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DIVERSITY AND DISTRIBUTION OF LICHENS IN DIFFERENT ECOLOGICAL ZONES OF WESTERN HIMALAYAS PAKISTAN

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Abstract

Thirty four lichen species encountered in 10 localities from Azad Jammu and Kashmir. Altitudinal range of the sampling stations was 1000 - 2200 m. The reported lichens belonged to 24 genera of 15 families. Parmeliaceae was the dominant family with 8 species followed by Ramalinaceae, Telochistaceae (5 species each). Collemataceae, Caliciaceae, Lecanoraceae, Lobariaceae (2 species each) and Candelariacea, Cladoniaceae, Dermatocarpaceae, Thalotrenataceae, Ramalinaceae, Rhizocarpaceae, Umbilicaraceae and Xanthoparmeliacea (1 species each). Foliose was the dominant growth form followed by crustose, sqamulose and fruticose. Altitude, anthropogenic pressure and pollution are the main factors controlling the diversity and distribution of lichens in the Azad Jammu and Kashmir.

Lichens, mutualistic association of phycobiont and mycobiont are the most successful symbiotic organisms which can grow in all types of terrestrial habitat because of their unique anatomical and physiological peculiarities. This unique association evolved as an adaptation to the varied microhabitats withstanding extreme microclimatic conditions unfavorable for the fungi and algae in isolation (Negi and Upreti 2000). Approximately 25000 species of lichens have so far been identified globally (Chapman 2009). Lichens are considered as the pioneer colonizers of terrestrial habitats on this earth with a worldwide distribution from arctic to tropical regions and from the plains to the highest altitudes. Himalayan regions are rich in lichen biodiversity having more than 2000 lichen species (Singh and Sinha 2010).

The state of Azad Jammu and Kashmir (AJK) lies between 73^0 and 75^0 E and 33^0 and 36^0 N over an area of 13,297 km^2. It is a mountaneous area intercepted by valleys and stretches of plains having elevational gradient of 360 m in south to 6325 m at north. Average annual rainfall is 1300 mm (Dar *et al*. 2012). The area harbours wide range of lichen diversity but there is no records of lichens. The current research was carried out to explore the lichen flora systematically through extensive collection with habitat preferences and distribution.

Samples of lichens were collected from April to October, 2012 at 10 sites in 4 districts of AJK selected on the basis of altitude and ecological zones (Table 1). The sample collections were made from rocks and tree barks up to 2 m above the ground using magnifying lenses (10×). During collection, notes on forest vegetation types, host tree type, habitats (tree trunk, branch, twigs or leaves, soil and rock substratum) and altitudes were taken. Fresh specimens of collected lichen samples were placed in brown paper bags. After air drying, the specimens were stored in dry wooden cabinets. Lichens thallii were initially characterized based on morphology and color spot tests (Walker and James 1980). Identification was followed by comparing the morphometric and biochemical test results after Sipman (2003). The voucher specimens were deposited at the herbarium, Department of Botany, The University of AJK Muzaffarabad.

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The study revealed the presence 134 specimens belonging to 34 species from 15 families and 24 genera (Table 2). Parmeliaceae was the dominant family with 8 species followed by Ramalinaceae, Telochistaceae (5 species each). Collemataceae, Caliciaceae, Lecanoraceae, Lobariaceae (2 species each) and Candelariacea, Cladoniaceae, Dermatocarpaceae, Thalotrenataceae, Ramalinaceae, Rhizocarpaceae, Umbilicaraceae and Xanthoparmeliacea (1 species each) (Table 2). Among the various growth forms, foliose was dominant (16 species) followed by crustose (13 species), sqamulose (3 species) and fruticose (2 species) (Table 2). Maximum number of lichen species (24) including, 11 foliose, 12 crustose, 1 fruticose lichens were recorded from temperate sites of District Bagh at an altitudinal range of 1676 - 2134 m. Neelum Valley site with similar ecological conditions and altitude (1200 - 2100 m) contributed 22 species including 11 foliose, 6 crustose, 3 sqamulose and 2 fruticose (Fig 1-4). On the other hand, the subtropical sites in district Hattian Bala and Muzaffarabad at lower altitude showed minimum number of species i.e. 12 each (Table 2).

Table 1. Lichen collection sites in 4 district of AJK .

Sl. No.	District	Site	Altitude (meter)	Ecological zone
1	Neelum	Kundal Shahi	1200	Humid
		Athmuqam	1371	Moist temperate
		Sharda	1900	
		Keil	2100	
2	Muzaffarabad	Kohala	1000	Subtropical
		PirChinasi	2097	Moist temperate
3	Hattian Bala	Chakothi	1114	Subtropical
		Chikar	1400	Humid
4	Bagh	DhirKot	1676	Moist temperate
		Sudhan Galli	2134	Moist temperate

Foliose lichens were found dominant in the study area. *Xanthoria* spp., foliose lichen was observed in maximum sampling sites. Among crustose lichens the most frequent species was *Umbilicaria hirsute* observed in all of the sampling sites. *Xanthoparmelia* spp. had broad ecological distribution being found in both low and high altitude sites over a diverse set of environmental conditions. Increase in lichen diversity along increasing altitudes and their preference to tericolous and saxicolous habitat can be attributed to the favorable environmental conditions such as temperature, rainfall and substrate. Lichen distribution is very strongly influenced by perception pattern of the area (Caldiz and Brunet 2006).

Diversity and dominance of lichen communities are mainly controlled by abiotic conditions of local environment (Brodo *et al.* 2001). The lowest number of lichen species recorded from the lower altitudinal sites of Hattian Bala and lower Neelum was mainly due to unsuitable environmental condition especially low precipitation and high temperatures. Another important driver of lower lichen diversity is higher anthropogenic disturbances in these densely populated areas. Extensive disturbances degrade the microhabitat types for most of the rock and soil inhabiting lichens which results in lower species turn out. Similarly, Low diversity of lichens in city areas of Muzaffarabad was might be due to air pollution as lichens are highly sensitive to any change in any environmental condition of the area (Kricke and Loppi 2002).

Table 2. Lichen diversity recorded from AJK including the habit, habitat, thalline test and altitude.

Serial No.	Species	Family	Specimen number[1]	Thallus type	Substratum	Altitude	K[2]	NaCl[2]	K+C[2]
1	*Caloplaca marinea*	Teloschistaceae	Khan 250	Crustose	River stone	1000-1676	-	-	-
2	*C. saxicolor*	"	Khan 251	"	On rock	1676-1900	-	-	-
3	*C. citrine*	"	Khan 252	"	"	1676-1900	-	-	-
4	*Candelaria concolor*	Candelariaceae	Khan 253	"	"	1667	-	-	-
5	*Cladonia fimbrata*	Cladoniaceae	Khan 254	Sqamulose	Shady places /On Soil	1900	Y	NR	R
6	*Collema furfuraceum*	Collemataceae	Khan 255	"	Mossy rocks/ forest	1900	B	B	B
7	*C. subflaccidum*	"	Khan 256	"	Shady or mossy rocks	1900	B	B	W
8	*Dermatocarpon vellereu*	Dermatocarpaceae	Khan 257	Foliose	On rock	2097	-	-	-
9	*Diploschistes actinostomu*	Thelotremataceae	Khan 258	Crustose	"	1676-1900	-	-	-
10	*Dimelaena oreina*	Caliciaceae	Khan 259	"	Rock	1676	-	-	-
11	*D. radial*	"	Khan 260	"	"	1676	-	-	-
12	*Evernia mesomorpha*	Parmiliaceae	Khan 261	Foliose	Bark of tree	1900-2100	NR	NR	NR
13	*E. prunastri*	"	Khan 262	"	Dead wood	1900-2100	NR	NR	G
14	*Evernia strumcirrhatum*	"	Khan 263	"	Bark of gymnosperm	1900-2100	G	G	G
15	*Flavoparmilia carparata*	"	Khan 264	"	Bark of tree	1900-2134	G-YG	P-P	NR-G
16	*Lecanora muralis*	Lecnoraceae	Khan 265	Crustose	Rock	1676-1500	-	-	-
17	*Lecanora* sp.	"	Khan 266	"	"	1676-1500	-	-	-
18	*Lobaria qucercizans*	Lobariaceae	Khan 267	Foliose	Bark of Conifers	1600	Y	P	R
19	*Parmeliopsis ambigua*	Parmiliaceae	Khan 268	"	On branches of tree	1667	-	-	-
20	*Parmilia sulcata*	"	Khan 269	"	Deadwood of graveyard	1900-1667	GY	NR-Y	NR-G

(Contd.)

Table 2 (contd.).

Serial No.	Species	Family	Specimen number[1]	Thallus type	Substratum	Altitude	K[2]	NaCl[2]	K+C[2]
21	*Phaeophyscia* sp.	Physciaceae	Khan 270	Foliose	Stone	1800-2097	BR	NR	NR
22	*Physcia aipola*	"	Khan 271	Foliose	B bark of conifers	1900	NR	NR	NR
23	*P. albinea*	"	Khan 272	Crustose	On rock	1900	-	-	-
24	*P. dimidiata*	"	Khan 273	Foliose	Bark	1500	NR	NR	NR
25	*Physconia enetroxentha*	"	Khan 274	Foliose	Bark of quercus	1900	Y	Y	Y
26	*Ramalina fraxinea*	Ramalinaceae	Khan 275	Fruticose	Trees bark	2100-2097	YR	NR	NR
27	*Rhizocarpon* sp.	Rhizocarpaceae	Khan 276	Crustose	On rock	1400	-	-	-
28	*Stictalimbata*	Lobareaceae	Khan 277	Foliose	Mosses/ bark of trees	1900	BR	BR	BR
29	*Umbilicaria hirsuta*	Umbilicaraceae	Khan 278	Crustose	On rock	1000-2200	NR	W	NR
30	*Usnea* sp.	Parmiliaceae	Khan 279	Fruticose	On dead wood	1900	Y	P	PY
31	*Xanthoparmelia* sp.	"	Khan 280	Foliose	On rock	1000	-	-	-
32	*X. Mexicana*	Xanthoparmeliaceae	Khan 281	Crustose	"	1000	-	-	-
33	*Xanthoria parietina*	Teloschistaceae	Khan 282	Foliose	Bark	1200	NR	NR	NR
34	*Xanthoria* sp.	"	Khan 283	Foliose	Rock rusty	1200	-	-	-

1=HUAJK (Herberium of the University of Azad Jammu and Kashmir), 2 = Thalline spot test results. Thallus color - B = Black, Br = Brown, G = Green, R = Red, NR = Not reported, P = Pink, W = White, Y = Yellow, YG = Yellow green.

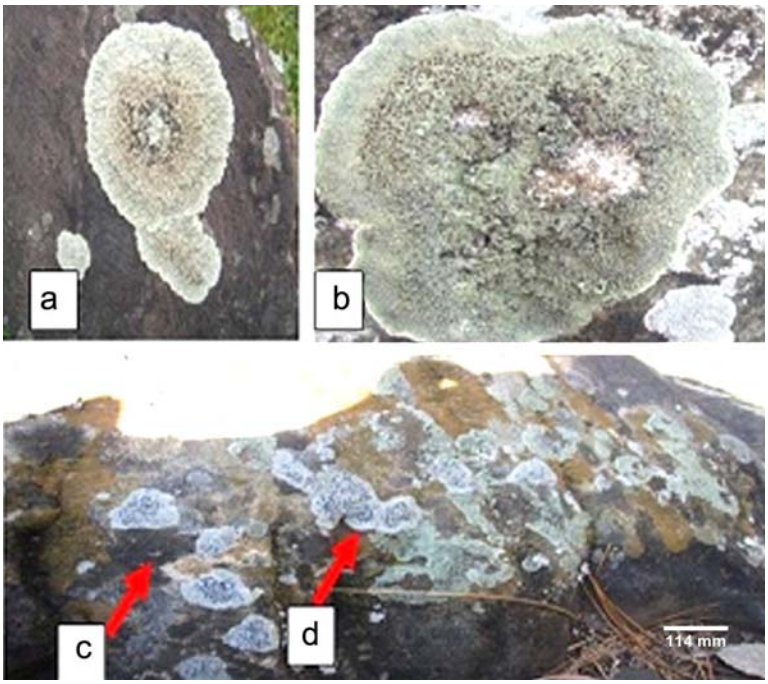

Fig. 1. Crustose lichens of AJK (a) *Dimelana radiate*, (b) *Dimelanaoreina*, (c) *Candelaria concolor* and (d) *Lacanora* cf. *muralis.*

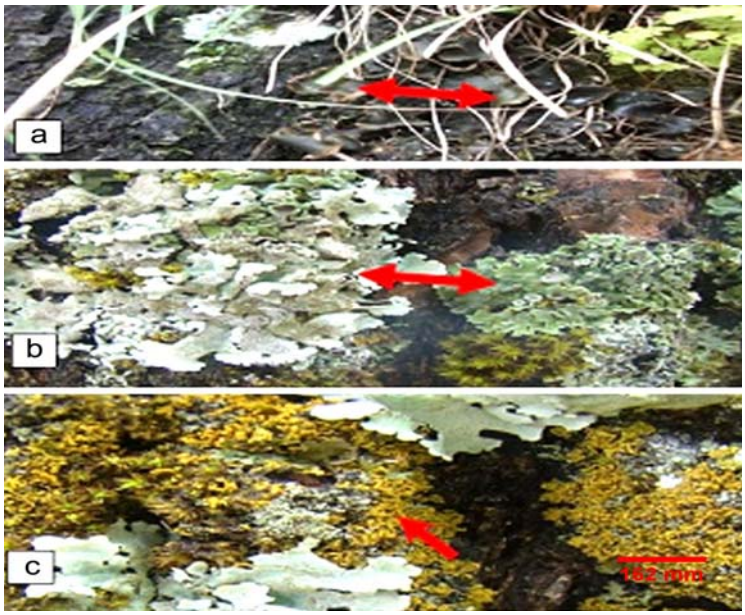

Fig. 2. Folioselichens of AJK (a) *Flavoparmelia caperata* (L.) Hale (b) *Parmelia caperata* (L.) Ach. and (c) *Xanthoria parietina.*

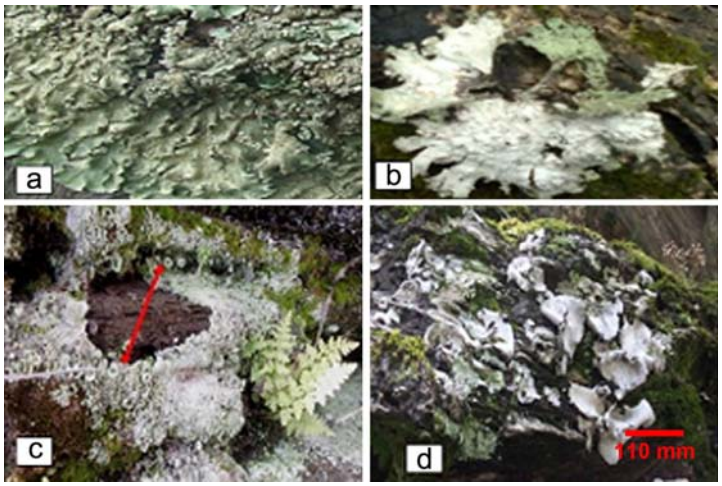

Fig. 3(a) *Xanthoparmelia mexicana* Gyelnick) Hale *(crustose)*, (b) *Ramalina fraxiana* (fruticose), (c) *Cladonia* (foliose) and (d) *Umbilicaria hirsuta* (crustose).

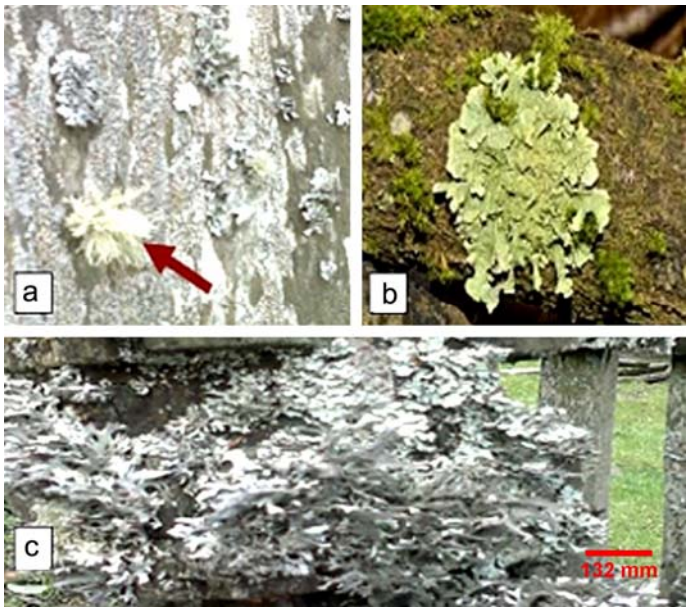

Fig. 4(a) *Usnea subfloridiana (fruticose*), (b) *Parmeliopsis ambigua* (foliose) and (c) *Everniastrum cirrhatum* (foliose).

Higher altitudes of the area were characterized by maximum types of foliose lichens including *Stictalimbata, Pheophysia* sp., *Xanthoriaparietina, Physia aipola, Physconia enetroxentha, Xanthoparmelia lineola, Evernaia mesomorpha, Evernia prunistri, Lobaria quercizans, Flavoparmilia carparata, Evernia strumcirratum, Parmiliopsis ambigua, Evernia prunistri* and *Xanthoria parietina.* Foliose lichens prefer high altitudes with maximum precipitation, low temperature and shade. The sole representatives of fruticose and sqamulose lichen reported from

the higher altitude temperate sites were *Usnea subfloridiana* and *Cladonia fimbrata*, respectively. *Umbilicaria hirsuta* exhibited broad distribution reported from all the studied sites.

The current study revealed unique dominance of foliose lichens followed by crustose, fruticose and sqamulose, respectively. This trend is contradictory to the previous findings of Dulnuan (2006) in Philippines and Kumar *et al.* (2010) in Grahwal Himalayas who have reported the dominance of corticolous, saxicolous and terricolous lichen tyes. Results revealed strong correlation of fruticose lichens with high altitude that is in accordance with the findings of Pinokiyo *et al.* (2008). The results of thalline spot test showed significant variations in the thallus color which can be used as a characterization and identification tool. Moreover, in the present results yellow and red color of K tests showed the presence of secondary metabolites in the lichen thallus. K test of *Usnea* sp. showed red color which indicated the presence of usnic acid whereas C test showed red color which can be attributed to the presence of dihydroxyphenols. These results are in agreement with the findings of Müller (2001) and Sipman (2003).

It is concluded that the lichen diversity and distribution was strongly influenced by the environmental conditions. Altitude appeared as the limiting factor governing the lichen diversity and distribution across a broad range of habitats and microclimates. Maximum diversity was reported from the high altitude temperate sites whereas the lower subtropical sites represented least values. The densely populated Muzaffarabad city and adjoining towns represented very poor lichen diversity correlated to the intense anthropogenic disturbances, higher pollution levels as well as unsuitable geographic and climatic conditions.

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