

**An Approach to Determine the Diversity and Conservation
Status of Bryophytes in Northern Sindhupalchok District of
Nepal**

Final report

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Summary

This study within the elevation of 1300 m to 3020 m brought a diversity of 137 species of bryophytes of different status categories. The diversity of this plant was least represented at 3000 meter of elevation whereas the diversity was recorded rich at the northwest part (1300- 1850 meter).

Distribution mapping of the species at different altitudinal spots was done and is developed on flex print poster in order to raise conservation awareness among publicly circle.

Epiphytic leafy liverworts like Frullania, Porella and Plagioichila species were also reported growing upon the trunks of different tree species. Likewise some moss species were found growing on tree barks. They were Entodontopsis, Erythrodontium, Plagiothecium, Hypnum, Mnium, Thuidium, etc. Altogether 32 tree species at different ecological zones were identified within 1300 to 3000 m of elevation. Pohlia species mainly prefer to grow on rocks and Sphagnum moss on seepage rock cliffs. Identification of 63 invertebrates and 13 vertebrates was made which were reported in and around the bryophyte habitats.

Use of bryophytes was done differently in some village societies for making pillows, infant's bedding materials and basal stuffs to support water vessel especially at Doring and Timbu villages of the study sites

Tourism promotion activity in this part has left adverse effect though tourism is one of the important income sources for the peoples of this part. Construction of road at various places also has left direct impact on this plant.

This study at different potential areas of the northern Sindhupalchok revealed that majority of the peoples were unknown about bryophyte and its conservation. Questionnaires were developed to this work and 10 % of the house holds were selected in each village community for door to door awareness program. They were also informed about the valuable and endangered bryophytes of their areas. This was done with interaction, books, photographs and real specimens.

Acknowledgement

This extensive work which was carried out at different areas of the Northern Sindhupalchok district was completed very successfully with helps and co operations received from various organizations and individuals. I would like to express my sincere thanks to the reputed Rufford Foundation for this funding which was very valuable and fruitful to come up with many new and interesting findings besides stimulating the local communities in bryophyte conservation in this region.

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All the local communities of Timbu, Doring, Nagote, Gumba, Tarkeghyang, Sharmathang and Melamchi Gaun are specially acknowledged for their Co-operation and help in this study.

Acronyms and Abbreviations

BPP	Biodiversity Project Profile	Km ²	Square kilometer
C	Common	eds.	Editors
CITES	Conservation on International Trade of Endangered species of Fauna and Flora	e.g.	for example
FC	Fairly common	<i>et al.</i>	and other
GIS	Geographical Information System	m	meter
GPS	Geographical Positioning System	mm	millimeter
H	Humidity	max.	maximum
I	Indeterminate	min.	minimum
ICIMOD	International Center for Integrated Mountain Development	sp.	species
N	North	spp.	species (pleural)
NHM	Natural History Museum	sq.m.	square meter
R	Rare	0° C	degree Celsius
RSGF	Rufford Small Grant Foundation	viz.	namely
SPTDMC	Sindhupalchowk Panchpokhari Tourism Development and Management Committee	%	percentage
T	Threatened	*	new records
V	Vulnerable		
VR	Very rare		

CONTENTS

	Page
Summary	
Acknowledgements	
Acronyms and Abbreviations	
1. Introduction	8
1.1 Background	
1.2 Topography and Geography	8
1.3 Climate	9
1.4 Vegetation	11
1.4.1 Tropical Zone (below 1000 m)	11
1.4.2 Subtropical Zone (1000-2000 m)	12
1.4.3 Temperate Zone (2000-3000 m)	12
1.4.4 Subalpine Zone (3000-4000 m)	12
1.4.5 Alpine Zone (4000 – 5000 m)	13
1.4.6 Nival Zone (above 5000 m)	13
1.5 Agriculture	13
1.6. Major Occupation	14
1.7. Major Festivals	14
1.7.1 Janai Purnima	14
1.7.2 Dasahara	14
1.7.3 Buddha Purnima	15
1.8. Economy	15
1.9. Significance of the Study	16
1.10. Tourism	16
1.11. Local Efforts	17
2. Objective	18

3. Methodology	18
3.1. Study Area	18
3.2. Research Sites	20
3.3. Routes followed	20
3.3.1. First Phase Field Visit	20
3.3.2. Second Phase Field Visit	21
3.3.3. Third Phase Field Visit	21
3.4. Ecology	22
3.5. Enumeration of Bryophytes	23
3.6. Assessment of Conservation Status	23
4. Results	23
4.1. Categorization of specimens	23
4.2. Vertical Distribution of Bryophytes from 1300- 3000 m	24
4.3. Endangered Bryophytes species	27
4.4. Rare Bryophytes species at Remote Northern Sindhupalchok	28
4.4.1. Panch Pokhari	28
4.5. Associated Higher Plants	28
4.6. Traditional Use	29
4.7. Faunal Association of Bryophytes Habitats	30
5. Discussion	31
5.1. Graphs	32
6. Conservation	33
6.1. Endangered and Protected species	34
6.1.1. Faunal species	34
6.1.2. Floral species	34
6.2. Conservation Awareness	35
7. Recommendation	37
8. Suggestions	38

9. References	39
Appendices	
I. Species Diversity of Bryophytes	41
II. Species Diversity of Newly recorded species	49
III. Fern Diversity associated with Bryophytes	50
IV. Gymnosperms	52
V. Angiospermic Flora of First Phase Study	53
VI. Angiospermic Flora of Second Phase Study	56
VII. Faunal Diversity	61
Tables	
1. Monthly Mean temperature	9
2. Altitudinal species Diversity of Bryophytes	25
3. Quadrata reading at Nagote	26
Figures	
1. Map showing location og Study Sites	19
2. Study Routes	22
3. Pyramids showing Species Diversity of Bryophytes of N. Sindhupalchowk	32
4. Pyramids showing Species Diversity of Hepaticae of N. Sindhupalchowk	32
5. Pyramids showing New record to the Country	33
6. Pyramids showing Vertical Distribution of Bryophyrs in N. Sindhupalchowk at 1300 m -3000 m	33

1. INTRODUCTION

1.1. Background

A stepwise change in altitudinal pattern can be noticed approaching from the southern lowland to the northern Himalayan region. On the basis of the geographical structure this country is divided principally into three major ecological zones viz. Mountain, hill and Terai regions. The mountain region occupies 35.2% of the total area of Nepal consisting altogether 16 districts of the country. Only 2 % of the total area is fertile land fit for cultivation. So only in the lower valleys and river basins, the agricultural practices have been intensified. The hilly region is located between the mountain and Tarai regions. It has fertile land with moderate and mild climatic type. Occupying 42 % of the total area of the country, this region is more populated than the mountain region. The lowland or Tarai is the southern flat land which is in continuation to the alluvial gangetic plain of India. The increasing population pressure mainly by migrants from the hills is imposing serious impact on forest resources of this part.

This district encompasses many of the accessible and remote villages where literacy rate is still under minimum level. Poverty has become the main obstacle to many of those who wish to peruse higher education in Kathmandu or abroad, so they have to divert themselves fully to other professional activities like farming, business or others. Many youths of this district also go abroad mainly in the countries like UAE, Malaysia, Saudi Arabia, Qatar, etc. for temporary employment purpose.

1.2. Topography and Geography

The mid-hill zone is of generally rugged mountain topography, so the altitude can vary considerably within a short horizontal distance. Thus, the mid-hills include deep river valleys well below 1000 m, while the nearby ridge tops may rise to more than 3000 m. accordingly, climate and the vegetation show great variation over a very short distance, and give rise to great ecological diversity and complexity. In general, the area rises towards the north, to the main Himalayan ranges, and up to 30% of these slopes are worked traditionally into innumerable terraces, which are extensively cultivated.

1.3. Climate

The climate of the region is very complex due to variation of the geographical features. A drastic change in climatic condition can be experienced within a short distance on elevation rise at the warm sub-tropical to the cold temperate zones. These zones are further influenced due to their location under the rain shadow parts.

Country's major rain is brought by the monsoonal wind in summer that arises from the Bay of Bengal and entry into the eastern point of the country which later are spread over the country. About 80 % of the annual precipitation is due to this wind in mid June and the end of August. Mediterranean wind is responsible to bring pre-monsoonal and winter rain in this country. The southern side of the Himalayas and the northern Mahabharat range receive greater amount of rainfall (about 5000 mm) than other areas.

The mercury rise of this district go parallel to the altitudinal rise indicating maximum thermal rise of 26°C in May (upper temperate zone, 1500 m - 2200 m) and drops to below 0° C in winter. Temperature across country is predominated by the season, altitudinal variation, slopes and forest condition. South-facing slopes are hotter and drier than the face north. The mean temperature decreases by 5.5°C for every 1000 m rise in altitude and minimum temperature falls below freezing point in the winter on the upper range (over 3500 m) with snowing condition. The snowline in the east is at 5000 m and the tree line remains at 4300 m.

The monthly mean daily temperature in °C for a year from the elevation 1000 m to 3000 m is shown in table 1.

Table 1: Monthly mean daily temperatures (°C) for selected elevations.

Month	Elevation			
		1000 m	2000 m	3000 m
January	max	18.3	13.0	7.8
	min	6.1	1.8	-4.5
February	max	20.4	14.5	8.6
	min	7.5	3.1	-2.2
March	max	25.2	18.2	11.2
	min	11.4	6.6	1.8
April	max	28.7	21.8	14.9
	min	16.1	10.1	4.1
May	max	29.8	23.2	16.6
	min	18.5	12.4	6.4
June	max	29.1	23.6	18.1
	min	20.3	15.1	9.8
July	max	27.8	23.1	18.3
	min	20.7	15.8	10.9
August	max	28.1	23.3	18.5
	min	20.5	15.5	10.5

September	max	27.8	22.9	18.1
	min	19.3	14.2	9.2
October	max	26.1	20.6	15.1
	min	15.9	10.3	4.1
November	max	23.0	17.2	11.4
	min	10.6	6.0	1.4
December	max	19.5	14.3	9.1
	min	6.8	3.0	1.6

Source: LRMP (1986)

1.4. Vegetation

The changing pattern of altitudinal gradients display different ecosystem types of which 170 types have been mentioned in the CNRS vegetation maps (Dobremez, 1976, 1984 and Dobremez *et al.*, 1985). Later, they were reviewed and concluded to 118 types by the BPP (1995) supported by the GIS unit of ICIMOD.

Dobremez et al (1976) have identified 118 ecosystems and classified Nepal into 4 domains and 11 sub-levels with following six vegetation categories based on an altitudinal classification (bioclimatic zones). The general use pattern of classification in most of the cases is as follows.

1.4.1. Tropical Zone (below 1000 m)

Tarai and the Shivalik represent this type of Broadleaved forests with a total of 1,829 species of flowering plants and about 81 species of Pteridophytes (BPP, 1995a).

Shorea robusta dominates entire Tarai region. Other popular species of this region are *Adina cordifolia*, *Aegle marmelos*, *Albizia spp.*, *Anthocephalus chinensis*, *Anogeissus latifolia*, *Butea frondosa*, *Dillenia pentagyna*, *Dillenia indica*, etc. The bryophytes like *Asterella wallichiana*,

Plagiochasma pterospermum, *Heteroscyphus argutus*, *Bryum coronatum*, *Fissidens sylvaticus*, etc. are common in lowland region below 1000 m of elevation (Pradhan, 2008).

1.4.2. Subtropical Zone (1000 to 2000 m)

The subtropical forest represents the blend of *Schima wallichii*, *Castanopsis indica*, and *Castanopsis tribuloides* on relatively humid areas while *Pinus roxburghii* is predominant in drier regions. Coniferous forests are dominated by *Tsuga dumosa* (Thingre Salla), *Pinus roxburghii* (Rani Salla) and *Pinus wallichiana* (Gobre Salla) with *Quercus* and *Rhododendron* spp. This zone consists of more than 1,945 flowering plant species. The common bryophytes of this zone are *Marchantia emarginata*, *M. polymorpha*, *Bryum argenteum*, *Pohlia flexuosa*, *Funaria hygrometrica*, *Pogonatum microstomum* and so on.

1.4.3. Temperate zone (2000 to 3000 m)

Broadleaved evergreen forest is predominant in this zone which represents the mixed vegetations of *Alnus nepalensis*, *Quercus lamellosa* and *Quercus semicarpifolia*. Species of *Lindera* and *Litsea*. *Tseuga dumosa* and *Rhododendron* are common at upper parts. Other popular species found here are *Magnolia campbellii*, *Michelia doltsopa*, *Pieris ovalifolia*, *Daphniphyllum himalayense*, *Acer campbellii*, *Acer pectinatum*, and *Sorbus cuspidata*. Rich diversity of bryophytes (322 spp.) had been recorded from this region (Pradhan, 2008). *Polytrichum commune*, *Mnium confertidens*, *Sphagnum* spp., *Thuidium cambifolium* and many species of *Jungermannia* are popular in this region.

1.4.4. Sub alpine zone (3000 - 4000 m)

About 177 species of endemic plants are accommodated in this zone. *Betula-Rhododendron campanulatum* and *Abies spectabilis* are wide spread vegetation in this zone. Different species of *Rhododendron* are found here. Some popular vegetation of this zone are *Sorbus cuspidata*, *Sorbus microphylla*, *Euonymus tingens*, *Acer pectinatum*, *Salix* spp., *Lyonia* spp., *Prunus rufa*, *Acer caudatum*, *Acanthopanax cessionifloia* and *Berberis* spp. The notable Bryophytes of this region are *Andreaea rupestres*, *Blasia pusilla*, *Brotheria himalayana*, *Polytrichum juniperinum*, *Pohlia*

cruda, etc. The IUCN 2000 World Red Listed Bryophytes viz. *Andrewsianthus ferrugianus*, *Diplocolea sikkimensis*, *Scaphophyllum speciosum* and *Takakia ceratophylla* are also recorded in this region (Tan *et al.*, 2000).

1.4.5. Alpine zone (4000-5000 m)

This zone is represented with bushy shrubs of *Rhododendron setosum*, *R. anthopogon*, *R. lepidotum*, *Potentilla fruticosa*, *Ephedra gerardiana*, *Berberis* spp. and *Cotoneaster acuminata*. In river valleys *Hippophae* spp. and *Salix* spp. along with *Saxifraga*, *Arenaria*, *Androsace* species and alpine grasses are found. Some common herbs of this zone include *Primula* spp., *Gentiana* spp. and *Corydalis* spp. Bryoflora of this region are *Bryum pallescens*, *Campylopus hardelii*, *Plagiochila retusa*, *Rhacomitrium crispulum*, *Sphenolobopsis minutus*, etc

1.4.6. Nival zone (above 5000 m)

No vegetation is seen in this zone. Mosses and lichens can be seen scattered over snow melted rocks, cliffs, etc. The bryophytes recorded are *Bryum argenteum* (5100 m), *Marsupella commutata* (5200 m), *Grimmia longiorostries* (5350 m), *Pohlia microstroma* (6250 m) and *Aongstoemia julacea* (6532 m) which is the highest limit of moss recorded from the world.

1.5. Agriculture

The total area occupied by this district is about 252800 hectares of land, of which 1300 hectares are fit for agriculture while remaining 2,39,000 hectares includes non-usable and waste land.

Potato is the main cash crop in higher parts and has gained wide market even to Kathmandu city. Other common vegetables include soybeans, beans and tomatoes which grow mainly during rainy season. Cereal crops like wheat and maize grow up to the 1600 m. They also harvest wild edible mushrooms for their food but use their own traditional system to distinguish a poisonous mushroom from a non poisonous one. Among fruits, apple and berries grow well in higher parts especially above Bhotang areas. The good quality apple which has just been initiated to grow here has a wide market up to the Kathmandu and adjoining cities. The stored

grains like maize, barley, millet, etc are ground up into flour with the help of the locally made water turbines notice between the Timbu and Nagote villages.

The crosses of yak (*Bos grunniens*) and local hill cow (*Bos indicus*) and vice versa are called Chauri. Chauri farming is a main source of households' income in the Upper Slope Areas of Sindhupalchok. The Chauris are reared under migratory systems, grazing around the

Bhairabkund lake areas during summer and feeding oak forest leaves during winter. Due to continuous lopping, the oak forest is threatened to its existing. The herders are abandoning the Chauri farming occupations and shifting into other businesses, mainly due to lack of adequate pastures, low production of Chauris, hardship, low return compared to investment and poor animal health care services (Pande, 2004)

1.6. Major Occupation

Agriculture and livestock rearing are the main occupation in this part. In geographically complicated terrains, the agriculture farming is less developed naturally due to small sized fertile land and lack or less access to transportation facilities. So people of these and adjoining areas are engaged themselves to other professions like the labour, porters, Government workers and other professions.

1.7. Major Festivals

1.7.1. Janai Purnima: This festival is observed in the mid of August annually when devotees from countrywide reach to Panch Pokhari to take their holy bath which is said to carry significant mythological belief. About two thousand peoples are estimated visiting this place annually.

1.7.2. Dasahara: This festival is observed in March/ April and lasts for a month. During this time, many devotees visit to Panch Pokhari Lake to worship Lord Shiva and to take

holy bath there. They also pay visit to a locality at Chitre where a small fountain of sour water (water with high rate of basic elements) is located. They believe, this water may cure their contaminated diseases if they drunk it once in their life.

1.7.3. Buddha Purnima: Thousands of Buddhist devotees visit Monasteries at Tarki Ghyang, Ghyangkiul and Melamchi Ghyang in Buddha Purnima and other festivals related to Buddhism.

1.8. Economy

The major source of economy of this area is predominantly agriculture based with practicing of a mixture of harvesting of forest products such Uttis timber. Local people are gradually attracted towards cultivation of cash crops and vegetables such as Broom grass (*Thysanolaena maxima*), Potato (*Solano tuberosus*), Cauliflower (*Brassica oleracea*), Ginger (*Zingiber officinale*), Lapsi (*Choerospondias axillaris*), etc. Dairy production and selling to the market is also another source of income for local farmers. Over 80 percent of total population is dependent on agricultural activities for their livelihood. Diversity in employment pattern has been also observed in recent years. Local people have increasingly engaged in business activities in Kathmandu, Sildhunga, and Khadichour area. Seasonal migration to Kathmandu and even different parts of India to earn some money for their livelihood has significant contribution to the local economy.

Next potential source of economy in this part is from tourism. Helambu is recognized as the trekkers preferred destination where physical facilities for tourists are well developed. Some of the villages are also operating home stay programs for tourists visiting this place. Good hotels and restaurants can be found in Nagote, Tarkyghyang, Dhupgyang, Melamchi Gaun and Sermathang. Panch Pokhari area is also under developing stage for tourist's facilities. These areas are now accessible to tourists by public transportations.

1.9. Significance of this Study

Nepal Government's plan to promote tourism in this place though can be helpful to uplift the financial status of many of the rural people, may still leave equal impact upon the forest resources of this place. So this study of documenting the existing biodiversity of northern Sindhupalchok and peripheral areas has been felt essential before any damages can be made for tourism promotion.

Once baseline data is documented, the future follow up can be made easy by monitoring the degree of habitat alteration. If any impact is found in future, the village communities, local leaders and government organizations will be reported to add effectiveness in their conservation policies.

1.10. Tourism

The cultural and natural diversity are the main attractions of this district adding extra attractions by Sunkoshi and Bhotekoshi which are famous for river rafting in the country. Bhairav Kunda and Panch Pokhari are popular trekking destination carrying religious and cultural important.

Due to scenic beauty, incredible landscape, diverse cultural and natural diversity, Panch Pokhari can be expected to attract many tourists of different interests. This all need good management especially the required physical facilities, camping areas, and trained guides. Many other interesting spots like Bhairab Kund, a popular high altitude lake is also located in this region at 4300 m. The next beautiful lake called Suraj Kund lies at the junction of Sindhupalchok, Nuwakot and Rasuwa districts.

Though under developing stage, this district still offers many preferable destinations to tourists both of the national and international standards. This study area has also been encompassed within the buffer zone of the Langtang National Park, a mid central Himalayan National Park of Nepal. Sindhupalchok is a potential district for rich biodiversity components which are displayed at different altitudinal pockets of the subtropics to the Himalayan bio-climatic zones.

Helambu which includes Malemchi Gaun and Tarkegyang is situated in higher region offers scenic meadows of considerable beauty. The word Helambu derives from the word Yolmo or Hyolmo who are the original residents of this region. Helambu is well known for Buddhist followers where Buddhist monasteries of high architectural values can be seen.

1.11. Local Efforts

Sindhupalchok Panch Pokhari Tourism Development and Management Committee (SPTDMC) a non profit Organization is supporting local peoples who are engaged to promote tourism in this place. This organization is located in Chautara, the head quarter of the district.

This organization envisions on sustainable development and management of rural tourism supporting human resource development, providing economic opportunities, empowerment of the local peoples that are the basic requirements for community development.

This organization assists in different sectors such as health, education, eco-tourism, social mobilisation and social empowerment. Besides the natural beauty, innumerable historical monuments, pilgrim sites and both the tangible and intangible tourism products do prevail in the district. Because of all these tourism products, it can proudly be said that tourism has high potential in the district. Some parts of the districts that fall within Helambu region are very popular for tourism activities as Langtang - Helambu area is ranked third tourism destination of

Nepal. Some of the well known and highly possible tourism sites within the district are Helambu area, Tatopani, Ama Yangri, Bhote Koshi, Panch Pokhari, Duganagadi, etc.

2. OBJECTIVES

- To enumerate bryophyte species occurring at different altitudinal zones of the northern Sindhupalchok district of central Nepal.
- To assess conservation status of the reported species including their threat factors.
- To identify micro and mega fauna associated to bryophyte habitats.
- To develop distribution map of bryophytes occurring at different study sites.
- To gather information on traditional uses of this plant in the society.
- To launch door to door awareness program to bring conservation participation of the local peoples and communities.

3. METHODOLOGY

3.1. Study Area

Sindhupalchok occupies its position at 27°13' N to 85° 27" to 86° 06' E of Central Nepal. Presenting interesting ecological zones for flora and fauna, this district also provides popular destinations and routes for visiting tourists and trekkers from the country and abroad.

This is one of the midland districts covering an area of 2,542 Sq. km (981 sq. m). The geographical complexity has made this place less fertile so the agricultural yield is not enough to meet entire year sustenance. This district now is under the process of development where construction of the broad roads is underway that link hilly villages and wards to the town area. The upper Bhote Koshi is one of the main sources of hydropower in the country. Many small scaled hydropower plants can also be in this district. Likewise Melamchi River which crosses

this district at Nagote, Timbu and different areas is a good source for potable water besides its use in irrigating farm lands. Certain percentage of this water is under the process of diversification to the Kathmandu City.

This study as proposed is confined to the northern belt of this district which is also linked to the Nuwakot and Bhaktapur to the south and northwest respectively. Phyto-geography of this district is more diverse corresponding to the changing landscape and variable climatic features. The highest range of elevation at 4300 m where this study was limited is connected to the First RSG Fund which was funded for the study of the biodiversity of Panch Pokhari, Sindhupalchok district of Central Nepal in 2008. This study which has encompassed many interesting bryoflora zones where diverse species of this plant with different conservation status have been reported. The interesting bryoflora species recorded from this northern Sindhupalchowk region are *Cephalozia massalongii*, *Conocephalum japonicum*, *Herbertus adunca*, *Trichocolea tomentaella*, *Bryum coronatum*, *Homalothecium nilgheriensis*, *Sphagnum junghuhnianum* and *Tayloria indica*.

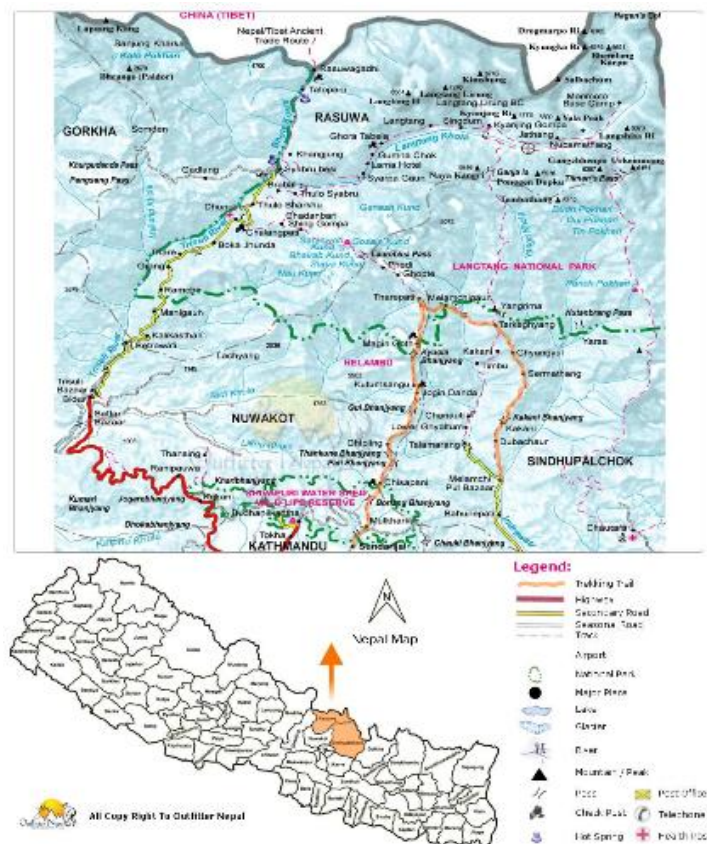


Fig.1. Map showing the location of Study Sites

3.2. Research Sites

An extensive study was carried out at various potential sites. The study were made in three different phase. The first phase study were made in September to October, 2011 starting from Melamchi Bazar (850 m) to Timbu (1300 m), Kakani (2000 m), Tarkyghyang (2743 m), Shermathang (2520 m), Ghyangul (2420 m) and ended in Timbu (1250 m). The second phase study made in February, 2012 starting from Melamchi Bazar to Melamchi Gaon towards northwest of Sindhupalchowk. It covered Timbu (1250-1040 m), Ambathan (1400-1560 m), Doring (1700 m), Dhupyang (1780 m), Nagote (18000- 1940 m) and Melamchi Gaon (2100 m). The Humidity and temperature and a Quadrate at different potential sites were taken. Quadrates taken in Nagote has been given below in Table 2. The third phase study was made in June, 2012 for awareness program at Timbu (1350 m) gathering local peoples and school students of Sarkathali and at Doring villages.

This investigation also provided interesting findings on the faunal species which were found in associations to the bryophyte habitats at various bioclimatic zones.

3.3. Routes Followed

3.3.1. First Phase study

September 24, 2011: Kathmandu - Bus –	Melamchi Bazar (850 m)
September 25, 2011: Melamchi -	Timbu (1350 -1400 m)
September 26, 2011: Timbu -	Kakani (2000 m)
September 27, 2011: Kakani -	Tarkeghyang (2740 m)
September 28, 2011: Tarkeghyang –	Helambu and periphery areas (3000 m)
September 29, 2011: Tarkeghyang –	Ghyangul (2420 m)
September 30, 2011: Ghyangul -	Shermathang (2520 m)
October 1, 2011: Shermathang -	Timbu (1350 m)
October 2, 2011: Timbu -	Melamchi (850 m)
October 3, 2011: Melamchi -	Kathmandu (1300 m)

3.3.2. Second Phase Study

February 18, 2012: Kathmandu - Bus – Melamchi Bazar (850 m)
February 19, 2012: Melamchi - Timbu (1350 -1400 m)
February 20, 2012: Timbu - Doring (1700 m)
February 21, 2012: Doring - Nagote (1820 m)
February 22, 2012: Nagote – Melamchi Gaun (2150 m)
February 23, 2012: Melamchi Gaun Ghayang Associated areas (2250 m)
February 24, 2012: Melamchi Gaun Nagote (2000 m)
February 25, 2012: Nagote - Doring (1700 m)
February 26, 2012: Doring - Timbu (1350 m)
February 27, 2012: Timbu - Kathmandu (1300 m)

3.3.3. Third Phase Study

June 16, 2012: Kathmandu – Timbu (1350 m)
June 17, 2012: Timbu (Awareness program)
June 18, 2012: Timbu – Doring (1700 m)
June 19, 2012: Doring ((Awareness program)
June 20, 2012: Doring – Timbu –Bus – Kathmandu

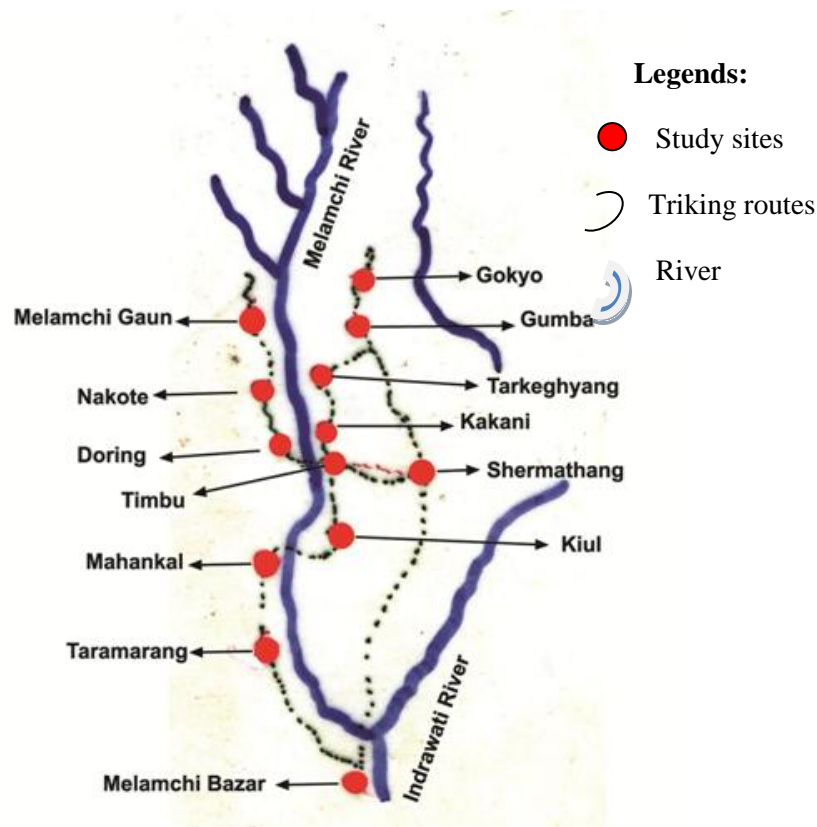


Fig.2. Study Route from Melamchi Bazar to Melamchi Gaon

3.4. Ecology

From ecological perspective, this district has interesting display of the diverse and rare faunal components. The notable species represented here are Barking Deer (*Muntiacus muntjak*), Musk Deer (*Moschus chrysogaster*), Common Leoprad (*Panthera pardus*), Clouded Leopard (*Neofelis nebulosa*), Leopard Cat (*Felis bengalensis*), Thar (*Hemitragus jmlaihcus*), Goral (*Nemodhaedus goral*), Himalayan Palm Civet (*Paguma larvate*), Sloth Beer (*Malursus ursinus*), Himalayam Beer (*Selenarctos thibetanus*), Red Panda (*Ailurus fulgens*), Pikas (*Ochorona species*). Procupine (*Hystrix indica*) and many rodent species.

Avian diversity is remarkable in this part that includes Danfe pheasant (*Lophophorus impejanus*), Monal Pheasant (*Tragopan satyr*), different pheasant species, Finches, Thrushes, Warblers, Choughs, Babblers, etc.

3.5. Enumeration of Bryophytes

Best effort was carried out to identify the observed species of bryophytes in the field. This was done with the help of magnifying hand lens and consulting books by Gangulee (1969-1980), Kashyap (1972), Chopra (1975), Eddy (1988, 1990, 1996), Smith (1996) and Long (2006). The collections were made using a pocket knife to scrape specimens from the substratums. The collected specimens were placed in paper packets to bring to the laboratory in Kathmandu in order to confirm their correct identification. The book by Brummitt and Powel (1992) was used to check the author citation. The process of identification is still continuing and the collected specimens were deposited at Natural History Museum, Tribhuivan University, Kathmandu.

3.6. Assessment of Conservation Status

The local status was determined on frequency basis in the field and IUCN Redlist has been consulted for the native status of the species collected in this study. Threat factors were determined by study and direct observation at different potential areas of this region. The list provided in Appendix I also include status of this species on native and local levels.

4. RESULTS

4.1. Categorization of the Specimens

A total of 451 specimens had been collected from Northern Sindhupalchowk district, which were categorized into 75 genera and 141 species under 41 families and three classes. The class Anthocerotae included two genera and three species under the family Anthocerotaceae. The class Hepaticae included 23 genera and 50 species under 19 families and the class Musci with 50 genera and 88 species belonging to 21 families. Among the Hepaticae, the order

Jungermanniales including an acrogynial-jungermannial is dominant with the records of 33 species under 13 families. The order Marchantiales records six species with dominant genera *Asterella* and *Marchantia*. Among the Musci, the family Bryaceae is most dominant with the record of 18 species. Of the total species recorded, eleven species are new records for the country (Appendix II).

4.2. Vertical Distribution of Bryophytes from 1300-3000 m

The final phase of study was confined within the elevation of 1300 m to 3020 m where bryophytes of different status categories were recorded. The species diversity of bryophyte was found changing with the effect of altitudinal gradients representing rich diversity from 2000-3000 meter whereas the mid elevation level accommodated less diversity of this flora.

Of the reported species, long range of distribution was shown by the species called *Conocephalum conicum* (L.) Underw. (Conocephalaceae). This species occurred in every pocket within the range of 1800-2600 m of elevations. *Anthoceros punctatus* L. (Anthocerotaceae) at the elevation of 1400-1700 meter was remarkably displayed, so was with *Plagiochasma appendiculatum* Lehm. & Lindb. (Aytoniaceae) at 1350 to 1400 m. *Taxiphyllum taxirameum* (Mitt.) Fleisch. (Hypnaceae) was seen common within 1400-2700 m with distributional gaps at some places. The species like *Bryum cellulare*, *Bryum clavatum*, *Funaria hygrometrica* and *Hypnum pleuromaforme* had been recorded above 3000 m. The species like *Cephaloziella massalongi* (Spruce.) K. Muell. (Cephaloziellaceae), *Frullania gracillima* St. (Frullaniaceae) and *Jamesoniella autumnalis* (D.C) Steph. (Jungermanniaceae) were reported as very rare species. They were recorded at the elevation of 1700 m and 2450 m in a micro habitat. Similarly the occurrence of *Tayloria indica* Mitt. (Splachnaceae) at an elevation of 2460 m was also very rare in status. Among the hepaticae, many species of different families were found rare as well. Likewise 28 species of Musci also were recorded rare in status. *Heteroscyphus argutus* (Reinw. et al.) Schiffn, of the family Geocalycaceae, a common species in lowland below 1000 m was

reported rare in this area (Pradhan, 2008). A list of bryophytes including Anthocerotae, Hepaticae and Musci is provided in Appendix I.

The distribution of Bryophytes were noted at every 100 m starting from 1300 m to 3000 m. Rich diversity of this plant was documented at elevation of 2000-3000 m where 170 species were recorded. About 47 species were identified at 1800-2000 meter whereas 88 species were recorded at 1300-1800 meter at the northwest part (Table 2.). These are represented here in pyramid diagram (Fig. 12)

Table 2. Altitudinal species diversity of Bryophytes in Northern Sindhupalchok

S.N.	Altitude	Species Number
1.	1300-1400 m	10
2	1400-1500 m	15
2..	1500- 1600 m	13
3.	1600-1700 m	11
4.	1700-1800 m	39
5.	1800- 1900 m	26
6.	1900-2000 m	21
7.	2000-2100 m	21
8.	2100-2200 m	20
9.	2200- 2300 m	18
10.	2300-2400 m	14
11.	2400- 2500 m	39
12.	2500- 2600 m	25
13.	2600- 2700 m	14
14.	2700- 2800 m	4
15.	2800-2900 m	6
16.	2900- 3000 m	5

Table 3. Quadrant reading at Nagote (Nakote) Village

Latitude: 28°00'35.57"N

Longitude: 85°31'59.66"E

Altitude: 1938m

Size of quadrat: 10x10 m

S.N.	Bryophyte species	No. of patches observed	Relative cover (%)
Hepaticae			
1	* <i>Jungermania exertifolia</i>	1	1.14
2	<i>Marchantia emarginata</i> Reinw. et al.	2	2.28
3	<i>Plagiochila spinulosa</i>	1	1.14
4	* <i>Scapania undulata</i> (L.) Dumort.	1	1.14
Musci			
5	<i>Barbula tenuirostris</i> Brid.	1	1.14
6	<i>Brachythecium buchani</i> (Hook.) A. Jaeger	1	1.14
7	<i>Entodontopsis wightii</i> (Mit.) W. R. Buck & Ireland	3	3.44
8	<i>Funaria hygrometrica</i> Hedw.	31	35.63(most dominant)
9	<i>Hyophila involuta</i> (Hook.) A. Jaeger	28	32.1
10	<i>Hypnum plumaforme</i> W. Wilson	6	3.44
11	<i>Pholia flexuosa</i> Hook.	1	1.14
12	<i>Pogonatum microstomum</i> (Schwaegr.) Brid.	10	11.4
	Total	87	

Funaria hygrometrica was found in majority with relative coverage of 35.63 %. Likewise, *Hyophila involuta* represented 28 patches with a total cover of 32.1 %. *Pogonatum microstomum* within 10 patches has 11.4 % of coverage. Least coverage had been noticed in *Pholia flexmosa*, *Barbula tenuirostries*, *Brachythecium buchani*, *Jungersnia exertifolia*, *Plagiochila spinulosa* and *Scapania undulata*. *Marchantia emarginata* covers 2.28 % whereas *Entodontopsis wightii* had 4.59 % of coverage.

4.3. Endangered Bryophyte species resulted

The peat moss (*Sphagnum junghuhnianum*) has been found very rare in status which so far is reported only from a single place of eastern Nepal. This was reported in a single patch around the damp place at 2200 m on the way to Shermathang. The species like *Ricardia multifida* (Anuriaceae), *Reboulia hemispherica*, (Aytoniaceae), *Cephaloziella massalongi* (Spruce.) K. Muell. (Cephaloziellaceae), *Frullania gracillima* St. (Frullaniaceae) and *Jamesoniella autumnalis* (D.C) Steph. (Jungermanniaceae) were reported very rare in status. They were recorded in a microhabitat type. Similarly *Tayloria indica* Mitt. (Splachnaceae) was recorded at an elevation of 2460 m. They are the notably very rare and endangered species recorded in this study. Newly reported leafy liverwort species like *Frullania gracillima* St., *Plagiochila spinulosa* (Dicks.) Dumort., *Scapania irrigua* (Nees) Nees and *Scapania undulata* were also rare in status collected at 1700 m to 2450 m of elevation. The common lowland *Bryum coronatum* Schwaegr. (Crown moss) of the family Bryaceae was recorded at 1350-1760 m. This is a tropical species and the present record at 1760 m indicates its habitat shift due to climate change impact thus providing a significant margin for its extensive research. *Conocephalum japonicum* (Conocephalaceae) is the next rare and endangered species reported at 1800 m in this study.

4.4. Rare Bryofloral species at Remote northern Sindhupalchowk

4.4.1. Panch Pokhary (2000- 4300 m)

Among the bryophytes, the rare species recorded in this study includes *Asterella mussuriensis*, *Riccardia multifida*, *Jungermannia hyalina*, *Heteroscyphus coliatu*, *Metzgeria conjugata*, *Cephalozeia* and *Calypogeia* species and likewise in Music the species like *Philonotis thwaitisii*, *Fissidens grandiflorus*, *Bryum cellulare*, *Hyophila involuta*, etc. are rare in status. The peat moss (*Sphagnum cuspidatum*) is very rare in status and was recorded from Hinger Khola, 3000 m of Northern region. The species *Folioceros assamicus* which was recorded in Tarai for the first time also occurs here (Pradhan and Joshi, 2007b). It was also recorded at the Mahadev Khola, 1300 m on the way to Panch Pokhari. Among other sites in this study Tangu Khola, Chitre, Chhare Kharka and Hinger Khola, Gupha Danda, Mahadev Khola and Nosim are noted potential for bryofloral diversity (Pradhan *et al.*, 2008).

4.5. Associated Higher Plants

Different forest types provide preferable habitats and canopy to various species of bryophytes carrying different conservation values. Epiphytic species like *Frullania*, *Porella*, *Plagiochila*, *Hypnum*, *Entodontopsis*, *Mnium*, spp. were also reported growing upon the trunk of different tree species like *Alnus nepalensis*, *Castanopsis*, *Choerospondias axillaris*, *Prunus cerasoides*, *Schima wallichii*, *Quercus semecarpifolia* and *Persea odoratissima*. Altogether 32 tree species at different ecological zones were identified within 1300 to 3000 m of elevation.

Four species like *Schima wallichii*, *Castanopsis indica*, *Castanopsis tribuloides* and *Pinus roxburghii* were the notable species at 1300-2000 m. The temperate part above this was dominated by *Alnus nepalensis*, *Quercus semicarpifolia* and *Quercus lamellosa*. *Rhododendron arboreum* was well spread in this region which is the National flower of Nepal.

A detail list of reported flora including Pteridophytes, Gymnospermae, Angiospermae with their altitudinal record has been provided in Appendix III to Appendix VI. The bryophyte associated Pteridophytes include 20 genera and 29 species belonging to 12 families (Appendix III). Six species of Gymnosperm under two families were recorded at the followed routes (Appendix IV). The higher plants recorded in first and second phase are given separately in Appendix V and Appendix VI. The list of plants in Appendix V are arranged alphabetically with their habit, altitude and status where as the plants in Appendix VI are given altitude wise with their GPS readings.

The association of faunal components to Bryophyte habitats is given in Appendix VII.

4.6. Traditional Use

One of the aspects of this study is also to find out traditional uses of bryophytes in the community or society of the peoples of this district. This study revealed very few information on its uses. This study was made by direct observation and information gathering through questionnaires. Peoples at every stopped station were interviewed besides letting them know on uses of bryophytes in different ways. They were also informed to make its use under sustainable way.

The use of the bryofloral specimens was done by the local inhabitants differently for making pillow stuffs and clothes wrapped for basal support to make stand to water vessels in their homes especially at Doring and Timbu villages of the study sites. Especially the moss *Calliergonella cuspidata* (H 62) and *Hypnum* spp. were used for these purposes. At Doring village, these plants were dried and stuffed in infant's bed which was placed in a flat basket thus making easy to carry on back. They used called these plants (Mosses) as *Bhop* in their local language.

The local inhabitants were made familiarized with this plant with regards to its use in various ways. They were informed to harvest very soft specimens of mosses, make them dry which eventually can be used to make pillow, mattress or small beds. They were also informed that soft specimens of bryoflora which are common in their areas can be used for baby diapers after drying and wrapping the specimens with soft clothes. These mosses have the capacity to absorb moisture and water so can be used for different purposes. Colored Pictures of different bryofloral species, books and real specimens were used in this program

The peoples in Nagote and Dhupgyang villages were also informed that the use of these mosses should follow sustainable pattern. It is essential that after harvesting, the capsules of the mosses should be separated very lightly, dry them out, mashed them gently and spread over the land or its habitats. This helps to germinate and grow these plants again and compensate harvested specimens.

4.7. Faunal Association to Bryophyte Habitats

Identification of insects, nematods, mammal, and some bird species reported in and around bryophyte habitats have been made. Birds and mammals were identified in the field using field guide books written by Fleming (1976) and Prater (1971). Field identification of butterflies and moths were done with the help of Khanal and Smith (1997) and Haruta (1995). Other faunal components like beetles, earwigs (Dermaptera), millipedes, molluscans and nematods were brought to the research institutes in Kathmandu to confirm their identification. Ethyl alcohol was used as preservatives for millipedes and nematodes while dry preservative method was adopted for beetles and some molluscans except slug which was preserved in ethyl alcohol of 70 % as well.

Many small invertebrates were recorded in moss habitats. These habitats are located generally at the northern slopes of the mountains where damp and wet condition prevailed. A list of the reported faunal species in and around bryophyte habitats is provided in **Appendix VI**

5. DISCUSSION

A total of 451 specimens of bryophytes were collected from Northern Sindhupalchowk district, which were categorized into 75 genera and 141 species under 41 families and three classes. The class Anthocerotae included two genera and three species under the family Anthocerotaceae. The class Hepaticae included 23 genera and 50 species under 19 families and the class Musci with 50 genera and 88 species under 21 families (Fig. 9). Among the Hepaticae, the diversity of leafy liverwort (Jungermanniales) were dominant with the records of 31 species under 11 families and two species from Anacrogynous Jungermanniales (Metzgeriales) (Fig.10). The thalloid liverworts (Marchantiales) included 17 species. Among the order Marchantiales, the family Aytoniaceae is dominant with the record of six species under three genera.

Among the Music, the family Bryaceae is the most dominant with the record of 18 species from different localities at the elevation of 1250-3000 m. The second dominant families are Fissidentaceae and Pottiaceae with the record of six species each and Hypnaceae and Thuidaceae have five species each. The species *Tayloria indica* Mitt is very rare species recorded only in a place at the elevation of 2400 m.

Of the total records, eleven species are new to the country (Appendix II). Of them, seven species belong to the order Jungermanniales of Hepaticae and rest four species are from the class Musci which includes two species of Bryaceae, one species each from Calymperaceae and Polytrichaceae (Fig. 11)

5.1. Graphs

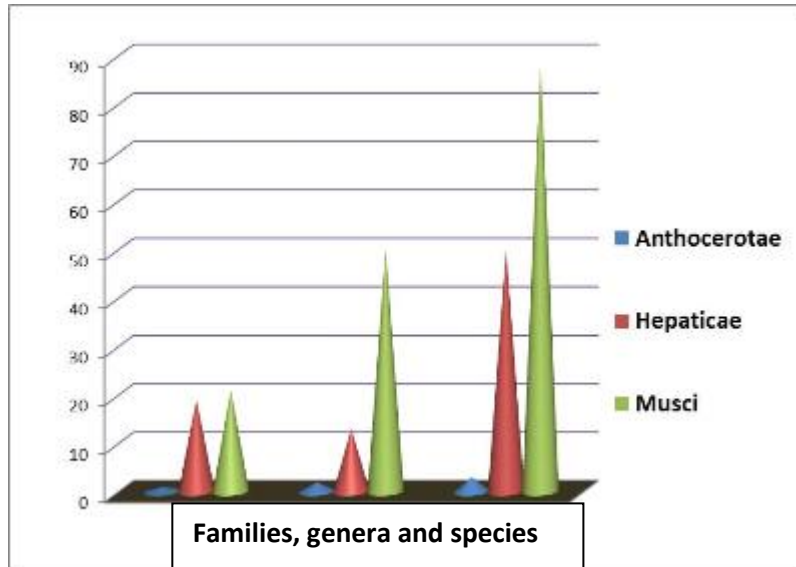


Fig.3. Species Diversity of Bryophytes of Northern Sindhupalchok

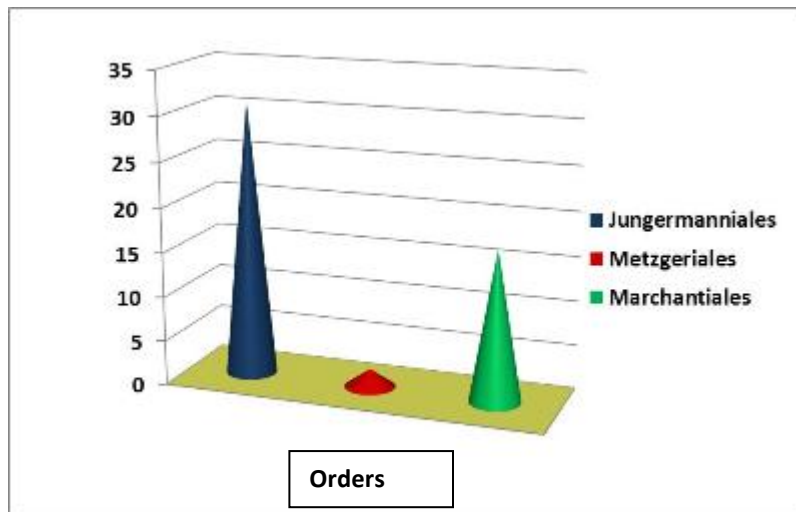


Fig.4. Number of species in three Orders of Class Hepaticae

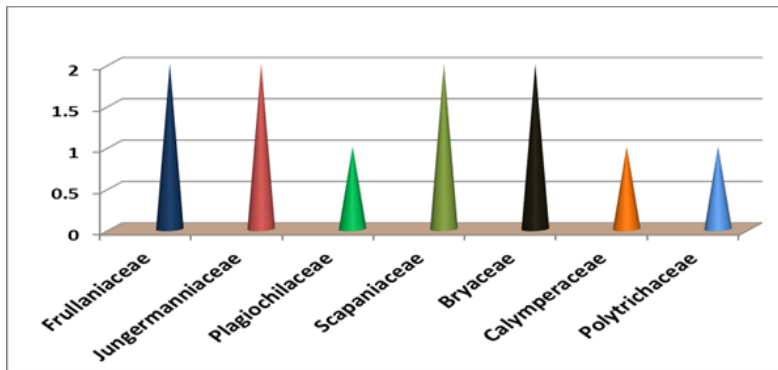


Fig.5. New records to the Country.

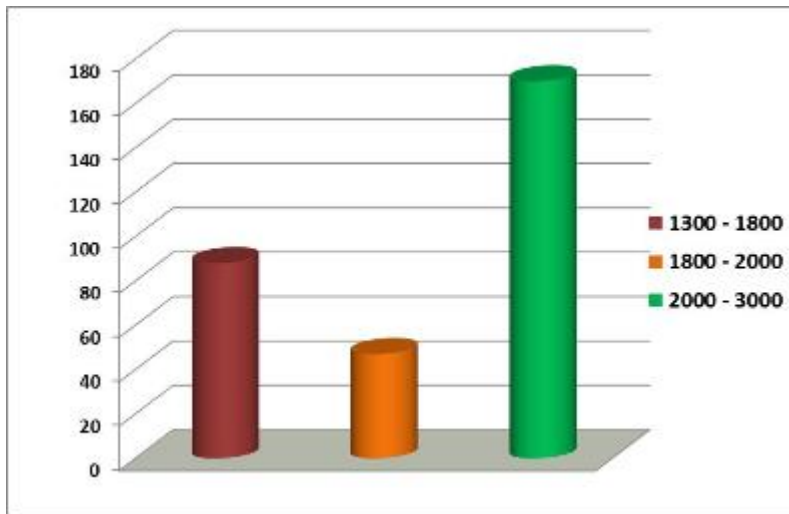


Fig.6. Diversity of bryophytes in N. Sindhupalchok at 1300 m – 3000 m.

6. CONSERVATION

Threat factors imposing direct impact on bryophyte habitats were studied at different altitudinal pockets. The major impact assessed in this part is mainly due to high rate of deforestation which is causing habitat loss of many rare bryophyte species occurring here. Agricultural extension which has demolished a major part of the natural forests was noticed in various places. This has made direct impact on bryoflora habitats mainly at Shermatnag (2620 m), Timbu (1300 m) and Melamchi (846 m) and Nagote (18000-2000 m) areas. The undergoing road constructions linking

Melamchi, Timbu to the Tarkyghyang. Melamchighyang, Nagote and Shermathang are the next adverse effect on the habitats of many rare bryophyte species. Major habitats have been destroyed for this work with complete loss of many species so their diversity and status remained completely unknown for-ever.

Tourism promotion activity in this part without proper management also has left adverse effect though tourism is one of the important income sources for the peoples of this part. Many significant habitats were found demolished in order to provide essential physical facilities for tourists visiting this part.

Villagers were found interested to participate in conservation campaign, they can do still better to promote tourism in their area if they are supported by the government or any other agencies. The women of this area have formed Women's Group which is actively participating in village development programmes. They are equally interested in the conservation of forest resources, wild life and to promote tourism in their areas. They also have planned to increase the economy of the villagers with the development of the horticultural and agricultural sectors; this has been found very encouraging especially at Nagote, Dhupgyang, Botang and Mane Bhanhyang areas.

6.1. Endangered and protected species

6.1.1. Faunal species: Among the fauna present in the forest area along the road alignment, Leopard (*Panthera pardus*) and Bear (*Ursus thibetanus*) are listed in CITES Appendix-I. Dumsi (*Hystrix indica*), Monkey (*Macaca mulatta*), Common frog (*Rana tigrina*), Wild cat (*Felis Chaus*) are listed in CITES Appendix-II.

6.1.2. Floral Species: Okhar (*Juglans regia*), is protected plant species and Sugandawal (*Cinnamomum glaucescens*) and Jhyau (*Lichen* sp.) are prohibited species for export to

other countries (IEE Study Report of February -2010). Chiraito (*Swertia chirayita*) and Jhyau (*Parmelia* sp.) are vulnerable species under IUCN category.

6.2. Conservation Awareness

Awareness Program aims to endorse awareness, promote conservation skills in nature conservation that helps to safeguard many pristine habitats of rare and endangered bryophyte species found in their community areas. It assists communities to become more aware of the pros and cons of the issue selected and promote goodwill and public relations to bring cooperation in conservation campaigns. This kind of program also increases the ability of community members to evaluate the effectiveness of the ongoing impact on their natural surroundings.

In Nepalese perspective this kind of program keeps special significances. The knowledge on the sustainable use of forest resources is still feebly developed in this country basically due to complicated pattern of geographical variation which has created non-uniformity in resources distribution from the lowland district to the Himalayan villages. As a tradition adopted so far, peoples of mountains and higher elevations still rely on forest resources due to the lack of alternate resources available there. Many parts of the country which are tourism perspectives are facing forest depletion for tourist's facilities. Road constructions and extension programs have led to demolish many pristine forests where bryophyte habitats are impacted seriously. Unsustainable harvesting of forest resources is the next serious impact on this lower plant group.

This study at different potential areas of the northern Sindhupalckok revealed that majority of the peoples is unaware of bryophyte conservation. Many of them were also unknown about bryophyte and its significant value in nature and mankind. Livestock rearing in mountain region is common phenomenon so they are more diverted to the foraging plants ignoring bryophytes which are not the foraging group.

These facts made this work to launch door to door awareness program at different village development committees in order to bring local people's attentions on the significant values of bryophytes and its use for the benefits of the society if used under sustainable way.

Questionnaires were developed to this work and 10 % of the households in every visited village were selected to provide them knowledge on the use and conservation of bryophytes in their areas. They were also informed about the valuable and endangered bryophyte species found in Total of 50 houses were selected in five different village wards. About 150 individual members of the houses were provided knowledge on bryophytes making their commitments in bryophyte conservation and sustainable use of forest resources.

Evaluation of filled out questionnaires revealed following information. Fifty questionnaires were used in five different Villages.

1. 95 % of the peoples were completely unknown about bryophytes. They simply call this plant "Jhyau" (native language) and do not know its significance and conservation values.
2. 3 % of the peoples mentioned their little knowledge on this plant but do not know its conservation values.
3. Only 2 % of the peoples mentioned that these are valuable plants in nature, they also know little about its uses. They opine that the conservation of this plant can help to control landslides, flooding and maintains soil fertility.

This awareness program made all the village peoples familiarized with bryophyte, its uses and conservation significances. Now these village communities are highly interested to participate in bryophyte conservation in their areas and make its use under sustainable way. They are planning to conserve this plant together with other plants on community level.

7. RECOMMENDATION

1. Detail information needs documented to understand the ecosystems in which different species of bryophytes grow.
2. Documentation on the traditional uses of bryophytes by different tribal peoples in the country. This helps to develop appropriate policies on sustainable use and conservation of this plant.
3. To evaluate the patterns of use and the economic values of bryophytes.
4. To provide information on the uses and availability of bryophytes.
5. There is a need to develop effective bryophyte conservation programs before more species and communities become critically endangered. Bryophyte conservation strategies are not only needed to protect the most imperiled species, but to ensure the long-term survival of all endangered and native species.
6. It is also essential to promote consistent policies for plant conservation including bryophytes.
7. To bring effectiveness in bryophyte conservation and familiarization. It is necessary to incorporate conservation message into primary, secondary, and adult education curricula.
8. It has been felt essential to encourage coordinated lower plant conservation planning and management.
9. Develop and implement guidelines and management techniques for collecting, propagating, and utilizing bryophytes in ecosystem restoration.
10. This has been found necessary for the application of adaptive management principles
11. Bryologists of the country should share the knowledge of bryophytes to the public especially in simple, easily understood public forums.
12. It is also necessary to safeguarding the bryophyte habitats against invading species.
13. Recommendations are made for conservation of important bryophyte communities and habitats, where feasible, in relation to development works

14. Concerned authorities should think to introduce a coordinated policy of Grazing.
15. Inadequate availability of fuel substitutes in remote areas is also causing impact on forest resources leading destruction of many significant bryophyte habitats.
16. Adequate budgeting should be made available for improvement of institutional framework in conducting extensive research on bryophytes.
17. Public awareness. Program is the basic requirement in conservation so its implementation should be extensive and effective.

8. SUGGESTIONS

1. Establishment of Bryophyte database is an essential aspect.
2. Inclusion of Bryophyte experts in Environment Impact Assessment programs.
3. Bryologists should be included in integrated programs on biodiversity documentation and conservation.
4. Increasing tourism promotional activities at the expense of forest resources in Sindhupalchok needs to be supervised for proper management.
5. Information center on existing biodiversity including bryophytes of Sindhupalchok district is equally essential.
6. Need of effective policy has been felt to implement for sustainable use of forest resources in this district.
7. Students should be made attracted to conduct their dissertation research on different aspects of bryophytes.
8. Local communities should be made more aware in bryophyte conservation.
9. Establishment of Moss Garden is the next need to flow information on bryophytes and to bring conservation consciousness.
10. Allocation of appropriate funding to run regular monitoring program on bryophyte diversity and its changing status in northern Sindhupalchok district.

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Appendix I

Species Diversity of Bryophytes of Northern Sindhupalchok district at 1300-3020 m

S.N.	Voucher No.	Families	Latin names	Elevation (m)	Status	Remarks
Anthocerotae						
1	10	Anthocerotaceae	<i>Anthoceros chambensis</i> Kashyap	1300	FC	
2	8, 29a, 291	Anthocerotaceae	<i>Anthoceros punctatus</i> L.	1480- 1700	C	Black small beetle
3	288, 290	Anthocerotaceae	<i>Phoeceros laevis</i> (L.) Prosk.	1700	FC	
Hepaticae						
1	127	Aneuraceae	<i>Riccardia multifida</i> (Linn.) Gray	2850	R	
2	3,15,	Aytoniaceae	<i>Asterella khasiana</i> (Griff.) Pande <i>et al.</i>	1430- 1480	FC	
3	424	Aytoniaceae	<i>Asterella multiflora</i> (Steph.) Pande <i>et al.</i>	1430	FC	
4	19, 245, 310b	Aytoniaceae	<i>Asterella wallichiana</i> (Lehm. & Linden.) Grolle	1420- 1750	FC	
5	418	Aytoniaceae	<i>Plagiochasma appendiculatum</i> Lehm. & Linden.	1350	FC	
6	247, 331	Aytoniaceae	<i>Plagiochasma pterospermum</i> C. Massal.	1350- 1770	FC	
7	417	Aytoniaceae	<i>Reboulia hemispherica</i> (L.) Raddi	1600	R	
8	401	Cephaloziellaceae	<i>Cephaloziella massalongi</i> (Spruce.) K. Muell.	2000	VR	
9	130, 295	Conocephalaceae	<i>Conocephalum conicum</i> (L.) Underw.	1890- 2600	FC	
10	346	Conocephalaceae	<i>Conocephalum japonicum</i> (Thunb.) Grolle	1800	R	
11	6,31, 220a, 260a	Frullaniaceae	* <i>Frullania dilatata</i> (L.) Dumort.	1480- 2120	C	
12	405	Frullaniaceae	<i>Frullania ericoides</i> (Nees) Montin	1740	R	
13	44	Frullaniaceae	* <i>Frullania gracillima</i> St.	1760	VR	

14	7, 44, 254	Frullaniaceae	<i>Frullania muscicola</i> Steph.	1280-1840	FC	
15	32a	Frullaniaceae	<i>Frullania retusa</i> Mitt.	1720	FC	
16	7, 41, 164	Frullaniaceae	<i>Frullania tamarisci</i> (L.) Dumort.	1480-1840	FC	
17	446	Frullaniaceae	<i>Frullania yunnanensis</i> Steph.	2400	FC	
18	349, 415	Geocalycaceae	<i>Heteroscyphus argutus</i> (Reinw. et al.) Schiffn.	1500-1800	R	Common in low land below 1000 m
19	447	Geocalycaceae	<i>Heteroscyphus planus</i> (Mitt.) Schiffn.	1300	R	
20	302, 320	Herbertaceae	<i>Herbertus adunca</i> (Dicks,) Gray	1900	R	
21	165b	Herbertaceae	<i>Herbertus</i> sp.	2440	R	
22	180	Jungermanniaceae	<i>Jamesoniella automnalis</i> (D.C) Steph.	2440	VR	
23	416	Jungermanniaceae	<i>Jungermannia atrovirens</i> Dumort.	2500	R	
24	326, 406	Jungermanniaceae	* <i>Jungermannia exertifolia</i> Steph.	1765	FC	Coccinidae beetle; Black nematods
25	173b	Jungermanniaceae	* <i>Jungermannia pumila</i> With.	2460	R	
26	315	Lejeuneaceae	<i>Lejeunea cavifolia</i> (Ehrh.) Lindb.	1766-1950	FC	
27	190a	Lejeuneaceae	<i>Lejeunea flava</i> (Sw.) Nees	2420	FC	
28	157	Lepidoziaceae	<i>Bazzania tridens</i> (Reinw. et al.) Trev.	2440	R	
29	13, 286, 341, 347	Marchantiaceae	<i>Marchantia emarginata</i> Reinw. et al.	1480-1800	C	
30	451	Marchantiaceae	<i>Marchantia paleacea</i> Bertol.	1800	FC	
31	429	Marchantiaceae	<i>Marchantia polymorpha</i> L.	1300-1650	C	
32	132, 135, 141, 172	Pelliaceae	<i>Pellia epiphylla</i> (L.) Corda	2420-2460	R	
33	211	Porellaceae	<i>Porella arboria</i> (Taylor) Spruce	2300	FC	

34	60b,	Porellaceae	<i>Porella denticulata</i> (Kashyap & R.S. Chopra) J.X. Luo	2120	FC	
35	274	Porellaceae	<i>Porella nitens</i> (Steph.) S. Hatt.	1530	R	
36	222	Plagiochileaceae	<i>Plagiochila chinensis</i> Steph.	2460	R	
37	231	Plagiochileaceae	<i>Plagiochila denticulata</i> Mitt.	2400	R	
38	450	Plagiochileaceae	<i>Plagiochila flexuosa</i> Mitt.	2350	R	
39	449	Plagiochileaceae	<i>Plagiochila retusa</i> Mitt.	2400	R	
40	217a, 280	Plagiochileaceae	* <i>Plagiochila spinulosa</i> (Dicks.) Dumort.	1750-2300	R	
41	38	Ricciaceae	<i>Riccia himalayensis</i> Steph.	1720	R	
42	67a,	Scapaniaceae	<i>Scapania ciliata</i> Sande Lacey	2400	R	
43	152a	Scapaniaceae	* <i>Scapania irrigua</i> (Nees) Nees	2400	R	Earwig (<i>Forficula</i> sps)
44	411	Scapaniaceae	<i>Scapania stephani</i> K. Muell.	2460	R	
45	163, 437	Scapaniaceae	* <i>Scapania undulata</i> (L.) Dumort.	1950-2440	FC	Earwig (<i>Forficula</i> sps.)
46	310, 340	Targioniaceae	<i>Cyathodium tuberosum</i> Kashyap	1750-1766	FC	
47	2, 46, 63b, 256, 331b	Targioniaceae	<i>Targionia hypophylla</i> L.	1430-1840	C	
48	154,220 176a, 258	Trichocoleaceae	<i>Trichocolea tomentaella</i> (Furh.) Dumort.	.2440-2460	FC	
49	118, 151, 155, 286 338, 345	Wiesnerellaceae	<i>Dumortiera hirsuta</i> (Sw.) Nees	1765-2440	C	Common land Snail Carabid
50	287	Wiesnerellaceae	<i>Wiesnerella denudate</i> Steph.	1700	R	
Musci						
1	402	Amblystegaceae	<i>Calliergonella cuspidata</i> (Hedw.) Loesk.	1800	FC	White Pupa of beetle
2	344	Amblystegaceae	<i>Campylium halleri</i> Hedw.	1800	R	Carabid

3	441	Brachytheciaceae	<i>Brachythecium buchananii</i> (Hook.) A. Jaeger	1900-2000	FC	
4		Bartramiaceae	<i>Philonotis fontana</i> (Hedw.) Brid.	2420	FC	
5	444	Bartramiaceae	<i>Philonotis hastata</i> (Duby) Wijk & Margad	1600	R	
6		Bartramiaceae	<i>Philonotis thwaitzii</i> Mitt.	1760	FC	
7	63a	Brachytheciaceae	<i>Bryhnia decurvans</i> (Mitt.) Dixon	2240	R	
8	238, 284	Brachytheciaceae	<i>Eurhynchium proelongum</i> (Hedw.) Schimp. var. <i>rigidum</i>	1295-1816	FC	
9	327, 427	Brachytheciaceae	<i>Eurhynchium ripariodes</i> (Hedw.) Richs.	1750-1825	C	Nematods (<i>Plectus</i> sp.)
10	67b,	Brachytheciaceae	<i>Homalothecium nigheriensis</i>	2400	R	
11	193, 214	Bryaceae	<i>Anomobryum auratum</i> (Mitt.) A. Jaeger	2300-2420	C	
12	42	Bryaceae	* <i>Anomobryum julaceum</i> (Gaertn. & al.) Schimp.	1420-1760	FC	
13	431	Bryaceae	<i>Brachymnium acuminatum</i> Harv.	1550	FC	
14	442	Bryaceae	<i>Brachymnium capitulatum</i> (Mitt.) Kindb.	2000		
15	64c	Bryaceae	<i>Brachymnium exile</i> (Dozy & Molk.) Bosch & Lacey	2350	R	
16	260b	Bryaceae	<i>Brachymnium nepalensis</i> Hook.	1560	R	
17	374	Bryaceae	<i>Brachymnium ptychothecium</i> (Besch.) Ochi	1825	R	
18	18, 37	Bryaceae	<i>Bryum argenteum</i> Hedw.	1510-2350	C	
19	339	Bryaceae	<i>Bryum cellulare</i> Hedw.	3020	R	
20	443	Bryaceae	<i>Bryum clavatum</i> (Schimp.) C. Muell.	3000	R	
21	236, 336	Bryaceae	<i>Bryum coronatum</i> Schwaegr.	1250-1760	R	Common in lowland
22	70, 114,	Bryaceae	<i>Pohlia</i> sp.	1750-	FC	

	167, 264,			2500		
23	442	Bryaceae	<i>Pohlia fl.exuosa</i> Hook.	1900	C	
24	70, 114, 167, 204, 264, 319	Bryaceae	<i>Pohlia elongata</i> Hedw.	1750- 2500	MC	
25	16, 85	Bryaceae	<i>Pohlia leucoloma</i> (Bosch. & Lacey) Fleisch.	1490- 2500	FC	
26	66, 166	Bryaceae	* <i>Pohlia nutans</i> (Hedw.) Lindb	2360- 2440	R	
27	115, 176b, 227, 342	Bryaceae	<i>Rhodobryum giganteum</i> (Schwaegr.) Paris	2460	C	
28	270, 403	Bryaceae	<i>Rhodobryum roseum</i> (Hedw.) Limpr.	1765	FC	
29	35	Calymperaceae	<i>Calymperes erosum</i> C. Muell.	1720	C	
30	45	Calymperaceae	* <i>Calymperes subfragilis</i> Ren. & Cardot	1770	R	
31	203	Dicranaceae	<i>Campylopodium khasianum</i> (Griff.) Paris	2120	R	Moth (Arctiid moth)
32	251	Dicranaceae	<i>Campylopus ericoides</i> (Griff.) A. Jaeger	1360	FC	
33	438	Dicranaceae	<i>Campylopus recharidii</i> Brid.	1934- 2120	FR	Moth (Noctuid moth)
34	45	Dicranaceae	<i>Campylopus subfragilis</i> Ren. & Cardot	1770	R	
35	354	Dicranaceae	<i>Dicranella heteromalla</i> (Hedw.) Schimp.	1940	R	
36	439	Dicranaceae	<i>Dicranum himalayanum</i> Mitt.	2850	R	
37	61, 201, 267	Dicranaceae	<i>Trematodon longicolle</i> Michx.	1770- 2160	C	
38	186	Dicranaceae	<i>Wilsoniella</i> sp.	2420	R	
39	43	Entodontaceae	<i>Erythrodontium julaceum</i> (Hook. ex Schwaegr.) Paris	1760	R	
40	53, 55,	Entodontaceae	<i>Entodon flavescens</i> (Hedw.) A. Jaeger	2050	FC	
41	62, 250,	Entodontaceae	<i>Entodon rubicundus</i>	1890-	C	

	297		(Mitt.) A. Jaeger	2220		
42	188	Entodontaceae	<i>Entodon veridulus</i> Cardot	2430	FC	
43	12,182	Fissidentaceae	<i>Fissidens bryoides</i> Hedw.	1480	FC	
44	177	Fissidentaceae	<i>Fissidens cristatus</i> Wils. ex Mitt.	2440	FC	
45	119, 419	Fissidentaceae	<i>Fissidens ceylonensis</i> Dozy & Molk.	1900- 2500	FC	
46	420	Fissidentaceae	<i>Fissidens grandifrons</i> Brid.	2500	FC	
47	421	Fissidentaceae	<i>Fissidens nobilis</i> Griff.	1300	FC	
48	305	Fissidentaceae	<i>Fissidens sylvaticus</i> Griff.	1750	R	
49	422	Fissidentaceae	<i>Fissidens taxifolium</i> Brid.	2900	FC	
50	64a, 185	Funariaceae	<i>Funaria hygrometrica</i> Hedw.	1900- 3000	C	
51	224	Hylocomiaceae	<i>Leptohymenium tenue</i> (Hook.) Schwaegr.	2460	R	
52	445	Hypnaceae	<i>Ectropothecium sikkimense</i> (Ren. & Cardot) Ren. & Cardot	2000	FC	
53	271	Hypnaceae	<i>Ectropothecium nervosum</i> Dixon	1765	R	
54	54, 408	Hypnaceae	<i>Hypnum pleumaforme</i> W. Wilson	1800- 3020	C	
55	290	Hypnaceae	<i>Ptilium crista castrensis</i> (Hedw.) De Not.	1560- 1700	R	
56	257	Hypnaceae	<i>Taxiphyllum taxirameum</i> (Mitt.) Fleisch.	1410- 2700	FC	
57	422	Leucobryaceae	<i>Leucobryum juniperoideum</i> (Brid.) C. Muell.	2500	FC	
58	423	Leucobryaceae	<i>Leucobryum mittenii</i> Besch.	900	FC	Common in lowland
59	241, 245	Leucobryaceae	<i>Octoblepharum albidum</i> Hedw.	1300	FC	
60	279	Meteoriaceae	<i>Barbella stevensii</i> (Ren. & Cardot.) M. Fleisch.	1720- 2500	FC	
61		Mniaceae	<i>Mnium punctatum</i> Hedw.	2800- 3021	FC	
62	296	Mniaceae	<i>Mnium rostratum</i> Schrad.	1890	R	
63	384	Mniaceae	<i>Orthomnium bryoides</i>	1820	R	

			(Griff.) Norkett			
64	243	Mniaceae	<i>Plagiomnium cordatum</i> Kop. & Norris	1300	FR	
65	329	Plagiotheciaceae	<i>Plagiothecium nemorale</i> (Mitt.) A. Jaeger	1766	FC	Red ant
66	65, 69	Polytrichaceae	* <i>Oligotrichum javanicum</i> (Hampe.) Dozy & Molk.	2480	R, New	
67	272	Polytrichaceae	<i>Polytrichum commune</i> Hedw.	1760- 2340	FC	
68	4, 58, 244, 249, 303	Polytrichaceae	<i>Pogonatum microstomum</i> (Schwaegr.) Brid.	1480- 2060	MC	
69	56, 59	Polytrichaceae	<i>Pogonatum nudiusculum</i> Mitt.	2040	C	
70	158, 160	Polytrichaceae	<i>Pogonatum submacrophyllum</i> Herzog	2460- 2500	FC	
71	1355,	Polytrichaceae	<i>Pogonatum microphyllum</i> (Dozy & Molk.) Dozy & Molk,	1949- 3020	C	
72	320	Pottiaceae	<i>Barbula tenuirostries</i> Brid.	1760- 1950	FC	
73	175, 284	Pottiaceae	<i>Bryoerythrophyllum nogoehianum</i> Gangulee	2460	FC	
74	189	Pottiaceae	<i>Bryoerythrophyllum recurvirostre</i> (Hedw.) P.C. Chen	2420	FC	
75	14	Pottiaceae	<i>Hydrogonium arcuatum</i> (Griff.) Wijk. & Margad	1480	FC	
76	71, 276, 298	Pottiaceae	<i>Hyophila involuta</i> (Hook.) A. Jaeger	1510- 2500	FC	
77	187, 335	Pottiaceae	<i>Oxystegus cylindricus</i> (Brid.) Hilp. ex Beih.	1755- 2449	C	
78	430	Sphagnaceae	<i>Sphagnum</i> sp.	2200	R	
79	200	Sphagnaceae	<i>Sphagnum junghuhnianum</i> Dozy & Molk.	2200	R	
80	221	Splachnaceae	<i>Tayloria indica</i> Mitt.	2460	R	
81	304	Stereophyllaceae	<i>Entodontopsis leucostega</i> (Brid.) W.R. Buck & Ireland	1750	R	

82	11, 20, 275, 262, 285	Stereophyllaceae	<i>Entodontopsis tavoyense</i> (Hook. F.) W. R. Buck & Ireland	1540- 1816	MC	
83	22, 23, 50, 242, 246	Stereophyllaceae	<i>Entodontopsis wightii</i> (Mit.) W. R. Buck & Ireland	1300- 2000	C	
84	435	Thuidaceae	<i>Haplocladium</i> <i>angustifolium</i> (Hampe. & C. Muell.) Broth.	1350	R	
85	434	Thuidaceae	<i>Herpetineurion toccoe</i> (Sull.& Lesq.) Cardot	1350	FC	
86	51, 426, 433	Thuidaceae	<i>Thuidium cambifolium</i> (Dozy & Molk.) Dozy & Molk.	1880- 2100	C	
87	232, 289	Thuidaceae	<i>Thuidium glaucinum</i> (Mitt.) Bosch.	1700- 2440	FC	
88	432	Thuidaceae	<i>Thuidium tamariscellum</i> (C. Muell.) Bosch. & Lacey	1500	FC	

Appendix II

Species Diversity of Newly Recorded species

S.N.	V.N.	Families	Bryophytes species	Proper Locality	Elevation (meter)	Habitats
Hepaticae						
1	6,31, 220a, 260a	Frullaniaceae	<i>Frullania dilatata</i> (L.) Dumort.	Timbu, Kakani, Shermathang	1480-2120	Soil, bark
2	44	Frullaniaceae	<i>Frullania gracillima</i> St.	Timbu	1760	Tree bark
3	326, 406	Jungermanniaceae	<i>Jungermannia exertifolia</i> Steph.	Kharchung, Nakote	1765	Boulder stone
4	173b	Jungermanniaceae	<i>Jungermannia pumila</i> With.	Tarkeghyang	2460	Rock
5	217a, 280	Plagiochilaceae	<i>Plagiochila spinulosa</i> (Dicks.) Dumort.	Doring	1750-2300	Tree base, tree bark
6	152a	Scapaniaceae	<i>Scapania irrigua</i> (Nees) Nees	Tarkeghyang	2440	Rock
7	163, 437	Scapaniaceae	<i>Scapania undulata</i> (L.) Dumort.	Nagote; Shermathang	1950-2440	Tree bark
Musci						
8	42	Bryaceae	<i>Anomobryum julaceum</i> (Gaertn. et al.) Schimp.	Timbu	1420-1760	
9	66, 166	Bryaceae	<i>Pohlia nutans</i> (Hedw.) Lindb.	Ghyangul; Tarkeghyang	2360-2450	Soil, rock
10	45	Calymperaceae	<i>Calymperes subfragilis</i> Ren. & cardot	Timbu	1770	Rock
11	65, 69	Polytrichaceae	<i>Oligotrichum javanicum</i> (Hampe.) Dozy & Molk.	Kakani	2480	Mountain slope

Appendix III

Fern Diversity associated with Bryophytes

S.N.	Name of the species	Common name	Family	Habit	Altitude (meter)	Status
1.	<i>Adiantum capillus-veneris</i> L.	Rani sinki	Pteridaceae	Herb	1440	C
2	<i>Adiantum philippina</i> L.		Pteridaceae	Herb	1500-1650	C
3	<i>Azolla imbricota</i> (Roxb.) Nakai.	Floating fern	Salviniaceae		1600	C
4	<i>Botrychium multifidum</i> (S.G. Gmel.) Rupr.		Ophioglossaceae	Herb	1800	R
5	<i>Cheilanthes anceps</i>	Silver fern	Pteridaceae	Herb	1440	C
6	<i>Cyathea spinulosa</i> Wall. ex Hook.	Tree fern	Cytheaceae	Herb		C
7	<i>Diplanium esculentum</i>	Cooking fern	Aspidiaceae	Herb	1350	C
8	<i>Diplanium japonicum</i> (Thunb.) Moore Bedd.		Aspidiaceae	Herb	1820	FC
9	<i>Dryopteris acutodentata</i> Ching Syn. <i>Dryopteris filix-mas</i>	Unyu; Cooking fern	Gleicheniaceae	Herb	1720	C
10	<i>Dicranopteris linearis</i>		Gleicheniaceae	Herb	1600	FC
11	<i>Dryopteris cochleata</i> (Ham. ex D. Don) C. Chr.	Danthe niuro; Kuthurke	Gleicheniaceae	Herb	1820	FC
12	<i>Dryopteris pulcherrima</i>		Dryopteridaceae	Herb	1850	FC
13	<i>Equisetum arvense</i> L.	Ankhe jhar	Equisetaceae	Herb	1440	C
14	<i>Equisetum diffusum</i> D. Don	Ankhale jhar; Harjor; Kumkum; Talche jhar	Equisetaceae	Herb	1450	FC
15	<i>Equisetum palustre</i>	Horse tail	Equisetaceae	Herb	1500	C
16	<i>Gleichenia gigantea</i> Wall. ex Hook. et Bauer.		Gleicheniaceae	Herb	1770	C
17	<i>Lepisorus nudus</i> (Hook.) Ching.		Polypodiaceae	Herb		C
18	<i>Loxogramme</i> sp.		Polypodiaceae	Herb		C

19	<i>Lycopodium cernuum</i> L.	Nagbeli	Lycopodiaceae	Herb	2025	C
20	<i>Lycopodium clavatum</i> L.	Nagbeli	Lycopodiaceae	Herb	2060	C
21	<i>Nephrolepis cordifolia</i> (L.) Presl.	Sword fern		Herb	1300-2000	C
22	<i>Oleandra musifolia</i> (L.) Pr.		Davalliaceae	herb	2050	R
23.	<i>Onychium siliculosum</i>	Golden fern	Pteridaceae	Herb	1610	C
24.	<i>Pteris vittata</i> Linn.		Pteridaceae	Herb	1480	
25.	<i>Polystichum</i> sp.		Dryopteridaceae	Herb	2040	R
26	<i>Selaginella ciliaris</i> (Retz.) Spring		Selaginellaceae	Herb	1480	FC
27	<i>Selaginella monospora</i> Spring.		Selaginellaceae	Herb	1440	C
28	<i>Selaginella pinnata</i> (D. Don) Spring.		Selaginellaceae	Herb	1490	C
29	<i>Tectaria odorata</i>	Kalo neuro	Dryopteridaceae	Herb	1440	FC

Appendix IV

Gymnosperms on the way to Study Route

S.N.	Name of the species	Common name	Family	Habit	Altitude (meter)	Status
1	<i>Abies spectabilis</i>	Fir	Pinaceae	Tree	1880	
2	<i>Cedrus deodara</i>	Deodar	Pinaceae	Tree	2400	
3	<i>Juniperus sp.</i>	Cedar	Cupressaceae	Tree	2200	
4	<i>Pinus roxburghii</i>	Chir pine	Pinaceae	Tree	1780	C
5	<i>Pinus wallichiana</i>	Blue pine	Pinaceae	Tree	1880	C
6	<i>Tsuga dumosa</i>		Pinaceae	Tree	2180	

Appendix V

Angiospermic Flora of First Phase Study

S. N.	Name of the species	Nepali name	Family	Habit	Altitude (meter)	Status
1	<i>Ageratum conyzoides</i>	Ganemane Ghar	Compositae	Herb	1300-1480	MC
2.	<i>Allium wallichii</i>	Ban lasun	Amaryllidaceae	Herb	1800	R
3	<i>Alnus nepalensis</i>	Uttis	Betulaceae	Tree	1400	C
4	<i>Anaphalis contorta</i>	Pansan	Compositae	Herb	1800-2000	C
5.	<i>Anaphalis triplinervis</i>	Phajar Mendo	Compositae	Herb	2300	R
6	<i>Arisaema erubescens</i>	Sarpako makai	Araceae	Herb	2000	C
7	<i>Artemisia indica</i>	Tite pate	Compositae	Herb	1420	C
8	<i>Aster ageratoides</i>		Compositae	Herb	1500	C
9	<i>Begonia sp.</i>		Begoniaceae	Herb	1800	FC
10	<i>Berberis aristata</i>	Chutro	Berberidaceae	shrub	1480-1800	C
11	<i>Bidens pilosa</i>	Kuro	Asteraceae	Herb	1400-1650	MC
12	<i>Bistorta amplexicaulis</i>	Raktaryaulo	Polygonaceae	Herb	2350	R
13	<i>Bistorta vivipara</i>	Khalti	Polygonaceae	Herb	1900	C
14	<i>Buddleja asiatica</i>	Bhimsen Pati	Loganiaceae	Shrub	1980	C
15	<i>Callistemon citrinus</i>	Krishnakali	Myrtaceae	Tree	1600	FC
16	<i>Carex insignis</i>		Cyperaceae	Herb	1450	C
17	<i>Castanopsis indica</i>	Katush	Fagaceae	Tree	1600	C
18	<i>Choerospondias axillaris</i>	Lapsi	Anacardiaceae	Tree	1480-1740	C
19	<i>Commelina benghalensis</i>	Bankane	Commelinaceae	Herb	1400	C
20	<i>Conyza japonica</i>	Salaha Jhar	Compositae	Herb	1480	FC
21	<i>Corydalis sp.</i>		Papaveraceae	Herb	2470	R
22	<i>Cuscuta reflexa</i>	Hawajadi	Convolvulaceae	Climber	1350	R
23	<i>Cyanodon dactylon</i>	Dubo	Gramineae	Herb	1450	C
24	<i>Cyrtococcum patens</i>		Poaceae	Herb	1350	R
25	<i>Dalbergia sisso</i>	Sisso	Leguminosae	Tree	1480	FC
26	<i>Daphne bholuia</i>	Lokta	Thymelaeaceae	shrub	1880	FC

27	<i>Desmodium confertum</i>		Leguminosae	Climber	1300-1420	C
28	<i>Desmodium multiflorum</i>	Bhatmase Jhar	Leguminosae	Climber	1850	C
29	<i>Dioscorea sagittata</i>	Tarul	Dioscoreaceae	Climber	1680	FC
30	<i>Erigeron sublyratus</i>	Mahadi	Compositae	Herb	1300	R
31	<i>Eupatorium adenophorum</i>	Ban mara	Compositae	Herb	1300-1600	C
32	<i>Eurya ceracifolia</i>	Pate	Theaceae	Tree	2200	FC
33	<i>Ficus bengalensis</i>	Bar	Moraceae	Tree	1300	R
34	<i>Ficus religiosa</i>	Peepal	Moraceae	Tree	1300	FC
35	<i>Ficus semicordata</i>	Khanyu	Moraceae	Tree	1440	C
36	<i>Fragraria nubicola</i>	Bhui kaphal	Rosaceae	Herb	1600-2000	C
37	<i>Galinsoga parviflora</i>		Compositae	Herb	1300-2000	MC
38	<i>Gaultheria fragrantissima</i>		Ericaceae	Shrub	2000	FC
39	<i>Girardinia diversifolia</i>	Allo	Urticaceae	Herb	1680	C
40	<i>Gnaphalium affine</i>	Kairo Jhar	Compositae	Herb		C
41	<i>Hedychium ellipticum</i>	Kyamana	Zingiberaceae	Herb	1860	FC
42	<i>Heracleum nepalensis</i>	Phaki	Umbelliferae	Herb	2350	R
43	<i>Hypechusa hybrida</i>		Fabaceae	Climber	1430	R
44	<i>Hypestrum hybrid</i>	Dhwang phool	Amaryllidaceae	Herb	1420	C
45	<i>Imperata cylindrica</i>		Gramineae	Herb	1500-2000	C
46	<i>Inula cappa</i>	Kan pate	Compositae	Herb	1420	C
47	<i>Juglans regia</i>	Okhar	Juglandaceae	Tree	2100	FC
48	<i>Litsea monopelata</i>	Kutmero	Lauraceae	Shrub	1800	R
49	<i>Lobelia pyramidalis</i>	Ekievir	Lobeliaceae	Herb	1800	FC
50	<i>Mahonia acanthifolia</i>	Chutro	Berberidaceae	Shrub	1800	FC
51	<i>Mahonia nepaulensis</i>	Jamane mandro	Berberidaceae	Small Tree	1800	C
52	<i>Melastoma melabathricum</i>	Angeri	Melastomaceae	Shrub	1000	FC
53	<i>Mucuna pruriens</i>	Kauso	Leguminosae	Climber	1360	R
54	<i>Ocimum gratissimum</i>	Tulsi	Labiatae	Herb	1980	C
55	<i>Osbeckia nepalense</i>	Seto chulsi	Melastomaceae	Shrub	1780	FC
56	<i>Oxalis comiculata</i>	Chari amilo	Oxalidaceae	Herb	1300-	C

					2000	
57	<i>Oxyspora peduncularis</i>		Melastomaceae	Shrub	2200	R
58	<i>Persicaria nepalensis</i>		Polygonaceae	Shrub	2000-2400	C
59	<i>Phragmites karka</i>	Narkat	Gramineae	Shrub	1650	FC
60	<i>Phyllanthus emblica</i>	Amala	Euphorbiaceae	Herb	1760	C
61	<i>Potentilla peduncularis</i>	Bajradanti	Rosaceae	Herb	1800	FC
62	<i>Primula irregularis</i>		Primulaceae	Herb	1650	FC
63	<i>Prinsepia utilis.</i>	Ghatelo	Rosaceae	Shrub	2200	C
64	<i>Quercus semicarpifolia</i>	Oak	Fagaceae	Tree	1900	C
65	<i>Rhododendron arboreum</i>	Gurans	Ericaceae	Shrub	1800-2400	C
66	<i>Rubus ellipticus</i>	Ainselu	Rosaceae	Shrub	1550-2250	C
67	<i>Rumex crispus</i>	Halhale	Polygonaceae	Herb	1450	C
68	<i>Saccharum spontaneum</i>	Kharu	Gramineae	Herb	1440	C
69	<i>Sapium insigne</i>	Khirro	Euphorbiaceae	Shrub	1300	FC
70	<i>Saxifraga diversifolia</i>		Saxifragiaceae	Herb	2400	R
71	<i>Satyrium nepalense</i>		Orchidaceae	Herb	1800	T
72	<i>Schima wallichii</i>	Chilaune	Theaceae	Tree	1560	C
73	<i>Scircium wallichii</i>		Orchidaceae	Herb	1450	V
74	<i>Scutellaria discolor</i>		Labiatae	Herb		R
75	<i>Selinum striatum</i>		Umbelliferae	Herb	1850	R
76	<i>Senecio candolleanus</i>		Compositae	Herb	2520	R
77	<i>Sunchus sp.</i>	Kanike fool	Compositae	Herb	1300	FC
78	<i>Swertia chiraita</i>	Chiraito	Gentianaceae	Herb	1850	FC
79	<i>Tanacetum cinerariifolium</i>		Compositae	Herb	1350	FC
80	<i>Thalictrum foliolosum</i>		Ranunculaceae	Shrub	2100	FC
81	<i>Torenia cordifolia</i>		Scrophulariaceae	Herb	1610	FC
82	<i>Viburnum erubescens</i>		Sambucaceae	Shrub	2450	R
83	<i>Zanthoxylem armantum</i>	Timur	Rutaceae	Tree	1600	C

Appendix VI

Angiospermic Flora of Second Phase Study

S.N	Scientific name	Family	Habit	Altitude	Latitude	Longitude	Remarks
1	<i>Schima wallichii</i>	Theaceae	tree	1250m	27°56'52.00'N	85°32'45.21''E	Kharchung
2	<i>Alnus nepalensis</i>	Betulaceae	„	„	„	„	„
3	<i>Lindenbergia grandiflora</i>	Scrophulariaceae	Herb	„	„	„	„
4	<i>Rubus ellipticus</i>	Rosaceae	Shrub	„	„	„	„
5	<i>Artemisia indica</i>	Asteraceae	Shrub	„	„	„	„
6	<i>Macaranga indica</i>	Euphorbiaceae	Tree	„	„	„	„
7	<i>Sacroccca coriacea</i>	Buxaceae	Shrub	„	„	„	„
8	<i>Colebrookea oppositifolia</i>	Lamiaceae	Shrub	„	„	„	„
9	<i>Ageretina adenopjora</i>	Asteraceae	Herb	„	„	„	„
10	<i>Maesa chisia</i>	Myrsinaceae	Shrub	„	„	„	„
11	<i>Caryopteris odorata</i>	Verbenaceae	Shrub	„	„	„	„
12	<i>Lyonia ovalifolia</i>	Ericaceae	Small tree	„	„	„	„
13	<i>Cynoglossum zeylanicum</i>	Boraginaceae	Herb	„	„	„	„
14	<i>Bidens pilosa</i>	Asteraceae	„	„	„	„	„
15	<i>Aconogonum molle</i>	Poligonaceae	„	„	„	„	„
16	<i>Polygonum barbatum</i>	Poligonaceae	„	„	„	„	„
17	<i>Pilea symmeria</i>	Urticaceae	Shrub	„	„	„	„
18	<i>Myrica esculenta</i>	Myricaceae	Tree	„	„	„	„
19	<i>Woodfordia fruticosa</i>	Lythraceae	Herb	„	„	„	„
20	<i>Phyllanthus sp</i>	Euphorbiaceae	Shrub	„	„	„	„
21	<i>Myrsine capitellata</i>	Scrophulariaceae	Tree	„	„	„	„
22	<i>Rhododendron arboreum</i>	Ericaceae	Small tree	„	„	„	„
23	<i>Clematis sp</i>	Ranunculaceae	Climber	„	„	„	„
24	<i>Asparagus filicinus</i>	Liliaceae	Shrub	1300m	„	„	„

25	<i>Bauhinia purpurea</i>	Leguminosae	Tree	''	''	''	''
26	<i>Baridelia retusa</i>	Euphorbiaceae	Tree	''	''	''	''
27	<i>Prunus cerasoides</i>	Rosaceae	Tree	''	''	''	''
28	<i>Punica sp</i>	Punicaceae	Shrub	''	''	''	''
29	<i>Eurya acuminata</i>	Theaceae	Small tree	''	''	''	''
30	<i>Rhus javanica</i>	Anacardiaceae	Small tree	''	''	''	''
31	<i>Ficus nerifolia</i>	Moraceae	Tree	''	''	''	''
32	<i>Pyracantha crenulata</i>	Rosaceae	Shrub	''	''	''	''
33	<i>Pyrus pashia</i>	Rosaceae	Tree	''	''	''	''
34	<i>Ficus semicordata</i>	Moraceae	Tree	''	''	''	''
35	<i>Urtica dioica</i>	Urticaceae	Shrub	''	''	''	''
36	<i>Buddleja asiatica</i>	Buddlejaceae	Shrub	''	''	''	''
37	<i>Litsea monopetala</i>	Lauraceae	Tree	''	''	''	''
38	<i>Euphorbia royleana</i>	Euphorbiaceae	Tree	''	''	''	''
39	<i>Hydrangea aspera</i>	Hydrangeaceae	Tree	''	''	''	''
40	<i>Choerospondias axillaris</i>	Anacardiaceae	Tree	''	''	''	''
41	<i>Ficus carica</i>	Moraceae	Tree	''	''	''	''
42	<i>Zanthoxylum armatum</i>	Rutaceae	Shrub	''	''	''	''
43	<i>Luculia gratissima</i>	Rubiaceae	Shrub	''	''	''	''
44	<i>Hypericum uralum</i>	Hypericaceae	Shrub	''	''	''	''
45	<i>Melastoma melabathricum</i>	Melastomaceae	Shrub	1330m	27°57'20.07''N	85°32'45.01''E	''
46	<i>Psidium guajava</i>	Myrtaceae	Shrub	''	''	''	''
47	<i>Urena lobata</i>	Malvaceae	Shrub	''	''	''	''
48	<i>Crassocephalum crepidiodes</i>	Asteraceae	Herb	''	''	''	''

49	<i>Bistorta amplexicaulis</i>	Poligonaceae	Herb	„	„	„	„
50	<i>Reinwardtia indica</i>	Linaceae	Herb	„	„	„	„
51	<i>Madhuca indica</i>	Sapotaceae	Herb	„	„	„	„
52	<i>Anaphalis contorta</i>	Asteraceae	Herb	1360m	„	„	„
53	<i>Thysanolaena maxima</i>	Poaceae	Herb	„	„	„	„
54	<i>Bombax ceiba</i>	Bombacaceae	Tree	„	„	„	„
55	<i>Inula cappa</i>	Asteraceae	Herb	„	„	„	„
56	<i>Quercus semecarpifolia</i>	Fagaceae	Tree	„	„	„	„
57	<i>Phyllanthus emblica</i>	Euphorbiaceae	Tree	1380m	„	„	„
58	<i>Albizia chinensis</i>	Leguminosae	Tree	1410m	„	„	„
59	<i>Amomum subulatum</i>	Zingiberaceae	Herb	„	„	„	„
60	<i>Celtis australis</i>	Ulmaceae	Shrub	„	„	„	„
61	<i>Ficus lacor</i>	Moraceae	Tree	„	„	„	„
62	<i>Sonchus asper</i>	Asteraceae	Herb	1462m	27°57'44.25''N	85°32'39.76''E	„
63	<i>Premna integrifolia</i>	Verbenaceae	Shrub	„	„	„	„
64	<i>Yucca sp</i>	Agavaceae	Shrub	„	„	„	„
65	<i>Cinnamomum tamala</i>	Lauraceae	Tree	„	„	„	„
66	<i>Callicarpa macrophylla</i>	Verbenaceae	Tree	„	„	„	„
67	<i>Albizia procera</i>	Leguminosae	Tree	„	„	„	„
68	<i>Rhododendron arboreum</i>	Ericaceae	Tree	„	„	„	„
69	<i>Pinus roxburghii</i>	Pinaceae	Tree	1660m	„	„	Doring
70	<i>Oxyspora paniculata</i>	Melastomataceae	Shrub	„	„	„	„
71	<i>Astilbe rivularis</i>	Saxifragaceae	Herb	1760m	„	„	„
72	<i>Gautheria fragrantissima</i>	Ericaceae	Shrub	„	„	„	„
73	<i>Leucas sp</i>	Lamiaceae	Herb	„	„	„	„
74	<i>Achyranthes aspera</i>	Amaranthaceae	Herb	„	„	„	„
75	<i>Elsholtzia sp</i>	Lamiaceae	Herb	„	„	„	„

76	<i>Geranium wallichianum</i>	Geraniaceae	Herb	„	„	„	„
77	<i>Dendrocalamus strictus</i>	Poaceae	Shrub	„	„	„	„
78	<i>Nepeta clarkei</i>	Lamiaceae	Shrub	„	„	„	„
79	<i>Saurauia nepalensis</i>	Saurauiaceae	Tree	„	„	„	„
80	<i>Smilax aspera</i>	Liliaceae	Climber	„	„	„	„
81	<i>Piper sp</i>	Piperaceae	Climber	„	„	„	„
82	<i>Juglans regia</i>	Juglandaceae	Tree	„	„	„	„
83	<i>Berberis wallichiana</i>	Berberidaceae	Shrub	„	„	„	„
84	<i>Solanum nigrum</i>	Solanaceae	Herb	„	„	„	„
85	<i>Hedyotis scandens</i>	Rubiaceae	Climber	„	„	„	„
86	<i>Boenninghausenia albiflora</i>	Rutaceae	Herb	„	„	„	„
87	<i>Prunus domestica</i>	Rosaceae	Tree	1700m	„	„	„
88	<i>Swertia chirayita</i>	Gentianaceae	Herb	„	„	„	„
89	<i>Indigofera heterantha</i>	Leguminosae	Shrub	„	„	„	„
90	<i>Osbeskia nepalensis</i>	Melastomaceae	Shrub	„	„	„	„
91	<i>Osbeskia stellata</i>	Melastomaceae	Shrub	„	„	„	„
92	<i>Tonna ciliata</i>	Meliaceae	Tree	„	„	„	„
93	<i>Rubia manjith</i>	Rubiaceae	Climber	„	„	„	„
94	<i>Fagopyrum esculentum</i>	Polygonaceae	Herb	„	„	„	„
95	<i>Rumex nepalensis</i>	Polygonaceae	Herb	„	„	„	„
96	<i>Pisum sativum</i>	Leguminosae	Herb	1885m	27°39'21.33'N	85°32'04.31''E	„
97	<i>Chenopodium album</i>	Chenopodiaceae	Herb	„	„	„	„
98	<i>Crotolaria cystisoides</i>	Leguminosae	Herb	„	„	„	„
99	<i>Cyathula tomentosa</i>	Amaranthaceae	Herb	„	„	„	„
100	<i>Magnolia champbelli</i>	Magnoliaceae	Tree	„	„	„	„
101	<i>Syzygium cunini</i>	Myrtaceae	Tree	„	„	„	„
102	<i>Rosa sp</i>	Rosaceae	Shrub	„	„	„	„

103	<i>Lithocarpus pachyphylla</i>	Fagaceae	Tree	„	„	„	„
104	<i>Viburnum erubescens</i>	Sambucaceae	Shrub	„	„	„	„
105	<i>Oxalis corniculata</i>	Oxalidaceae	Herb	„	„	„	„
106	<i>Viburnum mullaha</i>	Sambucaceae	Shrub	„	„	„	„
107	<i>Oplismenus compositus</i>	Poaceae	Herb	„	„	„	„
108	<i>Conyza japonica</i>	Asteraceae	Herb	„	„	„	„
109	<i>Persea Odoratissima</i>	Lauraceae	Tree	„	„	„	„
110	<i>Persea duthiei</i>	Lauraceae	Tree	„	„	„	„
111	<i>Cotoneaster acuminiatus</i>	Rosaceae	Shrub	„	„	„	„
112	<i>Bergenia ciliata</i>	Saxifragaceae	Herb	„	„	„	„
113	<i>Rubus acuminiatus</i>	Rosaceae	Climber	„	„	„	„
114	<i>Rubus paniculatus</i>	Rosaceae	Climber	„	„	„	„
115	<i>Bistorta macrophyllum</i>	Chenopodiaceae	Herb	„	„	„	„
116	<i>Gonostegia hirta</i>	Urticaceae	Shrub	„	„	„	„
117	<i>Xylosma longifolium</i>	Flacourtiaceae	Shrub	„	„	„	„

Appendix VII

Faunal Diversity

Scientific Names	Altitude
A. Annelids	
1. <i>Pheretima posthuma</i>	900-1500 m
2. <i>Hirudinaria granulose</i>	1000-3000 m
B. Araneidae	
1. <i>Araneus</i> sps.	1300 m
2. <i>Gnaphosa</i> sps	1350 m
3. <i>Cyclosa</i> sps	1500 m
4. <i>Salticid</i> sps.	1100- 2000 m
C. Coleoptera	
1. <i>Trechus himalayanus</i> (Carabiidae)	2100 m
2. <i>Carabus</i> sp. (Carabiidae)	1900-2050 m
3. <i>Acropteryx</i> sps. (Chrysomelidae)	1750 m
4. <i>Dorcus antaeus</i> (Lucanidae),	3000 m
5. <i>Dorcus lineatopunctatus</i> (Lucanidae)	2500 m
6. <i>Onthiphagus</i> sp. (Scarabiidae)	2000 m
7. <i>Amara</i> sp.	2000 m
8. <i>Ipelates</i> sp.	1850 m
9. <i>Prostomis beatae</i>	2500 m
10. <i>Acalolepa freudi</i>	2150 m
11. <i>Oberea</i> sp.	2150 m
12. <i>Xystrocera</i> sp.	1700 m
13. <i>Glyphocassis trilineata</i>	2500 m
14. <i>Corynodes pyrophorus</i>	2200 m
15. <i>Ambrostoma mahesa</i>	2632 m

D. Hemiptera

16. <i>Pineus laevis</i>	1500 m
17. <i>Liosomaphis himalensis</i>	1400 m
18. <i>Neoacyrthosiphon nepalensis</i>	1800 m
19. <i>Myzocallis alnicola</i>	2200 m
20. Lygaeidae bugs	2400 m
21. <i>Beesonia brevipes</i>	2100 m
22. Pentatomidae bug	2550 m

E. Hymenoptera

23. <i>Orientalibombus haemorrhoidalis</i>	1800 m
24. <i>Podagrion pachymerum</i> Wik.	1600 m

F. Dermaptera

25. <i>Forficula</i> sp.	1300-2000 m
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G. Diplopoda

26. <i>Millipedes</i>	1900 m
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H. Lepidoptera

H.a. Moths

1. <i>Deiopia pulchella</i> (Arctiidae)	1470 m
2. <i>Eusemia victrix</i> (Agaristidae)	1800 m
3. <i>Chrysorabdia bivitta</i> (Arctiidae)	1680 m
4. <i>Spilosoma casignatum</i> (Arctiidae)	1300-2000 m
5. <i>Spilosoma</i> sps. (Arctiidae)	1700 m
6. <i>Xestia aquila</i> (Noctuidae)	1400-1559 m
7. <i>Xestia fakosharga</i> (Noctuidae)	1200 m
8. <i>Epiplima adamantina</i> (Uranidae)	1950 m
9. <i>Dysstroma aquilum</i> (Geometridae)	2100 m

H.b. Butterflies

- | | |
|---|--------|
| 1. <i>Mycalesis mineus</i> (Satyridae) | 1600 m |
| 2. <i>Callerebia scanda</i> (Satyridae) | 1780 m |
| 3. <i>Acraea issoria</i> (Acreeidae) | 1800 m |

I. Nematoda

- | | |
|-----------------------------|--------|
| 27. <i>Plectus</i> sps. | 2100 m |
| 28. <i>Eudorylaimus</i> sp. | 2350 m |

J. Mollusca

- | | |
|----------------------------------|-------------|
| 1. <i>Helix</i> sp. (Land Snail) | 1350-1700 m |
| 2. <i>Meghimatium</i> sp. (Slug) | 1500 m |

K. Aves

- | | |
|---|--------------|
| 1. <i>Hypoplicus hyperythrus</i> (Rufous- bellied Sap sucker) | 2200 m |
| 2. <i>Pnoepyga albiventer</i> (Scaly bellied Wren Babbler)- | 2400 m above |
| 3. <i>Garrulax affinis</i> (Black-faced Laughing Thrush) | 1900 m |
| 4. <i>Cutia nepalensis</i> (Nepal Cutia) | 2300 m |
| 5. <i>Actinodura nepalensis</i> (Hoary Barwing) | 2000 m |
| 6. <i>Yuhnia occipitalus</i> (Rufous Vented Yuhnia) | 2000 m. |
| 7. <i>Heterophasis capistrata</i> (Black Capped Sibia) | 2230 m |
| 8. <i>Seicerus burkii</i> (Yellow Eyed Warbler) | 1900 m |
| 9. <i>Aegithalos concinnus</i> (Read Headed Tit) | 2400 m |
| 10. <i>Aethopya nipalensis</i> (Nepal Sunbird) | 2400 m |
| 11. <i>Turdus boul boul</i> (Graywinged Blackbird) | 2450 m |

L. Mammals

- | | |
|--|--------------|
| 1. <i>Muntiacus muntjak</i> (Barking Deer) | 1590 -2100 m |
| 2. <i>Ratus ratus</i> | 900 – 1700 m |