

DIVERSITY AND DISTRIBUTION OF LICHENS IN KATARNIAGHAT WILDLIFE SANCTUARY, UTTAR PRADESH

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The lichens of Katarniaghat Wildlife Sanctuary, Uttar Pradesh are studied for the first time. The survey in 11 localities resulted in 42 species with dominance of crustose and epiphytic lichens. The sanctuary has luxuriant growth of graphidaceous and pyrenocarpous lichens. The most dominant genera are *Pyrenula* and *Graphis* with 5 species each and the most common lichen species in the sanctuary are *Dirinaria consimilis*, *Graphis subasahinae*, *Letroitia transgressa* and *Pyrenula subacutalis*. The present study added a total of 33 species to the lichen flora of Uttar Pradesh. *Parmotrema mesotropum*, *P. praesorediosums* and *P. saccatilobum* are the only parmelioid lichens known from the sanctuary can be considered as indicators of healthy, moist and shady environment of the sanctuary. Lichen diversity in different forest sites is discussed and lichen rich sites are identified for conservation. Although Katarniaghat is heavily influenced by anthropogenic activities, it appears that lichen flora of the sanctuary is less affected.

Key words: Conservation, Ecology, Flora, India, Protected area.

The lichens are considered as excellent indicators of microclimatic changes in the environment and air pollution, and are widely used as biomonitors. There are about 20,000 species of lichens distributed throughout the world and Indian subcontinent is represented by 2,450 species (Awasthi 2000). Before the creation of new state Uttarakhand, Uttar Pradesh was represented by about 470 species of lichens (unpublished). Uttar Pradesh is now left with only 55 species, while most of the lichen rich sites are located in Uttaranchal. The record of 55 lichen species in the state is a poor estimate and based on the extensive collection from Lucknow district (Saxena 2004) and cursory collections from other localities in the state. Out of 71 districts in Uttar Pradesh with forest cover of 7.05%, except for the few localities in the east and north side of the state most of the areas are still remaining unexplored, which also includes eight important wildlife

sanctuaries. In the present study an hitherto unexplored protected area, Katarniaghat Wildlife Sanctuary is selected to study its lichen diversity.

Katarniaghat Wildlife Sanctuary though established in the year 1976, it is more popularized only in the recent years for both scientific as well as tourist activities. Situated in Tarai region of Indo-Nepal border in Baharaich district it is the only place in India where the endangered vultures found breeding under natural conditions (Anonymous 2005). Panigrahi *et al.* (1969) reported a total of 530 species of angiosperms and 14 species of Pteridophytes from Tarai forests of Baharaich district, of which 34 species were listed from Katarniaghat. According to the 'work plan' of Katarniaghat Wildlife Division (Tiwari *et al.* 2005) the sanctuary host a total of 236 angiosperms, 4 fungi, 42 mammals, 274 birds, 29 reptiles, 4 amphibians and 23 fishes.

However, the 'work plan' lacks the information on cryptogams such as lichens, pteridophytes, bryophytes and algae. This indicates that either cryptogamic studies in the sanctuary are rare or not at all being undertaken.

MATERIALS AND METHODS

A total of 11 sites in Katarniaghat Wildlife Sanctuary were surveyed for lichens (Fig. 1). The various lichens habitats, forest types and phorophytes are recorded. Lichens were identified by studying their external and internal morphology and following Awasthi (1988, 1991, 2007), Frisch (2006), Lücking & Kalb (2000), Nayaka (2005), Staiger (2002), Upreti (1998), Wetmore (2004). The lichen substances were studied following Orange et al. (2001). The lichen classification outline by Lumbsch and Huhndorf (2007) is followed for segregation of taxa. The identified lichens are listed and some qualitative analyses were carried out.

RESULT

The survey of lichens in 11 localities of the Katarniaghat Wildlife Sanctuary resulted in identification of 42 species of lichens belonging to 25 genera, 15 families (Table I) and 33 new additions to the lichen flora of Uttar Pradesh. The sanctuary is dominated by crustose lichens with 34 species while foliose lichens are represented by 8 species only. The most dominant families in the sanctuary are Graphidaceae with 9 species under 4 genera, followed by Physciaceae with 7 species under 6 genera. Similarly, the most dominant genera are *Pyrenula* and *Graphis* with 5 species each.

The most common lichens in the sanctuary are *Dirinaria consimilis*, *Graphis subasahinae*, *Letrouitia transgressa* and *Pyrenula subacutalis*. Except for the saxicolous *Caloplaca holocarpa* and *Endocarpon nanum* all other species recorded are epiphytic. Further, the study encountered several sterile lichens belonging to genera

Cryptothecia and *Lepraria*.

DISCUSSION

Lichen diversity vs. vegetation: The major vegetation in Katarniaghat Wildlife Sanctuary comprises of *Tectona grandis*, *Eucalyptus*, sal or *Shorea robusta* and mixed forests. The mixed forest includes some important trees such as *Acacia catechu*, *Adenia cordifolia*, *Bombax ceiba*, *Dalbergia sissoo*, *Grewia nudiflora*, *Holoptelea integrifolia*, *Murraya koenigii*, *Syzygium cuminii*, *Terminalia alata* and *T. bellirica*.

Tectona grandis and *Eucalyptus* forest in Katarniaghat did not host any lichen species. The lichens requires stable substratum for their establishment and growth. The exfoliating nature of *Eucalyptus* and *Tectona* bark do not support the growth of lichens. The mixed tropical evergreen forest in core zone (Katarniaghat area), Bichhiya, Bardiya, near Shree Mote Baba temple and Motipur has a shady and moist habitat and a total of 31 lichen species found growing luxuriantly. *Syzygium cuminii* is one of the important trees in the mixed forest hosting several lichens such as *Caloplaca bassiae*, *Dirinaria consimilis*, *Graphis subasahinae*, *Pyrenula comirana*, *Pyxine cocoes* and *Letrouitia transgressa*. Mixed forest also has numerous smooth barked trees as it is evident from the luxuriant growth of graphidaceous and pyrenocarpous (*Pyrenula*) lichens which prefer such substratum.

Sal (*Shorea robusta*) forest at Nishangarha provides a unique environment for the growth of lichens with its humid and shady environment. In one of our earlier study (Satya et al. 2005) *Shorea robusta* tree found hosting as many as 64 lichens. The variation in bark nature of mature tree at different heights is found be one of the major reasons for such luxuriant growth of lichen. In the present study several lichen species such as *Bacidia millegrana*, *Buellia almorensis*, *Dirinaria*

aegilata, *Lecanora* sp., *Maronea constans* and *Parmotrema praesorediosum* found exclusively growing in this forest. The fallen twigs are found covered with lichens, which indicates that the tree canopy has unique lichen flora represented by *Buellia almorenis*, *Lecanora* sp., *L. interjecta* and *Parmotrema praesorediosum*.

Some cultivated trees around Girijapuri PWD Inspection Bungalow such as *Mangifera indica* supported good growth of *Dirinaria consimilis* and some sterile lichens belonging to genus *Cryptothecia* while *Pyrenula subglabriuscula* found growing luxuriantly on *Emblica officinalis* covering the whole tree with dark brown colouration of the thallus. The other smooth barked of the tree near the bungalow also supported growth of *Pyrenula subacutalis* and *Graphis* cfr. *striatula*. A foliose lichen *Physcia dimidiata*, which is rare in the Sanctuary and found growing only in the bungalow campus. Abundant growth of *Pyxine cokes* along with scanty *Chrysothrix chlorina* was recorded on two trees of *Bombax ceiba* near lake towards Girijapuri Barrage from Bichhiya. Primarily rock inhabiting lichens *Caloplaca lithophila* (= *C. vitellinula*) and *Endocarpon nanum* are found growing on the cement plaster of Girijapuri barrage.

Lichens of Katarniaghat WLS vs. near by protected areas: Lichen flora of the Katarniaghat WLS is compared with Corbett Tiger Reserve (CTR) (Upreti and Nayaka 2004) from which a total of 108 species were recorded. Both the areas were dominated by crustose lichens with exactly same proportions (81%). Both the protected areas have luxuriant growth of graphidaceous and pyrenocarpous lichens. The common lichen species between the two localities include; *Bacidia alutaceae*, *B. millegrana*, *Caloplaca bassiae*, *Chrysothrix candelaris*, *Dirinaria aegialita*, *D. consimilis*, *Graphis nigroglaucata*, *G. subasahinae*, *Parmotrema mesotropum*, *P. praesorediosum*, *P. saccatibulum*, *Pertusaria quassiae* and

Pyrenula brunnea. The high diversity of lichens in CTR may be attributed to the larger area of the reserve with variety of substratum and altitudinal gradient available for the growth of lichens. Whereas, the Katarniaghat is only 400 sq km and the altitude is about 120 m and lacks rocky substratum.

In another study conducted in Achanakmar Wildlife Sanctuary, Chhattisgarh, 32 lichens were reported of which 30 were belonging to crustose group (Nayaka *et al.* 2007). Achanakmar is also situated in lower altitude but differ from Katarniaghat by having much drier deciduous forest. Out of 32 lichen species in Achanakmar only 24 were epiphytic, 7 were saxicolous and one foliicolous, where as 40 lichens in Katarniaghat are epiphytic and only 2 were saxicolous. This clearly indicates the better conducive environment of tropical semi-evergreen and moist deciduous forest present in Katarniaghat.

Lichen rich sites Katarniaghat Wildlife Sanctuary: The mixed forest and *Shorea robusta* forest exhibited conducive environment for lichen growth. The forest near Shree Mote Baba Shree Raghuvar Das Baba temple, 10 km away from Bichhiya towards Mahinpurwa is found to be richest in lichen diversity with 15 species. It is followed by Bichhiya village near to the core zone of the sanctuary with 14 species. Nishangarha with *Shorea robusta* forest is the other lichen rich site in Katarniaghat with 11 species.

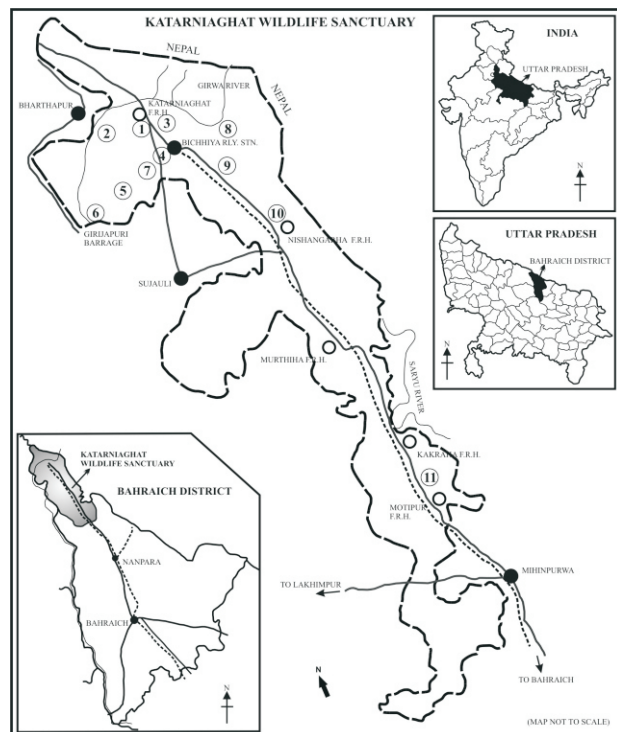
Indicator lichens of Katarniaghat Wildlife Sanctuary: It is a well-known fact that lichens are very sensitive to microclimatic conditions and air pollution. The luxuriant growth of the lichens depends on the several ecological factors such as altitudinal variation, temperature, humidity, shade, substratum availability and anthropogenic activity. Due to the lower altitude and tropical climate fruticose lichens are absent in Katarniaghat and very few foliose lichens are present. By observing the various ecological conditions of the forests,

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| 24. <i>*Letrouitia transgressa</i> (Malme) Haf. & Bellem | Letrouitiaceae | C | - | + | - | + | - | - | - | + | + | + | + |
| 25. <i>*Malcolmiella granifera</i> (Ach.) Kalb & Lücking | Pilocarpaceae | C | - | + | - | + | - | - | - | - | + | - | + |
| 26. <i>Maronea constans</i> (Nyl.) Hepp | Fuscideaceae | C | - | - | - | - | - | - | - | - | - | + | - |
| 27. <i>*Opegrapha cfr. heterospora</i> Vainio | Rocellaceae | C | - | - | - | - | - | - | - | - | - | - | + |
| 28. <i>*O. subvulgata</i> Nyl. | Rocellaceae | C | + | - | - | - | - | - | - | - | - | - | - |
| 29. <i>*Parmotrema mesotropum</i> (Müll. Arg.) Hale | Parmeliaceae | F | - | - | - | - | - | - | - | - | + | - | - |
| 30. <i>*P. praesorediosum</i> (Nyl.) Hale | Parmeliaceae | F | - | - | - | - | - | - | - | - | - | + | - |
| 31. <i>*P. saccatilobum</i> (Taylor) Hale | Parmeliaceae | F | - | - | - | - | - | - | - | - | + | - | - |
| 32. <i>*Pertusaria quassiae</i> (Fée) Nyl. | Pertusariaceae | C | - | - | - | + | - | - | - | - | + | - | + |
| 33. <i>Phaeographis</i> sp. | Graphidaceae | C | + | - | - | - | - | - | - | - | - | - | - |
| 34. <i>*Physcia dimidiata</i> (Arn.) Nyl. | Physciaceae | F | - | - | - | - | - | + | - | - | - | - | - |
| 35. <i>*Pyrenula brunnea</i> Fée | Pyrenulaceae | C | - | - | - | - | - | - | + | - | - | - | - |
| 36. <i>*P. comirana</i> Vainio | Pyrenulaceae | C | - | + | + | + | - | - | - | - | + | - | - |
| 37. <i>*P. mamillna</i> (Ach.) Trevisan | Pyrenulaceae | C | - | - | - | - | - | - | - | - | - | - | + |
| 38. <i>*P. subacutalis</i> Upreti | Pyrenulaceae | C | + | + | - | + | - | - | + | - | + | - | - |
| 39. <i>*P. subglabriuscula</i> Vainio | Pyrenulaceae | C | - | - | - | + | - | - | + | - | + | + | - |
| 40. <i>Pyxine cocoes</i> (Swartz) Nyl. | Physciaceae | F | - | - | + | - | + | - | - | - | - | - | - |
| 41. <i>*Thelotrema alborosellum</i> (Nyl.) Tuck | Thelotremataceae | C | - | - | - | - | - | - | - | + | - | - | - |
| 42. <i>*Thelotrema pachysporum</i> Nyl. | Thelotremataceae | C | - | - | - | + | - | - | - | - | - | - | - |

among the existing lichens flora of sanctuary, *Parmotrema mesotropum*, *P. praesorediosums* and *P. saccatilobum* can be considered as indicators of healthy, moist and shady environment. These three parmelioid taxa are more frequent and found in lichen rich sites near Mote baba temple and Nishangarha. They can be used as reference species for future monitoring of microclimatic conditions in these forests.

Anthropogenic activity and lichens in Katarniaghat Wildlife Sanctuary: Katarniaghat being situated near the capital of the state, it is an easily approachable recreational place for people. Hundreds of tourists visit the sanctuary every year. Apart

from them researchers are the other groups of people who regularly visit the sanctuary. The roads, which passes through the sanctuary links important place like Bahraich, Lakhimpur, Bharatpur, Nepal and hence vehicular activity is common in the sanctuary. The narrow railway track that ends in Katarniaghat is indeed causes noise and air pollution in the sanctuary. The sanctuary has few villages and their residents are involved in agriculture or dependents on minor forest products. Using lichen for any commercial or traditional purpose by the inhabitants of the sanctuary has not been observed in the present study. In spite of such anthropogenic activity, Katarniaghat is one of the well-managed protected areas of the



Legend for the figure:

Figs. 1. Map of Katarniaghat Wildlife Sanctuary showing sites surveyed for lichen study (1. around Katarniaghat Forest Rest House, 2. 5 km left of Girwa river ghat, forest band, 3. 1 km away from Katarniaghat Forest Rest House towards ghat, water locked area, 4. near Bichhiya village, 5. on the way to Girijapuri barrage, 6. Girijapuri barrage, 7. around Girijapuri PWD inspection bungalow, 8. Bardiya, 3 km away from Bichhiya, near BSF camp, 9. near Jai Shree Mote Baba Jai Shree Raghuvir Das Baba mandir, 10. Nishangarha, near check post, 11. Motipur)

country.

Conclusion

It is interesting to note that the present study added a total of 33 species to the lichen flora of Uttar Pradesh (marked * in table 1), and now the total number of lichen occurring in the state is 88 species. This clearly indicates the need for extensive lichen study in the whole state, especially in forested and protected area. The complete exploration of lichens in the Uttar Pradesh state will certainly add many more lichens, increasing the final count in the list to at least 250 species.

Katarniaghat Wildlife Sanctuary

although has a smaller area and mediocre in lichen diversity but it possesses an interesting lichen flora dominated by crustose lichens mostly belonging to pyrenocarpous and graphidaceous group. The lichen taxa identified up to only generic level such as *Diorygma* sp., *Lecanora* sp. and *Phaeographis* sp. appear to be either new to science or at least new records for Indian lichen flora. The tropical semi-evergreen to moist deciduous forest environment in Katarniaghat is suitable for luxuriant growth of tropical lichens when compared to such protected areas like Achanakmar Wildlife Sanctuary. Highly protected Katarniaghat Wildlife Sanctuary is a reservoir for lichens of the Gangaic plain. The present study will be baseline information for biomonitoring studies in the future. The data will be useful for forest officials and bureaucrats for preparing management plans for the sanctuary. Detailed community ecology studies may reveal the inter relation among lichens, their hosts and ecological continuity of forests in Katarniaghat. The heavy metal estimation in naturally growing lichens of the sanctuary is needed for monitoring the air quality of the sanctuary.

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