Application ID: 12663-B

Study on the Bryofloral Diversity, Their Current Status and Conservation Issues in Central and South-eastern Region of Sindhupalchok District, Central Nepal

Progress Report

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Summary

The fourth and fifth phases of study on bryophytes and its related aspects were conducted in August to October, 2014, after completion of the midterm of study initiated in May to July, 2014. Most of the areas of the central, southern and eastern parts of the Sindhupalchok district within the altitudinal ranges of 750 m to 1450 m were considered for both phases of study.

This study from August to October brought a list of 125 species of bryophytes of different status categories. The total species of different classes of bryophytes were analyzed which included 4 species of hornworts (Anthocerotae) of 2 genera and 1 family. Class Hepaticae represented 3 orders, 17 families, 20 genera and 44 species. More diversity was recorded in the class Musci which represented 39 genera and 77 species categorized under 7 orders and 18 families.

This study was also fruitful to bring 7 new records of bryophytes to the country. This included 5 species to the class Hepaticae and 2 species of the class Musci.

This study also added 70 more species of bryophytes to the record of the midterm of study which was held in May to July end, 2014. These additions included 2 species of Hornworts of the class Anthocerotae, 20 species of liverworts of the class Hepaticae and 48 species of Mosses of the class Musci.

Studies were also made on faunal components sheltered in bryophyte habitats and its peripheral areas. This brought a list of 53 species of fauna which included mostly invertebrates associated to the habitats of bryophytes.

Local peoples and communities were consulted to make them familiarized with bryophytes found in their areas. They were informed on the significances bryophytes in nature. This program was followed by the Door to Door awareness and gatherings of the local peoples. They were also made aware of the negative impact of unsustainable harvesting of forest resources. They were also made realized to extend their participate in conservation of forest resources which help to protect the habitats of many rare and endangered species of bryophytes. This kind of awareness program in the form of Door to Door visits and in gatherings is still continuing and will be covered extensively in December, 2014.

Road networking, deforestation and landslides are the main factors to impose serious impact on the habitats of many species of bryophytes. This work to assess impact factors is still continuing and details will be incorporated in the final report due by the end of this grant in February 2015.

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Acronyms and Abbreviations

BM	British Museum, Natural History
B.S.	Bikram Sambat (Nepali Calendar)
E	East
N	North
S.N.	Serial Number
VDC	Village Development Committee
Fig.	Figure
km	Kilometer
m	Meter
var.	Variety
sp.	Species
spp.	Species (pleural)
sq. km	Square kilometer
%	Percentage
+	Addition to the previous list
*	New records for the country
◆	Study sites

1. Introduction

1.1. Background

This study conducted in the tropical and subtropical parts of Sindhupalchok district covered the elevation range of 760 m to 1600 m. Areas lying at the central, southern and south eastern parts were covered extensively in this study and was initiated in August (after midterm of study) to October end. These parts represent both dry and open areas and are crossed by the rivers like the Sunkoshi and Indrawati. Other rivulets which make this land fertile and moist include Melamchi, Ripar, Balefi, Libang etc. The major precipitation in this region depends on the southwest monsoon that arises from the Bay of Bengal during June to the end of August.

Being a warmer region, these areas are densely populated than the cooler northern belt of the district. Mostly Maize, millet, and rice are the main agriculture yields of this part. Among the popular tree species found in this region are *Castanopsis indica, Schima walichii, Pinus roxburghii, Alnus nepalensis, Shorea robusta* etc.

The geographical position of Sindhupalchok District is 27° 36' N to 28° 13' N and 85° 27' E to 85º 85'E, and covers an area of 2542 sq. km. The elevation in this district ranges from 800 m at Melamchi to the highest range of 7083 m and includes the snow-capped peak of Langpo Gang. This district borders Rasuwa district to the west and Kavrepalanchok District to the south and is indirectly connected to the Kathmandu district through Sankhu of Bhaktapur district (Department of Information 2028 B.S.).
This district now represents only 30.51 % of the forested land. About 29% of the land in this district is used for agricultural practices. Snow fed land lies mostly to the northern belt is about 1.85% and rivers and lakes represent about 0.1 %.

1.2. Climate

The bio climate of this district varies as per geographical features. Major areas of the central, southern and eastern parts of this district are under direct influence of the tropical and subtropical climatic types. The tropical zone which goes up to 1000 m of elevation is very hot in summer showing maximum temperature of 33° C which drops to the lowest of 5° C in winter. The subtropical zone starts at 1000 m up to 2000 m is warm and humid with good forest condition. The average maximum temperature in this part usually ranges from 30°-32° C and lowest below 5° C in winter. Temperate climatic zone starts at 2000 m up to 3000 m. This part features mild climate than the subtropical zone. The temperature in this zone ranges between 28° to 30° C and lowest to 1° C. Rest of bio-climatic zones above 3000 m to the alpine zone features cold climatic types and the coldness increases as per altitudinal rise which causes decline in the floral and faunal diversity. Diverse moss species can be found in the upper temperate (3000-4000 m) zone where wet moss forests can be observed.

2. The Fourth & Fifth Phase Study

Study and collection dates after the midterm work (1st to 3rd Phases) are provided below in tabulated form. (Table1 and Table 2).

Table 1. Fourth Phase Study

Date	From	To	Locality major
August 30, 2014	Kathmandu	Melamchi	Melamchi Bazar, 820 m
August 31, 2014	Melamchi	Melamchi	Dovantar, 840 m; Gupha Danda, 1250 m.
September 1, 2014	Gupha Danda	Melamchi	Hydro power, 1050 m; On the way back to Melamchi (850-1000 m)
September 2, 2014	Melamchi	Badegaun	Bahunpati, 1250 m; Koiralatar, 770 m; Sipa Khola, 1150 m; Basantapur, 1300 m.
September 132014	Badegaun	Bhimtar, Sipa Pokhari, Shikhapur, Melamchi	Bhimtar, 800 m; Sipaghat, 950 m; Simle, 940 m; Shikharpur, 1250 m; Kota Chour, 1200 m.
September 4, 2014	Melamchi	Timbu	Kiualpati, 1150 m; Tar, 1150 m; Timbu, 1600 m.
September 5, 2014	Timbu	Kathmandu	

Table 2. Fifth Phase Study

Date	From	To	Locality Major
September 20	Kathmandu	Chautara	Purana Bazar, 1300 m; Chautara Bazar, 1430 m.
September 21, 2014	Chautara	Irkhu; Sano Sirubari	Chilaune, 1260 m; Jalkani, 1470 m; Lamidanda, 1240 m; Mulabari, 1470 m; Tipling, 1040 m.
September 22, 2014	Irkhu	Thulo Sirubari	Ratamate, 820 m; Ranitar, 1060 m; Bhulbhule, 1380 m; Thulo Sirubari, 1420 m.
September 23, 2014	Thulo Sirubari	Sanga Chok	Phalete, 1100 m; Panichour, 1040 m; Karki Tar, 1030 m.
September 24, 2014	Sanga Chok	Chautara	Laxman Danda, 1290 m; Bhirkuna, 1330; Gaurati, 1530 m.
September 25, 2014	Chautara	Kubinde; Batase	Gairigaun, 1340 m; Kaptanpati, 1330 m; Bag Bazar, 1270 m; Thulo Khet, 1040 m; Kubinde Khola, 870 m; Daurali, 1230 m; Batase, 930 m.
September 26, 2014	Batase	Jalbire	Katunje 930 m; Jalbire, 780 m.
September 27, 2014	Jalbire	Jalbire	Ranitar, 910 m; Sera, 820 m; Khatarbesi, 815 m, Jalbire, 780 m.
September 28, 2014	Jalbire	Selang	Sano Bhanjyang, 800m; Dobate, 820 m; Kunigaun, 1380 m; Selang, 1340 m; Sera, 1000 m; Daurali, 1180 m; Ale 1100 m.
September 29, 2014	Jalbire	Kathmandu	----
October 1-31, 2014	Kathmandu	Kathmandu	Identification and Lab. work
November 2-20, 2014	Kathmandu	Kathmandu	Preparation of Progress report

3. Study Periods and Locality Information

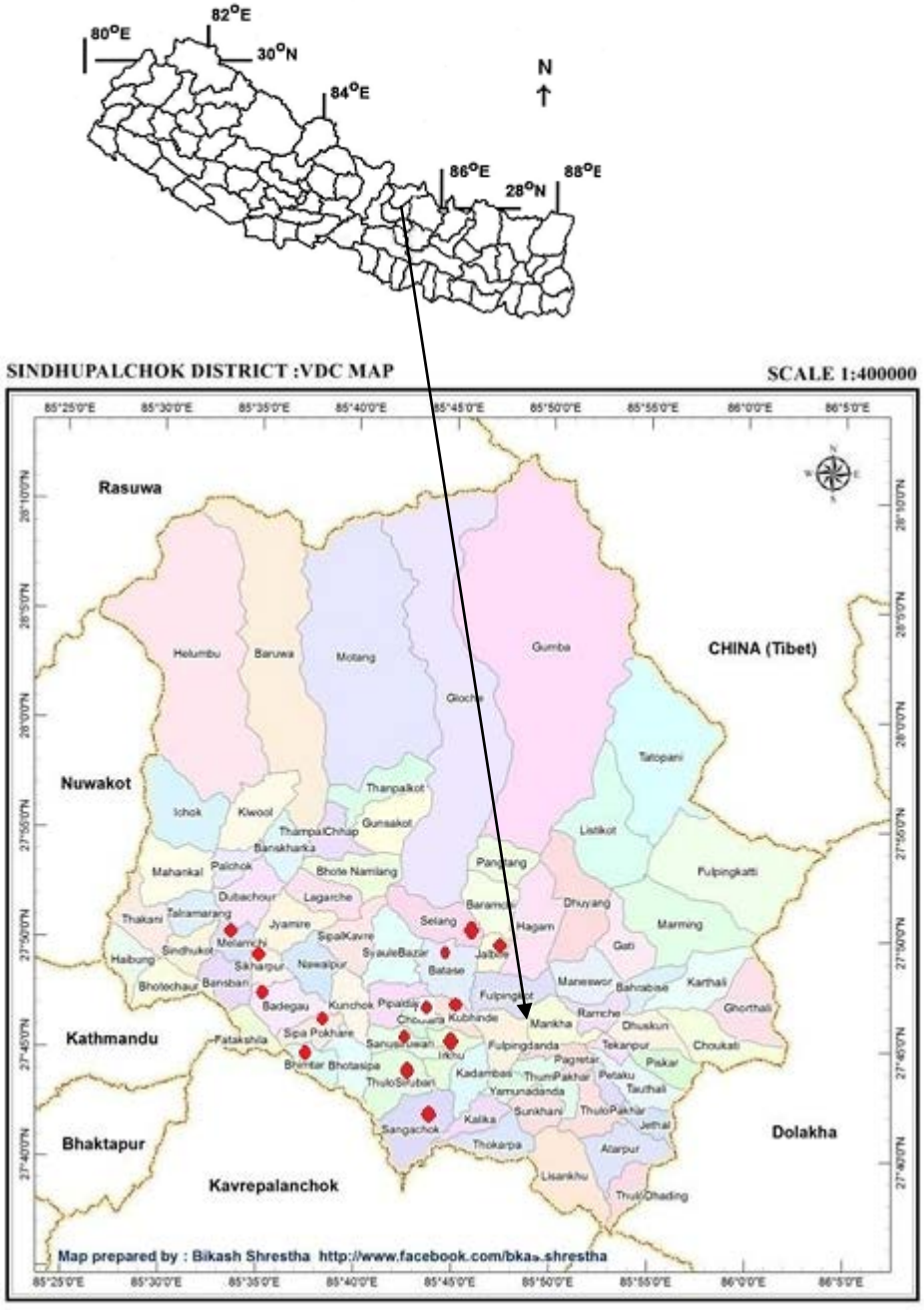


Fig.1. Map of Sindhupalchok showing the Study Sites

4. Study Areas and Outcomes

4.1. Melamchi and Associated VDCs

Checking Field Coordinates

Melamchi is one of our major study sites and is a crossing zone for the high and low altitude species. It lies at the elevation of 850 m to 1480 m in the central part of the district. Being a densely populated area this part represents mixed tribes of Newars, Brahmins, Chhetrias, and Tamangs. Riverine, forested and open areas were considered for our study in this place. Melamchi stands at its geographical position of 27°.83' N and 85.56°E. This is a fertile place and is the main route to the northern higher parts.

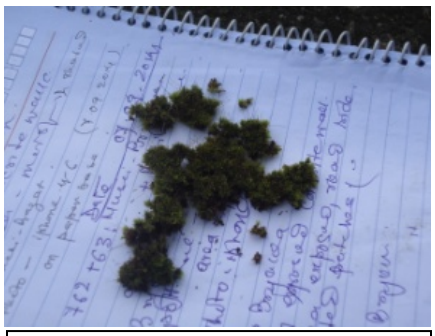
4.1.1. Study Outcome

Popular vegetation noted here included *Schima wallichiana, Choerospondias axillaris,* Castanopsis *indica*, *Shorea robusta, Sapium insignis* etc. Among shrubs *Mimosa rubicaulis*, *Hypericum cordifolium*, *Eupatorium adinophorum*, *Clerodendron cerratum* were noted common in this place. Common herbs observed here were *Desmodium* spp., *Drymeria cordifolia, Artimesia indica* etc.

Specimens with field data

Among the 146 specimens of bryophytes collected from Melamchi and its periphery, 26 species were the members of the class Hepaticae two species of Anthocerotae and 31 species of Musci. Altogether 59 species were recorded from the Melamchi Village. *Pallavicinia subciliata* of the family Pallaviciniaceae was collected at the Bahunpati Community forest is a new record to the country. Common species noted in this village are *Bryum coronatum* Hedw. (Bryaceae), *Cythodium tuberosum* (Targioniaceae) and *Plagiochasma pterospermum* (Aytoniaceae).

Studies were also made in different localities of the associated VDCs like Sikhapur (850-1590 m), Badegaun (770-1600 m), Sipapokhari (7765-1310 m) and Bhimtar (700- 950 m) in southern Melamchi and Gupha Danda (1250 m) and Timbu (1600 m) to the northern Melamchi.



Checking specimens in field

Among the tree species *Shorea robusta, Bombax cieba, Alnus nepalensis, Sapium insigne*, etc. are common. The common bryophytes recorded in these VDCs are *Asterella wallichiana, Marchantia polymorpha, Cyathodium tuberosum, Dumortiera hirsuta, Philonotis thwaitsii, Bryum coronatum, Octoblepharum albidum, Thuidium cambifolium,* and *Fissidens* species.

4.2. Chautara

Being located at its geographical position of 27°.76' N and 85°.70' E, this place has its altitudinal variation of 1100m to 1500 m and

Entering Field Data

is the headquarter of the Sindhupalchok district. Mixed population of different tribes can be found in this place. This is one of the former routes to the Tibet. This place is located about 43 Km east to Kathmandu, the capital city of Nepal. This is a subtropical bioclimatic zone where extended vegetation both of tropical and subtropical zones can be found.

4.2.1. Study Outcome

Vegetations found here are *Castanopsis indica*, *Alnus nepalensis*, *Schima walichii*, *Shorea robusta*, *Dalbergia sisoo* etc. Other tree species observed here include *Sapium insigne, Pinus roxburghii, Euryaacuminata, Bouhinia purpurea* L. etc. *Ficus benjamina*. Is an evergreen religious tree observed in Gaurati Mandeer. *Eleocarpus spaeericus* is a religious tree cultivated at Gaurati Mandeer periphery. Common shrubs noted here are *Ficus semicardifolia, Hypericum cordifolium, Clerodendron cerratum, Osbekia astellata,* etc.

Among bryophytes, only one species *Anthoceros punctatus* L. from the class Anthocerotae was recorded, which has been noticed rare in this region. Members of the class Hepaticae recorded in this part included a list of 23 species belonging to 12 genera of 11 families. *Jungermannia subelliptica* (Lindb. & Kaal.) Lev. of Jungermanniaceae is a new record to the country and its status is common in this area. Other common species of Hepaticae recorded here comprised *Asterella multiflora, Plagiochasma pterospermum* and *Marchantia emarginata. Heteroscyphus argutus, Frullania tamarisci* and *Bazzania tridens* were recorded rare in this part.

Of the class Musci, *Bryum argenteum* though common in Jalbire was noticed rare in this place. *Macrodus brasiliensis* (Doby.) Ther. of Dicranaceae and *Macromitrium moorcroftii* of Orthotrichaceae were also recorded rare in this area. This was previously collected by N. Wallich from Nepal which later was deposited in the British Museum (BM), England. The most common species noticed in this site included *Bryum coronatum, Funaria hygrometrica* and *Hydrogonium arcuatum.*

4.3. Irkhu

It is located about 1.5 km away from the district headquarter Chautara and covers an area of 12.23 sq.km. With its geographical positioning of 27° 74' N and 85° 74 E', this place features varying elevation range of 1035 to 1760 m. Being influenced with subtropical climate, this area is moist and humid with representations of diverse bryophyte species. This village has mixed caste system and most of them depend on agricultural profession. Total population of this place is 3310 individuals.

4.3.1. Study Outcome

Common Vegetation noticed at various elevations of this place are *Alnus nepalensis, Quercus semicarifolis, Schima walichii, Castanopsis indica, Morus nigra, Nerium oleander, Sumbucus canadensis, Ficus religiosa, Ficus benghalensis, Callistemon citrinus*, *Pinus roxburghii, Dalbergia sissoo,* etc. *Dioscoria deltoids* and *Ipomia betatas* (L.) Lam. was the common climbers noted here.

Moderate diversity of bryoflora was recorded in this place. No species representation of the class Anthocerotae was made.

The class Hepaticae (Liverworts) represented 15 species categorized under 8 genera and 5 families, of them *Metzgeria conjugata* (Metzgeriaceae) and *Reboulia hemisphwrica* (Antoniuaceae) were noticed rare in this place.

Mosses (Class Musci) were found more diverse than the liverworts. Fifteen genera and 18 species of mosses under 10 families were recorded. Rare species recorded here include *Herpetineuron toccoae* **of** Thuidaceae and common were *Bryum coronatum, Hydrogonium arcuatum* and *Funaria hygrometrica*

4.4. Sano Sirubari

This place is one of the populated localities of the Sindhupalchok district. The elevation of this place ranges from 870- 1319 meters and is located at 27°45'N and 85°42'E".

4.4.1. Study Outcome

Popular vegetation noted here included *Alnus nepalensis, Castanopsis* sps*, Dalbergia sisoo, Shorea robusta***,** *Lagerstroemia indica, Ficus benghalensis, Ficus religiosa, Schima wallichii, Symbucus Canadensis, Bombax cieba, Celtis australis,* etc.

- Six species of Hepaticae, one species of Anthocerotae and 13 species of Musci were recorded from Sano Sirubari.
- Of the total records, the class Hepaticae represented 5 genera, 6 species under 4 families. All were common in status.
- Ten genera of mosses (Musci) were recorded which included 13 species of seven families. All were common species.

4.5. Thulo Sirubari

Located to southern part of the district, this place occupies about 47 sq.km area. The southern part of this place is the borderline to Kavrepalanchok district. Brahmin caste is in majority in this village and agriculture is their main profession. Maize, wheat and rice are the major crops in this part. The altitude of this place ranges from 750-1420 m and stands at its geographical position of 27°44'N; 85° 43'E. This place accommodates individual population of 5602 with about 1000 households.

4.5.1. Study Outcome

Common vegetation noted in this place include *Berberis aristata, Albizia julibrissin, Agave cantula, Alnus nepalensis, Bombax cieba, Castanopsis indica, Ficus religiosa, Mangifera indica, Pinus roxburghii, Shorea robusta, Myrica esculenta, Lagerstroemia indica,* etc.

This place represented a list of 10 genera, 18 species and 8 families of Hepaticae, of them *Jungermannia crenulata* Smith. (Jungermanniaceae) was recorded for the first time in the country.

Jungermannia exertifolia, J. confertissima, Asterella khasiana and Targionia hypophylla were found rare in this place. *Marchantia emarginata and Cyathodium tuberosum* were commonly observed species in this place.

Three species of Anthocerotae viz. *Anthoceros erectus*, *Anthoceros punctatus* and *Phaeoceros laevis* were found rare in this area.

Of the recorded 26 species of Musci at 750- 1420 m of elevation belonged to 10 genera and 8 families. Common species observed here were *Bryum coronatum, Funaria hygrometrica, Thudium cambifolium* and *Fissidens* species.

4.6. Sanga Chok

Located to the southern part of this district this village covers an area of 61 sq.km. Its southern part is bordered to Kavrepalanchok district. Brahmin casts are in majority in this village who follow agriculture as their main occupation. This village covers both the tropical and subtropical climate within the elevation range of 670 to 1480 m. This fertile place lies at 27° 69'N and 85° 71' E. Principal agricultural yields in this part are rice, maize and wheat. Total individual population of this village is 3825.

4.6.1. Study Outcome

Common vegetation noted here included *Cannamomum camphora, Castanopsis indica, Ficus religiosa, Ficus benghalensis, Lagerstroemia indica, Alnus nepalensis, Aesandra butyracea Albizia julibrissin, Myrica esculenta, Schima wallichii, Shorea robusta, Sapium insigne, Ricinus communis*, *Choerospondias axillaris, Bombax cieba* etc . Popular shrubs noted here included *Cleistocalyx operculata,* Desmodium sp. etc.

This place represented preferable habitats for diverse bryophyte species. Altogether 41 specimens of bryoflora were collected in this part with a total of 36 species. This included 15 species of the class Hepaticae, 1 species of Anthocerotae and 20 species of Musci.

This included 11 genera, 15 species under 9 families. All the recorded species are common in status.
The moss diversity counted in this part included 14 genera, 20 species under 8 families. Rare species of mosses recorded here are *Pohlia leucostoma* (Bryaceae), *Weissia edentula* (Pottiaceae) and *Isopterigium* sp. of the family Hypnaceae.

4.7. Kubninde and Batase

This village is located near to Chautara, the headquarter of the district and occupies an area of 8.7 sq.km. The elevation ranges from 815-1830 m. This place has mixed population of Brahmins, Newars and Tamangs. Rice, maize, millet and some cash crops are the main agricultural yields in this part. Livestock farming is also popular in this village. Individual population of Kubinde village is 3229 and stands at its geographical position of 27°47" 1'N and 85° 44'41"E. Batase village has 1002 houses with population of 4800 individuals and its geographical position is 27°47'16"N; 85° 45'17" E .

4.7.1. Study Outcome

Common vegetation noted in this part included *Oroxylum indicum*, *Dalbergia sissoo, Myrica esculenta, Alnus nepalensis, Litsea monopetala, Choerospondia axillaris, Bamboo* spp., etc. Common Shrubs noted here were *Jasminum officinale, Clerodendron cerratum, Eupatorium adinophorum, Osbekia stellata. Cannabis sativa* and *Rubus ellipticus*. *Drymeria cordata, Cyperus rotundus, Agiratum conyzoides, Begonia picta, Oxalis latifolia, Piperomia* spp., etc. was the common herbs observed here.

Twenty one species of Hepaticae, 2 species of Anthocerotae and 35 species of Musci were recorded in Kubinde and Batase. About 107 specimens of bryophytes were collected in this part.

Hepaticae collected here were categorized into 12 genera, 21 species belonging to nine families. *Cyathodium cavernarum* Kunze in Lehm. was noted rare among the thalloid liverworts which was found growing as dull green patch on moist soil.

Phaeoceros laevis and *Anthoceros punctatus* of Anthocerotaceae were observed growing commonly on the moist mountain slopes shaded under different species of ferns, grasses and trees.

Of the 35 species of Mosses, *Bryum* spp. and *Hydrogonium arcuatum* were common in this part. *Rhodobryum giganteum* of Bryaceae was recorded in one locality of Batase at an elevation 1600 m.

4.8. Jalbire

This place is located at the elevation of 860-1560 m and stands at its geographical position of 27.83°N 85.78°E. It lies at about 8 km north to Chautara on the bank of Balefi River. Once this place was a well-known trade route to the Tibet. This place has mixed caste system like Brahmins, Newars and Tamangs. Forested and riverine areas were considered here for our study.

4.8.1. Study Outcome

Common Vegetation of this part are *Alnus nepalensis, Adina cordifolia, Agave cantula, Castanopsis indica, Castanopsis latifolia, Ficus benghalensis, Ficus religiosa, Schima wallichii, Rhus javanica* L., *Eurya acuminata* etc. Common shrubs observed here include *Osbekia stellata, Osbekia nepalensis, Urtica dioca* L*, Hypericum cordifolium* and *Clerodendron viscosum*.

Good diversity of bryofloral species were documented in this place. Two rare species of Hornworts (Anthocerotae), 23 species of 12 genera and 9 families of Liverworts (Hepaticae) were recorded besides 2 new records to the country's list which are *Metzgeria fruticulosa* (Dicks.) of the family Metzgeriaceae and *Riccia cavernosa* of the family Ricciaceae. Among mosses (Musci) *Barbula convoluta* Hedw. of the family Pottiaceae is also a new record to the country.

Rare species of liverworts (Hepaticae) recorded in this study comprised *Riccia fluitans, Reboulia hemispherica, Metzgeria conjugata, Scapania undulata and Targionia hypophylla*. Common records included *Marchantia emarginata, Cyathodium tuberosum, Plagiochasma pterospermum and Dumortiera hirsuta.*

Rare mosses noted in this place included *Macromitrium moorcroftii* (Orthotrichaceae), *Gymnostomiella vernicosa* (Splachnaceae), *Hymenostylium recurcirostre* var. *aurantiacum* (Pottiaceae), *Trematodon longicollis* (Dicranaceae) and *Leucoloma taylorii* (Dicranaceae). Common species found here were *Bryum coronatum, Funaria hygrometrica, Fissidens sylvaticus, Pogonatum microstomum, Octoblepharum albidum, Hydrogonium arcuatum*, etc.

4.9. Selang

Selang village lies at north of Jalbire within the altitudinal range of 1100-2600 m. It stands at its geographical position to 27°51' N; 85°45'E.

4.9.1. Study Outcomes

Common vegetation noted in this part includes *Schima wallichii, Castanopsis indica, Alnus nepalensis, Eurya acuminata, etc.* Among the Shrubs *Osbekia,* and *Eupatorium* species are widely spread here. The delicate herb *Begonia picta* are found growing on cliffs here and there.

Out of 26 specimens of bryophytes collected here, 1 species of *Anthoceros* species from the class Anthocerotae, 8 species from the class Hepaticae and 10 species of mosses are recorded.

5. Remarks

The field study of this Booster Grant was initiated in May when the season started for the diversity of bryophytes. The midterm field work was done till the end of July. During this period 750 specimens were collected from the eastern and southern parts of Sindhupalchok. This progress report which covered the field study in different periods of August to October, 2014, includes species diversity of 673 specimens of bryophytes collected at the central and southern sides within the elevation range of 750 m to 1450 m of this district. List of all the identified species is provided in the Appendix Section below. So a total of 1423 specimens have been collected from May to October, 2014. Many of the species have been identified and some are still under identification process and will be completed till the mid period of January, before submission of the final report in February. The next field work (6th Phase) has been scheduled in the first week of December which covers the diversity documentation and awareness programs at different potential sites of this district.

6. Awareness Activities

Effective and impressive launching of conservation programme basically depends on simple education and awareness raising activities in the relevant areas. Without letting peoples to know on grass root level about conservation issues and sustainable harvesting the conservation policy may be weak or not possible considering villages and areas where conservation awareness is still not well understood. So awareness programme is a need in the present context that motivates peoples impressively on environmental conservation. This enhances the understanding of people at grass root levels on how to develop harmony with the environment. This kind of program builds up their capacity and definitely aids to protect the habitats of bryophytes and other flora and fauna in wild.

Familiarizing Bryophytes among Community Peoples

Knowledge dissemination of rare bryophytes, its uses and Conservation issues were implemented at many of the study sites. This was done in gatherings of some village peoples and visiting their houses and shops in and round the study sites. School students were also made aware on bryophytes, uses and conservation aspects. All the contacted peoples responded positively and were enthusiasts to know more about this plant. This program was found still more effective as many of school students learnt more about this plant as this is also in their 8th and 9th grade courses but briefly. Some peoples were

Door to Door Awareness

interested on the uses of this plant which they were taught to use in their livelihood but under sustainable way.

Assisting botanists of the team were also very active to disseminate knowledge to the village peoples which was very appreciable. Real specimens of this plant were shown to the peoples so to make their understanding effectively.

Such kind of activity also helped us to collect some more information on this plant on local level. Every details of this work will be incorporated in the final report due by February, 2015.

This work of awareness is still continuing and will cover still more areas and communities in December, 2014.

7. Information Sharing and Awareness

Information on rare and endangered bryophytes which is a significant outcome of this work was provided to the public through Science Exhibition organized by the Ministry of Science, Technology and Environment in Kathmandu on September 17-18, 2014. Visitors were provided knowledge on bryophytes, its uses and conservation issues and also they were informed about the prestigious Rufford Small Grant and how this grant made generous support in this study. Flex prints and specimens of bryophytes both were used as exhibits in this exhibition which was inaugurated by the Honorable Prime Minister of Nepal.

Display of Bryophytes of Specimens of Sindhupalchok District in Exhibition

Explaining Bryophytes of Sindhupalchok district to Prime Minister of Nepal

8. Conservation Issue

Physical constructions and road networking are the principal factors to impose direct impact on the habitat of bryophytes in this part. Environment Impact Assessment prior to initiate construction is still feebly developed in this part. People's dependency on forest resources is high especially around the peripheral parts of this district which are still beyond the conservation area system. High deforestation rate and unsustainable harvesting of forest resources are basic problems in different parts of this

Habitat Loss due to Land Slide

district. So awareness Program which is one of the important aspects of this work has been expected to make effective understanding of local peoples on the value of forest resources and associated habitats of bryophytes and other biodiversity components. Assessing impact factor is underway, it has been estimated that only 30 % of forest cover has been left in this district till date. Details of our work on impact assessment will be provided in the final report at the end of this work**.**

9. Field Collection and Species Diversity of Bryophytes

Altogether 673 specimens of bryophytes were collected in two phases of study (4th and 5th). An outline of the diversity of bryophytes recorded during these phases is provided below in Table 3 and Table 4.

Table 3. Specimens and Species Diversity of bryophytes in 4th. & 5th. Phase Field Visits

Serial No.	VDCs	Specimens Collected	Species Diversity			Total species
			Hepaticae	Anthocerotae	Musci	
4th. Phase Collection						
1	Melamchi and associated VDCs	146	26	2	31	59
5th. Phase Collection						
2	Chautara	108	23	1	35	59
3	Irkhu	65	15	-	18	33
4	Thulo Sirubari	75	19	1	25	45
5	Sano Sirubari	15	6	-	7	13
6	Sanga Chok	41	15	1	20	36
7 8	Kubinde & Batase	107	21	2	35	58
9	Jalbire	90	24	2	28	54
10	Selang	26	8	1	10	19
	Total	**673**				

Table 4. Species Diversity of Bryophytes in Fourth & Fifth Phase Field Collection

Classes	Orders	Families	Genera	Species
Anthocerotae	1	1	2	4
Hepaticae	3	17	20	44
Musci	7	18	20	77
Total	**11**	**36**	**42**	**125**

Among the recorded 125 species, seven species are new record to country's list (5 species of the class Hepaticae and 2 species of the class Musci). These include *Jungermannia paroica* (Schiffn.) Grolle,

Jungermannia subelliptica (Lindb. & Kaal.) Lev., *Riccia cavernosa* Hoffm, *Metzgeria fruticulosa* (Dicks) Evans, *Pallavicinia subciliata* (Aust.) Steph, *Macromitrium moorcroftii* (Hook. & Grev.) Schwaegr and *Barbula convulata* Hedw.

Seventy species were added more to the list of midterm work (1st to 3rd Phases). These include 2 species of the class Anthocerotae, 20 species of Hepaticae and 48 species of Musci. A complete list is provided in Appendix I.

Common species recorded in 4th and 5th phases: *Jungermannia subelliptica, Asterella wallichiana, Asterella multifida, Marchantia emarginata, Riccia fluitans, Cyathodium tuberosum and Plagiochasma appendiculatum* of the class Hepaticae. *Bryum coronatum, Fissidens sylvaticus, Funaria hygrometrica, Hypnum pleumaformae*, and *Hydrogonium arcuatum* of the class Musci**.**

10. Faunal Association

Various faunal species associated to bryophyte habitats were also recorded in this study conducted at different areas of the tropical to lower temperate parts of Sindhupalchok district. Due to warm and humid atmospheric conditions the faunal components recorded in August to October end were little different than the records made before the midterm work. Most of the records were made on invertebrates which were sheltered in bryofloral habitats. The lower parts of this district were mostly warm and dry and a vast area of the study sites was the riverine forests. This also has influenced the diversity richness of the faunal components at this belt. A list of the recorded faunal components is provided in the Appendix Section (Appendix II).S

Appendix I

Species Diversity of Bryophytes of Fourth and Fifth Phase Field Visit

Serial No.	Orders	families	Latin Names	Localities	Additional species in the previous list
Class Anthocerotae					
1	Anthocerotales	Anthocerotaceae	*Anthoceros erectus* Kashyap	Jalbire	+
2		Anthocerotaceae	*Anthoceros longii* Steph.	Jalbire	+
3		Anthocerotaceae	*Anthoceros punctatus* L.	Melamchi; Chautara	
4		Anthocerotaceae	*Phaeoceros laevis* (L.) Prosk.	Melamchi;	
Class Hepaticae					
1	Jungermanniales	Cephaloziaceae	*Cephalozia bicuspidata* (L.) Dumort.	Melamchi;	+
2	Jungermanniales	Frullaniaceae	*Frullania muscicola* Steph.	Melamchi; Chautara; Thulo Sirubari; Sanga chok	
3	Jungermanniales	Frullaniaceae	*Frullania tamariscii* (L.) Dumort.	Chautara	+
4	Jungermanniales	Geocalycaceae	*Heteroscyphus argutus* (Reinw. *et al*.) Schiffn.	Chautara; Thulo Sirubari	
5		Geocalycaceae	*Heteroscyphus planus* (Mitt.) Schiffn.	Melamchi; Chautara; Batase; Jalbire; Sanga chok	
6	Jungermanniales	Jungermanniaceae	*Jungermannia crinulata* Smith	Thulo Sirubari	+
7		Jungermanniaceae	*Jungermannia confertissima* Nees	Thulo Sirubari	+
8		Jungermanniaceae	*Jungermannia exertifolia* Steph.	Melamchi; Thulo Sirubari; Sanga chok	
9		Jungermanniaceae	*Jungermannia hyaline* Lyell in Hook.	Chautara; Kubinde; Batase	
10		Jungermanniaceae	**Jungermannia paroica* (Schiffn.) Grolle		+
11		Jungermanniaceae	*Jungermannia pumila* With.	Jalbire	
12		Jungermanniaceae	**Jungermannia subelliptica* (Lindb. et Kaal.) Lev.	Chautara; Kubinde; Jalbire	+
13		Jungermanniaceae	*Jungermannia tetragona* Lindenb.	Melamchi; Chautara	+
14		Jungermanniaceae	*Jungermannia truncata* Nees	Jalbire	
15		Jungermanniaceae	*Mylia taylorii* (Hook.) Gray	Melamchi; Kubinde; Batase; Sano Sirubari; Sanga chok	
16	Jungermanniales	Lepidoziaceae	*Bazzania tridens* (Reinw. *et al.)* Trev.	Chautara	+

17	Jungermanniales	Plagiochilaceae	*Plagiochila chinensis* Steph.	Melamchi	+
18		Plagiochilaceae	*Plagiochila nepalensis* Lindenb.	Melamchi	+
19	Jungermanniales	Scapaniaceae	*Scapania undulata* (Sw. ex Lindb.) Dumort.	Jalbire	+
20	Marchantiales	Aytoniaceae	*Asterella khasiana* (Griff.) Pande *et al.*	Chautara, Kubinde; Batase; Thulo Sirubari; Irkhu	
21			*Asterella multiflora* (Steph.) Pande *et al.*	Melamchi; Chautara; Kubinde; Batase; Thulo Sirubari; Sano Sirubari; Sanga chok; Irkhu; Jalbire	
22			*Asterella wallichiana* (Lehm. & Lindenb.) Grolle	Melamchi; Chautara; Kubinde; Thulo Sirubari; Sano Sirubari; Sanga chok; Irkhu; Jalbire	
23			*Plagiochasma appendiculatum* Lehm. & Lindenb.	Melamchi; Chautara; Kubinde; Thulo Sirubari; Irkhu; Jalbire	
24			*Plagiochasma pathankotensis* Kashyap	Irkhu	
25			*Plagiochasma pterospermum* C. Massal	Melamchi; Chautara; Thulo Sirubari; Sano Sirubari; Sanga chok; Irkhu; Jalbire	
26			*Reboulia hemispherica* (L.) Raddi	Irkhu; Jalbire	
27	Marchantiales	Conocephalaceae	*Conocephalum conicum* (L.) Underw.	Melamchi; Chautara; Batase; Jalbire	
28			*Conocephalum japonicum* (Thunb.) Grolle	Batase	+
29	Marchantiales	Marchantiaceae	*Marchantia emarginata* Reinw. *et al.*	Melamchi ; Chautara; Kubinde, Selang; Batase; Jalbire; Thulo Sirubari; Sanga chok; Irkhu; Jalbire	
30			*Marchantia paleacea* Bertol.	Melamchi; Chautara; Selang; Batase; Jalbire; Sanga chok; Irkhu; Jalbire	
31			*Marchantia papillata* Raddi	Melamchi; Kubibde; Thulo Sirubari; Sano Sirubari; Irkhu; Jalbire	+
32			*Marchantia polymorpha* L.	Melamchi; Chautara; Sanga chok; Jalbire	
33	Marchantiales	Ricciaceae	**Riccia cavernosa* Hoffm.	Jalbire	+
34			*Riccia fluctans* L.	Melamchi; Chautara; Selang; Thulo Sirubari; Sanga chok; Irkhu; Jalbire	

35			*Riccia himalayensis* Steph.	Melamchi; Chautara; Batase; Thulo Sirubari; Sano Sirubari; Sanga chok	
36			*Riccia pathankotensis* Kashyap	Irkhu	+
37	Marchantiales	Targioniaceae	*Cyathodium cavernarum* Kunze	Kubinde;	+
38			*Cyathodium tuberosum* Kashyap	Melamchi; Chautara; Kubinde; Batase; Thulo Sirubari; Sanga chok; Irkhu; Jalbire	+
39			*Targionia hypophylla* L.	Melamchi; Kubinde; Batase; Thulo Sirubari; Irkhu	
40	Marchantiales	Wiesnerellaceae	*Dumortiera hirsuta* (SW.) Nees	Melamchi; Chautara; Batase; Thulo Sirubari; Jalbire	
41	Metzgeriales	Aneuraceae	*Riccardia multifida* (Linn.) Gray	Melamchi; Sanga chok	
42		Metzgeriaceae	*Metzgeria conjugata* Lindb.	Chautara, Jalbire; Irkhu;	+
43		Metzgeriaceae	**Metzgeria fruticulosa* (Dicks.) Evans	Jalbire	+
44		Pallaviciniaceae	**Pallavicinia subciliata (*Aust.) Steph.	Melamchi;	+
Class Musci					
1	Dicranales	Dicranaceae	*Campylopus ericoides* (Griff.) A. Jaeger	Melamchi; Kubinde	
2		Dicranaceae	*Campylopus nilghiriensis* (Mitt.) A. Jaeger	Chautara; Thulo Sirubari; Jalbire	+
3		Dicranaceae	*Campylopus umbellatus* (Arnott) Paris	Thulo Sirubari	+
4		Dicranaceae	*Garckea phascoides* (Hook.) C. Muell.	Kubinde; Thulo Sirubari	+
5		Dicraniaceae	*Microdus brasiliensis* (Dub.) Then	Chautara	+
6		Dicranaceae	*Trematodon longicollis* Michx.	Melamchi; Thulo Sirubari; Sano Sirubari; Sanga chok; Jalbire	
7	Dicranales	Leucobryaceae	*Octoblepharum albidum* Hedw.	Melamchi; Thulo Sirubari; Sano Sirubari; Irkhu; Jalbire	
8	Eubryales	Bartramiaceae	*Fleischerobryum longicolle* (Hampe.) Loeske	Melamchi;	+
9		Bartramiaceae	*Philonotis falcata* (Hook.) Mitt.	Thulo Sirubari	+

10		Bartramiaceae	*Philonotis fontana* (Hedw.) Brid.	Thulo Sirubari	+
11		Bartramiaceae	*Philonotis mollis* (Dozy & Molk.) Mitt.	Thulo Sirubari	
12		Bartramiaceae	*Philonotis revoluta* Bosch & Sande Lac.	Melamchi; Chautara	+
13		Bartramiaceae	*Philonotis thwaitesii* Mitt.	Melamchi; Chautara; Thulo Sirubari; Irkhu; Jalbire	
14		Bartramiaceae	*Philonotis turneriana* (Schwaegr.) Mitt.	Melamchi; Chautara; Kubinde, Batase; Thulo Sirubari	
15	Eubryales	Bryaceae	*Anomobryum julaceum* W.P. Schimper	Melamchi; Kubinde; Sanga chok	
16		Bryaceae	*Brachymenium acuminatum* Harv.	Thulo Sirubari	+
17		Bryaceae	*Bryum apiculatum* Schwaegr.	Jalbire	+
18		Bryaceae	*Bryum argenteum* Hedw.	Melamchi; Chautara; Batase; Selang; Thulo Sirubari; Sano Sirubari; Sanga chok	
19		Bryaceae	*Bryum capillare* L. ex Hedw.	Kubinde; Sanga chok	
20		Bryaceae	*Bryum cellular* Hook.	Irkhu	+
21		Bryaceae	*Bryum coronatum* Schwaegr.	Melamchi; Kubinde; Thulo Sirubari; Sano Sirubari; Sanga chok; Irkhu; Jalbire	
22		Bryaceae	*Bryum dichotomum* Hedw.	Irkhu	+
23		Bryaceae	*Bryum recurvulum* Mitt.	Kubinde	+
24		Bryaceae	*Pohlia camptotrachela* (Ren. & Cardot.) Broth.	Melamchi;	
25		Bryaceae	*Pohlia flexuosa* Hook.	Melamchi; Thulo Sirubari; Sanga chok; Irkhu; Jalbire	
26		Bryaceae	*Pohlia leucostoma* (Buhch & Lac.) Fleisch.	Sanga chok	+
27		Bryaceae	*Rhodobryum giganteum* (Schwaegr) Paris	Batase	
28	Fissidentales	Fissidentaceae	*Fissidens bryoides* Hedw.	Melamchi; Chautara; Kubinde; Batase; Thulo Sirubari; Sano Sirubari; Melamchi- Bhimtar	+
29		Fissidentaceae	*Fissidens ceylonensis* Dozy & Molk.	Thulo Sirubari; Melamchi- Badegaun	+
30		Fissidentaceae	*Fissidens crenulatus* Mitt.	Batase; Sanga chok	+

31		Fissidentaceae	*Fissidens gangulee* Norkett	Melamchi;	+
32		Fissidentaceae	*Fissidens javanicus* Dozy & Molk.	Thulo Sirubari; Sanga chok; Jalbire	
33		Fissidentaceae	*Fissidens roninsonii* Broth.	Sano Sirubari; Jalbire	
34		Fissidentaceae	*Fissidens sylvaticus* Griff.	Melamchi – Sikhapur; Chautara; Kubinde, Batase; Thulo Sirubari; Sano Sirubari; Irkhu; Jalbire	
35		Fissidentaceae	*Fissidens taxifolius* Hedw.	Batase; Thulo Sirubari; Sanga chok; Irkhu	
36		Fissidentaceae	*Fissidens zippelianus* Dozy & Molk.	Thulo Sirubari	+
37	Funariales	Funariaceae	*Enthosthodon wallichii* Mitt	Melamchi; Jalbire	+
38		Funariaceae	*Funaria hygrometrica* Hedw.	Melamchi; Chautara; Thulo Sirubari; Sano Sirubari; Sanga chok; Irkhu: Jalbire	
39		Funariaceae	*Funaria nepalensis* C. Muell.	Chautara	+
40		Funariaceae	*Physcomitrium eurysthomum* Sendth.	Melamchi – Bhimtar; Chautara; Sano Sirubari	
41	Funariales	Splachnaceae	*Gymnostomiella vernicosa* (Hook.) Fleisch.	Jalbire	+
42	Hypnobryales	Brachytheciaceae	*Brachythecium buchananii* (Hook.) A. Jaeger	Melamchi- Sipaghat; Shikhapur,	+
43		Brachytheciaceae	*Brachythecium rutabulum* (Hedw.) B.S.G.	Chautara	
44		Brachytheciaceae	*Brachythecium wichurai* (Broth.) Paris	Melamchi; Batase, Selang; Irkhu	+
45		Brachytheciaceae	*Eurhynchium proelongum* W.P. Schimper	Kubinde, Batese	+
46		Brachytheciaceae	*Eurhynchium swartzii* (Turne) Curn.	Melamchi- Sipa Ghat	+
47	Hypnobryales	Entodontaceae	*Entodon flavescens* (Hedw.) A. Jaeger	Jalbire	+
48		Entodontaceae	*Entodon macropodus* cf. (Hedw.) C. Muell.	Chautara	+
49		Entodontaceae	Entodon prorepens (Mitt.) A. Jaeger	Chautara	+
50		Entodontaceae	*Erythrodontium julaceum* (Hook. ex Schwaegr.) Paris	Kubinde	+
51	Hypnobryales	Hypnaceae	*Hypnum cupressiforme* Hedw.	Batase	+

52		Hypnaceae	*Hypnum pleumaforme* W. Wilson	Melamchi; Chautara; Kubinde; Thulo Sirubari; Sano Sirubari; Sanga chok; Irkhu; Jalbire	
53		Hypnaceae	*Isopterygium minutirameum* (C. Muell.) A. Jaeger	Sanga chok	+
54		Hypnaceae	*Taxiphyllium taxirameum* (Mitt.) Fleisch.	Chautara; Kubinde; Sanga chok; irkhu; Jalbire	
55	Hypnobryales	Plagiotheciaceae	*Plagiothecium neckroideum* B.S.G.	Melamchi; Chautara	+
56	Hypnobryales	Rhytidiaceae	*Rhytidium regosum* (Hedw.) Kindb.	Melamchi; Chautara	+
57	Hypnobryales	Sematophyllaceae	*Foreauella orthothecia* (Schwaegr.) Dix. & Verd.	Melamchi;	+
58	Hypnobryales	Stereophyllaceae	*Entodontopsis anceps* (Bosch & Sande Lac.) Buck & Ireland	Chautara; Sanga chok; Jalbire	+
59		Stereophyllaceae	*Entodontopsis leucostega* (Bred.) Buck & Ireland	Chautara Jalbire	+
60	Hypnobryales	Thuidaceae	*Haplocladium angustifolium* (Hampe & C. Muell.) Broth.	Chautara; Thulo Sirubari; Irkhu	+
61		Thuidaceae	*Herpetineuron toccoae* (Sull & Losq.) Card.	Irkhu	
62		Thuidiaceae	*Thuidium cambifolium* (Dozy & Molk.) Dozy & Molk.	Melamchi; Chautara; Thulo Sirubari; Irkhu	+
63		Thuidiaceae	*Thuidium glaucinoides* Broth.	Irkhu	+
64		Thuidiaceae	*Thuidium meyanianum* (Hamp.) Dozy & Molk.	Jalbire	
65		Thuidiaceae	*Thuidium tamariscellum* (C. Muell.) Bosch & Lac.	Melamchi; Chautara; Thulo Sirubari	
66	Orthotrichales	Orthotrichaceae	**Macromitrium moorcroftii* (Hook. & Grev.) Schwaegr.	Chautara; Jalbire	+
67	Polytrichales	Polytrichaceae	*Pogonatum microphyllum* (Dozy & Molk.) Dozy & Molk.	Kubinde	+
68		Polytrichaceae	*Pogonatum microstomum* (Schwaegr.) Brid.	Chautara; Batese, Selang; Irkhu; Jalbire	
69		Polytrichaceae	*Pogonatum neesii* (C. Muell.) Dozy &	Kubinde, Batase	+

			Molk.		
70		Polytrichaceae	*Polytrichum commune* Hedw.	Chautara; Jalbire	
71	Pottiales	Pottiaceae	**Barbula convuluta* Hedw.	Irkhu; Jalbire	+
72		Pottiaceae	*Barbula cylindrica* (Tayl.) Schimp.	Chautara	+
73		Pottiaceae	*Barbula constricta* Mitt.	Chautara; Kubinde; Sano Sirubari; Sanga chok	+
74		Pottiaceae	*Barbula indica* (Hook.) Spring.	Chautara; Kubinde	+
75		Pottiaceae	*Hydrogonium arcuatum* (Griff.) Wijk. & Marg.	Melamchi; Chautara; Kubinde: Sano Sirubari; Sanga chok; Irkhu; Jalbire	
76		Pottiaceae	*Hymenostylium recurvirostre* (Hedw.) Dix. in Rev. var. *aurantiacum* (Mitt.) Gangulee	Batese; Jalbire	+
77		Pottiaceae	*Hyophyla involuta* (Hook.) A. Jaeger	Melamchi; Kubinde; Sano Sirubari; Sanga chok	

Appendix II

Faunal Components Associated to Bryophyte Habitats

S.N.	Class	Order	Family	Genus and species
1.	Insecta	Diptera	Culicidae	*Anopheles culicifacies*
2.			Psychodidae	*Phleobotomus* spp.
3.			Bibionidae	*Bibio* sp.
4.			Tipulidae	*Tipul*a sp.
5.				
6.		Homoptera	Aphidae	*Aphis* sp.
7.				*Brachysiphoniella* sp.
8.			Cicadidae	*Cicadas*
9.		Hemiptera		*Pleotrichophorus* spp.
10.				*Rhopalosiphum*
11.				*Greenidea ormosana*
12.		Hymenoptera	Tenthredinidae	*Lycosa* sp.
13.			Chalsiidae	*Polistes* spp.
14.			Apidae	*Apis dorsata*
15.			Bombydae	*Orientalibombus* spp.
16.		Coleoptera	Ciccindalidae	*Orthotrichinus* spp
17.				*Cicindela virgule*
18.			Lampyridae	*Luciola cruciata*
19.			Cerambycidae	*Hoplocerambyx spinicornis*
20.			Chrysomelidae	*Laccoptera quadrimaculata*
21.				*Colasposoma semicostatum*
22.				*Corynodes pyrophorus*
23.				*Chrysolina* sp.
24.				*Chrysomela chlorine*
25.			Lucanidae	*Dorcus antaeus*
26.			Scrabeidae	*Onthophagus*
27.			Carabidae	*Carabus* sp.
28.		Dermaptera	Forficulidae	*Forficula* sp.
29.				*Forficula* sp.
30.		Lepidoptera	Acreidae	*Acreae issoria*

31.			Lycaenidae	*Ziseeia maha*
32.				*Freyeria putli*
33.				*Celastrina pusp*
34.			Nymphalidae	*Precis iphiia*
35.			Pieridae	*Pieris brassicae*
36.				*Eurema hecabe*
37.				*Eurema brigitta*
38.			Arctiidae	*Cyana distinct*
39.			Syntomidae	*Amata bicincta*
40.			Geometridae	*Arichana flavinigra*
41.			Zygaenidae	*Campylotes histrionicus*
42.		Odonata	Aeschinidae	*Anotogaster gregoryi*
43.			Gomphidae	*Paragomphus* sp.
44.			Coenagriidae	*Agriocnemis clauseni*
45.		Arachnida	Salticidae	*Bocus* sp (Jumping spider)
46.			Araneidae	Garden spider
47.	Phylum: Mollusca	Gastropoda	Helicidae	*Cornu aspersum*
48.	Phylum: Annelida	Class: Clitellata	Hirudinidae	*Hirudinea* sp.
49.			Megascolecidae	*Pheretima posthuma*
50.	Mammalia	Rodentia	Muridae	*Ratus*
51.	Aves		Upupidae	*Upupa epops*
52.	Amphibia	Anura	Bufonidae	*Duttaphrynus melanostictus*
53.	Reptilia	Squamata	Agamidae	*Calotes versicolor*