

ID 32825-1_Diversity and Conservation challenges of Bryophytes in Merak and Sakteng gewogs (semi-nomadic communities) under Trashigang district, Bhutan.

Progress Report



EXECUTIVE SUMMARY

On completion of first phase of data collection and taxonomic treatment, total of 234 bryophytes were documented of which 104 bryophytes species were identified. Out of 104 bryo-species, 60 species were mosses, 43 liverworts and 1 hornwort.

BACKGROUND

As mentioned in Checklist of mosses of Bhutan by David G. Long (1994), of all the countries and states in the Himalayan region, Bhutan is probably one of the richest in bryophyte owing to its location. Bhutan lies in the region of Eastern Himalayan Hotspots and climatic conditions are

characteristically moderate in the favor for growth of diverse bryophytes, yet Bhutan have least number of bryophytes recorded. Currently, only 282 species under 156 genera of mosses and 55 species of liverworts are recorded from Bhutan. Bryophytes are considered as a pioneer species in various types of succession. It also play an important role in ecosystem stability and conservation. But due to absent of complete information on this plant, Bhutan has not integrated bryophyte in the conservation paradigm. Moreover, due to small size, numerous and not much economic use, people do not consider in conserving this species. The study site is in the remotest part of Bhutan. There are no or little touch of modern developmental activities. Therefore, there are chances of spotting rare and complete diversity of bryophytes of Bhutan in the study area, which are extinct due to developmental activities in other parts of the country.

STUDY AREA

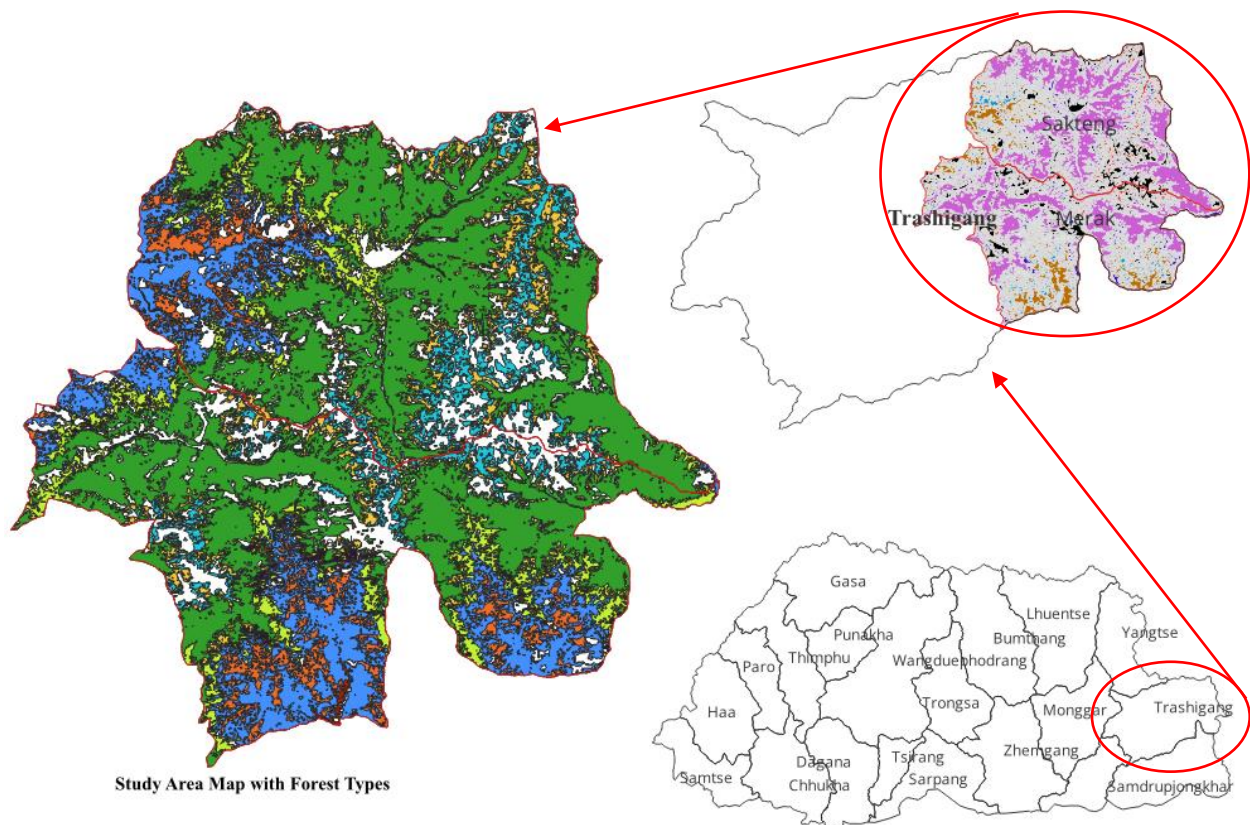


Figure 1: Study area Map prepared using QGIS 3.2.8.

Merak and Sakteng are two gewogs (sub- districts), semi-nomadic communities, located in remotest and eastern most part of Bhutan, under Trashigang district. It is located at 27° 18'06.8''N, 91°51'20.8''E and 27°24'14.1''N and 91°55'20.4''E. It shares border with Indian state of

Arunachal Pradesh in the north and east. It is inhabited by a unique cultural people called Brokpas, who depends mostly on livestock rearing and with little subsistence farming. It is famous for ecotourism and trekking due to its exquisite landscape and rich biodiversity. Merak and Sakteng experiences temperate climatic conditions characterized by long cold winter and short summer with occasional heavy rainfall.

METHODOLOGY

Systematic collection was made from various habitats and forest types covering whole study area as mentioned in Vanderpoorten et al (2010). 21 sampling grids of 5km x 5km Map of project site with transect walks was used as reference while collecting. Standardized transect method covering 1000m x 5 m inside each grid was used for data collection. Best effort was made to identify the observed specimen of bryophytes in the field with the help of magnifying hand lens and consulting books by Gangulee (1969-1980), Kashyap (1929), and other authentic books and literatures. While other specimens which could not be identified in field was scientifically collected as mentioned Vanderpoorten et al (2010) for identification in lab.

COLLECTION OF SPECIMENS



Figure 2: Equipment used during data collection; 1. magnifying hand lens; 2. Herbarium packet for storing those bryophytes that are not identified in field; 3. Canon eos 200D; 4, 5, 6 & 7. Images during data collection.

TAXONOMIC TREATMENT

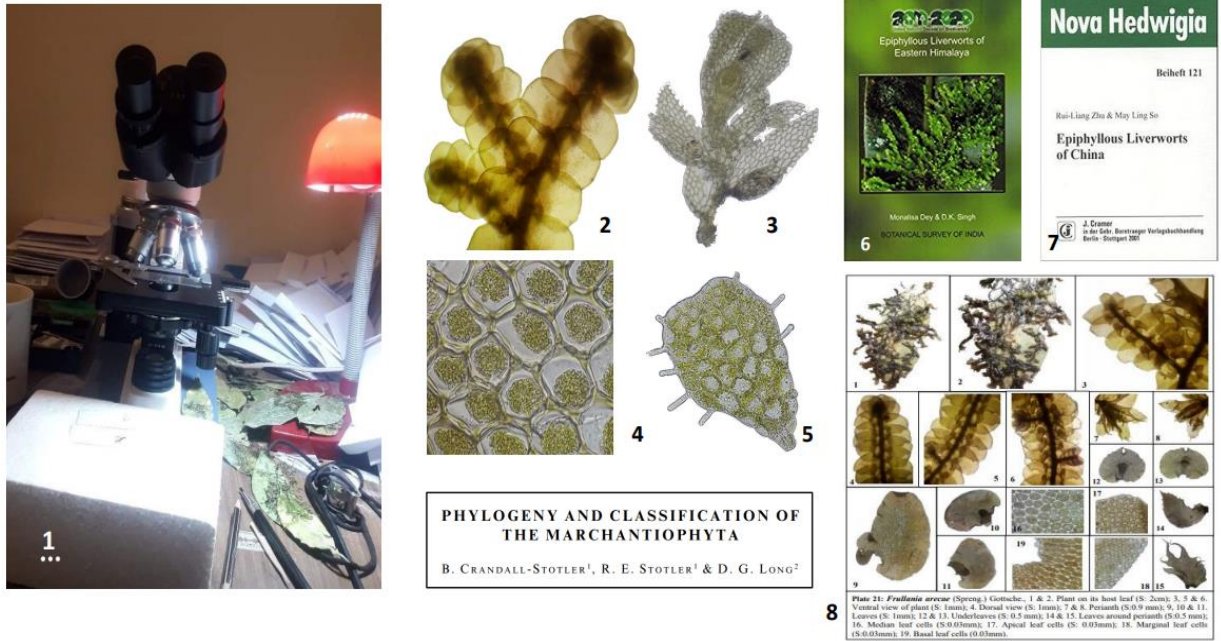


Figure 3: Taxonomic treatment (identification and classification of bryophytes. 1. Biological Microscope SME-F8BH (Model No.) for identification. 2,3, 4 & 5. Microscopic images of bryophytes used for identification; 6 & 7. Identification references; 8. Plate developed for easy identification and future references.

IMPORTANT COLLECTION SITES

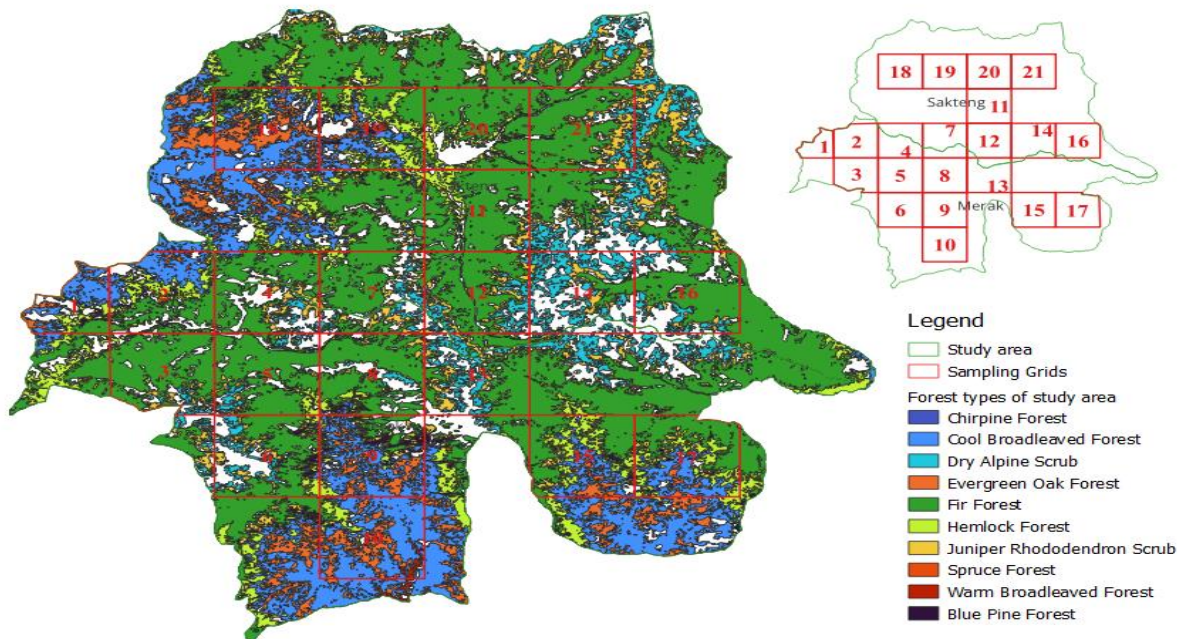


Figure 4: Major collection sites in 3x3 km grid system created using QGIS.

RESULT

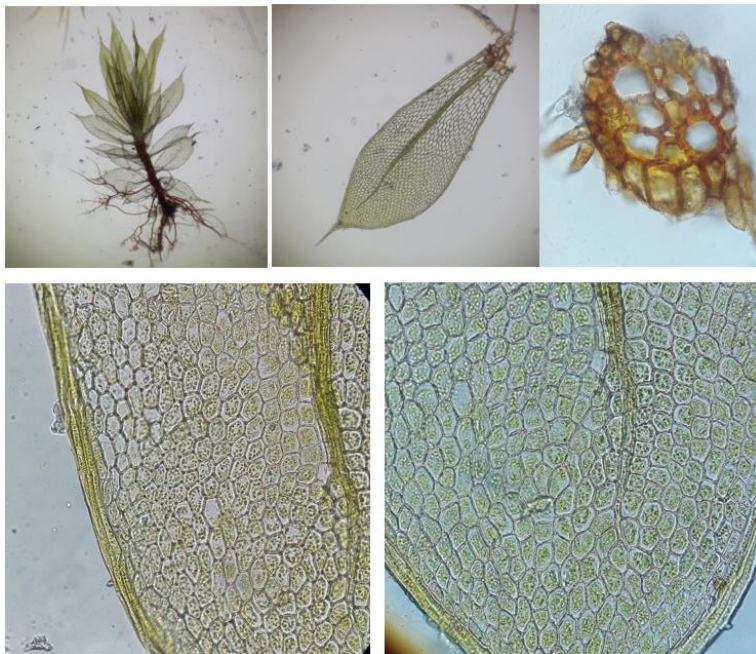
MOSESSES

Botanical Name	Family	Forest types	Habit
<i>Actinothuidium hookeri</i> (Mitt.) Broth.	Thuidiaceae	Fr	Acrocarpous
<i>Amblystegium serpens</i> (Hedw.) Schimp.	Amblystegiaceae	WBLFr	Acrocarpous
<i>Anomodon viticulosus</i> (Hedw.) Hook. & Taylor	Anomodontaceae	WBLFr	Pleurocarpous
<i>Atrichum undulatum</i> (Hedw.) P.Beauv.	Polytrichaceae	WBLFr	Acrocarpous
<i>Bartramia pomiformis</i> Hedw.	Bartramiaceae	WBLFr	Acrocarpous
<i>Breutelia dicranacea</i> (Müll.Hal.) Mitt.	Bartramiaceae	WBLFr	Acrocarpous
<i>Breutelia elongata</i> (Müll.Hal.) Mitt.	Bartramiaceae	WBLFr	Acrocarpous
<i>Bryum argenteum</i> Hedw.	Bryaceae	CBLFr	Acrocarpous
<i>Bryum billardierei</i> Schwägr.	Bryaceae	WBLFr	Acrocarpous
<i>Bryum coronatum</i> Schwägr.	Bryaceae	WBLFr	Acrocarpous
<i>Calyptothecium hookeri</i> Brotherus	Pterobryaceae	CBLFr	Pleurocarpous
<i>Campylopus umbellatus</i> (Arn.) Paris	Dicranaceae	CBLFr	Acrocarpous
<i>Cyathophorella hookeriana</i> (Griff.) M.Fleisch.	Hypopterygiaceae	CBLFr	Acrocarpous
<i>Cyathophorella spinosa</i> (Müll.Hal.) M.Fleisch.	Hypopterygiaceae	WBLFr	Acrocarpous
<i>Dicranum scoparium</i> Hedw.	Dicranaceae	WBLFr	Acrocarpous
<i>Entodon concinnus</i> (De Not.) Paris	Entodontaceae	WBLFr	
<i>Epipterygium tozeri</i> (Grev.) Lindb.	Mniaceae	WBLFr	Acrocarpous
<i>Fissidens grandifrons</i> Brid.	Fissidentaceae	WBLFr	Acrocarpous
<i>Fissidens nobilis</i> Griff.	Fissidentaceae	Fr	Acrocarpous
<i>Floribundaria floribunda</i> (Dozy & Molk.) M.Fleisch.	Meteoriaceae	WBLFr	Pleurocarpous
<i>Herpetineuron toccocae</i> (Sull. & Lesq.) Cardot	Thuidiaceae	Fr	Acrocarpous
<i>Homaliodendron flabellatum</i> (Sm.) M.Fleisch.	Neckeraceae	Fr	Pleurocarpous
<i>Homaliodendron microdendron</i> (Mont.) M.Fleisch.	Neckeraceae	WBLFr & Fr	Pleurocarpous
<i>Hookeria acutifolia</i> Hook. & Grev.	Hookeriaceae	WBLFr & Fr	Pleurocarpous
<i>Hypnum cupressiforme</i> Hedw.	Hypnaceae	WBLFr & Fr	Pleurocarpous
<i>Leptodontium viticulosoides</i> (P.Beauv.) Wijk & Margad.	Pottiaceae	CBLFr	Pleurocarpous
<i>Leucobryum juniperoideum</i> (Brid.) Müll.Hal.	Leucobryaceae	WBLFr	Acrocarpous
<i>Lyellia crispa</i> R.Br.	Polytrichaceae	CBLFr	Pleurocarpous
<i>Meteoriopsis reclinata</i> (Müll.Hal.) M.Fleisch.	Meteoriaceae	WBLFr	Pleurocarpous
<i>Neckeropsis lepineana</i> (Mont.) M.Fleisch.	Neckeraceae	WBLFr	Pleurocarpous
<i>Octoblepharum albidum</i> Hedw.	Octoblepharaceae	WBLFr	Acrocarpous
<i>Papillaria semitorta</i> (Müll.Hal.) A.Jaeger	Meteoriaceae	WBLFr	Pleurocarpous
<i>Philonotis hastata</i> (Duby) Wijk & Margad.	Bartramiaceae	WBLFr	Pleurocarpous
<i>Plagiomnium acutum</i> (Lindb.) T.J.Kop.	Mniaceae	Fr	Pleurocarpous
<i>Plagiomnium medium</i> (Bruch & Schimp.) T.J.Kop.	Mniaceae	WBLFr	Pleurocarpous
<i>Plagiothecium nemorale</i> (Mitt.) A.Jaeger	Plagiotheciaceae	WBLFr	Pleurocarpous
<i>Plagiothecium neckeroideum</i> Schimp.	Plagiotheciaceae	CBLFr	Pleurocarpous

Plagiothecium undulatum (Hedw.) Schimp.
Pogonatum urnigerum (Hedw.) P.Beauv.
Polytrichum juniperinum Hedw.
Ptilium crista-castrensis (Hedw.) De Not.
Rhizomnium horikawae (Nog.) T.J.Kop.
Rhodobryum giganteum (Schwägr.) Paris
Rhodobryum roseum (Hedw.) Limpr.
Rhytidium rugosum (Hedw.) Kindb.
Rosulabryum billardierei (Schwägr.) J.R.Spence
Taxiphyllum taxirameum (Mitt.) M.Fleisch.
Tayloria indica Mitt.
Thuidium assimile (Mitt.) A.Jaeger
Thuidium cymbifolium (Dozy & Molk.) Dozy & Molk.
Tortula muralis Hedw.
Floribundaria setschwanica Broth.
Tetraplodon mnioides (Hedw.) Bruch & Schimp.
Sphagnum girgensohnii Russow
Sphagnum palustre L.
Pohlia elongata Hedw.
Papillaria africana (Müll.Hal.) A.Jaeger
Aerobryopsis capensis (Müll.Hal.) M.Fleisch.
Brachythecium rutabulum (Hedw.) Schimp.
Pterobryopsis orientalis (Müll.Hal.) M.Fleisch.

Plagiotheciaceae	CBLFr	Pleurocarpous
Polytrichaceae	CBLFr	Acrocarpous
Polytrichaceae	WBLFr	Acrocarpous
Pylaisiaceae	Fr	Acrocarpous
Mniaceae	Fr	Acrocarpous
Bryaceae	Fr	Acrocarpous
Bryaceae	CBLFr	Acrocarpous
Rhytidiaceae	Fr	Pleurocarpous
Bryaceae	Fr	Pleurocarpous
Taxiphyllaceae	Fr	Pleurocarpous
Splachnaceae	WBLFr	Acrocarpous
Thuidiaceae	Fir	Pleurocarpous
Thuidiaceae	Fr	Pleurocarpous
Pottiaceae	Fr	Pleurocarpous
Meteoriaceae	Fr	Pleurocarpous
Splachnaceae	JRS	Acrocarpous
Sphagnaceae	Fr	Acrocarpous
Sphagnaceae	JRS	Acrocarpous
Mniaceae	WBLFr	Acrocarpous
Meteoriaceae	WBLFr	Pleurocarpous
Meteoriaceae	WBLFr	Pleurocarpous
Brachytheciaceae	WBLFr	Pleurocarpous
Pterobryaceae	CBLFr	Pleurocarpous

Note: Forest types (Fir: Fir Forest; JRS: Juniper Rhododendron Scrub; CBLFr: Cool Broadleaved Forest; WBLFr: Warm Broadleaved Forest; HL: Hemlock forest).



Mosses of Sakteng and Merak gewog

- 60 moss species of 47 genus under 25 families.
- Out of 25 families, Bryaceae is most common family with 7 species.
- Out of 47 genus, Bryum and Plagiothecium are common genus with 3 species each.
- Most moss species are recorded from Warm broadleaved forest and Fir Forest.
- Most moss species recorded are in pleurocarpous habit



Figure 5: Mosses. 1. *Aerobryopsis capensis*; 2. *Meteorium buchanani*; 3. *Breutelia dicranacea*; 4. *Atrichum undulatum*; 5. *Hookeria acutifolia*.



Figure 6: Mosses. 1. *Bryum coronatum*; 2. *Cyathophorella spinosa*; 3. *Tayloria indica*; 4. *Rhodobryum giganteum*; 5. *Bartramia pomiformis*.

HORNWORTS & LIVERWORTS

Botanical Name	Family	Forest types	Habit
<i>Anthoceros angustus</i> Steph.	Anthocerotaceae	Fr, CBLFr &WBLFr	Hornwort
<i>Bazzania tridens</i> (Reinw., Blume & Nees) Trevis.	Lepidoziaceae	Fr, WBLFr	Leafy liverwort
<i>Cololejeunea latilobula</i> (Herzog) Tixier	Lejeuneaceae	WBLFr	Leafy liverwort
<i>Conocephalum japonicum</i> (Thunb.) Grolle	Conocephalaceae	WBLFr	Thalloid liverwort
<i>Conocephalum salebrosum</i> Szweyk., Buczk. & Odrzyk.	Conocephalaceae	WBLFr	Thalloid liverwort
<i>Cyathodium tuberosum</i> Kashyap	Cyathodiaceae	WBLFr	Thalloid liverwort
<i>Diplasiolejeunea cavifolia</i> Steph.	Lejeuneaceae	WBLFr	Leafy liverwort
<i>Dumortiera hirsuta</i> (Sw.) Nees	Dumortieraceae	Fr, WBLFr	Thalloid liverwort
<i>Frullania arecae</i> (Spreng.) Gottsche	Frullaniaceae	CBLFr	Leafy liverwort
<i>Frullania neurota</i> Taylor	Frullaniaceae	CBLFr	Leafy liverwort
<i>Herbertus dicranus</i> (Taylor) Trevis.	Herbertaceae	Fr	Leafy liverwort
<i>Heteroscyphus argutus</i> (Reinw., Blume & Nees) Schiffn.	Lophocoleaceae	Fr,HLFr	Leafy liverwort
<i>Heteroscyphus coalitus</i> (Hook.) Schiffn.	Lophocoleaceae	WBLFr	Leafy liverwort
<i>Heteroscyphus planus</i> (Mitt.) Schiffn.	Lophocoleaceae	WBLFr	Leafy liverwort
<i>Jubula hutchinsiae</i> (Hook.) Dumort.	Jubulaceae	WBLFr	Leafy liverwort
<i>Lejeunea obscura</i> Mitt.	Lejeuneaceae	WBLFr	Leafy liverwort
<i>Lejeunea tuberculosa</i> Steph.	Lejeuneaceae	WBLFr	Leafy liverwort
<i>Lophocolea bidentata</i> (L.) Dumort.	Lophocoleaceae	WBLFr	Leafy liverwort
<i>Marchantia nepalensis</i> Lehm. & Lindenb.	Marchantiaceae	WBLFr, Fr	Thalloid liverwort
<i>Marchantia paleacea</i> Bertol.	Marchantiaceae	WBLFr	Thalloid liverwort
<i>Marchantia polymorpha</i> L.	Marchantiaceae	WBLFr	Thalloid liverwort
<i>Marchantia</i> <i>polymorpha</i> subsp. <i>montivagans</i> Bischl. & Boissel.-Dub.	Marchantiaceae	WBLFr	Thalloid liverwort
<i>Mastigophora woodsii</i> (Hook.) Nees	Mastigophoraceae	Fr	Leafy liverwort
<i>Metacalypogeia alternifolia</i> (Nees) Grolle	Calypogeiaceae	Fr	Leafy liverwort
<i>Metzgeria consanguinea</i> Schiffn.	Metzgeriaceae	WBLFr	Thalloid liverwort
<i>Metzgeria furcata</i> (L.) Dumort.	Metzgeriaceae	WBLFr	Thalloid liverwort
<i>Metzgeria lindbergii</i> Schiffn.	Metzgeriaceae	WBLFr	Thalloid liverwort
<i>Metzgeria pubescens</i> (Schrank) Raddi	Metzgeriaceae	Fr	Thalloid liverwort
<i>Odontoschisma denudatum</i> (Mart.) Dumort.	Cephaloziaceae	Fr	Leafy liverwort
<i>Pallavicinia lyellii</i> (Hook.) Carruth.	Pallaviciniaceae	WBLFr	Leafy liverwort
<i>Plagiochasma cordatum</i> Lehm. & Lindenb.	Aytoniaceae	WBLFr HLFr, Fr,	Thalloid liverwort
<i>Plagiochila fordiana</i> Steph.	Plagiochilaceae	WBLFr HLFr, Fr,	Leafy liverwort
<i>Plagiochila fruticosa</i> Mitt.	Plagiochilaceae	WBLFr	Leafy liverwort

<i>Plagiochila nepalensis</i> Lindenb.	Plagiochilaceae	HLFr, Fr, WBLFr	Leafy liverwort
<i>Plagiochila parvifolia</i> Lindenb.	Plagiochilaceae	HLFr, Fr, WBLFr	Leafy liverwort
<i>Plagiochila sciophila</i> Nees ex Lindenb.	Plagiochilaceae	WBLFr	Leafy liverwort
<i>Plicanthus hirtellus</i> (F.Weber) R.M.Schust.	Anastrophyllaceae	Fr	Leafy liverwort
<i>Porella campylophylla</i> (Lehm. & Lindenb.) Trevis.	Porellaceae	WBLFr	Leafy liverwort
<i>Porella gracillima</i> Mitt.	Porellaceae	WBLFr	Leafy liverwort
<i>Radula kojana</i> Steph.	Radulaceae	WBLFr	Leafy liverwort
<i>Riccardia chamedryfolia</i> (With.) Grolle	Aneuraceae	WBLFr	Thalloid liverwort
<i>Riccia fluitans</i> L.	Ricciaceae	WBLFr	Thalloid liverwort
<i>Trocholejeunea sandvicensis</i> (Gottsche) Mizut.	Lejeuneaceae	WBLFr	Leafy liverwort
<i>Wiesnerella denudata</i> (Mitt.) Steph.	Wiesnerellaceae	WBLFr	Thalloid liverwort

Note: Forest types (Fir: Fir Forest; JRS: Juniper Rhododendron Scrub; CBLFr: Cool Broadleaved Forest; WBLFr: Warm Broadleaved forest; HL: Hemlock forest.



Hornworts and liverworts of Sakteng and merak gewog.

- 43 liverworts are identified and documented from first phase of data collection.
- 43 liverwort species of 27 genus under 24 families.
- Only single species of hornwort was recorded from project site.
- Out of 43 liverworts identified, 27 are leafy liverworts and 16 are thalloid liverworts.
- Plagiochilaceae are common families with 5 liverwort species.
- Most species are recorded from warm broadleaved forest and fir forests.



Figure 7: Liverworts: 1 & 2. *Metzgeria lindbergii*; 3. *Wiesnerella denudata*; 4. *Cyathodium tuberosum*; 5. *Lophocolea bidentata*; 6. *Mastigophora woodsia*.

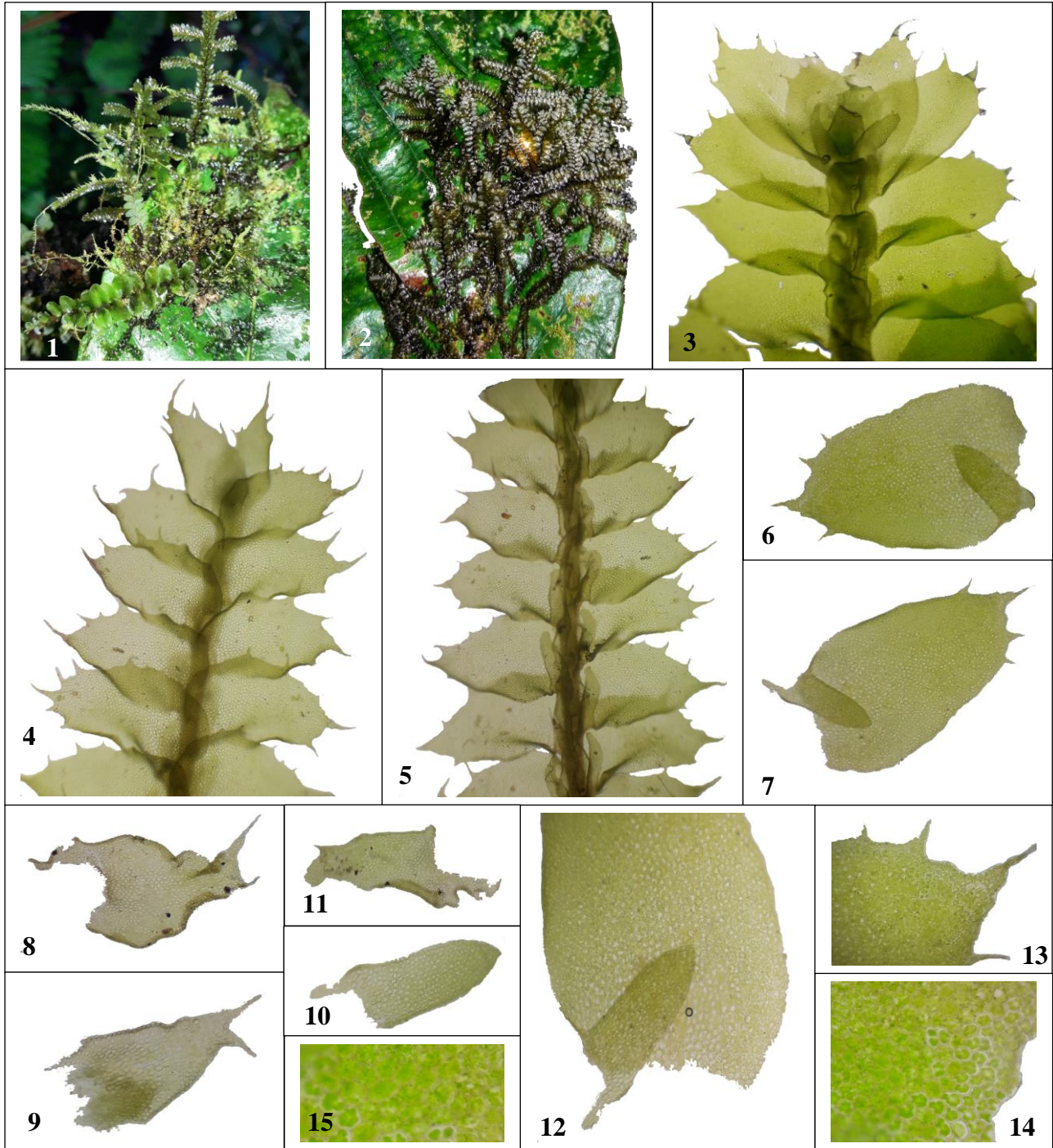


Plate 1: *Porella campylophylla* (Lehm. & Lindenb.) Trevis., 1 & 2. Plant on its host leaf (S:1.5 cm); 3, 4 & 5. Habit of the plant (S:2mm); 6 & 7. Leaves (S:0.4mm); 8, 9, 10 & 11. Underleaves (S:0.1mm); 12. Basal leaf cells with underleaf (S:0.1mm); 13. Apex of leaf (S:0.03 mm); 14. Marginal leaf cells (S:0.03mm); 15. Mid leaf cells with oil bodies (S: 0.03mm).



Figure 8: Liverworts: 1. *Lejeunea obscura*; 2. *Marchantia nepalensis*; 3. *Plicanthus hirtellus*; 4. *Anthoceros angustus*; 5. *Cololejeunea latilobula*.

ANNEXURE: Images taken during data collection





