

Diversity and distribution pattern of lichens in some prominent localities of Nilgiris Biosphere of Tamil Nadu, India

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Abstract:

Many lichen specimens were collected from seven agroclimatic zones of Nilgiri Biosphere Reserve namely Udhagamandalam, Kotagiri, Kundah, Coonoor, Gudalur, Pandalur and Doddabetta. The study resulted in a total of 38 lichen species belonged to 17 genera within 10 lichen families. The family Parmeliaceae was dominant with maximum record of 56.7% of total lichens. The majority of lichen diversity was recorded at an altitude of 979 m with the total representation of 21.6%. Among the substrates corticolous lichen was found to be abundant with 81% followed by saxicolous (8.1%) and terricolous (5.4%). The majority of lichen belonged to foliose growth form which accounted for 45.9%. A species of fruticose lichen *Ramalina obtusata* (Arnold) Bitter, identified at an altitude of 2,197 m is a new addition to Tamil Nadu.

Keywords: Biodiversity, Doddabetta, lichenized fungi, South India, Western Ghats

INTRODUCTION

The algal and fungal symbiotic associations results in the formation of lichens. Sometimes, a heterogeneous mixture of bacteria, fungi, actinomycetes or more organisms are also involved. The alga that forms associations are referred to a Phycobionts while the fungi surviving from the photosynthesis of phycobionts are called Mycobionts. Although 20,000 species of lichens have been identified in the world, 2985 species are the currently recorded data in India (Sinha 2021). More than 30 % of the total species of India, which accounted a total of 892 species have recorded from the state of Tamil Nadu. Western Ghats, Eastern Ghats coastal regions, Himalaya, Gangetic plain and Andaman Nicobar Islands are the most common regions of lichen habitats in India.

China, Canada, Europe, Nepal, India, Iceland, South Africa, Philippines, Spain, England, Germany, Sweden, Turkey and Madagascar are known for its traditional pharmaceutical uses of lichens (Negi and Kareem, 1996). Pharmaceutical lichens are the good source of lichen compounds that can be therapeutic against many ailments like heart disease, wound, asthma, cancer, ulcers, urinary problems, leprosy, bronchitis, stomach disorders, skin disease etc. (Shukla et al. 2010; Uprety et al. 2012). The species of *Cladonia*, *Parmotrema* *Ramalina*, *Usnea* and *Xanthoria* are reported to possess anti-cancer activities (Shrestha et al. 2015 and Suh et al. 2017). The growth rate is slow which may be the reason that the lack of in vitro culturing and lack in conservation of lichens. So, intensive and extensive research is on to culture the whole lichen thallus or mycobiont alone in lab in vitro and extract the lichen compound to offer therapeutic uses. (Shanmugam et al. 2022). Cultured mycobionts acknowledge the presence of bioactive compound in the extract and it is after the identification using NMR, LCMS, HPLC, it can be assured and it is the only substitute for the extraction of lichen compound from the natural thalli.

In India, The Nilgiris Biosphere (NBR) is the most popular tourist place in the Western Ghats. It is designated as UNESCO World Network of Biosphere Reserves (Radhakrishna 2001) and researchers are aware about the diversity of lichens one of the important biodiversity hotspots which The NBR lies between 10°50' - 12°16' N latitude, 76°00' - 77°15'E longitude and spread across Tamil Nadu, Kerala and Karnataka covering an area of 5520 km². The NBR is registered as India's first and foremost natural heritage and has rich in flora and fauna. The highest peak in the NBR is Doddabetta with an elevation of 2,637 m from mean sea level. However, there is no serious exploration in terms of estimation of lichen population in the biosphere since 1990s. The lichens are sensitive to microclimate changes in the ecosystem and are proven bioindicators of environmental changes. The biosphere apart from natural calamities such as forest fire flood, it is facing the heavy anthropogenic disturbances including urbanization, road building and tourism (Anonymous). Therefore, there is an urgent need for thorough survey and documentation of lichen species in NBR before they vanish from their natural habitat. With this view, aim of the present study is to document the lichen diversity from some prominent localities within NBR.

MATERIALS AND METHODS

The lichen samples were collected from the seven agroclimatic zones of NBR namely Udthagamandalam, Kotagiri, Kundah, Coonoor, Gudalur, Pandalur and Doddabetta (Fig. 1, Table 1) in the months of November and December 2020. These agroclimatic zones are designated on the basis of taluk. For each site various environmental parameters such as temperature, relative humidity, rainfall, sunshine, wind speed and UV index were recorded. The collected lichens were identified by studying their morphological and taxonomical characters (Awasthi 1991, 2007). The chemistry of the samples were examined with the spot tests of K, C, KC, PD and Thin layer chromatography (TLC) in solvent system A (Toluene: Dioxane: Acetic acid at 180:45:5 ratio) following Orange et al. (2001). The morphological identification of lichen samples were carried out with stereomicroscopes (Olympus SZ51). All the voucher specimens

were preserved in lichen herbarium, Department of Botany, Bharathiar University, Coimbatore, Tamil Nadu, India. The lichen population percent for each site were measured using the formula $A/B \times 100$ (A- Number of lichens in specific location, B- Total Number of lichens) The classification of kingdom Fungi has proposed by wijayawardene et al. (2020) is followed for arranging the species under different families.

RESULTS

The climatic conditions of the NBR showed the high humidity with southwest and northeast monsoon in which southwest monsoon pattern is more prevalent than northeast monsoon. The annual rainfall range was about 259-265 cm of which about 80-90% is received during the southwest monsoon period. The relative humidity of NBR was around 80% and wind breeze recorded was 15 km/h. The mean temperature regimes recorded was 15.7oC (Table 1).

Lichen diversity in the NBR

The study resulted in total of 38 lichen species belonging to 16 genera in the NBR (Table 2). The numbers of lichens were the highest at Pandalur (21.6%) and Coonoor (18.9%) regions coinciding with the conducive climatic conditions (Figure 1).

Lichen family diversity

The enumerated lichen species from the NBR fell within 10 lichen families which were taxonomically well-represented such as Chrysothrichaceae, Cladoniaceae, Collemataceae, Graphidaceae, Lobariaceae, Parmeliaceae, Physciaceae Ramalinaceae, Teloschistaceae and Thelotremataceae. Among these Parmeliaceae was found to be predominant family in the study area which accounted for 56.7% total lichen population (Figure 2). The family Ramalinaceae members registered 10.8% and Physciaceae was 8.1%, Cladoniaceae and Graphidaceae showed only 5.4% of lichen species and all other families such Chrysothrichaceae, Collemataceae, Lobariaceae, Teloschistaceae and Thelotremataceae represented only 2.7% of the lichen population.

Distribution of lichen growth forms

The NBR represented almost all lichen growth. Growth form diversities such as crustose, fruticose, foliose, leprose, squamulose and dimorphic. Among them foliose form of lichens was found to be predominant which accounted for 45.9%. The fruticose form of lichens showed the second leading growth form diversity with a record 35.1% followed by crustose (10.8%) and dimorphic (5.4%) and leprose forms (2.7%) as depicted in the figure 3.

The substrate preference

These lichens in NBR preferred to grow on both living and non-living substrates such as rock (saxicolous), soil (terricolous), bark (corticolous), leaves (foliicolous), moss (musicolous) and wood (lignicolous). Among the various substrates the study revealed corticolous lichens were most abundant with about 78.3% followed by saxicolous (8.1%), terricolous (5.4%), muscicolous (2.7%), lignicolous (2.7%) and foliicolous (2.7%) as depicted in the figure 4.

Altitudinal distribution of lichens

The distribution of lichens in different altitudes was documented in the NBR. The results indicated that the lichen diversity was predominant at an altitude of 979 m above msl which accounted for 21.6%. About 18.9% of lichen species observed was growing at an altitude of 1813 m followed by at 1873 m with the record of 16.2%. A very less amount of lichen population recorded at 2615 m which accounted 8.1% in the study site (Fig. 5).

DISCUSSION

Lichens have been the most successful organism with cosmopolitan in distribution in the world. India is one of the major contributors among the Asian countries to world's lichenological database. The state Tamil Nadu by having parts of Western, Eastern Ghats and Deccan Plateau harbour a rich diversity of lichens along with endemic species (Sinha 2021). Kodaikanal hills located in Dindugal district of Tamil Nadu has rich lichen flora as recorded by Kalidoss et al. (2020 a).

This study was aimed to conduct the lichen survey at the higher elevation of Western Ghats (Figure 6&7). In a research conducted by McVicar and Korner (2013) elevation gradients and environmental conditions were influencing the lichen growth but it is proved that altitude in terms of height had a positive correlation against abundance of lichen species. So, in this study, altitude variable was used for the diversity distribution analysis of lichen species. The altitude above 979 m showed maximum lichen species and suggested that this altitude might possess conducive climatic factors such as humidity, sun shine, rainfall, temperature and wind. This result is supportive in agreement to the survey study conducted by Kalidoss et al (2020 b). These results further indicated that there was a positive correlation between the environmental parameters, height of the hills and the population diversity of lichens. The high elevated areas along with very low temperature regimes with high relative humidity and rainfall pattern did not support the growth of lichen species.

The family diversity study was conducted. The Parmeliaceae family showed maximum diversity. Several works have shown a strong positive relationship between parmeilaceae family against environmental variables. It can be noted that Parmeliaceae is the largest family in the world with 2,765 species and 77 genera (Lücking et al. 2017). The Parmeliaceae lichens have large thallus

and wide range of substrate preference. Many of the parmelioid lichens are used in traditional medicine (Crawford 2015).

The results also showed that all the environmental parameters registered at Doddabetta region were distinct from other regions due to its high elevations. But the number of lichen species were found to be the less, about 8.1%. There was a negative correlation between environmental parameters, height of the hills and the diversity of lichens.

Based on the growth form diversity analysis, it is found that the study area possess dominant fruticose form. This could be due to the presence of highly conducive environment. The substrate diversity study was done and the study area showed maximum of corticolous lichen. This is supportive in agreement to the findings recorded by Kalidoss et al. (2020b).

In the present study a new record of lichen is being discussed (Figure 6). *Ramalina obtusata* (Arnold) Bitter, which is a rare fruticose species in the study area was recorded for the first time from Tamil Nadu. *R. obtusata* is a temperate species widely distributed in Europe, North America and Canada. In India it is reported from Jammu & Kashmir (Singh and Sinha 2010).

CONCLUSION

Many hills and mountains are being explored for their lichen diversity. Many environmental conditions are essential to justify their maximum diversity. The present study showed excellent diversity of lichens and conducive growing conditions in NBR. The lichens are sensitive to air pollution and microclimatic conditions. Growing urbanization, developmental activities and tourism in the region is affecting the lichen population. Therefore it has become necessary to document the complete diversity of lichens in NBR at the earliest. The compilation of earlier work in the NBR and fresh collections from unexplored areas will certainly yield at least 300 species of lichens to the region.

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