Lichen Richness and Composition Patterns along Altitudinal gradients and Land use types in the Manaslu Conservation Area, Central Nepal

Dissertation

Submitted for the partial fulfillment of Masters' Degree in Botany (Plant Pathology and Applied Mycology)

Submitted by

Laxmi Sankhi

Exam Roll No.:6285/ 2008-2010

T. U. Regd. No. 5-2-37-835-2005

Central Department of Botany
Tribhuvan University
Kirtipur, Kathmandu, Nepal

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Recommendation

This is to recommend that the thesis entitled **"Lichen Richness and Composition patterns along Altitudinal gradients and Land use types in the Manaslu Conservation Area, Central Nepal"** has been carried out by Ms. Laxmi Sankhi for the partial fulfillment of the Degree of Master of Science in Botany with special paper **'Plant Pathology and applied Mycology'**. This is her original research work and has been carried out under our supervision. To the best of our knowledge, this thesis work has not been submitted for any other degree in any institutions. We recommend the thesis to be evaluated and accepted for the Master of Science in Botany (Plant Pathology and Applied Mycology), Tribhuvan University, Kirtipur, Kathmandu, Nepal.

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LETTER OF APPROVAL

The M.Sc. dissertation entitled "**Lichen Richness and Composition patterns along Altitudinal gradients and Land use types in the Manaslu Conservation Area, Central Nepal"** submitted at the Central Department of Botany, Tribhuvan University by Ms. Laxmi Sankhi, has been accepted for the partial fulfilment of requirements for Master's of Science in Botany (Plant Pathology and Applied Mycology).

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ABSTRACT

Lichens, the mutualistic association between an alga (green and/or blue green) and a fungus are the most successful symbiotic organisms in nature. Nepal is rich in biodiversity. In comparison to higher plants, research work on lichen is very scanty. In the present study I selected Manaslu Conservation Area. Though the Manaslu Conservation Area (MCA) is rich in biodiversity but is less explored. My study focused on species richness and composition of lichens in different land use types, altitudinal gradients and aspects. Four land use types selected are Cropland land, Meadow, Disturbed forest and Natural forest at five altitudinal gradients 2200m, 2600m, 3000m, 3400m and 3800m respectively. A total of 40 transect of $25 \times 2.5m^2$ each were laid down in the study site. R-software was used to perform all the statistical analyses.

Altogether 250 species of lichens under 86 genera and 38 families have been reported by this study. I found significant difference in lichens species richness within different land use types ($p \leq 0.00$, df = 3) that may due to effect of habitat heterogeneity. Higher species richness of lichens has been recorded at natural forest, followed by meadows, exploited forest and cropland. Post hoc analysis (TukeyHSD) reveals that there was a significant difference in species richness of lichens between cropland land and meadow, cropland land and exploited forest, cropland land and natural forest whereas there is no significant difference observed among other land use types .Thus the main variation for the species richness of lichens in different land use type is mainly due to major difference in cropland with other three land use types that is meadow, exploited forest and natural forest. Different life forms of lichen showed significant difference with different land -use types. All four forms of lichens (crustose, foliose, fruticose and leprose) were dominant in natural forests followed by meadows, exploited forests and cropland.

There was no significant difference in species richness of lichens along altitudinal gradients ($p \geq 0.05$, df = 3) and aspects. It might be due to less number of altitudinal gradients and almost similar habitat types respectively. The DCA diagram for species composition showed a good dispersion among species along first two axes. Permutation result showed that altitude, natural forest and cropland land were important environmental variables to structure the composition of lichens.

Key words: Altitude, Species richness, Land use types, DCA

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ABBREVIATIONS AND ACRONYMS

VDC	Village Development Committee
NTNC	National Trust for Nature Conservation
MCA	Manaslu Conservation Area
DNPWC	Department of National Parks and Wildlife Conservation Area.
DCA	Detrended Correspondence Analysis
GPS	Global Positioning System
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora.
M asl	Metre above sea level
Df	Degree of freedom
P	Probability value
Fig	Figure
TUCH	Tribhuvan University Central Herbarium
C	Cropland
M	Meadow
E	Exploited Forest
F	Natural forest

CHAPTER- 1
INTRODUCTION

1.1 Background

The term lichen was first introduced by Theophrastus (300 BC) to describe the outgrowths on the bark of olive trees (Hale, 1974; Hawksworth and Hill, 1984). The term lichen has been defined variously by different lichenologists. Hale (1974) defined lichen as a vegetative plant body of remarkable complexity, having a little external resemblance to either non lichenised fungi or algae. Palmquist and Sunberg (1995) defined lichens are symbiotic organisms where a heterotrophic fungus receives carbon and in some cases nitrogen from photobiont partners. Although the majority of the lichens are xerophytic or mesophytic, only few are aquatic (Hale, 1974). The "body" of lichen is termed as thallus. The fungus forms the main body of lichen, and in most cases, the alga lies in layers between upper and lower fungal cortex (Mulligan, 2009).The unique associations of algae and fungi hence unique anatomical features (absence of cuticle and root) and physiology (poikilohydry and absorbance of nutrient from general thallus surface) probably helped lichen to adopt in various microhabitats, withstanding extreme microclimatic conditions unfavourable for the fungi and algae in isolation (Negi and Upreti, 2000, Gauslaa and Solhaug, 1996, Sancho et al, 2007). It is estimated that there are about 17,000 to 20,000 lichen species throughout the world (Hale, 1974; Hawksworth and Hill, 1984). Similarly, the International Workshop on lichen Taxonomy held in Kathmandu in 1994 estimated around 2000 lichen species likely to occur in Nepal (Sharma, 1995). This figure represented 10% of the expected global lichen flora (Baniya, 1996) and at that time fewer than 500 lichen species were actually recorded from Nepal. This difference between expected and observed lichen diversity shows that very few studies have focused on the lichen flora in Nepal. The latest checklist (Olley and Sharma, 2011) included 792 taxa in 187 genera representing an expansion of 170% over the previous checklist that included 465 species (Sharma, 1995). However, the documentation has lack of enormous inferences such elevation, habitat and their associations.

1.2 Composition of lichen in different land use

Lichens are key components of forest diversity but there is ongoing decline of its richness due to habitat degradation caused by human interference such as disturbance by management activities, air pollution and many others (Boch et al., 2013). Growing tourism and unconstrained forest management are other factors affecting the biodiversity of the Himalayan habitats. In general, main threats to biodiversity e.g. habitat degradation and fragmentation, over exploitation of species, invasions and climate change are also affecting lichens

(Scheidegger and Werth, 2009). Change in land use has a strong influence on species diversity and species composition (Rosenzweig, 1995). Relative species richness of lichens decreases from landscapes dominated by forests to open agricultural landscapes (Stofer et al., 2006). Lichen diversity is strongly influenced by forest age and forest fragmentation (Svoboda et al., 2009). Old forests support more rare and endangered lichen species than younger forests (Rose, 1976; 1992). Lichen species richness is low in cropland as soil harbours poor diversity probably due to its unstable top layer augmented with disturbance by the grazing animals (Negi and Upreti, 2000) and other anthropogenic disturbance.

1.3 Variation of species richness of lichens along altitudinal gradient

The change in vegetation along a mountainside is conspicuous (Grytnes et al., 2006). Due to this reason changes in species composition and species richness along altitudinal gradients have been studied by ecologist for a long time (Lomolino, 2001). Species richness along the Himalayan altitudinal gradient has been analysed for flowering plants (Grytnes and Vetaas, 2002; Bhattarai and Vetaas, 2003; Carpenter, 2005), no flowering plants such as ferns (Bhattarai et al., 2004), Liverworts and mosses (Grau et al., 2007), lichens (Baniya et al., 2010), and birds and mammals (Hunter and Yonzon, 1993). No consistent altitudinal species richness pattern has emerged so far yet (Grytnes et al., 2006). The species richness pattern varies with space and time (Baniya, 2010). Some of the studies involving vascular plants have found maximum richness at intermediate altitudes (Whittaker, 1960; Whittaker and Neiring, 1975; Lieberman et al., 1996; Kessler 2000, Bhattarai and Vetaas, 2003; Grytnes and Vetaas, 2002; Grytnes, 2003; Lomolino, 2001). Whereas other studies on the same taxonomic group reported monotonically decreasing trends (Hamilton, 1975; Odland and Birks, 1999; Grytnes, 2003; Fossa, 2004). Some researchers have also found both monotonic declining and hump shape relationships (Grytnes, 2003). Studies regarding to lichen richness with altitude showed hump shaped relationship (Baniya et al., 2010). The lichen richness is increased from the lowest up to the forest limit, with no trend above (Grytnes, et al., 2006).

1.4 Lichen species richness and aspects

Aspects play effective role in the distribution of vegetation structure (Nuzzo, 1996). Slope inclination and aspect exposition play an important role in determining abundance of lichen species. The more humid north facing slope harbours high lichen richness than south facing slope (Cobanoglu et al., 2009, Temina et al., 2009). There may be several reasons for the difference in the species richness at two aspects. In the Himalayas, northern aspects are relatively moister, with a higher closed canopy than southern aspects. Thus that may be one of causes of higher species richness towards the north facing slopes than the south facing slopes (Sharma 2012). The north and south aspects are differed in microclimates which affect the composition and richness (Pook and Moore, 1996).

1.5 Research Objectives

The general objective of this research work is to study the lichen richness and composition patterns along land use types and altitudinal gradient in the Himalayas, whereas the **s**pecific objectives are:

A.To study the variation in lichen composition and richness with land use type

B.To study the variation in lichen composition and richness with altitude

C. To study the variation in lichen composition and richness with aspect

1.6 Rationale

Nepal is rich in biodiversity. In comparison to higher plants, research works in the field of lichen is very negligible. Habitat fragmentation has been one of the major causes of loss of species in present world which is common for lichens as well. The change in land use types has considerable effect on the composition of the lichens which is not explored yet. In Nepal it is still been ignored by botanists too. Thus this study on the effect of changes in land use pattern in the species richness was carried out. Since Nepalese Himalayan Mountains have unique features this study of species richness and composition along altitude is also important in addition to land use types.

CHAPTER-2

LITERATURE REVIEW

2.1 Lichen research work within Nepal

Some research on lichens of Nepal has been already initiated. Most of them have been done by foreign researchers. Awasthi (1960) described 38 species of lichen collected by R.S. Rao from Cho-Oyu Himal in 1958. Asahina and Kurokawa (1966) presented a total of 133 taxa of lichens from Eastern Himalayas out of which 62 were from Nepal. Bystrek (1969) described 12 species of *Alectoria* from Eastern Nepal among which 3 taxa: *Alectoria perspinosa, A. poeltii* and *A. variabilis* were new to science. Poelt (1966) described 6 species of *Ochrolechia* and 12 species of *Leconara* from Nepal, out of which 3 species of *Ochrolechia* were new to Nepal. Abbayes (1974) worked out *Cladonia* and out of the 20 species enumerated, 10 taxa were new reports. Kurokawa (1974) enumerated 13 species of *Anaptychia*, out of which 3 were new reports. Schmidt (1974) reported *Chaenotheca* and *Coniocybe*; out of the 8 taxa mentioned, 6 were new reports to science. Poelt (1977a) described 12 species of *Umbilicaria* from Nepal. Lamb (1977) has stated the occurrence of 10 species of *Stereocaulon* in Nepal. Hertel (1977) reported 24 Saxicolous species from Nepal, out of which 7 species were new to science. Awasthi and Awasthi (1985) described 14 species of *Bryoria*, 2 species of *Sulcaria* and a single species of *Alectoria* from India and Nepal. Upreti (1987) prepared an artificial key for 62 species of lichen genus *Cladonia* reported from India and Nepal. Kurokawa (1988) collected total 38 species from genus *Parmelia* (24 species) and *Anaptychia* (14 species) from Kathmandu valley. Sharma and Kurokawa (1990) collected 10 species of *Anaptychia* and 21 species of *Parmelia* from Nepal, of which *Parmelia erumpens* and *P. sinuosa* were new to Nepal. Awasthi (1991) published artificial keys to 163 genera and 1150 species of microlichens from India, Nepal and Sri Lanka in a volume of the series *Bibliotheca Lichenologica*.

Sharma (1995) enumerated 465 species of lichens covering 79 genera and 30 families from Nepal. Baniya (1996) enumerated 99 taxa, out of which, 33 species were new report to Nepal. Pathak (1998) enumerated 52 taxa from Dang and Hetauda, out of which 15 species were new to Nepal.

Baniya et al., (1999) studied diversity of lichens in Nepal and documented the major lichen species present in the five physiographic regions of Nepal. Devokota (1999) studied the floristic composition of lichens of Namobuddha, Kavrepalanchok and described 55 species and studied the antibiotic properties of *Heterodermia diademata, Parmelia nepalensis* and *Parmelia reticulata*. Thapa (1999) studied the apothecial anatomy of some foliose and fruticose lichens of Namobuddha. Shakya (2001) studied the ecology of lichens of Phulchoki area and described 52 species and used some as bio-indicators.

Shrestha (2001) studied the nutrient content in lichens from the *Quercus semecarpifolia* forest of Phulchoki hill. Baniya and Gupta (2002) enumerated a total of 78 species of lichens under 15 families and 17 genera from an altitude of 1,100 to 2,300 m asl., in between line transect of Arun bridge to Tashigaun in the buffer zone of Makalu-Barun National Park. Baniya et al., (2003) studied the floristic composition, use and database of lichens of Kakani, Central Nepal and enumerated 64 species of lichens under 18 families and 21 genera.

2.2 Land use type and species richness

Muir and McCune, (1988) studied the lichen communities of two different areas of different tree growth, and foliar symptoms in relation to air pollutants. They found lichen communities differed significantly between two areas; species richness and total cover were lowest near the utility areas. Rogers, (1990) studied the ecological strategies of lichens and found that the foliose species were often competitive with a high relative growth rate than others. The decreasing importance of crustose growth forms with increasing altitude, especially in forest plots could be influenced by decreasing ecological disturbance.

Lesica et al., (1991) compared lichens and Bryophyte communities between secondary managed and unmanaged grand forest growth in North Western Montana. They observed that old-growth forests have more species of trunk epiphytes than second-growth forests. Species of *Alectoria* (*Sulcaria*) were more abundant in old growth whereas species of *Bryoria* dominated second-growth forests. *Lobaria* species was common in old-growth forests but was absent in second growth and *Cladonia* species were more dominant in second growth forest.

Gustanfsson et al., (1992) studied the important factors that influence to some lichen species of deciduous broad-leaved forest in southern Sweden. The lichen species recorded were significantly correlated with the large, old, deciduous broad-leaved forests. They concluded that unless the forest were protected or had modified management, the lichen species tend to decrease.

Upreti (1997) studied the diversity of the Himalayan lichen. Foliose and fruticose types of lichens belonging to genera *Collema, Leptogium, Pyxine, Physcia and Drinaria* occur in good number in moist places of tropical Himalayan belt. Lichens growing in temperate Himalayan region on the bark are greatly influenced by the physical characters of the bark i.e., smooth or rough surface. Therefore *Caloplaca, Pertusaria, Lecanora, Bacidia* and *Lecidia* thrive on smooth surface. The mature rough bark with cracks and crevices of fully grown trees provide suitable growth of lichens like *Parmelia, Leptogium, Phaeophyscia, Ramalina* and *Usnea* species. He also found that the most common corticolous alpine lichen genera are *Pertusaria,* *Buellia, Ochrolechia* and *Lecanora*.

Gould et al., (1999) analyzed the structure and diversity of the lichen vegetation along an arctic river to determine the relationship between species richness and plant community structure as (1) an increase in the number of communities due to increasing landscape heterogeneity, (2) an increase in the floristic distinctiveness beta diversity as species-poor communities were replaced by species rich communities. Lichen richness was negatively correlated with moisture.

Negi and Upreti (2000) studied species diversity and relative abundance of lichen in Rumbak catchment of Hemis National Park in Ladakh. Rocks were richer than soil in terms of species richness, contributing to more than 80% of total species encountered in the study area. While rocks seemed to provide a relatively stable and very fertile substrate for the rich growth of lichens, soil harboured poor diversity probably due to its unstable top layer augmented with disturbance by the grazing animals.

Stofer et al., (2006) studied the lichen species and its functional group richness pattern in relation to land use intensity and attempted to identify patterns or trends of lichen functional groups along a land use gradients ranging from natural forest to open agricultural landscapes. Relationship between the land use belts and relative species richness of trait classes were analysed. Open and intensively managed landscapes harbour more fertile species while sterile species are relatively more important in forests. A considerable decline in rare lichen species richness as a result of land intensification was predicted.

Svoboda et al., (2009) investigated lichen diversity in temperate oak forest in Central Europe. The effects of natural environmental predictors and human influences on lichen diversity were analysed. They found that lichen diversity responded differently to environmental predictors between two regions with different human impacts. Air pollution was the strongest factor in the industrial region behind the disappearance of lichens. Lichen diversity was strongly influenced by the forest age and forest fragmentation in the agricultural to highly forested regions.

Sharma (2012) studied the species richness pattern along the elevational gradient and different land use types in Manaslu Conservation Area and Sagarmatha National Park, Buffer zone of Nepal. She found linear decreasing pattern of species richness pattern along elevation gradient. She found higher species richness at exploited forest than other land use types: cropland, meadow and natural forest.

2.3 Altitude and lichen species richness

Dietrich and Scheidegger (1997) studied the frequency, diversity and ecological strategies of epiphytic lichens in Swiss Central Plateau and the Pre-Alps. Differences in the lichen diversity, with higher species richness were caused by the bigger altitudinal range in the Pre-alps. Alpha diversity of forest and non-forest were similar whereas each vegetation formation showed one third of its species restricted to it. They concluded that the percentage of crustose and generative lichens declined with every altitudinal step, fruticose and vegetative lichens were found increased and foliose lichens species were also found increasing.

Rai et al., (2011) studied the terricolous lichens as indicator of anthropogenic disturbance at high altitude grassland in Garhwal (Western Himalaya), India. A total of twenty soil lichen species belonging to ten genera, six families and four morphological groups (i.e, leprose, foliose, dimorphic and fruticose) were identified. Terricolous lichen diversity was negatively correlated with altitude. Among the four growth forms fruticose was an indicator of grazing disturbance.

Grytnes et.al, (2006) Compared the species richness patterns of ground dwelling vascular plants, bryophytes and lichens along an altitudinal gradient (310-1135 m asl) in Western Norway. Total species richness peaked at intermediate altitude, vascular plant species richness peaked immediately above forest limit at 600-700 m asl, bryophyte species richness had no statistically significant trend, whereas lichen richness increased from the lowest point and upto the forest limit, with no trend above.

Baniya et al., (2010) studied an elevation lichen species richness pattern in Nepal aimed to compare distribution patterns of different life-forms, substratum affinities, photobiont types and Nepalese endemism. The total number of lichens as well as the number of endemic species (55 spp) showed hump shaped relationships with altitude. Their highest richness was observed between 3100-3400m and 4000-4100m respectively. Almost 33% of the total lichens and 53% of the endemic species occurred above the treeline (>4300m). All growth forms showed a unimodal relationship of richness with altitude, with crustose lichens having a peak at higher altitudes (4100-4200m) than fruticose and foliose lichens

Ozturk et al., (2010) compared the diversity and distribution of epiphytic lichens along an altitudinal gradient (900-1400m) in the Fagetum Zone of Uludag Mountain, Turkey. Twenty four species of epiphytic lichens was significantly related to altitude. Foliose and fruticose lichens showed positive correlation with an altitudinal gradient. Crustose lichens were dominant at all altitudes that did not show a meaningful correlation with an altitudinal gradient.

Panthi (2012) recorded 79 species of herbaceous flowering plant species from Ghunsa valley. Among them 23 species found pre-monsoon and 69 species in post-monsoon. Asteraceae family found as the dominant large family which followed by Cyperaceae. The species richness negatively correlated with elevational gradient, i.e. the species richness decrease with increase in elevation.

Tamang (2013) studied the species richness pattern along the elevational gradient and different land use types in Kanchanjunga Conservation Area. He found monotonically decreasing pattern of species richness pattern along elevational gradient. He found species richness lowest in cropland highest species richness at exploited forest. He found no significant difference in two aspects but quite higher species richness on west facing mountain slope than east facing slope.

2.4 Aspects and lichen richness

Cobanoglu et al., (2009) evaluated an environmental factors limiting the distribution of epiphytic lichens species diversity in 34 sites along an altitudinal gradient from 1300 to 1900 m in north facing and south facing slopes of Elmali, Cedar research Forest (Antalya Province, Turkey) regarding the dispersion of lichens in different tree diameter classes (0-15 cm, 15-30 cm, 30-45 cm 45-60 cm and >75 cm). The highest number of species was occurred in the diameter class of 30-45 cm. Changes in the community structure of the epiphytic lichen vegetation were detected along an altitudinal gradient revealing the highest species richness in the highest zone. The number of species was higher in the north aspects than in the south aspects in all diameter classes.

CHAPTER-3
MATERIALS AND METHODS

3.1 Description of Study Area: Manaslu Conservation Area.
3.1.1 Location and Physiography:
The study was carried out in Manaslu Conservation Area (Figure 1). The Manaslu Conservation Area is located between the latitude of 85º 29' 12.4" to 85 º11'51.114" N and the longitude of 28º20'25.6" to 28º45' 6.68" E. It was declared as conservation area in 1998 by Nepalese Government. It covers an area of 1663 sq. km, ranging from 1400 above sea level (m asl) to Mt. Manaslu 8,163 m asl, bordering the Annapurna Conservation Area to the west, the Tibetan plateau to the north and east and the mid part of Gorkha district to the south. This conservation area comprises seven Village Development Committees (VDCs): Samagaun, Lho, Prok, Bihi, Sirdibas, Chumchet and Chhekampar (Anonymous, 2009).

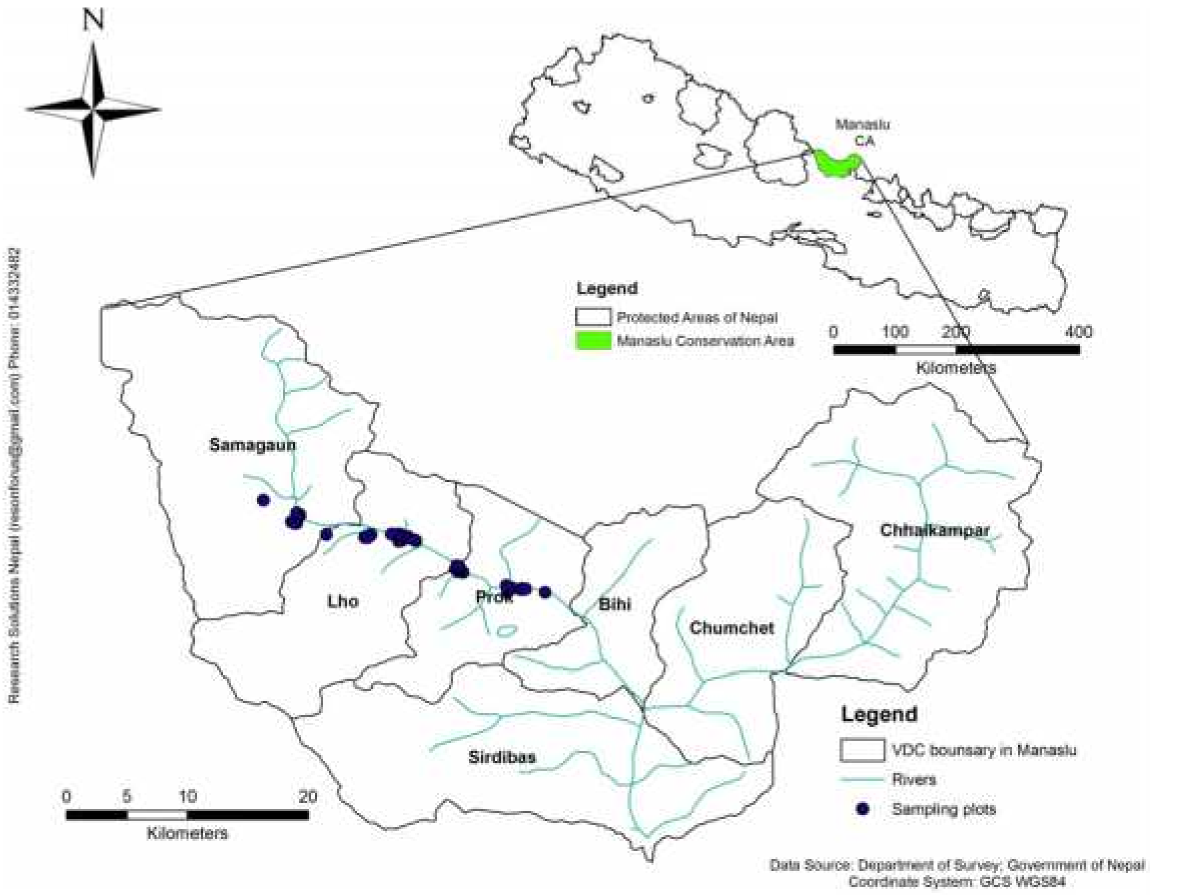

Figure 2: Map of Study Area: Manaslu Conservation Area

The area is characterized by the snow Peak Mountains, river valleys, steep slopes, deep gorges, glacial valleys, ice fields, glaciers and glacial lands. The major river of the area is Budi Gandaki which is fed by a glacier originated from the Birendra Tal there are a number of beautiful high lakes and glaciers. The most beautiful places are Kal Tal (3630 m), Birendra Tal, Prok, Larke, Puingen glacier, Lindanda glacier, Manaslu glacier (Baskota and Sharma, 1995; Mc Eachem and Shah, 1995; Gulrel and Sharma, 1996; Anonymous, 2009).

3.1.2 Climate:

The Manaslu region comprises of five climatic zones (Tropical, Subtropical, Temperate, Subalpine and Alpine) between Arughat to the Larke Pass (Anonynous, 2009, 2010). My study site represents the Subtropical to Alpine bioclimatic zone. Extreme climatic variations can be found in between tropical in the south to alpine in the north. The southern part is warmer with an average temperature of 30 ºC during summer to 10℃ in the winter, while northern part is very cold with below freezing points.

The snow line is found at about 5000 m. Precipitation is in the form of snow and the temperatures drop far below to freezing point towards north. The monsoon falls between June to September. The post monsoon lasts between October to November and the winter months are from December to February which is usually dry. The average rainfall is around 1900 mm per annum. In general, the northern part of the region remain is cloudier and wetter than the upper subalpine areas and alpine areas (Anonymous 2009, 2010).

3.1.3 Vegetation:

The vegetation of MCA falls under three main categories: low hill, Middle Mountain and high Himalayas. Each category has its own kind of elevation limit and specific type of dominant forest associated species. The flora of MCA is estimated to have 1500-2000 species of flowering plants and has been categorized under 19 different forest types (Anonymous, 1998).

The flora of this region includes many endemic plants of the country. The area is also rich in medicinal plants such as *Aconitum spp*., *Nardostachys grandiflora* (Jatamasi), *Dactylorhiza hatagirea* (Panchaunle), *Valeriana jatamsnsi* (Sugandhawal) (Anonymous 2009).

3.1.4 Wildlife:

The Manaslu Conservation Area is rich in both animals and plant diversity. A total of 110 species of birds, 33 species of mammals, 3 species of reptiles, 11 species of butterflies and 2000 species of flora including 19 forest types (Anonymous, 2009). The current checklist included nine species of mammals protected under The Convention on International Trade in Endangered Species of Wild fauna and Flora (CITES). Six species of mammals and one species of bird are protected under Appendix I of National Park and Wildlife Conservation (NPWC) Act, 1973. The snow leopard *(Panthera ucnia, Ucnia ucnia),* Musk deer (*Moschus chrysogaster),* Himalayan Thar *(Hemitragus jimalhicus*) and Ground Squirrel are mammal species symbolic of MCA. Variegated laughing thrush (*Garrulax verigatus),* Grandala (*Grandala coelicolor*) and northern Goshwak (*Accipiter gentiles)* bird species are symbolic to MCA (Anonymous, 2007).

3.1.5 Culture and ethnicity:

The seven VDCs of MCA has multi ethnic diversity in tradition and culture. Its ethnic composition is found influenced by altitude and also their culture. In the southern region, the ethnic communities are Brahmins, Chhetris, Thakuris, Kami, Sarki, Damai, etc. who follow Hinduism. The Northern region is inhabited by Bhotias who follow Buddhism also practice Tibetan language and culture. The northern region has many monasteries (Anonymous, 2009).

3.2 Study design

3.2.1 Field visit

The field was visited during the month of March/April 2011. Study sites at MCA were selected at five different altitudinal levels starting from Gaup (2200 m) to Samagaun (3670 m). At each altitude two aspects (exposition) each on either side of Budi Gandaki River were chosen along the same contour line. At each altitudinal level following four land use types was considered (Scheidegger et al., 2010).

1 .Natural forest- These are pristine forest or with a low anthropogenic influence forest. This includes mainly coniferous trees and mixed broad leaf trees etc. They are normally far from the human settlement.

2. Exploited forests- They include tress of average age > 20 years, where the species composition is altered or exploited for agriculture livestock, collection of fodders and fuels woods or plantation after intensive domestic or commercial forest management.

3. Meadows- They include tree canopy of less than 20% ground coverage. Domestic livestock including goats, buffaloes, cows, yaks and horses graze or browse the vegetation.

4. Cropland- Areas with intensively managed, fertilized, sometimes irrigated and yearly ploughed. On slopes fields are often terraced.

3.2.2 Transects:

A 25×2.5 m² transect was laid at each land use type. The first altitude started from 2200 m asl and then at an interval of 400 m reached up to 3800 m along fifth altitudinal level. Altogether eight transects were laid down on each altitude. Altogether 40 transects were laid to complete this field work. Lichen species occurred inside each transect was recorded. Longitude, Latitude and altitude of each sample plot were recorded by Global Positioning System (GPS).

3.3 Lichen collection and identification

3.3.1 Collection of lichen:

All lichen species dwelled inside each transect were recorded at first. Each different lichen was collected from each transect of study. A total of 40 transects were sampled during this study. Each collected specimens was kept in a separate paper envelope and information such as localities, altitude, aspects, collection number, substratum type and field name of each lichen sample was recorded.

3.3.2 Lichen identification:

The collected specimens were properly identified by observing their morphology and anatomy at first under the dissecting microscope. The key to the macrolichens (Awasthi, 2007) and "The key to the microlichens (Awasthi, 1991) were consulted for the further identification. The anatomical study was done by preparing histological slides as prescribed by Hale (1974). Thin sections of either thallus or apothecia were mounted in KOH and it was stained with cotton blue.

Colour Reaction:

The standard colour reaction procedures for identification of lichens given by Asahina Shibata (1954) as given below has been applied on each lichen thallus during its determination.

- A 10% aqueous (aq.) solution of potassium hydroxide (KOH), which is only represented by 'K was applied upon cortex and medulla of lichen thallus.
- A freshly prepared aq. solution of calcium hypochlorite (CaoCl), which is only represented by 'C' was applied upon the cortex and medulla of that same lichen thallus.
- 'C' was applied on the spot immediately after 'K', which is represented by 'KC'.
- Paraphenylene diamine was used after dissolving in ethanol on the upper cortex and medulla of the same thallus, which is represented by 'PD' or 'P' only.
- An aqueous solution of iodine (I) and 1% solution of potassium iodide (KI) were applied upon the thallus.
- The colour reaction on cortex and medulla were seen on the small piece of the main thallus. The cortex was removed by razor for the observation of reaction on medulla.

Above detailed procedures were applied on each of the lichen specimen at the Laboratory in the Central Department of Botany, TU. Further validation and cross checking were essential to lichens but not possible here in Nepal. Thus all lichen samples were sent to the Lichenologist, Professor Dr. Christoph Scheidegger, Swiss Federal Research Institute, Switzerland. All lichens were re-analyzed by Dr. Christine Keller and C. Scheidegger at WSL, Switzerland.

Critical specimens were investigated by thin-layer chromatography (TLC) at WSL. So, all determinations based on him and his contacts. He is the co-supervisor of this thesis. A high number of taxa did not perfectly match with descriptions provided in regional descriptions. Species names should be used with caution and should names not be found in current checklists this does under no circumstances mean that the taxa should be considered new records for the country or the region.

3.4 Data analysis:

After completion of the field work and confirmed identification of all lichens data entry and data checking were done. The strength in each variable collected was determined first by plotting its residuals, dispersion among data and checking their variances. Square root, log and double log transformations were also tested on not normally distributed data. Non-parametric way of analysis was adopted after they did not improve during normality tests. Species composition and richness were analyzed on the normal data through ordination and regression procedures. A comparative data analysis was done after using different statistical tools and techniques.

3.4.2 The Kruskal-Wallis Rank Sum Test

Kruskal-Wallis Rank Sum test was used to analyse the variation in species richness of lichen with altitude and land use types. It is non parametric test which is an alternative to Analysis of variance (ANOVA).

3.4.3 Wilkoxon W Test

Wilkoxon W Test was done to analyse the variation in species richness of lichens with aspects.

3.4.1 Analysis of Variance (ANOVA)

One-way ANOVA was used to find the significant difference in lichen species richness data to different land use types, aspects and altitudinal gradients.

The Post Hoc analysis, TukeyHSD test was carried out within the result of ANOVA to find more pair wise comparison and significant difference (multiple comparisons of mean) of species richness of lichens within the environmental variables.

3.4.4 Species Composition:

Gradual change in species composition can be expressed by an application of ordination methods on the sample by species data matrix (Leps and Smilauer, 2003). Species composition of sample plots was analyzed after using Detrended Correspondence Analysis (DCA) (Hill and Gauch, 1980). DCA is an indirect ordination technique (Hill and Gauch, 1980; Leps and Smilauer, 2003). Beta diversity of the plots was measured with the help of the axis length of the first DCA axis (Hill and Gauch, 1980). Beta diversity is regarded as the measure of turnover rate in species along spatial or environmental axis.

Environmental variables were overlay on the DCA diagram. The environmental variables were different land use types, aspects and altitude. This helped to explore and explain relationships between species occurrence and environmental conditions.

3.4.4 Software used

R Console version 3.0.2 (R Core Team, 2013) was used for these analyses as well as its graphics, and DCA was performed through package vegan (Oksanen et al., 2013). All default options of DCA such as permutation tests of environmental variables were applied. R is free and widely used software program and basically works under the script designed by different experts. *SPSS* version 17.1 was applied for testing of different relations.

CHAPTER-4

RESULTS

4.1 Status of Lichens in MCA

Altogether 250 species of lichens under 86 genera and 38 families (Appendix 1) reported by this study. The most frequently occurring lichen genera were *Leconara, Cladonia, Heterodermia, Parmotrema, Hypotrachina, Caloplaca Ramalina, Bacidia.* The least occurring genera included were *Collema Leptogium, Chaenotheca, Graphis, Dimerella, Umbilicaria, Xanthoria.* Most frequently occurring family included Parmeliaceae, Physiaceae, Lecanoraceae, Cladoniaceae, verrucariaceae, Ramalinaceae, Teloschistaceae. The least occurring family were Rhizocarpaceae, Stereocaulaceae, Pyrenulaceae, Porpidiaceae, Graphidaceae, Psoraceae, Umbilicariaceae.

The Foiliose lichens have the highest abundance followed by crustose, fruticose, and leprose (Appendix 1).

4.1.1 Land use types and species richness of lichens

There is a statistical significant difference (p = 0.00001, df = 3) among lichen species richness of different land use types (Table 1).

Table 1: ANOVA for total species richness and land use type.

	Sum of Squares	df	Mean Square	F	P
Between Groups	1238.1	3	412.7	9.141	**0.00001**
Within Groups	1625.4	36	45.15		
Total	2863.5	39			

Lichen species richness was found high in natural forest followed by meadow, exploited forest and cropland (Figure 2).

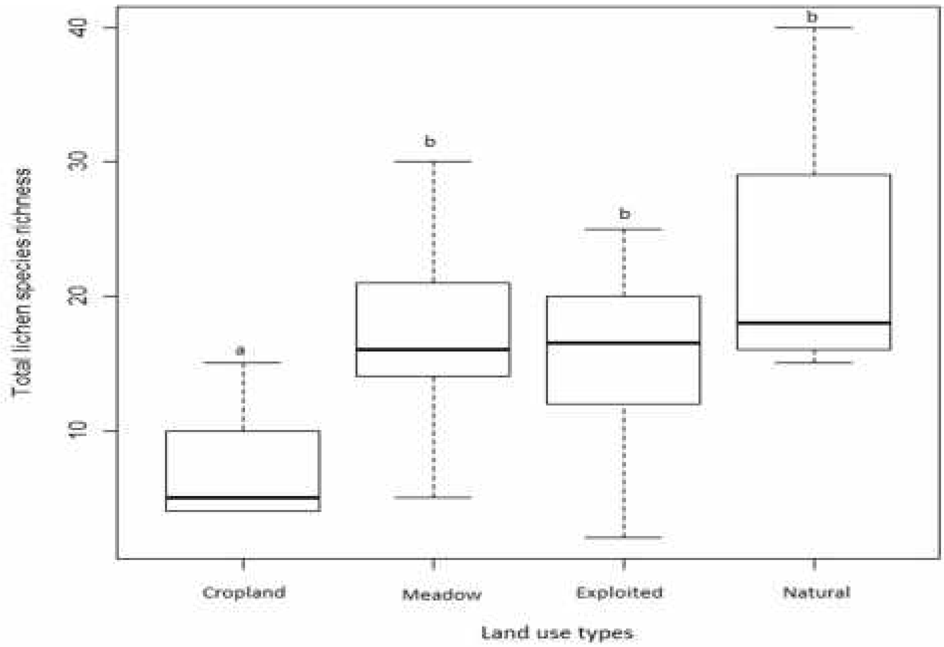

Figure 2: Lichen species richness among different land use types. Two similar letters between two land use types represent significant differences in species richness (Tukey HSD Test).

Post hoc analysis (TukeyHSD Test) revealed that there was more significant difference in species richness of lichens between cropland and meadow, cropland and exploited forest, cropland and natural forest whereas there was no significant difference observed among other land use types (Table 2).Thus the main variation for the species richness of lichens in different land use type is mainly due to major difference in cropland with other three land use types that is meadow, exploited forest and natural forest.

Table 2: Multiple Comparisons of lichen species richness with respect to different land use types (Tukey HSD test). C is cropland, M is meadow, E is exploited forest and F is natural forest, dif =difference, lwr= lower limit, upr= upper limit.

	diff	lwr	upr	p	Remarks
M-C	10	1.7974	18.4026	0.0123	Significant
E-C	9	0.2974	16.9026	0.0401	Significant
F-C	16	7.1974	23.8026	0.0001	Significant
E-M	-2	-9.8026	6.80261	0.9607	Non significant
F-M	5	-2.9026	13.7026	0.3088	Non significant
F-E	7	-1.4026	15.2026	0.1309	Non significant

All four life forms of lichens (crustose, foliose, fruticose and leprose) were found dominant in natural forest followed by meadow, exploited forest and cropland (Figure 3). Foliose lichen was found dominant in all land use types followed by crustose, fruticose and leprose.

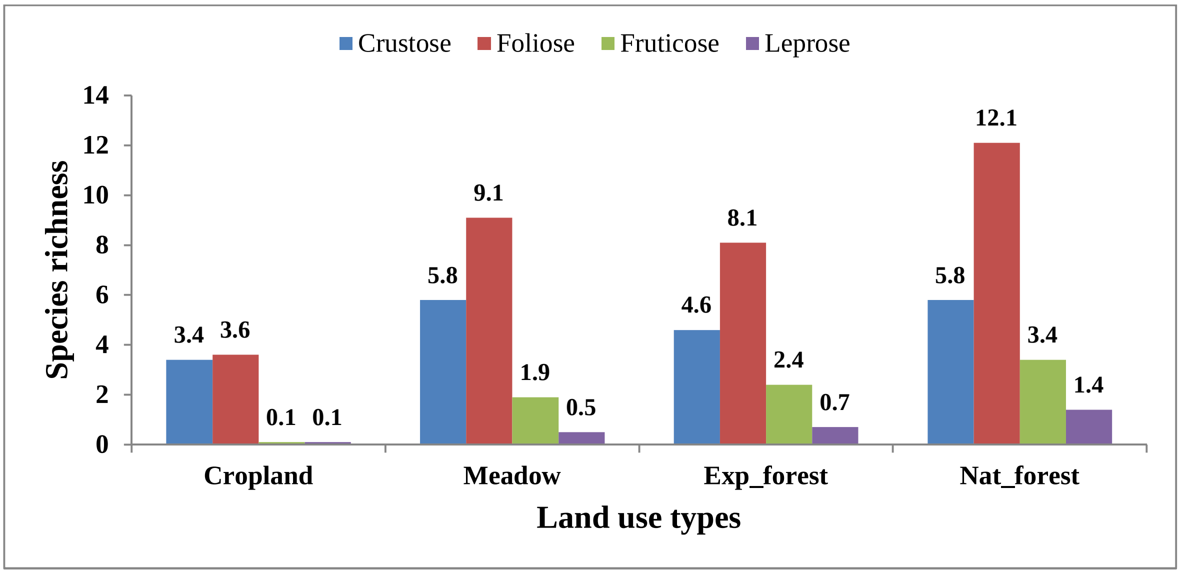

Figure 3: Relationship among lichen life form richness and land use types. Nat-forest represents natural forest and Exp-forest is exploited forest.

Richness of different life forms of lichens showed significant difference with different land use types (Table 3).

Table 3: Kruskal Wallis Test of lichen species richness and land use types

Life-form	**Chi-Square**	**df**	**p**
Crustose	5.371	3	0.147
Foliose	14.527	3	0.002
Fruticose	20.996	3	0.000
Leprose	11.711	3	0.008

4.2.1 Variation of species richness of lichens along altitudinal gradient

Equal lichen species richness was observed at each altitudinal gradient studied in the MCA. The difference was not found statistically significant (Figure 4). There seemed some outliers at 2600 m asl and 3400 m asl. The median value of lichen species richness at each altitudinal gradient showed no significant difference (Figure 4). Altitude was therefore less important than land used types.

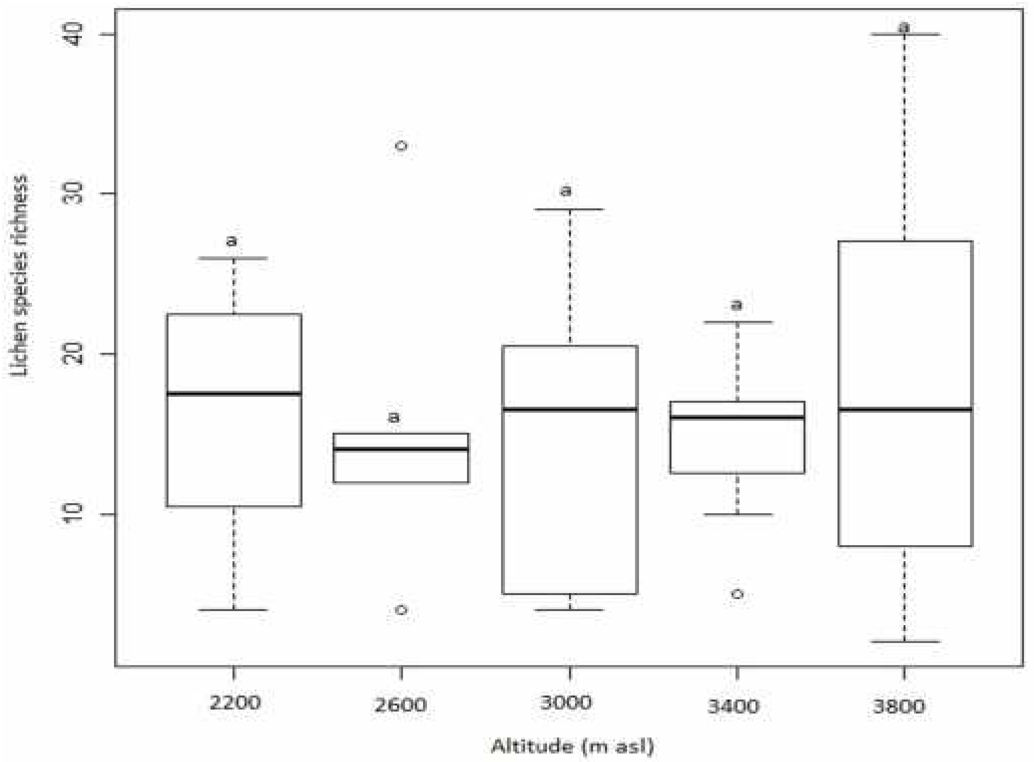

Figure 4: Lichen species richness along the altitudinal gradient at MCA. The darker line inside each box represents the median value. One similar letter between altitudinal gradients represents no significant differences in lichen species richness.

4.2.2 Variation in life-forms along altitudinal gradient

The foliose lichen richness showed the highest richness at all altitudes studied (Figure 5). Crustose showed the second highest richness among all altitudes studied. Crustose lichens were followed by fruticose and leprose (Figure 5). But richness of fruticose lichens showed an increasing trend with altitude (Figure 5).

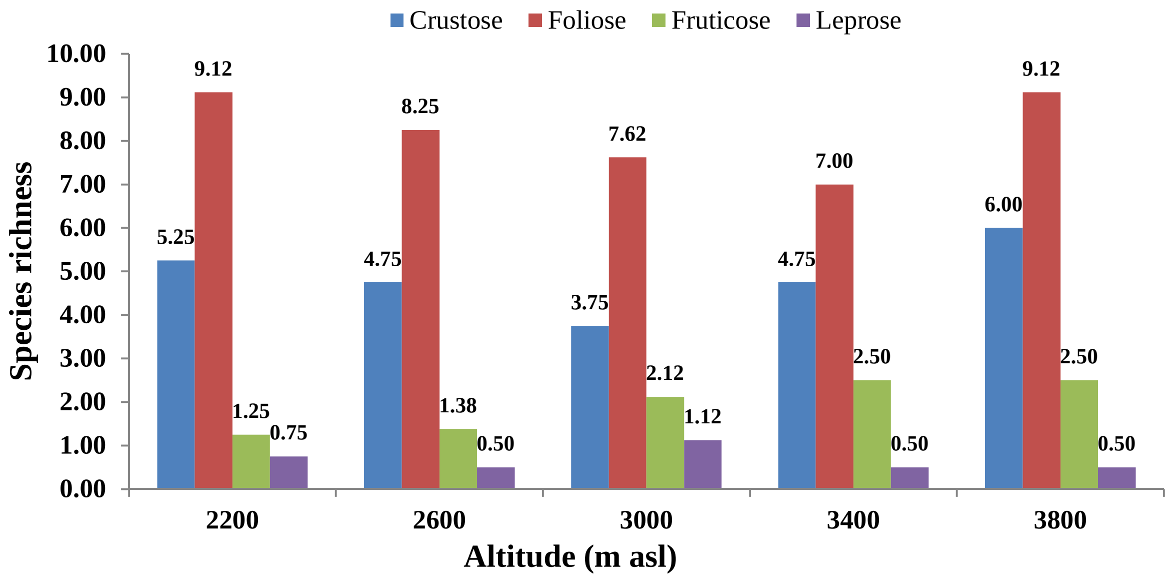

Figure 5: Relationship among species richness (life-form) and altitude.

The Kruskul Wallis test performed on the lichen richness of different life form and their altitudinal gradient since they did not meet normal distribution to see the variation in different life forms of lichens with altitudinal gradient. There was no significant difference found among these life forms of lichens along altitudinal gradients (Table 4).

Table 4: Kruskal Wallis Test of species richness and altitude

Life-form	**Chi-Square**	**df**	**p**
Crustose	2.91	4	0.573
Foliose	0.74	4	0.946
Fruticose	2.01	4	0.734
Leprose	3.34	4	0.503

4.3 Total lichen species richness and their life forms in relation to aspects

There is no statistical significant difference between total lichen species richness with aspects (Table 5). This result is found also true to their life form richness.

Table 5: Wilcoxon W Test for total lichen species richness, their life forms and aspect

	Wilcoxon W	Z	p
Total	371.5	-1.044	0.297
Crustose	382.5	-0.75	0.453
Foliose	389	-0.57	0.569
Fruticose	361.5	-1.347	0.178
Leprose	369.5	-1.216	0.224

4.4 Species composition

The Detrended Correspondence Analysis (DCA) summary showed that there is a strong eigenvalue along by the first axis (Table 6). The total inertia of the data was found to be 8.37. The axis length i.e., length of gradient in terms of standard deviation (*SD*) units for first and second axes were 5.2 *SD* units and 3.82 *SD* units respectively (Table 6). The first and second DCA axes explained 7.2 % and 4.7 % of total variation in the species data respectively.

Table 6: DCA summary of lichen composition in MCA

	DCA1	DCA2	DCA3	DCA4	Total inertia
Eigenvalues	0.611	0.396	0.354	0.332	8.37
Axis lengths	5.287	3.829	4.478	5.529	
Cumulative percentage variance of species data	7.2	4.7	4.2	3.9	

The species composition score values were found statistically significant to elevation ($p \leq 0.001$) and land use types ($p \leq 0.01$) (Table 7). However, here too the species scores did not show statistical significant to aspect.

Table 7: Permutation tests of different environmental variables with DCA axes. *P* values based on 999 permutations and their significant levels were shown.

<table>
<tr><th colspan="2"></th><th>DCA1</th><th>DCA2</th><th>r^2</th><th>p</th></tr>
<tr><td colspan="2">Altitude</td><td>0.195</td><td>-0.981</td><td>0.423</td><td>0.001 ***</td></tr>
<tr><td rowspan="2">Aspect</td><td>East</td><td>0.354</td><td>-0.082</td><td rowspan="2">0.051</td><td rowspan="2">0.191</td></tr>
<tr><td>West</td><td>-0.282</td><td>0.066</td></tr>
<tr><td rowspan="4">Land use type</td><td>Cropland</td><td>1.824</td><td>0.184</td><td rowspan="4">0.470</td><td rowspan="4">0.001 ***</td></tr>
<tr><td>Exploited forest</td><td>-0.677</td><td>-0.285</td></tr>
<tr><td>Natural forest</td><td>-0.783</td><td>0.129</td></tr>
<tr><td>Meadow</td><td>0.888</td><td>0.028</td></tr>
</table>

The DCA diagram for species composition (Figure 6) showed that there was a good dispersion among species along the first two main axes. From left to right or vice versa along the DCA first axis represents land use types. The highest abundance of species occurred towards the left end of the first axis represents the species of open land (i.e., cropland and meadow) like *Aspicilia contorta*, *Lepraria* sp, *Cladonia pocillum*, *Diploschistes scruposus, Staurothele succedes, Caloplaca holoccarpa*, *Pertusaria acuta*, *Peltigera didactyla, Physcia dilata* (Figure 6). Similarly, the highest abundance of species occurred towards the right hand side of the first axis which represents species found in forest (i.e., Natural and Exploited) such as *Lecanora albella, Menegazzia terebrata*, *Nephromopsis pallescens, Parmotrema nilgherrense, Haematomma sp., Parmotrema pseudonilgherrense, Lecanora rugosella, Pertusaria multipuncta*. From up to down or vice versa along the DCA second axis represents altitude. Species like *Tuckeneria laureri, Buellia montana, Peltigera praetexta, Everniastrum nepalensis, Sticta nylanderiana,* represent species limited to higher altitude. In the same way species like *Heterodermia obscurta Pyxine sorediata, Psilolechia lucida, Peltigera dolichorrhiza*, *Cetrelia pseudolivetorum,* represent low altitude loving species (Figure 6).

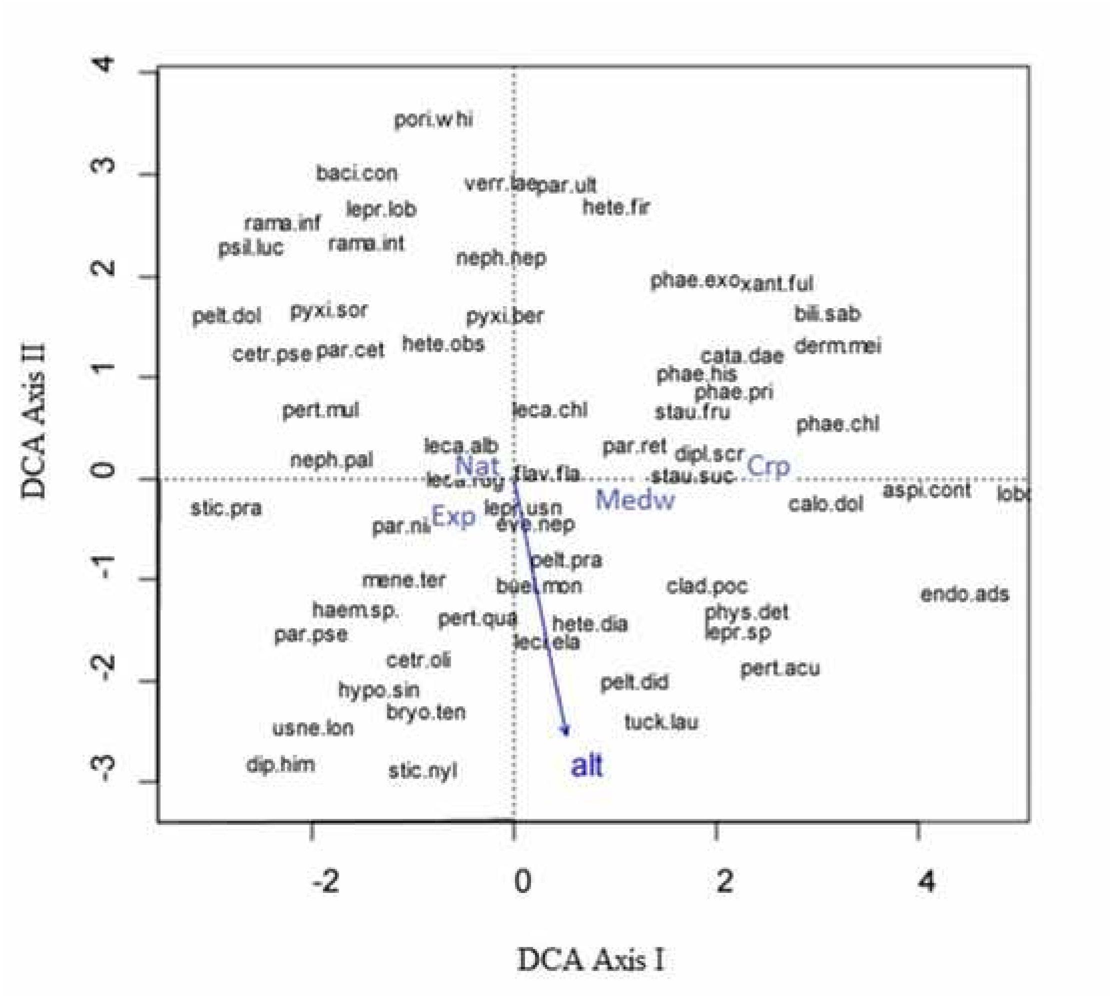

Figure 6: DCA diagram of lichen species occurred in different transects of Manaslu Conservation area with overtop of different statistically significant environmental variables. (Crp = cropland land, Medw = meadow, Exp = exploited forest, Nat = natural forest and alt = altitude). Three letters of generic and species names are used for the notation of each species. Full form of each species name is given at Appendix 1.

CHAPTER-5

DISCUSSION

5.1 Species richness of lichens in different land use types

The present study is carried out in four different land use types namely cropland, meadow, exploited forest and natural forest. This study found four different types of variation in species richness as land use types. Species richness was found highest in natural forest followed by meadows, exploited forests and croplands. Many factors may be collectively acting with land use changes.

Lichen species richness decreased from landscapes dominated by forests to open agricultural land (Stofer et al., 2006). Similar results have been presented by many studies (Gustafsson et al., 1992; Lesica et al., 1991; Muir and Mc Cune, 1988; Negi and Gagil, 1996). In this study also species richness was high in natural forest. It might be true as natural forest contains mature old trees hence gets more lichen species richness. The characteristic of old trees is that it provides better habitat for lichen species. The mature rough barks with cracks and crevices of fully grown trees provide suitable habitats for growth of lichens like *Parmelia* sp, *Leptogium* sp, *Phaeophyscia* sp, *Ramalina* sp and *Usnea* sp species. This finding coincides with the finding of Upreti, (1997).

Findings of lower number of lichen species at cropland land in this study is nearly similar pattern to Muir and McCune (1988); Negi and Upreti, (2000) and (Svoboda et al., 2009). I agreed to their justification as soil harbours poor number of lichen species due to its unstable top layer as augmented with disturbance by the grazing animals and other anthropogenic disturbances. Muir and McCune (1988) found lichen species richness and total cover lowest at near the utility areas. Similarly, disturbed forest (exploited forest) is poor in lichen species richness. It might be because lichen diversity is strongly influenced by forest age and forest fragmentation, disturbed forest possesses younger trees which do not provide proper substrates for lichen growth (Svoboda et al., 2009).

Though, meadows are composed of more shrubs and herbaceous species but rich in lichen species richness. It might be due to meadow possesses number of rocks as substrates. Rocks provide a relatively stable and fertile substrate for rich growth of lichens as stated by Negi and Upreti, (2000).

5.2 Species richness of lichens and altitudinal gradients

There are many studies which suggest that there is correlation between altitude and species richness. Some of the studies involving vascular plants have found that there is maximum richness at intermediate altitudes showing a hump shaped relationship (Lomolino, 2001;

Bhattarai and Vetaas, 2003, Whittaker, 1960; Whittaker and Neiring, 1975; Lieberman et al., 1996; Kessler 2000,Grytnes and Vetaas,2002; Grytnes, 2003). Other studies on the same taxonomic group reported monotonically decreasing trends (Hamilton, 1975; Odland and Birks, 1999; Grytnes, 2003; Fossa, 2004). Similarly, studies regarding lichens species richness with altitude have shown meaningful correlation. Sharma et al., (2009) collected maximum lichen species at lower altitude (2250-1850 m asl) medium at mid altitude (2600-2400 m asl) and lowest at higher altitude (2800-2400 m asl). In the same way unimodal relationship was found by many studies (Brunn et al., 2006; Grytnes et al., 2006; Baniya et al., 2010). Grytnes et al., (2006) found lichen richness increased from the lowest point and up to the forest limit and no trend afterwards.

In the present study species richness didn’t vary significantly, it might be due to less number of altitudinal gradients and almost similar habitat types respectively. But species richness of lichens is found maximum at highest altitudinal gradient. Similar results were found by Baniya et al. (2010) and Cobanoglu et al., (2009). Total richness for lichens occurs at higher altitudes than for any other groups (vascular plants) studied (Baniya et al., 2010). The important factor for such richness might be due to response of existing habitat types. The forest at 3800 m asl were relatively thicker with large number of mature coniferous trees with bark differing in roughness. The lichen species richness is significantly correlated with the large, old, deciduous broad-leaved woods that provide a wide variety of habitats for lichens (Gustafsson et al., 1992). Similarly the meadow in 3800 m asl consists of large number of rocks. Rocks provide a relative stable and very fertile substrate for rich growth of lichens (Negi and Upreti, 2000). From these above different findings, lichen species richness does not show strictly same altitudinal pattern within the same landscape of a country of different geographies.

In the same way, many studies have shown meaningful correlation between life forms of lichen with altitude. Dietrich and Scheidegger (1997) concluded that the percentage of crustose and generative lichens declined with every altitudinal step, fruticose and vegetative lichens were found increased and foliose lichens species were also found increasing. Pinokiyo *et al.*, (2008) reported a greater number of foliose species in the intermediate altitudes and fruticose lichens were absent from lower altitudes in India and among growth forms, crustose lichens accounted for 56 % of the lichen flora, whereas

Foliose lichens represented 34 % and fruticose lichens 8 % and there is only one squamulose species. Baniya et al., (2010) found fruticose lichen richness maximum at higher attitude than foiliose lichens.

In the present study among the different life forms foliose lichen reached the highest richness at all altitudinal gradients. After foliose, crustose has the highest richness followed by fruticose and leprose all altitudinal gradients. But fruticose lichen has shown the increasing trend along different altitudinal gradients. High richness of foliose and fruticose lichen might be due to that epiphytic macrolichens are known for their drought tolerance and high light requirement (Pentecost, 1998, Gauslaa and Solhaug, 1996) which might support its high richness. Similarly, Leppik and Jüriado (2008) indicated that more lichens of foliose and fruticose growth forms occurred in the open habitats than in the overgrown stands. These findings as well as my findings related on life forms can state that no particular life form and altitudinal gradients are strictly suitable and distinctive to the lichen species richness.

5.3 Species richness of lichens between the aspects

Aspects play effective role in the distribution of vegetation structure (Nuzzo, 1996). There may be several reasons for the difference in the species richness in two aspects. In the Himalayas, northern aspects are relatively moister with a higher closed canopy than southern aspects. These differences in microclimate between the north and south aspects are observed through differences in the composition and richness of the species (Pook and Moore, 1996). Lichen species richness is also affected by aspects. The results of Cobanoglu et al., (2009), and Temina et al. (2009) also showed that more humid north facing slope harbored high lichen richness than south facing slope. No significant variation in lichen species richness between the aspects in my study might be due to presence of almost similar habitat types required for lichens. A big river passes between two aspects may create almost similar microhabitats at ground level of the river. That may increase when their distance of separation increase. Thus aspect here accounted less than similar studies done elsewhere.

5.4 Species Composition

A complete turnover of species along the environmental variable was found to be similar to Baniya *et al* (2009), Panthi (2012), Sharma (2012), Katuwal (2013). The length of gradient for first axis was found greater than 4 *SD* units, that indicates the area is highly heterogeneous and rich in beta diversity which also similar as Baniya *et al* (2009), Panthi (2012), Sharma (2012) and others. The species found at one end of the gradient are distinctly different than another end of gradient (DCA diagram). The length of gradient was found greater than 1.5 which indicates the unimodal relationship of species with the elevation as well as land use types. The elevation and land use types are highly significant for change in species composition but the aspect has no significant role on it. DCA diagram indicates that there is high abundance in species found towards mid elevation and decreasing towards higher and lower altitudinal gradient was found similar as Grytnes et al., (2003); Baniya *et al* (2009), Sharma (2012). The land use types also showed the unimodal pattern of species composition. The cropland has poor species richness compared to other land use types also found same as Sharma (2012).

CHAPTER-6
CONCLUSIONS

The MCA is rich in different forms of lichen species in the natural surroundings. The lichen species richness and its composition were assessed within different land use types, altitudinal gradients and aspects. During this study period, altogether 250 species of lichens under 86 genus and 38 families within 40 plots, from 2200 m to 3670 m at the interval of 400 m along the catchment of Budi Gandaki River were recorded. Lichen species richness was interrelated with the land use types. There was significant differences in lichen species richness among the land use types. There was no marked variation in species richness of lichens between meadow and exploited forest. But the variation was prominent between forests and cropland. However, species richness of lichens didn't vary significantly along altitudinal gradients and within the aspects. The DCA diagram for species composition showed good dispersion among species along first two axes. Permutation result showed that altitude, natural forest and cropland were important environmental variables to structure the composition of lichens. A big river when passing between two aspects at high altitudes may create almost similar microhabitats. That may homogenize the habitats. Hence, there is no significant role of aspect on lichen species richness. But it has to be tested by the future research.

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APPENDIX

S.N	Lichen species	Short form	Family	Frequency	Life form	Land Use Type
1	*Agonimia sp* Zahlbr.	agon	Verrucariaceae	1	crustose	E
2	*Agonimia tristicula* (Nyl.) Zahlbr.	agon tri	Verrucariaceae	1	crustose	F
3	*Aspicilia calcarea* (L.) Mudd	aspi cal	Megasporaceae	1	crustose	M
4	*Aspicilia cinerea* (L.) Körb.	aspi cin	Megasporaceae	2	crustose	M
5	*Aspicilia contorta* (Hoffm.) Körb.	aspi cont	Megasporaceae	7	crustose	C, M
6	*Aspicilia griseocinerea* Rasanen	aspi gri	Megasporaceae	1	crustose	E
7	*Aspicilia radiosa* (Hoffm.) Poelt & Leuck.	aspi rad	Megasporaceae	1	crustose	M
8	*Bacidia convexula* (Miill. Arg.) Zahlbr.	baci con	Bacidiaceae	2	crustose	F
9	*Bacidia egenula* (Nyl.) Arnold	baci ege	Bacidiaceae	1	crustose	M
10	*Bacidia laurocerasi* (Delise ex Duby) Zahlbr.	baci lau	Bacidiaceae	9	crustose	E, F, M
11	*Bacidia millegrana* (Taylor) Zahlbr.	Baci mil	Bacidiaceae	3	crustose	E, C
12	*Bacidia nigrosticta* Zahlbr.	baci nig	Bacidiaceae	1	crustose	F
13	*Bacidia phacodes* Korber	baci pha	Bacidiaceae	4	crustose	E, F, M
14	*Bacidia rosella* (Pers.) de Not.	baci ros	Bacidiaceae	1	crustose	M
15	*Bacidia rubella* (Hoffm.) A.Massal.	baci rub	Bacidiaceae	2	crustose	F
16	*Bacidia submedialis* (Nyl.) Zahlbr.	baci sub	Bacidiaceae	1	crustose	E
17	*Biatora subduplex* (Nyl.) Printzen	biat sub	Ramalinaceae	1	crutose	F
18	*Bilimbia sabuletorum* (Schreb.) Arnold	bili sab	Lecanoromycetes	3	crustose	C, M
19	*Bryoria tenius* (Å.E.Dahl) Brodo & D.Hawk	bryo ten	Parmeliaceae	3	fruticose	E, F
20	*Buellia disciformis* (Fr.) Mudd	buel dis	Physciaceae	1	crustose	E
21	*Buellia dispersa* A. Massal	buel dis	Physciaceae	1	crustose	C
22	*Buellia inornata* (Stirt.) Zahlbr.	buel ino	Physciaceae	1	crustose	F
23	*Buellia montana* H. Magn.	buel mon	Physciaceae	5	crustose	E, F, M
24	*Buellia poeltii* T. Schauer	buel poe	Physciaceae	1	crustose	E
25	*Buellia polyspora* (Willey) Vain.	buel pol	Physciaceae	2	crustose	E
26	*Buellia tincta* H. Magn.	buel tin	Physciaceae	2	crustose	E
27	*Caloplaca cf. diphyodes*	calo dip	Teloschistaceae	1	crustose	M
28	*Caloplaca cf. handelii*	calo han	Teloschistaceae	1	crustose	M
29	*Caloplaca cf. vitellinula*	calo vit	Teloschistaceae	1	crustose	F
30	*Caloplaca citrina* (Hoffm.) Th.Fr.	calo cit	Teloschistaceae	2	crustose	F, M
31	*Caloplaca dolomiticola* (Hue) Zahlbr.	calo dol	Teloschistaceae	8	crustose	C, E, F, M,
32	*Caloplaca flavorubescens* (Huds.) J.R. Laundon	calo fla	Teloschistaceae	4	crustose	E, M
33	*Caloplaca holocarpa* A.E.Wade	calo hol	Teloschistaceae	1	crustose	C
34	*Caloplaca scotoplaca* (Nyl.) H. Magn.	calo sco	Teloschistaceae	1	crustose	M
35	*Candelaria indica* (Hue) Vain.	cand ind	Candelariaceae	5	foliose	E, F, M
36	*Candelariella aurella* (Hoffm.) Zahlbr.	cand aur	Candelariaceae	1	crustose	E
37	*Candelariella sorediata*	cand sor	Candelariaceae	1	crustose	F
38	*Candelariella vitellina* (Ehrh.) Müll.Arg.	cand vit	Candelariaceae	1	crustose	C
39	*Candelariella xanthostigma* (Pers. ex Ach.) Lettau	cand xan	Candelariaceae	2	crustose	F, M
40	*Catapyrenium cinereum* (Pers.) Körb.	cata cin	Verrucariaceae	1	sqamulose	C
41	*Catapyrenium daedalium* (Kremp.) Stein	cata dae	Verrucariaceae	3	sqamulose	C, F, M
42	*Cetrelia cetrarioides* (Delise) W.L.Culb. & C.F.Culb.	cetr cet	Parmeliaceae	8	foliose	E, F, M
43	*Cetrelia collata* (Nyl.) W.L.Culb. & C.F.Culb.	cetr col	Parmeliaceae	1	foliose	F
44	*Cetrelia olivetorum* (Nyl.) W.L.Culb. & C.F.Culb.	cetr oli	Parmeliaceae	4	foliose	E, F, M

45	*Cetrelia pseudolivetorum* (Asahina) W.L.Culb. & C.F.C	cetr pse	Parmeliaceae	4	foliose	E, F
46	*Chaenotheca chrysocephala* (Turner ex Ach.) Th.Fr.	chae chr	Coniocybaceae	3	crustose	E, F
47	*Chaenotheca furfuracea* (L.) Tibell	chae fur	Coniocybaceae	1	crustose	F
48	*Chaenotheca hygrophila* Tibell	chae hyg	Coniocybaceae	1	crustose	F
49	*Chaenotheca phaeocephala* (Turner) Th.Fr.	chae pha	Coniocybaceae	1	crustose	F
50	*Chaenotheca trichialis* (Ach.) Th.Fr.	chae tri	Coniocybaceae	1	crustose	F
51	*Chrysothrix candelaris* (L.) J.R. Laundon	chry can	Chrysothricaceae	8	leprose	C, F
52	*Cladoina corniculata* Ahti & Kashiw	clad cor	Cladoniaceae	1	fruticose	F
53	*Cladonia coccifera* (L.) Willd.	clad coc	Cladoniaceae	1	fruticose	E
54	*Cladonia coniocraea* (FlOrke) Spreng.	clad con	Cladoniaceae	9	fruticose	C, E, F, M,
55	*Cladonia fimbriata* Asahina	clad fim	Cladoniaceae	1	fruticose	M
56	*Cladonia furcata* (Huds.) Schrad.	clad fur	Cladoniaceae	2	fruticose	C, M
57	*Cladonia macilenta* (Hoffm.) Nyl.	clad mac	Cladoniaceae	1	fruticose	E
58	*Cladonia ochrochlora* Flörke	clad och	Cladoniaceae	5	fruticose	E, F, M
59	*Cladonia poccillum* (Ach.) Grognot	clad poc	Cladoniaceae	5	fruticose	F, M
60	*Cladonia praetermissa* A. W. Archer	clad pra	Cladoniaceae	1	fruticose	M
61	*Cladonia pyxidata* (L.) Hoffm	clad pyx	Cladoniaceae	4	fruticose	C, M, F
62	*Cladonia scabriuscula* (Delise) Nyl.	clad sca	Cladoniaceae	1	fruticose	F
63	*Cladonia sp.*	clad sp	Cladoniaceae	1	fruticose	M
64	*Cladonia sp. 1*	clad sp1	Cladoniaceae	1	fruticose	F
65	*Cladonia subsquamosa* Kremp	clad sub	Cladoniaceae	1	fruticose	F
66	*Collema cristatum* (L.) G.H. Web.	coll cri	Collemataceae	1	foliose	M
67	*Collema fuscovirens* (With.) J.R. Laundon	coll fus	Collemataceae	1	foliose	M
68	*Dermatocarpon meiophyllizum* Vain.	derm mei	Verrucariaceae	2	foliose	M
69	*Dimerella lutea* Trevis.	dime lut	Gylectaceae	3	crustose	E, F
70	*Dimerella pineti* (Ach.) Vezda	dime pin	Gylectaceae	1	crustose	F
71	*Diploschistes scruposus* (Schreb.) Ehrh.	dipl scr	Thelotremataceae	6	crustose	F, M
72	*Diplotomma cf himalayense*	dip him	Physciaceae	1	crustose	E
73	*Diplotomma epipolium* (Ach.) Arnold	dip epi	Physciaceae	1	crustose	M
74	*Diplotomma sp.*	dip sp	Physciaceae	1	crustose	E
75	*Endocarpon adscendens* (Anzi) Müll. Arg.	endo ads	Verrucariaceae	2	foliose	M, C
76	*Endocarpon nanum* A. Singh & Upreti	endo nan	Verrucariaceae	1	foliose	M
77	*Endocarpon pusillum* Hedw.	endo pus	Verrucariaceae	2	foliose	C, M
78	*Evernia mesomorpha* Nyl.	ever mes	Parmeliaceae	1	fruticose	M
79	*Everniastrum cirrhatum* (Fr.) Hale ex Shipman	eve cirr	Parmeliaceae	8	foliose	C, E, F, M,
80	*Everniastrum nepalensis* (Taylor) Hale ex Shipman	eve nep	Parmeliaceae	8	foliose	C, E, F, M,
81	*Flavoparmelia caperata* (L.) Hale	flav cap	Parmeliaceae	4	foliose	E, F, M
82	*Flavopunctelia flaventior* (Stirt.) Hale	flav fla	Parmeliaceae	11	foliose	C, E, F, M,
83	*Graphis scripta* (L.) Ach.	grap scr	Graphidaceae	1	crustose	E
84	*Graphis sp.*	grap sp	Graphidaceae	1	crustose	E
85	*Gyalecta sp. 2-celled*	gyal sp	Gylectaceae	1	crustose	F
86	*Haematomma leprarioides*	haem lep	Haematommaceae	1	crustose	F
87	*Haematomma puniceum* (Sw.) A.Massal.	haem pun	Haematommaceae	1	crustose	F
88	*Haematomma sp.*	haem sp.	Haematommaceae	2	crustose	E, F
89	*Heterodermia angustiloba* (Müll.Arg.) D.D.Awasthi	hete ang	Physciaceae	1	foliose	C
90	*Heterodermia boryi* (Fée) Hale	hete bor	Physciaceae	8	foliose	F, M
91	*Heterodermia comosa* (Eschw.) Awas.	hete com	Physciaceae	1	foliose	M

92	*Heterodermia diademata* (Taylor) D.D.Awasthi	hete dia	Physciaceae	5	foliose	C, E, M,
93	*Heterodermia dissecta* (Kurok.) D.D.Awasthi	hete dis	Physciaceae	1	foliose	E
94	*Heterodermia firmula* (Nyl.) Trevis.	hete fir	Physciaceae	3	foliose	F, M
95	*Heterodermia incana* (Stirt.) D.D.Awasthi	hete inc	Physciaceae	3	foliose	E, F, M
96	*Heterodermia isidiophora* (Nyl.) D.D.Awasthi	hete isi	Physciaceae	1	foliose	F
97	*Heterodermia obscurata* (Nyl.) Trevis.	hete obs	Physciaceae	6	foliose	E, F, M
98	*Heterodermia propagulifera* (Vain.) J.P. Dey	hete pro	Physciaceae	1	foliose	E
99	*Heterodermia speciosa* (Wulfen) Trevis.	hete spe	Physciaceae	6	foliose	F, M
100	*Hypogymnia vittata* (Ach.) Parrique	hypo vit	Parmeliaceae	3	foliose	E, F
101	*Hypogymnia wattiana* (MUll. Arg.) D. D. Awasthi	hypo wat	Parmeliaceae	1	foliose	F
102	*Hypotrachina brevirrhiza*	hypo bre	Parmeliaceae	1	foliose	E
103	*Hypotrachina crenata (Kurok. in Hale & S.Kurokawa) Hale*	hypo cre	Parmeliaceae	1	foliose	F
104	*Hypotrachina exsecta* (Taylor) Hale	hypo exs	Parmeliaceae	3	foliose	C, E, M,
105	*Hypotrachina neosingularis*	hypo neo	Parmeliaceae	1	foliose	F
106	*Hypotrachina revoluta* (Nyl.) Hale	hypo rev	Parmeliaceae	1	foliose	F
107	*Hypotrachina rigidula*	hypo rig	Parmeliaceae	1	foliose	E
108	*Hypotrachina sinuosa* (A.R.Sm.) Hale	hypo sin	Parmeliaceae	5	foliose	E, F
109	*Immersaria athroocarpa* (Ach.) Rambold & Pietschm	imme ath	Lecideaceae	1	crustose	C
110	*Ionaspis lacustris* (With.) Lutzoni	iona lac	Hymeneliaceae	1	crustose	M
111	*Lecanora aff. frustulata*	leca aff	Lecanoraceae	2	foliose	E, M
112	*Lecanora albella* (Pers.) Ach.	leca alb	Lecanoraceae	8	foliose	E, F, M
113	*Lecanora argentata* (Ach.) Malme	leca arg	Lecanoraceae	2	foliose	E, F
114	*Lecanora cateilea* (Ach.) A. Massal.	leca cat	Lecanoraceae	1	foliose	M
115	*Lecanora cenisia* Ach.	leca cen	Lecanoraceae	1	foliose	M
116	*Lecanora chlarotera* Nyl.	leca chl	Lecanoraceae	12	foliose	C, E, F, M,
117	*Lecanora circumborealis* Brodo & Vitik.	leca cir	Lecanoraceae	1	foliose	E
118	*Lecanora expersa* Nyl.	leca exp	Lecanoraceae	1	foliose	M
119	*Lecanora flavopunctata* Tønsberg	leca fla	Lecanoraceae	1	foliose	E
120	*Lecanora muralis* (Schreb.) Rabenh.	leca mur	Lecanoraceae	6	foliose	C, M
121	*Lecanora pseudistera* Nyl.	leca pse	Lecanoraceae	1	foliose	M
122	*Lecanora rugosella* Zahlbr.	leca rug	Lecanoraceae	6	foliose	E, F, M
123	*Lecanora sp.*	leca sp	Lecanoraceae	1	foliose	F
124	*Lecanora sp. brown-yellow*	leca bry	Lecanoraceae	1	foliose	M
125	*Lecanora sp. white*	leca whi	Lecanoraceae	1	foliose	M
126	*Lecanora subrugosa* Nyl.	leca sub	Lecanoraceae	2	foliose	E, F
127	*Lecanora tschomolongmae* Poelt	leca tsc	Lecanoraceae	1	foliose	M
128	*Lecidea molybdochroa* Hertel	leci mol	Lecideaceae	1	crustose	M
129	*Lecidea nylanderi* (Anzi) Th. Fr.	leci nyl	Lecideaceae	1	crustose	F
130	*Lecidella carpathica* Körb.	leci car	Lecanoraceae	2	crustose	M
131	*Lecidella elaeochroma* (Ach.) M. Choisy	leci ela	Lecanoraceae	10	crustose	E, F, M
132	*Lecidella sp. sored.*	leci sp.	Lecanoraceae	1	crustose	F
133	*Lepraria eburnea*	lepr ebu	Stereocaulaceae	1	leprose	F
134	*Lepraria lobificans* Nyl.	lepr lob	Stereocaulaceae	4	leprose	F
135	*Lepraria obtusatica* Tønsberg	lepr obt	Stereocaulaceae	1	leprose	E
136	*Lepraria sp.*	lepr sp	Stereocaulaceae	1	leprose	M
137	*Lepraria usnica* Sipman	lepr usn	Stereocaulaceae	8	leprose	E, F, M
138	*Leproloma vouauxii* (Hue) J.R. Laundon	lep vou	Stereocaulaceae	3	leprose	E, F

139	*Leptogium burnetiae* Dodge	lept bur	Collemataceae	1	foliose	F
140	*Leptogium lichenoides* (L.) Zahlbr.	lept lic	Collemataceae	1	foliose	M
141	*Leptogium saturninum* (Dicks.) Nyl.	lept sat	Collemataceae	1	foliose	E
142	*Lobaria fuscotomentosa* Yoshim.	loba fus	Lobariaceae	2	foliose	F
143	*Lobaria isidiosa* (Müll.Arg.) Vain.	loba isi	Lobariaceae	2	foliose	E, F
144	*Lobaria pindarensis* Räsänen	loba pin	Lobariaceae	2	foliose	E, F
145	*Lobaria retigera* (Bory) Trev.	loba ret	Lobariaceae	1	foliose	E
146	*Lobothallia praeradiosa* (Nyl.) Hafellner	lobo pra	Megasporaceae	1	crustose	C
147	*Megalaria grossa* (Pers. ex Nyl.) Hafellner	mega gro	Megalariaceae	1	crustose	F
148	Melanelixia fuliginosa (Fr. ex Duby) O. Blanco, A. Crespo, Divakar	mela ful	Parmeliaceae	1	foliose	F
149	*Melanelixia subargentifera* (Nyl.) O. Blanco, A. Crespo, Divakar, Essl.	mela sub	Parmeliaceae	1	foliose	M
150	*Melanohalea olivacea* (L.) Blanco, Crespo, Divakar, Essl.	mela oli	Parmeliaceae	1	foliose	F
151	*Menegazzia terebrata* Hoffm. ex A.Massal.	mene ter	Parmeliaceae	14	foliose	E, F, M
152	*Microthelia sp*	micr sp	Arthopyreniaceae	1	crustose	M
153	*Mycobilimbia epixanthoides*	myco epi	Porpidiaceae	2	crustose	C, M
154	*Mycoblastus sp.*	myco sp	Mykoblastaceae	1	crustose	M
155	*Nephroma sikkimense* Asahina	neph sik	Nephromataceae	1	foliose	F
156	*Nephroma sp.*	neph sp	Nephromataceae	1	foliose	C
157	*Nephromopsis nephromoides* (Nyl.) Ahti & Randlane	neph nep	Parmeliaceae	2	foliose	F
158	*Nephromopsis pallescens* (Schaer.) Park	neph pal	Parmeliaceae	6	foliose	E, F
159	*Ochrolechia rosella* Poelt	ochr ros	Pertusariaceae	2	crustose	F
160	*Parmelia squarrosa* Hale	parm squ	Parmeliaceae	2	foliose	E, F
161	*Parmelina quercina* (Willd.) Hale	par que	Parmeliaceae	2	foliose	E, F
162	*Parmelinella wallichiana* (Taylor) Elix & Hale	par wal	Parmeliaceae	1	foliose	F
163	*Parmelinopsis minarum* (Vain.) Elix & Hale	par min	Parmeliaceae	1	foliose	E
164	*Parmotrema cetratum* (Ach.) Hale	par cet	Parmeliaceae	2	foliose	F, M
165	*Parmotrema cf. Arnoldii*	par cf	Parmeliaceae	1	foliose	F
166	*Parmotrema crinitoides* J.c. Wei	par cri	Parmeliaceae	1	foliose	M
167	*Parmotrema eunetum* (Stirt.) Hale	par eun	Parmeliaceae	1	foliose	M
168	*Parmotrema nilgherrrense* (Nyl.) Hale	par nil	Parmeliaceae	6	foliose	E, F
169	*Parmotrema praesorediosum* (Nyl.) Hale	par pra	Parmeliaceae	2	foliose	E, M
170	*Parmotrema pseudonilgherrense* (Asahina) Hale	par pse	Parmeliaceae	2	foliose	E
171	*Parmotrema rampoddense* (Nyl.) Hale	par ram	Parmeliaceae	4	foliose	E, M
172	*Parmotrema reticulatum* (Taylor) Choisy	par ret	Parmeliaceae	6	foliose	C, E, F, M,
173	*Parmotrema tinctorum* (Nyl.) Hale	par tin	Parmeliaceae	1	foliose	F
174	*Parmotrema ultralucens* (Krog) Hale	par ult	Parmeliaceae	2	foliose	F, M
175	*Parmotrema upretii* Divakar	par upr	Parmeliaceae	1	foliose	F
176	*Peltigera didactyla* (With.) J.R. Laundon	pelt did	Peltigeraceae	2	foliose	C, F
177	*Peltigera dolichorrhiza* (Nyl.) Nyl.	pelt dol	Peltigeraceae	1	foliose	F
178	*Peltigera membranacea* (Ach.) Nyl.	pelt mem	Peltigeraceae	3	foliose	F, M
179	*Peltigera praetextata* (Flörke & Sommerf.) Vain.	pelt pra	Peltigeraceae	6	foliose	E, F, M
180	*Peltigera rufescens* (Weis.) Humb.	pelt ruf	Peltigeraceae	2	foliose	E, M
181	*Pertusaria acuta* Müll. Arg.	pert acu	Pertusariaceae	1	crustose	M
182	*Pertusaria leucosora* Nyl.	pert leu	Pertusariaceae	1	crustose	E
183	*Pertusaria multipuncta* (Turner) Nyl.	pert mul	Pertusariaceae	4	crustose	E, F
184	*Pertusaria quassiae* (Fée) Nyl.	pert qua	Pertusariaceae	2	crustose	E, F

185	*Pertusaria sp 1*	pert sp1	Pertusariaceae	1	crustose	F
186	*Pertusaria sp.*	pert sp	Pertusariaceae	1	crustose	M
187	*Phaeophyscia chloantha* (Ach.) Moberg	phae chl	Physciaceae	2	foliose	C, M
188	*Phaeophyscia endococcina* (Körb.) Moberg	phae end	Physciaceae	1	foliose	M
189	*Phaeophyscia hispidula* (Ach.) Essl.	phae his	Physciaceae	17	foliose	C, E, F, M,
190	*Phaeophyscia hispidula var. exornatula* (Zahlbr.) Moberg	phae exo	Physciaceae	2	foliose	F, M
191	*Phaeophyscia primaria* (Poelt) Trass	phae pri	Physciaceae	8	foliose	C, F, M
192	*Phaeophyscia pyrrophora* (Poelt) D.D.Awasthi	phae pyr	Physciaceae	1	foliose	F
193	*Phlyctella himalayensis* Nyl.	phly him	Phlyctidaceae	1	crustose	E
194	*Phlyctis argena* (Ach.) Flot.	phly arg	Phlyctidaceae	1	crustose	F
195	*Phyllopsora corallina* (Eschw.) Mi.ill. Arg.	phyl cor	Biatoraceae	1	crustose	F
196	*Phyllopsora parvifolia* (Pers.) Mlill. Arg.	phyl par	Biatoraceae	1	crustose	E
197	*Phyllospora haemophaea*	phyl hae	Biatoraceae	1	crustose	E
198	*Physcia alba* (Fee) MUll. Arg.	phys alb	Physciaceae	1	foliose	M
199	*Physcia caesia* (Hoffm.) Fürnr.	phys cae	Physciaceae	1	foliose	M
200	*Physcia dilatata* Nyl.	phys dil	Physciaceae	1	foliose	F, M
201	*Physcia stellaris* (L.) Nyl.	phys ste	Physciaceae	2	foliose	F, M
202	*Physcia tribacoides* Nyl.	phys tri	Physciaceae	1	foliose	M
203	*Physciella nepalensis* (Poelt) Essl.	phys nep	Physciaceae	4	foliose	C, M
204	*Physconia detersa* (Nyl.) Poelt	phys det	Physciaceae	3	foliose	C, F, M
205	*Physconia muscigena* (Ach.) Poelt	phys mus	Physciaceae	1	foliose	M
206	*Polyblastia cupularis* A. Massal.	poly cup	Verrucariaceae	1	crustose	M
207	*Porina mastoidella* (Nyl.) Müll. Arg.	pori mas	Trichotheliaceae	1	crustose	E
208	*Porina sp. white*	pori whi	Trichotheliaceae	1	crustose	F
209	*Porpidia crustulata* (Ach.) Hertel & Knoph	porp cru	Porpidiaceae	1	crustose	M
210	*Psilolechia lucida* (Ach.) M. Choisy	psil luc	Lecideaceae	2	crustose	F
211	*Psora himalayana* (Bab.) Timdal	psor him	Psoraceae	1	crustose	M
212	*Punctelia borreri* (Sm.) Krog	punc bor	Parmeliaceae	3	foliose	C, M
213	*Punctelia subrudecta* (Nyl.) Krog	punc sub	Parmeliaceae	4	foliose	E, F, M
214	*Pyrenula gibberosa* Vain.	pyre gib	Pyrenulaceae	1	crustose	F
215	*Pyrenula subnitida* Müll. Arg.	pyre sub	Pyrenulaceae	1	crustose	F
216	*Pyxine berteriana* (Fée) Imshaug	pyxi ber	Physciaceae	12	foliose	E, F, M
217	*Pyxine sorediata* (Ach.) Mont.	pyxi sor	Physciaceae	2	foliose	F
218	*Ramalina conduplicans* Vain.	rama con	Ramalinaceae	4	fruticose	E, F, M
219	*Ramalina hassei* Vain.	rama has	Ramalinaceae	1	fruticose	F
220	*Ramalina inflata* (Hook. f. & Taylor) Hook. f. & Taylor	rama inf	Ramalinaceae	1	fruticose	F
221	*Ramalina intermedia* (Delise ex Nyl.) Nyl.	rama int	Ramalinaceae	4	fruticose	E, F
222	*Ramalina leiodea* (Nyl.) Nyl.	rama lei	Ramalinaceae	1	fruticose	F
223	*Ramalina mesomorpha*	rama mes	Ramalinaceae	1	fruticose	M
224	*Ramalina sinensis* Jatta	rama sin	Ramalinaceae	9	fruticose	E, F
225	*Ramalina subpusilla* (Nyl.) Krog & Swinsc.	rama sub	Ramalinaceae	1	fruticose	F
226	*Ramalina usnea* (L.) Hoffm.	rama usn	Ramalinaceae	1	fruticose	F
227	*Rhizocarpon badioatrum* (Flörke & Spreng.) Th.Fr.	rhiz bad	Rhizocarpaceae	1	crustose	F
228	*Rinodina instrusa*	rino ins	Physciaceae	1	crustose	F
229	*Rinodina sp.*	rino sp	Physciaceae	2	crustose	F, M
230	*Solorina spongiosa* (Ach.) Anzi	solo spo	Peltigeraceae	1	foliose	F
231	*Squamarina crassa* (Huds.) Poelt	squa cra	Stereocaulaceae	2	crustose	M

232	*Squamarina kansuensis* (H. Magn.) Poelt	squa kan	Stereocaulaceae	1	crustose	M
233	*Staurothele frustulenta* Vain.	stau fru	Verrucariaceae	8	crustose	C, E, F, M,
234	*Staurothele succedes*	stau suc	Verrucariaceae	8	crustose	C, E, F, M,
235	*Sticta henryana* Müll.Arg.	stic hen	Lobariaceae	1	foliose	F
236	*Sticta nylanderiana* Zahlbr.	stic nyl	Lobariaceae	1	foliose	F
237	*Sticta praetextata* (Räsänen) D.D.Awasthi	stic pra	Lobariaceae	2	foliose	F
238	*Trapelia placodioides* Coppins & P. James	trap pla	Trapeliaceae	1	crustose	M
239	*Tuckneraria laureri* (Kremp.) Randl. & Thell.	tuck lau	Parmeliaceae	2	foliose	F, M
240	*Umbilicaria traberculata* Frey & Poelt	umbi tra	Umbilicariaceae	1	foliose	F
241	*Umbilicaria vellea* (L.) Ach. & Frey	umbi vel	Umbilicariaceae	1	foliose	F
242	*Usnea cirrhosa* Mot	usne cir	Usneaceae	4	fruticose	E, M
243	*Usnea cornuta* Körb	usne cor	Usneaceae	4	fruticose	E, M
244	*Usnea longissima* Ach.	usne lon	Usneaceae	3	fruticose	E, F
245	*Usnea sp., C. Truong*	usne sp	Usneaceae	6	fruticose	C, E, F, M,
246	*Verrucaria cf. laevata*	verr lae	Verrucariaceae	2	crustose	E, F
247	*Verrucaria nigrescens* Pers.	verr nig	Verrucariaceae	6	crustose	C, E, M,
248	*Xanthoparmelia mexicana* (Gyeln.) Hale	xant mex	Parmeliaceae	1	foliose	M
249	*Xanthoria elegans* (Link) Th.Fr.	xant ele	Teloschistaceae	1	foliose	M
250	*Xanthoria fulva* (Hoffm.) Poelt & Petut.	xant ful	Teloschistaceae	1	foliose	M