



## Diversity of lichens on commonly cultivated trees of Kashmir Valley

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### ABSTRACT

*The paper presents occurrence of 21 corticolous lichen species belonging to 8 families and 15 genera on the commonly cultivated trees of Kashmir valley. These lichen taxa fall under different growth forms; 12 species are foliose, 7 crustose and one each of leprose and fruticose growth form. Members of family Physciaceae are dominant colonizers followed by Lecanoraceae and only one lichen species from family Ramalinaceae inhabit the commonly cultivated trees.*

**Key words:** Diversity, Kashmir valley, Lichen,

### I.INTRODUCTION

By definition, lichens are composed of two or more unrelated obligate symbionts, with taxonomy based on the fungal partner. They are unique and important components of diverse terrestrial ecosystems world-wide and contribute to biogeochemical cycling, biomass production, pollutant sequestration, decomposition and soil formation [1].

The lichens are grouped on the basis of substratum they grow upon such as, corticolous lichens (lichens growing on tree trunks and bark), lignicolous (lichens growing on dead wood), ramicolous (lichens inhabiting twigs), terricolous (lichens growing on soil), humicolous (lichens growing on humus), saxicolous (lichens growing on rocks, boulders and bricks) and foliicolous (lichens growing on evergreen leaves) [2]. Based on morphology, lichens are classified as leprose (powdery), crustose (crust like), foliose (Leaf like) and fruticose (having shrubby appearance) [3].

Lichens, in general, and corticolous lichens, in particular, are most important from an ecological view point because they do not possess roots and cuticle; do not shed their organs; their primary source of most elements is the air and, therefore, elemental composition of such lichens often reflects the composition of the ambient air. Consequently, environmental studies on lichens have demonstrated their feasibility as effective biomonitors of atmospheric quality, particularly in urban polluted areas [4].



In addition to their ecological importance, lichens are also economically important. They are used in traditional or folk medicine [5][6]. Some of the lichens have shown inhibitory effects on HIV under *in-vitro* conditions [7]. Besides these, many lichen species possess antioxidant properties [8]. In the recent past, new compounds showing promise in treatment of some diseases, UVB protection and antifreeze proteins have been discovered from lichens [9].

Given this tremendous potential of lichens, many studies related to lichens have been carried out in different parts of India, including Jammu and Kashmir. In last century the State of Jammu and Kashmir was well surveyed for collection of higher plants, particularly angiosperms, however, lichens have received little attention [10]. Cursory collection of lichens in the State was initiated during thirties of the last century by Kashyap and specimens were subsequently identified and published [11]. Recently, workers like [12], Piyodarshani (2006); Sheikh *et al* (2006); Haq *et al.* (2013) have also reported lichens from the different regions of the state [13][14][15]. However, no exhaustive exploration for the collection and identification of lichen species has been done so far. Moreover, increasing urbanization in the State has drastic effects on vegetation in general, and on lichen species, in particular. It is in this context that the present study was undertaken to explore the lichen flora of commonly cultivated trees like *Aesculus indica*, *Ailanthus altissima*, *Celtis australis*, *Juglans regia*, *Morus* spp., *Populus* spp., *Robinia pseudoacacia*, *Salix* spp. and *Ulmus villosa*.

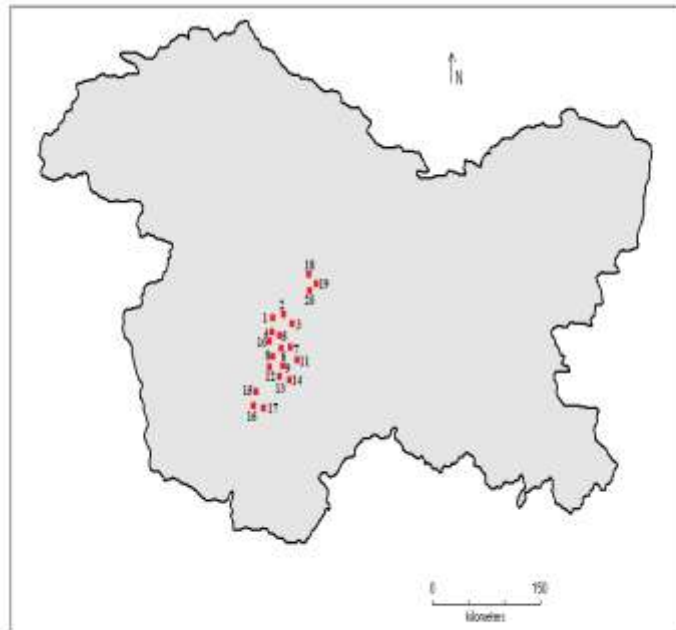
## II. MATERIALS AND METHODS:

### 2.1. Study area

The Kashmir Valley, called as '*the paradise on earth*', is a beautiful valley enclosed in a magnificent amphitheater of mountains. It extends between latitudes 33° 20' N to 34° 54' N and longitudes 73° 55' E to 75° 35' E, covering an area of 15,948 km<sup>2</sup>.

Kashmir valley is an integral, but geologically younger, part of the main Himalayan range. Politically, it is an important province of the Jammu and Kashmir State, accommodating much of its population and economic activity. The valley is an asymmetrical fertile basin, stretching from south-east to north-westerly direction. Its diagonal length (from SE to SW corner) is 187 km, while the breadth varies considerably, being 115.6 km along the latitude of Srinagar. The altitude of the floor of valley at Srinagar is 1600 m, and the highest peak among its surrounding mountains is that of the Kolahoi (5,420 masl).

Ten sites each in urban and rural areas were selected for the present study. The urban sites were Khanyar, Gulshan Nagar, Bemina, Soura, Rajbagh, Rawalpura, Lasjan, Dalgate, Shalteng, Zadibal while as the rural sites were Dara, Wanihama, Khimber, Syedpora, Ganiwan, Cheriwan, Thoun, Rajpora, Rohmoo, Letter and are depicted in Fig.1.



**Fig.1 Map showing study sites**

1. Khanyar,, 2.Gulshan Nagar, 3.Bemina, 4.Soura, 5.Rajbagh, 6. Rawalpora, 7. Lasjan, 8.Dalgate, 9.Shalteng, 10.Zadibal 11.Dara, 12.Wanihama, 13.Khimber, 14. Syedpora, 15. Ganiwan, 16. Cheriwan, 17.Thoun, 18. Rajpora, 19. Rohmoo, 20. Letter.

## **2.2. Lichen collection and Identification**

More than 200 lichen specimens were collected from commonly cultivated trees in the study site and were processed and examined according to the standard lichenological procedures. The lichen specimens were identified at Lichenology Laboratory, National Botanical Research Institute, Lucknow, Uttar Pradesh, India. Samples were morphoanatomically examined under stereomicroscope-Leica S8 and Leicca DM 500. Spot tests, UV light and Thin Layer Chromatography were utilized for the study of lichen chemistry [16]. Identification was done using relevant keys and monographs [17]. Quadrats of 25X25 cm<sup>2</sup> were laid on each tree through all the aspects to generate data for frequency, density and abundance. Standard formulae were used to calculate frequency, density and abundance. The authenticated specimens were deposited at the KASH herbarium of the Department of Botany, University of Kashmir, Srinagar, India and LWG (NBRI) Lucknow.

### III.RESULTS AND CONCLUSION

The present study revealed the occurrence of 21 corticolous lichen species with different growth forms viz 12 foliose, 7 crustose and one each of leprose and fruticose belonging to 8 families and 15 genera on the commonly cultivated trees of Kashmir valley. Members of family Physciaceae are dominant colonizers followed by Lecanoraceae and only one lichen species from family Ramalinaceae inhabit the commonly cultivated trees in the study sites. *Candelaria concolor*, *Lepraria lobificans*, *Melanelixia glabra*, *Melanelixia subargentifera*, *Phaeophyscia ciliata*, *Phaeophyscia orbicularis* *Physcia aipolia*, *Physcia tribacoides*, *Physconia distorta* and *Punctelia subrudecta* inhabit all the studied tree species. *Rinodina sophodes* occur only on the *Juglans regia*. *Lecanora achroa*, *L. allophana*, *L. japonica* and *L. interjecta* did not occur on *Robinia pseudoacacia*, *Salix spp* and *Ulmus villosa*. *Bacidia milligrana* and *Buellia disciformis* do not colonize *Robinia pseudoacacia*. *Ramalina sinensis* does not occur on *Juglans regia*, *Morus spp.* and *Ulmus villosa*.

Ecological characteristics like frequency, density and abundance of all the recorded lichen species were calculated on nine different phorophytes (*Aesculus indica* (Colebr. Ex. Cambess) Hook., *Ailanthus altissima* (Mill.) Swingle, *Celtis australis* Linn., *Juglans regia* Linn., *Morus spp.*, *Populus spp.*, *Robinia pseudoacacia* Linn., *Salix spp.*, *Ulmus villosa* Planchon. It was observed that frequency of corticolous lichen species ranged from 5% to 63%. *Ramalina sinensis* showed the minimum frequency of 5% on *Populus spp.* while as the maximum frequency of 63% were recorded for *Candelaria concolor* on *Robinia pseudoacacia*. The highest density (2.73 per 25 cm<sup>2</sup>) was recorded on *Ulmus villosa* for *Xanthoria parietina* and the lowest value of 0.05 per 25 cm<sup>2</sup> was observed for *Ramalina sinensis* on the phorophyte *Populus spp.* Present study also revealed that the abundance of different lichen species ranged between 1.01 to 5.08. The maximum abundance of 5.08 per 25 cm<sup>2</sup> was recorded for *Candelaria concolor* on *Robinia pseudoacacia*. However, the lichen species *Lecanora interjecta* showed minimum abundance of 1.01 per 25 cm<sup>2</sup> on *Celtis australis*. The data for all the recorded species are depicted in Tables 2, 3, and 4.

*Xanthoria parietina* shows relatively higher frequency, density and abundance for all the study sites. This is presumably due to its nitrophilic nature and tolerance to air pollution. The present study also brought to light that *Juglans regia* and *Ailanthus altissima* are suitable phorophyte for colonization of crustose and foliose lichens, respectively. During the present study it was observed that fruticose lichens were absent from the urbanized study sites. It is due to pollution in urban areas, because fruticose lichens are most sensitive to air pollution. The present study will act as baseline for future biomonitoring studies utilizing lichens as tools.

Lichen taxa	Growth Form	Family	Phorophyte								
			<i>Aesculus indica</i>	<i>Ailanthus altissima</i>	<i>Celtis australis</i>	<i>Juglans regia</i>	<i>Morus</i> spp.	<i>Populus</i> spp.	<i>Robinia pseudoacacia</i>	<i>Salix</i> spp.	<i>Ulmus villosa</i>
<i>Bacidia millegrana</i>	Crustose	Bacidiaceae	+	+	+	+	+	+	-	+	+
<i>Buellia disciformis</i>	Crustose	Physciaceae	+	+	+	+	+	+	-	-	+
<i>Candelaria concolor</i>	Foliose	Candelariaceae	+	+	+	+	+	+	+	+	+
<i>Lecanora achroa</i>	Crustose	Lecanoraceae	+	+	+	+	+	+	-	-	-
<i>Lecanora allophana</i>	Crustose	Lecanoraceae	+	+	+	+	+	+	-	-	-
<i>Lecanora interjecta</i>	Crustose	Lecanoraceae	+	+	+	+	+	+	-	-	-
<i>Lecanora japonica</i>	Crustose	Lecanoraceae	+	+	+	+	+	+	-	-	-
<i>Lepraria lobificans</i>	Leprose	Stereocaulaceae	+	+	+	+	+	+	+	+	+
<i>Melanelixia glabra</i>	Foliose	Parmeliaceae	+	+	+	+	+	+	+	+	+
<i>Melanelixia subargentifera</i>	Foliose	Parmeliaceae	+	+	+	+	+	+	+	+	+
<i>Parmelina tiliacea</i>	Foliose	Parmeliaceae	+	+	+	+	+	+	+	+	-
<i>Phaeophyscia ciliata</i>	Foliose	Physciaceae	+	+	+	+	+	+	+	+	+
<i>Phaeophyscia orbicularis</i>	Foliose	Physciaceae	+	+	+	+	+	+	+	+	+
<i>Physcia aipolia</i>	Foliose	Physciaceae	+	+	+	+	+	+	+	+	+
<i>Physcia tribacoides</i>	Foliose	Physciaceae	+	+	+	+	+	+	+	+	+
<i>Physconia distorta</i>	Foliose	Physciaceae	+	+	+	+	+	+	+	+	+
<i>Punctelia subrudecta</i>	Foliose	Parmeliaceae	+	+	+	+	+	+	+	+	+
<i>Ramalina sinensis</i>	Fruticose	Ramalinaceae	+	+	+	-	-	+	+	+	-
<i>Rinodina sophodes</i>	Crustose	Physciaceae	-	-	-	+	-	-	-	-	-
<i>Xanthoria candelaria</i>	Foliose	Telochistaceae	+	+	+	+	+	+	+	+	+
<i>Xanthoria parietina</i>	Foliose	Telochistaceae	+	+	+	+	+	+	+	+	+

Table-1 Occurrence of lichen species on commonly cultivated trees.

**Table 2: Frequency (%) of lichen species on commonly cultivated trees.**

Lichen taxa	Phorophyte								
	<i>Aesculus indica</i>	<i>Ailanthus altissima</i>	<i>Celtis australis</i>	<i>Juglans regia</i>	<i>Morus</i> spp.	<i>Populus</i> spp.	<i>Robinia pseudoacacia</i>	<i>Salix</i> spp.	<i>Ulmus villosa</i>
<i>Bacidia millegrana</i>	35	25	45	29	<b>47</b>	18	-	24	19
<i>Buellia disciformis</i>	45	25	46	<b>49</b>	40	4	-	-	11
<i>Candelaria concolor</i>	37	49	40	37	32	53	<b>64</b>	48	46
<i>Lecanora achroa</i>	53	34	42	<b>54</b>	38	11	-	-	-
<i>Lecanora allophana</i>	48	45	39	<b>59</b>	51	13	-	-	-
<i>Lecanora interjecta</i>	25	37	34	<b>52</b>	52	5	-	-	-
<i>Lecanora japonica</i>	44	30	38	<b>58</b>	39	19	-	-	-
<i>Lepraria lobificans</i>	38	34	43	38	<b>45</b>	12	25	26	17
<i>Melanelixia glabra</i>	41	<b>60</b>	31	36	29	23	21	31	20
<i>Melanelixia subargentifera</i>	39	<b>58</b>	30	31	38	19	16	27	16
<i>Parmelina tiliacea</i>	39	45	40	<b>46</b>	32	40	23	37	-
<i>Phaeophyscia ciliata</i>	44	39	<b>55</b>	37	49	40	40	8	28
<i>Phaeophyscia orbicularis</i>	32	<b>53</b>	48	49	43	47	45	23	40
<i>Physcia aipolia</i>	39	<b>70</b>	34	40	50	43	17	38	25
<i>Physcia tribacoides</i>	12.	24	11	<b>35</b>	24	33	14	31	10
<i>Physconia distorta</i>	32	<b>40</b>	26	25	30	32	9	25	20
<i>Punctelia subrudecta</i>	29	<b>54</b>	23	28	15	33	17	22	17
<i>Ramalina sinensis</i>	13	<b>22</b>	18	-	-	5	15	13	-
<i>Rinodina sophodes</i>	-	-	-	<b>47</b>	-	-	-	-	-
<i>Xanthoria candelaria</i>	28	37	33	<b>55</b>	13	35	46	38	31
<i>Xanthoria parietina</i>	48	58	50	46	28	52	45	40	<b>62</b>

Table 3: Density (per 25cm<sup>2</sup>) of lichen species on commonly cultivated trees.

Lichen taxa	Phorophyte								
	<i>Aesculus indica</i>	<i>Ailanthus altissima</i>	<i>Celtis australis</i>	<i>Juglans regia</i>	<i>Morus spp.</i>	<i>Populus spp.</i>	<i>Robinia pseudoacacia</i>	<i>Salix spp.</i>	<i>Ulmus villosa</i>
<i>Bacidia millegrana</i>	0.51	0.27	0.55	0.47	<b>0.56</b>	0.22	-	0.29	0.21
<i>Buellia disciformis</i>	0.55	0.26	0.44	<b>0.77</b>	0.45	0.09	-	-	0.13
<i>Candelaria concolor</i>	0.95	0.82	1.04	0.94	0.91	2.00	<b>2.32</b>	1.48	2.30
<i>Lecanora achroa</i>	0.89	0.45	0.52	<b>1.00</b>	0.63	0.11	-	-	-
<i>Lecanora allophana</i>	0.69	0.54	0.45	<b>0.95</b>	0.44	0.14	-	-	-
<i>Lecanora interjecta</i>	0.55	0.40	0.34	<b>0.69</b>	0.61	0.04	-	-	-
<i>Lecanora japonica</i>	0.60	0.51	0.47	<b>0.71</b>	0.63	0.21	-	-	-
<i>Lepraria lobificans</i>	0.57	0.41	0.52	0.61	<b>0.84</b>	0.22	0.31	0.30	0.22
<i>Melanelixia glabra</i>	0.52	<b>0.95</b>	0.39	0.55	0.57	0.29	0.30	0.38	0.27
<i>Melanelixia subargentifera</i>	0.52	<b>0.87</b>	0.35	0.45	0.66	0.24	0.23	0.32	0.21
<i>Parmelina tiliacea</i>	0.47	<b>0.75</b>	0.43	0.63	0.33	0.56	0.36	0.44	-
<i>Phaeophyscia ciliata</i>	0.64	0.97	<b>1.05</b>	0.68	0.97	0.67	0.81	0.09	0.73
<i>Phaeophyscia orbicularis</i>	0.42	0.61	<b>0.84</b>	0.75	0.60	0.70	0.61	0.44	0.48
<i>Physcia aipolia</i>	0.53	<b>0.91</b>	0.48	0.60	0.70	0.70	0.26	0.52	0.34
<i>Physcia tribacoides</i>	0.16	0.27	0.15	<b>0.60</b>	0.27	0.42	0.18	0.47	0.14
<i>Physconia distorta</i>	0.52	<b>0.57</b>	0.49	0.44	0.50	0.51	0.17	0.35	0.38
<i>Punctelia subrudecta</i>	0.44	<b>0.73</b>	0.31	0.44	0.27	0.51	0.25	0.30	0.25
<i>Ramalina sinensis</i>	0.17	<b>0.32</b>	0.25	-	-	0.05	0.16	0.15	-
<i>Rinodina sophodes</i>	-	-	-	<b>1.2</b>	-	-	-	-	-
<i>Xanthoria candelaria</i>	0.57	0.58	0.60	0.80	0.27	0.70	<b>0.87</b>	0.76	0.65
<i>Xanthoria parietina</i>	1.02	1.15	1.54	0.52	1.08	1.42	0.93	1.67	<b>2.73</b>

Table 4: Abundance (per 25 cm<sup>2</sup>) of lichen species on commonly cultivated trees.

Lichen taxa	Phorophyte								
	<i>Aesculus indica</i>	<i>Ailanthus altissima</i>	<i>Celtis australis</i>	<i>Juglans regia</i>	<i>Morus</i> spp.	<i>Populus</i> spp.	<i>Robinia pseudoacacia</i>	<i>Salix</i> spp.	<i>Ulmus villosa</i>
<i>Bacidia millegrana</i>	1.45	1.11	1.23	<b>1.64</b>	1.20	1.18	-	1.04	1.15
<i>Buellia disciformis</i>	1.22	1.06	1.11	<b>1.77</b>	1.11	1.25	-	-	1.22
<i>Candelaria concolor</i>	2.57	1.68	2.82	2.55	2.83	3.78	<b>5.08</b>	3.09	3.60
<i>Lecanora achroa</i>	1.69	1.35	1.23	<b>1.90</b>	1.67	1.19	-	-	-
<i>Lecanora allophana</i>	1.45	1.20	1.16	<b>1.62</b>	1.18	1.13	-	-	-
<i>Lecanora interjecta</i>	<b>2.18</b>	1.09	1.01	1.34	1.18	1.08	-	-	-
<i>Lecanora japonica</i>	1.16	<b>1.74</b>	1.23	1.53	1.64	1.13	-	-	-
<i>Lepraria lobificans</i>	1.51	1.22	1.22	1.62	<b>1.89</b>	1.87	1.27	1.17	1.31
<i>Melanelixia glabra</i>	1.26	<b>1.63</b>	1.25	1.54	1.38	1.27	1.46	1.22	1.37
<i>Melanelixia subargentifera</i>	1.34	<b>1.56</b>	1.16	1.47	1.24	1.28	1.36	1.21	1.47
<i>Parmelina tiliacea</i>	1.21	<b>1.66</b>	1.07	1.36	1.50	1.40	1.55	1.21	-
<i>Phaeophyscia ciliata</i>	1.09	1.96	1.94	1.86	1.96	1.67	2.04	1.22	<b>2.62</b>
<i>Phaeophyscia orbicularis</i>	1.33	1.15	<b>1.74</b>	1.53	1.41	1.51	1.38	1.64	1.20
<i>Physcia aipolia</i>	1.39	1.30	1.44	1.53	1.40	<b>1.63</b>	1.53	1.41	1.38
<i>Physcia tribacoides</i>	1.32	1.12	1.26	<b>1.72</b>	1.13	1.29	1.32	1.52	1.15
<i>Physconia distorta</i>	1.62	1.41	1.90	1.76	1.66	1.61	<b>2.00</b>	1.45	1.97
<i>Punctelia subrudecta</i>	1.53	1.37	1.38	1.62	<b>1.80</b>	1.58	1.55	1.38	1.52
<i>Ramalina sinensis</i>	1.31	<b>1.50</b>	1.39	-	-	1.08	1.09	1.26	-
<i>Rinodina sophodes</i>	-	-	-	<b>2.57</b>	-	-	-	-	-
<i>Xanthoria candelaria</i>	2.01	1.57	1.85	2.28	2.02	2.04	<b>2.32</b>	2.00	2.10
<i>Xanthoria parietina</i>	2.11	1.97	3.05	1.42	3.89	2.75	2.10	4.19	<b>4.41</b>



Photoplates

Plate-1


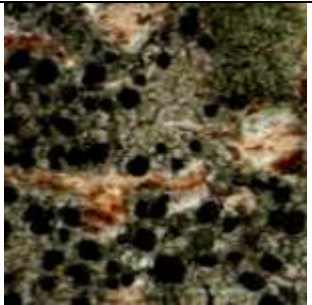

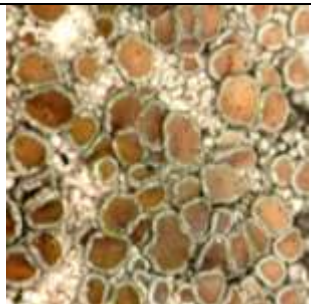
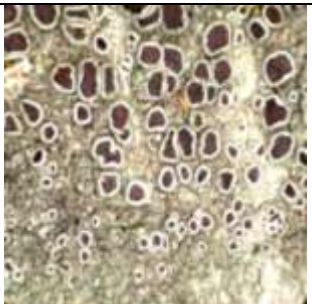


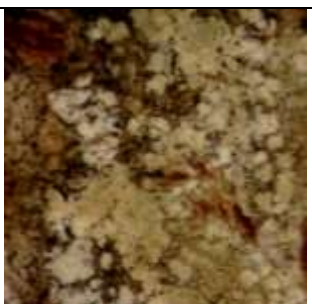







		
<i>Bacidia millegrana</i>	<i>Buellia disciformis</i>	<i>Candelaria concolor</i>
		
<i>Lecanora achroa</i>	<i>Lecanora allophana</i>	<i>Lecanora interjecta</i>
		
<i>Lecanora japonica</i>	<i>Lepraria lobificans</i>	<i>Melanelixia glabra</i>
		
<i>Melanelixia subargentifera</i>	<i>Parmelina tiliacea</i>	<i>Phaeophyscia ciliata</i>

Plate-2

		
<p><i>Phaeophyscia orbicularis</i></p>	<p><i>Punctelia subrudecta</i></p>	<p><i>Physcia aipolia</i></p>
		
<p><i>Physconia distorta</i></p>	<p><i>Punctelia subrudecta</i></p>	<p><i>Ramalina sinensis</i></p>
		
<p><i>Rinodina sophodes</i></p>	<p><i>Xanthoria candelaria</i></p>	<p><i>Xanthoria parietina</i></p>



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