	-	-	-	-	-	+	-	-	-
14	*Dermatocarpon miniatum*	-	+	-	-	+	-	-	-	-
15	*Dermatocarpon vellereum*	+	+	+	+	+	+	+	+	+
16	*Diploschistes euganeus*	-	+	+	-	-	-	-	+	-
17	*Diploschistes scruposus*	+	-	+	-	-	-	+	-	+
18	*Dirinaria aegialita*	-	-	-	-	-	+	-	-	-
19	*Endocarpon rosettum*	-	-	-	-	-	-	+	-	-
20	*Endocarpon spp*	-	-	-	-	-	-	+	-	-
21	*Graphis spp*	+		+	-	-	-	+	+	+
22	*Hyperphyscia granulata*	-	-	-	-	-	-	+	-	-
23	*Hyperphyscia adglutinata*	+	+	+	+	+	+	+	+	+
24	*Hyperphyscia syncola*	-	+	-	+	-	-	-	+	-
25	*Lecanora achroa*	-	-	-	-	+	-	-	-	-
26	*Lecanora albescens*	-	+	-	-	-	-	-	-	-
27	*Lecanora muralis*	-	+	-	-	-	-	-	-	+
28	*Lecanora perplexa*	-	-	-	-	+	-	-	-	-
29	*Lepraria lobificiens*	+	+	+	+	+	+	+	+	+
30	*Lepraria spp*	-	-	-	-	-	+	-	-	-
31	*Leptogium denticulatum*	-	+	-	-	-	-	-	-	-
32	*Parmelia spp*	-	-	-	+	-	-	-	-	-
33	*Parmotrema praesoredium*	-	-	-	-	-	-	-	-	+
34	*Pertusaria melastornella*	-	-	-	-	-	-	+	-	-
35	*Phaeophyscia hispidula*	+	+	-	+	-	+	+	-	+
36	*Phaeophyscia orbicularis*	+	-	-	-	-	-	-	-	-
37	*Phaeophyscia pyrrhophora*	-	-	-	-	-	+	-	+	-
38	*Phylliscum indicum*	+	+	+	-	+	+	+	+	+
39	*Phylliscum spp*	-	-	-	+	-	-	-	-	-
40	*Physcia dilatata*	+	+	+	+	+	-	-	-	-
41	*Physconia distorta*	-	+	+	-	+	-	-	-	-
42	*Pleopsidium flavum*	-	+	-	-	-	-	-	-	-
43	*Psora decipiens*	-	-	-	-	-	-	-	-	+
44	*Punctelia subrudecta*	-	-	-	-	-	-	-	-	+
45	*Pyxine cocoes*	+	+	-	-	-	-	-	-	-
46	*Rhizoplaca chrysoleuca*	-	+	-	-	-	-	-	-	-
47	*Staurothele fissa*	-	-	-	-	-	-	-	-	+
48	*Verrucaria coerulea*	-	-	-	+	-	-	-	-	-
49	*Xanthoparmelia congenesis*	+	+	-	-	+	-	-	-	-
50	*Xanthoria parietina*	-	+	-	-	-	-	-	-	-

'+'=presence,'-'=absence

DIVERSITY INDICES:

The diversity of lichen species for each site was determined using the Shannon-Weiner index(Fig.5) and Simpson's index(Fig. 6). At Site 2 (Thuru), the Shannon-Wiener index is the highest at 3.02, indicating a relatively higher biodiversity and more even distribution of species. In contrast, Site 3 (Katra) has the lowest Shannon-Wiener index of 2.25, suggesting that it has lower biodiversity compared to the other sites.

For Simpson's index, lower values indicate higher diversity, with Site 2 again showing the lowest value of 0.04, signaling greater biodiversity. In contrast, Site 3 (Katra) has the highest value of 0.07, meaning it has relatively lower species diversity.

Overall, these results suggest that sites with higher Shannon-Wiener indices tend to show lower Simpson's indices, and vice versa. The variation in biodiversity across sites reflects different ecological conditions, which may be influenced by factors such as habitat type, human activity, and environmental variables. Sites like Thuru demonstrate the highest biodiversity, while places like Katra show more limited species diversity.

FIG 5. The Shannon-Weiner index for the sampling sites

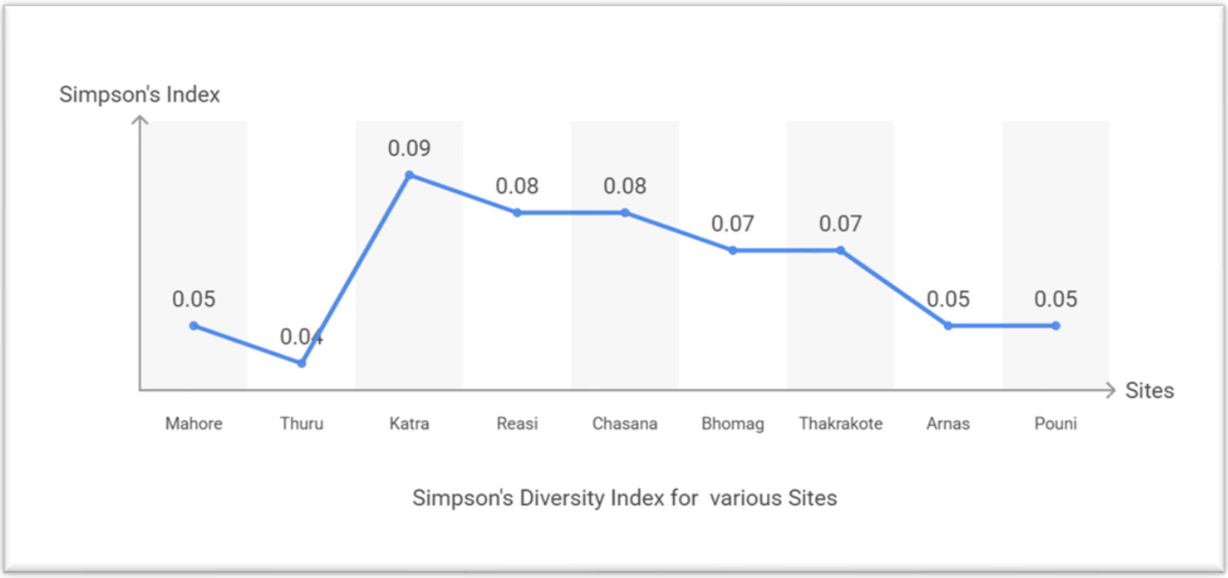


FIG 6. The Simpson's index for the sampling sites

THE SIMILARITY INDEX FOR THE SAMPLING SITES

The similarity index showed how the sites differed according to the presence or absence and abundance of species.The table highlights the similarity indices among nine sites, reflecting the resemblance in their species compositions, ranging from 0 (completely dissimilar) to 1 (completely similar). Site-1 shares its highest similarity with Site-2 (0.55) but diverges most from Site-9 (0.375). Similarly, Site-2 exhibits notable overlap with Site-1 (0.55) and Site-5 (0.529), but least with Site-8 (0.316). Site-3 stands out for its strong similarity with Site-5 (0.762), while Site-4 shows moderate similarity with Sites 5, 6, and 9 (~0.43–0.46) and minimal similarity with Site-7 (0.25). Site-5 and Site-3 exhibit the highest similarity index (0.762), while Site-5 is least similar to Sites 7 and 8 (~0.25). Site-6 shares moderate similarity with Sites 7 and 8 (~0.48–0.5), and Site-7 aligns closely with Site-9 (0.5) while differing significantly from Sites 4 and 5 (0.25). Site-8 shows overlap with Site-6 (0.5) but diverges from Site-5 (0.261). Lastly, Site-9 shares its highest similarity with Site-7 (0.5) and the least with Site-2 (0.316). Overall, the indices reveal clusters of ecological similarity, such as between Sites 3 and 5, and distinct differences, as seen between Sites 7 and 4, suggesting varying habitat features and conservation priorities.

Table 4:Similarity Index Between And Within Different Sites

	Site-1	Site-2	Site-3	Site-4	Site-5	Site-6	Site-7	Site-8	Site-9
Site-1	-	0.55	0.518519	0.5	0.5	0.482759	0.466667	0.413793	0.375
Site-2		-	0.484848	0.470588	0.529412	0.4	0.333333	0.457143	0.315789
Site-3			-	0.380952	0.761905	0.545455	0.608696	0.545455	0.48
Site-4				-	0.545455	0.434783	0.25	0.434783	0.461538
Site-5					-	0.434783	0.25	0.26087	0.307692
Site-6						-	0.48	0.5	0.37037
Site-7							-	0.4	0.5
Site-8								-	0.44444
Site-9									-

CONCLUSION

The investigation into lichen diversity within the District of Reasi, Jammu and Kashmir, has provided significant insights into the region's overall biodiversity. The discovery of 50 distinct lichen species distributed among 33 genera and 15 families emphasizes the ecological importance of this area. The predominance of the Physciaceae family is consistent with observations from adjacent regions, indicating a distinctive lichen assemblage characteristic of this segment of the Himalayas. The balanced representation of crustose and foliose growth forms, coupled with a preference for corticolous substrates, offers critical information regarding the local environmental conditions that facilitate lichen proliferation. The ecological assessment indicated varying degrees of lichen diversity across the nine study locations, with Thuru exhibiting the highest levels of biodiversity. This variation is likely attributable to differences in habitat characteristics, environmental conditions, and potentially the impact of human activities throughout the district. The similarity indices calculated between the sites further underscore the ecological diversity present in the region, which is essential for effective conservation strategies.However, the study also raises concerns about the potential negative impacts of increasing tourism and development activities on lichen biodiversity. The heavy tourist footfall, particularly around religious sites like the Shri Mata Vaishno Devi shrine, and ongoing construction projects, including the world's highest railway bridge in Arnas, pose significant challenges to lichen conservation.This study represents a pioneering effort in District Reasi, providing an essential foundation for subsequent ecological monitoring and conservation initiatives. It highlights the importance of implementing development strategies that prioritize the conservation of lichen diversity, a significant indicator of environmental well-being. Future research should concentrate on the long-term observation of lichen communities to evaluate the effects of human activities and climate change on this distinctive ecosystem. Furthermore, the insights gained from this research can guide policy-making related to sustainable tourism and development in the area, thereby safeguarding its abundant lichen biodiversity for the benefit of future generations.

REFERENCES

1. Ahmedjian, V. (1993). *The lichen symbiosis*. John Wiley and Sons, Inc.
2. Awasthi, D. D. (1988). A key to the macrolichens of India and Nepal. *Journal of the Hattori Botanical Laboratory, 65*, 207–302.
3. Awasthi, D. D. (1991). A key to the macrolichens of India, Nepal and Sri Lanka. *Bibliotheca Lichenologica (Suppl.), 40*, 1–337.
4. Awasthi, D. D., & Singh, K. P. (1970). A note on lichens from Kashmir. *Current Science, 39*, 441–442.
5. Awasthi, D. D. (2000). *Lichenology in the Indian subcontinent*. Bishen Singh Mahendra Pal Singh.
6. Bhat, M., Verma, S., & Upreti, D. K. (2014). Lichens for sustainable development. *International Journal of Environmental Research and Development, 4*(4), 325–328.
7. Bhat,M.(2018).Studies on Lichens of Rajouri district with emphasis on on air pollution monitoring.PhD Thesis,Baba Ghulam Shah Badshah University,Rajouri.
8. Elix, J. E., & Ernst-Russell, K. D. (1993). *A catalogue of standardized thin-layer chromatographic data and biosynthetic relationships for lichen substances* (2nd ed.). Australian National University.
9. Goni, R., Raina, A. K. P., Magotra, R., & Sharma, N. (2015). Lichen flora of Jammu and Kashmir State, India: An updated checklist. *Tropical Plant Research, 2*(1), 64–71.
10. Gupta, P., Upreti, D. K., & Raina, A. K. (2025). New additions to the lichen biota of Jammu and Kashmir, India. *Indian Forester, 151*(4), 352–357.
11. Hawksworth, D. L., & Hill, D. J. (1984). *The lichen-forming fungi*. Blackie & Son Limited.
12. Hawksworth, D. L., & Rose, F. (1976). *Lichens as pollution monitors*. Edward Arnold Publishers.
13. James, P. W., Hawksworth, D. L., & Rose, F. (1977). Lichen communities in the British Isles: A preliminary conspectus. In M. R. D. Seaward (Ed.), *Lichen ecology* (pp. 295–413). Academic Press.
14. Khan, S. I., Raina, A. K., & Upreti, D. K. (2010). Enumeration & distribution of lichens in Surankote, District Poonch, J&K (India). *Environment Conservation Journal, 11*(3), 27–31.
15. Khare, R., Upreti, D. K., Haq, M. U., & Behera, B. C. (2020). Diversity of lichens in Jammu and Kashmir State. In G. H. Dar & A. A. Khuroo (Eds.), *Biodiversity of the Himalaya: Jammu and Kashmir State* (pp. 1–100). Springer.
16. Krebs, C. J. (1999). *Ecological methodology* (2nd ed.). Benjamin Cummings.
17. Kumar, V., & Sharma, Y. P. (2020). New regional records and an updated checklist of lichen family Parmeliaceae from Jammu and Kashmir, India. *Journal of Mycology and Plant Pathology, 50*(2), 111–121.
18. Kumar, J., Khare, R., Rai, H., Upreti, D. K., Tayade, A., Hota, S., Chaurasia, O. P., & Srivastava, R. B. (2012). Diversity of lichens along altitudinal and land use gradients in the Trans Himalayan cold desert of Ladakh. *Nature and Science, 10*(4).
19. Kumar, V., Sharma, Y. P., Joseph, S., Ngangom, R. K., & Nayaka, S. (2021). Additions to the lichenized and lichenicolous fungi of Jammu & Kashmir from Kishtwar High Altitude National Park. *Journal of Threatened Taxa, 13*(12), 19799–19807.
20. Magurran, A. E. (2004). *Measuring biological diversity*. Blackwell Science Ltd.
21. Mishra, G. K., & Upreti, D. K. (2016). Diversity and distribution of macro-lichen in Kumaun Himalaya, Uttarakhand. *International Journal of Advanced Research, 4*(2), 912–925.
22. Mulligan, L. (2009). *An assessment of epiphytic lichens, lichen diversity and environmental quality in the semi-natural woodlands of Knocksink Wood Nature Reserve, Enniskerry, County Wicklow* (Doctoral dissertation, Dublin Institute of Technology).
23. Nayaka, S., & Upreti, D. K. (2011). An inventory of lichens in Uttar Pradesh through bibliographic compilation. *National Conference on Earth's Living Treasure, Uttar Pradesh State Biodiversity Board*.
24. Phillips, E. A. (1959). *Methods of vegetation study*. Henry Holt and Company Incorporated.
25. Pinokiyo, A., Singh, K. P., & Singh, J. S. (2008). Diversity and distribution of lichens in relation to altitude within a protected biodiversity hotspot, North-East India. *The Lichenologist, 40*(1), 47–62.
26. Schubert, R., & Klement, O. (1966). Beitrag zur Flechten Flora von Nord und Mittelindein. *Nova Hedwigia, 11*, 1–73.
27. Shannon, C. E., & Weiner, W. (1949). *The mathematical theory of communication*. University of Illinois Press.
28. Sharma, S., Raina, A. K., & Upreti, D. K. (2019). Lichen diversity of Padder Valley Kishtwar (J&K), India. *Journal of Applied and Natural Science, 11*(2), 511–515. https://doi.org/10.31018/jans.v11i2.2119
29. Sheikh, M. A., Upreti, D. K., & Raina, A. K. (2006). Lichen diversity in Jammu and Kashmir, India. *Geophytology, 36*(1–2), 69–85.
30. Simpson, E. H. (1949). Measurement of diversity. *Nature, 163*, 688.
31. Singh, K. P., & Sinha, G. P. (2010). *Indian lichens: An annotated checklist*. Government of India, Botanical Survey of India.
32. Smith, A. L. (1931). Lichens from Northern India. *Transactions of the British Mycological Society, 11*, 189–196.
33. Solan, S., Mehta, K. A., & Magotra, R. (2010). A catalogue of lichens of Ramnagar Wildlife Sanctuary, Jammu (J&K). *Phytotaxonomy, 10*, 134–138.
34. Sørensen, T. (1948). A method of establishing groups of equal amplitude in plant sociology based on similarity of species content. *Kongelige Danske Videnskabernes Selskab, Biologiske Skrifter*, 5(4), 1–34.
35. Upreti, D. K. (1998). Diversity of lichens in India. In S. K. Agarwal, J. P. Kaushik, K. K. Kaul, & A. K. Jain (Eds.), *Perspectives in environment* (pp. 71–79). APH Publishing Corporation.
36. Whittaker, R.H. (1972). Evolution and measurement of species diversity. *Taxon*, 21(2-3), 213-251.
37. Wolseley, P., & Aguirre-Hudson, B. (1997). *Lichens of tropical forests in Thailand: A field key to characteristic epiphytic species in northern Thailand*. Department of Botany, Natural History Museum.