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Range extension of foliicolous lichens in India: A case study from Nandhaur Forest Range, Lakhan mandi, Haldwani, Uttarakhand, India

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ABSTRACT

Foliicolous lichens, i.e. lichens colonizing on leaves of vascular plants, are always considered as one of the best bioindicators of human disturbance and microclimatic conditions of a forest, and their occurrence in India is mainly confined to tropical regions of Eastern Himalaya and Western Ghats. During a field trip to Nandhaur Range Lakhan mandi, Haldwani, Kumaun Himalaya, the authors found leaves of Shorea robusta heavily colonized by foliicolous lichens. The identification of the collected samples revealed the occurrence of 6 species of lichens all of which are new addition to the lichen flora of Uttarakhand. The preliminary data on diversity and distribution of the foliicolous lichen will act as baseline to conduct biomonitoring studies in the area, since foliicolous lichens are considered as the best bioindicator of climate change.

1) INTRODUCTION

Lichens, a well known group of lichenized fungi are ubiquitous in nature and have the capability to colonize all the substrates either natural or manmade. On the basis of their substrate preference lichens are classified as corticolus (bark inhabiting), saxicolous (rock inhabiting), terricolous (soil inhabiting) , lichenicolous (lichen inhabiting), muscicolous (moss inhabiting) etc. Besides these common substrates there is a special and interesting group of lichens that colonize living leaves of plants [1] known as foliicolous lichens. They are one of the most abundant epiphytes in tropical rainforests [2-4] and also one of the few groups of organisms that characterize tropical rain forests [3]. Apart from tropical areas, the foliicolous lichens have been reported from subtropical areas [5-11] and temperate rainforests [12, 13], but their occurrence in these regions is limited and restricted to humid areas.

In India, foliicolous lichens have a confined distribution in Nilgiri and Palni hills, Andaman and Nicobar Islands, and Northeast India [14-17]. A large number of floristic account of lichens from different localities of the state of Uttarakhand are available but so far not a single reference on the foliicolous lichens from this region is available. The present study initiated during a field excursion to Nandhaur Range Lakhan mandi, Haldwani, Uttarakhand, with an objective to assess the diversity of lichens from that place, the authors were surprised by the presence of foliicolous lichens in foothills of Central Himalaya, indicating that they are spreading their distributional range in India. The presence of these lichens in the present study looks forward for their occurrence from other parts of Kumaun Himalaya which need to be explored out more extensively for these lichens with an aim to study the foliicolous lichens of the state.

2) MATERIAL AND METHODS

2.1 Study area

The study was carried out in Nandhaur Range Lakhan mandi, forest division of Haldwani lying at the core of Terai Arc Landscape (TAL) which falls primarily within the *bhabar* belt of Kumaun Himalaya. The forest of the study site is a mosaic vegetation community comprising of *Shorea robusta*, mixed deciduous forests along drainages and water courses, tracts of scrub forest dominated by *Dalbergia*, *Acacia* and *Zizyphus* species, with little grass in the under story (*Eulaliopsis binata*, *Thysanolaena maxima*).

2.2 Lichen Sampling

The representative lichen specimens were collected randomly from Nandhaur Range in the month of January and February, 2014. Approximately 100 leaf samples bearing various foliicolous lichen species were collected.

2.3 Lichen Identification

The identification of lichens was done on the basis of the morphology and anatomy under Olympus Stereozoom dissecting microscope (SZ2-iLST), with the help of published flora of Lücking [18] (2008) and chemical test (spot test and TLC) was performed as per Orange *et al*. [19] (2001). The samples are deposited in the herbarium of Kumaun University

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(ALM).

3) RESULTS AND DISCUSSION

As far as lichen diversity of Nandhaur range is concerned, the area encompasses mostly crustose lichens belonging to genera *Bacidia* De Not., *Buellia* De Not., *Caloplaca* Th. Fr., *Graphis* Adans., *Lecanora* Ach., *Pyrenocarpous* lichens, etc. Besides this, some foliose lichens such as *Phaeophyscia* Moberg, *Heterodermia* Trevis., *Pyxine* Fr. are also noticed. But the most important finding was the discovery of foliicolous lichens. The present study revealed the occurrence of total 06 foliicolous lichen species belonging to 05 genera and 04 families, *viz. Arthonia trilocularis* Müll. Arg., *Bapalmuia palmularis* (Müll. Arg.) Sérus., *Fellhanera bouteillei* (Desm.) Vězda, *F. semecarpi* (Vain.) Vězda, *Gyalectidium filicinum* Müll. Arg., and *Tapellaria epiphylla* (Müll. Arg.) R. Sant., from Aided Natural Regeneration (ANR) Gate II of Nandhaur Range. Among the species, *Fellhanera bouteillei* (Desm.) Vězda, *F. semecarpi* (Vain.) Vězda and *Tapellaria epiphylla* (Müll. Arg.) R. Sant., were the commonest and found colonizing entire leaf area. The most dominant lichen family in the region was Pilocarpaceae with 02 genera and 03 sub generic taxa exhibit its dominance in the region. The families Arthoniaceae, Ectolechiaceae and Gomphillaceae were represented by single genus and single species. Amongst various phorophyte only *Shorea robusta* trees showed the occurrence of foliicolous lichens. All the foliicolous lichens recorded in the present study are first record for lichen flora of Uttarakhand and are briefly described as follows:

1. *Arthonia trilocularis* Müll. Arg.: The species is characterized by pale brownish grey to yellowish brown, smooth and ecorticated thallus, with brownish black apothecia having 2-septate ascospores (Fig. 1A). The ascospores (11-19 × 4-6 µm) lying within obovate asci (17-30 × 10-18 µm) are narrowly obovate and are without constriction at septa. The hypothecium is colourless to brown, 2-4 µm high, I- to I+pale yellow. Lichen substances are absent both in thallus and apothecia.

Distribution and ecology: It is a pantropical species extending its distribution into sub-tropical and temperate regions [18]. In India, the species is previously reported from Nilgiri and Palni hills, Andaman and Nicobar Islands, and Northeast regions [20].

Specimen examined: Uttarakhand, Nainital District, Haldwani, Lakhan mandi, Nandhaur Forest Range, 06 & 07 January 2014 and 03 February 2014, on leaves of *Shorea robusta*, Shashi Upadhyay and Snadhya Shukla, *s.n.* (ALM).

2. *Bapalmuia palmularis* (Müll. Arg) Sérus.: The species is characterized by its smooth pale greenish grey to green thallus, marginally hypophyllous apothecia (0.4-1 mm diam.) (Fig. 1B) with an orange to dark reddish brown disc and hyaline, long and filiform, 25-35 septate, ascospores (70-120 × 1.5-2.5 µm). Lichen substance 4, 5-dichlorolichexanthone (coronatone) is present.

Distribution and ecology: It is a common pantropical species found in lowland rain forest understory [18]. In India, the species is previously reported from Nilgiri and Palni hills, Andaman and Nicobar Islands, and Northeast regions [20].

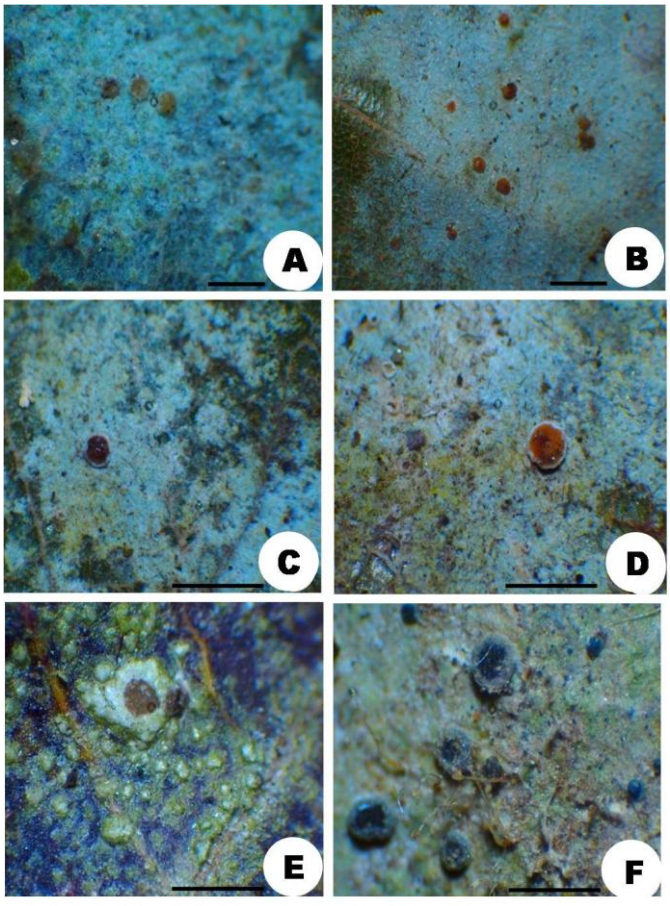
Specimen examined: Uttarakhand, Nainital District, Haldwani, Lakhan mandi, Nandhaur Forest Range, 06 & 07 January 2014 and 03 February 2014, on leaves of *Shorea robusta*, Shashi Upadhyay and Snadhya Shukla, *s.n.* (ALM).

3. *Fellhanera bouteillei* (Desm.) Vězda: The species is characterized by its farinose to strongly granulose, pale bluish grey thallus and yellow to orange, rounded to irregular, 0.2-0.4 mm diam. apothecia (Fig. 1C) having 1-septate ellipsoid-ovoid, 10-17 × 3-6 µm ascospores. Lichen substances usnic and iso-usnic acid present.

Distribution and ecology: It is a cosmopolitan and widely distributed species across the globe [18]. In India, the species is previously reported from Nilgiri and Palni hills, Andaman and Nicobar Islands, and Northeast regions [20].

Specimen examined: Uttarakhand, Nainital District, Haldwani, Lakhan mandi, Nandhaur Forest Range, 06 & 07 January 2014 and 03 February 2014, on leaves of *Shorea robusta*, Shashi Upadhyay and Snadhya Shukla, *s.n.* (ALM).

4. *Fellhanera semecarpi* (Vain.) Vězda: The species is characterized by its smooth, pale greenish grey thallus which is dispersed into rounded patches (3-15 mm across), and small, ochraceous yellow to reddish brown apothecia (Fig. 1D) that produce oblong-ovoid, 1-septate ascospores (10-16 × 4-5 µm) with constriction at septum. Lichen substances not known.



A) ***Arthonia trilocularis*****, B)** ***Bapalmuia palmularis*****, C)** ***Fellhanera bouteillei*****, D)** ***Fellhanera semecarpi*****, E)** ***Gyalectedium filicinum*****, F)** ***Tapellaria epiphylla***

Distribution and ecology: It is a widely distributed pantropical but uncommon species and is found under great variety of microclimatic conditions [18]. In India, the species is previously reported from Nilgiri and Palni hills, Andaman and Nicobar Islands, and Northeast regions [20].

Specimen examined: Uttarakhand, Nainital District, Haldwani, Lakhan mandi, Nandhaur Forest Range, 06 & 07 January 2014 and 03 February 2014, on leaves of *Shorea robusta*, Shashi Upadhyay and Snadhya Shukla, *s.n.* (ALM).

5. ***Gyalectidium filicinum*** Müll. Arg.: The species is characterized by the combination of pale greenish grey verrucose thallus with a cellular corticiform layer and well-developed, laminal to submarginal hyphophores with two lateral projections. The apothecia are yellowish green, rounded, 0.2-0.4 mm diam. (Fig. 1E), with abundant epithecial algae and the ascospores (30-40 × 13-18 µm) are hyaline, muriform with a slight constriction at septa. Lichen substances absent.

Distribution and ecology: It is a pantropical species extending its distribution into sub-tropical regions [18]. In India, the species is previously reported from Nilgiri and Palni hills, Andaman and Nicobar Islands, and Northeast regions [20].

Specimen examined: Uttarakhand, Nainital District, Haldwani, Lakhan mandi, Nandhaur Forest Range, 06 & 07 January 2014 and 03 February 2014, on leaves of *Shorea robusta*, Shashi Upadhyay and Snadhya Shukla, *s.n.* (ALM).

6. ***Tapellaria epiphylla*** (Müll. Arg.) R. Sant.: The speices is characterized by its pale grey to white, ecorticate thallus which is dispersed into rounded patches and pure black, rounded apothecia (0.3-0.7 mm diam.) (Fig. 1F) having hyaline, ellipsoid, muriform ascospores (50-80 × 18-25 µm). Lichen substances are absent.

Distribution and ecology: It is possibly a pantropical species, but is also known from neotropics, tropical Africa, and Hawaii and extending its distribution into subtropical regions, and is quite abundant at higher elevation in more open situations [18]. In India, the species is previously reported from Nilgiri and Palni hills, Andaman and Nicobar Islands, and Northeast regions [20].

Specimen examined: Uttarakhand, Nainital District, Haldwani, Lakhan mandi, Nandhaur Forest Range, 06 & 07 January 2014 and 03 February 2014, on leaves of *Shorea robusta*, Shashi Upadhyay and Snadhya Shukla, *s.n.* (ALM).

4) CONCLUSION

Foliicolous lichens, a special group of leaf inhabiting lichens widely distributed in wet or moist, highly humid or foggy tropical and subtropical forests of the world [1] have great potential to indicate the human disturbance and microclimate of a particular area [21]. These lichens have an accelerated life cycle and respond rapidly to changes in environmental conditions. Compared to other foliicolous lichen enriched parts of India (Western Ghats and Eastern Himalaya), the foliicolous lichen diversity of subtropical regions of Uttarakhand is very poor and so far unknown. Even the checklist of lichens from India [20] indicates that no foliicolous lichens were collected from Uttarakhand. Therefore much task is ahead before the distribution and diversity of foliicolous lichens of India is adequately known. This study will attract lichenologists across India to explore the diversity of foliicolous lichens from this region because prior to this study researchers generally suppose that foliicolous lichens were confined only to Nilgiri and Palni hills, Andaman and Nicobar Islands, and Northeast India. Besides this, long term monitoring with the help of these lichens will help to find out the human interference, climate change and forest health of that particular forest without spending too much money, since they are the best bioindicator of climate change and human disturbance.

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