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## Diversity of Foliose Lichens in Nepal

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### ABSTRACT

Though lichen is an important biological entity, it has been overlooked in biodiversity assessment, research and priorities. To minimize this gap with the available resources and facilities, an initiation has been taken to enumerate the available lichen species in the premises of Prithvi Narayan Campus (PNC), Pokhara, Nepal. A survey has been conducted to explore mostly the foliose lichens diversity in 2022 and resulted 17 confirmed species belonging to 12 genera from 5 families. The Parmeliaceae and Physciaceae are found to be dominated families. Though the findings of this study are based on the morphological features, using available laboratory facilities at PNC, further in-depth survey and advanced identification methodologies are recommended.

**KEYWORDS:** Lichen, host, macrolichen, Seti river, microhabitat

### INTRODUCTION

Lichen is a dual organism formed by an association of a fungus (mycobiont) and an alga (phycobiont). The symbiotic nature of lichen demonstrates the major role in ecosystem. The thallus is morphologically appearing and physiologically behaving as a single autonomous biological unit (Ahmadijin, 1993). Lichen is also

a very slow growing organism that appears to grow few millimeters to few centimeters in a year. The thallus is able to grow in diverse climatic conditions and can adapt to survive in extremely xeric habitats such as on rocks and, on barks of trees (Emerman et al., 2016). Some species are hanging from branches of trees in virgin forests and may have different forms and coloration, especially brown or yellow or red. They are slow growing and long-lived perennial organisms (Galloway, 1992). The foliose lichens, a leafy thallus is loosely attached to the substratum.

Lichens are widely distributed in almost all phytogeographical regions ranging from tropical to alpine zone (Awasthi, 2000; Schroeter et al., 1994; Kappen et al., 1996). A wide range of morphological variations of distribution pattern of lichens are also due to

microclimatic variation of thallus in near urban area and non-settlement area (Hauck, 2011).

Nowadays, lichens are widely used as economical and long-term bio-monitoring tool in many countries (Rindita et al., 2015). They are also used in foraging, sheltering and building materials for deers, birds and insects. Some species help in the formation of soils, improving the quality of the soils and also enriching the soils required for the plants' growth (Devkota, et al., 2017; Yang et al., 2021).

A total of over 650 genera and 17,500 to 20,000 species of lichens are estimated all over the world (Hawksworth & Hill, 1984). The lichens dominate approximately 8% of the total earth's surface (Nash, 2008). Yet about 50% of tropical lichens still remain lichenologically unexplored and under-explored (Aptroot & Sipman, 1997). Nepali lichens are represented by 1129 taxa (1078 species and 51 infra-specific categories) belonging to 232 genera and 64 (Baniya et al, 2022). The species are much less unknown and still remain largely unexplored in Nepal (Bhujju et, al., 2007). The prime objective of this preliminary survey is to list out foliose lichen species from the premises of PNC.

### THE STUDY AREA

The study area is situated between 28° 14' 15" N to 28° 14' 30" N and 83° 59' 15" E to 83° 59' 30" E, PNC is located in a hilly area with an elevation 852 m to 922 m and covers 254.2 acre of land. The area is boarded by urban site on the west, Vinduwasini Sanskrit Vidhyapeeth on the north, Seti River on the east, and barren shrubby land on the south. The area comprises of a typical tropical habitat in between the border line of subtropical region characterized by two terraces, plain area settled by institutional buildings and lower terrace dominated by the grassland. The two sites were selected to conduct the research.

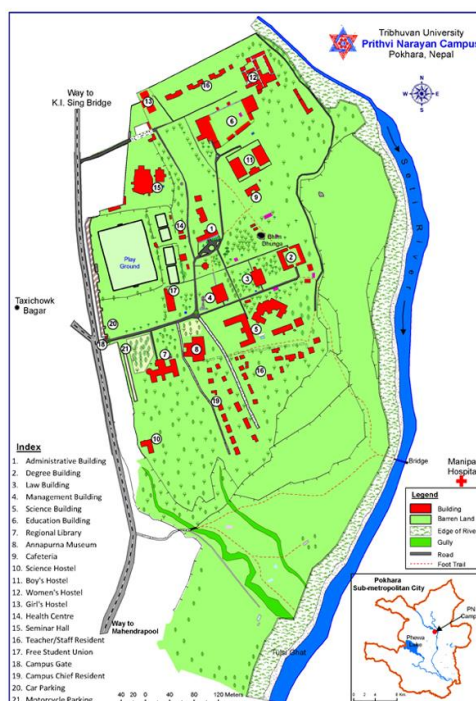
### MATERIALS AND METHODS

On the basis of availability of lichens, the convenient random samplings were carried out to collect specimens. The collection of foliose lichens is somehow easy, so not so sophisticated instruments were used.

The geographical coordinates of each sampling sites were recorded from a GPS device. All samples of lichens were photographed using Canon Rebel T6 model camera for voucher specimens and the lichen samples were examined morphologically and taxonomically on the basis of published literature, monographs, journal articles and world-wide network of lichen systematists. Lichens were properly identified using taxonomic keys (Awasthi, 1988; Awasthi, 1991) and the experts' opinions and deposited at the Department of Botany in PNC.

The morphological characters of the upper and lower surface of lichen thallus colour, texture (rough, smooth or warty), presence of reproductive bodies such as isidia, granular structure (soredia), fine

**Figure 1**  
*The Premises of Prithvi Narayan Campus, Pokhara*



powder (pruina), black dots (pycnidia), etc. were studied. The length and breadth of margin of thallus were also noted down.

## RESULTS AND DISCUSSION

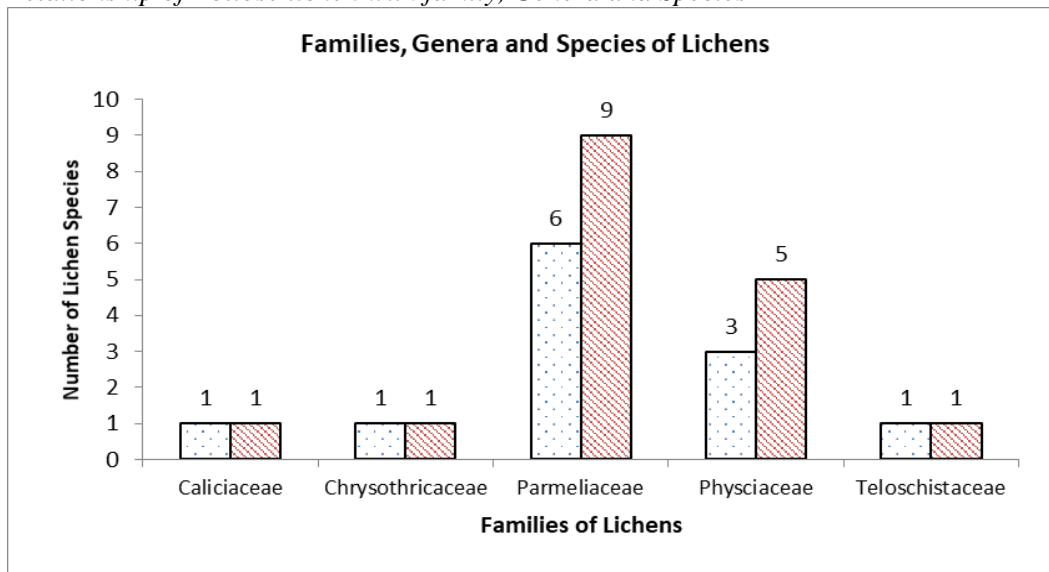
A total of 17 lichen species comprising of 12 genera and 5 families are recorded (Table 1, Fig 2). The most common family is Parmeliaceae comprising *Flavoparmelia caperata* (L.) Hale, *Parmelia sulcata* Taylor, *Parmelia saxatilis* cf., *Parmotrema austrosinense* (Zahlbr.) Hale, *Parmotrema tinctorum* (Nyl.) Hale, *Parmellinopsis expallida* (Kurok) Elix & Hale, *Parmellinopsis minarum* (Vain.) Elix & Hale, *Arctoparmelia subcentrifuga* (Oxner) Hale and *Melanelixia glabra* (Schaer.) O. Blanco, A Crespo, Divakar, Essl. Hawksw, & Lumbsch. Out of the findings, *Parmelia saxatilis* cf. needs further detail analyses. Each species with their geo-coordinates (Latitude/Longitude/Altitude) including their host species is provided in an Annex I.

**Table 1**

*Foliose lichens recorded in the PNC premise*

S.N	Family	Genus	Scientific Name of Lichen
1	Caliciaceae	<i>Pyxine</i>	<i>Pyxine soredata</i> (Ach.) Mont
2	Chrysothricaceae	<i>Chrysothrix</i>	<i>Chrysothrix candelaris</i> (L.) J. R. Laundon
3	Parmeliaceae	<i>Flavoparmelia</i>	<i>Flavoparmelia caperata</i> (L.) Hale
		<i>Parmelia</i>	<i>Parmelia sulcata</i> Taylor <i>Parmelia saxatilis</i> cf.
		<i>Parmotrema</i>	<i>Parmotrema austrosinense</i> (Zahlbr.) Hale <i>Parmotrema tinctorum</i> (Nyl.) Hale
		<i>Parmellinopsis</i>	<i>Parmellinopsis expallida</i> (Kurok) Elix & Hale <i>Parmellinopsis minarum</i> (Vain.) Elix & Hale
		<i>Arctoparmelia</i>	<i>Arctoparmelia subcentrifuga</i> (Oxner) Hale
4	Phyciaceae	<i>Melanelixia glabra</i>	<i>Melanelixia glabra</i> (Schaer.) O. Blanco, A Crespo, Divakar, Essl. Hawksw, & Lumbsch
		<i>Heterodermia</i>	<i>Heterodermia obscurata</i> (Nyl.) Trevisan
		<i>Physconia</i>	<i>Physconia enteroxantha</i> (Nyl.) Poelt
		<i>Physcia</i>	<i>Physcia tribacia</i> (Ach.) Nyl. <i>Physcia stellaris</i> (L.) Nyl.
		<i>Physcia</i>	<i>Physcia aipolia</i> (Ehrh.ex Humb.) Fumr.
5	Teloschistaceae	<i>Xanthoria</i>	<i>Xanthoria candelaria</i> (L.) Am.

Although *Diploknema butyracea* species is dominated, the most of the lichens are collected in the *Sapium insigne*, *Magnifera indica*, *Cedrella toona*, *Erithrina arborescens* and *Bombax ceiba*. An enumeration of recorded species is presented below (Table 2).

**Figure 2***Relationship of Foliose lichen with family, Genera and Species***Enumeration of the Species****1. *Pyxine sorediata* (Ach.) Mont**

Fungi: Ascomycota; Lecanoromycetes; Caliciales; Calicaceae; *Pyxine*; *sorediata*

Foliose thallus, green alga, corticolous, leaden or bluish gray; loosely appressed, up to 8 cm in diam., flat or slightly concave, lobes, 0.6-1.3 mm wide, very distinct along the lobe margins, sometimes pruinose and reticulately confluent; pruina: punctiform on the peripheral parts of the lobes soredia present, granular, rarely farinose.

**2. *Chrysothrix candelaris* (L.) J. R. Laundon**

Fungi; Ascomycota; Arthoniomycetes; Arthoniales; Chrysothricaceae; *Chrysothrix*; *candelaris*.

Bright yellow, orange-yellow or greenish-yellow in colour, wooly textured, powdery appearance on superficial thallus, lacks apothecia, isidia and soredia, known as mustard powder lichen, grow on the bark of trees and silicious rock, too.

**3. *Flavoparmelia caperata* (L.) Hale**

Fungi; Ascomycota; Lecanoromycetes; Lecanorales; Parmeliaceae; *Flavoparmelia*; *caperata*.

Foliose, green alga, ash like colour, very distinct foliose lichen, rounded lobes, 3-8 mm wide, granular soredia on patches, thallus smooth, often wrinkled, rhizoids attached to lower surface, found on trunks of trees, rock and soil.





**4. *Parmelia sulcata* Taylor**

Fungi; Ascomycota; Lecanoromycetes; Lecanorales; Parmeliaceae; *Parmelia*; *sulcata*.

Adnate foliose thallus, 4-20 cm in diam., sublinear lobate lobes, contiguous to imbricate, elongate, plane, upper surface gray, smooth, 2-4 mm wide, apices truncate smooth to strongly foveolate, shiny, sometimes white pruinose, becoming cracked along prominent.



**5. *Parmotrema austrosinense* (Zahlbr.) Hale**

Fungi; Ascomycota; Lecanoromycetes; Lecanorales; Parmeliaceae; *Parmotrema*; *austrosinense*.

Foliose thallus, grey with some blacked areas, loosely adnate, 3-10 cm in diam., lobate lobes: subirregular, elongate, slightly imbricate, plane, 10-30 mm wide; apices: rotund, often ascending, elacinate and eciliate smooth, dull to shiny, usually white maculate soredia: granular, in linear, sub-marginal or marginal soralia.



**6. *Parmotrema tinctorum* (Nyl.) Hale**

Fungi; Ascomycota; Lecanoromycetes; Lecanorales; Parmeliaceae; *Parmotrema*; *tinctorum*.

Foliose thallus, loosely attached, apically ciliate, grey, smooth, shiny margin, sub irregular lobes, adnate, 3-30 cm in diam., elongate, slightly imbricate, plane, separate, 10-20 mm wide; apices: rotund, crenate and dissected with age, ciliate; long shiny marginally, emaculate, finely reticulately isidia: simple to coralloid branched.



**7. *Parmellinopsis expallida* (Kurok) Elix & Hale**

Fungi; Ascomycota; Lecanoromycetes; Lecanorales; Parmeliaceae; *Parmellinopsis*; *expallida*.

Foliose thallus, thallus whitish to greenish grey, smooth to rugulose, dull to shiny, 2-10 cm in diam., adnate to loosely adnate, sub-dichotomously lobate, sub-concave to plane to subconvex, initially separate, becoming imbricate, 1-6 mm wide; margin: entire to rarely incised; usually strongly white maculate soredia: farinose to granular.



**8. *Parmellinopsis minarum* (Vain.) Elix & Hale**

Fungi; Ascomycota; Lecanoromycetes; Lecanorales; Parmeliaceae; *Parmellinopsis*; *minarum*.

Foliose thallus, whitish to greenish grey in colour, smooth, shiny, epruinose, emaculate, adnate, isidiate, eciliate; soredia and isidia absent, 2-7 cm in diam.; lobate lobes: narrow, sublinear, elongate, contiguous to imbricate, plane, 1-3 mm wide; apices: sub-rotund, ciliate; simple, up to 0.7 mm long upper surface.



**9. *Heterodermia obscurata* (Nyl.) Trevisan**

Fungi; Ascomycota; Lecanoromycetes; Teloschistales; Physciaceae; *Heterodermia; obscurata*.

Foliose thallus with orbicular rosettes or irregularly spreading, robust, 2-4 (-10) cm diam., firmly adnate, dichotomously to irregularly lobate, radiating, sparsely divided, flat to slightly convex, minutely notched, eciliate, shiny, soredia: granular, often rusty brown, sometimes confluent and forming marginal soralia.



**10. *Physcia stellaris* (L.) Nyl.**

Fungi; Ascomycota; Lecanoromycetes; Caliciales; Physciaceae; *Physcia; stellaris*.

Orbicular or irregular foliose thallus, up to 4 cm diam., whitish grey to cream-colored (margin often paler), pale grey with darker area in centre, sometimes confluent with other thalli, loosely adnate, radiating lobes, truncate with open sinuses, white to brownish on lower surface, with few pale rhizines, Usually Apothecia abundant.



**11. *Physcia aipolia* (Ehrh.ex Humb.) Fumr.**

Fungi; Ascomycota; Lecanoromycetes; Caliciales; Physciaceae; *Physcia; aipolia*.

Orbicular to irregular foliose thallus upto 5 cm, whitish gray to dark gray, rarely brownish gray, diam. lobes: up to 2 mm broad, flat to convex, eciliate, usually distinctly white-maculate, weakly white-pruinose; without soredia or isidia, lowermost part gradually forming rounded, white to dark on lower surface. growing on trees.



**12. *Physcia tribacia* (Ach.) Nyl.**

Fungi; Ascomycota; Lecanoromycetes; Caliciales; Physciaceae; *Physcia; tribacia*.

A foliose, scale-like; margin: mostly crenulate when soralia not present, orbicular to irregular, up to 3 cm diam. lobes: up to 1 mm wide, eciliate upper surface: whitish gray to dark gray or cream-colored (with darker margins), shiny and epruinose or rarely weakly pruinose, sorediate, eroding the tip and sometimes also the lower surface.



**13. *Xanthoria candelaria* (L.) Am.**

Fungi; Ascomycota; Lecanoromycetes; Teleschistales; Teleschistaceae; *Xanthoria; candelaria*.

Foliose lichen, small cushions like, upto 3 cm wide, lobate lobes: dorsiventral to subterete, 0.2-0.5 mm wide; tips: 0.1-0.3 mm wide, ±terete upper surface: yellow to light orange, smooth to somewhat coarse, often wrinkled, sorediate soredia: granular, blastidious, marginal to submarginal, lower surface white to yellow, somewhat wrinkled.



**14. *Arctoparmelia subcentrifuga* (Oxner) Hale**

Fungi; Ascomycota; Lecanoromycetes; Lecanorales; Parmeliaceae; *Arctoparmelia*; *subcentrifuga*.

Foliose thallus: tightly attached and adnate to adnate, foliose, 4-8 cm in diam., lobate lobes: narrow, sublinear to sub-irregular, contiguous to imbricate, somewhat elongate, upper surface: pale greenish to yellowish gray, smooth but cracked with age, dull, becoming rimose, emaculate, becoming strongly rugulose.

**15. *Physconia enteroxantha* (Nyl.) Poelt**

Fungi; Ascomycota; Lecanoromycetes; Caliciales; Physciaceae; *Physconia*; *enteroxantha*.

A foliose lichen, upper surface: gray-brown to dark brown, irregular to orbicular lobes, linear upto 6 cm in diam., and discrete lobes to somewhat irregular-rounded and complete pruina, sorediate, in primarily marginal soralia straight to somewhat curved.

**16. *Parmelia saxatilis* cf.**

Fungi; Ascomycota; Lecanoromycetes; Lecanorales; Parmeliaceae; *Parmelia*; *saxatilis*.

Foliose adnate thallus, upper surface: gray (to brown in exposed habitats), smooth to foveolate, shiny 4-20 cm in diam., lobate lobes: sublinear, contiguous, elongate, lower surface black, rhizinate, plane to subconvex, separate, 2-4 mm wide, apices truncate, white pruinose, becoming cracked along prominent, isidiate.

**17. *Melanelixia glabra* (Schaer.) O. Blanco, A Crespo, Divakar, Essl. Hawksw, & Lumbsch**

Fungi; Ascomycota; Lecanoromycetes; Lecanorales; Parmeliaceae; *Melanelixia glabra*.

Small to occasionally medium stratified foliose lichens, corticate above and below, sorediate or isidiate or not, pseudocyphellate or not, lobes closely appressed to rather loosely appressed, short to elongate, 0.4-4 mm wide, thin, apothecia located over upper surface, disc brown.

**Discussion**

As our result suggested, high number of species might be related to high microhabitat variation and open land mostly in terrains (Rubio-Salcedo et al., 2015; Sojo et al., 1997). Interestingly, it is found that lichen diversity greatly varies with host substrates, topography and canopy coverage (Bruun et al., 2006; Cáceres et al., 2016; Rai et al., 2012; Rose, 1992). The species presence in the upper terrace are more or less different than found in the lower terrace.

Several factors, such as tree size/age, microclimatic conditions, and forest quality, have been well studied in the global context to better understand colonization by epiphytic organisms (Belinchón et al., 2011). Previous studies have shown that epiphytic



lichen distribution is regulated by dispersal ability and establishment limitation, at both regional and local scales (Cornejo & Scheidegger, 2018).

In lichens, algae photosynthesize and share the product with the associated fungus, and the fungus protects the algae from negative environmental influences, like including UV radiation and herbivory by means of unique secondary metabolites (Cáceres et al., 2016). A rich number of lichen species in this clean city might be another indicator of good forest health as several similar studies depicted elsewhere (Bajpai et al., 2016; Ellis et al., 2007) where algae and fungi can survive in full extent.

## CONCLUSION

The PNC premises located in the mid-hill region of Nepal has supported a large number of lichen species and is a potential site for the further detailed study. It is hoped that this piece of publication might be helpful for graduate and postgraduate students pursuing their studies at PNC and other universities in Nepal and also for the lichenologists and other concerned stakeholders to understand lichens diversity in this pristine landcover. Being located in clean and green city, further investigation of lichen species could be a tool for measuring the environmental condition of academic institution and the surroundings.

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#### Annex I: Species geo-coordinates and their host details.

S.N	Scientific Name of Lichen Species	Latitude/Longitude (Degree)	Host (Plant/Rock)
1	<i>Pyxine soorediata</i> (Ach.) Mont	28.239842 83.992027	<i>Diploknema butyracea</i>
2	<i>Chrysothrix candelaris</i> (L.) J. R. Laundon	28.242028 83.990693	<i>Sapium insigne</i>
3	<i>Flavoparmelia caperata</i> (L.) Hale	28.236168 83.992443	<i>Magnifera indica</i>
4	<i>Parmelia sulcata</i> Taylor	28.239117 83.991948	<i>Diploknema butyracea</i>
5	<i>Parmelia saxatilis</i> cf.	28.240364 83.993194	Rock
6	<i>Parmotrema austrosinense</i> (Zahlbr.) Hale	28.236168 83.992443	<i>Magnifera indica</i>
7	<i>Parmotrema tinctorum</i> (Nyl.) Hale	28.239705	<i>Diploknema</i>

		83.992313	<i>butyracea</i>
8	<i>Parmellinopsis expallida</i> (Kurok) Elix & Hale	28.239306 83.990639	<i>Sapium insigne</i>
9	<i>Parmellinopsis minarum</i> (Vain.) Elix & Hale	28.242432 83.993532	<i>Cedrella toona</i>
10	<i>Arctoparmelia subcentrifuga</i> (Oxner) Hale	28.239569 83.993611	Rock
11	<i>Melanelixia glabra</i> (Schaer.) O. Blanco, A Crespo, Divakar, Essl. Hawksw, & Lumbsch	28.237036 83.992549	<i>Sapium insigne</i>
12	<i>Heterodermia obscurata</i> (Nyl.) Trevisan	28.240797 83.991223	<i>Erithrina arborescens</i>
13	<i>Physconia enteroxantha</i> (Nyl.) Poelt	28.238387 83.993399	<i>Bombax ceiba</i>
14	<i>Phycia tribacia</i> (Ach.) Nyl.	28.237188 83.991637	<i>Sapium insigne</i>
15	<i>Phycia stellaris</i> (L.) Nyl.	28.0236817 83.992057	<i>Bombax ceiba</i>
16	<i>Phycia aipolia</i> (Ehrh.ex Humb.) Fumr.	28.241987 83.990982	<i>Diploknema butyracea</i>
17	<i>Xanthoria candelaria</i> (L.) Am.	28.239655 83.992388	<i>Diploknema butyracea</i>