

# ALTITUDINAL DISTRIBUTION OF BRYOFLORA AT CHANDRAGIRI MOUNTAIN FOREST OF KATHMANDU DISTRICT, CENTRAL NEPAL.

NIRMALA PRADHAN

Natural History Museum, Tribhuvan University  
Swayambhu, Kathmandu, Nepal  
bryonep@yahoo.com

## ABSTRACTS

Chandragiri Mountain forest in Kathmandu borders Makwanpur district to the west was least known for bryophytes till this study was conducted. This mountain forest with varying elevation ranges from 1365 to 2300 m offered different habitat types for diverse bryofloral species which included 58 species of 39 genera categorized under 27 families and nine orders. Of the recorded species 18 species were rare and five new records to country's list. *Sauteria spongiosa* (Kashyap) S. Hatt., a rare moss species was not recorded in this study though was reported for the first time at 2250 m of this mountain in 1982. The habitat of this moss has completely been destroyed now due to expansion of the road in this part.

**Keywords:** diversity, elevation, habitat, liverworts, moss

## INTRODUCTION

Bryoflora of Chandragiri remained an unexplored group till this extensive study was carried out in different months of 2010 to 2012. The changing pattern of the bio-physical gradients at varying altitudinal habitats displayed a rich diversity of mosses and liverworts in this mountain forest. Phulchowki and Chandragiri are two among the four high ridges bordering Kathmandu Valley.

Dobremez (1996) has described an altitudinal distribution of flora of central Nepal. The eleven ecological levels from the lower tropical (below 500 m) to the highest vegetation line (above 5000 m) have been mentioned in his study. BPP (1995) has shown the distribution of flowering plants as well as bryoflora, which showed high diversity in the midhills.

Nepal has represented a good diversity of bryoflora which counts 1205 species hitherto and includes all the three classes comprising Hepaticae, Anthocerotae and Musci (Pradhan, 2013). An extensive work of Pradhan (2010) documented 213 species of bryoflora below 1000 m of elevation in Tarai and Churia range. Pradhan (2011a) also published the diversity record of this plant occurring in different bioclimatic zones which included 312 species in subtropical, 465 species in temperate, 323 species in subalpine, 233 species in alpine and 22 species in the nival zones. *Aongstroemia julaecia* (Dicranaceae) was collected at 6532 m of elevation in the Khumbu region of east Nepal. This has been mentioned as the highest limit for bryophytes in the world (Dixon, 1925).

A total of 118 ecosystems have been identified in Nepal (Dobremez, 1970). The natural

ecosystem ranges from the tall grasslands and marshlands and tropical and sub-tropical broadleaf forests along Tarai and Siwalik foothills to subtropical and temperate broadleaf and conifer forests in the middle Mountains; mixed and conifer forests in the high Mountains; and alpine meadows above the tree line.

Bryophytes are distributed in different bioclimatic zones across low to the highland regions of Nepal. The lowest record of this plant has been made at 62 m in the Jhapa district where tropical species like *Marchantia*, *Plagiochasma*, and *Fissidens* are fairly common besides epiphytic species like *Frullania* and *Entodontopsis* on *Shorea robusta* trees (Pradhan, 2010). Being a crossing zone of the high and lowland species, the species richness of this plant is high in midland region. Subtropical and temperate species are widely distributed in this part. Similarly, *Sphagnum nepalensis*, an endemic species is very much localized to the Ilam district of the east only (Pradhan, 2000).

In drought period the thallus of this plant remains dry and decomposed. In favorable condition when the environment become moist due to rain, vegetative propagation takes place in the old thallus which develops into new thalli. Water is an essential factor for the fertilization in this plant. During wet season, the thallus is transformed into the sporophytic phase followed with sexual reproduction which is accomplished before the onset of winter. Majority of this plant specifically in Chandragiri and other mountains of the midland zone show sporophytic growth during September to the start of November.

### STUDY SITE

Chandragiri mountain to the southwest part is the next highest ridge after the northern Shivapuri Mountain of Kathmandu city. This mountain continues below the valley floor of Kathmandu to the north and Chitlang of Makwanpur district to the west with co-ordinates of  $27^{\circ} 27' N$  to  $27^{\circ} 49' N$  and  $85^{\circ} 10'$  to  $85^{\circ} 32' E$ . The elevation of this mountain ranges from 1365 m to 2300 m (fig.1). Chandragiri Mountain is a transitory route which connects the districts of Makwanpur and Kathmandu through a broadened motorable road.

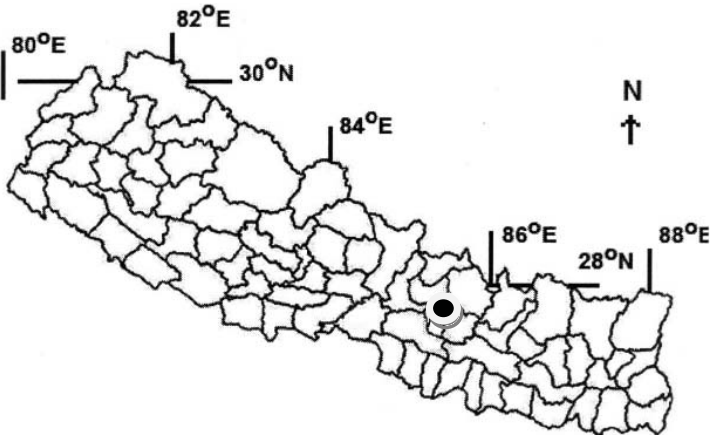


FIG. 1. Map showing the study area. (●)

## Vegetation

*Alnus nepalensis* is a pre-dominant species at the lower portion of the Chandragiri Mountain. Common floral species noted in this part are *Ligustrum confusum*, *Schima wallichii*, *Gravelia robusta*, *Maesia chisia*, *Albizia* spp., etc. Other species like, *Rhododendron arboreum* and *Pinus roxburghii* are well distributed with a good growth of *Schima wallichii*. The uppermost limit of 2300 m displayed the dominance of *Rhododendron arboreum*. Other species like *Quercus semicarpifolia*, *Celtis australis*, *Maesia chisia*, *Prinscepia utilis*, etc. are well distributed in this forest. Pteridophytic distribution is well marked with the presence of *Lycopodium cernua*, *Selaginella indica*, *Glychenia gigantea*, *Nephrolepis cordifolia*, *Lygodium japonicum*, *Cheilanthes bicolor*, *Thelypteris dentata*, etc. These fern species are associated to different altitudinal habitats of the bryophytes recorded here.

## Climate

Over the course of a year, the temperature typically varied from 3°C to 30°C and is rarely below 2°C or above 32°C. The warm season lasts from April to October with an average daily high temperature above 27°C. The hottest day of the year is June, with an average high of 30°C and lowest of 20°C. The cold season lasts from December to February with an average daily high temperature below 21°C. The coldest day of the year is the month of January, with an average lowest record of 3°C and highest of 18°C (fig.2).

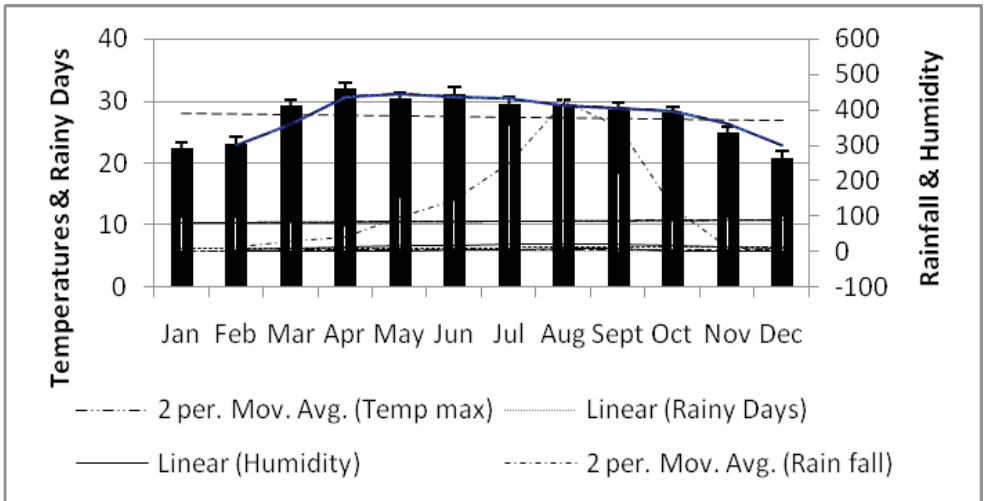


FIG. 2. Climatic pattern of Chandragiri.

## MATERIALS AND METHODS

Study was conducted in various months of the years 2010 to 2012. The months of August to November were emphasized most due to appearance of the sporophytic stage in this plant. The collection of bryoflora at ground level was done by peeling off from the substratum or ground

using a simple pocket knife. These specimens were placed in paper packets for further study and to confirm identification at the Natural History Museum in Kathmandu. Kashyap (1972), Gangulee (1969-1980), Chopra (1975), Pradhan (2000), Eddy (1088, 1990,1996), So (1995), Zhu and So (1996) and Smith (1996) were the key literatures consulted for identification. The status categorization was based upon field observation and consulting published records in the Red Data Book of IUCN-Nepal (Tan *et al.*, 2000) and the book by Brummitt and Powell (1992) was consulted to confirm author's citation.

These specimens are deposited at the Natural History Museum in Kathmandu.

## RESULTS

The diversity scale of bryoflora indicated its species variation as per altitudinal gradient. The elevation within the range of 1350 – 2300 m provided the highest diversity including many rare species. A list of the diversity of this plant is given in the appendix section (appendix I). Species diversity and conservation status of bryoflora of present study is tabulated (table 1) below.

**TABLE 1. Diversity and status of bryoflora at different elevation.**

Elevation (m)	Species diversity	Common species	Rare species	New records
1300-1400 m	4	4	x	x
1400 -1500 m	8	8	x	x
1500-1600 m	19	15	4	x
1600-1700 m	20	18	2	x
1700-1800 m	18	14	4	x
1800 -1900 m	19	14	5	x
1900 -2000 m	12	9	2	1
2000-2100 m	3	3	x	x
2100-2200 m	6	5	x	1
2200-2300 m	14	10	1	3

## DISCUSSION

This study brought a list of 58 species of bryoflora categorized under 39 genera under 27 families and nine orders. The class Hepaticae included 15 genera and 24 species, Anthocerotae with two genera and three species and Musci with 22 genera and 31 species a (appendix I). The species like *Jungermannia atrovirens* Dumort. *Porella arboris-vitae* (With.) Grolle, *Scapania nemorea* (L.) Grolle, *Scapania undulata* (Sw.ex Lindb.) Dumort and *Pogonatum microphyllum* (Dozy & Molk.) Dozy & Molk. are new additions to country's list. The order Jungermanniales displayed its dominancy with records of 10 species under five families. *Jungermannia exertifolia* recorded in this study was collected for the first time in Chitwan district of central Nepal (Pradhan, 2014). *Heteroscyphus argutus* though rare in Chandragiri is fairly common in lowland below 1000 m of elevation. Similarly, *Weissia edentula* is a common species in the lowland is rare in this mountain range.

The elevation of 1600-1700 m featured an optimal temperature range of 26° to 27° C and favorable moisture content of 80-90 % with display of varied habitat choices like the damp and moist and open and forested areas. Thus this part accommodated a highest diversity of 20 species which drastically decreased at the above range of 2000-2100 m where just three species were recorded. Low humidity content (70 % and less) and poor representation of habitat preferences are the main causes of species decline in this part. This record included one species of Hepaticae and two species of Musci only. *Cyathodium tuberosum* (Targioniaceae), *Marchantia emarginata*, *M. paleacea*, *M. polymorpha* (Marchantiaceae), *Hydrogonium arcuatum* (Pottiaceae), etc. were recorded as fairly common over the entire mountain range. *Bryum pachythea*, *Pohlia cruda* (Bryaceae), *Heteroscyphus argutus* (Geocalycaceae), *Bazzania tricanata* (Lepidoziaceae), *Pellia calycina* (Pelliaceae), *Campylopus richardii* and *Wilsoniella decipiens* (Dicranaceae), are the rare species noted in this study. Among five new records made in this study, four species belonged to the order Jungermanniales and one Polytrichales. These were recorded at different elevation habitats. These are *Scapania nemorea* (L.) Grolle at 1900-2000 m, *Porella arboris-vitae* (With) Grolle at 2100-2200 m and *Jungermannia atrovirens* Dumort., *Scapania undulata* (Sw. ex Lindb.) Dumort and *Pogonatum microphyllum* (Dozy & Molk.) Dozy & Molk. at 2200-2300 m.

Most of the recorded species were noted on mountain slopes intermingled with other bryofloral species and common weeds. Many species of Hepaticae especially the Marchantiales were found growing on soil, rocks and concrete walls. Nine species of epiphytes were recorded on barks and twigs of *Alnus*, *Schima* and *Castanopsis* trees. Of them *Bazzania japonica*, *Bazzania tricanata* and *Porella arboris-vitae* belonged to Jungermanniales of Hepaticae and rest six species were the Musci like *Brachythecium buchananii* (Hook.) A. Jaeger, *Brachythecium wachurae*, *Plagiomnium succulentum* (Mitt.) T.J. Kop., *Thuidium haplohymenium* (Harv.) A. Jaeger, *Thuidium cambifolium* (Dozy & Molk.) Dozy & Molk. and *Thuidium tamariscellum* (C. Muell.) Bosch & Lacey.

Conservation issue of bryoflora in this mountain is a serious concern mainly due to high impact imposed on the potential habitats of this plant by the roadway expansion leading from Thankot (Kathmandu District) to Chitlang of Makwanpur District. This completely has destroyed the habitat of a rare moss called *Sauteria spongiosa* (Kashyap) S. Hatt. This moss was reported for the first time in this mountain in 1982 (Manandhar, 1982). Its monitoring followed during the year 2010-2012 with the support of Mohamad bin Zayed Species Conservation Fund (Pradhan, 2011) revealed no record of this species due to complete destruction of its only known habitat in the country.

## ACKNOWLEDGEMENTS

The author is very much indebted to the prestigious Mohamed bin Zayed Species Conservation Fund for the generous support to this work. Professor Dr. Bhaiya Khanal of Natural History Museum, Tribhuvan University is acknowledged for his valuable suggestions in this work. I am thankful to Mr. Madan Krishna Shrestha (Zoology), Ms. Suprabha Shrestha and Ms. Sanam Prajapati (Botany) for their accompaniment and significant help during field visits. Mr. Padam Bahadur Tamang of Godam Village of Thankot is also acknowledged for his accompaniment and help in the field.

## ABBREVIATIONS

BPP	Biodiversity Project Profile
C	Common
FC	Fairly Common
MBZ	Mohamed bin Zayed Species Conservation Fund
R	Rare
*	new records

## REFERENCES

- BPP (1995) *Biodiversity profile of the tarai/siwalik physiographic zones*. BPP Pubs. 12. Department of National Park & Wildlife Conservation, Kathmandu, Nepal.
- BRUMMITT, R K; POWELL, C E (1992) *Authors of plant names*. Royal Botanic Garden, Kew.
- DIXON (1925) Mosses from Mt. Everest expedition (1924) *Jour. of Botany London* 10: 21–22.
- DOBREMEZ, J F (1970) Les grandes divisions phytogéographique de Nepal et de l'Himalaya. *Bull. Soc. Bot. France* 119: 111–120.
- DOBREMEZ, J F (1996) *Environment and biodiversity*. In JHA, P K; GHIMIRE, G P S; BARAL, S B; KARMACHARYA, S R; LACOU, P (eds) *The context of south Asia*. Ecological Society, Kathmandu, Nepal; pp. 1–3.
- CHOPRA, R S (1975) *Taxonomy of Indian mosses*. Bot. Monograph 10. Pubs. & Inf. Directorate, New Delhi, India.
- EDDY, A (1988) *A Handbook of Malaysian Mosses I*. The Nat. Hist. Mus. (BM), London
- EDDY, A (1990) *A Handbook of Malaysian Mosses II*. The Nat. Hist. Mus. (BM), London
- EDDY, A (1996) *A Handbook of Malaysian Mosses III*. The Nat. Hist. Mus. (BM), London
- GANGULEE, H C (1969-1980). Mosses of Eastern India and Adjacent Regions. *Fasc. 1–8: 1–2145*, Pubs. By the author, Kolkata, India.
- KASHYAP, S R (1972) *Liverworts of western Himalayas and the Panjab plain*. Research co. Pubs., Delhi; pp. 1–639.
- MANANDHAR, N (1982) Floristic and taxonomic studies of some thaloid liverworts of Kathmandu Valley. M.Sc dissertation, Tribhuvan University, Nepal.
- PRADHAN, N (2000) *Materials for a checklist of bryophytes of Nepal*. Pubs. British Museum, London; pp.1–97.
- PRADHAN, N (2010) Bryoflora of lowland Nepal: tarai and churia hills. PhD dissertation, Central Department of Botany, Tribhuvan University, Nepal.
- PRADHAN, N (2011) *A study on the distribution of Sauteria spongiosa (Kashyap) S. Hatt.: a rare and threatened liverwort and its conservation status in Kathmandu Valley*. A project report submitted to MBZ, Abu Dhabi, UAE.
- PRADHAN, N (2011a) Status and diversity of bryophytes in Nepal. *Hamro Sampada* 10(8): 40–42.
- PRADHAN, N (2013) Diversity and status of bryophytes in Panch Pokhari region of the northern

Sindhupalchok district of central Nepal. *Journal of Natural History Museum* 27: 45–58.

PRADHAN, N (2014) Three new records of *Jungermannia* species (Hepaticae, Jungermanniales) from Nepal. *Int. Journ. Enot.* 3(1): 85–92.

SMITH, A J E (1996) *The liverworts of Britain and Ireland*. Cambridge Univ. Press, Cambridge, UK; pp. 1–362.

SO, M.L. (1995) *Mosses and liverworts of Hong Kong*. Vol.1. Heavenly People Depot. pp. 1–162.

TAN, B C; GEISSLER, P; SODERSTROM, L (2000) The 2000 IUCN World Red List of Bryophytes. IUCN/SSC bryophytes specialist group mosses, *liverworts and hornworts*. In Hallingback, T; Hudgetts, N (eds). pp. 77–90.

ZHU, R L; SO, M L (1996) *Mosses and liverworts of Hong Kong*. Heavenly People Depot, Vol. 2. pp. 1–130.

## Appendix I

## Bryophytes diversity of Chandragiri mountain

Voucher Number	Order	Families	Latin names	Elevation (m)	Status
<b>HEPATICAEE</b>					
MBZ 76	Jungermanniales	Geocalycaceae	<i>Heteroscyphus argutus</i> (Reinw. & al.) Schiffn.	1600	R
MBZ 283	Jungermanniales	Jungermanniaceae	* <i>Jungermannia atrovirens</i> Dumort.	2250	FC
MBZ 366	Jungermanniales	Jungermanniaceae	<i>Jungermannia exertifolia</i> Steph.	1650	FC
MBZ 44	Jungermanniales	Lepidoziaceae	<i>Bazzania japonica</i> (Sande & Lacey) Lindb.	2250	FC
MBZ 264a	Jungermanniales	Lepidoziaceae	<i>Bazzania tricranata</i> (Wehlendb.) Lindb.	2300	R
MBZ 97	Jungermanniales	Lepidoziaceae	<i>Bazzania triloba</i> L.	2200	C
MBZ 38	Jungermanniales	Plagiochilaceae	<i>Plagiochila himalayesis</i> St.cf.	2200-2350	C
MBZ 43	Jungermanniales	Porellaceae	* <i>Porella arboris-vitae</i> (With.) Grolle	2200	R
MBZ 79	Jungermanniales	Scapaniaceae	* <i>Scapania nemorea</i> (L.) Grolle	1900-2000	FC
MBZ 81	Jungermanniales	Scapaniaceae	* <i>Scapania undulata</i> (Sw. ex Lindb.) Dumort.	2250	R
MBZ 371	Metzgeriales	Aneuraceae	<i>Riccardia multifida</i> (L.) Gray	1550	FC
MBZ 24	Metzgeriales	Pelliaceae	<i>Pellia calycina</i> (Tayl.) Nees	1800	R
MBZ 49,241	Marchantiales	Aytoniaceae	<i>Asterella multiflora</i> (Steph.) Pande <i>et al.</i>	1650-1950	FC



MBZ 40, 240, 252	Marchantiales	Aytoniaceae	<i>Asterella wallichiana</i> (Lehm. & Lindenb.) Grolle	1500- 1950	C
MBZ 4, 457	Marchantiales	Aytoniaceae	<i>Plagiochasma appendiculatum</i> Lehm. & Lindenb.	1350- 1650	C
MBZ 7a	Marchantiales	Aytoniaceae	<i>Plagiochasma nepalensis</i> Steph.	2100- 2350	FC
MBZ 7b	Marchantiales	Aytoniaceae	<i>Plagiochasma pterospermum</i> C. Massal.	1500- 1700	FC
MBZ 274, 288	Marchantiales	Conocephalaceae	<i>Conocephalum conicum</i> (L.) Underw.	2260	FC
MBZ 1	Marchantiales	Marchantiaceae	<i>Marchantia emarginata</i> Reinw. & al.	1400- 1850	C
MBZ 223	Marchantiales	Marchantiaceae	<i>Marchantia paleacea</i> Bertols.	1700- 1950	C
MBZ 460	Marchantiales	Marchantiaceae	<i>Marchantia polymorpha</i> L.	1500- 1850	C
MBZ 65, 285, 287	Marchantiales	Targioniaceae	<i>Cyathodium tuberos</i> Kashyap	1560- 2250	C
MBZ 27, 41	Marchantiales	Targioniaceae	<i>Targionia hypophylla</i> L.	2200- 2300	FC
MBZ 462	Marchantiales	Wiesnerellaceae	<i>Dumortiera hirsuta</i> (Sw.) Nees.	1350- 1500	C
<b>ANTHOCEROTAE</b>					
MBZ 3	Anthocerotales	Anthocerotaceae	<i>Anthoceros chambensis</i> Kashyap	1350- 1650	FC
MBZ 37	Anthocerotales	Anthocerotaceae	<i>Anthoceros punctatus</i> L.	1500- 1800	C
MBZ 53, 55	Anthocerotales	Anthocerotaceae	<i>Phaeoceros laevis</i> (L.) Prosk.	2150- 2350	C
<b>MUSCI</b>					

MBZ 14, 21	Eubryales	Bartramiaceae	<i>Philonotis secunda</i> (Dozy & Molk.) Bosch & Sande Lacey	1800-1900	C
MBZ 11, 243	Eubryales	Bartramiaceae	<i>Philonotis thwaitzii</i> Mitt.	1500-1900	C
MBZ 247	Eubryales	Bryaceae	<i>Bryum apiculatum</i> Schwaegr.	1820	R
	Eubryales	Bryaceae	<i>Bryum argenteum</i> Hedw.	1300-2350	C
MBZ 259	Eubryales	Bryaceae	<i>Bryum pachytheca</i> C. Muell = <i>Bryum jumghuhnianum</i> Dozy & Molk.	1960	R
MBZ 364	Eubryales	Bryaceae	<i>Pohlia cruda</i> (Hedw.) Linbd.	1650	R
MBZ 301,	Eubryales	Bryaceae	<i>Pohlia elongate</i> Hedw.	1950	FC
MBZ 96, 393	Eubryales	Mniaceae	<i>Plagiomnium succulenteum</i> (Mitt.) T. Kop	2200-2300	C
MBZ 16	Eubryales	Dicranaceae	<i>Campylopodium khasianum</i> (Griff.) Paris	1800	FC
MBZ 230	Eubryales	Dicranaceae	<i>Campylopus richardii</i> Brid.	1800-1850	R
MBZ 13	Eubryales	Dicranaceae	<i>Trematodon longicollii</i> Michx.	1500-1600	FC
MBZ 17	Eubryales	Dicranaceae	<i>Wisoniella decipiens</i> (Mitt.) Aist.	1800	R
MBZ 22	Funariales	Funariaceae	<i>Entosthodon wallichii</i> Mitt.	1500-1650	FC
MBZ 5, 10	Funariales	Funariaceae	<i>Funaria hygrometrica</i> Hedw.	1400-1800	C

MBZ 253	Funariales	Funariaceae	<i>Physcomitrium pyriformae</i> (Hedw.) Hampe	1800	R
MBZ 25	Hypnobryales	Brachytheciaceae	<i>Brachythecium buchananii</i> (Hook.) A. Jaeger	2350	FC
MBZ 11	Hypnobryales	Brachytheciaceae	<i>Brachythecium wichurae</i> Broth.	1600	R
MBZ 209,220, 254, 356, 256	Hypnobryales	Hypnaceae	<i>Hypnum pleumaforme</i> W. Wilson	1850-1950	C
MBZ 226	Hypnobryales	Hypnaceae	<i>Ptilium crista-cristensis</i> (Hedw.) De Not.	1450-1880	FC
MBZ 363	Hypnobryales	Plagiotheciaceae	<i>Plagiothecium neckroidium</i> B.S.G	1600-1780	FC
MBZ 361	Hypnobryales	Rhytidiaceae	<i>Rhytidium rugosum</i> (Hedw.) Kindb.	1650	R
MBZ 369	Hypnobryales	Sematophyllaceae	<i>Foreaula orthothecia</i> (Schwaegr.) Dix. & Verd.	1600	R
MBZ 242	Hypnobryales	Thuidaceae	<i>Thuidium cambifolium</i> (Dozy & Molk.) Dozy & Molk.	1900-2000	C
MBZ 250	Hypnobryales	Thuidaceae	<i>Thuidium glaucinum</i> (Mitt.) Bouch. & Lacey	1870	R
MBZ 372	Hypnobryales	Thuidaceae	<i>Thuidium haplohymenium</i> (Harv.) A. Jaeger	2300	FC
MBZ 358	Polytrichales	Polytrichaceae	<i>Pogonatum commune</i> Hedw.	1800-2100	C
MBZ 273	Polytrichales	Polytrichaceae	* <i>Pogonatum microphyllum</i> (Dozy & Molk.) Dozy & Molk.	2250	R

MBZ 80	Pottiales	Pottiaceae	<i>Anoetangium clarum</i> Mitt.	1850	C
MBZ 253	Pottiales	Pottiaceae	<i>Anoetangium stracheyanum</i> Mitt.	1900	R
MBZ 254, 258, 277	Pottiales	Pottiaceae	<i>Hydrogonium arcuatum</i> (Griff.) Wijk. & Marg.	1600- 1900	C
MBZ 261, 266	Pottiales	Pottiaceae	<i>Weissia edentula</i> Mitt.	1500- 1950	R