1. Introduction

1.1. Background

Bryophyte is a least studied lower plant group in Nepal. The available publications on Nepalese bryophytes are the result of the relatively infrequent expeditions conducted in the past by various botanists from abroad. Many remote parts are still unexplored for this plant especially the Himalayan regions, where a previous report has indicated their range extension up to 6500 m of elevation (Dixon, 1925). The former studies on bryophytes were concentrated mainly upon the hills and mountains of central and eastern Nepal. In lowland to Siwalik (below 1000 m), bryophytes are less conspicuous and are abundant mainly in favorable pockets of moist, shaded forest floors, rock cliffs and damp areas, however they substrate upon walls and disturbed ground. This is the first systematic survey of bryophytes undertaken along the lower zone (below 1000 m) of the country.

Bryophytes are considered to be the pioneer colonizer in terrestrial habitats from an aquatic environment. They are the simplest and the most primitive land plants as they do not have a well developed conductive tissue system. Though basically terrestrial, a few aquatic forms also exist like *Riccia fluitans*, *Ricciocarpus natans* and *Riella* spp. In Nepal, Bryophytes are more common in humid areas and usually show a microclimatic niches on rocks, trees and vicinity of small shady springs. However, they can grow on a wide range of substrata. They may be found on old discarded and abandoned leather goods, rubber tyres, wooden articles, tiled and asbestos roof, mortar of stones and mud walls. They also grow as epiphytes upon barks of trees, leaves, rocks, stones and boulders, fallen logs, river banks, roadside cuts, etc in many vegetative zones and habitats. They can grow almost anywhere except sea. Since water is inevitable for completing their life cycle, they are known as the ‘amphibians’ of the plant kingdom.

Bryophyta was first introduced by Robert Braun in 1864 which also included algae, fungi, lichen and mosses combinely (Chopra, 1998). Almost all bryophytes are autotrophic and absorb minerals, water and carbon dioxide directly through the cell wall as many of the true vascular systems are lacking. Some bryophytes have simple conducting tissue (hydroids and leptoids) through which water and nutrients are transported, others (e.g. members of Pottiaceae) have a highly ornamented leaf cuticle, which acts as an external capillary system to transport water up and down on the surface of the gametophyte for photosynthesis process achieved through the green thalli and leaves. Leaves are not only the efficient photosynthetic organs but also protect vulnerable tissues and organs like the growth of apices, axillary propagules, antheridia and archegonia. The highest level of structural specialization is probably attended in the gametophytes of Marchantiales liverworts, where internalization of the photosynthetic tissue and development of pseudo-intercellular spaces mimic to the

organization of the photosynthetic tissue of the sporophyte of tracheophytes (Apostolakos and Galatis, 1985). Such minerals are absorbed in soluble forms directly through the cell wall. In some forms they have simple conducting tissues through which they permit external capillaries to transport water up and down within the gametophyte. The green plants (gametophores) possess chlorophyll A and B, starch, cellulose wall and sometimes cuticle as well. Their size varies from microscopic to 2 meter in length. The moss *Nanamitrium austinii* has been reported to be the smallest species measuring about 0.1 mm in size. Similarly the aquatic Fountain moss (*Fontinalis dalacarlica*) can measure up to 166 cm long and has been claimed to be the largest moss in the world record (Takaki, 1984).

Bryophytes traditionally were considered as a natural plant group, being small in stature, they share a number of similarities such as 'alternation of generation' which in the past were considered collectively to be evidence of evolution as a single lineage. For example, in form they are often dorso-ventrally flattened green plants basically differentiated into stem and leaves. They share a lack of lignified tissues and true roots, and ancher to their substrate by means of non-chlorophyllose filamentous branches called rhizoids. Leafy gametophytes are differentiated into stems and leaves. In leafy liverworts, the leaves are arranged in two lateral rows but not uncommonly a third row of smaller leaves is present on the ventral side of the stem, the side is appressed to the substrate and anchor by unicellular rhizoids. Moss gametophytes are either erect or extensively branched prostrate plants that consist of an axis commonly called a stem bearing spirally arranged leaves. Antheridia and archegonia are the male and female gametes produced on the gametophytic generation. When the antherozoid (formed within an antheridium) fuses with the egg (formed within the archegonium) a called zygote is formed. The zygote is the first cell of the sporophytic generation. Water plays vital role in fertilization and is vital for bryophyte survival, so those plants are often most abundant in damp and shaded areas. The sporophyte generation consists of a capsule developed on a short to long seta. The capsule when ripe, disseminates thousands of tiny spores which is produced by mitosis and is the first cell of the gametophytic generation. It germinates to produce a protonema or sporeling in most of the species. Eventually, the protonema produces a bud that differentiates into an apical cell from which a more complex gametophore grows. The gametophore eventually produces sex organs (antheridia and archegonia). Each gametophore bears either a type of sex organs or both i.e. they may be monoecious or dioecious.

The asexual (vegetative) reproduction in bryophytes is frequent and may be accomplished by producing multicellular gemmae, fragmentation of the branches and tuber formation. In some bryophytes, the sporophytes are extremely rare and reproduction is achieved by asexual way. The moss *Rhytidium rugosum* for example rarely produces sporophytes and typically propagates vegetatively by fragmentation of gametophores when dry.

The three main taxonomic groups of bryophytes have been recognized, these are now known as Anthocerotopsida (Hornworts), Marchantiophyta (Liverworts) and Bryophyta (Mosses).

The hornworts consists of a dorsoventrally flattened thallus often in the form of rosette with long horn like sporophyte. They are widely distributed in temperate and tropical regions throughout the world. The liverworts have both thalloid as well as leafy growth forms and are distributed in tropical to alpine zones. The mosses have been advanced on account of the greater structural diversity (especially that of the sporophytic generation) than other bryophytes and are worldwide in distribution.

Bryophytes show diverse distribution patterns than the vascular plants, perhaps of their greater dispersal capacity through minute spores. Many cosmopolitan species are found over all the continents. The high humidity and predominating rain are the important factors to create suitable environment for the luxuriant growth of bryophytes. The decrease in precipitation is directly associated to the decrease in the growth and distribution. Some bryophytes can tolerate high temperature, extreme desiccation and some can survive prolonged freezing under wet or dry conditions.

1.2. Fossil records

The Devonian age is considered as the fossil age for bryophytes because a small fragment of *Hepaticites devonicus,* a member of Metzgeriales existed in Devonian age (Schofield, 1985). This material lacks sex organs, thus its interpretation remains tentative, since the gametophytes of some ferns are structurally similar, and is also possible that this fossil could represent an unlignified portion of a lignified plant. Although the fossil record is very rare, it is likely that the three linkage of bryophytes (liverworts, hornworts and mosses) were diversified during the Upper Ordovician-Silurian phase of the primary radiationof land biota (Bateman *et al.,* 1998; Lacey, 1969). Spore microfossils support the widespread occurrence of spore bearing bryophytes like plants by the end of Ordovician (Gray, 1985; Wellman *et al.,* 2003). Thus, bryophytes evolved during a pivotal moment in the history of life on earth and have persisted through hundreds of millions of years (Renzaglia *et al.,* 2007).

Some fossil specimens of bryophytes have also been recorded in India. Goshwami (1957) recorded hepatic species, a fossilized specimen which was collected from the Karewas of Kashmir (6000-10,000 feet) India. Saksena (1947) recorded fossil capsule of *Capsulities gondwanensis* in Permo-Carboniferous period at Ganjra Nala near its Confluence of Johilla River in India. Singhai (1964) also has mentioned about *Shuklanites deccani,* a fossil bryophyte sporangium from the Decan pleatue. The latest record of bryo-fossil so far was described by Vishnu-Mittre and Gupta (1971). This is *Sphagnum papillosum,* a subfossil moss fragment recorded from the sediments in Bhim Tal, western Himalayas. This specimen has been stated lesser than 1000 years old.

1.3. Phylogenetic Relationships

The origin of a land flora during the upper Ordovician- Lower Silurian border (440 millions years ago) represents significant evolutionary event in the history of life (Shaw and Goffinet 2000). Character innovations that coincide with exposure to new selective forces can then be examined in a Phylogenetic context for their evolutionary significance or potential adaptive value (Knoll *et al.*, 1984, Knoll and Niklas, 1987).

The origin of bryophytes needs examined extensively within the evolutionary history of all the land plant's lineage. Among extant embryophytes, bryophytes exhibit a series of characters reminiscent of aquatic habitat, and thus appear as prime candidates for marking the transition to land. Resolving the relationships among three lineages of land plants, the bryophytes, pteridophytes, and seed plants appear a priori straight forward. The monophyli of bryophytes and pteridophytes in particular has come under increased scrutiny.

With regards to the origin of bryophytes, their occurrence is consistent with, but not necessarily, indicative of the presence of taxa of bryophyte affinities, since trilite marks occur on spores of representatives hornworts, liverworts and mosses, as well as various other land plants (Taylor, 1982).

Affinities with hepatics were proposed on the basis of similarities between some associated tubes and rhizoids or conducting cells, and the tetrahedral arrangements of the spores. The naked tetrads of spores resemble the tetrad of *Tetrahedraletes medinensis* from the Ordovician, and could be first link between Ordovician spores and their sporangium (Edwards *et al*, 1995). Whether the taxon from the Devonian is allied to the liverworts needs to be reconsidered, since the interpretation of the tubes associated with the sporangium was subsequently revised, and directed toward a fungal origin (Edwards *et al.*, 1996).

The earliest occurrence of moss in the fossil record could be from the Lower Carboniferous, *Musatis plumatis* is described based on a single, densely foliate, sterile stem (Thomas, 1972). Other fossils clearly allied to moss, *Muscites polytrichaceus* and *M. betrandi* are from the Upper Carboniferous (Krassilov and Schuster, 1984).

The similarities between these microfossils and extant bryophytes are, however, at least congruent with the hypothesis that the early land plants associated with these fossils are derived from embryophytes at a bryophyte level of organization as suggested by Gray (1985) and Gray *et al.* (1992).

To invoke origins of an bryophytes independent to that of other embryophytes, may even from a distinct algal ancestor as proposed by Schuster (1977, 1979), Crandall-Stotler (1986) and others, would require convergence in all these features.

Many bryologists opine that the bryophytes were originated from the algal ancestor. This fact is supported by the necessity of water for the act of fertilization, amphibious nature and the presence of ciliated antherozoides (Pandey, 1977). These are the basic features found in aquatic group of plants. Lignier (1903) suggested that the algae gave rise to a connecting link known as prohepatics and there after bryophytes emerged out from this connecting link on one hand and pteridophyte on the other. Bower (1935) stated that the Archegoniatae was evolved from the aquatic algal ancestors. According to Pandey (1977) the bryophytes have many features common with algae i.e. Chlorophyceae. Fritsch (1916, 1945) mentioned that the Chaetophorales gave rise to bryophytes.

The algal eggs are not surrounded by any cellular jacket as it is enclosed by a protective layer as in bryophytes, the antheridium and archegonium of bryophytes originated from gametangia similar to that of *Ectocarpus*, a member of brown algae (Pandey, 1977). The ventral canal cell is similar to the sister cell of the oosphere of algae.

The viewpoint regarding the origin of bryophytes from the algal ancestor is named as Algal Hypothesis (Vasistha, 1985). The development of a green, filamentous, alga like protonema as a juvenile stage in the life cycle of some of the bryophytes provides the view that the bryophytes had their origin from some of the algal form. The biological principal reflects that the juvenile stage of an organism resembles its ancestral form. According to him, the bryophytes evolved from the green algae rather than the brown. Similarities between these two lie in the fact that both of them have identical phytogynthetic pigments (Chlorophylls and Xanthophylls), thallus like plant body, lacking vascular tissue, starch as food reserve, and cellulose as the main component of cell wall and type and number of flagella. This is called Chlorophycean Hypothesis.

The presence of a small, flat, plate like protonema in *Sphagnum* suggests the green alga with a small and simple *Sphaerocarpous* like thallus which was adapted to a life on land. To support this hypothesis, it has also been suggested that the *Fritschiella,* an amphibious green alga of the family Chaetophoraceae could be the nearer approach to the primitive ancestral form from which the bryophytes were evolved. The multicellular sex organ was developed in this amphibious plant as an adaptation to a life on land.

Kashyap (1919) has stated that the recognizing reduction tendencies of Hepaticae have no relationship with algae. The similarities with pteridophytes in many respects basically conclude that they have had some connections. The best developed gametophyte in Pteridophytes would be somewhat like the ancestral which gave rise to liverworts. Best example for this is the gametophyte of *Lycopodium cernum* which is erect, radial with a basal cylindrical portion composed of meristems all round. It has generally thought that the genus *Anthoceros* approaches the higher types more closely than any other liverworts, in respect with the distinctly differentiated capsule and the embedded sex organs. Considering this fact that the radial and erect specimens of *Anthoceros erectus* acquires a great significance in

being very much like the prothallus of *Lycopodium cernum* is general features except the lobes of the later. Initiation from such types, three different lines of simplification are considered, the Marchantiales, the Jungermanniales and the Anthocerotales (Udar, 1976).

The first step leading from the erect and radial position of the prostrate and dorso-ventral habit as shown by the prothallus of fern (*Equisetum debile*) provides a greater resemblance with the types of Marchantiales than the prothallus of any other Pteridophytes. Under certain conditions the prothallus of this plant likes Prothalli in other species of this genus, which is very much like the unbranched *Riccia*. Erect branched lobes of this prothallus correspond to the erect assimilating filament and to the walls of the chambers in the Marchantiales and also to the leaves of the Jungermanniales as well. Kashyap (1919) concluded that liverworts are more closely related to the Equisetales than to any other group of Pteridophytes. Considering this, the genus *Equisetum* in its leaves and vascular system and the spiral bands on the walls of sporangia are in common with the liverwort capsule walls are perhaps not without significances.

Considering the paleontological evidences, the whole group of plants like the Pteridosperms and the Sphenophyllales were flourished in very ancient period lacks other representatives except a widely distributed genus. *Equisetum* represented the huge ancient *Calamarias, Lycopodium* and *Selaginella* which also represented the ancient *Lepidodendrons* and *Sigillarias*. Kashyap (1919) emphasized that the diminution is size and the forms, which are superseded would perish out making strange phenomenon if all such forms perish all of a sudden. It can also be assumed that the number of them became gradually reduced before their entire disappearance. Now it can be said that the *Equisetum* or the liverworts are under extinctions, though the Jungermanniales show a flicker before final disappearance. Kashyap's views indeed are excellently presented and Fulford (1948) remarked that this work still remains unnoticed by many hepaticologists.

Kidston and Lang (1917-1921) published some of their works related to the origin of Bryophytes from the oldest Pteridophyte (Psilophytales). These Pteridophytes were in its sporophytic forms, rootless, leafless and dichotomously branched with terminal sporangia provided a good margin to compare with the Anthocerotales (Bryophytes) and also with the vascular plants. Proskauer (1960) explained the thickened columellar surface layer and jacket-lining layer in *Dendroceros crispus* as the vestige of the tapetum which occupies the identical position in the sporangia of *Horneophyton*. Due to similarity in sporangia, many botanists were of the view that the Anthocerotopsida (Bryophyta) may have their origin in reduction from the simplest known vascular plants i.e. the Psilophytales (Pteridophyta). Haskell (1949) considered that " The origin of the bryophyta from an algal ancestry is open to question and they may represent a group originating from Psilophytalean ancestry, following reduction due to their habitat." His conclusion lies in the fact that the bryophyte may be the alternation of Psilophytales and from a group so modified as to end blindly, their position with the pteridophyte is unchanged. Christensen (1954) presented his view that the pteridophyte gave rise to bryophyte due to the following alternative sources:

a. from pteridophytes with leaves on the stem of the gametophyte and that of the sporophyte.
b. from the leafless Pteridophytes as the Rhyniaceae.
c. the bryophytes are polyphyletic, derived from different types of pteridophytes; some are leaf bearing as well.

The previous work on phylogenetic relationships within the mosses (Vitt, 1984) explained three fundamental levels of structural organization, mainly based on the morphology of the capsules. In most pleisomorphic form, the Sphagnopsida capsules open through an apical pore. In the Andreaeopsida, a very small intermediate group, the capsules open through longitudinal valves. In the most derived and diverse linkage, the "true mosses" (commonly classified as the Bryopsida), the capsule is operculate and differentiate a peristome. Characters from the exostome and endostome provided a basis for classification of major groups at the ordinal level and above.

Much more has been revised in this aspect and the modern explicit hypothesis for moss relationships are based on several cladistic analysis related to morphological, ultrastructural and molecular data. Results include the monophyly of the mosses, the inclusion of *Takakia* as a moss sister to *Sphagnum*, and the monophyly of the peristomate mosses. In combination, these recent higher-level analysis provide the first cladistic framework for the major lineages of mosses.

Different lineages are currently recognized (Mishler and Churchill, 1984, Newton *et al.*, 2000), although their taxonomic ranking as classes or subclasses is still controversial. In most cases, higher-level classification of the mosses is not fully settled because there are different names used for the same major clades. A basal split divides the Sphagnopsida, sister to a large clade in which the Andreaeopsida is the most ancestral lineage. Peristomate mosses include three main lineages: 1. Polytrichopsida 2. Tetraphidopsida and 3. Bryopsida. *Ambuchania*, a separate genus closely related to *Sphagnum*, is now classified in its own order and placed as sister to the Sphagnales (Shaw, 2000). *Andreaeobryum*, a genus related to *Andreaea*, is also classified in its own order and placed as sister to the Andreaeales (Newton *et al*,. 2000). In some systems, the Polytrichopsida was considered as the most advanced because of the complexity of the gametophyte (Brotherus, 1925).

1.4. Classification

These thallus bearing plants called bryophytes are not encompassed among other thallus bearing plants like green algae to which they resemble certain features. So they are separated from the division Thallophyta. The features by which the bryophyte can not go to the line of green algae are that they share with the primitive vascular plant Pteridophyte due to the absence of vascular tissue, and domination of the gametophytic generation. The features by

which the bryophyte can not go to the line of green algae are that they share with the primitive vascular plant Pteridophyte Considering all these facts bryophytes have been placed under separate division called the Bryophyta which, in fact, is the intermediate form between the Thallophyta and the Pteridophyta (Vasistha, 1985).

Schimper (1879) was the first to consider bryophytes as one of the well defined group of the plant kingdom. Fourteen years later Eichler (1883) divided bryophytes into two distinct subgroups- Hepaticae and the Musci. Likewise Engler in 1892 again subdivided each of the two classes into 3 orders -. Marchantiales, Jungermanniales and Anthocerotales in Hepaticae and Sphagnales, Andreales and Bryales in Musci.

Rothmaler (1951) advised some slight modifications to the old names. According to his plan of modification, Hepaticae should be changed as Hepaticopsida, Anthocerotae as Anthoceropsida and Musci as Bryopsida. This has been recognized by the International Code of Botanical Nomenclature.

Proskauer (1957) classified the division Bryophyta into three classes Hepaticopsida (Hepaticae), Anthocerotopsida (Anthocerotae) and Bryopsida (Musci). Vasistha (1985) divided bryophytes into three distinct classes namely Hepaticae, Anthocerotae and Musci.

Caver (1976) proposed the division based upon enumeration of the families encompassed in each of the ten orders. The proposed ten orders and their families are:

1. **Sphaerocarpales**: Sphaerocarpaceae and Riellaceae
2.M**archantiales:** Ricciaceae,Corsiniaceae, Targioniaceae, Monocleaceae, Clevaceae, Aytoniaceae, and Marchantiaceae
3. **Jungermanniales:** Aneuraceae, Blyttiaceae, Calobryaceae, Cephaloziaceae, Codoniaceae, Lejeuneaceae, Lophoziaceae, Pleuroziaceae, Porellaceae, Ptilidiaceae, Raduliaceae and Scapaniaceae
4. **Anthocerotales:** Anthocerotaceae
5. **Sphagnales:** Sphagnaceae
6. **Andreaecales:** Andreacaceae
7. **Tetraphidales:** Tetraphidaceae
8. **Polytrichales:** Polytrichaceae
9. **Buxbaumiales:** Buxboumiaceae and Diphysciaceae
10.**Eu-Bryales:** Acrocarpous families followed by pleurocarpous ones. Important families are Bryaceae, Bartramiaceae, Mniaceae and Timmiaceae

Gangulee (1985) classified the class Musci into three subclasses on the basis of peristome structure. They are **Sphagnidae-** Plant aquatic and capsule without peristome teeth (*Sphagnum*); **Andreaeidae** – Acrocarpous moss, capsule without peristome teeth (*Andreaea*) and **Bryidae -** True moss with well developed teeth and consists of the following two

sections viz. **Nematodonteae** (Solid teeth): Buxbaumiales, Polytrichales and **Arthodonteae** (Scaly teeth): Archidiales, Dicranales, Fissidentales, Syrrhopodontales, Pottiales, Grimmiales, Encalyptales, Funariales, Isobryales, Hookeriales and Hypnobryales. Schofield (1985) divided the class Musci into 7 subcasses – Andreaeidae, Sphagnidae Tetraphidae, Polytrichichidae, Buxbaumidae, Bryidae, Archidiidae and class Hepaticae into 6 orders – Calobryales, Jungermanniales, Metzgeriales, Sphaerocarpales, Monocleales and Marchantiales.

Crandall-Stotler and Stotler (2000) divided Jungermanniopsida into two subclasses, the leafy liverworts or Jungermanniidae and the simple thalloid liverworts or Metzgeriidae. The Jungermanniidae comprise at least 85 % of the liverworts species (Schuster, 1984). The classification of Crandall-Stotler and Stotler (2000) also carry conflict with many of the phylogenetic inferences. Notably, Lepicoleales are extensively polyphyletic, and Radulales are nested within the Porellales. Herbertaceae, Lepidoziaceae, Balantiopsidaceae, Cephaloziaceae, Porellaceae and Radulaceae are supported as the monophyletic. Lejeuniaceae are the monophyletic only if *Bryopteris* is included within them. Jungermanniaceae, Gymnomitriaceae, Geocalycaceae, Cephaloziaceae, Lepidolaenaceae are paraphyletic.

Division Bryophyta or mosses, include about 10000 species (Crosby *et al.,* 2000). The most influential classification utilizing Philibert's observations and Fleischer's taxonomic concepts was Brotherus (1924-1925) worldwide synopsis of mosses for Engler and Prantl's *Die natürlichen Pflanzenfamilien*. With minor modifications, the Brotherus system formed the basis for moss classification (Vitt, 1984) until the last five years, during which insights from molecular analysis have accumulated (Buck *et al*., 2000).

Classification by Chopra (1975) and Smith (1996) have been found relevant to my work so are followed here**.**

1.5. Economic Importance

About 70 species of bryophytes are reported economically significant in Nepal, of which, 15 species are liverworts and 55 species of mosses (Pradhan and Shrestha, 2002). Most of the reported species are confined to the Himalayan regions. The economical use of bryophytes in lowland Nepal is still poorly understood. Some parts of west Tarai specially the villagers in Kailali district use mixed species of bryophytes randomly to make mattresses.

Sphagnum (Peat moss) in particular has many uses; it is the major component of the peat used as fuel and compost, as a horticultural substrate, and in the past as nappies and surgical dressings because of its absorbent and antiseptic properties (Glime and Saxena, 1991). During World War First, the Americans and Canadians had used *Sphagnum* in place of cotton bandages due to the possession of its antiseptic properties and also for packing gun powder (Porter, 1917; Hotson, 1918, 1921 and Nichols, 1920). The sphagnum bandage more comfortable for the user, because it is cooler, softer, less irritating and retards bacterial growth (Banerjee, 1974). *Sphagnum* species is also used for the treatment of eye diseases, sources of

food and products of industrial uses such as acetic acid, methyl alcohol, carbonic acid, paraffin, molten wax and lignin used to make plastics.

In bogs and forests, they absorb huge quantities of water, thereby bryophytes are of huge ecological (and therefore economic) importance in Himalayan ecosystems because of their water-storing capacity which act as a sponge and maintain humidity over dry periods and prevent rapid run-off and flooding. Destruction of the Himalayan forests has contributed greatly to run-off and flooding in India and Bangladesh. When mossy forests are logged or thinned they dry out, the bryophytes disappear and the forest cannot store heavy monsoon rains.

Bryophytes are still poorly-known among many people for their sustainable uses despite having in some cases a high medical value. Mosses by their nature are soft and absorbent and in many cultures have traditionally been used as bedding, padding and packing materials.

The traditional uses of bryophytes included treatment for liver ailments, ringworm, heart problems, inflammation, fever, urinary and digestive problems, infections, lung and skin diseases, and as filter and cleansing agent against pollution. They have been traditionary used in China, India and Native America (Glime, 2007). So, moss has a long traditional history of personal hygiene.

More important perhaps are their vital ecological roles. On bare and disturbed ground, they are primary pioneers enabling other plants to get a foothold. Moss cushions also serve as collection points for wind blown seeds forming a natural nursery for forest species and provide a moist foothold for many other plants such as epiphytic ferns and orchids in luxuriant moss forests. They also provide safe home for invertebrates, particularly to insects (Shrestha and Pradhan, 2000). Besides *Sphagnum* many bryophyte species like *Marchantia polymorpha, Marchantia emarginata, Dumortiera hirsuta, Conocephalum conicum, Polytrichium commune, Bryum, Mnium* species, etc are used in various medicines (Glime and Saxena, 1991).

Bryophytes show a wealth of adaptive features to all kinds of climates, substrates and habitats. Many are precise indicators of various rock types like *Tortella tortuosa* on limestone, *Andreaea* and *Racomitrium* on acidic or granitic rocks, *Sphagnum* species on acid bogs, *Ditrichum* species and *Grimmia atrata* on metalliferous rocks and soil and *Dicranoweisia cirrata* thrives mainly on the tree barks of polluted areas. *Dicranum scoparium* is an insect repellent and resists rot; it is also the food plant of rodents (*Myotis schisticolor).*

Frullania muscicola has Sulphur dioxide sensitivity so is used to determine the level of SO_2 in the atmosphere. Next species *Frullania tamarisci* is used to isolate sesquiterpenoids. *Nardia* species and *Blasia pusilla* in their natural state help to prevent soil erosion. *Plagiochasma articulatum* is the food plant of many insects like beetles. Some species of *Riccia* are used in external application to cure skin disease mainly the ring worm. *Riccia*

*natan*s and *Riccia fluitans* are the best known plants for aquarium. *Brachythecium revulatum* helps in the deposition of iron ore. Banerji and Sen (1979) studied antibiotic activity of 52 species of bryophytes belonging to 40 genera against some micro-organisms. *Brachythecium procumbens, Asterella sanguinea* and *Marchantia palaecea* showed the broadest spectrum of antibiotic activity. Similarly, *Dumortiera hirsuta* carries antibiotic property and is active against *Candida albicans*. *Brachythecium salebrosum* due to its light and insect resistance properties is useful for wrapping up soft fruits in the Himanchal Pradesh of India. Capsule of *Bryum argenteum* is the chief diet for the Norwegian grouse chicks; it is a pollutant- resisting species, can tolerate high level of Zinc content and is also used in bonsai.

Eurhynchium rapirioides is highly valued for analyzing heavy metal compositions in the rivers. It is also used by the aquatic birds for the construction of their quality nests. The protonema, leafy shoots and immature and mature capsules of *Funaria hygrometrica* and *Brachythecium rutabulum* are used as food for slugs (Davidson *et al*., 1990). *Brachymenium exile* is a good indicator of soil Ph besides its use in bonsai. *Rhodobryum roseum* is used for the treatment of the cardio-vascular diseases and nervous prostration. *Oncophorus wahlenbergii* is a rare moss and has been found highly sensitive to air pollution. *Ceratodon purpureus* has surface stabilizing properties, and is a well known pollutant resisting species. *Hypnum cupressiforme* carry antifungal and antibacterial effects. *Climacium dendroides* is loved by western women to decorate their hats.

1.6. Global Diversity of Bryoflora

There are about 21,000 species of bryophytes in the world (Rashid, 1998). Schofield (1985) has estimated the occurrence of nearly 8000 species of liverworts, 10,000 species of mosses and 400 species of hornworts in the world. Among the total species (16,600 spp.) described by Wilson (1988 & 1992), Chaudhary (1999) estimated 853 species of bryoflora in Nepal. Crosby *et al.* (2000) recorded 12,800 species of mosses (under 901 genera) in the world. Similarly Crandall-Stotler and Stotler (2000) recorded 6000-8000 species of liverworts under 380 genera in the globe. Shaw *et al.* (2005) used taxonomic and molecular data to test the hypothesis that the diversity of moss is highest near the equator and also mentioned that the species richness of mosses are more in the tropics than higher latitude.

The Bryoflora of Asia is not very well known. The total number of moss taxa in East Asia has been estimated (Shaw *et al.*, 2005) more than 2000 species representing nearly 1/5 of the world total moss diversity. Extensive work has been done on the bryophytes of China and utilization of many of the species in various ways has also been done in this country. The next neighboring country India which borders to the Nepalese lowland has also been studied extensively on bryophyte taxonomy and distribution. Many north Indian Bryophytes keep special significances for their extension to the Nepalese lowland territory as well. Common Bryophytes like *Frullania* spp., *Riccia* spp., *Bryum* spp., *Marchantia* spp., etc also extend their distributional range to the Indian plain. Many of the Indian lowland species are similar to

Nepalese species which occur below 1000 m of elevation. So the distribution of Indian bryophytes keeps special significance as many of them are also extended into Nepalese lowland areas.

Extensive work has been done on bryophytes of China and utilization of many of the species in various ways has also been done in this country. Piippo (1990) and Zhu and So (1996) had recorded 2150 species of mosses and 889 species of liverworts from China. The next neighboring country India which borders to the Nepalese lowland has also been studied extensively on bryophyte taxonomy and their distribution and recorded 2584 species (O'Shea, 2003). Similarly, the diversity of moss species in Bangladesh is 183 species (O'Shea, 2003), Bhutan has 235 species Long & Grolle (1990), Maldives with 298 species (Menzel & Passow-Schindhelm, 1990), Pakistan 339 species (Higuchi and Nishimura, 2003) and Sri Lanka 568 species (O'Shea, 2002).

1.6.1. Diversity of Bryoflora in Nepal

Bryophytes are found growing plentiful on tree trunks, stones, walls, caves, canals and exposed areas. The epiphytic mosses are more abundant in the lower portion of trees but gradually decrease towards the top. The moss population is higher in the eastern belt than the central and western zones. This is due to the fact that the monsoon rain in June and August gradually retards from the eastern to the western regions. The physiography plays vital role in the richness of moss species in a particular place. The dominance of broad leaved forest of *Schima-Castanopsis* in upper limit of subtropical zone and *Quercus-Rhododendron* in temperate zone provide luxuriant growth of bryoflora.

The checklist of bryophytes of Nepal enlisted 307 species of liverworts, 766 species of mosses and 8 species of hornworts (Pradhan, 2000a). The established Nepalese data base contains the records of 1150 species. The low land Tarai where my study was conducted represented 213 species 90 genera under 40 families and are incorporated into this thesis draft. The 2000 IUCN World Red list of Bryophytes includes 92 species, of which Nepal represents four species recorded mainly from the higher elevations in the east and none from the lowland regions. They are *Andrewsianthus ferrugineus*, *Diplocolea sikkimensis*, *Scaphophyllum speciosum* and *Takakia ceratophylla* (Tan *et al.*, 2000).

Kattel and Adhikari (1992) have indicated that about 7.1 % of the total moss flora in the country are distributed in tropical zone, 42.5 % in the subtropical zone, 70.8 % in temperate zone, sub alpine has 44.8 % and alpine has 21.9 % of the total moss species. So the maximum diversity of moss flora also occurs in the temperate zone within the altitudinal limits of 2000-3000 meter.

With respect to the altitudinal distribution of Hepaticae about 367 species of liverworts are found in Nepal (Kattel, 2002). This includes 17 species in tropical region, 153 species in sub-

tropical, 246 species in temperate, 186 in sub-alpine, 99 species in alpine and 16 species in nival zones. This shows an increased diversity in the lowland to temperate and decreased towards higher mountain regions.

Biodiversity Profile Project (BPP, 1995) has enumerated 61 species of Bryophytes (8.4 %), 81 species of Pteridophytes (21.32 %) and 1885 species of Angiosperm (36.53 %) in Tarai and Siwalik as shown in Fig. 1 and Fig. 2 respectively.

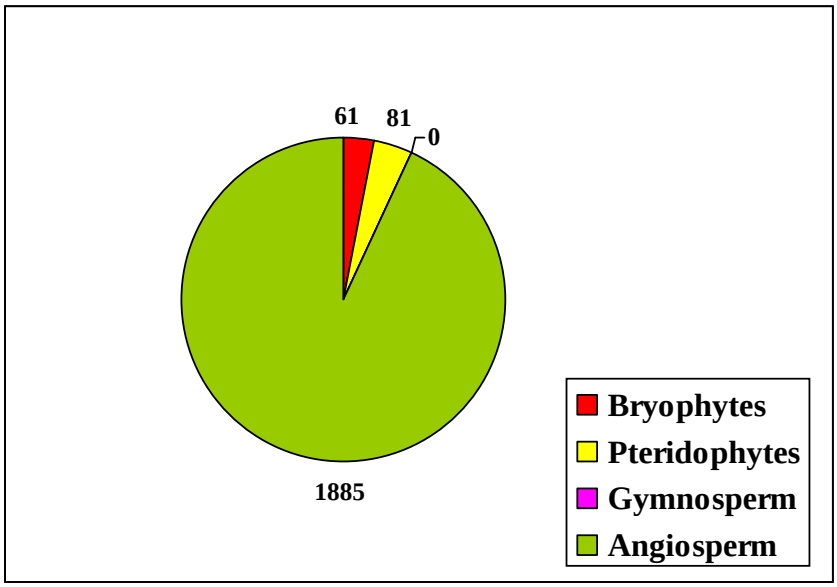


Fig. 1. Number of Floral species in Tarai and Siwalik range

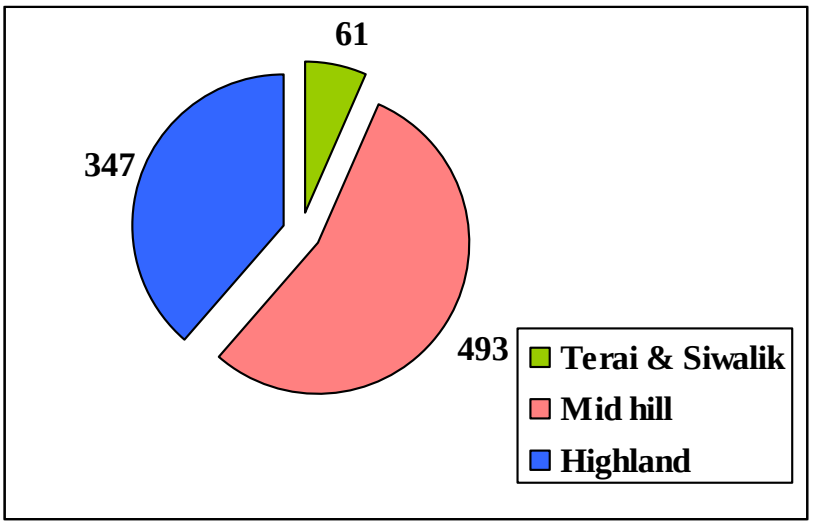


Fig. 2. Distribution of Bryoflora in Tarai and Siwalik by Physiographic Zones

1.7. Justification/Hypothesis

The southern lowland has its own bryofloral components adapted to warm climate type. In Nepalese context which has remarkable phytogeographical differences from 60 m to above 6000 m represent different biogeographical regions where variation in the diversity of bryoflora can be noticed very distinctly. Considering this fact, Tarai and Siwalik regions are also a distinct biogeographic regions where lowland species are adapted well in warm and humid climatic conditions.

My research was carried out with an expectation to come up with significant consequences which include a complete documentation of bryofloral species of lowland belt (below 1000 m), their distribution and conservation status. This study which lasted for five years completed all its objectives very successfully.

As compared to back history, this region now is highly pressurized by anthropogenic causes. Massive hectares of forested lands were ruthlessly destroyed for human settlements, road constructions, agricultural and industrial purposes. Such practices may have wiped out many bryophyte species putting them into vulnerable status. There is no any previous record to use for baseline data that can be compared to find out the exact number of species lost due to destructions.

Analyzing status category of every reported bryophyte is the next important aspect of this study. Status report made in this study is very interesting which showed 112 species as rare, 30 new report, 62 species common and 20 species are fairly common to this region. This data can be used for future references with regards to the study of lowland and Siwalik bryophytes of Nepal.

To determine the distributional range of every reported species is also an aspect of this research. Species like *Frullania muscicola, Jungermannia hyalina, Mylia taylorii, Nardia assamica, Reboulia hemisphaerica, Targionia hypophylla, Philonotis fontana, Thuidium cambifolium* and many species of *Bryum* were found sharing both habitats of lowland and highland areas. The species like *Monosolenium tenerum, Riccia glauca, Didymodon constrictus, Sphaerotheciella sphaerocarpa* showed very narrow distributional range and were restricted to certain microhabitats only.

I adapted very simple methodology in this study. The direct observation and collections of the materials were done in the field across lowland strip of the country. To assess Tarai bryophytes, many relevant literatures and herbarium specimens were consulted. All the possible help of the bryologists from Nepal, India and the UK were also taken for this purpose. In this research, documents of the Chinese, Indian, Malaysian, Thai and Japanese bryophytes were also consulted.

My interest to select lowland Nepal (Tarai and Churia Hills) basically is connected to ongoing urbanization process which may deplete many of the species before they are being documented, as no extensive research has been done nor has established any baseline data of this region so far. What kind of conservation measure is required and what can be done to meet this measure are the next aspects for this study.

1.8. Objectives

1. To collect, describe and identify bryophytes of lowland Nepal and develop identification Keys.

2. To describe ecology of bryophytes of lowland Nepal (below 1000 m).

3. To assess major habitats for bryophytes in lowland.

4. To assess rare, endangered and threatened bryophytes of the study-area and suggest required conservation measures.

5. To make complete documentation of bryophytes found in lowland areas.

2. Review of Literature on Nepalese Bryophytes

2.1. Early Period (1800-1950)

Early works on bryophytes of Nepal are very few and concerning literatures are correspondingly sparse. The pioneer work for Nepalese bryophytes was that of Dr. Buchanan-Hamilton who did remarkable study in central Nepal mainly in the Kathmandu Valley during 1802-1803. The first account on mosses of Nepal, W. J. Hooker's *Musci Nepalensis* (1808) comprised a list of 17 species recorded from various localities of the country. Wallich (1832), a Danish physician and botanist who made his collection within Kathmandu and adjoining areas had contributed to the Wallich Catalogue (1828-1832) which included 114 species of mosses of various status. These specimens were deposited in the Kew under the tag of Wallich Collection. Royle (1839) had published the catalogue of in his *Illustrations of the Botany and other branches of Natural History of the Himalayan Mountains* which contain the list of 114 species of mosses collected by Wallich mainly from Nepal and 55 species of his own collection made from western Himalayas.

The first major collecting trips were organized during 1850 -1900. Hooker in 1848 collected a great number of mosses from the east Himalayas, in which he described three new mosses from the Royle's collections.

A comprehensive account of mosses of Indian region with reference to Nepal was published by Mitten (1859). This is indeed the first broad systematic treatise on this group of plants found in Nepal and India both. He assigned 85 genera and about 800 species of Musci categorized under 19 families including many new species proposed by Mitten himself. His record included 187 species of moss from Nepal, representing 52 genera. This account comprised with the collection of Hamilton, Gardner and Wallich from Nepal.

Schiffner (1899) described the liverworts collected by Durel and Labor during British-Bhutan Expedition especially at the altitudes of 1515 m and 1820 m. Schiffner's monograph on liverworts covered species from India, Burma, and Sri Lanka including 35 species from Nepal, of which 10 species and 2 varieties were new to the science.

Anon (1912) mentioned some of the Hooker's collections made from the Himalayan region of Nepal.

During the next 50 years, International researchers continued to venture into the less explored regions of the country. Stephani (1900-1927) studied the World monograph on Liverworts where he dealed with a description of large number of Hepatic flora from India, Burma, Sri Lanka and Nepal. He had done a brief work on Nepalese bryoflora in 1925 and reported a

total of 62 species of Hepaticae under 32 genera and published in his book "Species Hepaticerum" (1924-27). Dixon (1925) studied the materials collected by Somervell during his Mt Everest expedition (1924). Notable additions to the Nepalese flora from this material were *Grimmia somervillii* from the Rombuk Valley (4850-5300 m) which was described as new to science and the interesting record of *Aongstroemia julacea* at 6,530 m, an altitude considered as the highest collection of a moss ever been made in this world. Blatter (1929) recorded 119 species of mosses of the High wavy Mountain and Mt. Abu of India of which 25 species are found in Nepal.

Bruhl (1931) recorded 141 species of mosses from Nepal; Kashyap (1924, 1934) mentioned some potential sites for liverworts in Nepal. Dixon (1937) recorded 202 species of mosses from Assam State of India. Seventy-seven species of this record also occur Nepal.

2.2. Mid Period (1950-2000)

In 1952, British Museum (Natural History) Expedition took place to Nepal mainly the western region and their route included Jumla, Humla, Jajarkot, Syalyan districts. The team members were J.D.A. Stainton, W.R. Sykes, L.H. Williams and O. Polunin. They collected many bryophyte specimens from Mugu, Jumla, Baglung, Pokhara, Chume of western region which were handover to S. K. Pande (India) for identification. In the same year (1952-1953), Japanese west Nepal expedition collected few specimens of bryophytes along with higher plant species. In 1952-1954, Geneva Expedition to Nepal (Kathmandu Valley and Koshi basin, eastern Nepal) took place. Zimmerman's collections made in this expedition were described by Noguchi (1964).

Horikawa (1955) reported 41 species of mosses belonging to 31 genera and 15 families which are mentioned in his *Fauna and Flora of Nepal Himalaya.* He had also reported *Ptychanthus strictu*s of Lejeuneaceae at the elevation of 960 -3800 m of central Nepal.

Svihla (1956) studied Frullaniaceae of Burma, of which she recorded *Frullania arecae* and *Frullania neurota* from Nepal.

Pande (1957) published a tentative list of liverworts of Nepal on the basis of the specimens collected by them. In the same period (1952-1954) Zimmermann collected mosses from eastern Nepal, which later was published by Noguchi (1964).

Banerji (1958) made a remarkable report of *Anthoceros erectus* and *Anthoceros gollanii* from eastern Nepal. In additions to this, he also reported 29 species of liverworts from the same area. He described some interesting features of *Plagiochasma cordatum, Plagiochasma nepalensis, Plagiochasma articulatum, Conocephalum conicum, Pellia epiphylla*, *Metzgeria hamata* and *Dumortiera hirsuta.* Norkett (1959) made a short note on Himalayan mosses and reported *Orthomnium bryoides* (W. Griff.) Norkett for the first time in east Nepal.

An Indian Mountaineering Expedition to the Cho Oyu Himalaya of 1958 collected 37 packets of bryophytes at 1900 to 5200 meter mainly in temperate and alpine zones of east Nepal. About 36 species of this collection were enumerated by Wadhwa and Vohra (1965) and made *Racomitrium heterostichum* as a new report to Nepal. Bharadwaj (1961) studied morphology of *Anthoceros erectus* of India. This species previously was reported in eastern and central Nepal at 1300-1600 m. Chen (1962) in his publication on the Bryophyts of Mount Jolmo Longma (Mount Everest) mentioned 107 species which also included collections of Chinese Expedition of 1958-1960.

During 1961-1962, bryologists of the British Museum (Natural History) collected some 2900 specimens of bryophytes (Norkett, 1962) in eastern Nepal. Norkett also collected some low altitude species of *Fissidens* like *Fissidens curvato-involutus* (Butwal-Tansen, 300 m), *Fissidens ceylonensis* var. simplex (Tumling Tar, 550 m), *Fissidens diversifolius* (Tumling Tar, 500 m), *Fissidens diversifolius* var. *diversifolius* (Tumling Tar, 500 m), *Fissidens geppii* (Begnas lake, 600 m), *Fissidens marginatulus* (Tamur river, 950 m) *Fissidens minutus* (Ghopa Camp, Dharan, 200 m), *Fissidens subbryoides* (Ghopa Camp, Dharan, 200 m) etc. Various studies have concluded the occurrence of 42 species and 7 varieties of *Fissidens* in Nepal (Pradhan and Joshi, 2006).

The only known report of *Pholia leucostoma* (Bryaceae) was collected by Norkett in 1961 at 550 m of Tumling Tar. The rare species of Hypnaceae is *Hypnum albescens* and was reported at 550 m in the Dobhan-Tamur River by Norkett (1962). Among Musci, *Bartramidula bartramioides* occurs at 1000 m to 1920 m in Rabong La-Temi and Sangu of the east. *Bartramidula royle* (Syn: *Philonotis royle*), was reported at 285 m to 3000 m in Dobhan of the east (Norkett, 1962).

Gangulee's work (1963) was remarkable indeed. His study enumerated about 10 species and 5 genera of east Indian Leucobryaceae which also included nine species collected by Wallich in Nepal. Noguchi (1964) studied mosses on Zimmermann's collections made during Mt Everest and Gauri Shankhar expeditions of 1954 and 1956 respectively.

Grolle (1964) transferred *Jamesoniella carringtonii* into *Plagiochila carringtonii*. *Plagiochila carringtonii* subsp. *lobuchensis* is restricted to Nepal and was recorded at Mahalangur Himal of Khumbu in east Nepal at an altitude of 5100 m collected by Poelt in 1962. Similarly, *Plagiochila poeltii* and *Plagiochila recurvata* are mentioned endemic to Nepal (Grolle, 1964).

Kuwahara (1965) gave an account of 8 species of *Metzgeria* including a variety of *Apometzgeria* of eastern Himalayas. *Metzgeria harae* has been described as new species from Nepal. Inoue (1965) studied a synopsis of *Plagiochila* of the Himalay including that of North-western India, Sikkim, Nepal and Bhutan. His synopsis included 9 species of *Plagiochila*

from Nepal. In 1967, he again studied *Plagiochila* of Himalaya and recorded 8 species of *Plagiochila* all from Nepal except *Plagiochila dichotomoramosa* of Sikkim and Bhutan.

Noguchi *et al.* (1966) made a list of 169 species of bryophytes including mosses, liverworts and hornworts collected by Dr. Yoda, a member of Himalayan Expedition of the Chiba University in east Nepal in 1963.

Three major Expeditions were organized by the University of Tokyo, Japan. The result of the first Expedition to central and eastern Nepal was published by Noguchi in 1967 which included 258 species mosses under 113 genera and 34 families collected by the members of the expedition and was published in *Flora of Eastern Himalaya* Vol.I. Hattori (1967a) included one species of Anthocerotae, 55 genera and 199 species under 28 families of Hepaticae collected in the same expedition (1960 and 1963) in Sikkim and east Nepal, were published in the "*Flora of Eastern Himalaya,* Vol. I. The second Expedition of the University of Tokyo took place in 1969 and focused on bryophytes mainly of central Himalaya. During this expedition, 147 species of mosses under 32 families were reported in central Nepal and this report was compiled and published separetely by Hattori (1971) and Noguchi (1971). The 1972 Expedition of the University of Tokyo to eastern Himalaya included three species of hornworts, 214 species of liverworts and 301 species of mosses. The report was published by Noguchi and Iwatsuki (1975a, 1975b). *Bryoerthrophyllum noguchianum* from Thudam was described as new to science.

Grolle (1966a) published a list of Nepalese liverworts based on Prof. Josef Poelt's collection made in 1962; the report contained 10 new species and one new genus *Poeltia* of family Gymnomitriaceae. He also included 39 Types, 3 syntypes and one Lectotype species of Nepal. Grolle (1966b & 1974) listed 171 species of Nepalese Hepatics, which later was revised into 266 species. His list included 39 species described mainly from Nepalese specimens.

Amakawa made a series of publications on Asiatic species of Jungermanniaceae in 1960, 1967, 1970 and 1972. In this study in 1967, he mentioned *Jungermannia macrocarpa* and *Jungermannia kanaii* reported from eastern Nepal and *Jungermannia truncata* in 1972 from Nepal.

Among the series of publications on Porellaceae made by Hattori (1967b, 1969), *Porella revoluta, P. plumosa, P. pariharii* var. *ligurifera, P. densifolia* spp. *appendiculata* and *P. setigera* (Syn. *Madotheca nepalensis*) were recorded in Nepal.

Mizutani (1967a) studied 12 species of Himalayan *Bazzania* from the collections of Zimmermann (1952). Mizutani (1967b) also studied some series of Asiatic Lejeuneaceae which included description of *Cheilolejeunea* and *Pycnolejeunea* and *Cheilolejeunea giraldiana* had been recorded from Nepal.

Among the moss species mentioned by Vohra (1970), *Thuidium meyenianum* occured at 200 to 240 m in the Dharan of east Nepal. Similarly, *Rhytidium rugosum* is well distributed above temperate region in the west. Udar (1976) reviewed previous works on hepaticae and musci separately and included many of the Nepalese species as well.

Hattori and Amakawa (1971) proposed Nepalese species of *Horikawaella* of Jungermanniaceae for Hepatic of Sikkim, previously it was classified as *Anastrophyllum subacuta* Herz. They also have discussed some additional species found in Nepal. Hattori (1972) made a remarkable note on distribution of *Folioceros glandulosus* in Nepal. According to him, *Folioceros glandulosus* is distributed vertically at 800 m to 1150 m in Birgaun Dingla of east Nepal.

The genus *Lejeunea* of Himalaya was described by Mizutani (1971) where he described 12 species of which 11 species were from Nepal. Mizutani (1972) reported the occurrence of *Drepanolejeunea monophthalma* at 1000 m to 2850 m in the eastern districts of Terathum and Taplejung. Next species, *Lejeunea tuberculosa* occurs between 940 m to 1250 m in Sanjuri Bhanjyang, Arun Khola to Num in the east. This species grows on trunks of *Schima wallichiana*. *Mastigoleujenea humilis* has been recorded at 200 m to 1100 m of Dharan and Dingla forests. Mizutani (1972) made his study on some little known species of Hepaticae (Lejeuneaceae) from Stephani's collection. He also revised nomenclature of some Lejeuneaceae species. Mizutani (1973) also studied *Ricciocarpus natans* and recorded the growth of sporophytes by culturing in water tank, which can be seen in the paddy field of Kathmandu valley during monsoon period.

Plagiochasma appendiculatum with abnormal receptacle was reported for the first time in Rajasthan of India (Bapna, 1971). Schustor (1971) recorded the abnormal receptacle of *Plagiochasma appendiculatum,* and also discussed its correct phylogeny which is very common in tropical and sub tropical regions of Nepal.

Vana's (1972a) miscellaneous notes included 16 species of Asiatic Jungermanniaceae reported from different regions of Asia and in the same year (1972b) recorded 22 more species of Jungermanniaceae which also included 6 species from Nepal.

Kashyap (1972) in his book mentioned some of the potential liverwort sites of Nepal. Noguchi (1972) collected mosses during Thai-Danish Expeditions held in 1958-1963. Of the reported 97 species, 11 species were recorded as new to Nepal.

Hattori *et al.* (1973) studied *Takakia* of Nepal, the same year Inoue (1973) studied chromosomes in *Takakia ceratophylla* collected from east Nepal.

Hattori (1979) in his work on *Frullania* of Sri Lanka has included *Frullania polyptera* and *Frullania ericoides*, both exist in the lower parts of east Nepal. *Frullania physantha* which is found in Nepal also extends its range to North Vietnam and India.

Chopra (1976) published an account of the majority of the mosses found in the Indian subcontinent (India, Nepal, Pakistan, Bhutan, West, east and South Tibet). He included 328 genera and 1200 species of mosses in his book. Udar and Singh (1976) described *Cyathodium tuberosum* from the Darjeeling (East Himalaya) district of the India. Later, its status was found common in Nepal (Manandhar, 1982).

In 1977, the Himalayan Expedition of Chiba University visited many localities of eastern Nepal. During this Expedition, Takiguchi, a team member, collected 500 packets of hepatics and a large number of mosses from the lowland (340 m) to the alpine zone (4700 m). Mizutani (1979a) later published the record of hepatics which included about 128 species of liverworts. Among them, *Haplocladium parvulum* and *Ctenidium campylophylloides* were new to science and the result of mosses was compiled and published by Iwatsuki (1979a) which were deposited in Hattori Botanic Laboratory (NICH), Japan.

The Kochi Himalayan Expedition to the Annapurna area, central Nepal was made in 1976. During this expedition, Kunisawa collected 400 specimens of Hepaticae and 1519 specimens of mosses. This report included two new species of *Pylaisiella* for Nepal. This result was compiled and published seperately by Mizutani (1979b) and Iwatsuki (1979b).

Shrestha (1977) presented an account on the distribution of *Anthoceros* species (Anthocerotaceae) of lowland Tarai. *Anthoceros chambensis* and *Anthoceros punctatus* both occured in Trisuli (545 m) of central Nepal.

Hattori and Thaithong (1978) made remarkable account on *Frullania* species collected from India, Pakistan, Nepal, Burma and Singapore and also provided detail description of *Frullania pariharii.* Lal and Parihar (1979) in their published work included some of the species found in Nepal. These include *Frullania muscicola, Frullania ericoides, Mastigolejeunea obfusca, Ptychanthus striatus* and *Mastigolejeunea humilis*.

Karezmarz (1981) listed 10 hepatics and 38 mosses collected during an excursion to central and eastern Nepal. Manandhar (1982) made floristic study of liverworts and other thalloid bryophytes of Kathmandu Valley. Her collections included five species of Anthocerotae and 16 species of Hepaticae (Marchantiales). This study was a contribution to the bryophytes of Kathmandu Valley made by a Nepalese bryologist.

Renliang (1983) mentioned 29 taxa (27 species and 2 varieties) of Chinese *Entodon* with their keys and sketch diagrams. Of them, five species had already been reported from Nepal,

Entodon caliginosus (Hooker, 751) and *Entodon prorepens* (Wallich, 752) were the Type species of Nepal deposited at the American Museum of Natural History, New York.

Kumar and Udar (1985) described *Jamesoniella nipponica* collected from the Himalayas. This species also occured at 3446 m in the Ghunsa forest (Taplejung) of the east Nepal collectyed by Long in 1989.

Pradhan and Joshi (1986) worked on liverwort flora of Kathmandu Valley, which included a total of 16 species collected at different localities of the valley. Among them, three species were reported as new to the country.

In 1986, the Botanical expedition to central and eastern Nepal was organized by the National Science Museum, Tokyo in August to October, 1986 and August to November of 1988. Higuchi and Takaki collected 5540 specimens of bryophytes in this expedition and the result was jointly published in 1990. This included 228 species of mosses collected from Tarai to alpine region of central and east Nepal Higuchi and Takaki (1990). In this study, Takaki (1988) recorded about 18 species of mosses from Kathmandu valley. Of them, four were new reports to Nepal. Higuchi & Takaki (1988) jointly reported 15 Hypnanceous mosses in the same area. Inoue and Higuchi (1990) studied chromosomes of some Hypnaceopus mosses of Nepal.

In 1988, another Botanical expedition organized by the National Science Museum, Tokyo made a good collection of liverworts in Nepal. The report of this expedition was published by Mizutani *et al.* (1995) and. Furuki and Higuchi (1995) respectively.

Srivastava and Singh (1988) added two more species of *Jungermannia* to the list of Himalaya. These were *Jungermannia fauriana* and *Jungermannia stephanii*.

Series of expeditions organized by the Royal Botanical Garden, Edinburgh took place in various years like 1989, 1991 1992 and 2001 and were concentrated mostly in the eastern and central regions of Nepal.

Ochi (1990) reported 29 well recognized bryoceous mosses from the different areas of Langtang Valley of central Nepal. Most of these specimens were collected at 3700-5200 m.

Plagiobryum duthiei is a new species of moss described from Nepal by Heddepson and Harold (1990). So far it is known restricted to two localities of Nepal and can be distinguished from all other congoneries by its circular neck and exostome with a well developed reticulum below outer surface and densely papillose enstostomal segments.

Long and Grolle (1990) published about Bhutanese Hepaticae in which they have recorded 2 species of Anthocerotae and 235 species of Hepaticae. Of them, 237 and 166 species from Bhutan and Nepal respectively which are included in their paper.

In a published list of endemic plants of Nepal, 31 species of bryophytes collected from different elevations of the country have been mentioned (Joshi & Joshi, 1991). Chaudhary (1998) recorded about 30 species of endemic bryophytes in Nepal, of which four species were mosses. Kattel (2002) listed slightly higher number of endemic species which includes 33 liverwort species.

Watanabe & Higuchi (1991) mentioned *Thudium magnisporum* (Musci), a new report to Nepal. Deguchi and Higuchi (1992) recorded Grimmiacae of Nepal which was collected during the botanical expeditions of National Science Museum, Tokyo.

Nath & Asthana (1992) added *Frullania neurota* to the bryoflora of west Himalaya. This is an epiphytic liverwort which was previously reported at Batasay- Bhuspate Danda (2300-2600 m) of the east. and Langtang National Park of central Nepal collected by Higuchi in 1988 and the specimen is deposited in TI.

Kattel & Adhikari (1992) published a checklist of Nepalese mosses which included a total of 559 species. The tropical, subtropical, temperate, sub alpine and alpine zones included about 6.4, 38.1, 64.9, 41.1 and 20 % of the species respectively. According to them, the maximum diversity of mosses occured in the temperate zone at 2000-3000 meter.

Grolle and Vana (1992) described 9 species of *Jungermannia* from Nepal of which *Jungermannia conchata* collected (Long, 16779) at Ghunsa Khola (4100 m) which is located between Rambuk valley and Kamboche of east Nepal. This is a Type species, a new report to Nepal.

Long (1993) reported a minute hepatic, *Sphaerocarpus stipitatus* from the unexplored Barun Khola Valley, this was growing upon eroding soil, locally restricted to 3920 m. This was collected during Makalu-Barun Expedition (1991) of the Royal Botanic Garden, Edinburgh.

Record of sixteen Nepalese *Frullania* taxa have been made by Yuzawa and Koike (1994) which were collected by Higuchi from Nepal. *Frullania pseudoshenxiana* var. *darjeelingensis*. *Frullania asposinensis*, *Frullania parihar*i and its form *intermedia* are new records to Nepal and *Frullania higuchi* is described as new to science.

Furuki and Long (1994) described a new species *Aneura crateriformis* upon Nepalese specimen. This was reported on the rock cliff at 4440 m of Sankhuwasabha district of east Nepal (Long 20915, 1991).

One of the remarkable work of Long (1995) included the review of sixty new taxa published in *Musci indici* which comprises 28 new species based mainly upon the materials of Nepal. Its authors, types and localities were also reviewed.

Higuchi and Long (1996a) reported 18 species of mosses from eastern Himalaya and Yunnan during their expeditions of 1975 and 1990. Among 18 species reported by the authors, nine were found endemic to Nepal. The diverse hypnaceous mosses collected mainly from Nepal, Bhutan and China were studied by Higuchi and Long (1996b). They also included Nepalese specimens collected by McBeath and Foster. All these specimens have been deposited in the Herbarium section of Royal Botanic Garden, E and TNS.

Chiang (1997) reported *Miehea indica* (Dixon) Ochyra as new genus to China and also recorded its distribution in Nepal. Ochyra (1989) recorded it as a Type species of Nepal in the name of *Miehea himalayana* Ochyra which is the synonym of *Miehea indica.*

Grolle and So (1997-1999) worked on the diversity of *Plagiochila* occurring in China. Their findings were published in several papers. In 1997, they published 11 species of *Plagiochila,* of which 9 species were new to China and 5 species were known from Nepal. Among Nepalese species, *Plagiochila hyalodermica* and *Plagiochila oblonga* are the Type species from Nepal. They again (1999a) made the record of 8 species of *Plagiochila* from China which included two species from Nepal. Their next paper (1999b) described and illustrated two new species of *Plagiochila* viz. *Plagiochila defolianus* and *Plagiochila grossa*. The former is an endemic species to China and later is the Sino-Himalayan species which occurs mainly in Yunnan and east Nepal. This was collected by Long in 1979 at 1980 m to 2350 m. In the same year (1999c), they recorded 13 species of *Plagiochila* of the Section Contiguae from east and south Asia. This included three species from Nepal. Munoz (1998) described *Grimmia ochyriana* J. Munoz as new to Nepalese Himalaya collected from the type locality in Nepal.

Higuchi and Zang (1998) discussed taxonomic relation of *Takakia ceratophylla* on the basis of anatomical and morphological studies of Chinese specimens. This species was reported in the east Nepal.

Long (1999a) described *Asterella grolle,* a new species from Nepal and China is allied to *A. saccata, A. muscicola* and *A. palmeri*. This has been collected from Sankhuwasabha (3735 m) of east Nepal. Long (1999b) reported *Vittia grandis* (Splachnaceae) as new record to Nepal, Yunnan and Qinghai of China. This was collected at 4330 m of Yalung Valley and 4630 m in Lhonak of east Nepal (Long, 17074, 16867).

2.3. Recent Era (2000 on-ward)

Zhu and So (2000) studied Lejeuneaceae of China which also included *Lopholejeunea sikimensis* Steph collected in Nepal (Mizutani, 1976 and Mizutani *et al.*, 1995). Zhu and Long (2003) published an account of 44 species of Lejeuneaceae, which were categorized into 17 genera. All these materials were collected from the Himalaya including Nepal, Bhutan, west Bengal and Sikkim. About nine species were reported new to the Himalaya. Among the mentioned 44 species, 34 species were collected from Nepal which also included seven new species.

About 480 species of *Plagiochila* are reported in Asia, of which, 132 are the recognized species and 110 are the endemic species. Many of the species included in this list are collected from Nepal (So and Grolle, 2000).

Higuchi *et al.* (2000) recorded *Haplomitrium hookeri* new to China. They also mentioned its distribution in Nepal. It was previously reported by Long from the Ghunsa Khola (3440 m) of east Nepal.

Contribution of Pradhan (2000a) included an enumeration of eight species of Anthocerotae, 306 species of Hepaticae and 767 species of Musci recorded from various localities of the country. The endemic and type species have also been included. In the same year (2000b), the author recorded 111 species of mosses and 30 species of Hepaticae from Phulchowki hills of central Nepal.

Potemkin (2000) recorded three new well defined and evolutionary interesting Type species of *Scapania* viz. *Scapania pseudocontorta, S. spiniloba* and *S. zhukovae,* which were collected by D.G. Long in Sankhuwasabha district of east Nepal in 1991. *Scapania davidii* was previously reported from the east Nepal (Long, 16980, E, TNS).

About 38 species of bryophytes under 25 families were reported from the Swayambhu hill of Kathmandu Valley (Pradhan, 2001). A brief work of Baniya (2001) came up with 17 species of mosses occurring in Abies spectabilis forest in the Kaski district of the west. In 2001 Edinburgh Nepal Expedition took place in Langtang Area and collected about 500 specimens of bryophyte (emphasis was paid upon liverworts).

Long (1999, 2001 and 2005) published a series of paper on Asiatic genus *Asterella.* His study mentioned the occurrence of six species of *Asterella* in Nepal. Long (2001) described four species of *Asterella* viz. *Asterella wallichiana, Asterella leptophylla, Asterella khasyana* and *Asterella mussuriensis* from the collections made at Langtang National Park of central Nepal. Ghimire (2001) precisely presented the data on *Acrocryphaea concavifolia, Brachythecium buchanani, Bryum nitens, Hyophila comosa, Stereophyllum tavayense, Taxiphyllum taxirameum,* etc. occurring below 1000 m in Nepal. Likewise, *Anomodon minor, Barbella enervis, Barbella pendula, Barbula javanica, Funaria hygrometrica, Pogonatum clavatum*

and *Sphagnum nepalensis* are distributed in the hot climate of tropics to 2000 meter of temperate areas. Kattel (2002) enumerated 387 taxa of liverworts and 8 species of hornworts under 41 families and 106 genera. A list of endemic species has also been included.

An extensive work on bryophytes of the Bardia National Park was done by Pradhan (2002) which brought out a list of 16 species of Hepaticae and 16 species of Musci, *Fissidens asplenioides* was reported as new to the country.

A brief survey of Townsend (2002) provided a list of 20 species of mosses from the Royal Chitwan National Park. Greven (2002) mentioned the occurrence of 10 species of *Grimmia* at 2688-5400 m in Lukla to Mount Everest base camp of the east. He had collected *Grimmia longirostris* in the Gorak and Kala Pattar at 5,350 m. This has been said to be the highest record of *Grimmia* species known so far. Pradhan and Shrestha (2002) listed about 70 species of economically important Nepalise bryophytes collected from different localities of Nepal. Pradhan (2005, 2007) published on the multiple utilities of bryophytes and diverse benefits of peat moss of Nepal

Pradhan and Shrestha (2003) enumerated 233 species of alpine bryophytes occurring above 4000 m of elevation mainly in eastern and central regions. Grolle *et al.* (2003) mentioned a new genus *Gottschelia* (Lophoziaceae) from Nepal. This specimen was collected by Long in 1991 from the Jaljale Mountain (3880 m) of east Nepal and was previously thought to be the species of *Anastrophyllum*, now it has been named *Gottschelia patoniae* Grolle, a new report to east Himalaya.

Anastrophyllum minutatum is the smallest known species and occurs mainly in the central and eastern Nepal at 3440-5050 m, the greatest ecological amplitude among the collected species (Schill and Long, 2003). The distribution and occurrence of *Anastrophyllum* in Sino-Himalayas region is still very fragmentary and many regions are still unexplored or poorly known (Long, 1979). The highest elevation for liverworts is achieved by *Anastrophyllum assimile*, which reaches upto 5450 m (Kattel, 2002).

Blockeel *et al.* (2003) published new national and reginal bryophyte records, contributed by bryologists of different countries. Long and Sollman (2003) contributed *Paraleptodontium recurvifolium* (Taylor) D.G. Long, a moss collected in Sankhuwasabha district at 2600 m (D.G. Long, 20577). This report constitutes the first record to Asia, the Himalayas and Nepal.

Pradhan (2004) published a list of bryoflora collected in Chitwan and Nawalparasi districts of central Nepal.

Ji *et al.* (2005) described *Neckera noguchiana* Ji *et al.* as a new species for Nepal which was collected at Dor-Chitre (2500 m) of east Nepal in 1972. This species resembles with *Neckera denigricans* of Vietnam.

Wilbraham and Long (2005) studied the genus *Zygodon* and *Bryomaltaea* (Orthotrichaceae) in the Sino-Himalaya region which recorded 3 species of *Zygodon* and one species of *Bryomaltaea* from Nepal. *Zygodon rupestris* collected in Sankhuwasabha district of east Nepal (Long 20749) has been recorded as new to Nepal.

Long (2005) recorded 24 species of Hepaticae during an expedition to east Nepal, organized by the Royal Botanic Garden of Edinburgh, U.K. Three species viz. *Geocalyx lancistipulus, Tritimeria quinquedentata* and *Tritimeria scitula* were reported as new to Nepal Himalaya and other 17 species new to Nepal.

Long (2006a) in the next series of Himalayan Hepaticae presented 21 new species collected from the Sino-Himalayan region, among them, *Cryptomitrium himalayense*, *Blasia pusilla* and *Cyathodium cavernarum* are reported as new to Nepal. The third species *Cyathodium cavernarum* was collected at 1400 m of Kathmandu Valley, Long and Pradhan 28918 (E). Long (2006b) described 69 taxa of *Asterella* under different names from Europe and Asia, of them five species showed the Type Locality of Nepal.

Boonkerd *et al.* (2007) published a note on *Asterella khasyana* of Thailand which also included its distribution in Nepal. This species is moderately common in lowland of Nepal.

Grau *et al.* (2007) explored species richness of liverworts and mosses in central Himalayas of Nepal (100-5500 m) and compared this distribution pattern with ferns and flowering plants. They recorded that the community changes of bryophytes vary greatly with changing altitudes in the Himalayas. Pradhan and Joshi (2007b) published an updated list of bryophytes occurring at the lower belt which included 115 species collected mainly from the east, central and western Tarai. Pradhan and Joshi (2008a) published a list of bryoflora of Dang district of midwest Nepal. In the same year (2008b), they made a diversity account of Bryaceae of Nepal.

3. STUDY AREA

3.1. Physiography

Nepal stands at the latitude of 26°22’ and 30° 27’ North and longitudes of 80° 40’ and 88° 12’ East. This country occupies a small position between China to the north and India to the south, east and west. The east-west strip of this country measures 800 km which is parallel to the main Himalayan axis compared to the average north-south width which is about 140 km only. The total area occupied by this country equals to 147,181 sq. km. The physiographic feature is very interestingly displayed with the lowest known elevation of 60 m (Kechana, Jhapa) to 220 m in the east and south which finally is elevated to the maximum elevation of 8848 m (Mount Everest) to the north.

Varied climatic and edaphic factors act effectively to bring about significant changes in the ecosystems and habitat types in Nepal. The published record of the Department of the Medicinal Plants estimates the occurrence of about 3940 species of vascular plants (of which 375 Pteridophytes, 19 Gymnosperms and 3546 Angiosperms) in this country. According to Chaudhary (1999), about 40 % of the species are still beyond exploration. Botanists of British Museum, based upon their extensive researches, have estimated the occurrence of 7000 species of flora in the entire nation. Press *et al.* (2000) mentioned the existence of 6,500 species of flowering plants in this country.

The classification of Stearn (1960) followed distinctly the climatologically floristic and ecological data, dividing the country into three major regions viz. west (longitude 80°40’-83°0’E), central (Longitude 83°0-86°30’E) and east (longitude 80°30’-88°12’E). Hara *et al.* (1978-1982) adopted this phytogeographical division in his *An Enumeration of the Flowering Plants of Nepal*, Vols 1-3. Banerji (1963) also classified this country into three main divisions. His floristic division based absolutely upon the major rivers like Karnali, Gandaki and Koshi.

3.2. Physiographic Division and Forest Types

According to major forest types, Nepal has been divided into the following five zones on the basis of elvational ranges and bioclimates (Chaudhary, 1999), such as Tropical Zone (1000 m), Subtropical Zone (1000-2000 m), Temperate Zone (2000-3000 m), Subalpine Zone (3000-4100 m), Alpine Zone (4100-5000 m), and Nival Zone (above 5000 m).

3.2.1. Tropical Zone

Tropical zone encompasses major areas of Tarai, Siwaliks, Duns and southern Mahabharat ranges. This zone is located below 1000 m where humid and deciduous forests are widely

spread in Tarai and Dun valleys. The major tree species of this zone are *Shorea robusta, Adina cordifolia, Terminalia tomentosa, Dalbergia sisoo, Acacia catechu,* etc. The main bryoflora of this region are *Bryum nitens, Bryum coronatum, Entodontopsis* spp,. *Fissidens* spp., *Hyophila involuta, Trachyphyllum influxum, Hypnum pleumaforme, Thuidium tamariscellum,* etc.

According to BPP (1995f), the biological diversity present in the Tarai and Siwalik keeps international significances both for globally threatened wildlife and endangered floral elements. Considering valuable biodiversity of Tarai and Siwalik, Nepal Government has established five protected areas in these regions. These include Koshi Tappu Wildlife Reserve (East), Parsa Wildlife Reserve (Central) Chitwan National Park (Central), Bardia National Park (Midwest) and Suklaphanta Wildlife Reserve (Far west).

There are altogether 118 ecosystem in Dobremez's classification (1970). Of which, 23 ecosystem types are occupied in Tarai and Siwalik regions and 15 are included into the current protected areas of Tarai and Siwalik regions.

3.2.1.1. Tarai plain

This region extends roughly to 800 km in the east-west direction paralleling the neighboring Indian borders. The total area covered by the Tarai is just 17 % of the entire country. This region is very fertile where 48 % of the Nepalese population inhabit. The forest cover is very rich and dense, mostly confined to the western parts. The average altitude of the Tarai ranges from 100-300 meter from the mean sea level.

3.2.1.2. Churia Hills (Siwalik)

Siwalik or Churia extends between 700 to 1500 m along mid horizontal axis of the country. This newly formed mountain system encloses warm valleys of the Bhitri Madesh (Inner Tarai). These hills are crisscrossed by several north-south directed rivers enclosing many wide and flat valleys. Siwalik is very popular for rich fossilized remnants of the pre-existing flora and fauna. The well known 8-12 kilometer strip or *Char Koshe Jhadi* (Four miles long forest) is the characteristic feature of this region

3.2.2. Subtropical Zone

Subtropical belt is extended between 1000 to 2000 meter at the southern strip of the country. *Schima -Castanopsis* forest is fairly common in the east and central parts while *Pinus roxburghii* is popular in the west. Major floral components of this zone are *Schima wallichii, Castanopsis indica, Rhus succedanea, Maesa chisia,* etc. The bryoflora of this region are *Marchantia polymorpha, Asterella walliachiana, Cyathodium tuberosum, Targionia hypophylla, Bryum argenteum, Rhodobryum giganteum, Babulla javanica, Bartramidula bartramiodes, Funaria hygrometrica, Haplocladium angustifolium,* etc.

3.2.3. Temperate Zone

This zone lying between 2000 -3000 m is under the influence of cold climatic condition. The temperate region has interesting moist and deciduous forest with *Aesculus indica* (Chestnut) and *Acer caesium* as the main components. Other trees found here are *Abies spectabilis, Quercus dilatata, Betula* sp., etc. Representations of the coniferous forests are *Cedrus deodara, Pinus wallichiana, Cupressus torulosa, Picea smithian*a, etc. Among bryophytes *Brachythecium formosanum, Bryum argenteum, Polytrichum commune, Pogonatum microstomum, Campylopus* sp., *Sphagnum cuspidatulum, Sphagnum nepalensis, Mnium confertidens, Thuidium cambifolium,* etc. are popular in this region.

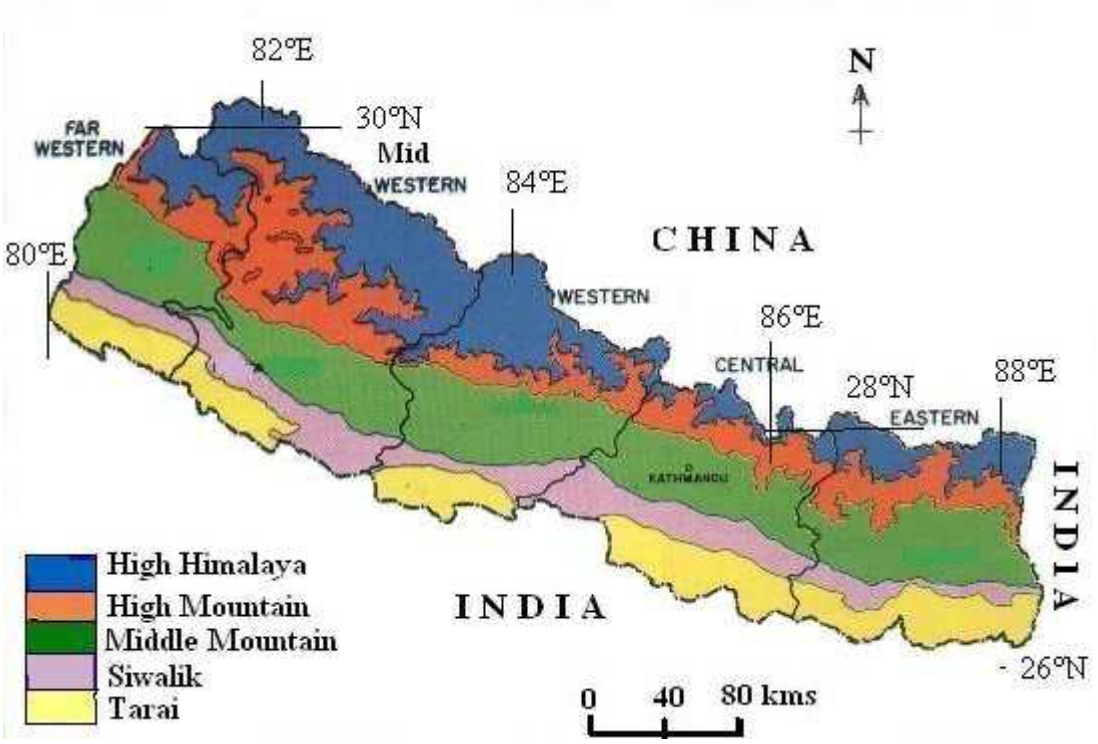


Fig. 3. Physiographical Regions of Nepal

3.2.4. Subalpine Zone

Subalpine zone lies within 3000 to 4100 m to the north. A good growth of *Abies spectabilis, Rhododendron barbatum, R. campanulatum, Juniperus* spp., etc. can be seen here. *Andreaea rupestris, Blasia pusilla, Brothera himalayana, Dicranum gymnostomum, Polytrichum juniperinum, Pohlia cruda* and *Jungermannia* spp. are the main bryofloral species of this region. The 2000 IUCN world Red Listed species viz. *Andrewsianthus ferrugineus, Diplocolea sikkimensis, Scaphophyllum speciosum* and *Takakia ceratophylla* are also recorded in this region (Tan *et al.*, 2000).

3.2. 5. Alpine Zone

The alpine zone is located over 4000 meter to the north. This zone comprises mainly the stunted growth of *Juniper-Rhododendron* and *Caragana-Lonicera* forests. The green and lustrous meadows represent varied flora like *Primula* spp., *Potentilla* spp., *Gentiana* spp., *Saxifraga* spp., *Saussurea* spp. etc. Bryoflora of this region are *Bryum pallescens, Campylopus handelii, Plagiochila retusa, Polytrichum alpinum, Rhacomitrium crispulum, Sphenolobopsis minutus*, etc.

3. 2. 6. Nival Zone

The nival zone is located above 5000 meter to the north. Mosses and lichens can be seen scattered over snow melted rocks, cliffs etc. The bryophytes recorded are *Bryum argenteum* (5,100 m), *Marsupella commutata* (5200 m), *Grimmia longirostris* (5,350 m), *Pohlia microstoma* (6,250 m), *Aongstoemia julacea* (6,530 m), etc.

3.3. Selected Study Areas/ Research Sites

Study on the distribution of bryophytes occurring below 1000 m is the main objective of this work. Major lowland districts in the east, central, west and farwest have been taken into account. Varied physiographical conditions, forest types and potentiality of the areas are the basic parameters considered for site selection. Maps of every collected regions from the east to the west of the country is provided in Appendix VI.

Table. 1. Table showing the collecting sites in different lowland districts

S. No	Zones	Districts	Area (Sq. km.)	Adjacent Districts	Potential sites	Geographical Location	Main Bryofloral Vegetation
Far Western Region							
1	Mahakali	Kanchanpur	2742	Kailali, Doti, Dadeldhura	SWR, S.N Campus area, nearby forest, Attariya	28°32'-29°8' N 80°3'-80°33' E	*Phaeoceros, Asterella, Entodontopsis, Fissidens*
2	Seti	Kailali	3235	Doti, Bardia, Surkhet, UP (Ind.)	Ghodaghodi Lake, Tikapur and Garden	28°22'-29°0' N 80°3'-81°15' E	*Asterella, Riccia, Jungermannia, Trematodon*
Mid Western Region							
3	Bheri	Bardia	2025	Banke, Surkhet, Kailali, UP	BNP, Chisapani, Guleria; Bhudigaon and forested areas	28°07'-29°29' N 81°03'-81°41' E	*Anthoceros, Plagoechasma, Barbula, Sematophyllum*
4	Bheri	Banke	2337	Bardia, Surkhet, Dang, UP	Chisapani Kha, Daurali, Chepang Post	27°50'-28°20' N 81°29'-82°80' E	*Marchantia, Jungermannia, Targionia, Fissidens*
5	Rapti	Dang	2337	Salyan, Rolpa,	Bhaluwang, Koilabash, Rapti	27°57'-28°21'N 82°20'-82°53'E	*Riccia, Asterella,*

				Pyuthan, Argakhanchi, Banke, UP	river sides, Tulsipur		*Marchantia, Bryum, Fissidens*, etc.
Western Region							
6	Lumbini	Rupandehi					
7	Lumbini	Palpa	2743	Kapilbhastu ,Nawalparasi ,Rupendehi, Tanahun, Syanja	Dobhan, Tansen, Srinagar	27°34'-27°57'N 83°15'-84°22'E	*Marchantia, Heteroscyphus, Bryum, Fissidens, Barbula*, etc.
8	Lumbini	Nawalparasi	935	Palpa, Rupendehi, Chitwan, Arghakanchi	Kawasoti, Triveni, Narayani river banks	27°21'-27°47'N 83°36'-84°23'E	*Anthoceros, Heterocyphus, Bryum, Fissidens*, etc.
Central Region							
9	Narayani	Chitwan	2239	Siwalik and Mahabharat ranges, Nawalparasi, Tanahun, Parsa, India	CNP (Tiger Top, Sauraha, Barandavar), Upprang Gadhi, Shaktikhor, Siddhi	27°21'-27°52'N 83°54'-84°48'E	*Anthoceros, Plagiochasma, Pallavicinia, Acrolejeunea, Pogonatum, Hypnum*, etc.
10	Narayani	Makwanpur	2236	Rautahat, Bara, Parsa, Kathmandu, Dhading, Chitwan	Hetauda-Bhindravan, Bhaise, Rapti river sides, Siwalik areas		*Folioceros, Riccia, Dumortiera, Bryum, Fissidens*, etc.
11	Narayani	Parsa	1203	Bara, Makwanpur, Chitwan, India (S).	PWR, Pathlaiya, Amlekhganj, field at Birgunj	27°26'N 83°38'-84°27'E	*Phaeoceros, Phelonotis, Hypnum, Entodontopsis*
12	Narayani	Bara		Parsa, Makwanpur, Rautahat, India (S)	Simrangad, Kalaiya, Canal sides, Sal forest.		*Riccia, Plagiochasm, Trematodon, Phelonotis*
Eastern Region							
13	Janakpur	Dhanusa	1219	Siraha, Udaypur, Sindhuli, Mahotari, India (S)	Dhanusa Dham, Jaleshwor, Lal Bandi	26°35'-27°05'N 85°52'-85°20'E	*Riccia, Marchantia, Trematodon, Phelonotis, Trachyphyllun*
14	Sagarmatha	Siraha	1013	Dhanusa, Sindhuli, Udaypur, Saptari, India (S).	Lahan, sides of highway	26°33'-26°55'N 86°60'-86°27'E	*Phaeoceros, Marchantia, Sematophyllum, Hypnum, Thuidium*
15	Koshi	Sunsari		Saptari, Udaypur, Bhojpur, Morang, India (S)	KPWR, Dharan, Inaruwa, Jhumka	26°23'-26°55'N 87°05'E	*Phaeoceros, Marchantia, Bryum, Hypnum, Thuidium*
16	Koshi	Morang	1914	Sunsari, Bhojpur, Ilam, Jhapa, India (S)	Belbari, Tarahara, Singhya river, Khanar	26°20'-26°53'N 87°16'-88°41' E	*Phaeoceros, Hypnum, Anoectangium*
17	Mechi	Jhapa	1532	Morang, Ilam, India (E, S)	Bhadrapur, Damak,Gaura Daha	26°20'-26°30'N 87°39'-88°12'E	*Bryum, Hypnum, Trachiphyllum*

Source: Modified after Aryal *et al.* (1982)

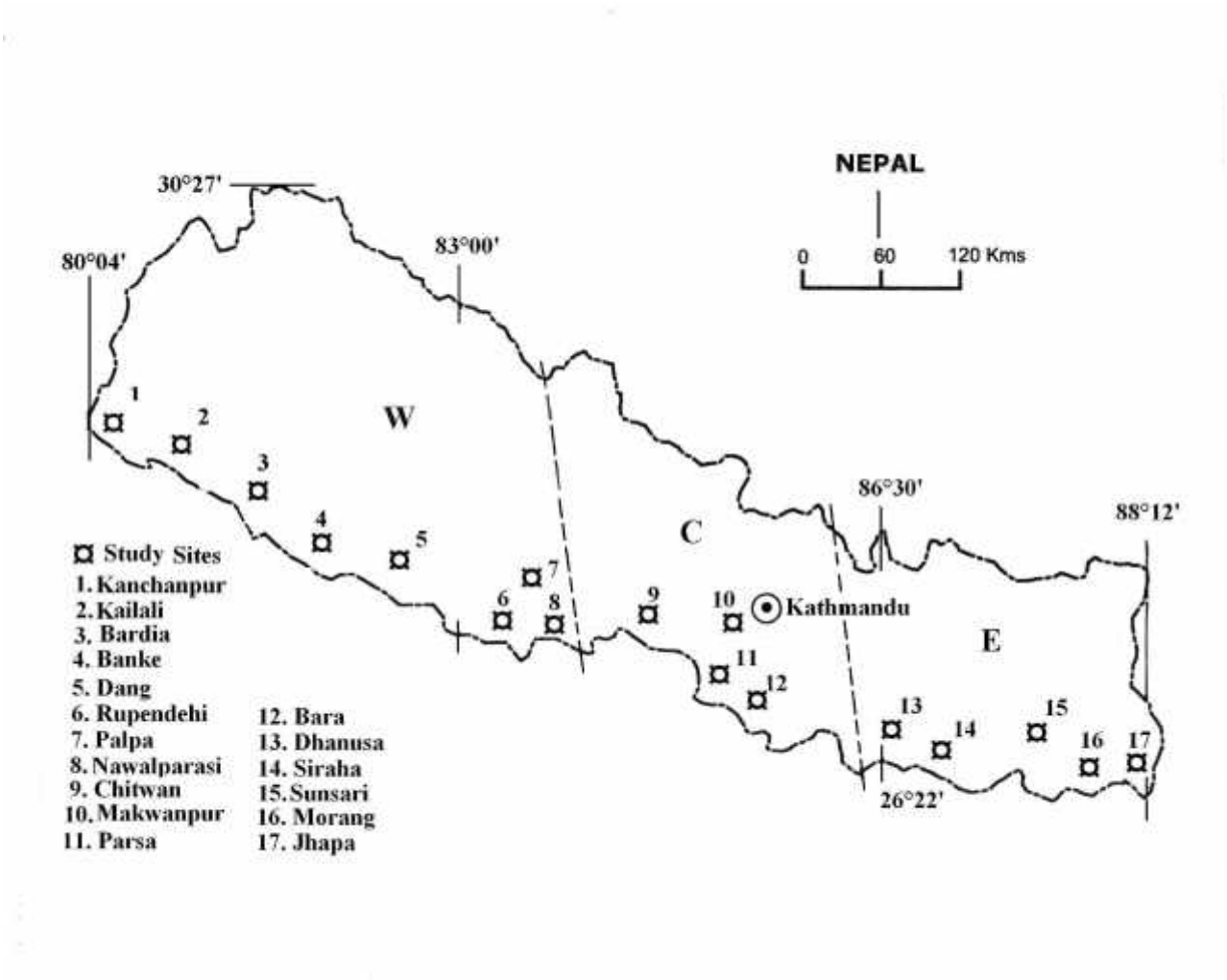
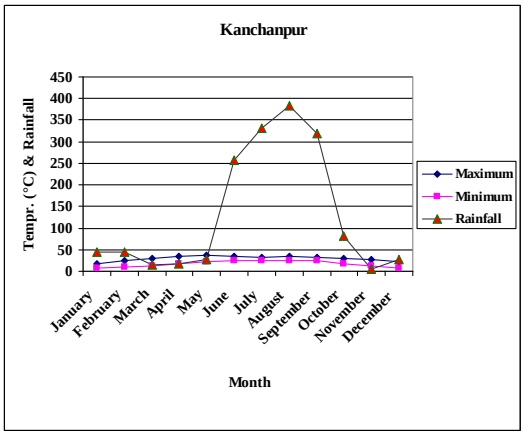


Fig. 4. Map showing specific areas selected for the present research

3.4. Climatological Records of Some Lowland Districts (below 1000 m.)

The climate in the study area is generally dry in October to April, warm in April to June and the rainy season starts from July to Septermber. The ombrothermic graphs of the climatological data (maximum and minimum temperature in °C and rainfall in mm) of four districts of the western region are presented here from 2001-2004. Chitwan to the central lowland and Morang to the eastern region are the representative districts indicated here in the graphical forms. Similarly, the ombrothermic graphs of western districts like Kanchanpur, Kailali, Banke and Bardia are also presented here based upon the average climatological data available so far from 1995-2004 (Adhikari, 2002 & Statistical Data of Nep. Govt., 2004)



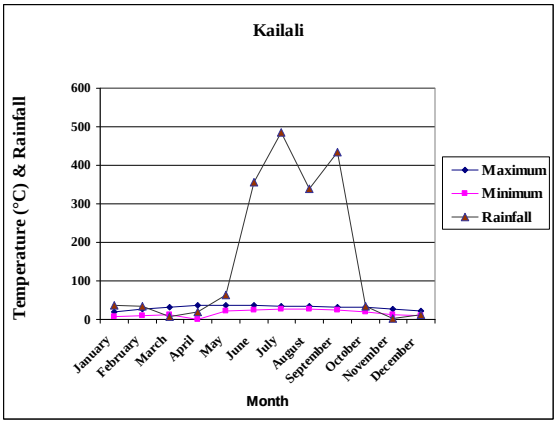
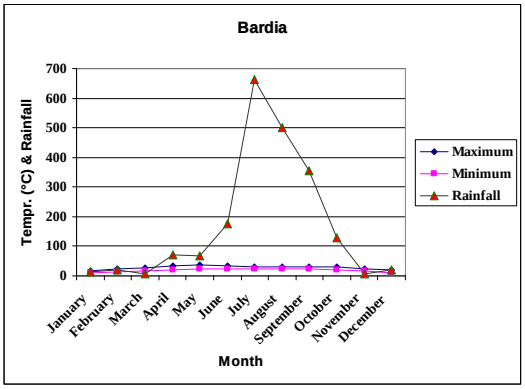


Fig. 5. Ombrothermic Graph of Kanchanpur District Fig. 6. Ombrothermic Graph of Kailali District



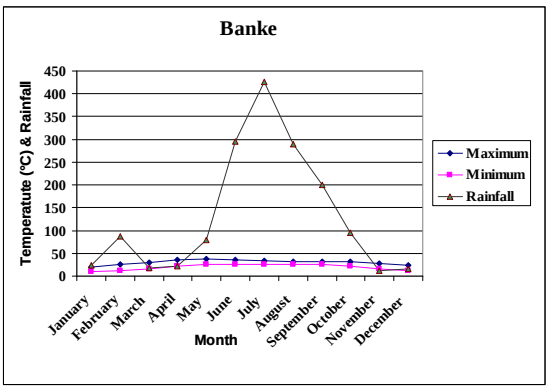
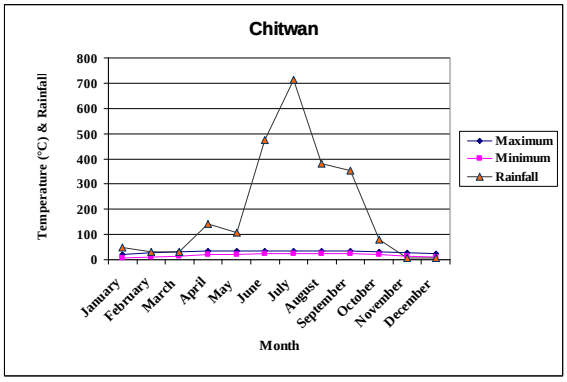


Fig. 7. Ombrothermic Graph of Bardia District Fig. 8. Ombrothermic Graph of Banke District



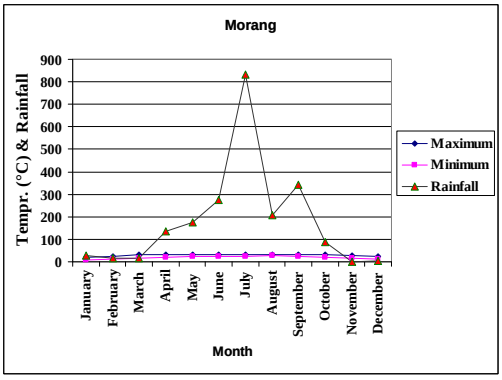


Fig. 9. Ombrothermic Graph of Chitwan District Fig. 10. Ombrothermic Graph of Morang District.

4. MATERIALS AND METHODS

4.1. Reconssaince of sites

Previous studies conducted with Nepalese bryophytes were not frequent and mostly elevated lands of the eastern and some central regions were covered by various International Botanists especially from Britain and Japan. The vast areas of lowland strip are still untouched with regards to the survey of this plant. This encouraged me to make a detail study on the bryophytes of lowland Nepal (below 1000 meter) which I decided to convert it into my PhD. thesis research.

The central and eastern lowland represent suitable habitats for various rare species. These regions represent sporophytic growth of bryophytes in November to February and rest of the period they remain as gametophytes.

4.2. Field trip

A systematic study was done at the lowest known elevation of 62 m of Jhapa district of the east to the Siwalik hills (1350 m) in Dang District, on the way to Pyuthan of west Nepal. Their distribution are mentioned in Appendix 1V. The collections were made in various seasons and are sub-divided into different phases. The collected specimens examined in this work is provided in Appendix V.

The western districts visited in connection to this study are Kanchanpur, Kailali, Banke, Bardia, Dang, Butwal, Palpa and Kaski. The districts of central region covered are Chitwan, Nawal Parasi, Makwanpur, Bara, Parsa, and Kavre. The eastern districts of Dhanusa, Sihara, Morang, Sunsari and Jhapa are undertaken for this study.

4.2.1. Western Region (below 1000 m)

First trip: January 11, 2001- January 28, 2001. (Collection No.: NGS1- NGS 335).
Second trip: June 2, 2001- June 4, 2001 (Coll. No.: NGS 336-NGS 357).
Third trip: July 6, 2001-15 July 2001 (Coll. No. NHM 1- NHM 45)
Fourth trip: October 28, 2001- November 10, 2001. (Coll. No.: NGS 358 - NGS 575).
Fifth trip: February 23, 2003- March 6, 2003 (Coll. No.: Br 1 - Br 144).
Sixth trip: May 25, 2003- June 7, 2003. (Coll. No.: NGS 376 - NGS 709).

4.2.2. Central Region (below 1000 m)

First trip: December 6, 2003 – December 22, 2003 (Coll. No.: Pn 1 - Pn 287).
Second trip: October 30, 2004-November 12, 2004 (Coll. No.: Pn 288 - Pn 455).
Third trip: November 13, 2005 – November 26, 2005 (Coll. No.: NP 1 - NP 65).
Fourth trip: April 14, 2006- April 27, 2006 (Coll. No.: c456- c509)

4.2.3. Eastern Region (below 1000 m)

First trip: June 1, 2002-June 10, 2002 (Coll. No.: dt 1 - dt 36)
Second trip: August 11, 2002- Auguast 20, 2002 (Coll. No.: dt 37 - dt 95)
Third trip: December 23, 20030 January 4, 2004 (Coll. No.: dt 96 - dt 241)
Fourth trip: February 16, 2005- March 2, 2005 (Coll. No.: dt 242 - dt 386)

4.3. Tools and Chemicals Used For Collection

Collecting bryophytes were extremely simple and basic equipments were sufficient to scrape out the specimens from substratum. The following equipments and chemicals were used in collection, preservation and identification:

4.3.1. Equipments

Pocket knife, wood chisel, hammer, forceps, hand lens with magnifying power 5X-15X, paper packets, labeling cards, blotting papers, polythene bags, rubber bands, collecting net, measuring scale, dissecting microscopes, compound microscope, oculo-micrometer, glass slides, cover slips, fine bristle painting brushes, needles with plastic handles, dropper, dropping bottles, petri plates, paper boxes or wooden boxes, etc.

4.3.2. Chemicals

The chemicals used for the experimental work are: Formalin, Glycerol, Acetic acid, Ethanol, Phenol, Cotton blue, Oxyquinolin Sulphate, Gelatin Powder, Gum Arabic, Chlorals hydrate, etc.

4.4. Collection

Moist and humid habitat generally play crucial role to maximize species richness of bryophytes in Nepal. Many parts of the tropical forests where this research was conducted include humid areas with high rate of species variations.

November to February is the best season for collecting bryophytes in lowland Nepal. Almost all the species during this period were in sporophytic forms. Most of the specimens used in this research were collected during this season across lowland belt of the country. Another season with a burst of sporophytic production is the late summer to autumn. Major rainfall occurs during this period in Nepal.

Some species attached themselves very firmly to the substratum, so a general tool was used to detach them from the substratum. Very simple equipments were used to collect bryophytes in the field. Common knife and a carpenter’s wood chisel were used mostly to scrape bryophytes growing on rocks or barks. For specimens growing on decaying woods, a simple knife was

used to cut or peel off patches of bryophyte colonies from their substratum. The aquatic specimens were collected by direct hand pulling method and the floating forms were taken out from water courses by using insect nets.

Those specimens with much soil adherence were made loose by washing under the flow of water. This might be difficult with hepatics, which could damage sporophytes seriously upon washing. Aquatic specimens of bryophytes generally have considerable amount of extraneous matter attached to them. Such specimens were rinsed carefully before they were dried off. In aquatic moss, the excessive water was carefully squeezed out by hands. Very keen attentions were paid upon the brittle stems and sporophytes.

The collected specimens were teased loose from each other, made free from the extraneous debries including loose fragments of soil. They were then flattened out in natural position to air dry in the room temperature keeping them between the blotting sheets. Most of the bryophytes should not be placed under high pressure when they are under drying process. Such pressure often ruptures sporophytes and destroys some of the critical morphological features of the specimens. So precaution should be taken with delicate materials.

4.5. Preservation

Both dry and wet preservation methods were followed in this work.

4.5.1. Dry Preservation

All the collected specimens in the field were placed separately into paper packets made from the used photo copy papers and old newspapers. When they were completely dry and free from debries were changed into new paper packets measuring 10 x 15 cm size for longer preservation.

4.5.1.1. Preparation of Improved Paper Packet

These packets were made with standard metric size letter sheets (210 x 300 mm or 21 x 30 cm). The paper was folded so the bottom edge was 11 cm from the top edge. The two sides of the paper folds were 3 cm flaps. The top portion (8 cm) was folded downward to make a flat fold over the lower flat portion. This made a complete closed paper packet of 10 x 15 cm size which was ready for enclosing the specimens (Fig 11). Each of the paper packets were labeled with important information as shown in (Fig.12).

Polythene bags were used normally in the field for collecting larger quantities of specimens. These were changed immediately into new paper packets when brought in the labortory. Specimens collected in plastic bags tend to decompose or decolorize sooner if the specimens were kept for longer period. The thoroughly dried specimens were preserved in well labeled

paper packets. They were arranged in row treating like files in the shoe-boxes or any wooden boxes or in pigeonhole cupboard.

4.5.2. Wet preservation

Some of the delicate vegetative thalli of hepaticae were preserved in wet solution mainly for anatomical study. The preservatives used were 4% Formalin, FAA Solution (Formalin 5 ml. Glacial acetic acid 5 ml. and 70 % Ethyl alcohol 90 ml.) and 50 % Ethanol. For museum display, the hepatic specimens with sporophytes were preserved specially in specimen bottles and rectangular jars containing 4% of formalin solution. A pinch of Oxyquinolin sulphate saturated in water was used in the field for wet preservation.

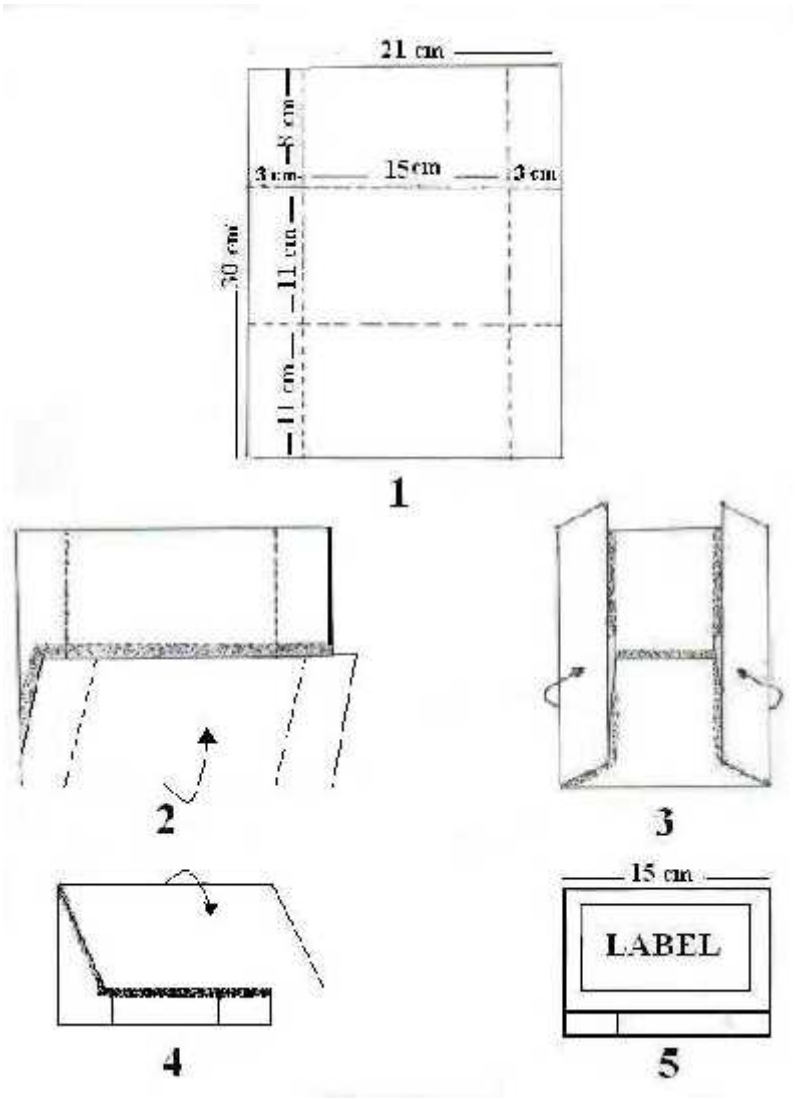


Fig.11. Steps in making a paper packet. 1. Size and folding lines indicated, 2. Fold up lower ½ of sheet, 3. Fold inward the two sides, 4. Fold down the front flap, 5. Final packet.

Table. 2. Label showing the important information on Field Data

Bryoflora of Nepal	
Accession No.	Collection No.
Date of collection:	
Latin name:	
Common/Vernacular name:	
Family:	
Locality:	District:
Altitude:	
Latitude/Longitude:	
Field notes:	
Collector(s):	
Determinavit:	Date:

4.5.3. Filing and Storage

The dried specimens in paper packets were placed upright like file cards. Generally small boxes like shoe boxes or any other wooden boxes were used to put these specimens. They were arranged alphabetically and familiwise. Every paper packet contains label tag in which complete field data was written as shown in Fig. 14. The small sized paper packets were not used because they may be hidden between the larger one. Bryophytes are immune to insect pest, they have certain ingredient of chemical Sesquiterpenoids that protects specimens from being attacked by insect. Cockroaches and silver fishes destroy sporophytes of dried specimens when they come to feed upon glue. Generally, Naphthalene balls were used to repel them out.

4.5.4. Anatomical Study

Anatomical study was made under dissecting microscope. All the distinguishable features were noted down with sketchings of anatomical structures. For the anatomical study, thin sections of the thalli or stems were made with a sharp razor blade by freehand or using pith or pressing them between two glass slides. The cut sections were placed in petri plates containing clean water. The thin and unbroken section was selected and kept upon dried glass slide with a drop of water or stain (Cotton blue) on it. Finally, a cover slip was placed carefully upon the slide where the thin cut section was positioned. The internal structures of

the specimens were then noted under 15 x 10 and 15 x 40 diameters of magnification of a compound microscope.

The internal structure of leaves of leafy liverworts and mosses can be studied directly without taking their section being their semi translucent nature. The oil bodies present in leafy liverworts, cell sizes and spores were measured in micro mew (mμ). The value of μ was calculated by using following methods:

4.5.5. Calibration of micro meu (mμ):

For 15 x 10 Power

10 division of Stage micrometer = 10 division of Oculo-micrometer
1 div. ……. = 1 division of Oculo-micrometer
1 div. …… = 11.33/1000 = 0.01133 mm

1 mm = 1000 μm
0 .01133 mm = 1000 x 0.01133 μm
= 11.33 μm

Therefore, 1 division of Oculo-micrometer = 11.33 mμ

For 15 x 40 Power

10 division of Stage micrometer = 40 division of Oculo-micrometer
= 40/10 division of Oculo-micrometer
= 4 division of Oculo-micrometer
4 division of Oculo-micrometer = 11.33/4 mμ

Therefore, 1 division of Oculo-micrometer = 2.83 mμ

4.5.6. Mounting Media for Temporary Slide

For quick identification, the wet material (cross section of thallus, stem, leaves) were placed in glass slide with a drop of clean water and observed under microscope. The temporary slides were stained with Cotton blue and mounted in Lacto-phenol. This was added directly to the wet leaves or transverse section of the thalli or stems of mosses on the microscopic slides and a cover slip was placed carefully over it. A single drop was found sufficient to stain a complete material. If the stain amount was found excessive, the extra stain was removed by sucking slide with a piece of blotting paper or a paper napkin.

4.5.6.1. Cotton Blue

It was used for staining and mounting bryofloral section with hyaline structures.
This fluid was prepared with the following ingredient-

Polyvinyl alcohol (PVA) ----- 1.66 g
Distilled water ……..…….. 10 ml.
Lactic acid …….. …… 10 ml.
Glycerin …….. 1 ml.

PVA crystals were first dissolved in distilled water, lactic acid was added by stirring mixture. Glycerine was finally added. The solution was filtered if required and transferred into dropping bottle.

4.5.6.2. Lacto-phenol

This mounting fluid was used without adding any other stains.Its composition are as follow-

Phenol crystals …….. 20 gm
Lactic acid …….. 20 ml
Glycerol …….. 40 ml
Distilled water …….. 0-20 ml (depending upon density of mounting required)

4.5.6.3. Mounting Media for Permanent Slide

The mounting media for anatomical studies of the specimens was the Glycerol Jelly for semi-permanent slide and the Hoyer's solution for permanent slide.

4.5.6.1. Preparation of Glycerin Jelly

Fifty gram of Gelatin powder was allowed to soak for about 30-40 minutes in 175 cc of distilled water. The superfluous water was poured off. About 150 ml. of Glycerin was mixed with the soaked gelatin. The mixture was allowed to melt in a hot water bath which was properly boiled for few minutes to clear mixture and make it free from air bubbles. Then 0.7 gm. of Phenol crystal was added and mixed with the help of a glass rod.

The mixture of Glycerin jelly was passed through 3-4 layers of muslin cloth, and then collected in petri dish which ultimately was allowed to cool and solidify.

The wet section after staining in cotton blue was mounted on glycerin jelly. A lump of Glycerin jelly was taken on a dry slide. Made it melt by heating gently upon the sprit lamp. When the jelly was just to melt, transferred the section on it and placed the cover slip over it with no air bubbles at all. The dried jelly at the periphery of the cover slip was cut and cleaned, the next day.

Chemical Composition

Gelatin Powder	50 gm.
Distilled water	175 ml.
Glyceral	150 ml.
Phenol	0.7 gm.

4.5.6.2. Preparation of Hoyer's solution

The Hoyer's solution causes leaf distortion of some bryophytes, it has been found useful specifically for mosses only. The Cleoral hydrate solution has bleaching effect on the cell content. Since the solution was dried very slowly, the slides prepared with this solution were stored horizontally for an extended period. As mentioned by Schofield (1985), the great advantage of Hoyer's solution is that the specimen which is dissected and thoroughly moistened with water can be transferred directly into Hoyer's solution before the cover slip is placed over it.
The formula for the solution provided by Anderson (1954) is:

Distilled water	50 ml.
Gum Arabic	30 gm.
Chlorals hydrate	200 gm.
Glycerin	20 ml.

Chlorals hydrate was dissolved in distilled water, then Gum Arabic and Glycerin were added. The ingredient mixture was blended at the room temperature. Flake gum Arabic was used since it has the ability to go into the solution more rapidly than other forms. An electric rotary magnetic mixture was used to reduce air bubbles. After the final mixture was prepared, it was allowed to remain as such for several hours before being used. This permits most of the bubbles to disappear. This solution was stored in an air tight bottle.

4.6. Identification

A hand lens or eye piece with 5 to 20 diameter of magnifying power was used for identification in the field. A binocular microscope was also used to study habits. A compound microscope containing 15 power eye pieces with 5, 10, 40 diameters of magnifying lenses are sufficient for anatomical study. The nature of air pores of hepaticae were studied by peeling

off a thin layer on the dorsal surface of the thalli with a razor blade and observations were recorded under microscope.

The identification of the collected specimens were done by consulting various relevant literatures, books, reports etc. The original literatures were collected mainly from the British Museum (BM), London; Royal Botanic Garden (E), Edinburgh; Royal Botanic Garden, Kew (K); National Botanic Research Institute (NBRI), Lucknow; Botanical Survey of India (Cal), Kolkata; Hattori Botanic. Lab (NICH), Japan and Central Library, Tribhuvan University, Nepal. The basic consultations were made with Arnell (1956), Bruce *et al*. (2002), Chopra (1975), Eddy (1988, 1990, 1996), Gangulee (1969-1980), Kashyap (1972), Nyholm (1956-1060), Scott *et al*. (1976), Schofield (1969, 1985), Smith (1996), So (1995), Watson (1968), Zhu and So (1996), Long (2006b) and so on. The author's names were checked consulting book by Brummitt & Powell (1992).

The present work is focused basically on lowland species which occur below 1000 m of the east, central and west of southern Nepal. The total species included here are presented with alphabetically and family-wise. The species name is denoted by bold letter and the synonyms in Italics. After each species the name of author's citation and references are provided with.

Representative Collections: This follows with the district of collections given on bold italic, locality of the district, altitude where plants occur, collectors' name, collection number, date of collection, a short description of the species, their status, habitat and global distribution of each species are attempted to present here precisely. The key for identification and sketch diagrams of some important species have also been included.

5. RESULTS

5.1. Morphology

5.1.1. Habitat: Bryophytes are terrestrial and semi-aquatic thallophytes growing upon cooler earth surface and humid climate of the temperate, tropics and alpine regions. The humid forest has greater degree of suitability for luxuriant growth of bryophyte species. They grow in various habitats which include moist forest, open ground, rock cliffs, stone walls, twigs and barks of the trees, dead logs, house walls, dense forest ground etc. The dark brown *Frullania* species of hepaticae grows on tree barks. A deeply dichotomously branched thalloid *Riccia fluitans* are aquatic in habit.The bryophytes show an interesting pattern of distribution with high rate of diversity in sub-tropical and temperate and lesser in alpine climates. The hypneous moss *Isopterygium minutirameum* has been collected at an elevation of 104 m of Pathlyaiya of Parsa district, which is the lowest known altitudinal record made in this investigation.

5.1.2. Habit: The plant body is either thalloid or differentiated into stem, leaves and rhizoids which anchor to the substratum and function as root of higher plants. Plant shows alternation of generation in its life cycle i.e. the gametophytic phase follows the sporophytic phase in which the sporophytes after reduction division is turned into the gametophytic generation.

5.1.2.1. The Gametophyte: The gametophytic growth has a considerable morphological variation both in protonemal and gametophore phases. The gametophytes are differentiated into rhizoids (which are obliquely septate in mosses and smooth walled and tuberculated in hepaticae), leafy shoots in musci and thalloid in hepaticae. The leaves of leafy liverworts do not bear costae. Plant may be acrocarpous or pleurocarpous or dorsoventrally flattened. The stems are without lignified tissues so they depend on other plants for support. The shapes of the leaf usually follow the magnitude of moisture changes, which helps to control water losses in the gametophore. The gametophores may produce gemmae either on the stem or leaves (*Calympers* spp.) or on the dorsal surface of the thallus (*Marchantia* spp.).

5.1.2.2. The Sporophyte: The sporophyte depends upon the gametophyte to survive. The foot penetrates the gametophyte for food. A seta pushes the sporangium which is sheathed with calyptra to its maturity. Seta is very short in Hepaticae. An operculum and peristome teeth are usually present in sporangium of musci. Spores are released out when sporangium is matured.

5.2. Description of the Classes, Orders, Families, Genera and species

The lowland bryophytes of Nepal presented remarkable diversity. About 5000 specimens of bryofloral specimens were collected which now are categorized into 90 genera and 213 species. These were collected at different pockets of the Tarai and Churia hills (below 1000 m) across nation. They belong to 40 families of the classes of Musci, Hepaticae and Anthocerotae. Very

least information was available on lowland and Churia bryophytes of Nepal till this research was initiated. Besides many significant data on distribution, this study also brought out a list of 30 species which are new record to Nepal.

The plants are described following the classification scheme of Chopra (1975) and Smith (1996) which includes three classes viz. **Anthocerotae**, **Hepaticae** and **Musci**. Anthocerotae is described under one order and two families; Hepaticae with three orders and 18 families and Musci with nine orders and 20 families.

5.2.1. ANTHOCEROTAE

Members of this group are thalloid with 5-30 almost uniform thick cells, each contains single large chloroplast with a pyrenoid. Oil bodies are lacking in the cells but mucilage filled cavities are found in some of the cells, often contains *Nostoc* colonies. The antheridia are in group, endogenous in origin, broadly ellipsoid and stalked. Archegonium single flask shaped with neck canal cells, ventral canal cell and egg cell almost embedded in the gametophyte. Sporophytes cylindrical, short, horizontal or erect, capsule epidermis with or without stomata, columella may or may not present.

Anthocerotae constitutes one order, the Anthocerotales and two families. Their distribution is worldwide and contains eight genera viz. *Notothylas, Anthoceros, Folioceros, Phaeoceros, Leiosporoceros, Megaceros, Australoceros* and *Dendroceros* (Hasegawa, 1988). Vashistha (1985) described five genera, 300 species under two families. *Anthoceros, Folioceros, Phaeoceros* and *Notothylas* are reported in Nepal.

5.2.1. 1. ANTHOCEROTALES

Thalloid forms various lobes of irregular rosettes. The thallus is without midrib except Dendroceros species. Cells uniform in size usually with a large chloroplast containing pyrenoid. Oil bodies lacking but with mucilage filled cavities which often open to the ventral surface containing *Nostoc* colonies. Ventral surface with smooth walled rhizoids, scales absent. Antheridia endogenous in origin. Archegonia embedded in the gametophyte. Sporophyte cylindrical, long or short and embedded into the thallus.

5.2.1.1.1. ANTHOCEROTACEAE

Plants epiphytic or terrestrial upon moist soil and rocks. Thalli green to dark green, variously lobed, midribs lacking, cells somewhat larger towards the centre, each with single large chloroplast containing a pyrenoid, oil bodies absent. Ventral scales lacking, rhizoids smooth-walled. Antheridia endogenous, ellipsoid and shortly stalked. Archegonia borne singly on dorsal surface, consisting neck canal, ventral canal and an egg cells. Sporophytes cylindrical, long, horn shaped, foot bulbous and lack setae. Capsule epidermis with elongated stomata, columella

distinct, pseudo-elaters geniculate, spores spherical, yellowish to blackish, and dehiscence occurs by the openings and 1-2 longitudinal slits in the capsule wall.

In Stephani's Species Hepaticarum, 319 species of the Anthorerotae have been listed worldwide, but are briefly described without comparing to the allied species (Hasegawa, 1979). About 330 species of this family are described in the world (Smith, 1996), of them 8 species have been recorded in Nepal (Pradhan, 2000a). Four genera and 5 species of this family are described here.

Key to the genera

1. Thalli strap-like, dichotomously divided many times; elaters brown ……..…….. **2**. *Foliocerus*
   Thalli rosette, not much folded; elaters pale or dark green ….……...…..…… 2

2. Thalli usually pale green with crisped margin ……..……..……..… 3
   Thalli usually dark green, margin entire ……..…….....….....… **3**. *Phaeoceros*

3. Thalli with large cavities, antheridial wall with 4 rows of cells, spores dark brown.. **1**. *Anthoceros*
   Thalli without cavities, antheridial wall with many small cells, spores yellowish. .. **3**. *Phaeoceros*

1. Anthoceros L., Sp. Pl.: 1139, 1753.

Plants terrestrial growing in moist areas. Thalli variously lobed. Cross section of the thallus shows more or less uniform hexagonal cells, some filled with mucilage and *Noctoc* colonies. Antheridia are found in closed chambers. Capsules linear, long and bi-valved with distinct columellae in the centre. Pseudo-elaters may or may not have spiral bands. Spores generally dark brown to blackish in colour. Five species of *Anthoceros* are reported in Nepal (Pradhan, 2000a). Three species are described in this investigation.

Key to the species

1. Plant monoecious ……..…….....……..…..…...…….. 2
   Plant dioecious ……...…….....……..… 3

2. Thallus pale yellowish green, capsules grater than 30 mm long .....… **3**. *Anthoceros punctatus*
   Thallus dark green, capsule less than 30 mm long …….……...……..... 3

3. Spores smooth, 40-48 µm in diameter ……...…..… **1**. *A. chambensis*
   Spores papillose, 50-65 µm in diameter ……...…...……. **2**. *A. formosae*

1.1. Anthoceros chambensis Kashyap, J. Bomb. Nat. Hist. Soc. **25**: 281, 1917; Shrestha, J. Nat. Hist. Mus. **1**(2-4): 184,1977; Pradhan, Mats. Checklist Bryo. Nep.: 1, 2000a; Kattel, Liverworts Nep.: 11, 2002; Pradhan & Joshi, Current Trends in Bryology : 20, 2007b; Pradhan & Joshi, Our

Nature **5**: 32, 2007c.

Plants thalloid, grow densely, rosette upto 3 cm, sometimes with irregular lobes, firmly attached to the substratum. Thalli thick, fleshy, dark green, 15 mm long and 5 mm wide with smooth walled rhizoids. Cross section of the thallus shows large hexagonal cells containing mucilage cavities. Plants dioecious, antheridia club shaped with single layer of jacket cells, capsule long, cylindrical, solitary, 20-25 mm long; involucres tubular surrounds the capsule at the base, foot bulbous, spores brown, opaque, spherical and faintly granular, 40-48 µm in diameter; pseudo-elaters light brown, long, slender, branched 113 x 11 µm in size.
Status: Uncommon.
Habitat: Soil.
Distribution: Nepal (W, C, 200-1600 m): Nawalparasi (190 m), Nuwakot (545 m); India and Japan.
Remarks: There is no report of this species from higher elevations.

1. 2. Anthoceros formosae Steph., Sp. Hepat. **5**: 1002, 1964; J. Haseg., J. Hattori. Bot. Lab. **56**: 24-28, 1984; Jha *et al.*, J. Nat. Hist. Mus. **9**(1-4): 66-68, 1985; D.G. Long & Grolle, J. Hattori Bot. Lab. **68**: 384, 1990; Pradhan & Joshi, Our Nature **5**: 33, 2007c.

Anthoceros angustus Steph., Taiwan Kushaku **6**: 49, 1903.

Thalli dark green, folded in the form of rosette, about 2 cm in diameter. Rhizoids smooth walled on the ventral surface. Cross section of the thallus shows large hexagonal cells containing mucilage cavities. Sporophytes long, erect. Spores spherical, dark brown, irregular and measure 50-65 µm in diameter
Status: Rare
Habitat: Humus soil.
Distribution: Nepal (E, 180 m): Morang (180 m); Bhutan, Formosa, India (Darjeeling), South China (Taiwan) and South Japan.
Remarks: Hasegawa (1984) recorded its distribution in central and eastern Nepal.

1. 3. Anthoceros punctatus L., Spec. Plant.: 1130, 1753; Shrestha, J. Nat. Hist. Mus. **1**(2-4): 184, 1977; Pradhan, Mats. Checklist Bryo. Nep.: 1, 2000a; Kattel, Liverwort Nep.: 11, 2002; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana : 20, 2007b; Pradhan & Joshi, Our Nature **5**: 33, 2007c.

Anthoceros crispulus (Montin) Douin, Rev. Bryol. **32**: 25, 1905.
Anthoceros fissus Steph, Spec. Hep. **5**: 1004, 1916.

Wrinkled-margin Hornwort; Dotted Hornwort (Eng.).

Thalli pale green, becoming dark when dry, rosette of 2.5 -3 cm, margin undulate, lobed and crisped. Transverse section of the thallus shows a compact mass of hexagonal cells with single

perynoid in each cell and presence of *Nostoc* colonies in few cells. Plants monoecious, antheridia inside the cavities of the upper surface of the thallus, globose and 100-150 µm in diameter. Capsule measures 50 mm in length, solitary, light green, spores are blackish, spinose on the distal side and smooth on the proximal side, about 35-50 µm in diameter, pseudo elaters are short, pale white, thin walled, rarely branched and measure 80-90 µm long **(**Fig.12).
Status: Rare
Habitat: Soil.
Distribution: Nepal (W, C, 200-1550 m): Nawalparasi (200 m), Chitwan (1000 m), Nuwakot (545 m); China, Europe, Japan, New Caledonia, North Africa, North America and Turkey.

2. Folioceros D.C. Bhardwaj, Geophytology **1**: 6-15, 1971.

Folioceros is a genus of hornworts, common locally in the tropical and subtropical regions of Asia. Gametophytic thalli yellow-green to dark green, crispy and translucent with short pinnately branches, usually less than 1 cm wide and 3 cm long. They may be monoecious or dioecious.

The genus first was studied by Bharadwaj (1971). The type species *Folioceros assamicus* was described from Guwahati-Shillong Road (Bharadwaj, 1971). Asthana and Nath (1999) studied its distribution pattern in India and observed their laxurent growth in the moist subtropical evergreen as well as deciduous forest of the Eastern and Western Himalaya as has been discussed Bharadwaj (1971) and Hasegawa (1984). The genus *Folioceros* can be distinguished from the genus *Anthoceros* by the narrow, elongated thick walled elaters.
Previously only one species of *Folioceros* has been known from Nepal.

2.1. Folioceros assamicus D.C. Bhardwaj, Geophytology **1**(1): 10, 1971; Asthana & Nath, J. Bryo. **24** (4): 318-321, 2002; Pradhan & Joshi, Our Nature **5**: 33-34, 2007c.

Leafy Hornwort (Eng.).

Thalli dark green, dorsoventrally flattened, dichotomously branched into short strap-shaped branches of varying length, boarder at distal ends. Thalli 10-15 mm long and 4-5 mm wide, margin deeply or less pinnately lobed with irregular and dentate margins, spongy. Thallus surface smooth. Thallus cells hexagonal with single large perynoid. Ventral surface with smooth walled rhizoids, pale white and 23 µm in diameter. Plants dioecious. Sporophytes on dorsal surface on the median region. Involucre solitary, 3-5 mm long, cavernous with small lamellae outgrowth on outer surface. Capsules dark green, erect, 3-5 cm long, 0.2 mm wide with stomatous epidermis. Stomata with guard cells measure 25 x 6 µm in diameter. Spores spherical with rough surface with very short tubular projections, 33-44 µm in diameter, pseudo-elaters dark brown, thick walled, vermiform, 225-285 µm long and 6-7 µm wide. Dehiscence of spores and elaters by opening two valves (Fig. 13).
Status: Rare

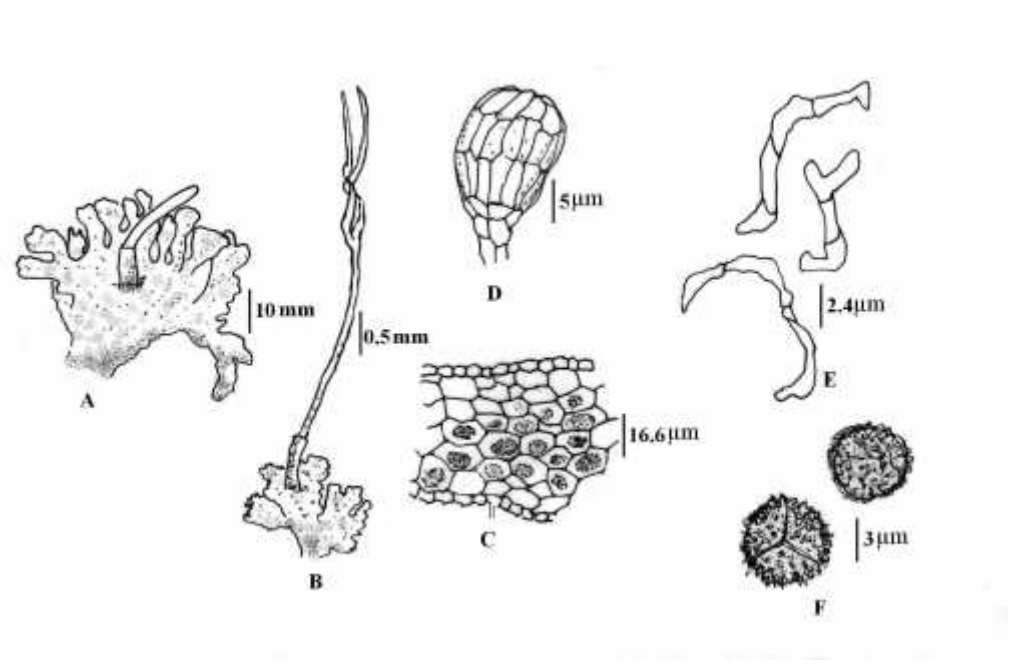


Fig 12. *Anthoceros punctatus* L. A. habit, B. thallus with sporophyte, C. Cross section of the thallus, D. antheridium, E. elaters, F. spores.

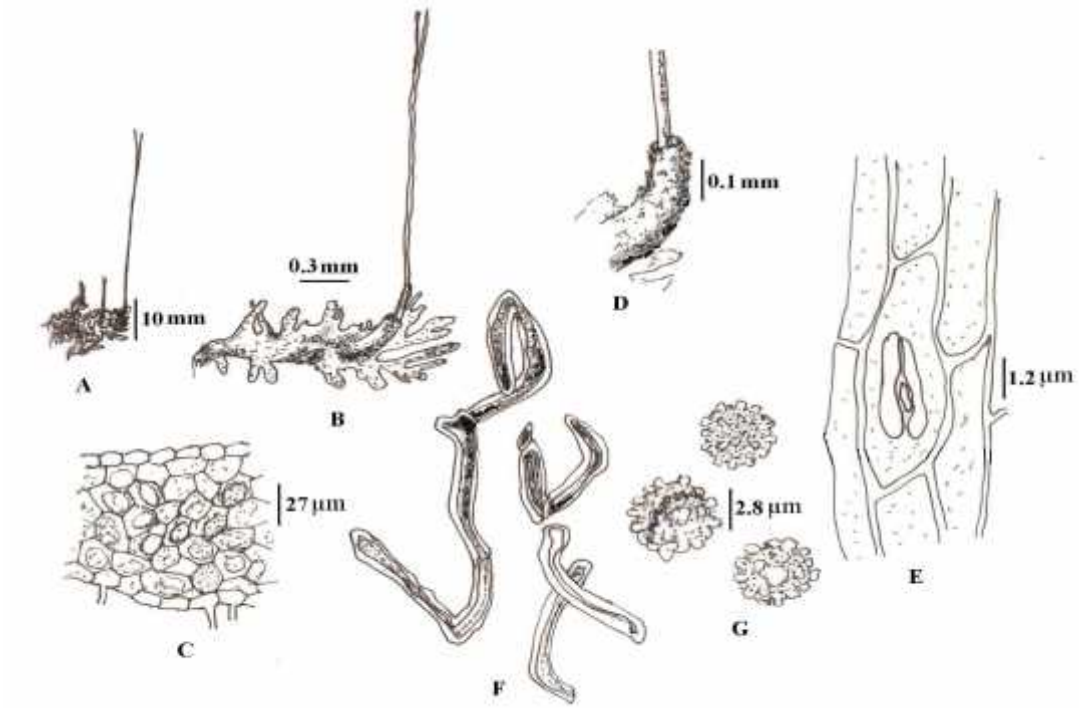


Fig.13. *Folioceros assamicus* D.C. Bhardwaj, A. habit, B.the plant enlarged, C.cross section of the thallus, D. involucre, E. cells with stoma, F. elaters, G. spores.

Habitat: Soil covered rock.
Distribution: Nepal (C, 600 m): Bara (600 m); Asia, Africa and India; Bara (600 m).
Remarks: Bharadwaj (1971) found pseudoelaters less than 7 µm wide and more than 300 µm long and spores ornamentation bacculate rather than reticulated. Under the SEM, the spores seen was bacculate sporoderm with variously shaped bacculae of 2 µm high and 1.2-1.5 µm wide distributed all over the sporoderm (Asthana and Nath, 2002). This species is new recorded for Nepal.

3. Phaeoceros Prosk**.,** Bull. Torrey Bot. Club **78**: 346, 1951.

Plants thalloid, deep to dark green, rarely lobed, simple or dichotomously branched with entire or crisped margin, costae not distinct, cells without mucilage cavities. Antheridia 2-4 in each antheridial cavity. Involucre erect, cylindrical, capsule projecting far beyond the involucre, bivalved at maturity with stomata on its epidermis and with well developed columella. Spores unicellular, spherical-tetrahedral, generally yellowish always with distinct tri-radiate marks, elaters usually1-4 celled, elongated, pale brown, thin walled with regular bands of thickenings.

Stephani (1916, 1923) studied many species of *Phaeoceros* from Asia which were described in Species Hepaticarum. Two species from this genus has been reported from Nepal of which one has recorded in the present investigation.

3.1. Phaeoceros laevis (L.) Prosk., Bull. Torrey Bot. Club **78**: 347, 1951; Nog. *et al.,* Bull. Nat. Sci. Mus. **9** (3): 378, 1966; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 20, 2007b; Pradhan & Joshi, Our Nature **5**: 34-35, 2007c; Pradhan & Joshi, Nep. J. Pl. Sci. **2**: 28, 2008a.

Anthoceros laevis L., Sp. Pl. **2**: 1139, 1753.
Phaeoceros laevis subsp. *laevis* (L.) Prosk., Rapp. et Comm.VIII Congr. Int. Bot. Paris **14-16**: 69, 1954.

Smoth Hornwort (Eng.).

Thalli annual or perennial, generally dark green and appears in the form of rosette, ca. 5-20 mm in diameter. Thalli lobed, margin often irregularly fringed, no midrib, Anatomy of central portion of thallus shows several layers of cells with large chloroplast but lacks oil bodies, rhizoids smooth walled arising from the ventral surface. Plants autoecious. Antheridia globose on short stalks, 95-120 µm in diameter embedded in the tissue of the thallus with the number of 2-5 in each cavity, capsules generally 15-40 mm long, involucres fleshy which surround the tubular capsule, dehisces longitudinally by 2 valves, spores yellowish brown, papillose, 34-40 µm in diameter, pseudo-elaters long, rarely branched, 203 x 11 µm in diameter. (Fig. 14).
Status: Common
Habitat: Forest floor, Soil (intermingle with *Pallavicinia lyellii*, Pn 260).
Distribution: Nepal (W, C, E, 190-1000 m): Kanchanpur (190), Bara (200 m), Parsa (250),

Makwanpur (350-1000 m), Chitwan (300 m), Morang (180 m); California, China, East Asia, Formosa, Japan, Korea, North and South Africa, North America, Mexico, Philippines, South Europe and Turkey.

Remarks: This species is very common in tropical region of Nepal.

5.2.1.1.2. NOTOTHYLADACEAE

Plants show strong resemblance with Anthocerotaceae however sporophytes are quite different. Sporophytes are usually short, compact, marginal and grow out horizontally from the fertile lobes of the rosette thallus. The capsules may contain columella and lack stomata on their wall. Pseudo-elaters simple with oblique bands and spores spherical.

Notothylaceae is a phyletically isolated yet interesting group of bryophytes. The family is largely represented in East and South-East Asia, with principal focus of its origin and differentiation being the Indian subcontinent (Singh, 2002). *Notothylas* is monogeneric with *four* species in India and one in Nepal.

1. Notothylas Sull., Amer. Acad. Art. & Sci. New Ser. Bd. **3**: 1848.

It is the smallest of all the hornworts with yellow-green gametophytic thallus that is seldomly more than a centimeter, and usually much smaller. The genus *Notothylas* is also unusual among hornworts in that the sporophyte is bullet-shaped and does not grow very large (less than two millimeters). The sporophytes grow outwards rather than upwards, and like *Megaceros*, there are no stomata on the surface of the sporophyte. Capsules short with large foot, almost entirely enclosed by a gametophytic tissue and open by two valves. Columella may or may not be present. Spores large, spherical, elaters with simple oblique bands.

Notothylas is an isolated and interesting genus of hornwort which has the record of seven species in Asia (Hasegawa, 1979). Only one species has been recorded in this present work.

1.1. Notothylas levieri Schiffn., Sp. Hep. **5**: 1021, 1917; Hattori, Fl. E. Him.**1**: 503, 1966; Grolle, Khumbu Himal, Bd. 6, Lfg.: 119, 1974; Pradhan, Mats. Checklist Bryo. Nep.*:* 1, 2000a; Pradhan, J. Nat. Hist. Mus. **20**: 27, 2001, Kattel, Liverworts Nep.: 11, 2002; Pradhan & Joshi, Our Nature **5**: 35, 2007c.

Thalli thin, yellowish green to dark green, growing as small thick rosette, thallus thick in the middle. Some cells with *Nostoc* colonies, epidermis lacks stomata; rhizoids generally smooth walled. Plants dioecious, sporophytes not extended out as in *Anthoceros* spp. Capsules dark green, ellipsoidal or bullet shaped and measure 1 mm long, columella totally absent so that number of spores and pseudo-elaters are scattered within the capsule, foot lies within gametophytic tissues. Margin with four rows of special thick walled elongated cells. Spores dark brown, spherical, 45 µm in diameter, pseudo elaters generally pale yellow, 50 x10 µm in diameter (Fig. 15).

Status: Rare

Habitat: Soil.

Distribution: Nepal (E, 200-2200 m): Sunsari (180 m); India (Kumaon Himalaya); Morang (200 m), Sunsari (180 m).

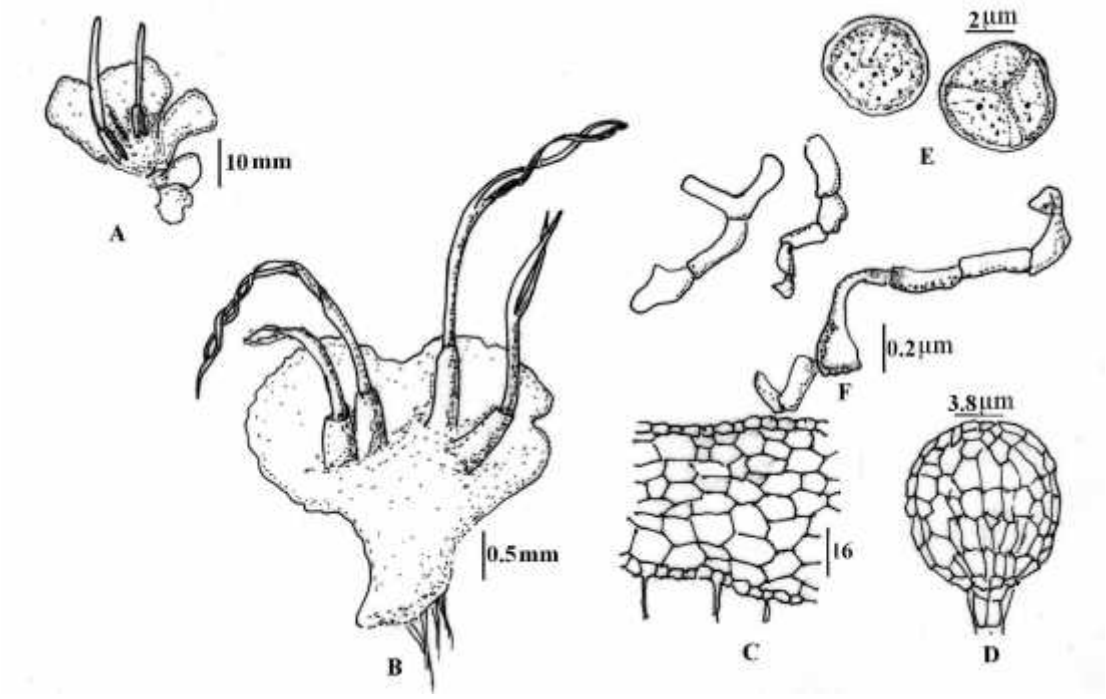


Fig. 14. *Phaeoceros laevis* (L.) Prosk. A. habit, B. the plant enlarged, C. cross section of the thallus, D. Antheridium, E. spores, F. elaters.

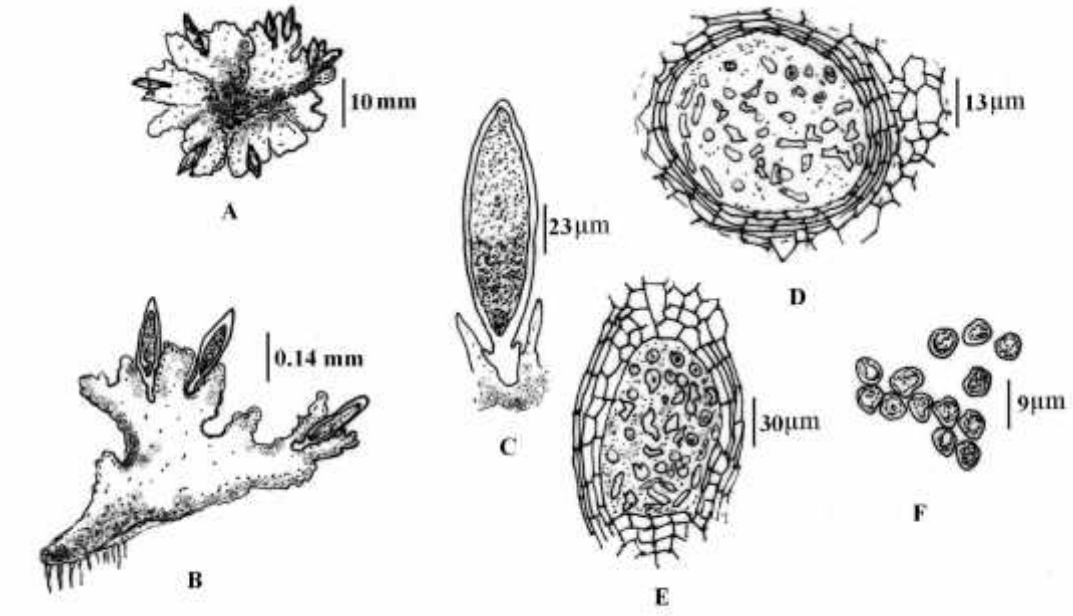


Fig. 15. *Notothylas levieri* Schiffn., A. habit, B. fertile thallus, C. capsule, D. cross section of the capsule, E. vertical section of the capsule, F. spores.

5.2.2. HEPATICAE

Hepaticae may be thalloid or leafy. The thallus is dorsoventrally flattened, with or without well defined midrib, lack mucilage filled cavities, contains air cavities. Rhizoids usually smooth walled and tuberculated, ventral scales may be present. Leafy plants are erect to dorsiventral, leaves are under three ranks, the third ranked ventral leaves may be reduced. Stem with or without central strand, rhizoids simple, leaves with various shapes and without midrib. Archegonia flask shaped consisting of neck and venteral surrounding ventral canal cell and egg cell. In thalloid form, the developing sporophyte is protected by involucre, pseudoperianth or fleshy calyptra while in leafy form it is protected by perianth or fleshy calyptra. Sporophyte is differentiated into foot, very short seta and capsule. Capsule lacks columella and stomata. Sporogenous tissues give rise to spores and spirally thickened elaters.

About 330 genera and 8000 species have been recorded in the world (Schofield, 1985). Nepal represents 398 species under 37 families so far. Sixty species of 33 genera and 18 families under three orders have been described in the present text.

Key to the orders of Hepaticae

1. Gametophores with flattened thallus ..... **2**. Marchantiales
   Gametophores with leaves and stems..... 2

2. Plants acrogynae, with three ranks of leaves …….....…...….. **1**. Jungermanniales
   Plants anacrogynae, with two ranks of leaves ..... **3**. Metzgeriales

5.2.2.1. JUNGERMANNIALES

Plants usually dorsoventral with leaves in two lateral and one ventral ranks. The ventral row of leaves are usually reduced or absent. Apical cells of stems with three cutting faces. Leaves bilobed or simple, incubous or succubous. Rhizoids present. Plants monoecious and dioecious. Antheridia produced in axils of modified lateral leaves, archegonia terminal on main axis or branched axis. Developing sporophytes are protected by tubular perianths. Capsules spherical to cylindrical on hyaline setae, dehiscing by four valves. Spores 6-60 µm in diameter.

About 275 genera and 7000 species are found in the world (Smith, 1996). Nepal has the record of 56 genera and 251 species under 20 families (Pradhan, 2000a). The present investigation includes 34 species under Nine families.

Key to the Families of Jungermanniales

1. Leaves succubous …….……...…….…..…… 2
   Leaves incubous ……...……...…..…3

2**.** Leaves simple; amphigastrae distinct ……. ……...…. **4**. Geocalycaceae
Leaves complicated; amphigastrae absent or reduced …….……..…… 4

3. Leaves bilobed; flagelliform shoots absent ……...…… **1**. Calypogeiaceae
Leaves 3-4 lobed; flagelliform shoots present ……..….**7**. Lepidoziaceae

4. Leaves opposite, margin toothed …… 5
Leaves alternate, margin entire …….…..……..…….…. 6

5. Leaves obliquely inserted, margin not decurrent …….……..… 8
Plagiochilaceae Leaves not obliquely inserted, margin decurrent ……...…….……..… 7

6. Stem without flagelliform shoots, gemmae absent ……...……..... **5**. Jungermanniaceae
Stem with flagelliform shoots, gemmae present ……..… **2**. Cephaloziaceae

7. Ventral lobe jointed with dorsal lobe at lower part ……..…….……..…… 8
Ventral lobe free from dorsal lobe ……..…….. 9

8. Under leaves present ……...……...…….…… **9**. Porellaceae
Under leaves lacking ……..... **6**. Lejeuneaceae

9. Ventral lobe helmet shaped …….……..…… **3**. Frullaniaceae
Underleaves bilobed, shaped ……...……. **4**. Geocalycaceae

5.2.2.1.1. CALYPOGEIACEAE

Plants prostrate, rarely branched, branching ventral or apical, stems without well defined cortex. Leaves incubous, very obliquely inserted, entire to bidentate, laminal cells large, thin walled, mostly hexagonal. Under leaves large, entire, deeply bilobed, hyaline and smaller than leaves. Rhizoids cluster on ventral surface. Perianth lacking. Capsules ovoid or cylindrical.
Two genera of *Calypogeia* are recorded in Nepal.

1. Calypogiea Raddi corr. Corda in Opiz., Naturaliantausch: 653, 1829.

Plants pale greyish or brownish green with prostrate sparsely branched creeping stem. Leaves incubous, distant or imbricate, spreading horizontal, plain or slightly convex, ovate to broadly ovate, apex round to acute or bidentate, very obliquely inserted, cells large, thin walled, with or without trigones, oil bodies colourless or bluish. Under leaves larger than stem, deeply lobed and entire. Gemmae often present. Inflorescences upon dwarf ventral branches. Male bracts 3-5 pairs, very small. Female bracts 2-3 pairs, scale like. Perianth lacking. Capsules cylindrical and spores 8-18 µm.

This genus has 90 species in the world (Smith, 1996). Three species of Calypogies from east Nepal has been recorded . One recent record from the lowland Tarai has been described here.

1.1. *Calypogiea neesiana (Massal. & Carest.) K. Muell. in Loeske, Hedwigi*a* **47**: 165, 1908; Arnell, Moss Fl. Fennos.**1**: 58-59, 1956; Piippo *et al.*, Ann. Bot. Fennici. **34**: 57-58, 1997.

Calypogeia cordistipula (Steph.) Steph., Spec. Hep. **3**: 400, 1908.

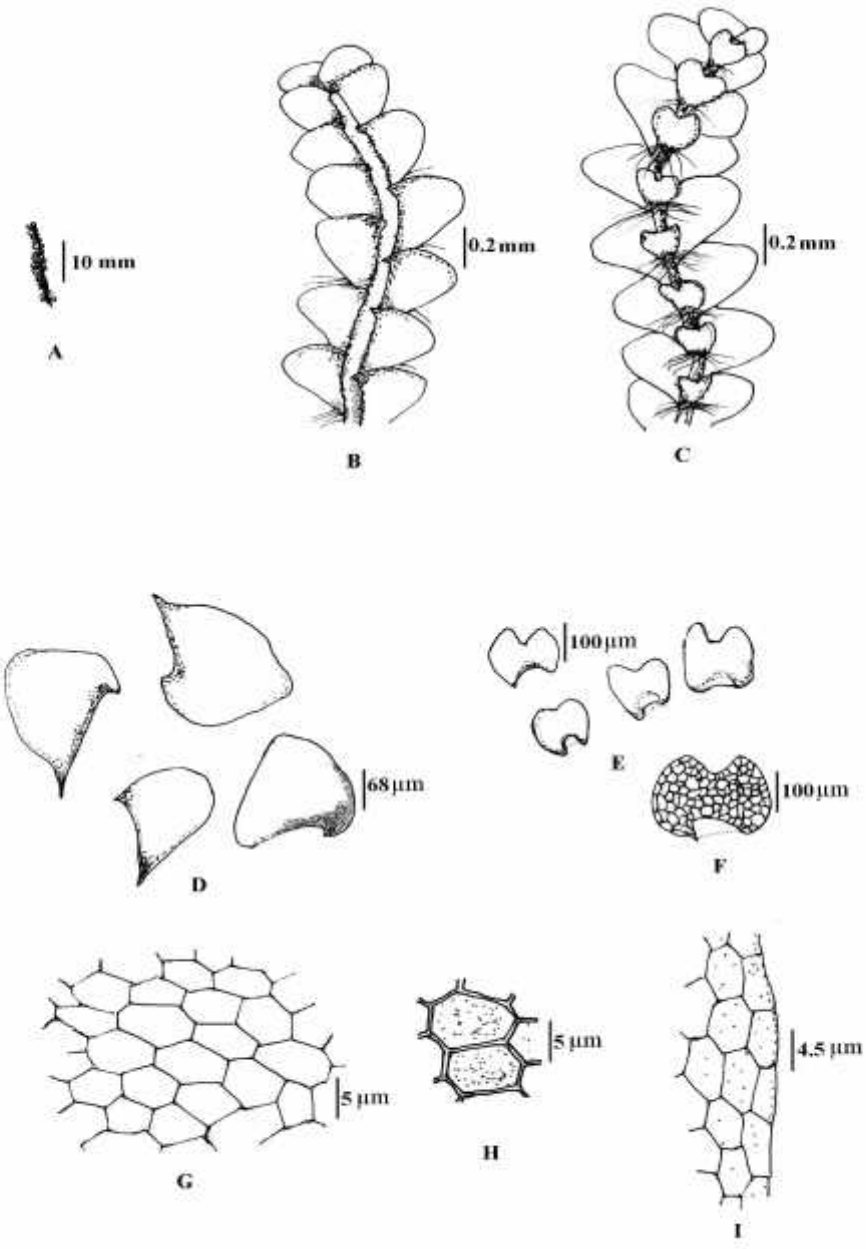


Fig. 16. *Calypogiea neesiana* (Massal. & Carest.) K. Muell. A. Habit, B. A portion enlarged, dorsal view, C. A branch from ventral view, D. Leaves, E. Under leaves, F. under leaf showing tissues, G. middle laminal cells, H. middle laminal cells enlarged, I. marginal cells.

Plants yellowish green to brownish, glossy, prostrate over other mosses. Shoots 2-4 cm long, 1-3 mm wide with expanded leaves, sparsely branched, Leaves imbricate, slightly raise, ovate wide at the base, 1.2-1.5 mm long and 0.8-1 mm wide at the median region, margin entire, hyaline oil bodies present in some of the marginal cells, marginal cells elongated hexagonal, 23-35 x 46-50 µm in diameter, middle laminal cells and basal cells elongated hexagonal, 23-40 x 50-91 µm in size, hyaline, thick walled. Underleaves bilobed, margin entire, 0.5 mm long and 0.7 mm wide, loosely appressed to the stem. Gemmae formation on shoot is common. Rhizoids pale white, cluster, long and 10 µm in diameter. Plants autoecious and paroecious. Capsules very rare (Fig.16).

Status: Rare

Habitat: Damp soils, rocks and dacaying woods.

Distribution: Nepal (W, 220-420 m): Bardia (220 m), Banke (420 m); Europe, Japan, Italy, North America, Spain and Yugoslavia.

Remarks: This species is new recorded for Nepal.

5.2.2.1.2. CEPHALOZIACEAE

Plants characteristically slender to robust. Most species are brown, redish brown, red or purplish, sometimes almost black and greenish on shaded areas. Shoots usually procumbent, irregularly branched arise from ventrally or laterally. Stem section shows large cortical cells or resembles the central strands. Leaves distant to closely imbricate, succubous, margin entire, cells thin to thick walled, trigone absent or present, oil bodies present or absent. Under leaves absent or reduced. Male bracts bilobed with solitary antheridia, female bracts in three ranks, perigynium lacking. Capsules ellipsoidal to cylindrical. Spores usually 8-26 µm in diameter. Twelve genera has been recorded worldwide (Smith, 1996).

Nepal has two genera and three species. One species is dersribed here.

1. Odontoschima (Dumort.) Dumort., Recueil Observ. Jungerm.: 19, 1835.

Plants 1- 8 cm, green or reddish brown or purplish black. Stems prostrate and branched. Stem sections may show differentiated cortical cells. Leaves succubous, orbicular, entire, obliquely inserted and cells with large bulginig trigones. Gemmae frequently present on the margin of upper leaves, underleaves 1-2 celled, male bracts are much smaller than the leaves and bilobed. Female bracts larger than the leaves and bilobed. Capsules are generally ovoid. Spores 8-16 µm in diameter.

The global data shows the occurence of about 20-25 species so far (Smith, 1996) and one species has been recorded from the Eastern lowland of Nepal.

1.1. **Odontoschima denudatum** (G. Martens) Dumort., Racueil Observ. Jungerm.: 19, 1835; Grolle, Ergebn. Forsch-Unternehmen Nepal Him. Bd.**1**, Liefg **4**: 291, 1966a; D.G. Long & Grolle, J. Hattori. Bot. Lab. **68**: 391, 1990; Sm., Liverworts Brit. & Ireland: 96-97, 1996; Kattel, Liverworts Nep.: 14, 2002.

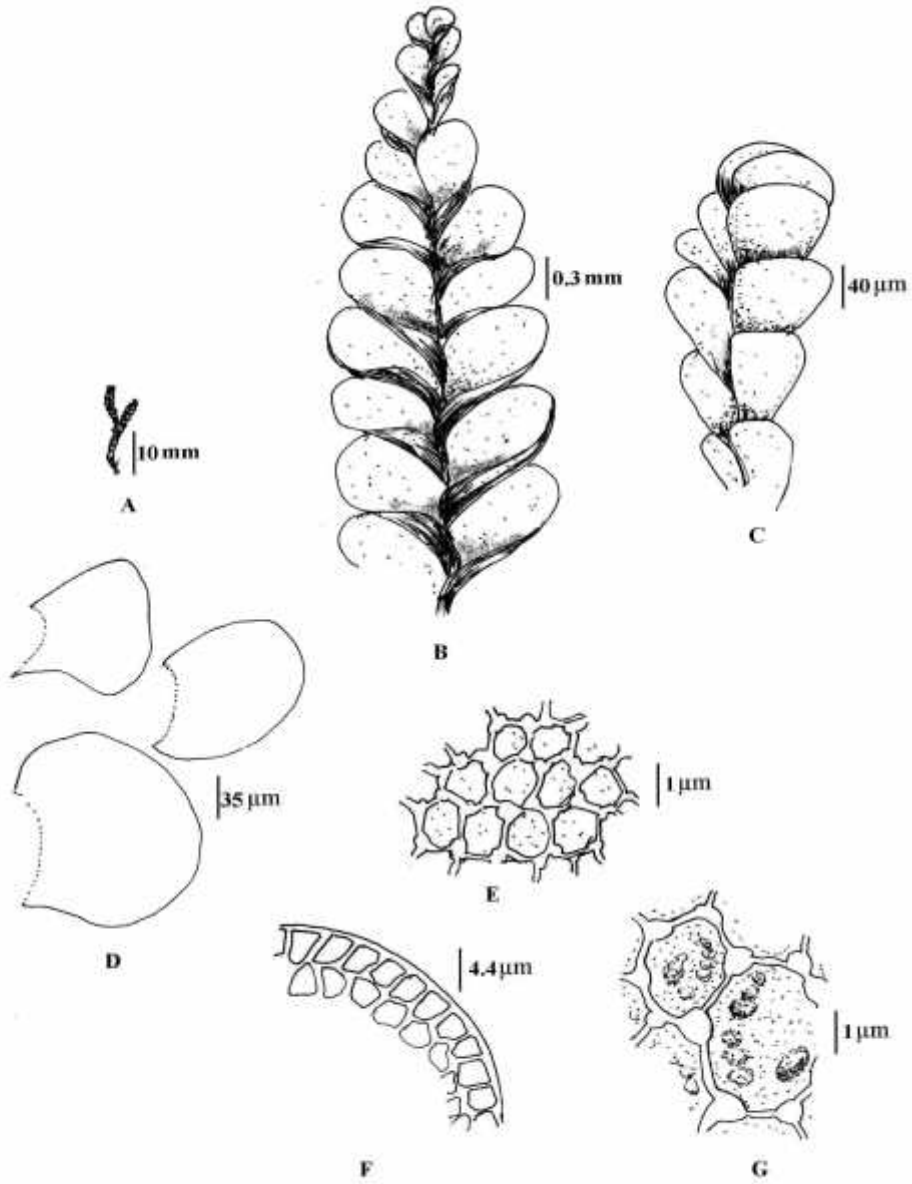


Fig. 17. *Odontoschima denudatum* (G. Martens) Dumort. A. habit, B. a branch enlarged, C. a branch on lateral view, D. leaves, R. middle laminal cells, F. a portion of leaf on marginal region, G. middle laminal cells enlarged.

Matchstick Flapwort (Eng.).

Plants reddish brown to purplish brown, about 10 mm long and 1 mm broad with expanded leaves. Main shoots dark brown, flat, procumbent usually with erect, pale white branches arise vertically. Rhizoids smooth walled, pale white, clustered at the ventral stem at the leaf attachment, 11-12 µm in diameter Stem dark brown, flat with elongated rectangular cells.
Leaves succubous, ovate to orbicular, brownish green, entire margin and 1 x 0.8 mm in size. Marginal cells are radially elongated or rectangular with uniformly thickened walls, middle

laminal cells 23 x 29 µm in diameter, irregular structure due to bulging trigones. About 5-6 oil bodies are present. Underleaves very small usually present at the apical region of the stem. Plants dioecious. Sporophytes not observed (Fig. 17).

Status: Rare

Habitat: Damp soil and intermingle with *Marchantia palmata* Nees and *Barbula fuscescens* Wall. (dt 388).

Distribution: Nepal (W, E, 180-3000 m): Bardia (200 m), Morang (180); America, Azores, Bhutan, China, Europe, Formosa, Japan, North America, Madeira, South Africa and Siberia.

Remarks: Smith (1996) has mentioned its distribution in Nepal. Its distribution is found in western and eastern Nepal and not is recorded in central region.

5.2.2.1.3. FRULLANIACEAE

Plants glossy, dark green to reddish brown. Stem irregularly branched and with or without cortex. Rhizoids arise from the underleaf base. Leaves bilobed, dorsal lobes are large, incubous, imbricate and overlaps dorsally, margin entire and the ventral lobe is generally lanceolate to helmet–shaped. Under leaves with 0-1 teeth. Male and female inflorescences without innovations. Bracts and bracteoles are arranged in 1- 3 whorls larger than the leaves. Sporophytes with well developed setae. Spores shaped irregularly due to precocious division.

The family Frullaniaceae consists three genera and more than 800 species worldwide. One genus of *Frullania* and 20 species have been recorded in Nepal.

1. Frullania Raddi, Soc. Ital. Sc. Mod. **18**: 20, 1818.

Plants dull green to reddish brown to brownish black. Stems irregular with 2-3 pinnate branches. Female plants with more branches than the male. Leaves arranged horizontally, bilobed almost to the base, dorsal lobes incubous, imbricate, orbicular to ovate with entire margin. The ventral lobules much smaller, cucullate, galeate and sometimes evolute. Trigones often present. Amphigastra always present usually smaller than the leaves and usually bilobed. Plants dioecious rarely autoecious. Male inflorescence terminal on short lateral branch, bracts closely imbricate and synmmetrical. Female inflorescence terminal on lateral branch, rarely seen in main axis, bracts in 2-5 pairs, asymmetrically bilobed. Spores 40 -50 µm in diameter.

Frullania is a large genus with 800 species worldwide (Smith, 1996), 16 taxa from Nepal (Yuzawa and Koike, 1994) and the following three species from lowland Tarai, Nepal. Three species are described here.

Key to the species Frullania Raddi

1. Plants greater than 2 cm ……..……..……..……..… 2
   Plants less than 2 cm …….……..... **3**. *Frullania muscicola*

2. Plants dark green to deep brown with very few rhizoids ..... **2**. *F. ericoides*
   Plants dull green to purplish brown with numerous rhizoids ……..…. **1**. *F. dilatata*

1.1. *Frullania dilatata* (L.) Dumort., Recueil Observ. Jungerm.: 13, 1835.

Jungermannia dilatata L., Sp. Pl. : 1133, 1753.

Moss like liverwort; Delicate Scalewort (Eng.).

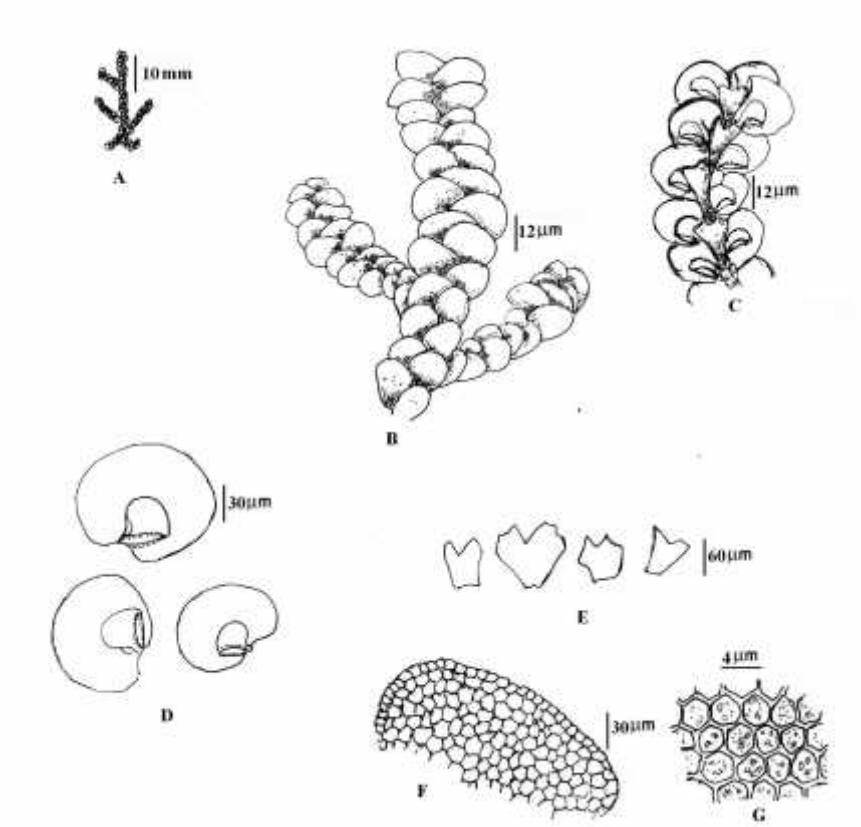


Fig. 18. *Frullania dilatata* (L.) Dumort., A. habit, B. a sterile branch, C. a branch from ventral view, D. leaves, E. underleaves, F. a portion of marginal region of the leaf, G. middle laminal cells enlarged.

Plants dull green, purplish brown to blackish green, forming a thin patch of circular rosette, closely appressed to the substratums. Stems creeping, 2-4 cm long, irregularly pinnately branched. Rhizoids numerous on the ventral surface on creeping stem. Leaves closely imbricate, dorsal lobes reniform-circular, slightly convex, margin entire, overlapping and crossing the stem. Ventral lobes hemispherical, larger than dorsal lobes. Amphigastra broadly obovate, slightly wider than stem, more or less similar size of ventral lobes, margin bilobed and entire. Cells in the dorsal lobes, 25-30 µm in diameter, trigones large, oil bodies 3-4 per cells. Plants dioecious. Female bracts bilobed (Fig. 18).

Status: Rare
Habitat: Bark of Sal tree (*Shorea robusta*).
Distribution: Nepal (W, 340 m): Bardia (340 m); China, Denmark, Finland, Norway and Russia.
Remarks: New record for Nepal.

1.2. Frullania ericoides (Nees ex Mart.) Mont., Annales des Sci. Naturelles, Botanique, ser. 2, **12**: 51, 1839**;** D.G. Long & Grolle, J. Hattori Bot. Lab. **68**: 413, 1990; Yuzawa & Koike, J. Hattori Bot. Lab. **75**: 194, 1994; Pradhan, J. Nat. Hist. Mus. **19**: 60, 2000b; Kattel, Liverworts Nep.: 17, 2002.

Jungermannia ericoides Nees in G. Martens, Fl. Bras. **1**(1): 346, 1833.
Jungermannia squarrosa Reinw., Blume & Nees, Nova Acta Phys.-Med. Acad. Caes. Leop.-Carol. Nat. Cur. **12**: 219, 1824.
Frullania squarrosa (Reinw. *et al.)* Nees, Syn. Hepat. **3**: 416, 1844.

Plants usually dark green to deep brown. Stems creeping, 3- 4 cm long, irregularly pinnately branched. Leaves opaque, imbricate, suborbicular, 1 x 0.5 mm in size with entire, rounded apices and squarrous margin, leaf cells 30-25 µm in diameter, trigones present usually thickened. Leaf lobules usually galeate and almost free from leaf lobes. Amphigastra large, broadly ovate and with bilobed apex. Plants dioecious, perianths large, capsules globouse, dark brown on short, hyaline setae. Spores spherical, 30-40 µm in diameter.
Status: Medium
Habitat: Tree trunk and soil.
Distribution: Nepal (W, C, 800-2200 m): Kaski (800 m), Kavre (900-1000 m); Africa, Australia, Bhutan, Bolivia, Brazil, Burundi, China (Sichuan), Combodia, Cuba, Ecuador, India, Indonesia, Japan, Kenya, Maxico, Netherland, Sri Lanka, Taiwan, Thailand, United Kingdom and United State.
Remarks: This is a common species recorded from different localities of Kathmandu valley and Langtang National Park, Central Nepal (Yuzawa and Koike, 1994). This is a common and wide spread species in pantropical region. Previously it was known as *Frullania squarrosa* which is a synonym of *Frullania ericoides* (Hattori, 1987).

1.3 Frullania muscicola Steph., Hedwigia **33**: 146, 1894; S. Hatt. in Hara, Fl. E. Him. **1**: 526, 1966; Yuzawa & Koike, J. Hattori Bot. Lab. **75**: 194, 1994; Pradhan, Mats. Checklist Bryo. Nep.: 4, 2000a; Pradhan, J. Nat. Hist. Mus. **21**: 49, 2002; Kattel, Liverworts Nep.: 17, 2002; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 20, 2007b.

Plants light green to brownish, 10-25 mm tall. Stems with lateral leaves and ventral lobules. Rhizoids dark brown. Leaves lobules strongly saccate with 5-6 keeled perianth, slightly imbricate, entire with obtuse apex, 0.7- 0.9 x 0.5- 0.7 mm in diameter with smooth margin. Cells more or less uniform but basal cells somewhat larger, about 34 x 17 µm in diameter, trigones small. Plants dioecious, bracteoles generally ovate-lanceolate, bilobed with revolute margin and galeate on the older parts, perianth obovoid-oblong and smooth and dorsoventrally compressed. Androecia ovate,

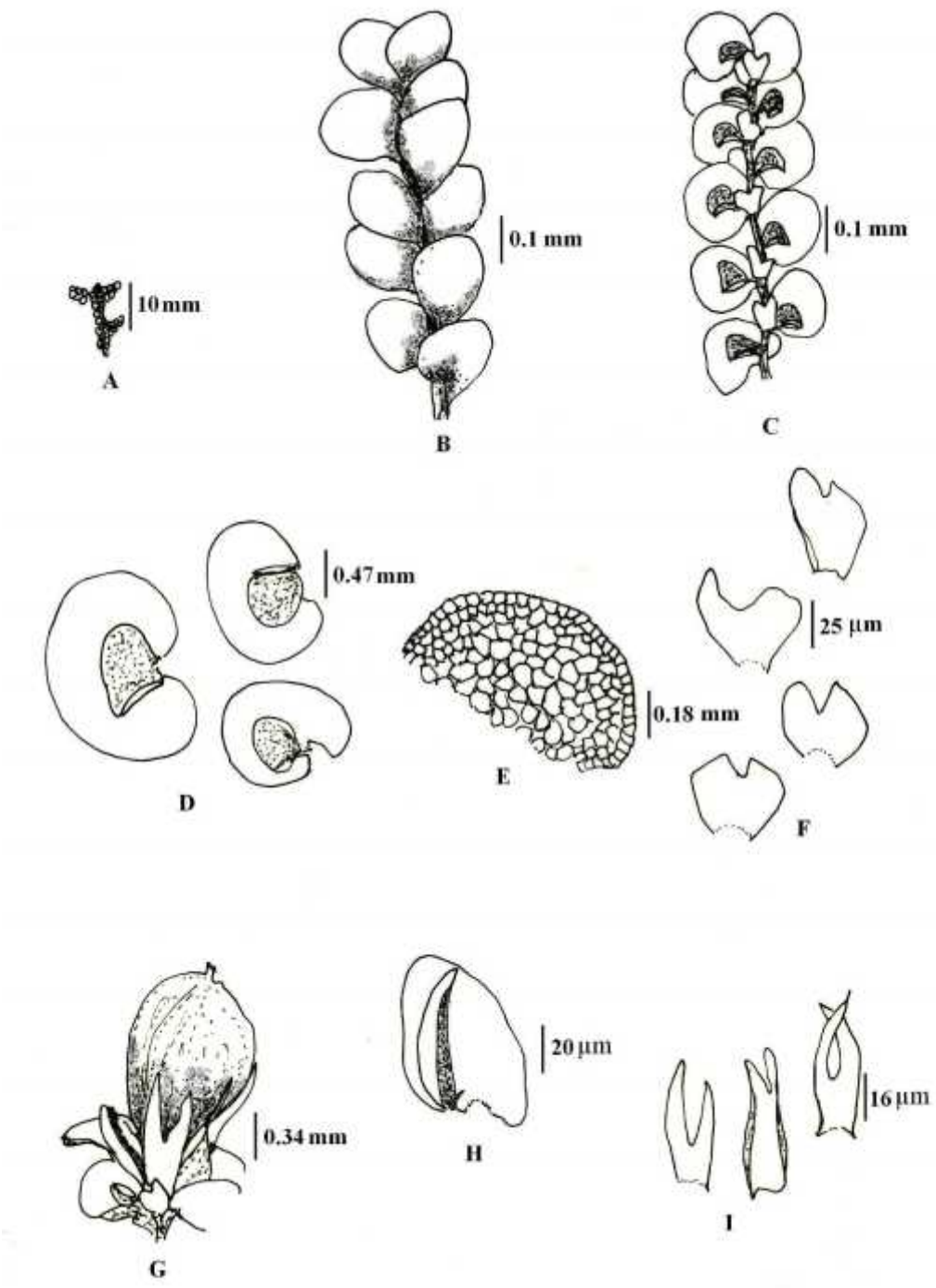


Fig. 19. *Frullania muscicola* Steph., A. habit, B. A branch enlarged, C. ventral face of the same branch, D. leaves, E.a portion of leaf showing marginal cells and middle laminal cells, F. under leaves, G. capsule, H. female bract, I. bractioles

involucral bracts longer than leaves. (Fig. 19).

Status: Common
Habitat: Moist soil, cliffs and barks.
Distribution: Nepal (W, C, 260-4000 m): Bardia (340 m), Kaski (800 m), Chitwan (260 m); China, Formosa, Himalaya, India, Japan, Korea, Mongolia, Munchuria and Saghalin.
Remarks: This is a common species of *Frullania* distributed from lowland to alpine regions. Piippo (1990) also recorded it as common species in China. Nath and Asthana (1998) described it as a common species in South India.

5.2.2.1.4. GEOCALYCACEAE

Plants small to robust, whitest - yellowish green to pale green. Stems prostrate and irregularly branched. The branches arise laterally, ventrally or terminally. Female branches which arise from the ventral surface are very small. Rhizoids are scattered ventrally to the underleaves basees. Leaves succubous, alternate or opposite, obliquely inserted. Leaf cells thin or thicked, trigones often present,oil bodies usually 12 per cell. Underleaves bilobed smaller than leaves. Male inflorescence spicate occasionally intercalory, bracts few to numerous. Female inflorescence terminal on the leafy branch. Female bracts are smaller than the leaves or remain almost vestigial. Perianth present, capsule ovoid to cylindrical.

The family represents 21 genera. 30 species are known from China. Three genera and eight species have been recorded in Nepal.

Tentative Key to the genera

1. Plants dioecious or monoecious, amphigastra bilobed, closely arranged 2
   Plants dioecious, aphigastra 4-lobed, distant .....**2.** *Heteroscyphus*

2. Gemmae lacking, male inflorescence intercalary ..... **1.** *Chiloscyphus*
   Gemmae present or absent, male inflorescence terminal on main axis..... **3**. *Lophocolea*

1. Chiloscyphus Corda, Opiz. Beitr. **1**: 651, 1829.

Plants dioecous or monoecious, medium to large and pale to dark green. Shoots procumbent to erect, branching irregular. Tuft of rhizoids arise from the underleaf bases. Leaves are alternate, succubouse, very obliquely inserted, entire, rounded to quadrate to oblong, dorsal margin decurrent, cells are thin walled, trigones are smaller, sometimes absent, about 2-8 oil-bodies are present in each cell. Underleaves are usually bilobed with teeth in one or both sides. No gemmae. Male bracts intercalary, resemble leaves, 1-2 antheridia in small inflexed lobe at the base of dorsal side. Female inflorescence on dwarf lateral branches, bracts smaller than leaves, usually with 2-3 lobes. Setae stout, capsules ovoid and spores usually 12-18 µm in diameter.

China reported 16 species from this genus (Piippo, 1996) and Nepal has only two species.

1. 1. Chiloscyphus polyanthos (L.) Corda in Opiz Correns Dumort., Sylloge. Jung. Europ. Indig: 67, 1831; Nog. *et al.,* Bull. Nat. Sci. Mus. **9**(3): 381, 1966; S. Hatt. in Hara, Fl. E. Him. **1**: 512, 1966; D. G. Long & Grolle, J. Hattori. Bot. Lab. **68**: 402, 1990; Pradhan, Mats. Checklist Bryo. Nep.: 12, 2000a; Kattel, Liverworts Nep.: 43, 2002.

Jungermannia polyanthos L., Sp. Pl.: 1131, 1753.
Jungermannia fragilis Roth., Tent. Fl. Germ. **3**: 370, 1800.
Chilocyphus fragilis (Roth) Schiffn., Krit. Bem. **4**: 27, 1910.

St. Winifred's Moss (Eng.).

Plants pale green to brownish, dorsoventally flattened, 2-4 cm long and rarely branched forms loose prostrate mat. Leaves alternate, imbricate, succubous, round or semi orbicular, margin entire, laminal cells pale green, papillous and parenchymatous about 18-26 µm in diameter, basal cellls are oval, 25 x 45-50 µm in sizes, oil bodies 2-4 per cell and trigone is not distinct. Amphigastra rather large, bilobed, sometimes with little tooth in the lateral margin, spread and appressed. Plants monoeceous. Antheridium singly in the axils of bracts which occur in several pairs in the mid or the end of the stems. Perianths on short lateral branches. The calyptra extends well beyond the mouth of the perianth. The mature capsule ovoid. Spores spherical, 12-18 µm in diameter and elaters 8 µm wide.
Status: Rare
Habitat: Moist damp soil near water source.
Distribution: Nepal (W, E, 350-3400 m): Dang (350 m); Bhutan, China (Sichuan), Himalaya, India (Darjeeling, Sikkim), Japan, Morocco, North Africa, North America, Siberia, Tunisia and Turkey.

2. Heteroscyphus (Tayl.) Schiffn., Oesterr. Bot. Z. **60**: 171, 1910.

Members of this genus can be recognized easily from the shapes and arrangements of leaves. Leaves succubouse, often toothed and almost square or rectangular. Margins slightly raised from the substratum and succubose. Ventral leaf margins often toothed. Under leaves well developed. Stem branched, creeping in habit and found mostly upon rotton logs, moist rocks and soil. Plants dioecious.

Heteroscyphus is the largest genus with major diversity found in tropic and more than 100 species have been recorded (He-Nygren, & Piippo, 2003) and 10 species from China (Piippo, 1996). Nepal has recorded four species of *Heteroscyphus*. One more species is added in the present investigation. Two species are described from the lowland and *Heteroscyphus planus* (Mitt.) Schiffn. is new record for Nepal.

Key to the species

1. Teeth usually not well developed, two in number ..... **2.** *Heteroscyphus planus*
   Teeth well developed, three or more..... **1.** *H. argutus*

2.1 Heteroscyphus argutus (Reinw. et al.) Schiffn., Oesterr. Bot. Zeitschr. **60**: 169-179, 1910; Grolle, Ergebn. Forsch.-Unternehmen Nep. Him. Bd.1. Liefg.**4**: 264, 1966; D. G. Long & Grolle, J. Hattori Bot. Lab. **68**: 402, 1990; Pradhan, Mats. Chicklist Bryo. Nep.: 5, 2000a; Kattel, Liverworts Nep.: 43, 2002; He-Nygren & Piippo, Ann. Bot. Fennici. **40**: 320, 2003.

Jungermannia arguta Reinw. *et al.*, Nova Acta Phys, Med. Acad. Caes. Leop.- Carol. Nat. Cur. : 12- 206, 1824.
J. retrospectans Nees in Spreng., Syst. Veg. **4**(2): 325, 1827.
Chiloscyphus argutus (Reinw. *et al.)* Nees in Gottsche, Lindenb. & Nees, Sys. Hepat **2**: 183, 1845.
C. endlicherianus (Nees) Nees var. *muelleri* Gottsche, Linnaea **28**: 554, 1856.

Plants yellowish green to dark green, creeping usually 2-3 cm long and less than 3 mm wide forming dense parches on the substratums. Stems branched. Leaves alternate, rarely overlapped, imbricate, more or less quadrate to rectangular and measure about 1 x 1.5 mm in sizes. Outer margin with 3-5 teeth, rest portion smooth, laminal cells are hyaline to light brown, hexagonal to quadrate, 20 x 17 µm in diameter. Under leaves small, well developed, distant and deeply 4-lobed. (Fig. 20).
Status: Common
Habitat: On soil and boulder stones, damp rocks
Distribution: Northwest Nepal (W, C, E, 280-2900 m): Dang (780 m), Bara (230 m), Chitwan (280 m), Parsa (230 m); Africa, Australia, Bhutan, Brazil, China, India (Darjeeling, Sikkim), Japan, Java, New Guinea, New Zealand, Oceania and Taiwan.

2.2. *Heteroscyphus planus (Mitt.) Schiffn., Osterr. Bot. Zeitschr. **60**: 171, 1910; Z. Haseg. & Takimoto, Mem. Coll. Agric., Kyoto Univ. **126**(6): 63, 1985; Piippo, Ann. Bot. Fennici **35**: 45-47, 1996.
Chiloscyphus planus Mitt., J. Proc. Linn. Soc. London **8**: 157, 1865.

Plants olive green or greyish green, 1-3 cm long and 1.2-2 mm wide with expanded leaves. Stems light brown, flat with small rectangular cells 125 µm in diameter. Rhizoids smooth walled, pale white, cluster at the base of ventral leaves, 23 µm in diameter. Leaves alternate occasionally distant, rectangular, 0.6-0.8 mm long and 0.3-0.8 mm wide with 2-3 teeth at the apical margin, occasionaly 4-5 or only one. Teeth usually 1-4 cells long, apeces with or without an irregular V or U shaped sinus between the teeth. Laminal cells hexagonal, thick walled, 20-38x20-38 µm in diameter, marginal cells at the apical region 13-25 x 15-30 µm in diameter. Trigones absent. Underleaves hyaline, usually rectangular usually with two teeth. Perianth deeply lobed and toothed (Fig. 21).

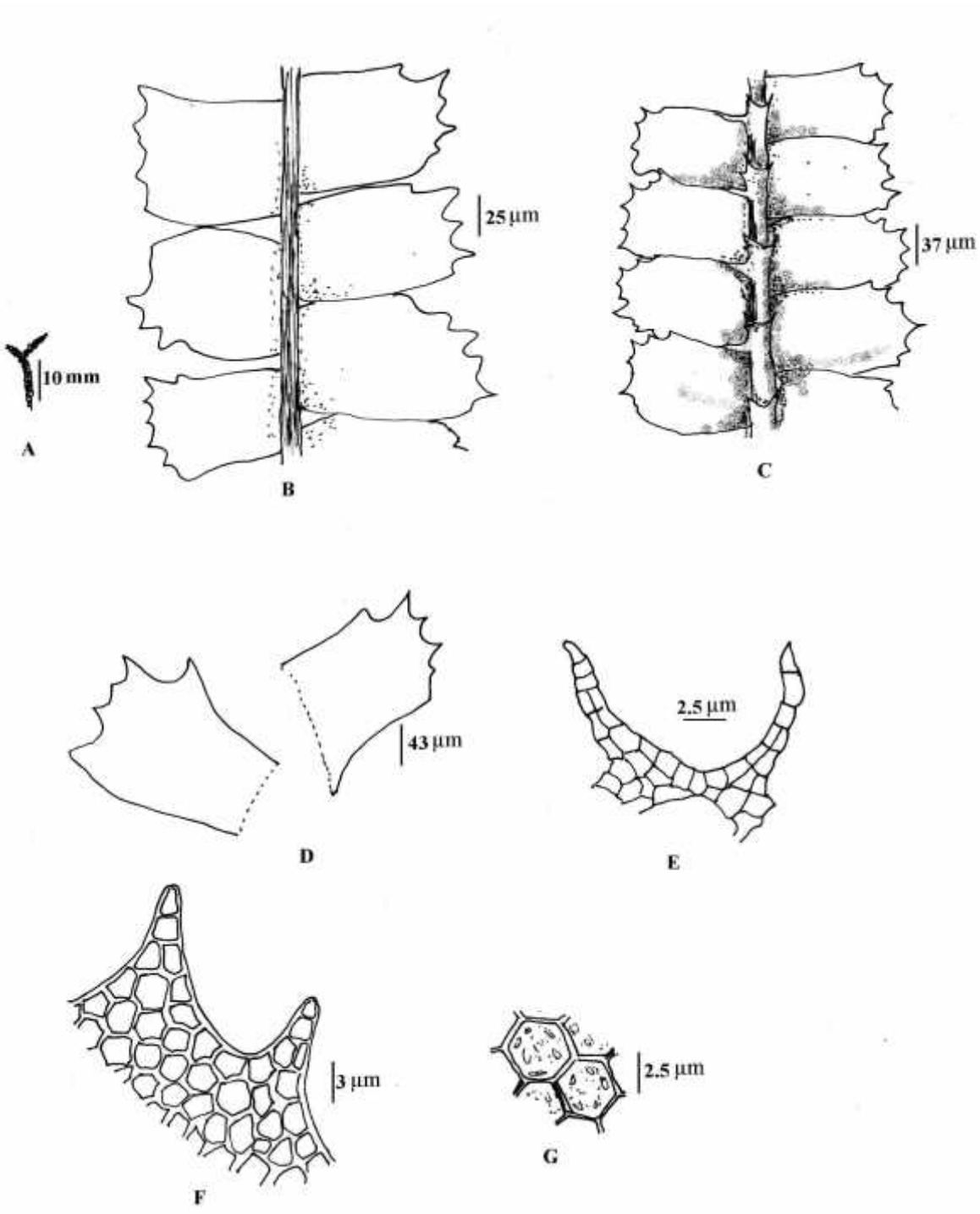


Fig. 20. *Heteroscyphus argutus* (Reinw *et. al.*) Schiffn. (Pradhan, Pn 263). A. habit, B. a portion of plant from dorsal view, C. a portion of plant from ventral view, D. leaves, E. under leaf, F. apical teeth and laminal cells, G. laminal cells in the median region.

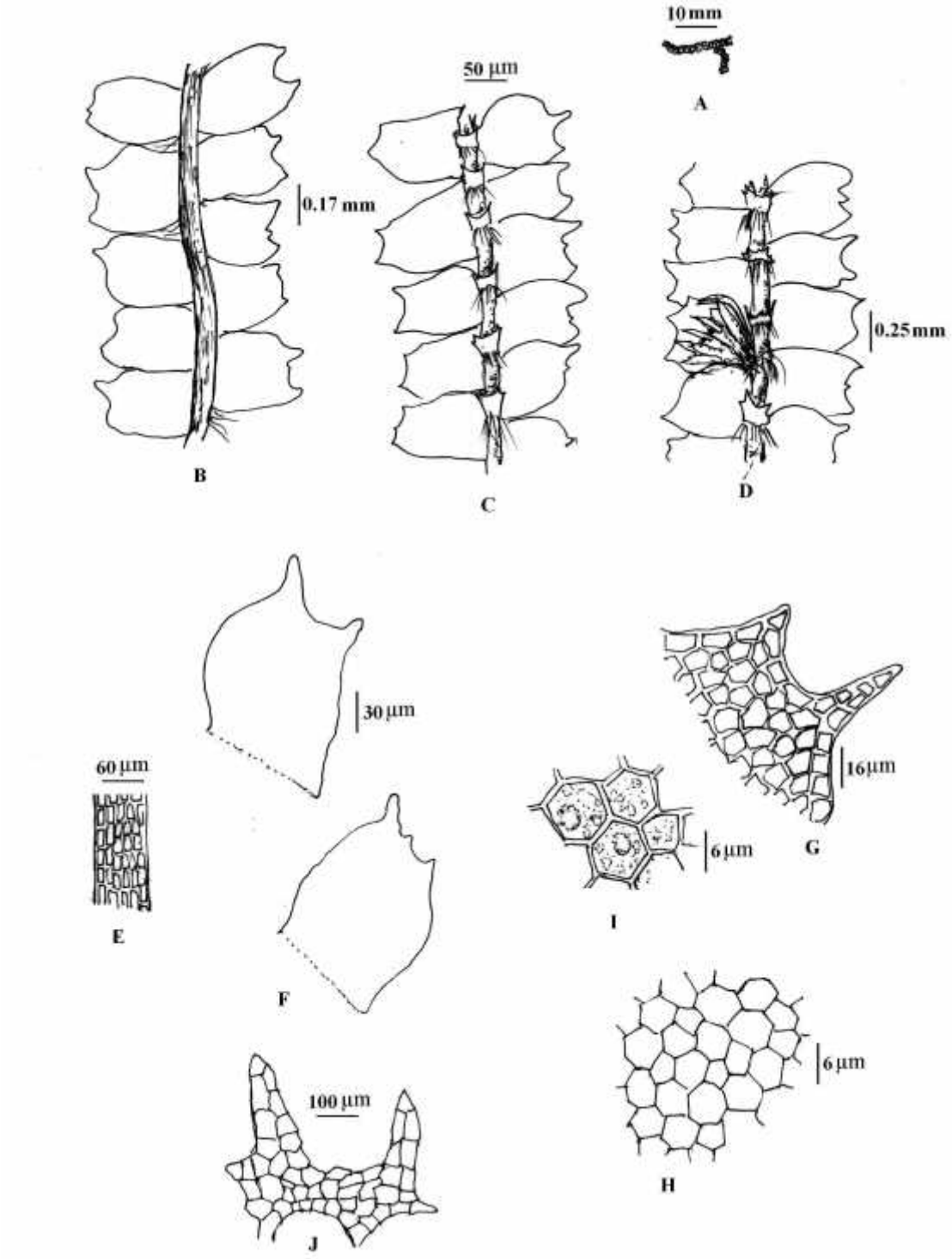


Fig. 21. *Heteroscyphus planus* (Mitt.) Schiffn. (Pradhan c 391). A. habit, B. a portion of the plant from dorsal view, C. a portion of the plant from ventral view, D. a portion of plant with female organ, E. a portion of the stem, F. leaves in different shapes, G. leaf margin, H. cells of middle lamina, I. middle laminal cells enlarged, J. under leaf.

Status: Rare
Habitat: Soil.
Distribution: Nepal (C, 600 m): Bara (6oo m); China and Japan.

Remarks: *Heteroscyphus planus* is closely related with *Heteroscyphus argutus* and only differentiated in number of teeth. *Heteroscyphus argutus* usually has 3-5 teeth while the teeth of *Heteroscyphus planus* are less developed. Some leaves however be even entire as in *Heteroscyphus coalitus* but not translucent. This is new record for Nepal.

3. Lophocolea (Dumort.) Dumort., Recueil Observ. Jungerm.: 17, 1835.

Plants vary from small to robust, yellowish green to whitish in colour. Stems irregularly branched and creeping. Rhizoids in cluster at the base of underleaves. Leaves succubous, alternate, very obliquely inserted, often spread horizontally. Underleaves bilobed, gemmae may be present, if present 1-multicellular. Male inflorescence terminal on branch, sometimes intercalory or below female, bracts saccate at the base and antheridia solitary. Female inflorescence terminal on the main shoot, bracts usually bilobed, bracteole smaller than bracts. Capsules ovoid, Spores 8-22 µm in diameter.
Three species of *Lophocolea* has been reported from Nepal.

3.1. Lophocolea minor Nees, Hepat. Eur. **2**: 330, 1836; Nog. *et al.*, Bull. Nat. Sci. Mus. **9** (3): 380-381, 1966; S. Hatt. in Hara, Fl. E. Him. **1**: 512, 1966; D. G. Long & Grolle, J. Hattori Bot. Lab. **68**: 403, 1990; Pradhan, Mats. Checklist Bryo. Nep.: 12, 2000a; Kattel, Liverworts Nep.: 44, 2002; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 21, 2007b.

Lophocolea heterophylla var. *minor* Douin., Rev. Bryol.: 23, 1907.

Plants small, delicate, yellowish green to pale green. Stems usually prostrate, upto 1-1.5 cm long 1-1.5 mm broad with sparse branches. Rhizoids long, hyaline in smaller tufts arising from the base of the amphigastra. Leaves alternate mostly distant, quadrate to sub rectangular, 0.5 x 0.4 mm in size, bilobed with broad rounded sinus, margin entire. Laminal Cells thin walled, 25-30 µm in diameter, marginal cells 20 µm in diameter, trigones small, oil bodies 5-6 per cell, spherical to elliptical in shapes. Gemmae always present, yellowish green, thin walled, spherical, 2-celled after maturation. Amphigastra erecto-patent, divided to the base into two narrow acute lobes. Male bracts with few lobes. Female bracts larger than the leaves and with 2-3 lobes. Parianth narrow and long. Spores sphrical, 10 µm in diameter, elaters long, 8-10 µm wide.
Status: Rare
Habitat: Soil and tree barks.
Distribution: Nepal (C, 600-2700 m): Kavre (600 m); Bhutan, China, Europe, India, Korea, Japan, Pakistan, North America, Siberia and Turkey.

5.2.2.1.5. JUNGERMANNIACEAE

Plants vary in suze from very small to large. Shoots erect to prostrate, dorsoventrally flattened with terminal or lateral or ventral branching. Rhizoids numerous, associated with leaves or underleaves bases or scattered. Leaves in three ranks, of them two are lateral and one is ventral called Amphugastra, which is usually small, sometimes vestigial. Leaves succubous, reniform, orbicular to spathulate, variously ovate to cordate, margin entire and rarely retuse, obliquely inserted. Underleaves if present are very small, Gemmae very rare. Male inflorescences terminal, sometimes intercalary or below female, male bract with saccate at the base. Female bract usually one in pair. Perigynium sometimes present, bearing bracts or not. Perianths smooth or plicare. Capsules ellipsoidal to spherical. Setae many celled in diameter. Spores spherical, 9-24 µm in diameter.
This is the largest family with 19 genera recorded in the world (Smith, 1996). Four genera and 36 species have been reported from Nepal (Pradhan, 2000a).

Key to the genera

1. Plants dioecious, mid-leaf cells less than 48-72 µm wide ..... **3.** *Mylia*
Plants paroecious, mid-leaf cells greater than 16-40 µm wide 2

2. Apical leaves pressing face to face, lower leaves spreading, perianth mouth ciliated or denticulate..... **1.** *Jamesoniella*
Apical leaves and lower leaves both succubously arranged, prianth mouth at most crenulate..... 3

3 Perianths generally exserted from female bracts, leaves opaque without persistent oil-bodies, under leaves lacking ……...… **2**. *Jungermannia*
Perianth not exserted, leaves translucent, oil bodies persisting, underleaves present ... **4.** *Nardia*

1. Jamesoniella (Spruce) Carrington in F. Lees, London Catal. Brit. Moss. Hepat. ed. **2**: 25, 1881.

Plants dioecious, red to purplish with variable sizes. Shoots generally prostrate to erect, markedly dorsoventral, branches terminal, lateral and ventral. Rhizoids associated with leaf bases, underleaf bases may be scattered, usually numerous. Leaves succubous and pressing face to face at the apical region and spreading at the lower region, reniform, orbicular to spathulate or variously ovate to cordate, entire or rarely retuse, trigones often present, oil bodies vary in number, usually 7-20 per cell. Perianth mouth ciliated. Underleaves if present are very small, subulate to lanceolate and present in female shoot which do not bear cilia. Gemmae lacking. Male inflorescence terminal or below female, antheridia usually solitary, male bracts imbricate, concave and saccate at the base. Female bracts usually toothed at the base, perigynium lacking. Capsules wall with 4-5 stratose.

About 40 species have been recorded from tropical and southern hemisphere (Smith, 1996). Three species are known in Nepal, of which two species have been recorded at the temperate and one at the tropical regions which are described here.

1.1. Jamesoniella autumnalis (D.C.) Steph., Spec. Hepat. **2**: 92, 1901; Nog. *et al.*, Bull. Nat. Sci. Mus. **9**(3): 381, 1966; S. Hatt. in Hara., Bryo., Fl. E. Him. **1**: 510, 1966.

Autumn flapwort (Eng.).

Plants dark green to red-tinged, opaque and in the patch form. Shoots procumbent, 2 cm long. Rhizoids pale white, numerous scattered on the ventral surface. Leaves succubous, orbicular, slightly concave, not undulate, 0.55-1.2 x 0.55-1.2 mm in diameter with entire margin, middle laminal cells 20-32 µm in wide with numerous chloroplast and with thin cell wall, marginal row of cells small with thick cell wall, trigones small or absent.Underleaves lacking or very small found on the upper part of fertile female shoots. Gemmae lacking. Male inflorescences terminal and become intercalory with age, male bracts concave, closely imbricate. Female bract erect, not undulate, capsules rare.
Status: Rare
Habitat: Damp and humus soil.
Distribution: Nepal (C, 600-1800 m): Kavre (600 m); China, Fennoscandia, Great Bratain, Iceland, Japan, Korea, Russia, Siberia and Turkey.

2. Jungermannia L., Sp. Plant. ed. **1**: 1131, 1753.

Plants dioecious or paroecious, vary in sizes, yellowish green to brown. Shoots prostrate to erect, branches arise laterally, innovations arise underneath the perianth. Rhizoids hyaline to brown or deep red to purple. Leaves alternate, obliquely inserted, succubous, reniform, orbicular, ovate to elliptical and entire. Underleaves and gemmae usually lacking. Oil bodies one to several per cell. Male inflorescence terminal, intercalary or below the female, bracts similar to leaves, entire, bracteoles lacking. Perigynium lacking or variable in sizes with 1-2 pairs of female bracts. Spores 10-24 µm in diameter.

About 90 species of *Jungermannia* ranging from the Arctic to the sub Antarctic regions have been recorded. Nepal has the record of about 36 species till date.

Key to the species

1. Plants paloecious ……..…….….. 2
   Plants dioecious ……..…… 3

2. Plants yellowish green to brown, 3-8 mm long, periant reniform **2**. *Jungermannia confertissima*
   Plants dull green to brackish, 10-20 mm long; perianth fusiform ……....……. **9.** *J. pumila*

3. Plants variable in colour; stem rarely branched; capsule oval, dark brown…….……..... 4
   Plants bright green; stem unbranched; capsule spherical, purplish ……..…… **6.** *J. infusca*

4. Trigone absent ……..... 5
Trigone present ……..……. 11

5. Plants bright green to yellowish brown; leaves elliptical ……..…….. 6
Plants lamon yellow; leaves rotund, wider than long ……..…..... **7.** *J. marcocarpa*

6. Leaves oval–elliptic; rhizoids clustered ……..…..……. 7
Leaves ovate-cordate; rhizoids scattered with elongated knob at the tip ……..… **4.** *J. exertifolia*

7. Plants purplish green; stems less than 3 cm long …….. **10.** *J. subulata*
Plants bright green to yellowish gree; stems more than 3 cm long ……..……. 8

8. Leaves closely imbricate, leaves more than 2 mm, margin entire …….. 9
Plants distantly inbricate; leaves less than 2 mm, margin slightly wavy..... **11.** *J. tetragona*

8. Stems stout, dark brown ……..……..……. 10
Stems soft, dull green ……..……. **2.** *J. comatum*

10. Stems somewhat accending; laminal cells 34 x 102 µm ……...…..….. **12.** *J. truncata*
Stems procumbent; laminal cells 86 x36 µm ……...…. **8.** *J. minutiverrucosa*

11. Leaves rotund, appress to the stem on drying; trigones slightly bulging ..... **1.** *J. appressifolia*
Leaves orbicular, not appress to the stem on drying; trigones distinctly bulging ... **5.** *J. hyalina*

2.1. Jungermannia appressifolia Mitt., J. Proc. of the Linnean Soc. **5**: 91, 1861.

Jungermannia gollanii Steph., Spec. Hepat. **6**: 86, 1917; Mizut. *et al.*, Crypt. Him. **3**: 132, 1995.
Jungermannia tenerrima Steph., Spec.Hepat. **6**: 94, 1917.

Plants yellowish brown, branched, 30 mm long and 2 mm broad forming in tuft on substratums. Stems erect, rigid, 0.3 mm thick. Rhizoids few towards the stem apex and somewhat numerous below. Leaves appressed to the stem on drying, imbricate obliquly spreading, concave, rotund, 0.8 mm long, 1 mm wide, middle laminal cells 36-36 µm in diameter, trigone slightly bulging, Plants dioecious. Female bracts in pair similar to stem leaves.
Status: Rare
Habitat: Humus soil.
Distribution: Nepal (W, C, E, 200-2000 m): Palpa (300 m), Makwanpur (230 m); Bhutan, Burma, China, East India, and Northwest Himalaya.

2.2. Jungermannia comata Nees, Hepat. Java.*:* 78, 1830; Karcz., Lindbergia **7**: 129, 1981; Mizut. *et al.*, Crypt. Him. **3**: 132, 1995; Pradhan, Mats. Checklist Bryo. Nep.: 7, 2000a; Kattel,

Liverworts Nep.*:* 27, 2002.

Plagiochila comata (Nees) Dumort., Rec. D'Observ.: 15, 1835.
Solenostoma comatum (Nees) C. Geo, Fl. Hepaticarum Chinae Boreal-Orientalis **73**: 220, 1981.

Plants dull green, creeping and branched. Rhizoids on ventral surface. Leaves concave to ovate, succubous and distant at the basal region. Leaf margin entire, middle laminal cells more or less oval to quadrate. Plants dioecious, sporophyte terminal.
Status: Rare
Habitat: Soil.
Distribution: Nepal (W, E, 800-1670 m): Kaski (800 m); Burma, China, India (Sikkim, Assam), Japan, Java, Korea, Malay Pen, Philippines, Sumatra, Taiwan and Thailand.

2.3. Jungermannia confertissima Nees, Naturg. Europ. Leberm. **1**: 277, 291, 1833; Vana, J. Hattori Bot. Lab. **36**: 63, 1972; D.G. Long & Grolle, J. Hattori Bot. Lab. **68**: 395, 1990; Sm., Liverworts Britain & Ireland: 142-143, 1996; Pradhan, Mats. Checklist Bryo. Nep.: 7, 2000a; Kattel, Liverworts Nep.*:* 27, 2002.

Jungermannia duthiana Steph., Spec. Hepat. **2**: 71, 1901; Amakawa, J. Hattori Bot. Lab. **30**: 196, 1967.

Kidney Flapwort (Eng.).

Plants yellowish brown, unbranched, procumbent to erect, 3-8 mm long and 1 mm broad with expanded leaves. Rhizoids smooth walled, pale brown, 6 µm in diameter, clustering at the base and axil of the leaves. Leaves generally succubouse, closed imbricate at the apical region and far alternate at the basal region, erectopatent, slightly concave, decurrent on both the sides, oval, yellowish brown, about 0.3-0.4 mm long and 0.1 mm broad, apical margin irregularly crenulated due to projection of marginal cells, middle laminal cells hexagonal to reactangular, 25-30 x15-25 µm in diameter, basal cells quite large with thin walled. Oil bodies present, 6-10 in number in each cell, 26-41 µm in diameter, trigones small. Gemmae lacking. Plants paroecious, male bracts 2-6 pairs below female, erect, imbricate and saccate. Female bracts ebracing the lower part of parianth, reniform. Capsules terminal, elaters thick, bispiral, 100 µm long, spores small, spherical, light green, 18-20 µm in diameter.
Status: Rare
Habitat: Damp soil and shaded rocks.
Distribution: Nepal (C, E, 350-2800 m): Makwanpur (350 m); Bhutan, Caucasus, China, Europe, Greenland, Himalaya, Iceland, Japan, North America, Papua New Guinea, Soviet Union and Siberia.
Remarks: This species was reported for the first time from east Nepal, 2830 m, (Amakawa,1972)

2.4. *__Jungermannia exertifolia__ Steph., Spec. Hepat. **6**: 86, 1971; Vana, J. Hattori Bot. Lab. **35**: 312, 1972; Vana, Folia Geobot.& Phytotaxo. **8**: 268, 1973; Sm., Liverworts Brit. & Ireland: 142, 1996.

Aplozia cordifolia (Dumort.) Vana, Folia Geobot. et Phytotaxo. **8**: 268, 1973.
Solenostoma cordifolium (Dumort.) Steph., Bull. Herb. Boissier, Ser. 2**, 5**: 499, 1901.

Cordate Flapwort (Eng.).

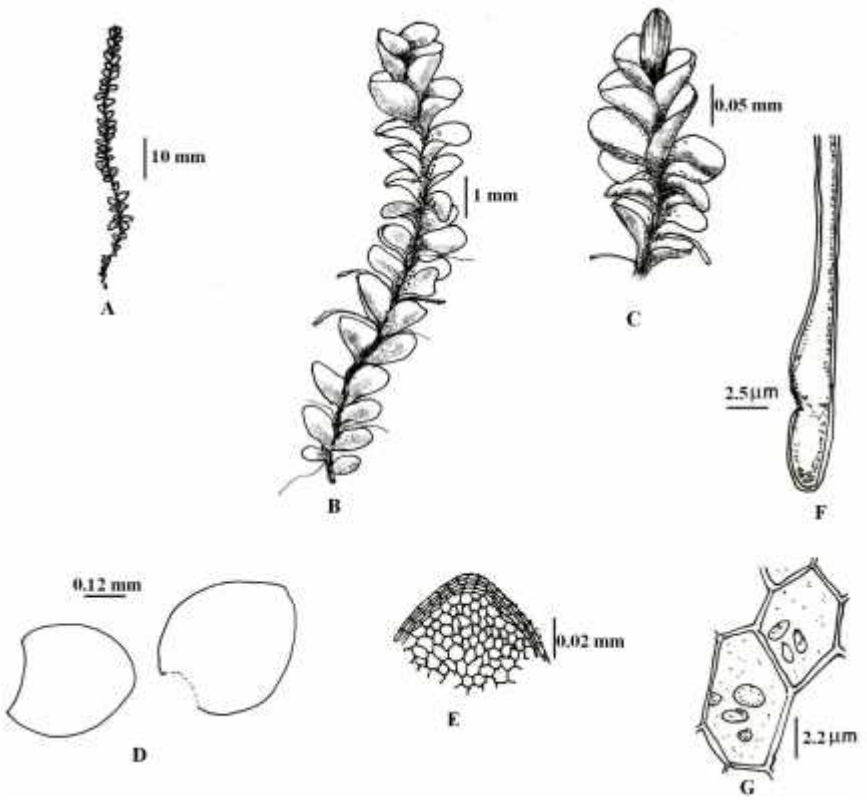


Fig. 22. *Jungermannia exertifolia* Steph. (Pradhan Pn 134). A. habit, B. the sterile plant enlarged, C. a portion of female branch, D. a portion of rhizoid with knob end, E. leaves, F. apical portion of the leaf, G. a laminal cell.

Plants large, dull green to brownish, procumbent, rarely branched, 5-6 cm long and 3 mm broad with expanded leaves and found in the form of patches. New branches arise from the older stem. Rhizoids generally hyaline to light brown, long with elongated knob at the end, few in numbers, occuring mostly near the stem base. Leaves distant to subimmbricate, flaccid, erectopatent, concave, ovate cordate to round cordate, 1.8 -2 x 1.5 mm in size, margin smooth, marginal cells reactangular, 6 celled thick, 34 x 17 µm in diameter, middle laminal cells hexagonal double walled and with 2-6 oil bodies in each cell, trigones very small or lacking. Gemmae lacking. Plants dioecious. Male bracts numerous, reflexed and saccate at the base. Female bracts orbicular, erecto-patent, embrassing the parianth base (Fig. 22).

Status: Rare
Habitat: Wet boulder stones.
Distribution: Nepal (C, 300 m): Chitwan (300 m); British Columbia, Canada, Caucasus, China, Europe, Greenland, Iceland, Japan, North Italy and South Spain.
Remarks: Amakawa (1960) and Vana (1972) considered it as a subspecies of *Jungermannia cordifolia* Hook. It differs from *J. cordifolia* by its ovate oblong leaves which only cordate at the base. But Schuster (1969) stated that both texa are conspecific. The species is recorded as new to Nepal.

2.5. Jungermannia hyalina Lyell in Hook., Brit. Jungerm, Tab. **63**: 1814; Grolle, Khumbu Himal, Bd. 6, Lfg.: 120, 1974; Pradhan, Mats. Checklist Bryo. Nep.: 7, 2000a; Kattel, Liverworts Nep.*:* 28, 2002.

Transparent Flapwort (Eng.).

Plants pale green to yellowish green, occasionally reddish green found on the form of patches. Stems procumbent to erect, fleshy, rarely branched, 1-2 cm long and 2 mm broad with leaves. Rhizoids numerous, reddish-purpled arise from leaf bases at the ventral surface. Leaves orbicular to obliquely orbicular with wide base, decurrent on dorsal ide, 0.8 to 1.5 mm long and 0.8-1.8 mm wide, margin smooth, marginal cells more or less hexagonal, middle laminal cells hexagonal, thin walled, 34 x 50 µm in diameter, each cell with 5-6 oil bodies, trigone distinct and bulging; leaves at the basal region of the stem apart, , obliquly inserted. Gemmae lacking. Plants dioecious. Male bracts 3-8 in pairs, saccate with spreading tips. Perigynium present with one pair of reniform bracts (Fig. 23).
Status: Common
Habitat: Rocks near streams, boulder tops and damp humas soil.
Distribution: Nepal (C, E, 260-4000 m): Chitwan (260 m); Asia minor, Azores, Caucasus, China, Europe, Iceland, Ireland, Japan, Macaronesia, North Africa, North America, Siberia and Turkey.

2.6. *Jungermannia infusca (Mitt.) Steph., Spec. Hepat. **2**: 74, 1901; Vana & Inoue, Bull. Natn. Sci. Mus, Tokyo, ser. B. **9**(4): 131, 1983; Hasegawa & Takimoto, Mem. Coll. Agr., Kyoto Univ. **126**(6): 61, 1985.

Prectocolea infusca Mitt., Trans. Linn. Soc. London 2, **3**: 196, 1891.
Nardia infusca (Mitt.) Steph., Bull. Herb. Boiss. **5**: 81, 1897.

Plants large patch of velvety bright green intermingle with mosses, generally creeping and overlapping each other. The exposed portion bright green and unexposed portion dull brown. Stems usually unbranched, 8-10 mm long, flat with rectangular cells (12 x 23 µm in diameter). Rhizoids long, pale brown arise from the creeping stem. Leaves on exposed parts succubous, large, oval with entire margin, leaf cells green containing chlorophyll and 2-3 oil bodies about 9

µm in diameter, cells oval 34 x 23 µm in diameter. Leaves upon unexposed stems are alternate, pale brown, oval and 442 x 430 µm in sizes, cells hexagonal usually without chlorophyll and oil bodies, marginal cells generally quadrate. Plants dioecious, sporophytes on apical region. Capsule spherical, dark purplish to maroon, 0.5 mm in diameter, on smooth hyaline seta, about 2-4 mm long and 0.5 mm wide. Spores numerous, sphrical, light brown, 20.5 µm in diameter, elaters light brown, double banded with blunt ends (Fig. 24).

Status: Rare

Habitat: Sandy soil

Distribution: Nepal (C, 260 m): Chitwan (260 m); China, Japan, Taiwan, and U.S.S.R.

Remarks: New record for Nepal.

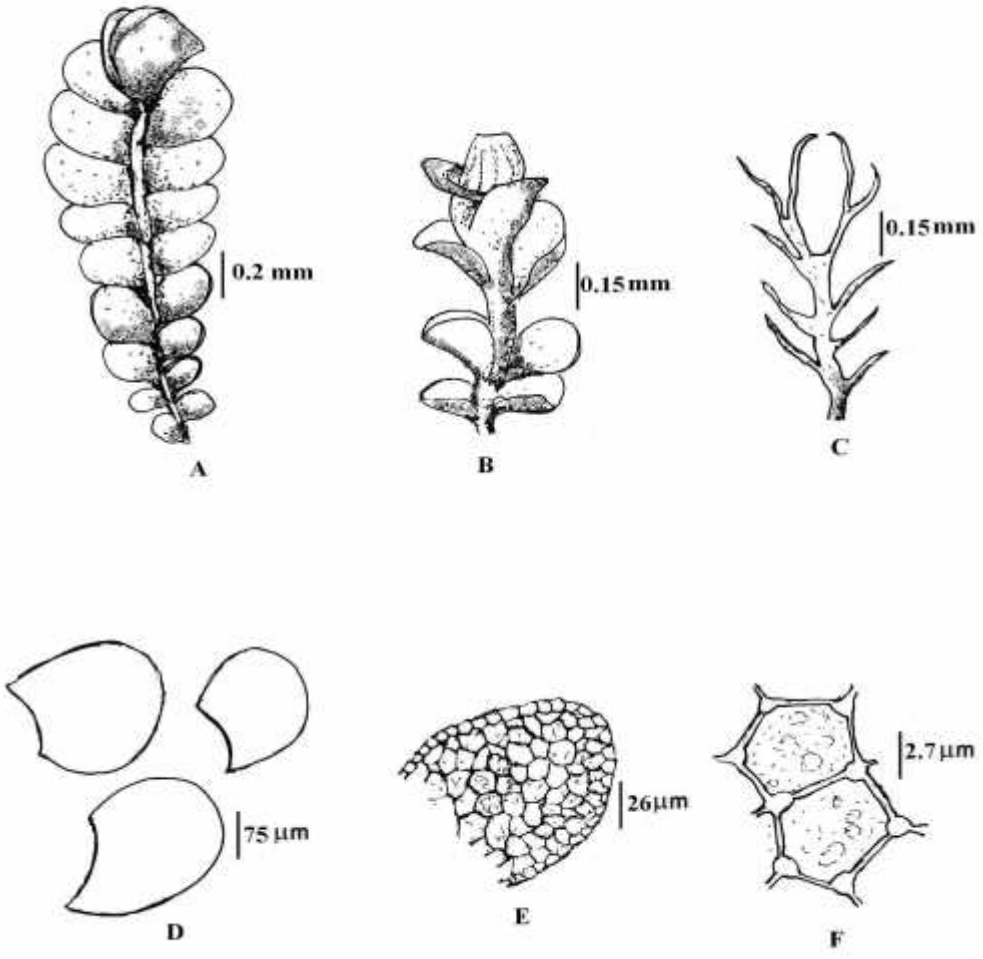


Fig. 23. *Jungermannia hyalina* Lyell., A. a vegetative plant, B. A fertile portion of the plant, C. verticle section of the fertile portion, D. leaves, E. leaf showing cell structure, F. middle laminal cells.

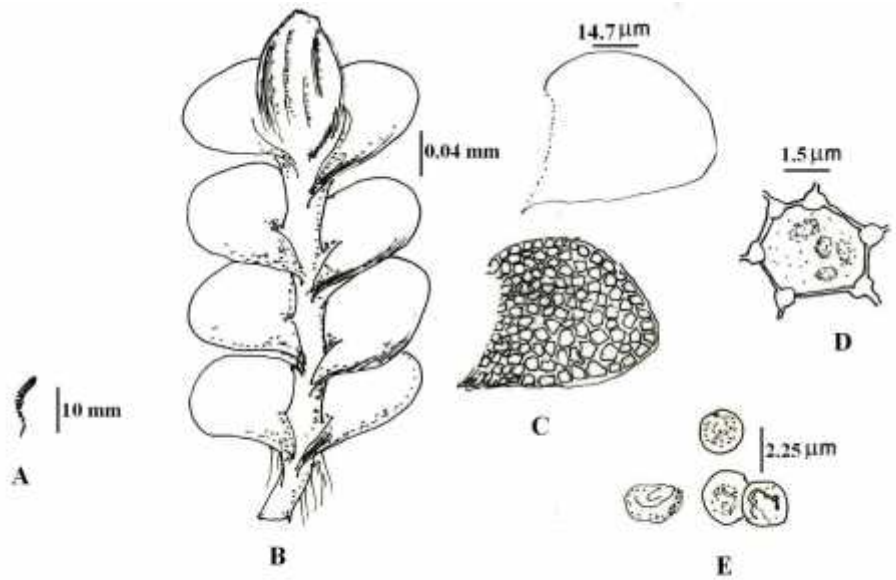


Fig. 24. *Jungermannia infusca* **(**Mitt.) Steph. A. habit, B. a fertile branch, C. leaves, D. a laminal cell with trigones, E. spores.

2.7. Jungermannia macrocarpa Steph., J. Hattori Bot. Lab. **30**: 190, 1967**;** Amakawa, J. Hattori Bot. Lab. **30**: 190, 1967; D.G. Long & Grolle, J. Hattori Bot. Lab. **68**: 395, 1990; Kattel, Liverworts Nep.: 28, 2002.

Plants flaccid, tinged with red, 9-20 mm long. Stems creepinig, fleshy, rarely branched. Rhizoids numerous, tufts purplesh towards the base at the attach point of stem and brown straw color at the apical region, long and 12 µm in diameter. Leaves compact, succubous, imbricate and ventral margins imbraced to the stem, dorsal margin orbicular, concave, rotund, 1-1.5 mm long, 1.2-2 mm broad, middle laminal cells more or less oval to hexagonal 17-20 x 30-45 µm in diameter, marginal cells 20- 48 x 20-32 µm in diameter. Plants dioeciuos. Male plants slender and distinct.
Status: Rare, endemic to East Himalaya.
Habitat: Humas covered rock near water sources intermingle with *Hyophila involuta* (Pn 214).
Distribution: Nepal (C, E, 200-2900 m): Chitwan (200 m); Bhutan, China and India.

2.8. Jungermannia minutiverrucosa Amakawa, J. Hattori Bot. Lab. **25**: 390, 1972; Mizut. *et al.*, Cryp. Him. **3**: 133, 1995; Pradhan, Mats. Checklist Bryo. Nep.: 8, 2000a; Kattel, Liverworts Nep.: 28, 2002; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 21, 2007b.

Plants bright green forming mats on the substratum. Stems brown, stout, cylindrical, procumbent, 1.5 -2 cm long, 4 mm wide with expanded leaves and rarely branched. Rhizoids long, purplish brown on ventral surface of the creeping stem. Leaves succubose, semi-transparent, oval with entire margin, 1.5 x1 mm in diameter, laminal cells hexagonal, 86 x 36 µm in diameter, trigones not seen. Plants dioecious, sporophytes terminal.

Status: Rare
Habitat: Soil.
Distribution: Nepal (E, 1000-2100 m): Sankhuwasabha (1000 m); Japan, New Guinea, Sumatra and Thailand.

2.9. * Jungermannia pumila With., Arrang. Brit. Pl. ed. 3, **3**: 883, 1796; Arnell, Moss Fl. Fennos **1**: 106, 1956; Amakawa, J. Hattori Bot. Lab. **22**: 49, 1960; Vana, J. Hattori Bot. Lab. **35**: 315, 1972; Vana, Folia Geobot. Phytotax., Praha, **8**: 285-292, 1973; Sm., Liverworts of Brit. & Ireland*:* 138-140, 1996.

Jungermannia zeyheri Hubuene, Hep. Germ. : 89, 1834.
Jungermannia rostellata Hubuene, Hep. Germ.: 95, 1834.
Jungermannia clavata Hook. F. & Tayl., London J. Bot. **4**: 88, 1845.
Aplozia pumila (With.) Dumort., Bull. Soc. Roy. Bot. Belgique **13**: 59, 1874.
Aplozia pumila var. *rivularis* Schiffn., Lotos **48**: 326, 1900.

Dwarf Flapwort (Eng.).

Plants small, dull green to blackish green. Shoots 1-2 cm long and 0.3 mm broad. Stems procumbent, apical part of stem ascending. Rhizoids numerous hyaline to brownish. Leaves

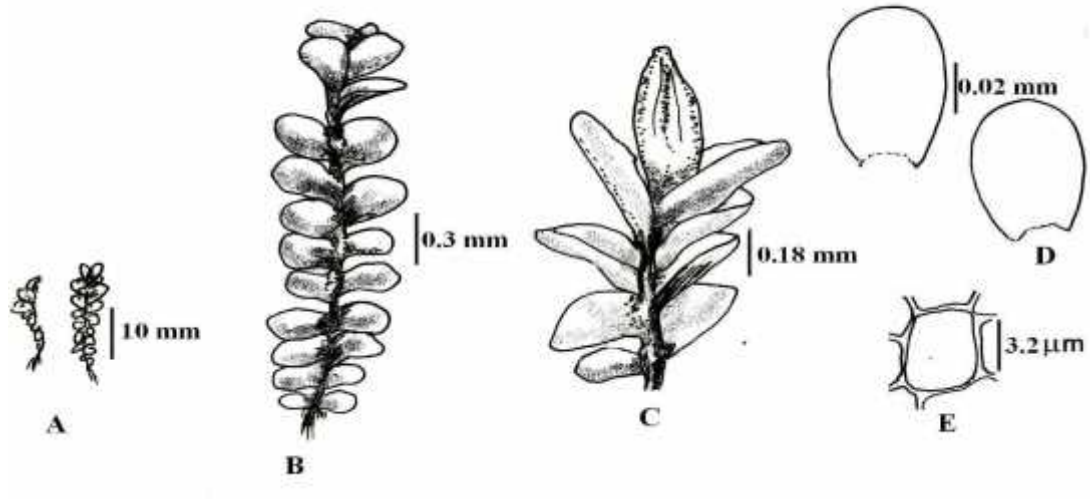


Fig. 25. *Jungermannia pumila* With. (Pradhan Pn 367, dt 332). A. habit, B. a sterile plant, C. a fertile shoot, D. leaves, E. a laminal cell.

loosely imbricate, obliquely inserted, more or less uniform, dark green, elliptical to ovate, somewhat concave, erect to erecto-patent and 0.4 x 0.3 mm in size, margin entire, cells more or less hexagonal, double walled, isodiametric measuring 32 x 18 µm in diameter, trigones absent, oil bodies oval-spherical usually brown. Female bracts resemble stem leaves, male bracts 4-8 in pairs below narrower and fusiforms perianth. Spores spherical, small, 16-20 µm in diameter (Fig. 25).
Status: Rare
Habitat: Barks and wet rocks
Distribution: Nepal (C, W, 1000-1250 m): Chitwan (1000-1200 m); China, Iceland, Ireland, Greenland, Peninsula, North Britain, North Fennoscandia, North Italy, Siberia, Tanzania, West Russia and Yugoslevia;
Remarks: New record for Nepal.

2.10. Jungermannia subulata A. Evans, Trans. Connect. Acad. Arts. Sci. **8**: 258, 1892; D.G. Long & Grolle, *J*. Hattori. Bot. Lab. **68**: 396, 1990; Mizut. *et al.*, Cryp. Him. **3**: 133, 1995. Pradhan, Mats. Checklist Bryo. Nep.: 8, 2000a.

Jaesoniella subulata (A.Evans) Steph., Spec. Hep. **2**: 100, 1901.
Jungermannia cylindrica (Steph.) S. Hatt., Bull. Tokyo Sci. Mus. **11**: 32, 1944.
Jungermannia amakawana Grolle, J. Jap. Bot. **41**: 230, 1966.
Jungermannia brunnescens Amakawa, J. Hattori Bot. Lab. **25**: 192, 1962.

Plants purplish green, branched, flat and creeping. Stems 1-3 cm long and 1-6 mm broad. Leaves succubous, oval to ellipsoidal with smooth margin, cells parenchymatous, thin walled. Setae hyaline, 3-6 mm long, capsules ellipsoidal, brown, 750-900 x 300-400 µm in diameter, spores reddish brown, 9-13 µm in diameter, elaters 120-150-x 6-10 µm in size (Vana, 1973).
Status: Rare
Habitat: Soil.
Distribution: Nepal (C, E, 800-2600 m): Chitwan (1000-1200), Morang (180 m); Bhutan, Caucasus, Europe, Japan, Hawaii, Korea, Siberia, South India, Sri Lanka, Taiwan and Thailand.

2.11. Jungermannia tetragona Lindenb. in Meissn., Bot. Zeit. **6**: 462, 1848; D. G. Long & Grolle, J. Hattori Bot. Lab. **68**: 396-397, 1990; Mizut. *et al.*, Crypt. Him. **3**: 133, 1995; Pradhan, Mats. Checklist Bryo. Nep.: 8, 2000a; Kattel, Liverworts Nep.: 30, 2002; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 21, 2007b.

Plants green to reddish brown forming tuft patches on the substratums. Stems light green to reddish green, soft measuring 4 cm long. Rhizoids in a cluster lie under the leaves. Leaves imbricate, succubous, round to elliptic, inserted obliquly and craspinig round the stem, margin slightly wavy. Under leaves absent. Plants dioecious, male and female receptacles both terminal, capsules dark brown, oval arise on pale white long setae.
Status: Common
Habitat: Wet substratum near the stream.

Distribution: Himalaya, Nepal (W, C, E, 300-1500 m): Kaski (800 m), Parsa (250 m), Chitwan, (300), Sunsari (730 m); Assam, Ambon, Andaman Australia, Bhutan (New), Borneo, China, India (Sikkim, Darjeeling), Japan, Java, New Guinea, New Caladona, Oceania, Sri Lanka and Sumatra.

2.12. Jungermannia truncata Nees, Hepat. Jav.: 29, 1830; Karczm., Lindbergia **7**: 130, 1981; D. G. Long & Grolle, J. Hattori Bot. Lab. **68**: 397, 1990; Mizut. et *al.*, Crypt. Him. **3**: 133-134, 1995; Pradhan, Mat. Checklist Bryo. Nep.: 8, 2000a; Kattel, Liverworts Nep.: 30, 2002.

Nardia truncata (Nees) Schiffn., Denkschr. Math.-Nat. Cl. K. Akad. Wiss. Wien **67**: 189, 1898.
Jungermannia shinii Amak., J. Hatori Bot. Lab. **33**: 156, 1970; Pradhan & Joshi, Nepal J. Pl. Sci. **2**: 29, 2008.

Truncated Leafy Liverwort (Eng.).

Plants light green to pinkish red forming mat on the substratums. Stems prostrate, somewhat ascending upto 2 cm long, dark brown and stout. Rhizoids purplish on ventral surface. Leaves variable, loosely imbricate to succubose, semi-transparent, oval with entire margin, 1.4 x 1 mm in size, marginal cells are not differented, laminal cells hexagonal and 34 x 102 µm in diameter. Trigones absent. Plants dioecious, perianths variable, male inflorescence terminal, Sporophyte terminal. Setae erect, soft and pale white and capsules oval, dark brown, erect.
Status: Common
Habitat: Found in different habitat, common on moist soil.
Distribution: Nepal (W, C, E, 320-2000 m): Dang (320 m), Kaski (800 m), Chitwan (1000 m), Sunsari (730 m); Bhutan, China, India (Sikkim, Darjeeling), Japan, Micronesia, New Guinea, Southwest Asia, Sri Lanka, Samoa, Thailand and Taiwan.
Remarks: Common in tropical and subtropical regions.

3. Mylia Gray, Nat. Arr. Br. Pl. **1**: 693, 1821.

Plants medium sized, stem rarely branched, rhizoids tuft associated with leaf bases. Leaves succubous, orbicular, laminal cells larger with bulging trigones, under leaves simple, small, 1-2 celled, gemmae often present at the margin of the apical leaves. Plants dioecious. Male bracts similar to leaves but with saccate, female bracts also similar to leaves, bracteole and perigynium lacking. Perianth emargent.

Four species have been reported from eastern Asia and only one species is known from Nepal and also occurs in lowland region.

3.1. Mylia taylorii (Hook.) Gray, Nat. Arr. Br. Pl. **1**: 693, 1821; Mizut., J. Hattori Bot. Lab. **46**: 315, 1979; D.G. Long & Grolle, J. Hattori Bot. Lab. **68**: 398, 1990; Sm., Liverworts Brit. & Ireland: 133-135, 1996; Pradhan, Mats. Checklist Bryo. Nep.: 8, 2000a; Kattel, Liverworts Nep.: 30, 2002.

Taylor's Flapwort (Eng.).

Plants small, bright green to purplish brown and brown on unexposed areas, overlapped and tuft. Stems erect and procumbent, 9-10 cm long and branched occasionally. Rhizoids purplish, long, tuft on ventral surface. Leaves succubous, ovate to orbicular, entire, 2-2.7 mm long and 1.2 to 2 mm wide, margin entire or eroded at apex in gemmiferous leaves, shortly decurrent on dorsal side, laminal cells hexagonal, 45-75 x 17 µm in diameter, trigones large and bulging and oily bodies present. Underleaves simple, lanceolate-subulate, 0.5-1mm long, concealed by rhizoids. Gemmae occasionally produced from the marginal cells of apical leaves. Plants dioecious, bracts similar to stem leaves. Perianths and capsules formation rare.
Status: Rare.
Habitat: Wet stones in association with *Hyophila* sp. (Pn 214).
Distribution: Nepal (C, E, 200-4000 m): Chitwan (200 m); Bhutan, China, Formosa, Greenland, Hawaii, India (Sikkim), Japan, North & West Europe and North America, Taiwan and Turkey.
Remarks: Smith (1996) has described its distribution Nepal.

4. Nardia Gray, Nat. Arr. Br. Pl. **1**: 679, 1823.

Plants very small to robust, sparsely branched, creeping forming tuft on wet earth. Rhizoids usually numerous developed under surface at the leaf base. Leaves alternate obliquely inserted, succubous, reniform-oval, concave, leaf margin entire, leaf cells thin or slightly thick walled, trigone lacking or with small triangular trigone, oil bodies homogenous. Underleaves lanceolate or subulate, usually restricted to young part of the stems. Gemmae lacking. Plants paroecious or dioecious.

Sixteen species of *Nardia* have been listed in the world (Vana, 1976) and the record of three species are made from Nepal. One species has been reported in the present investigation.

4.1. Nardia assamica (Mitt.) Amakawa, J. Hattori Bot. Lab. **26**: 23, 1963; Vana, J. Hattori. Bot. Lab. **36**: 71-73,1972; Grolle, Khumbu Himal, Bd. **6**(2): 120, 1974; Vana & Inoue, Bull. Nat. Sci. Mus, Tokyo, ser. B. **9**(4): 140, 1983; Kattel, Liverworts Nep.: 31, 2002.

Jungermannia assamica Mitt, J. Proc. Linn. Soc. London **5**: 90, 1861.
Jungermannia siedolbii Sande Lac. in Miq., Ann. Mus. Bot. Lugd.-Bat.**1**: 288, 1864.

Plants minute, light green, upto 10 mm long and 0.2 mm wide intermingled with *Bryoerythrophyllum rubrum* (dt 386). Stems reddish brown-purplish brown, prostrate, unbranched. Rhizoids cluster, on ventral surface. Leaves distant, obliquely inserted and widely spread, concave and ovate in shape. with a notch at the margin, 8 x 0.3 mm in size, margin slightly crenulate due to projecting marginal cells, middle laminal cells more or less oval to quadrate, 9-12 µm in diameter, papillous without trigones, basal cells rectangular, 35 x12 µm with number of perinoids (7-8) arranged in periphary.

Status: Rare.
Habitat: Moist soil.
Distribution: Nepal (E, 200 -4500 m): Morang (200 m); Caucasus, China, India, Japan and Korea.
Remarks: This species has slightly crenulate margin but S0 (1995) described its leaf with entire margin. This was previously reported Rauje, 3000-4500 m, east Nepal by Grolle (1966a).

5.2.2.1.6. LEJEUNEACEAE

Plants minute to medium, yellowish green to green, sometimes brownish tinged. Rhizoids restricted to under leaves bases. Leaves unequally bilobed, margin entire, ventral lobe folded under dorsal lobes and much smaller, under leaves much smaller than the lateral leaves. Archegonia two in each inflorescence. Perianth with 2-5 keels, abruptly narrowed at the apex.

Lejeuneaceae is one of the largest family of hepaticae with 1000 species and 91 correctly accepted genera have been recorded in the world (Gradstein *et al.,* 2003). He (1997) recorded 190 species and 37 genera of Lejeuneaceae from China. Zhu and So (1999b) added some more species to the previous list. Mazutani *et al.* (1995) described 22 species of Lejeuneaceae from Nepal. Nepal has the record of 13 genera and 35 species (Pradhan, 2000a) of which ten species are described in the present investigation.

Key to the genera

1. Underleaves present ……. 2
   Underleaves lacking ……. **2**. *Cololejeunea*

2. Plant small; underleaves bilobed …… **3**. *Lejeunea*
   Plants medium to large; underleaves orbicular or reniform ……..3

3. Plants reddish brown to blackish; trigones absent …… **4**. *Lopholejeunea*
   Plants yellowish green to brown, trigones present or lacking ……. 4

4. Plants small, irregularly branched; laminal cells hexagonal, trigone large …… **1**. *Acrolejuenea*
   Plants large, pinnately or bipinnately branched, trigone absent ……..…. **5**. *Ptychanthus*

1. Acrolejeunea (Spruce) Schiffn. in Engler & Prantl., *Nat. Pflanzenfam* **1**(3): 119, 128, 1893.

Plants green to brown, leaves densely convolute when dry. Leaves oval; incubous with toothed or least crenulate margin, cells of ventral epidermis is distinctly higher than medullary cells, perianth 4-10 keeled, lobules with two to several marginal teeth; laminal cells more or less hexagonal, trigone present . Underleaves orbicular slightly wider than stem.

Two species of *Acrolejeunea* are known from Nepal which are described here.

Key to the species

1. Plant dark brown to blackish; creeping; stem irregularly branched ……. **1.** *Acrolejeunea pusilla*
   Plants dark green; branch stem upright and usually flagellate …...….. **2.** *Acrolejeunea recurvata*

1.1. *Acrolejeunea pusilla (Steph.) Grolle & Gradst., J. Hattori. Bot. Lab. **38**: 332, 1974; Zhu & So, Mosses Hong Kong **2**: 50, 1996.

Archilejeunea pusilla Steph., Sp. Hepat. **4**: 731, 1911.

Small Scale Roof Moss (Eng.).

Plants blackish brown, branched, procumbent and tightly attached to the substratum. Stems brown, irregularly branched, creeping and strongly appressed to the substratums, 12-15 mm long and 1 mm broad. Leaves incubous, ovate, 0.3 x 0.5 mm in size and with entire margin. Leaf lobules large, strongly inflated with 2 teeth at apex, angular tooth 1-2 celled, median tooth with 1-3 celled and with hyaline papilla on the inner surface of median tooth base. Underleaves distant, orbicular, 44 x 35 µm in diameter, Leaf cells hexagonal, 23 x 18 µm in diameter, thick walled, oil bodies round, oval to ellipticle, hyaline and 15 – 25 in number in each cell, marginal cells more or less uniform, rectangular, 18 x 15 µm in diameter, median leaf cells 18-20x 20-30 µm in diameter and with slightly thick walled and large trigones (Fig. 26).
Status: Common.
Habitat: Tree trunks (*Shorea robusta)*, living leaves, rotton logs and rarely on rocks.
Distribution: Nepal (C, 280 m): Chitwan (180-250 m); China and Japan.

Remark: New record for Nepal.

1.2. Acrolejeunea recurvata Gradst., *Bryoph. Biblioth.* **4**: 79, 1975; Zhu & D.G. Long, *J. Hattori Bot. Lab.* **93**: 102, 2003.

The plant is recognized by its upright and usually barren flagellae stems. Sporophytes not seen.

Status: Rare

Distribution : Nepal (955 m); Australia, Borneo, China (Yunnan), Hewaii, India (W. Bengal), Japan, Java, Laos, New Caledonia, New Guinea, Philippines, Sumatra, Taiwan and Thailand.

Remarks: *Acrolejeunea recurvata* Gradst was originally described by Gradsten (1975), based on materials from Indo-China. Zhu and So (1999a) recorded it as new to Yunnan, China. This is a rare species and recorded only from Sankhuwasabha district of East Nepal. This was new generic recorded for the bryoflora of Nepal (Zhu and Long, 2003).

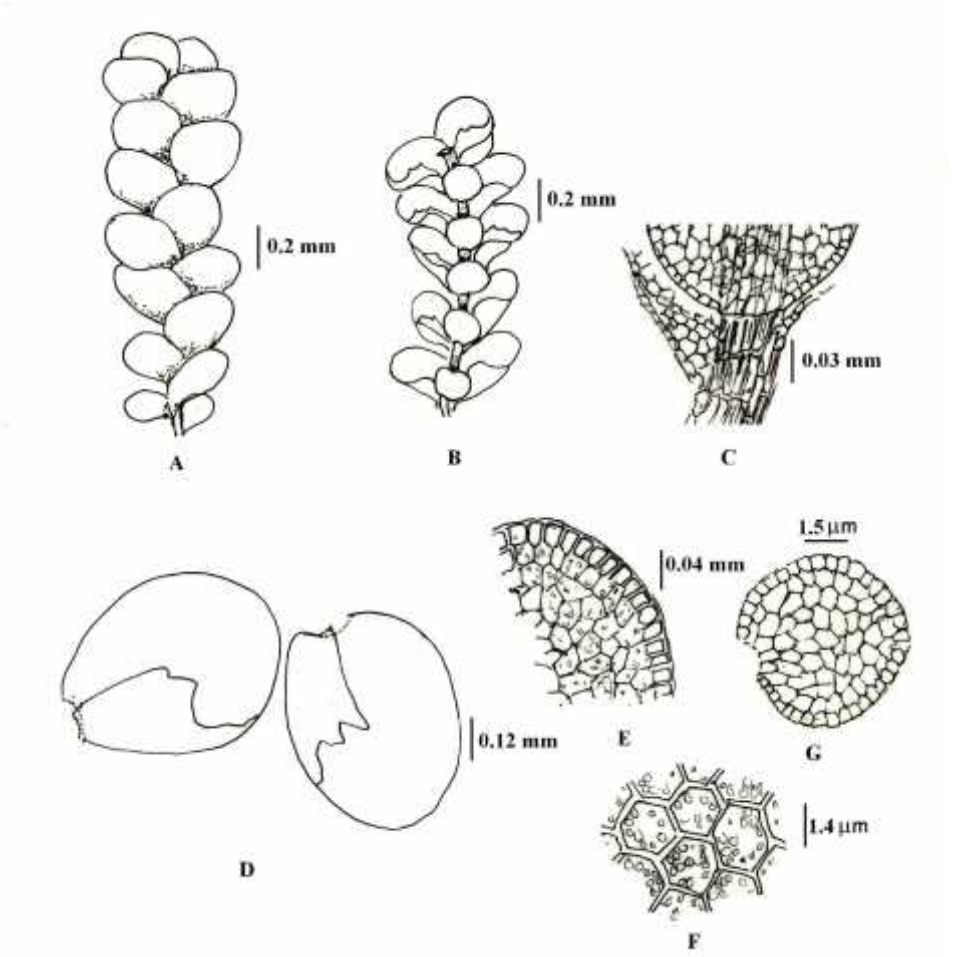


Fig.26. *Acrolejeunea pusilla* (Steph.) Grolle & Gradst. (Pradhan Pn 457). A. plant from dorsal view, B. plant from ventral view, C. a portion of stem and a portion of underleaf from ventral view, D. leaves, E. apical portion of the leaf showing marginal and middle laminal cells, F. middle laminal cells in detail, G. underleaf.

2. Cololejeunea (Spruce) Schiffn. in Engl. & Prantl., Naturl. Pfl.. **1**(3): 117-121, 1893.

Plants heterogeneous, strongly compressed and firmly adhered to the substrate. Leaves distant to imbricate, narrowly lanceolate to suborbicular, ventral lobe inflated, apex 1-2 celled tooth with hyaline papilla on the inner face, cells smooth to mamillose, thin walled or slightly thickened, trigones may be present, oil bodies 2-10 per cell. Underleaves absent. Perianth inflated. Female inflorescences pseudolateral. Spores 12-20 µm in diameter.

The genus *Cololejeunea* is one of the most delicate minute liverwort occuring all over the world in a variety of habitat preferences, yet it is poorly understood probably due to its smaller sizes. They often grow on living leaves. China has reported 67 species and varieties (Zhu and So, 1998a, 1998b, and 1999b).

Thirteen species of *Cololejeunea* are known from Nepal and one species are described here.

2.1. Cololejeunea raduliloba Steph., Hedwigia **31**: 251, 1895; Mizut. *et al.,* Crypt. Him. **3**: 138 1995.

Plants extremely small, glossy and pale green. Stems creeping, branched, leaves imbricate arranged at right angle to the stem, leaves small, bright green more or less oval with entire margin, apex rounded, leaf-lobules very small. Plants autoicous, both male and female inflorescences arise upon short lateral branches.
Status: Rare
Habitat: Epiphytes on other leaf surfaces, rarely on boulder stones.
Distribution: Nepal (C, 900-1000 m): Kavre (900-1000m); China, Japan, Taiwan and Vietnam.
Remarks: Mizutani (1995) recorded as new to Neapl.

3. Lejeunea Lib., Ann. Gén. Sci. Phys. **6**: 372, 1820.

Plants small to minute, pale green to yellowish green, branches arise behind the ventral leaf base.Transverse section of the stem with 3-14 smaller central cells and 7 cortical cells. Leaves imbricate to distant, spreading laterally, apex of dorsal lobe rounded to obtuse, ventral lobe small and sometimes vestigial. Leaf cells without papillous, trigone small or lacking, underleaves bilobed and orbicular. Reproduction by gemmae and vegetative propagation absent. Female inflorescence terminal on the main axis, rarely upon dwarf branch, bract unequally bilobed, bracteole bilobed and joined at the base. Male organs arise upon short lateral branches.

Eleven species of *Lejeunea* are known from Nepal. One species is described here.

3.1. Lejeunea ulicina (Taylor) Gottsche *et al.,* Syn. Hepat.: 387, 1845; Mizut. et *al.,* Crypt. Him. **3**: 139, 1995; Pradhan, Mats. Checklist Bryo. Nep.: 10, 2000a; Kattel, Liverworts Nep.*:* 35, 2002.

Microlejeunea ulicina (Taylor) A. Evans, Mem, Torr. Club. **8**: 176, 1902.

Sparsely-leaved Lejeunea (Eng.).

Plants minute, 4-8 mm long, 0.2- 0.4 mm wide, yellowish green, prostrate and irregularly branched forming tufts on the substratums. Leaves distant, dorsal lobe broadly ovate, 0.18-0.3 mm long and 0.1-0.2 m wide, apex obtuse or subacute, slightly convex, margin entire or crenulate with prominant cells. Ventral lobes convex with a large tooth upon free margin. Amphigastra distant, convex, oval, bilobed slightly wider than the stem, 0.09x 0.06 mm in diameter. Leaf cells hexagonal, 14-20x10-15 µm in diameter with small trigone. Oil bodies present, 2-6 in number in each cells, spherical or elliptical, 2 µm in diameter. Gemmae lacking. Plants dioecious. Male inflorescences on short branch, bracts 2-3 pairs, equally bilobed and saccate. Female inflorescences terminal on male axis.
Status: Rare
Habitat: Tree trunk, rotton logs and leaving leaves.
Distribution: Nepal (C, E, 800-2850 m): Kaski (800 m); Britain, Europe, Ireland, Japan,

Macaronesia, North and South America, Norway and Turkey.
Remarks: This is the smallest species of *Lejeunea* known so far, distributed at lowland to the mountain regions.

4. Lopholejeunea (Spruce) Schiffn. in Engler & Prantl., Nat. Pflanzenfam. **1**(3): 119, 129, 1893.

Plants usually brown to blackish or reddish, found growing in different habitat types but usually epiphytic in habit. Leaves unequally bilobed with lower lobule folded under the upper lobes. Lobules inflated and adnate to the stem. Underleaves orbicular or subreniform, smaller than leaves, undivided and one per pair of lateral leaves. Female inflorescence terminal on short lateral branch and without innovation. Perianth almost flat with 4 keels in cross section.
Two species of Lopholejeunea has been recorded from Nepal. Of them one is described here.

4.1. Lopholejeunea nigricans (Lindenb.) Schiffn., Conspectus Hepaticarum Archipelagi Indici: 293, 1898.

Lopholejeunea sikkimensis Steph., Spec. Hepat. **5**: 87, 1912; Mizut., J. Hattori Bot. Lab. **40**: 443, (1976); D. G. Long & Grolle, J. Hattori Bot. Lab. **68**: 418, 1990; Mizut. *et al.*, Crypt. Him. **3**: 140, 1995; Zhu & So, Bot. Bull. Acad. Sin **41**: 48, 2000; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 21, 2007b.

Plants dark green, flat and creeping. Stems dark green to brownish, flat, 20-25 mm long and and 0.5 mm wide with purplish brown rhozoids on ventral surface. Stem cells long, rectangular. Leaves alternate, loosely arranged, semi-orbicular, green with entire margin, incurved usually at the apical region. Leaf cells hexagonal and parenchymatous, 15-20 µm in diameter with oil bodies. Amphigastra present. The apical region of amphigastra is entire and not bilobed. Plants autoecious, female bract lobules, large, entire and bracteoles with recurved margin.
Status: Uncommon
Habitat: Bark and boulder stone.
Distribution: Nepal (W, C, E, 200-2400 m) - Dang (290 m), Kaski (800 m), Chitwan (300 m), Sankhuwasabha (1000 m); Bhutan, China and India.
Remarks: Recently in Tropicos, *Lopholejeunea sikkimensis* is kept under the syn. of *Lopholejeunea nigricans* (Lindenb.) Schiffn. *Lopholejeunea sikkimensis* resembles with *L. nigricans* which is considered to be pantropical (Gradstein, 1994), but only differs in underleaves. The female bract lobules are reduced in size.

5. Ptychanthus (L. & L.) Nees, Natur geschichte der Eur. Léber. **3**: 211, 1838.

Plants medium to robust, pinnetely branched and creeping. Stems with leaves either with two or three ranks. Rhizoids attached to the stems or at the base of under leaves. Leaves unequally bilobed with lower lobules folded under the upper lobes. Lobules inflated and adnate to the stem. Underleaves orbicular to subreniform, undivided, not larger than leaves and one per pair of lateral

leaves. Plants monoecious. Female inflorescences terminal with one or two innovations. Bracts and bractioles somewhat toothed in the female iniflorescences. Only one species is known from Nepal.

5.1. **Ptychanthus striatus** (Lehm. & Lindenb.) Nees, Natur geschichte der Eur. Léber. **3**: 212, 1838; Grolle, Ergebn. Forsch-Unternehmen Nepal Himalaya Bd.**1**, Liefg 4: 291, 1966; S. Hatt. in Hara, Fl. E. Him. **1**: 531-532, 1966; Nog. *et al.*, Bull. Nat. Sci. Mus. **9** (3): 386, 1966, Kashyap, Liverworts W. Him. Suppl. **1**: 25-26, 1972; D. G. Long & Grolle, J. Hattori. Bot. Lab. **68**: 419, 1990; Mizut. *et al*., Crypt. Him. **3**: 140, 1995; Pradhan, Mats. Checklist Bryo. Nep.: 10, 2000a; Pradhan, J. Nat. Hist. Mus. **19**: 60, 2000b; Kattel, Liverworts Nep.: 37, 2002; Zhu & D.G. Long, J. Hattori Bot. Lab. **93**: 111, 2003.

Jungermannia striata Lehm. & Lindenb., Nov. Strip. Pug. 4: 16, 1832; Zhu & D.G. Long, J. Hattori Bot. Lab. **93**: 101, 2003.
Ptychanthus squarrosus Montin ex Lehm., Nov. Strip. Pug. **8**: 22, 1844.

Plants large and light brown. Stems creeping upto 20 cm long, bipinnetly branched and spread out. Leaves strongly spread, concave, cortiguous, broadly ovate with acute apex and strongly toothed below the apex, 2.5 mm long and 1.5 mm wide in the center. Apical laminal cells 27 x 18 µm in diameter with large trigones, basal cells are 36 x 18 µm in diameter. Underleaves large, subrotund inserted by a notch, cordate base. Plants monoecious. Bracts slightly smaller than the leaves with short truncate acute apex, bracteoles similar to bracts but with short emarginate apex.
Status: Common
Habitat: On hanging twigs, decaying branches, forest floors.
Distribution: Nepal (W, E, 700-3800 m) - Kaski (800 m), Sankhuwasabha (700 m); Africa, Australia, Bhutan, China, Formosa, India (Assam, Khasia, Kumaon, Sikkim), Japan, Madagascar, Malaya and Oceania; Kaski (800 m), Sankhuwasabha (700 m).
Remarks: *Ptychanthus striatus* is widely distributed in the tropical and subtropical region of Asia, Oceania and Africa (Zhu and So, 2001).

5.2.2.1.7. LEPIDOZIACEAE

Dioecious. Plant minute to robust and whitish green to brown. Shoot erect, isophyllous to dorsoventral and anisophyllous, 1-2 pinnetly branched or dichotomously branched. Leaves incubous or transverse, very rarely succubous, 3-4 lobed or 2-4 toothed at apex. Underleaves are similar to leaves. Vegetative propagules is very rare but the flagelliform branches may act as Propagules. Inflorescences upon dwarf ventral branches. Male inflorescences terminal on flagelliform branches. Capsules ovoid to short cylindrical.

1. Bazzania Gray, Nat. Arr. Br. Pl. **1**: 704, 775, 1821.

Dioecious to sterile. Plants small to robust with tufts, mats or scattered shoots. Stems dichotomously branched, also produce ventral flagelliform branches. Section of stem shows large

cortical cells similar to central cells but of smaller sizes. Leaves distant to imbricate, incubous, leaf apex 2-3 lobed or toothed, cells with small to large trigones, 2-6 oil bodies per cell. Underleaves smaller than upper leaves, entire to several lobed, margin entire to dentate. Male and female organs are present upon short ventral branches. Male bracts 4-6 pairs, smaller than leaves, concave and toothed. Female bracts are smaller than the leaves, ovate to ovale-lanceolate, open, often lobed, margin dentate to ciliate. Perianth cylindrical, fusiform in the lower portion generally thick and fleshy. Spores about 15-20 µm in sizes.

About 250 species have been reported in the world (Smith, 1996) and 14 species are known in Nepal. Only one species has been recorded in lowland Nepal which is descbed here.

1.1. Bazzania tridens ((Reinw. *et al.)* Trev., Mem. Real. Instit. Lombarda Sci. Lett. ser. **3, 4**: 415, 1877; Mizut., J. Hattori Bot. Lab. **30**: 72-73, 1967; Mizut., J. Hattori Bot. Lab. **46**: 314, 1979; D.G. Long & Grolle, J. Hattori Bot. Lab. **68**: 388, 1990; Mizut. *et al*., Crypt. Him. **3**: 129, 1995; Kattel, Liverworts Nep.: 41, 2002.

Jungermannia tridens Reinw., Blume et Nees, Nova Acta Acad. Caes. Leop.-Carol. **12**: 228, 1824; *Mastigobryum tridens* (Reinw., Blume et Nees) Nees in Gott., Lindenb. & Nees, Synop. Hepat: 227, 1845.
Bazzania lobulistipa (Steph.) S. Hatt. in Hara, Fl. E. Him. **1**: 505, 1966.

Plants small to medium sized, olive to brownish green. Stems 20-30 mm long and 0.2-0.4 mm wide with expanded leaves and flagelliform branches. Leaves imbricate, incubous, ovate to oblong, slightly falcate, 0.8-2 mm long and 0.5-1 mm wide at the base, margin with three tooth, triangular shaped, rest of the portion is smooth, laminal cells in the apical region are more or less oval or parenchymatous, 15-20 x 12-20 µm in diameter, cells in the median region slightly large and thick walled, 15- 38 x 12 -25 µm in diameter, basal cells large, 58 x 45 µm in diameter, trigones present but are small or indistinct. Underleaves hyaline, distant to contiguous, appress to the stem and about twice as wide as stem, subquadrate, 4-7 mm long and 4- 5 mm wide, cells ovals and trigones lacking.
Status: Rare
Habitat: Soil.
Distribution: Nepal (W, E, 800-3800 m): Kaski (800 m), Sankhuwasabha (1000 m); Bhutan, Burma, Borneo, Celebes, China, Formosa, India (Sikkim, Assam, Darjeeling), Japan, Java, Korea, Sri Lanka, Sumatra, Tibet and Thailand.
Remarks: Mizutani (1967) and Long and Grolle (1990) recorded it as one of the commonest species Southeast Asia.

5.2.2.1.8. PLAGIOCHILACEAE

The family Plagiochilaceae was first recognized by Muller (1956) who included 8 genera including *Plagiochila* in this family. Plants yellowish green to dark green, branched and creeping in habit.,

prefer to grow on barks, wet rocks, boulder, etc. The Stem and branches bear thick walled cortical cell layers. Leaves alternate, nearly flat, plane or strongly convex or concave, the shapes and sizes are variable depending upon species. Margins variously toothed with cilia, spines or triangular teeth or sometimes nearly entire, the ventral base of leaf margin usually flat and plane. Underleaves typically present.

This is one of the largest families of Hepaticae, which includes 6 genera- *Plagiochila, Acrochila, Pedinophyllum, Xenochila, Chiastocaulon* and *Plagiochilidium*. More than 90 % of species of this family belong to a single genus *Plagiochila* (Inoue, 1984). Nepal has the record of three genera and 49 species of this family.

1. Plagiochila (Dumort.) Dumort., Rec. d'obs.: 14, 1835.

Plants dioecious, small to robust, procumbent to erect. Leafy shoots arise from the rhizomatous stems, shoots sparsely to freely branch. Leaves varying in shapes and sizes, obliquely inserted, succubous, dorsal margin frequently reflexed, with or without teeth, ventral margin usually toothed, apex rounded or truncate, trigones small to large and bulging, oil bodies 4-15 per cell. Under leaves small and usually subulate. Gemmae lacking. Capsules usually rare. Spores 12 to 40 µm in diameter.

Plagiochila is the largest genus with about 1800 binomial species in the world (Inoue and Schuster, 1971). Out of 480 named species from Asia, 132 are the recognized species and 110 species are considered endemic (So & Grolle, 2000). 38 species have been recorded so far from Nepal. In Japan, Vietnam and Thailand this genus has been studied in greater detail by Inoue (1958, 1968 and 1974). Long and Grolle (1990) have published their findings on this genus of Bhutan. Similarly, Tan and Engel (1986) made an extensive study of this genus in Philippines.

Key to the species

1. Plants large; leaves not caducous, trigone large nodulose; underleaves lacking ……. *Plagiochila nepalensis*

Plants small, leaves caduceus, trigone small; underleaves bilobed ……..…..… **2**. *P. parvifolia*

1.1. Plagiochila nepalensis Lindenb., Spec. Hepat. (fasc.2-4): 93, 1840; Lindenb in Lindenb. & Gott., Monogr. Plagiochila: 93, 1842; S. Hatt. in Hara, Fl. E. Him. **1**: 517-518, 1966; Mizut., J. Hattori. Bot. Lab. **46**: 317, 1979; D. G. Long & Grolle, J. Hattori Bot. Lab. **68**: 406, 1990; Grolle & So, Bryologist **102**(2): 298-300, 1999c; Grolle & So, Bryologist **102**(1): 72, 1999d; So & Grolle, J. Hattori Bot. Lab. **88**: 217-218, 2000; Pradhan, Mats. Checklist Bryo. Nep.: 17, 2000a; Kattel, Liverworts Nep.: 56, 2002.

Plagiochila gammiana Steph., Bull. Herb. Boissier (ser.21) **3**: 963, 1903.
Plagiochila grata Steph., Spec. Hepat. **6**: 160, 1918.
Plagiochila celebica Schiffn. ex Inoue, Acad. Sci. Boo Inc, Tokyo: 79-80, 1984.

Plants large, robust, 4-10 cm long and 2-2.4 mm wide, pale green to dark brown, not glossy, dichtomously branched, stem brown, 14-17 cells across, the cortical cells well differentiated with extremely thickened bright brown walls. Leaves with soft textured, not caducous, triangular ovate to broadly ovate, wider than long, 1-1.3 mm long and 1-1.6 mm wide, dorsal margin entire and ventral margin with 1-2 teeth, apex subrotundate with spinose teeth, teeth 2-7 cells long and 3-4 cells wide, leaves cells with large nodulose trigones, perianth campanulate, under leaves lacking. Asexual reproduction frequently by means of vegetative propagation. Androecial and gyanocial branches terminal.
Status: Type, Wallich, 1820 (BM).
Habitat: Barks, forest floors.
Distribution: Nepal (E, 700-2800 m): Taplejung (700 m); America, Bhutan, Burma, Celebes, China, Europe, India (Sikkim, Darjeeling), Japan, Java, Malaya, Philippines, Thailand and Vietnam.
Remarks: Inoue (1984) named *Plagiochila nepalensis* as *Plagiochila celebica* Schiffn. This species is confined to east and south Asia. Tha most distinguishing character of this species is the large perianth compared to the size of aerial shoots, together with small and inconspicous bracts (Grolle & So, 1999c)

1.2. Plagiochila parvifolia Lindenb., Spec. Hepat. **1**: 28, 1839.
Plagiochila phalangea J. Taylor, London J. Bot. **5**: 264, 1864; So & Grolle, J. Hattori Bot. Lab. **88**: 2000, 1999; Kattel, Liverworts Nepal: 58, 2002.

Plants 4-7 cm long and 2-3 mm wide, dark brown, glossy and dichtomously branched, stem brown. Leaves with soft textured, caducous, oblong ovate to broadly ovate, wider than long, 1mm long and 1-1.5 mm wide, dorsal margin entire and ventral margin with 1-2 teeth, apex subrotundate with spinose teeth. Underleaves always present, oblong, usually bilobed, ca. 400 µm in diameter. Asexual reproduction by vegetative propagulation.Gynoecia terminal on main shoot, Androecia short on basal or superbasal or on uppermost terminal branches, bracts usually broadly ovate with triangular marginal teeth.
Status: Rare, Type (Isotype 1820, Wallich, BM).
Habitat: Soil.
Distribution: Nepal (E, 700-2700 m.): Taplejung (700 m); China, India (Sikkim).
Remarks: *Plagiochila phalangea* is the synonyme of *Plagiochila parvifolia* (So and Grolle, 1999).

5.2.2.1.9. PORELLACEAE

Plants dioecious, robust, yellowish green and brown. Stem procumbent to erect, basal portion rhizomatous, 2-3 pinnately branched. Leaves bi-lobed with very short or vestigeal keel, dorsal lobes

incubous, orbicular to lanceolate, entire, dentate or ciliate, ventral lobes parallel to stem, both lobes with or without water sacs, cells with or without hyaline papillae. Underleaves large, entire, dentate or ciliate. Vegetative propagation unknown. Inflorescences on dwarf lateral branches. Antheridia axillary surrounded by imbricate bracts. Spores in the capsule, dehiscing by irregular opening of capsule and spores 24-80 µm in diameter.

1. Porella L., Sp. Pl. **2**: 1106, 1753; Lindenb, Act. Soc. Sc. Fenn.: 329, 1869.

Plants large, dark green to yellowish brown, usually 2-3 pinnately branched. Stems creepinig. Rhizoids few arise at the base of under leaves. Leaves divided into two oval or rounded lobes, upper lobes larger than lower lobes, the under leaves more or less the similar sizes of lower lobes. Margins of upper lobes and lower leaves entire but a bit dentate at the sides of lower lobes. Laminal cells with 20-30 small oil bodies but without hyaline papillae. Plants monoecious. Male inflorescences is in the form of spherical antheridia in the axil of densely imbricate leaves. Perianths oval or obovate.

This genus is common in temperate region but is very rare at lowland area. More than 100 species has been recorded (Smith, 1996). Nine species are known from Nepal and only one species is recorded in lowland area.

1.1. Porella campylophylla (Lehm. & Lindenb.) Trev., Mem. Real. Istit. Lombardo, Sci. Lett. ser. *3*, **4**: 408, 1877; Grolle, Die Lebermoose Nepals: 265, 1966; Grolle, Khumbu Himal **6**(2): 118, 1974; Mizut., J. Hattori Bot. Lab. **46**: 322, 1979; S. Hatt. in Hara, Fl. E. Him. **1**: 524 1966; D.G. Long & Grolle, J. Hattori Bot. Lab. **68**: 411, 1990; Pradhan, Mats. Checklist Bryo. Nep.: 19, 2000a; Kattel, Liverworts Nep.: 61, 2002.

Plants large, brownish green to dark green, up to 30 mm long with irregularly ascending branches. Leaves distant and slightly imbricate, oblong to ovate-oblong, 2.5 x 1.5 mm in size and with broad base, anterior margin entire, convex and slightly twisted at the posterior end. The subapical portion of leaf has several coarse teeth.The marginal teeth of leaves and under leaves are variable in number. Amphigastra large, ovate- or subquadrate. Bracts small about the half the size of leaves. Plants dioecious.

Status: Rare

Habitat: Rocks.

Distribution: Nepal (E, 950-3250 m): Sankhuwasabha (1000 m); Bhutan, Burma, India (Sikkim, Darjeeling, Punjab plain), Philippines, Thailand and Vietnam.

5.2.2.2. MARCHANTIALES

The gametophytes of this order are thalloid, dichotomously branched, differentiated into an upper photosynthetic region with dorsal pores and air chambers and lower solid storage region. Air chambers simple and elongated form with simple air pores or well developed chambered with

barrel shaped pores. Two types of rhizoids and two or more rows of scales usually abundent on the ventral surface of the thallus. The smooth walled rhizoids usually anchor the thallus to the substratum while the pegged tuberculated rhizoids generally function as capillary conducting system. Gemmae if present born in gemma cups. Antheridia and archegonia born on short or long stalks or immersed in dorsal surface of the thallus. The sporophytes with or without setae.The sporangium bears spores and elaters. Spores usually in tetrad. Elaters help in dispersal of spores.
Marchantiales is the largest order of Hepaticae and consists 27 genera and ca. 450 species under 12 families (Schofield, 1985), distributed from tropical environment to arctic and alpine region. Nepal has recorded 15 genera and 34 species under seven families (Pradhan, 2000a). The present investigation presented 21 species under 10 genera and six families.

Key to the Families

1. Plants terrestrial ……..…… 2
   Plants aquaric or semi-aquatic ……...…...…..... 3

2. Air-pores barrel shaped connected with air chambers within the thallus; male and female receptacles both on long stalk ……..……...……..…..…. **2**. Marchantiaceae
   Air pores simple, no air chambers; male receptacle sessile and female receptacles on short stalk4

2. Plants mono or dioecious, male and female sex organs both embedded within the thallus, rhizoidsnot pegged ……..... **4**. Ricciaceae
   Plants monoecious, male and female sex organs on dorsal surface of the thallus on short stalks, tuberculated rhizoids with well developed pegs …….……..…….. **3**. Monosolenaceae

4. Male receptacle sessile on the median region of the thallus on dorsal surface ……..…… 5
   Male receptacle with short stalk and lateral in position ……....… **5**. Targionaceae

5. Male receptacle cushion or horse shoe shaped ……..…….……..… **1**. Aytoniaceae
   Male receptacle disc shaped …….…….....… **6**. Wiesnerellaceae

5.2.2.2.1. AYTONIACEAE

Thallus dorsoventrally flattened, pores simple, air cavities are present in two or more layers. Male receptacles occupy the dorsal surface of the median region, female receptacles lobed born on short stalks, pseudo perianth lacking, capsule dehiscences by opening the lids, elater simple and spores large. About 5 genera occur in the world, of them 4 genera and 13 species are reported from Nepal.

Key to the genera

1. Peduncle dorsal on thallus and without rhizoid furrow ……..… **3**. *Plagiochasma*
   Peduncle terminal in apical notch of thallus with rhizoid furrow …… ……. 2

2. Pseudoperianth present …….. **1**. *Asterella*
Pseudoperianth absent ……. 3

3. Air pores with 4-6 rings of cells, receptacles deeply lobed, spores yellow ……... **4**. *Reboulia*
Air pores with 1-3 rings of cells, receptacles shallowly lobed, spores black or brown..**2**. *Mannia*

1. Asterella P. Beauv., Dict. Sci. Nat. **3**: 257. 1805.
Fimbriaria Nees, Horae Phys. Berol.: 45, 1820.

Asterella is the second largest genus of order Marchantiales. It has been known principally under the three names- *Asterella, Fimbriaria* and *Hypenantron*. This genus is distinguished from other genera of Aytoniaceae primarily by the presence of a deeply divided pseudoperianth around the sporangium and many of the species have a characteristic fishy smell due to having certain chemical terpenoid (Long, 2006b).

Plants may be monoecious or dioecious, thalli rarely divided; ventral scales with a row of appendages on either side of the costa. Male receptacles are cushion shaped on the median region of dorsal surface; female receptacles grow on short stalk with rhizoidal furrows. Single sporangium in each involucre, capsule globose, shortly pedicelled with one layered wall, spores are tetrahedral, reticulated, elaters short, simple or furcated and mono or bi-spiral.

So far about 48 species have been recorded worldwide (Boonkerd *et al*., 2007). Long in his unpublished data has included about 80 species globally (Long *et al.*, 2000). Long (2006b) has mentioned 135 species of *Asterella* with its synonymes and record of six species from Nepal.

Key to the species

1. Plants dioecious, thalli deeply dichotomous ……..…..... **4**. *Asterella wallichiana*
Plants monoecious, thalli not deeply dichotomous ……..……...…...……..…. 2

2. Male receptacles on the main thallus; female receptacles terminal on the main shoot in front of male receptacle ……..…….. 3
Male receptacles terminal; female receptacles lateral receptacle ……..… **3**. *A. multiflora*
3. Spores golden yellow, 72 µm in diameter ……..…….…..... **1**. *A. blumeana*
Spores yellowish brown, 75-90 µm in diameter ……..……...……..... **2**. *A. khasyana*

1.1. Asterella blumeana (Nees.) Pande, Syn. Hepat.: 564, 1844; Shrestha, J. Nat. Hist. Mus. **1** (2-4): 188, 1977; Kattel, Liverworts Nep.: 64, 2002; Pradhan & Joshi, Nep. J. Pl. Sci. **2**: 28, 2008a

Thalli thick, light green, simple to dichotomously branched, upto 7-10 mm long and 3 mm broad, intermingling with *Plagiochasma articulatum* (NGS 330), apex notched, margin entire, air pores and air chambers large, costa not conspicuous on ventral side. Ventral surface green and contains two types of rhizoids and scales. Plants monoecious, male receptacle generally cushion shaped behind the stalk of female receptacle. Female receptacle convex with 3 lobes. Spores bright yellow to golden yellow, reticulated, about 70 -75 µm in diameter; elaters long and bi-spiral.
Status: Rare
Habitat: Rocks.
Distribution: Nepal (W, E, 284-780 m); Dang (780 m), Sankhuwasabha (920). India, Indonesia, Java, Philippines and Thailand.

1.2 Asterella khasyana (Griff.) Pande *et al*., J. Hattori Bot. Lab**. 11**: 7, 1954; Grolle, Khumbu Himal, Ergebnisse des Forschungsunternehmens Nepan Himalaya **1**(4): 267, 1966; D.G. Long and Grolle, J. Hattori Bot. Lab. **68**: 423, 1990; D.G. Long, Bryophytorum Bibliotheca **63**: 170-271, 2006b; Boonkerd *et al.*, Nat. Hist. Journ. of Chulalongkorn Univ. **7** (2): 112, 2007.

Fimbriaria khasyana (Griff.) Mitt., J. Proc. Linnean Soc. Bot., London **5**: 126, 1961.

Plants thalloid, bright green, thin, medium sized, 2-3 cm long and 2 mm wide with delicate margin, sinuate-crenate, iinroll when dry. Dorsal surface reticulated with simple air pores surrounded by 2-3 rings of cells. Air chambers usually one layer and without photosynthesic filaments. Thalli monoecious. Both male and female sex organs embedded on the median region on dorsal surface. Androecia, the male sex organs, small cushion shaped just behind at the base of archegoniophore. Female receptacles light green, flat, 3-4 mm diameter, strongly papillose above and with a small group of archegonia underneath surrounded by cup-shaped inivolcres Spores yellowish brown, more or less triangular, irregularly reticulated, areolate, 70-90 µm in diameter and the proximal faces differ from dorsal sides. Elaters dark brown, bispiral, 190-220 µm long .
Status: Common
Habitat: Soil covered rocks.
Distribution: Nepal (W, C, W, 190-600 m): Kanchanpur (190 m), Kailali (220 m), Bardia (118 - 200 m), Dang (335-690 m), Chitwan (180-250 m), Parsa (220 m); Africa, Bhutan, China, India (Sikkim), Indochina, Indonesia, Philippines (Long and Grolle, 1990) and Thailand (Boonkerd *et al.*, 2007).
Remarks: Its distribution is wide in the Himalayan region (Long, 2006).

1.3. Asterella multiflora (Steph.) Pande *et al*., J. Hattori Bot. Lab. **11**: 2, 1954; D.G. Long, *Lindbergia* **26**: 44, 2001; Kattel, Liverworts Nep.: 65, 2002; D.G. Long, Bryophytorum Bibliotheca **63**: 282-283, 2006b; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 20, 2007b; Pradhan & Joshi, Nep. J. Pl. Sci. **2**: 29 2008a.

Fimbriaria multiflora Steph., Spec. Hep. **1**: 124, 1809.
Asterella pathankotensis Kashyap, J. Bomb. Nat. Hist. Soc. **24**: 344 (1916); Pradhan & Joshi, J. Nat. Hist. Mus. **10**: 77, 1986.

Plants small, light green, 13-15 x 3 mm in size, deeply dichotomous with apical joint, Dorsal surface green flat slightly convex, margin wavy and purple, costa distinct from the ventral surface. Transverse section of thallus shows large chambers filled with numerous chlorophyllous filaments, stomata large, slightly convex bounded by 5 series of 8 cells each. Ventral scales small with long appendages, rhizoids smooth walled and tuberculated typed. Plants monoecious, female receptacles 1-2 arise on the apical region at notched region born on dark brown stalk of 5-7 mm long, receptacle with 2-4 lobes. Male receptacles cushion shaped lying dorsally on the mid apical region, female receptacles on the periphery of the apical region, convex with 2-4 lobes on 4-5 mm long stalk and with purple wings. Spores spherical, brown, reticulated, 80 µm in diameter, elaters mono or bispiral with blunt ends, rarely branched, 130-190 µm long and 10 µm wide.
Status: Common
Habitat: Soil, brick walls and rocks.
Distribution: Nepal (W, C, 180-2000 m): Kanchanpur (190), Kailali **(**220 m), Bardia (118-200 m), Dang (340- 690), Chitwan (180-250), Parsa (220 m); China, India, Pakistan and Philippines.
Remarks: This is a common species distributed in lowland Tarai growing on different habitats and distributed upto the elevation of 2000 m.

1.4. **Asterella wallichiana** (Lehm. & Lindenb.) Grolle, Die Leberoose Nepals, Ergebn. Forsch.-Unternehmen Nep. Him. Bd. 1. Liefg. **4**: 268, 1966; Pradhan, Mats. Checklist. Bryo. Nep.*:* 20, 2000a; Pradhan, J. Nat. Hist. Mus. **19**: 59, 2000b; Pradhan, J. Nat. Hist. Soc. **21**: 49, 2002; Kattel, Liverworts Nep.: 65, 2002; D.G. Long, Bryophytorum Bibliotheca **63**: 261-262, 2006; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 20, 2007b; Pradhan & Joshi, Nep. J. Pl. Sci. **2**: 29, 2008a.

Fimbriaria angusta Steph., Spec. Hep. **1**: 104, 1899; Pradhan & Joshi, J. Nat. Hist. Mus. **10**: 76, 1986.

Thalli light green, deeply dichotomous, 20 mm long and 3 mm broad, costa with faint margin which slightly rises up. Rhizoids tuberculated and smooth walled, scales in two rows on either sides of the midrib with purplish appendages. Air pores generally large, surrounded by 3 series of 6 cells and connected to large air chamber. Thalloid cells hexagonal 57 x 68 µm in diameter, cells of the mid storage region thick and compactly arranged. Plants dioecious. Male receptacles cushion shaped, long and yellowish brown. Female receptacles with 2-6 lobes upon short stalk. Spores brown, reticulated, more or less triangular, 68 µm in diameter. Elaters generally light brown, monospiral, blunt at both the ends and 153 x 13 µm in diameter.
Status: Fairly common
Habitat: Rocks, soil, exposed walls and concrete canal walls.
Distribution: Nepal (W, C, E, 190-2000 m): Kailali (360 -600 m), Bardia (190-670 m), Dang

(300-1000 m) Gulmi (510 m), Chitwan (200-1250 m), Parsa (250 m), Makwanpur (490 m), Sankhuwasabha (275 m), Sunsari (180 m); Bangladesh (Long, 2006), Bhutan, Burma, China, India, Japan, Myanmar and Thailand.

2. Mannia Corda, Opiz, Beitr.: 646, 1828.

Plants autoicous or dioecious, prefers to grow upon cliffs and slopes, and also on calcarious substrates. Thalli 1-3 cm. long and 3-4 mm broad, dichotomously branched and distinctly channeled in the median region including the entire margin. Ventral scales larger, purplish to pale red. Air pores distinctly surrounded by 2-3 concentric rings of cells and connected below with air chambers. Thalloid cells more or less hexagonal, trigones distinct, oil bodies absent or one in each cell. Male organs desciform at the apical region, female organs on short stalk, covered at the base and apex by numerous hair like scales. Spores reticulated, yellowish brown, papillous and elators with 2-3 spiral bands.

Two species of *Mannia* are known from Nepal mostly from temperate region and one species is described here.

2.1. Mannia fragrans (Balb.) Frye & L. Clark., Univ. Wash. Publ. Bios. **6**: 62, 1937; Furuki & Higuchi, Crypt. Him. **3**: 147, 1995; Kattel, Liverworts Nep.: 65, 2002.

Marchantia fragrans Balb., Sci. Physiques et Malkematique ser **27**: 76, 1804.

Plants dark green, dorsoventrally flattened, dichotomously branched, usually with strong smell of cedar-oil. Thallus 1-3 cm long, 2-3 mm wide, almost linear somewhat wider at the apex, strongly concave in dry condition with the margins curved unwards. Dorsal surface green with irregularly wavy margin. Ventral surface purple by having purplish scales with 2-3 branched lanceolate appendages and translucent oil bodies in the cells. Air pores prominent surrounded by 2-3 concentric rings of cells which communicate with the air chambers below. Air chambers filled with numerous filaments and discs of photosynthetic cells. Female receptacle at the apical region on dorsal surface born on the pedicel of 1-2 cm long. Spores lemon yellow- yellowish brown, reticulated, papillous with wide yellow wings, 55-70 µm in diameter, elaters 2-3 spiral and 8-10 µm in wide.

Status: Rare

Habitat: Soil.

Distribution: Nepal (W, 800-2000 m): Kaski (800 m); Caucasia, China, Europe, Japan, Louisiana and North America.

Remarks: Thallus more or less similar to *Plagiochasma* but of smaller sizes.

3. Plagiochasma Lehm. & Lindenb., Novarum et Minus Cognitarum Stirp. Pugillus **4**: 13, 1832.

Plants caspitose, grow in a large patch upon rocks, soil, brick walls etc. Thallus is differentiated into the chambered photosynthetic and storage regions. Chambers are empty with several narrow layers. Pores are surrounded with thick cells of radial wall. Scales are arranged in two rows. Male receptacle is median dorsal and is horse shoe shaped under acropetal order. Female receptacle lies on the apical dorsal region of the thallus, sessile in young and short stalked at maturity. Receptacle contains 2-9 lobes, involucres large, calyptra thin, capsule thin walled, spores large, yellowish and tetrahedral. Elaters bi to tri-spiral, sometimes uniformly thickened with no spirals. Five species of *Plagiochasma* are known from Nepal. Three species are described here.

Key to the species

1.Thallus distinctly articulated; female receptacle at the articulated join ……...……. **3**. *Plagiochasma pterospermum*
Thallus not articulated; female receptacle dorsal surface 2

2. Lobes broad, scaly appendage large ..... **1**. *P. appendiculatum*
Lobes narrow, scaly appendages small..... **3**. *P. simlinsis*

3.1. Plagiochasma appendiculatum Lehm. & Lindb., Nov. Minus Cogn. Strip Pug.**4**: 14, 1832; Grolle, Die Lebermoose Nepals, Ergebn. Forsch.-Unternehmen Nepal Him. Bd. 1. Liefg. **4**: 263, 1966; Nog. *et al.*, Bull. Nat. Sci. Mus. **9**(3): 378, 1966; Shrestha, J. Nat. Hist. Mus. **1**(2-4): 189, 1977; Pradhan & Joshi, J. Nat. Hist. Mus. **10**: 75, 1986; D.G. Long & Grolle, J. Hattori Bot. Lab. **68**: 424, 1990; Furuki & Higuchi, Crypt. Him. **3**: 147, 1995; Pradhan, Mats. Checklist Bryo Nep.: 20, 2000a; Pradhan, J. Nat. Hist. Mus. **19**: 5, 2000b; Kattel, Liverworts Nep.: 66, 2002; Pradhan & Joshi, Current Trends in Bryology : 22, 2007b; Pradhan & Joshi, Nep. J. Pl. Sci. **2**: 30, 2008a.

Thalli thick, overlapped, light green in young and dark green on maturation, 1-4 cm long and 4-8 mm broad, dichotomously divided. Lobes oblong, obcorded, slighly concave with undulating margin. Thallus in transverse section shows distinctly the photosynthetic and storage portions. Air pores usually large and surrounded with 3-4 concentric rings of 6-10 cells. Ventral surface purplish due to the presence of two rows of scales on either side of the costa, scales with broad lucunate body and 1 or 2 appendages. Plants monoecious. Male receptacles horse shoe shaped surrounded by small scales. Female receptacles generally sessile in young with short stalks (3-5 mm). Receptacle includes 4-6 lobes. Capsules globouse, spores yellowish brown, reticulated, 50-90 µm in diameter including wings. Elaters bispiral, 220- 300 µm long.
Status: Most Common
Habitat: Rocks, soil, bricks walls, canal walls, etc.
Distribution: Nepal (W, C, E, 200-2000 m): Bardia (200 m), Dang 340-780 m), Kaski (920), Nawalparasi (200 m), Chitwan (240), Morang (300 m); Afganistan, Africa, Bhutan, Bangladesh,

Celebes, China, India (Assam, Darjeeling, Kashmir, Sikkim), Indo-China, Pakistan, Philippines, Taiwan and Vietnam.

3.2. Plagiochasma pterospermum C. Massal., Mem.Accad. Agric. Verona (ser3) **73** : 46, 1897.

Plagiochasma articulatum Kashyap, New Phyt. **13**: 320, 1914; Shrestha, J. Nat. Hist. Mus. **1**(2-4): 188-189, 1977; Pradhan & Joshi, J. Nat. Hist. Mus. **10**: 75, 1986; Pradhan, Mats. Checklist Bryo. Nep.*:* 20, 2000a; Pradhan, J. Nat. Hist. Mus. **19**: 59, 2000b; Pradhan, J. Nat. Hist. Mus. **21**: 49, 2002; Kattel, Liverworts Nep.: 66, 2002; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana:: 22 , 2007b; Pradhan & Joshi, Nep. J. Pl. Sci. **2**: 30, 2008a.

Thalli 2-5 cm long and 5-8 mm broad, lobes oblong to obovate, flat, margin undulate and apex notched. Dorsal surface of the thallus dark green with empty chambers. Air pores oval to round, 34x 46 µm, inconspicuous bounded by three series of 7 to 8 cells each. Scales overlapped, purplish on ventral side each containing two purple appendages and inconspicuous midribs. Plants monoecious. Receptacles always terminal and appear mid dorsal forming apical adventitious shoots. Male receptacles acropetal in order, followed by a female receptacle. Male receptacles horse shoe shaped with small scales around, female receptacles with 3-4 lobes. Spores generally yellowish, reticulated, 60-80 µm in diameter. Elaters bispiral and 220-250 µm long .
Status: Common
Habitat: Soil, rocks and concret walls, brick walls.
Distribution: Nepal (W, C, 240-3600 m): Dang (400-780 m), Bara (600 m), Chitwan (240-280 m); Bhutan (Long, 2006), China, India, Japan, Mongolia (Bai and Zhao, 1996) and Pakistan.

3.3. Plagiochasma simlensis Kashyap, J. Bomb. Nat. Hist. Soc. **25**: 27, 1917; Shrestha, J. Nat. Hist. Mus. **1**(2-4): 189-190, 1977.

Plagiochasma nepalensis Steph., Sprc. Hepat. **1**: 81, 1900; Pradhan & Joshi, J. Nat. Hist. Mus. **10**: 75, 1986; Pradhan, Mats. Checklist Bryo. Nep.*:* 2, 2000a; Kattel, Liverworts Nep.: 66, 2002.

Thalli large, bluish green mostly overlapped, about 25-30 mm long and 4-5 mm broad, margin entire with blunt apex, areolae indistinct, pores minute and simply bounded with 4- 5 cells. Ventral surface purplish with small scales, appendages not constricted, ovate to lanceolate, costa prominent on the ventral side. Plants dioecious. Male receptacles small dot like seen in young stage on the dorsal surface near the apical region. Female receptacles on short stalks about 1 mm long, 2-3 lobed. Spores broadly reticulated, light brown, winged and 110 µm in diameter. Elaters 3-4 spiraled, broad and 350-400 µm in diameter.
Status: Rare
Habitat: Damp soil near stream.
Distribution: Nepal (W, C, 200-1600 m): Banke (200 m); India.

4. Reboulia Raddi, Opuse. Sci. (Bologna) **2**: 357, 1818.

Gametophytic thalli with dichotomous branching which are innovated at the apex. Dorsal surface without distinct areolae. Air chambers empty with simple pores. Ventral surface contains two types of rhizoids and two rows of scales. Plants monoecious or dioecious. Male receptacles sessile and cushion shaped on the apical region of the thallus. Female receptacle has 4 - 9 lobes developed on the terminal stalks. Small narrow scales surround the base of the stalk. Capsules subglobose, shortly pedicellate with large foot and irregularly dehiscing at the apex. Elaters are 2-3 spiral. About 2- 4 species have been recorded from the world. Nepal has only one species recorded so far.

4.1. Reboulia hemisphaerica (L.) Raddi, Opuse. Sci. (Bologna) **2**: 357, 1818; Grolle, Ergebn. Forsch.-Unternehmen Nep. Him. Bd. 1. Liefg. **4**: 267, 1966; Nog. *et al.*, Bull. Nat. Sci. Mus. **9**(3): 378, 1966; D.G. Long & Grolle, J. Hattori Bot. Lab. **68**: 424, 1999, Furuki & Higuchi, Crypt. Him. **3**: 147, 1995; Kattel, Liverworts Nep.: 66, 2002; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: : 22 (2007b); Pradhan & Joshi, Nep. J. Pl. Sci. **2**: 30, 2008a.

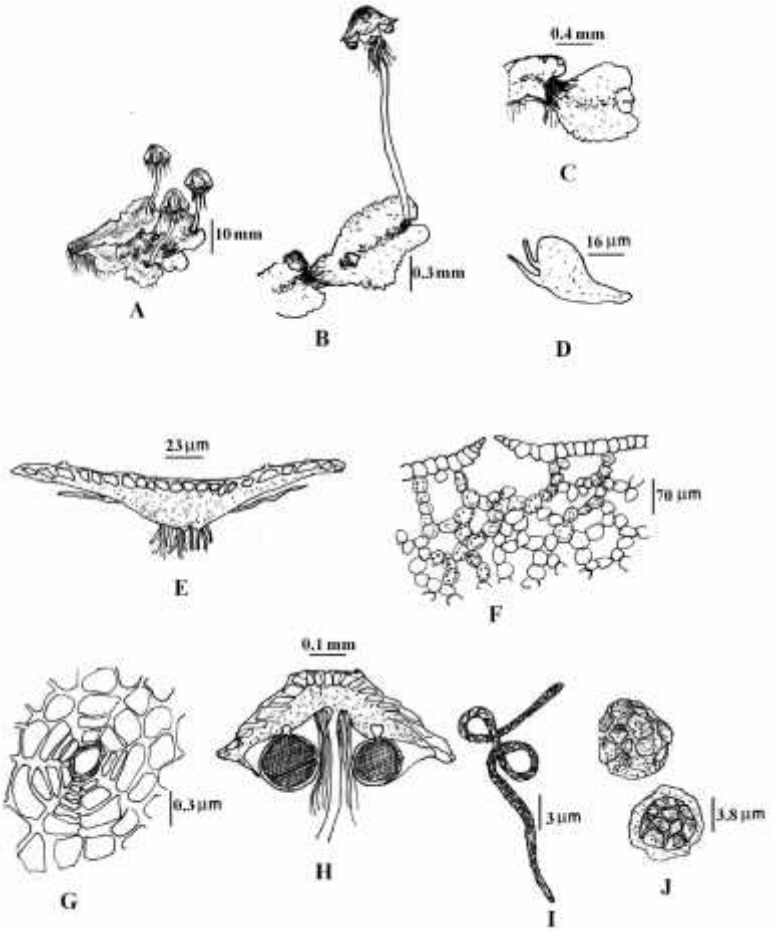


Fig. 27. *Reboulia hemisphaerica* (L.) Raddi. (Pradhan NGS 320). A. habit, B. a female thallus, C. a male thallus, D. scale, E. cross section of outline sketch of the thallus, F. cross section of thallus showing pores and chambers, G. a stoma, H. vertical section of archigonium, I elaters, J. spores.

Marchantia hemisphaerica L., Spec. Pl.: 1138, 1753..
Asterella hemisphaerica L. Beauvis, Dict. Sci. Nat. **3**: 257, 1805.
Grimaldia hemisphaerica Lindenb., Nov. Act. Leopold. **14**: 1829
Reboulia queenslandicum (Steph.) M.L. Hicks, J. Hattori Bot. Lab. **71***:* 144, 1992.

Purple-margined Liverwort; Hemisphaeric Liverwort (Eng.).

Thallus light green, forked and dichotomously branched, 2-4 cm long and 0.5 cm broad, leathery texture when moist and papery in dry; apically notched with faint purplish margin. Air pores are polyhydral on the upper surface of the thallus. The lower surface bears rows of large crescentic scales on either side of the costa and many hyaline rhizoids in the median region. Female receptacle contains four lobes and long stalk which arise from the apical notch of the thallus. Male receptacle is disc shaped lying behind the female receptacle. Spores spherical, brown, reticulate, 60-78 µm in diameter, elaters bispiral, coiled and 300-400 µm long (Fig. 27).
Status: Rare
Habitat: Soil and rocks.
Distribution: Nepal (W, C, E, 350-4600 m): Dang (780 m), Chitwan (355 m), Sankhuwasabha (1000 m), Morang (180 m); Bhutan, Caucasus, China (Sichuan), Europe, India (Sikkim, Darjeeling), Ireland, Japan, Java, Korea, New Guinea, North and South America and Pakistan.

5.2.2.2.2. MARCHANTIACEAE

Plants thalloid, dichotomous and dorsoventrally flattened. Thalli generally large, ca. 5-10 cm in length. Air pores barrel-shaped, composed of stack of cells and air chamber lie in one layer only. Oil body single in scattered cells of the thallus. Receptacles at the apical region of the thallus, both with stalked. Male receptacle disciform arise on a short stalk. Female receptacle with 8-9 radial lobes, between these lobes the perichaetium has several archegonia or sporangia. Each sporangium is enclosed by a campanulate pseudoperianth. Sporangium spherical to oval, capsules with elaters and spores. Elaters simple, long, narrow and bispiral. Spores smaller to medium and smooth.

1. Marchantia L., Sp. Plant.: 137, 1753.

Plant dioecious, dichotomously branched, dorsoventrally flattened with broad costa and hexagonal areolae. Lenticular gemmae are produced in the gemma cups for vegetative propagation, arise on the dorsal surface of the thallus, male and female reproductive organs also develop on the dorsal surface. Ventral surface has two rows of scales and two types of rhizoids. Transverse section of the thallus shows chambered photosynthetic and storage region, air pores barrel shaped. Male receptacle desiform on the long stalk, female receptacle with 4-10 elongated rays each with a rhizoid canal underneath, involucres 2-valved alternating the rays enclosing several capsules and each surrounded by perianth. Sporophytes with foot, seta and capsule. Spores small, tetrahedral, elaters simple long and bispiral.

Key to the species

1. Thalli short or long, midrib present..... 2
   Thalli large, mid rib ansent 3

2. Thalli small, not deeply dichotomous, midrib faint ……....…..... **1**. .*Marchantia emarginata*
   Thalli long, narrow deeply dichotomous, midrib distinct ……..…..…… **3**. *M. papillata*

3. Gemma cup margins furrowed ..... **2**. *M. palaecea*
   Gemmae cup margins serrulated ..... **4**. *M. polymorpha*

1.1. Marchantia emarginata Reinw. *et al.,* Bischler in Litt , 1988; Pradhan, Mats. Checklist Bryo. Nep.: 14, 2000a; Pradhan, J. Nat. Hist. Mus. **19**: 61, 2000b; Kattel, Liverworts Nep.: 49, 2002; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 21, 2007b; Pradhan & Joshi, Nep. J. Pl. Sci. **2**: 29 2008a.

Marchantia palmata Nees, Nova Acta **12**: 139, 1824; Shrestha, J. Nat. Hist. Mus. **1**(2-4): 185, 1977; Pradhan & Joshi, J. Nat. Hist. Mus. **10**: 77, 1986.

Plants grass green, deeply dichotomous, 20-40 mm long and 3-8 mm broad, margin entire and emarginate apex with distinct midrib. Gemma cups are small, green, 1-1.5 mm in diameter with smooth edges, developed on the dorsal surface of the median region. Gemmae, 325-400 x 240 µm in sizes.Ventral surface with two rows of scales and two types of rhizoids. Plants dioecious. Male receptacles more or less circular with 8-9 lobes on 10-20 mm long stalk. Female receptacle with 7 - 11 flat, slightly emarginate rays, arise on a long stalk. Capsules spherical to oval with number of brown, reticulated spores which are 20-30 µm in diameter. Elaters generally longer.
Status: Common
Habitat: Soil, rock, brick walls, concrit walls, cannel sides, forest floor, etc.
Distribution: Nepal (W, C, E, 118-2000 m): Bardia (200-240 m), Dang (690 m), Nawalparasi (250 m), Chitwan (200 m), Parsa 250 m), Kavre (900 m), Sankhuwashava (1000 m), Jhapa (150 m); Burma, Bhutan, China, India (Darjeeling), Japan and Pakistan.
Remarks: A very common species distributed over tropical to temperate regions of Nepal.

1.2. Marchantia paleacea Bertol., Opus Sci. Bologna **1**: 242, 1817; S. Hatt. in Hara, H., Fl. E. Him. **1**: 535, 1966; Nog. *et al.,* Bull. Nat. Sci. Mus. **9** (3): 379, 1966; Karczm., Lindbergia **7**: 129, 1981; Pradhan, Mats. Checklist Bryo. Nep.: 14, 2000a; Kattel, Liverworts Nep.*:* 49-50, 2002.

Money Liverwort (Eng.).

Thalli dark green to greyish green, ribbon like dichotomously branched, 4-5 cm long and 1 cm wide, overlapped forming large patch. Margin smooth, costae not distinct, dorsal surface with many deeply forrowes gemma cups on the median region, ventral surface purplish with four rows of

purple scales. Smooth walled and tuberculated rhizoids accumulated on the median region on the ventral surface of the thallus. Plant dioecious. Male receptacle disc shaped on shoet stalk. Female receptacle slightly convex on pale white stalk.
Status: Uncommon
Habitat: Rocks.
Distribution: Nepal (C, 550-2600 m): Makwanpur (550 m); China, India and Japan.

1.3. Marchantia papillata Raddi subsp. **grossibarba** (St.) Bischl., Cryptogamie, Bryol. Lichenol. **10**: 78, 1989; D. G. Long & Grolle, J. Hattori. Bot. Lab. **68**: 425, 1990; Furuki & Higuchi, Crypt. Him. **3**: 148, 1995; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana:: 21, 2007b.

Thalli dark green, deeply dichotomous leathery in texture and with smooth margin, overlapped forming a large patch. Thallus 3-4 cm long and 3 mm wide, midrib and hexagonal chambers distinct on dorsal surface. Gemma cups at the apical region at nutch region of the dorsal thallus, cups edge is smooth and 1.5-1.8 mm in diameter, gemmae green, discoids bodies measure 182-249 x 340-374 µm in size. Air pores 68-70 µm in diameter, numerous on dorsal surface surrounded by four concentric rings of cells. Ventral surface with two types of rhizoids and rows of scales on either sides of costa. Scales purphish brown with two appendages, tuberculated rhizoids pale white, 9-10 µm in diameter and smooth walled rhizoids 23 µm in diameter clustered at mid ventral region. Anatomical section shows the filamentose photosynthetic region and large storage region, cells in the storage region are hexagonal smaller towards the median region and larger and thin walled towards the periphery and 55-90 µm in diameter.
Status: Common
Habitat: Soil covered rocks, river banks.
Distribution: Nepal (W, C, 220-2500 m): Kailali (220 m), Kaski (800 m), Nawalparasi (250 m), Chitwan (250 m), Makwanpur (490 m); Bangladesh, Bhutan, China, India (Darjeeling, Sikkim, Assam, Kashmir), Pakistan, Sri Lanka, Myanmar and Thailand.
Remarks: The deeply dichotomous branched thallus is the characteristic of this species.

1.4. Marchantia polymorpha L., Sp. Plant.: 1137, 1753; Nog. *et al.*, Bull. Nat. Sci. Mus. **9**(3): 379, 1966; Grolle, Khumbu Himal, **6**(2): 119, 1974; Shrestha, J. Nat. Hist. Mus. **1**(2-4): 184 1977; Pradhan & Joshi, J. Nat. Hist. Mus. **10**: 77, 1986; D. G. Long & Grolle, J. Hattori Bot. Lab. **68**: 425, 1990; Pradhan, Mats. Checklist Bryo. Nep.: 14, 2000a; Pradhan, J. Nat. Hist. Mus. **19**: 61, 2000b Kattel, Liverworts Nep.: 50, 2002; D.G. Long, Crypt. Bryol.. **27**(1): 125, 2006a; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 21, 2007b; Pradhan & Joshi, Nep. J. Pl. Sci. **2**: 30 2008a.

Common Liverwort, Money Liverwort (Eng.).

Thalli dark green, prostrate, deeply dichotomous, 5 to 10 cm long and 1-2 cm wide, pores visible and margin plane to crisped. Gemma cup with serrulated edges and with number of multicellular, discoid gemmae which are one celled thick with short hyaline stalk. Ventral surface with two types

of rhizoids and the rows of scales present on either sides of the costa. Dorsal epidermis with barrel-shaped air pores, 40-50 µm in diameter, surrounded by 4-6 concentric rings of super imposed cells which communicated to the air-chamber of the thallus. Tissues differentiated into upper filamentous bearing chlorophyllous region which seperate air chambers vertically and the lower zone has compact hexagonal storage tissue.The antheridiophore and archegoniophores arise seperately on the dorsal surface of the thallus in the apical region. Male receptacles disc shaped eight short rounded lobes upon short stalk measuring 15 mm long. The antheridia within the antheridial chamber, each surrounded by a layer of jacket cells. Female receptacles umbrella shaped with 9-10 rays which arise upon a 20 mm long cylindrical stalk. Sporophytes differentiated into capsule, seta and bulbous foot. Spores spherical, 20-30 µm in diameter and elaters long spindle shaped.

Status: Most common.

Habitat: Soil, rocks, brick walls, concrite walls, etc

Distribution: Nepal (W, C, E, 200-2100 m): Bardia (200 m), Dang (1000-1350 m), Kaski (800 m), Nawalparasi (300 m), Parsa (245 m), Kavre (1000 m), Morang (130 m); Australia, Bhutan (North-West), China, Europe, India, (Northwest, Sikkim, Darjeeling) and many Asian countries.

Remarks: Common in artificial habitats espicially as a horticultural weed, frequently grows upon shaded brick walls, soil, rocks, stream sides, etc.

5.2.2.2.3. MONOSOLENACEAE

Monosolenaceae is monogeneric and monospecific family of order Marchantiales. Plants dorsoventrally flattened thalloid, and relatively appear in natural habitat. The reports include wet and moist shaded soil (Horikawa, 1934, Inoue, 1976, Kapila & Kumar,1995) and calcareous mud in an area of limestone caves in Japan (Shin, 1968), in the garden soil (Kashyap, 1924) and in green house soil (Yang, 1965).

1. Monosolenium Griff., Notulae ad Plantas Asiaticas II: 341-343, 1849.

This monospecific complex thalloid liverwort is aquatic in habit. Thalli monoecious, dorsoventrally flattened, dark green, deeply dichotomous and with folded margin. Dorsal surface smooth without air pores and chambers. Ventral surface with smooth walled rhizoids and pegged tuberculated rhizoids, scales hyaline. Male and female receptacles both on dorsal surface on apical region of the thallus. The plants are found for sale as an aquarium plants and is readily grows into dense submerged colonies with thinner and more delicate thalli than plants growing in terrestrial colonies. In this respect it is similar to aquatic *Riccia fluitans.*

The genus is reported for the first time in Nepal and which is described in the present investigation.

1.1. ***Monosolenium tenerum** Griff., Notulae ad Plantas Asiaticas II: 341 -343, 1849; Kashyap, J. Ind. Bot. Soc.: 181, 1924; Yang, Taiwania **11**: 29-34, 1965; Inoue, Illus. Jap. Hepat. **2**: 86, 1976; Pradhan *et al.*, Cryptogamie, Bryologie **28**(3): 243-248, 2007d. Singh & Singh, Current**.** Sci. **92:** 1483-1485, 2007.

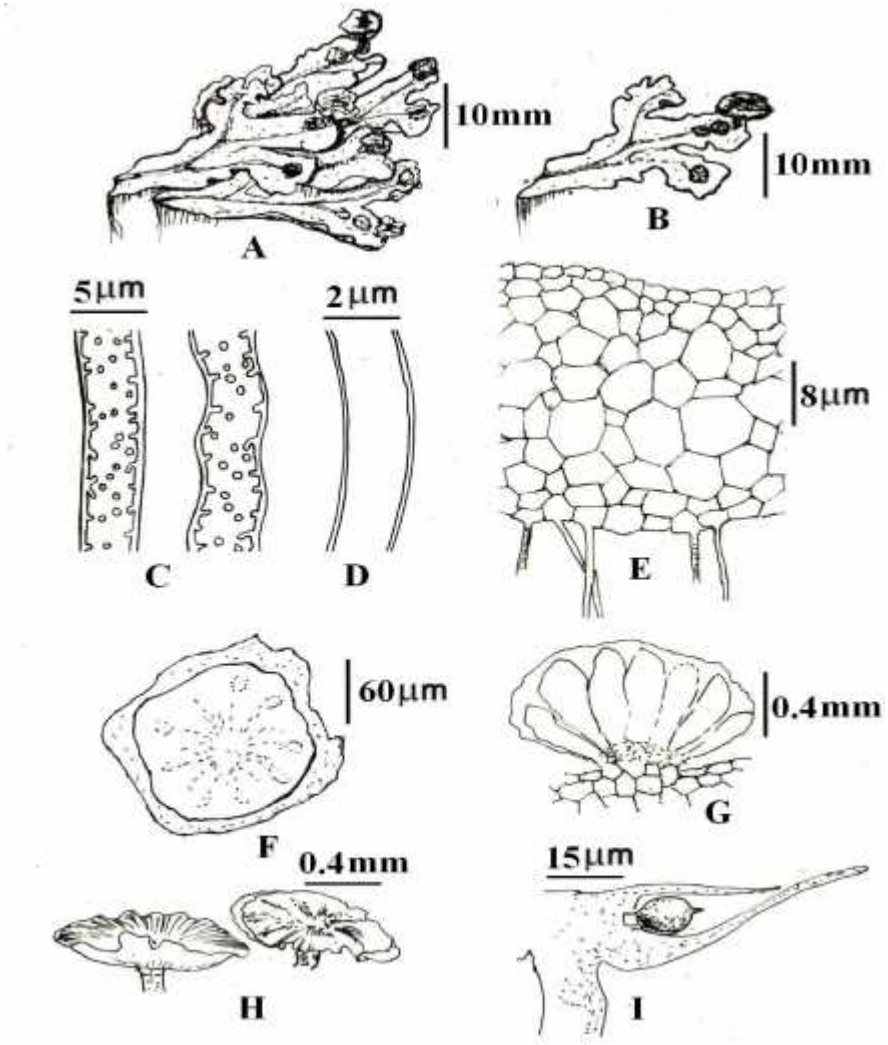


Fig. 28. *Monosolenium tenerum* Griff., A. habit, B. Fertile thallus, C. Part of two pegged rhizoids, D. part of smooth walled rhizoid, E. Portion of tranverse section of the thallus, F. androecial cushion in dorsal view, G. cross section of androecial cushion, H. Two detached carpocephala, I. verticle section of part of carpocephalum with developing sporophyte.

Thalli thin, dark green, semi-translucent, dorsoventrally flattened and dichotomously branched with wavy margin. The thallus 3.5 cm long and 5-8 mm broad. The dorsal surface smooth with distinct costa. Vertical section of the thallus shows compact masses of hexagonal hyaline cells with brown specialized oil bodies situated within the cells. Two types of rhizoids on the coastal region of ventral surface. The tuberculated rhizoids are pegged, 12-15 µm in diameter while the smooth walled are 23 µm in diameter. Scales are hyaline and thread like. Plants monoecious, both male and female receptacles found on dorsal surface in the median region of the apical part. The female carpocephala resembles inverted umbrella with folded margin born on pale green, smooth stalk of

1-2 mm long. Male receptacles cushions shaped, found just behind the female receptacle, which are more or less circular, convex, yellowish green and measures 1.8-2 mm in diameter. Antheridia in antheridial chambers. Archegonia flask shaped borne on short stalk (Fig. 28).

Status: Rare.

Habitat: In undisturbed damp soil in mixed forest where *Shorea robusta* (Sal) is dominant. Ground vegetations are ferns and weeds.

Distribution: Nepal (W, 118 m): Bardia (118 m); China, India, Japan, Ryukyu, Taiwan and Thailand.

Remarks: This species is recorded as new to Nepal. It was first discovered by Griffen in 1849 based on his own collection from agricultural field of Suddya and Tengrei of Assam. Over eight decades after, this species was again collected from Manipur in 1920, Western Himalaya in 1984 and recently from Dehradun in 2002 and 2003 (Singh and Singh, 2007).

5.2.2.2.4. RICCIACEAE

Plants thalloid, monoecious or dioecious. Thallus dichotomously branched with linear to obcordate segments, terrestrial, some are aquatic in habit. Thallus may or may not contain pores. Thalli with compact vertical columns of green cells with narrow air spaces. Antheridia and archegonia embedded into the dorsal side of the thallus. Capsules with unistratose wall. Elaters absent and spores generally larger. Two genera and six species has been recorded from Nepal.

1. Riccia L., Sp. Plant.: 1138, 1753.

Plants monoecious or dioecious, terrestrial or aquatic. Thalli dichotomously branched. Thallus has compact vertical columns of green cells with apical hyaline cell which is connected to the narrow air space on the upper region and compact parenchymatous tissue on the lower region which can be seen in V. S. of thallus. Rhizoids usually smooth walled and tuberculated, smooth walled or sometimes absent. Antheridia and archegonia are immersed in the dorsal surface of the thallus. Sporophyte remains within the thallus. Capsule sessile without foot and seta. Calyptrae persistent. Spores large, tetrahedral, reticulated and 40-150 µm in diameter. *Riccia* is widely distributed in the world. Nepal has the report of six species so far. Four species are described here.

Key to the species

1. Plants aquatic, semi-aqatic ..... **2**. *Riccia fluctans*
   Plants terrestrial 2

2. Thalli bluish green, scales lacking …..... **1**. *R. crystallallina*
   Thalli light green, scales present ..... 3.

3. Spores smooth, 56 µm in diameter ……..... **3**. *R. pathankotensis*
   Spores grandular-papillose, 70-95 µm in diameter ..... **4**. *R. glauca*

1.1. Riccia crystallallina L., Spec. Plant., ed. **1, 2**: 1138, 1753; Raddi, Opuse. Sci. **2**: 251-253, 1818.

Crystalwort (Eng.).

Plants monoecious found growing on different habitats. Thalli bluish-green, forms a rosette around the soil, measures about 25 mm in diameter. Thallus flat, branched dichotomously, 2-4 mm wide. Ventral scales lacking. Capsule embeded on the dorsal surface of the thallus, spores reticulate, yellowish brown and 55-85 µm in diameter.
Status: Rare
Habitat: Soil, shaded field, paths and near muddy pools.
Distribution: Nepal (C, 900-1600 m): Kavre (900-1000 m); Australia, China, Europe, France, Israel, Macronesia, North & South America, North & South Africa, Russia, South India and Turkey.

1.2. Riccia fluitans L., Spec. Plant, ed.1, 2: 1139, 1753; S. Hatt. in Hara, Fl. E. Him. **1**: 536, 1966; Nog. *et al.,* Bull. Nat. Sci. Mus. **9**(3): 379, 1966; Shrestha, J. Nat. Hist. Mus. **1**(2-4): 190, 1977; Pradhan & Joshi, J. Nat. Hist. Mus. **10**: 74, 1986; Furuki & Higuchi, Crypt. Him. **3**: 148, 1995; Pradhan, Mats. Checklist. Bryo. Nep.*:* 21, 2000a; Pradhan, J. Nat. Hist. Mus. **19**: 62, 2000b; Kattel, Liverworts Nep.: 66, 2002; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 22, 2007b; Pradhan & Joshi, Nep. J. Pl. Sci. **2**: 30, 2008a.

Floating Crystlewort (Eng.).

Thalli dark green, semitrasparent, 35-50 mm long and 1 mm broad, dichotomously branched several times, free floating upon fresh water or wet sand beds. The aquatic form has long, thin, semi transparent thalli with deep dichotomous branches. No scales and rhizoids are found. The terrestrial form comprises light green thalli, broadly channelled with numerous smooth walled rhizoids and hyaline scales which are confined to the ventral surface. Air chambers generally large and scattered over spongy tissues. Plants autoecious, both antheridia and archegonia embedded in the tissue of the thallus. Capsules globose and blackish dot like. (Fig. 29).
Status: Common.
Habitat: Aquatic and semi-aquatic.
Distribution: Nepal (W, C, 230-1500 m): Kanchanpur (230 m), Dang (685 m), Chitwan (250-280 m), Kavre (900-1000 m); Africa, Borneo, China, East Asia, England, Europe, India (Sikkim, Assam, Kashmir), Ireland, North and Central America and Pakistan.
Remarks: Common at lower elevation.

1.3. *Riccia glauca L., Spec. Plant. : 1139, 1753; Arnell, Heptc., Moss Fl. Fennosc.: 282, 1956; Hasegawa & Takimoto, Mem. Coll. Agr., Kyoto Univ. **126** (6): 68, 1985; Sm., Liverworts Brit. & Ireland: 328, 1996; So, Mosses Hong Kong **1**: 155, 1995; Kurschner & Erdag, Turk. J. Bot. **29**: 8, 2005.

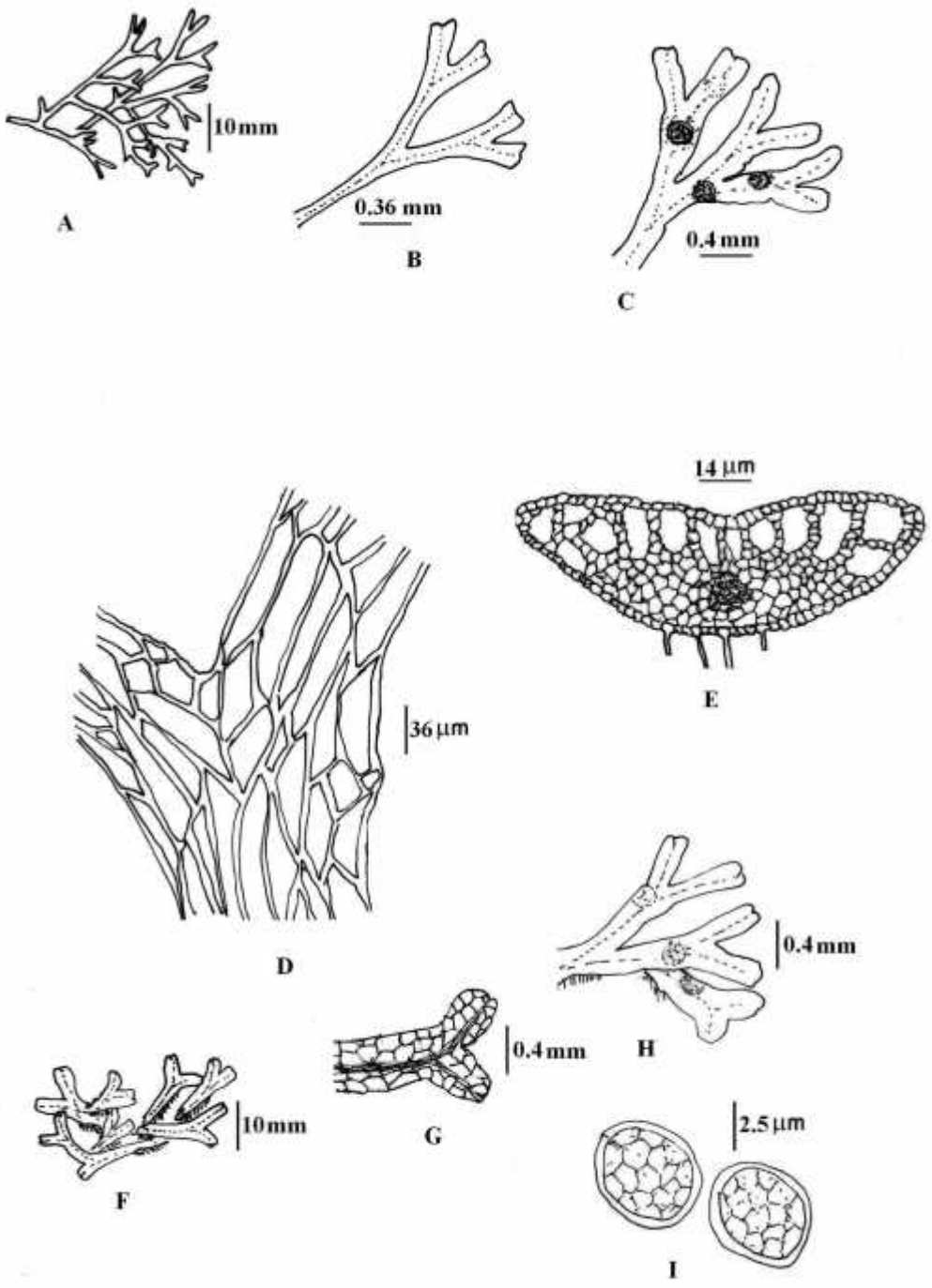


Fig. 29. *Riccia fluitans* L., (Pradhan NGS 52). A. habit of floating form of plants, B. a thallus of floating form, C. floating thallus portion showing position of sporophytes, D. cell structure of floating form of thallus, E. cross section of floating form of thallus, F.-G. terrestrial foor, F. thalli habit, G. apical portion of the thallus, H. thallus showing position of sex organs, I. spores.

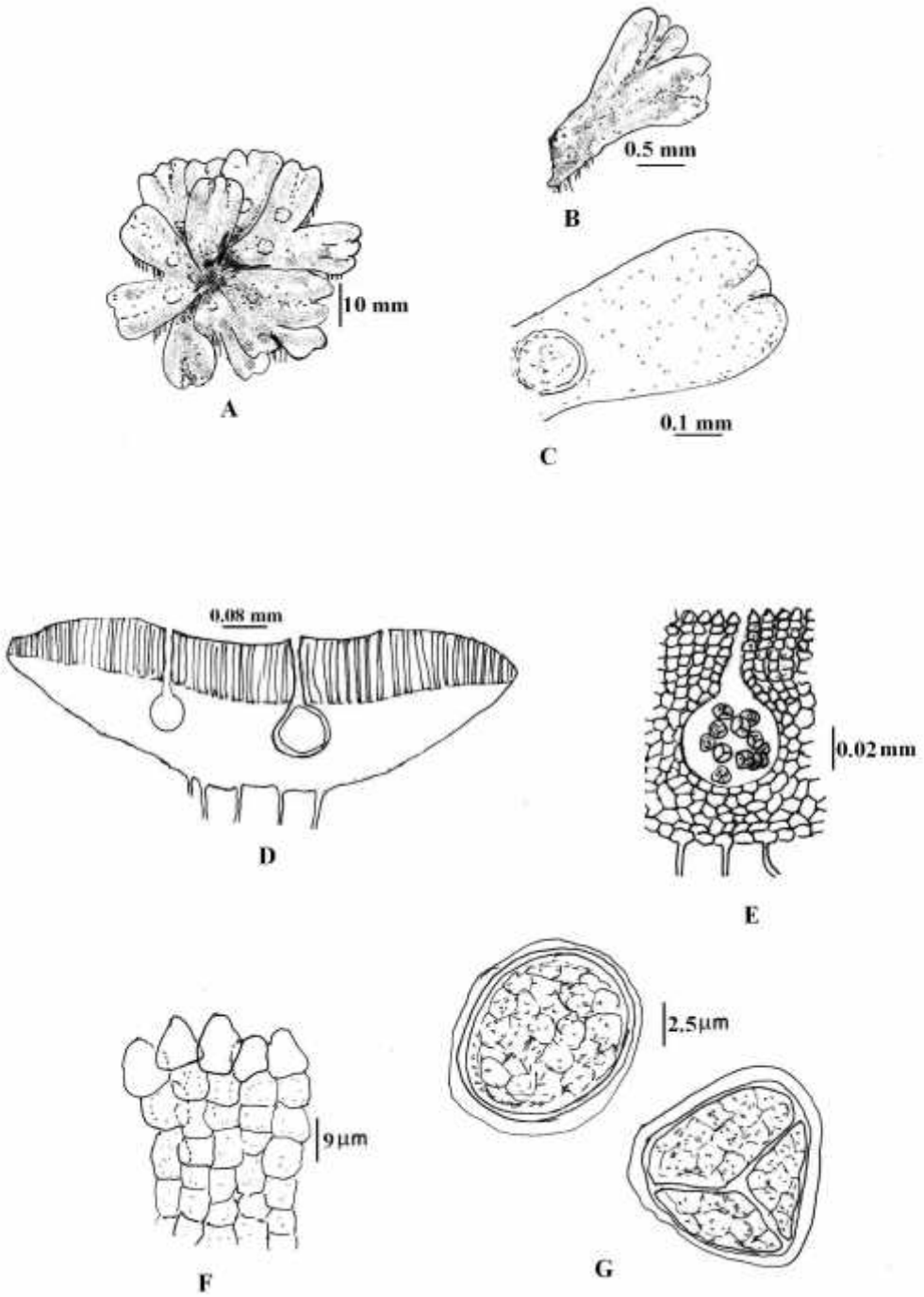


Fig. 30. *Riccia glauca* L. (Pradhan Pn 314). A. habit, B. a single thallus, C. a portion of thallus, D. cross section of the thallus showing assimilatory and storage zones, E. portion of cross section of thallus showing sporophyte and spore tetrads, F. assimilatory filaments, G. spore and spore tetrad.

Glaucous Crystalwort (Eng.).

Plants thalloid in rosettes. Thalli usually glaucous-green, 2-3 times dichotomously branched, flattened, partial or complete rosette measuring 1-2 cm in diameter. Dorsal surface with shallow channel in the median region, margin acute. Ventral surface slightly convex, without furrow andthin, margin somewhat recurved with rhizoids and scales. Scales colourless and seldom purplish. Epidermal cells pyriform-balloon shaped and thin walled. Plants autoecious, sporophytes deeply embedded on the ventral surface of the thallus and appear as black dots. Capsules globose, dark brown to blackish, common in summer. Spores dark brown, reticulated, grandular-papillose, triradiate and 70-95 µm in diameter (Fig. 30).
Status: Rare
Habitat: Soil.
Distribution: Nepal (C, 300 m): Chitwan (300 m); Algeria, China, Europe, Iceland, Japan, Lebnon, Macaronesia, Morocco, North America, North Russia, South Fennoscandia and Turkey.
Remarks: Hasegawa and Takimoto (1985) reported its distribution in experimental foresty of Kyoto University, Japan. This is new record for Nepal.

1.4. Riccia pathankotensis Kashyap, J. Nat. Hist. Soc. **24**: 349, 1916; Shrestha, J. Nat. Hist. Mus. **1**(2-4): 190, 1977; Pradhan, Mats. Checklist Bryo. Nep.: 21, 2000a; Kattel, Liverworts Nep.: 67, 2002.

Plants monoecious, rossette and scattered around moist ground. Thalli small, deeply dichotomous, yellowish green, overlapped and measure 4 x 1.2 -2 mm. Margin smooth and grooved in the median region. The ventral surface with two types of rhizoids and small, hyaline overlapped scales. Sporophytes seen as black dots on the median region, globose, 340 µm in diameter and are embedded into the thallus. Spores numerous, spherical, dark brown, opaque, reticulated and 56 µm in diameter.
Status: Rare
Habitat: Loamy soil near river bank.
Distribution: Nepal (C, 250 - 1400 m.): Chitwan (300 m); India, Japan, North America and Pakistan.

5.2.2.2.5. TARGIONIACEAE

Thalli dichotomously branched. Air pores on the dorsal surface are simple and dot like, air chambers usually in one layer. Male receptacles arise upon short lateral branches. Female receptacles sessile at under surface of the thallus of the apical region. Sporophyte globose and is surrounded by 2 lobed involucre, pseudoperianth lacking. Spores large, unicellular and elaters sometimes branched.

Three genera are recorded worldwide. Of them two genera represents in Nepal.

Key to the genera

1. Plants small, semi-translucent; involucre hyaline, scales minute, Sporophytes within the thallus. ..... **1**. *Cyathodium*
Plants large, opaque; involucre purple, scales conspicuous, Sporophytes on ventral surface of the apical region ..... **2**. *Targionia*

1. Cyathodium Kuntze in Lehm., Pug. **4**: 17, 1854.

Plants may be monoecious or dioecious, thin, semi transparent, small, tuft generally overlapped and grow upon bricks and stone walls. The dorsal and ventral layers of cells are seperated by air spaces which in turn are divided by thin vertical partitions. Thallus is dichotomously divided. Scales minute, rhizoids usually smooth walled. Antheridia are numerous. The position of male receptacle is variable. Involucre usually under surface as in *Targionia*. Archegonia are found in clusters but fewer in number. Capsule globose inserted by a small foot, disperse by 8 equally large valves. Spores spherical, muricate, elaters fusiform and trispiral.

Two species of *Cyathodium* have been recorded in Nepal. *Cyathodium cavernarum* Kuntze is recorded as new to Nepal (Long, 2003).

1.1. Cyathodium tuberosum Kashyap, New Phyt. **13**: 210, 1914; Shrestha, J. Nat. Hist. Mus. **1** (2-4): 187, 1977; Pradhan & Joshi, J. Nat. Hist. Mus. **10**: 75, 1986; Furuki & Higuchi, Crypt. Him. **3**: 146, 1995; Pradhan, Mats. Checklist Bryo. Nep.*:* 22, 2000a; Pradhan, J. Nat. Hist. Mus. **19**: 62-63, 2000b; Kattel, Liverworts Nep.: 72, 2002; D.G. Long, Crypt. Bryol. **27** (1): 125, 2006a; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 22, 2007b.

Large patch growing upon exposed ground and shaded brick walls, thalli yellowish to bright green, dichotomously divided and densely overlapped. Each thallus is thin, semi translucent and fan shaped, 8 x 4 mm in size, rhizoids smooth walled and 10-12 µm in diameter. Cells hexagonal with chloroplast, 23 x 46 µm in diameter and no costa on the dorsal surface. Dorsal pores simple, rounded to elliptical, 45 µm in diameter and is surrounded with 2-3 series of 4- 5 cells .
Status: Rare
Habitat: Exposed ground, concrete walls and shaded brick walls.
Distribution: Nepal (W, C, E, 250- 2400 m): Rupendehi (300 m), Kaski (800 m), Chitwan (250-300 m), Parsa (120-250 m), Makwanpur (320 m), Morang (300 m); India.
Remarks: This common species covers large substratum forming thick carpet in sub tropical region but are rare in tropical region.

2. Targionia L., Sp. Plant.: 1136, 1753.

Monoecious or dioecious. Thalli dark green, overlapped and rarely dichotomous. Pores simple, areolae distinct and dot on the dorsal surface. Ventral surface with rhizoids and scales. Antheridia

on the dorsal surface of the thallus, ventral innovations arise from the ventral shoots or the main shoot. Sporangium generally one in each involucre on ventral surface at the apical region. Capsule shortly pedicellate with well developed foot. Spores reticulate, elaters bispiral.

2.1. Targionia hypophylla L., Spec. Plant, ed.**1, 2**: 1136, 1753; Grolle, Khumbu Himal, Bd. 6, Lfg.: 119, 1974; Shrestha, J. Nat. Hist. Mus. **1**(2-4): 188, 1977; Karczm., Lindbergia **7**: 129, 1981; Pradhan & Joshi, J. Nat. Hist. Mus. **10**: 75, 1986; D.G. Long & Grolle, J. Hattori Bot. Lab. **68**: 422, 1990; Furuki & Higuchi, Crypt. Him. **3**: 146, 1995; Pradhan, Mats. Checklist Bryo. Nep.*:* 22 2000a; Pradhan, J. Nat. Hist. Mus. **19**: 63, 2000b; Kattel, Liverworts Nep.: 72, 2002; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 22, 2007b.

Thalli overlapped, 10-15 mm long and 3-4 mm broad, rarely dichotomous, darkgreen with small notch at the apical region. Ventral surface light green with distinct costa, scales generally purplish dark on either side of the midrib, rhizoids tuberculated and smooth walled in the median region of the ventral surface, air pores simple, wide conspicuous, 60-62 µm surrounded with 4 concentric rings of cells, communicated to air chambers below. Storage region with compact hyaline parenchymatous cells. Dioecious. Sporophyte globose, sessile on the ventral surface near apical region. Spores spherical, light brown, reticulated, double walled and 40 -65 µm in diameter. Elaters long, 175- 220 µm long, 10 -16 µm broad with two spiral bands.
Status: Rare
Habitat: Soil, rocks, brick walls, etc.
Distribution: Nepal (W, C, 200-4550 m.): Banke (200 m), Palpa (300 m); Australia, Bhutan, China, Cyprus, England, Europe, Java, Korea, Macronesia, Madagascar, N. W. India, North, Central and South America, North and South Africa, Netherland, New Zealand, Southwest Russia, Sumatra, Tasmania and Turkey.
Remarks: Very rare in lowland areas, common in subtropical to temperate zones of Nepal.

5.2.2.2.6. WIESNERELLACEAE

Monoecious or dioecious. Thalli usually large, dark green, pores simple or absent, air chambers in a single layer or lacking. Male and female receptacles stalked with 2 rhizoid furrows. Male receptacles generally disc shaped. Female receptacles hemispherical, lobed, involucre 2 lipped, pseudoperianth lacking, cells of capsule wall with annular thickenings and elaters simple. Two genera are know from this family and one is described here.

1. Dumortiera Nees in Reinw. *et al*., Nova Acta Leop. Carol. **7**: 410, 1824.

Plants thalloid.Thalli large, dark green, dark green, dichotomous with folded margins, prostrate found in the form of expanded patches. Dorsal surface smooth, air chambers and ventral scales lacking. Rhizoids smooth walled, tuberculated rhizoids scare. Monoecious or dioecious. Male receptacles disc shaped on short stalk in the apical region of the dorsal surface, female receptacle on long stalk with 2-rhizoidal furrows, receptacle 6-10 lobed, pseudoperianths lacking, capsules

dehiscence by 4 valves, spores tetred, dark brown and elaters long, simple sometimes branched.

1.1. Dumortiera hirsuta (Sw.) Nees in Reinw. *et al.,* Nova Acta Acad. Leop. Carol. Nat. Cur. **12**: 410, 1824; S. Hatt. in Hara, Fl. E. Him. **1**: 534, 1966; Nog. *et al.,* Bull. Nat. Sci. Mus. **9** (3): 379, 1966; Pradhan & Joshi, J. Nat. Hist. Mus. **10**: 76, 1986; D. G. Long & Grolle, J. Hattori Bot. Lab. **68**: 423, 1990; Furuki & Higuchi, Crypt. Him. **3**: 146, 1995; Sm., Liverworts Brit. & Ireland: 314, 1996; Pradhan, Mats. Checklist Bryo. Nep.: 14, 2000a; Pradhan, J. Nat. Hist. Mus. **19**: 63, 2000b; Koponen *et al.,* Ann. Bot, Fennici **37**: 25,2000; Kattel, Liverworts Nep.: 73, 2002; D.G. Long, Crypt. Bryol. **27** (1): 127, 2006a; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 22, 2007b.

Dollar Plant (Eng.).

Thalli dark green, 5- 12 mm wide and 10 cm long, margin slightly undulate, apex emarginate, costa broad, light brown and distinct from ventral surface. Transverse section of thallus shows a single type of tissue. Air pores and chambers lacking, ventral surface with numerous smooth walled rhizoids, tuberculated rhizoids absent, ventral scales very small and disappear very soon. Plants dioecious. Male receptacles circular, little raised, disc shaped slightly grooved in the centre and rings of short hairs at the margin, born at the apical region on dorsal surface. Female receptacle terminal with 15 – 20 mm long stalk and 6 lobed receptacle. Capsule rare, spores brown, papillose and 25 -35 µm in diameter.
Status: Uncommon
Habitat: Moist soil near water sources.
Distribution: Nepal (W, C, E, 370-2600 m): Kaski (800 m), Chitwan (1000 m), Kavre (900-1000 m), Sankhuwasabha (825 m), Sunsari (450 m); Australia, Bhutan, China, Greece, India, Italy, Japan, Kenya, Mayalsia, Philippines, Sri Lanka, Spain, Southwest Ireland and Southeast USA.
Remarks: Recorded mostly in dark, shaded areas.

5.2.2.3. METZGERIALES

Plants dorsoventral, thalloid with or without well defined midrib, thallus wings entire, incised into a leaf-like lobes. Thallus with an apical cells having two cutting faces, air-chambers lacking, central conducting may be present, cells thin walled, about 32-35 µm in diameter, trigones absent, oil bodies few, underleaves absent. Rhizoids on ventral surface of the median region. Archegonia produce behind the growing point, growth is monopodial on dorsal surface or on short lateral branches or on ventral branches. Developing sporophytes are protected by pseudoperianth or by scales. Capsules spherical opened by 4 valves. Elatophores present at the base or apex of the capsule. Spores spherical usually 30-32 µm in diameter. About 28 genera and 550 species under 12 families are known in the world (Schofield, 1985).

Nepal represent six genera and four families. Five species under four genera and three families are included in the present investigation.

Key to the Families

1. Thallus thin, margin plane, midrib faint ……..……..……..... 2
   Thallus broad ribbon like, margin crisped, midrib distinct …….....… **3**. Pallaviciniaceae

2. Thallus regularly dichotomous, marginal hairs present …….....… **2**. Metzgeriaceae
   Thallus irregularly branched, marginal hairs absent ……..…… **1**. Aneuraceae

5.2.2.3. 1. ANEURACEAE

Plant body is thalloid. Thallus fleshy or embranous, ribbon shaped and many celled thick with poorly defined costa, branching is irregular or regular with 1-3 pinnate. Oil bodies are 1- 30 in number and are present in each cell, gemmae requent, 1-many celled. Antheridia 1-8 on short lateral branches. Pseudoperianth lacking. Calyptra fleshy, cylindrical to clatate, papillouse above. Capsule oblong to cylindrical, dehiscing by four valves, eplaterophores apical. Elaters free or fixed, free elaters are monospiral, tapering at both ends, fixed forms are short and obtuse with an indistinct spiral bands and persistent as erect tufts at the apex of the valves, spores unicellular and spherical. Four genera and 222 species has been recorded in the World (Cavers, 1976).

Key to the genera

1. Thalli greater than 3-7 mm wide, greasy, 7-12 cells thick …… **1**. *Aneura*
   Thalli less than 0.3-2.5 mm wide, pale green to dark green, 5-9 cells thick …..……..... **2**. *Riccardia*

1. Aneura Dumort., Comment. Bot.*:* 115, 1822.

Plant dioecious, yellowish green to dark green and fleshy with broad midrib. Thallus simple to bipinnate, 2-6 mm wide, plano convex to deeply concave under section. Epidermal cells usually smaller than inner cells, oil bodies are usually 5- 40 in number and are present in each cell. Gemmae is rarely present, if present, may be exogenous and multicellular. Anhteridia and Archegonia usually biseriate. Perianth is absent. Calyptra 5-12 celled thick, smooth, tuberculate or ciliate. Capsule long, pedicellate opening by four valves and seta has 6-18 cell. Elaters short, monospiral and spores small.
About 150 species from this genus have been recorded in the world (Cavers, 1976) and Nepal has the record of one species only.

1.1. Aneura blasioides (Horik.) Furuki, J. Hattori Bot. Lab. **70**: 311, 1991; Furuki & Higuchi, Crypt. Him**. 3**: 144, 1995.

Green Liverworts (Eng.).

Plants thalloid, flattened, ribbon like, dark geen, 4-5 cm long, 4-5 mm wide and 8-10 celled thick.

Cells hexagonal with 9-30 oil-bodies in each cell. Margin slightly undulate, no midrib, rhizoids on the ventral surface accumulated in the median region. Plants dioecious, sporophytes with pale white setae and brown ellipsoidal capsules.
Status: Rare
Habitat: Wet soil.
Distribution: Nepal (W, 600 -1000 m.): Palpa (600 m), Kaski (920 m); Japan and Pakistan.

2. Riccardia Gray, Nat. Arr. Br. Pl .**1**: 679, 1821.

Plant thalloid, monoecious or dioecious. Thallus pale green to dark green, pinnately or palmetely or irregularly branched, 0.5 -2 mm wide. Apical slime papillae persistent and oil bodies 0-15 per cell. Gemmae often present at the apical region of the thallus, 1-3 celled thick and endogenous. Calyptra 3-12 celled thick, smooth, papillous or ciliate above. Capsule wall cells with semi-annular thickings, seta 4 celled in diameter and spores spherical.

Smith (1996) has described 5 species of *Riccardia* from Britain and Ireland. Nepal has the record of two species so far.

Key to the species

1. Thallus simple, branches without parallel sides; cells with oil bodies …… **1**. *Riccardia cardoti*
   Thallus bi to tri pinnately branched; oil bodies rare in the cell ……..... **2**. *R. multifida*

2.1. Riccardia cardotii (Steph.) Pande & S. C. Srivast. ex Srivast. & Udar [Pande & S. C. Srivast., J. Ind. Bot. Soc. **37**: 417, 1958]; D. G. Long & Grolle, J. Hattori Bot. Lab. **68**: 421, 1990; Furuki & Higuchi, Crypt. Him. **3**: 145, 1995.

Plants thalloid, prostrate and generally grow upon boulder stones. Thalli are not pinnately branched and branches without parallel sides. Cells with oil bodies. Capsules club shaped, papillous with long calyptra, open by four parts. Spores spherical, 15-17 µm in diameter.
Status: Rare
Habitat: Damp soil covered rock.
Distribution: Nepal (W, C, 800-2000 m): Kaski (800 m), Chitwan (1000-1200 m); Bhutan, Himalaya (Sikkim).

2.2. Riccardia multifida (Linn.) Gray, Nat. Arr. Br. Pl. **1**: 684, 1821; Furuki & Higuchi, Crypt. Him. **3**: 145, 1995.

Jungermannia multifida L., Spec. Pl.: 1136, 1753.
Aneura multifida (L.) Dumort., Comm. Bot.: 115, 1823.

Delicate Germanderwort; Pinnate Liverwort (Eng.).

Plants thalloid, generally light green to brownish green, prostrate, bi or tri pinnately branched, upto 30 mm long and 0.3-1 mm broad Thalli laterally branched, biconvex, 5-7 celled thick, apex rounded or slightly emarginate, margin crenulate with the prominent cell walls, oil bodies rare and present in the young cells or absent, marginal cells usually rounded to quadrate, 45 x 45-65 µm in diameter. Gemmae if present are two celled thicked. Mid rib not distinict which is the distinguishing character of this species. Plants autoecious, male branches short, oval and lateral. Female branches are also short. Female branches laciniate with shirt uniseriate hairs, capsules club shaped, papillous with long calyptra, open by four parts. Spores spherical, 15-20 µm in diameter, elaters 15 µm wide
Status: Rare
Habitat: Boulder stones, bogs and wet rocks.
Distribution: Nepal (W, 600-3000 m): Kaski (600-900 m); China, Europe, Greenland, Hawaii, Iceland, Japan, North America, Northern Russia, Pakistan, South Africa, Taiwan and Tunisia.

5.2.2.3. 2. METZGERIACEAE

Plants thalloid, thalli linear with well defined midrib several cells thick. Wings unistratose, with or without marginal hairs on ventral and dorsal surfaces, trigones and oil bodies absent, Male branches with midribs but lack hairs, while female branches with hairs and lack midrib. Caplyreae pyriform, fleshy and hairy. Pseudoperianth lacking, capsules with pseudoelaters and spores.

Four genera are known in the world (Smith, 1996). Nepal's record represents two genera in this family and only one genus with one species is reported from the lowland area.

1. Metzgeria Raddi, Jungerm. Etrusca: 34, 1818.

Plants thalloid. Thalli linear, dichotomously branched and branches arise from ventral surface of midrib. Midrib sharply defined from the unistratose thalloid wings, with small elongated inner cells and large short cells on dorsal and ventral surface; rhizoids present only on older parts. Thallus wings usually with marginal hairs and with or without scattered rhizioids. Gemmae sometimes born on winged margin. Male branches drarf, involute, hairless and with costae. Female branches drarf, involute, subglobose with numerous hairs and without midrib. Calyptrae pyriform, fleshy and hairy above. Capsules dehiscence by four valves.Twenty one species are known from the world (Smith, 1996). Eight species are described from Nepal (Kattel, 2002) and one species is described here.

1.1. Metzgeria conjugata Lindb., Acta. Soc. Sci. Fenn. **10**: 495, 1875; Kattel, Liverworts Nep.: 50, 2002.

Plants thalloid, deeply dichotomous, dorsoventrally flattened, semi translucent, dark green or bluish green and with distinct midrib and numerous marginal hairs. Thallus 15-30 mm long and 1-1.5 mm wide, midrib 2-4 celled thick, 68 µm in diameter with elongated rectangular cells and also bear elongated hairs.. Thallus wings without rhizoids on the ventral surface. Marginal hairs usually in

pairs, straight, hyaline with blunt tips, measure 12-105 x 9 µm in size. Gemmae and oil bodies absent. Plants monoecious. Sex organs on the ventral surface along the midrib. Male branches spherical with midribs and without hairs. Female branches with hairs and without midrib (Fig.31).

Status: Rare

Habitat: Rocks, humus, cliffs and trunk (c 398).

Distribution: Nepal (C, 1000-3000 m): Makwanpur (1000 m); Arojes, Bermunda, Brazil, Celebes, China ((Sichuan), Himalaya, Java, Japan, Korea, Madagaskar, New Zealand, North America, North and West Europe, South Africa, Sumatra and Turkey.

Remarks: Kuwahara (1958) mentioned that the bluish green coloration of thallus is due to the presence of cyanobacteria in the thallus.

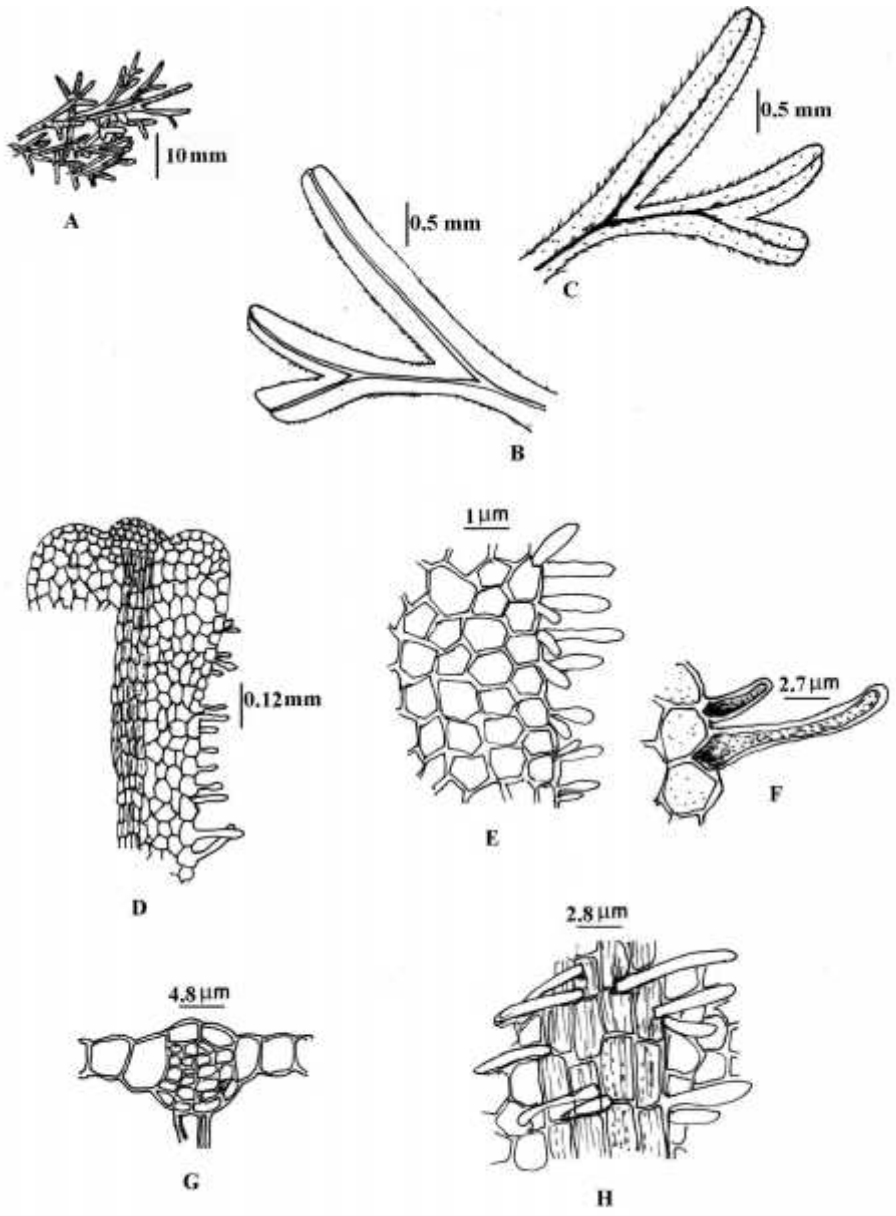


Fig. 31. *Metzgeria conjugata* Lindb., (Pradhan c 398). A. habit, B. dorsal view of the thallus, C. thallus ventral view, D. apical portion of the thallus with marginal hairs, E. median cells and marginal hairs, F. marginal hairs in pair, G. cross section of the midrib, H. hairs on midrib.

5.2.2.3. 3. PALLAVICINIACEAE

Plants thalloid with thick midribs and unistatose wings, ventral scales absent or in reduced forms. Central strands with conducting cells differentiated,. Antheridia usually in two rows on the dorsal surface of the thallus, protected by scales. Archegonia generally in groups on the dorsal surface of the thallus which are surrounded by involucres of fused bracts. Young sporophytes protected by the pseudoperianth. Capsules ellipsoidal to cylindrical on long stalk, dehiscence by opening 2-4 valves, 2-3 spiral elaters and spores are reticulated.

Six genera are known from the world (Smith, 1996). Only one genus is described here.

1. Pallavicinia Gray, Nat. Arr. Br. Pl. **1**: 175, 1821.

Plants dark green and procumbent thalloid. Thallus prostrate, simple, unistatose wings, entire or lobed, costa with central strand of small elongated conducting cells.Ventral scales lacking. Antheridia biseriate, capsule short and cylindrical. Plant dioecious.Thirty species are known in the world. Only one species is roported from Nepal which is represented in lowland Tarai.

1.1 Pallavicinia lyellii (Hook.) Carruth., J. Bot. Br. Foreign **3**: 203, 1865; Nog. *et al.*, Bull. Nat. Sci. Mus. **9**(3): 380, 1966; Grolle, Khumbu Himal **6**(2): 119, 1974; D. G. Long & Grolle, J. Hattori Bot. Lab. **68**: 421, 1990; Furuki & Higuchi, Crypt. Him. **3**: 144, 1995.

Jungermannia lyellii Hook., Brit. Jungerm. t.: 77, 1816.
Steetzia lyellii (Hook.) Lehm., Pl. Preiss. **2**: 129, 1846.

Ribbon liverwort; Veilwort (Eng.).

Thalli simple or occasionally branched, pale green or dark green, glossy, ribbon like about 30-60 mm long and 4-5 mm wide, wings palne or undulate and semi translucent, central strands well definedin the thallus transverse section, cells usually hexagonal, 79 x 45 µm in diameter with numerous pigments. mid ribs distinct and prominent, light brown with 14-16 rectangular elongated cells. Rhizoids pale brown, pigmented, double walled, 18 µm in diameter and clusters on the ventral saurface on the median region of the thallus. Plants dioecious. Female thalli quite larger than male thalli. Antheridia spherical, arrange in rows on either sides of the midrib on dorsal surface and protected by fringed outgrowth, archegonia in groups surrounded by involucre basically made by fringed scales, develop on the median region on dorsal surface. Capsules cylindrical, chocolate brown or maroon red, smooth with blunt tips, 4-5 mm long and 1.5 mm wide, setae pale white, very soft, delicate, upto 3-4 cm long and 1.5 mm in diameter develop on the apical region on dorsal surface. Spores usually discharged on the month of April to June (Fig. 32).
Status: Rare
Habitat: Wet damp edges of streams.

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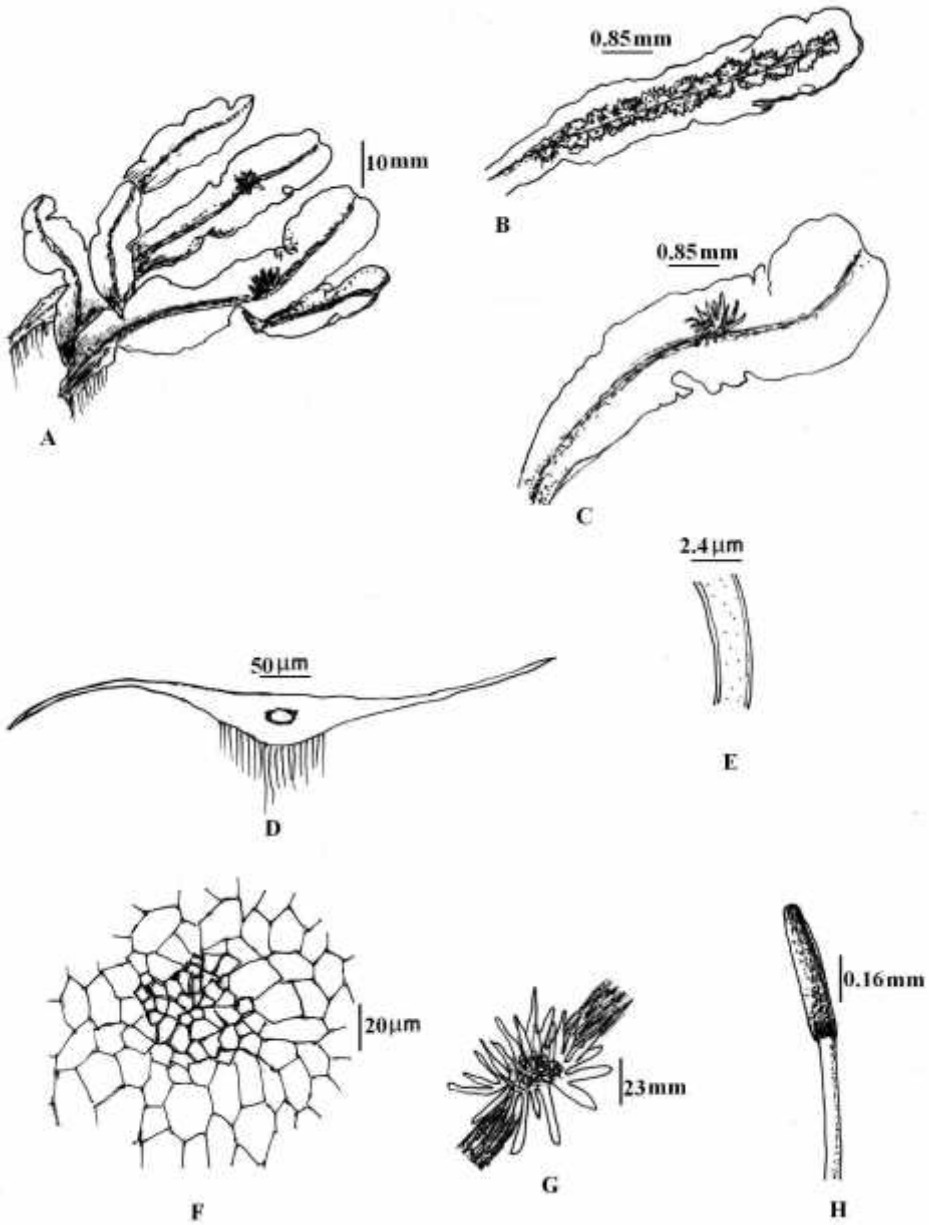

Fig. 32. *Pallavicinia lyellii* (Hook.) Carruth., (Pradhan, Pn. 260). A. habit, B. male thallus with rows of antheridia, C. female thallus with archegonia, D. cross section of the thallus, E. rhizoid, F. cells in the median of the thallus, G. group of archegonia with fringed scales, H. capsule with portion of seta.

Distribution: Nepal (C, 300-2000 m); Chitwan (300 m); America, Bermunda, Bhutan, China, Denmark, Hungary, Ireland, Japan, North and South Philippines, New Zealand, Polynesia, Singapore, Spain and West Europe.

Remarks: Long and Grolle (1990) recorded it as common species in subtropical and warm temperate region

5.2.3. MUSCI

They are generally the most conspicuous bryophytes in the vegetation. The gametophyte is differentiated into stems and leaves arising from a filamentous or thallose called protonema which is formed from a germinating spore. Stem consists simple internal tissue organization with outer thick walled cells and inner thin walled cells. The sex organs are borne at the apex of the main shoot and on the lateral branches. The mature plant produces sporophytes, which is differnetiated into setae and capsules. Capsules after maturation produces spores.

The class Musci contains ca. 10, 000 species in nearly 700 genera (Schofield, 1985). A total of 766 species of mosses has been recorded in Nepal (Pradhan, 2000a). This includes 53 genera and 147 species under 9 orders and 20 families.

Key to the Orders

1. Plants acrocarpous ……..…. 2
   Plants pleurocarpous ……..……..…….……. 7

2. Peristome teeth haplolepideae ……..…..……..... 3
   Peristome teeth deplolepideae ……..……. 6

3. Leaves in single plane or spirally arranged ……..……..……. 4
   Leaves in many rows …….…… 5

4. Leaves opposite, boat shaped; peristome teeth forked……...….... **3**. Fissidentales
   Leaves three rows, linear; peristome teeth horse shoe shaped ……...…. **8**. Polytrichales

5. Leaves linear-lanceolate to oblong; laminal cells smooth, linear or rectangular…..... **1**. Dicranales
   Leaves broad, ovate, spatulate or linear; laminal cells quadrate to rectangular …..... **9**. Pottiales

6. Endostome on same radii as the teeth of the exostome …….……...… **4**. Funariales
   Endostome alternate with the teeth of the exostome ……..……..….. **2**. Eubryales

7. Plants pleurocarpous; leaves oval, obtuse to lanceolate, laminal cells hexagonal to rhomboidal ……..…..….. 8
   Plants acrocarpous or pleurocarpous; leaves ovate-lanceolate, laminal cells not hexagonal or rhomboidal ....……...…… **7**. Isobryales

8. Plants bright green; laminal cells elongated rhomboidal; calyptrae smooth …..... **6**. Hypnobryales
   Plants dark green; laminal cells hexagonal; calyptrae fimbriate…….…… **5**. Hookeriales

5.2.3.1. DICRANALES

Plants erect with leaves evenly arranged around the stem, elongate-lanceolate, often subulate, costae long and distinct, cells long or short, straight or sinuous, smooth or mamillose. Acropous, setae long, capsule globose or elongate, erect or curved, operculum and peristome well developed in elongated capsule and absent or poorly developed in globular capsules.

Key to the families

1. Leaves multistrarose, costae very broad, laminal cells usually differentiated into chlorocysts and leucocysts …….…… **3.** Leucobryaceae
   Leaves either unistatous or multistrarose, costae fine, laminal cells not differentiated into chlorocysts and leucocysts ……. 2

2. Alar cells distinct; leaf base generally sheathing ……..……..…. **1**. Dicranaceae
   Alar cells not distinct; leaf base not sheathing to the stem ……..… **2.** Ditrichaceae

5.2.3.1.1. DICRANACEAE

Plants small to robust in loose or dense tufts. Stems often erect, simple or forked with central strand. Leaves with many rows, margins plane or recurved, entire or serrulate; costae single, percurrent or excurrent, in cross section mostly with a row of median central guide cells; upper leaf cells variable in shape, smooth, lower laminal cells often elongate, alar cells often clearly differentiated. Plants dioecious or autoecious. Setae mostly elongate, stomata present or absent; peristome teeth rarely lacking, 16 in number, often reddish, dicranate to the middle, mostly lanceolate and deeply splited into 2-3 divisions, calyptrae cucullate, entire, smooth or sometimes fringed at base.

The Dicranaceae is a large family with 50 genera and over 1000 species worldwide. 63 species so far has been recorded from Nepal.

Key to the genera

1. Laminal cells papillose ……..…..……..…. 2
   Laminal cells smooth …….…..…… 4

2. Leaf bordered, central strand absent ……..…… **4**. *Leucoloma*
   Laef without border, central strand present ……..……..... 3

3. Urn cylindrical with long neck. ……..……..…..…… **5**. *Trematodon*
   Urn ovoid, neck not differented ..... **1**. *Campylopus*

4. Alar cells distinct ……..……..…..…… **3**. *Dicranum*
   Alar cells inconspicuous..... **2**. *Dicranella*

1. Campylopus Brid., Muscol. Recent. Suppl. **4**: 71, 1819.

Plants small to robust, forming loose to dense tufts, light to dark green, yellow or golden and occasionally blackish-brown. Stems erect, few to several branched, central strand present; often densely tomentose, rhizoids rusty-brown or whitish. Leaves foliate forming a tuft, erect-spreading to appressed, lanceolate to subulate with ovate or oblong base, apex acute to long acuminate, tips mpostly hyaline margins usually entire below and distally often serrulate, costae single, strong, percurrent to long excurrent, laminal cells smooth, distal cells usually thick-walled and variously shaped, oval, quadrate, rhomboidal to short or long rectangular, basal cells elongate, thin or thick-walled, rectangular; alar cells usually differentiated, enlarged, oval-short rectangular, hyaline or rusty-red. Plants dioecious. Setae elongate, smooth, cygneous, capsules exserted, urn ovoid-cylindrical, stomata absent; annulus present; opercula rostrate; peristome single, teeth 16, Calyptrae cucullate. Spores papillose.

Campylopus is a largest genus with a high degree of taxonomic complexity and worldwide distribution. It includes about 700 accepted species in the world (Frahm, 1978, 1991). About 15 species are known from Nepal.

Key to the species

1. Plants rarely branched, more than 2 cm tall, alar region indistinct **1**. *Campylopus nilghiriensis*
   Plants dichotomously branched, 1-6 cm tall, alar region distinct …. **2.** *Campylopus schimperi*

1.1. Campylopus nilghiriensis (Mitt.) A. Jaeger in Ber. Sci. Gall., Naturw. Ges. 1870-71: 426, 1872; Nog. in Hara, Fl. E. Him. **1**: 546, 1966; Ganguee, Mosses E. Ind. & Adj. Reg. **2**: 283-284, 1972; Nog. & Z. Iwats. in Ohashi, Fl. E. Him **3**: 249, 1975; Higuchi & Takaki in Watanabe & Malla, Crypt. Him. **2**: 127, 1990; Kattel & Adhikari, Mosses. Nep.: 22, 1992; Pradhan, Mats. Checklist Bryo. Nep.: 35, 2000a; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 24, 2007b.

Campylopus goughii (Mitt.) A. Jaeger, B.S.G,. Naturw. Ges., 1870-71: 424, 1872; Gangulee, Mosses E. Ind. & Adj. Reg. **2**: 283-284, 1972.

Plants erect, caespitose, comose and rarely branched. Stems light brown, 18-20 mm long. Leaves long, erect, erectopatent, flexuous when dry. Leaves lanceolate, 3.5 mm long and 0.5 mm wide at the base, margin smooth at the basal region and the upper 2/3 serrulate portion inflexed, costae percurrent, very wide at the base and 0.2 mm wide, cells towards the apical region rhomboid, rectangular in the middle and basal region up to 45 x 22 µm in diameter, alar not bulginig out. Plants dioecious, acrocarpous. Setae brown, erect, 4 mm long when dry and cygneous when moist, capsules reddish brown, ovate, 1.5 mm long and 0.5 mm wide, operculum rostrate, calyptrae short, cucullate with crenate edges. Spores small, spherical.

Status: Uncommon

Habitat: Rocks

Distribution: **Nepal** (W, C, E, 800-3300 m.): Kaski (800 m), Chitwan (1000-1200 m), Sankhuwasabha (900 m); Bhutan, East India, (Darjeeling, Assam).

1.2.*Campylopus schimperi Milde., Bot. Zeit. **22**: 13, 1864; Takaki, J. Hattori. Bot. Lab. **30**: 235-236, 1967; Nyholm, Ills. Moss Fl. Fenns. Musci **2**(4): 80, 1974; Chen *et al.*, Moss Fl. China **1**: 117, 1999; Ignatov *et al.*, *J*. Hattori Bot. Lab. **88**: 155, 2000.

Campylopus subulatus Schimp. var. *schimperi* (Milde) Husn., Muscol. Gall.: 43, 1884.

Campylopus subulatus ssp. *schimperi* (Milde) Dix., Stud. Handb. Brit. Mosses*:* 91, 1896.

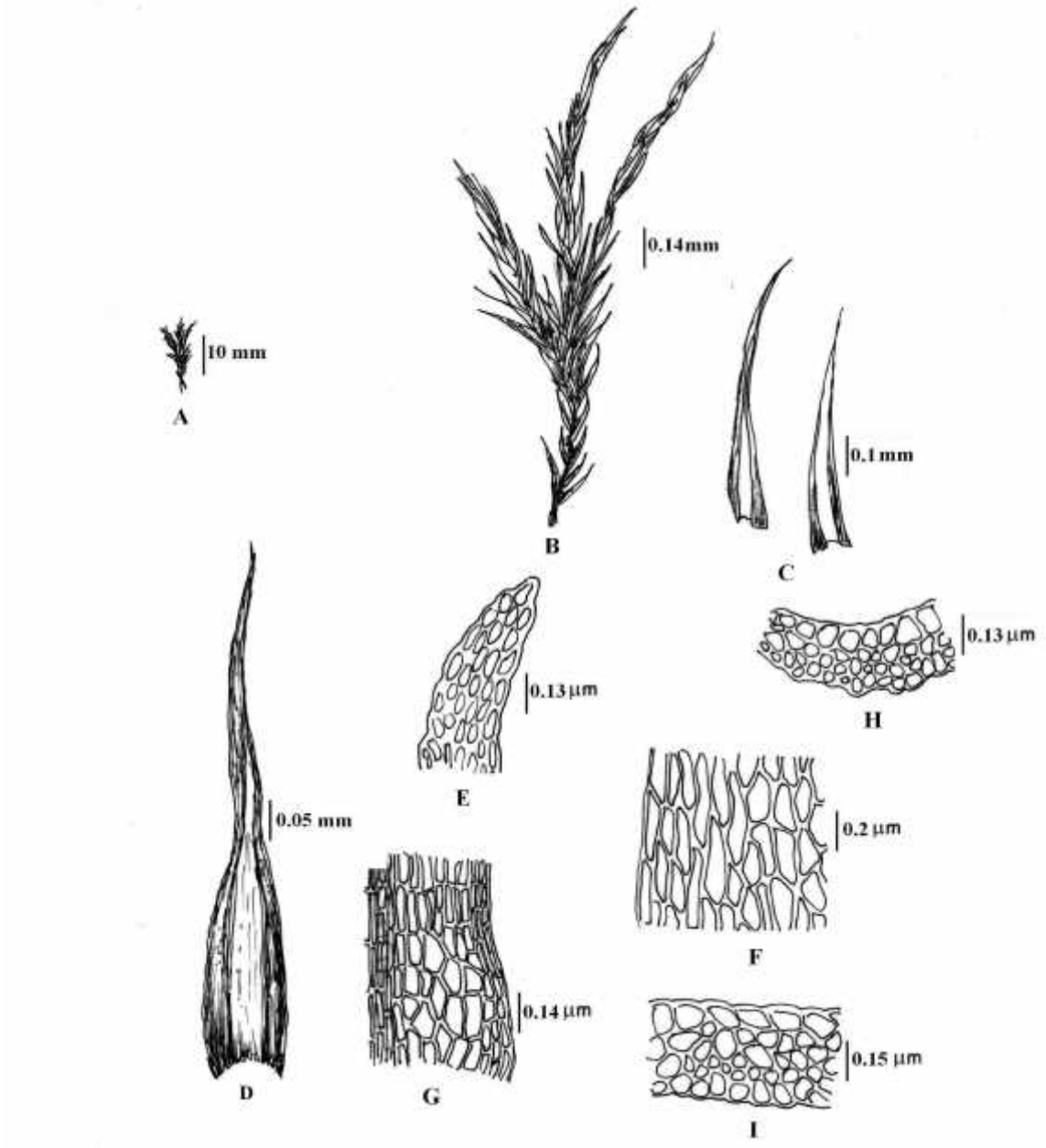

Fig. 33. *Campylopus schimperi* Milde. (Pradhan Pn 345). A. habit, B. the palnt enlarged, C-D, leaves, E. apical portion of the leaf, F. median portion of the leaf, G. basal portion of the leaf, H. cross section of the upper region of the leaf, I. cross section of the basal region of the costa.

Schimper's Swan-neck Moss (Eng.).

Plants small to robust up to 1-6 cm high, dark green, erect, branching at the basal region forming a thick green carpet on wet rocks. Stems erect, brown, dichotomously branched, densely radiculose below, 1-6 cm high with well developed central strand. Leaves closely apressed to the stem when dried and spreading when moist, lanceolate, long towards apical region and smaller towards the basal region, apex acute with long point, 3-5 mm long and 0.6 mm in wide, costae broad at the base, pale green ends below the apex or excurrent, smooth at the back at the upper region, margin serrulated at the apical region, laminal cells variable oval to quadrate in the median region gradually smaller towards the apical region and large rectangular towards the basal region, hyaline towards the margin, alar cells not differentiated . Plents dioecious, setae slender, flexuose when dry, cygneous when moist, 5-8 mm long and yellowish brown. Capsules erect, oblong-ellipsoidal (Fig. 33).

Status: Rare

Habitat: Wet rocks.

Distribution: Nepal (C, 1000-1200 m): Chitwan (1000 m); Bhutan, Caucasus, China, Europe, Japan and North America.

Remarks: New record for Nepal.

2. Dicranella (C. Muell.) Schimp., Coroll. Bryol. Eur.: 13, 1856.

Plants small, forming loose to dense tufts of green, or brown. Stems erect, branched, central strand present. Leaves small and somewhat distant at the basal region, distally larger and crowded, ovate- or triangular-lanceolate to narrowly lanceolate and a oblong or obovate sheathing base, apex acute to bluntly obtuse; margins plane to reflexed below, costae single, percurrent, rarely excurrent; laminal cells mostly thick-walled; lower and basal cells long rectangular, alar region not differentiated. Plants dioecious, setae long and smooth, capsules erect or inclined, subglobose to ovoid-cylindrical, smooth or furrowed, neck sometimes distinct, occasionally gibbous; opercula conic-short to long rostrate, peristome single, teeth 16, calyptrae cucullate, smooth and naked. Spores finely to coarsely papillose.

Only one species under this genus is known from Nepal, which is described here.

2.1. Dicranella heteromalla (Hedw.) Schimp., Caroll. 13, 1856; Nog. in Hara , Fl. E. Him. **1**: 547, 1966; Gangulee, Mosses E. Ind. & Adj. Reg. **2**: 257-259, 1971; Nog. & Z. Iwats. in Ohashi, Fl. E. Him. **3**: 250, 1975; Higuchi & Takaki, Crypt. Him. **2**: 127 -128, 1990; Kattel & Adhikari, Mosses Nep.*:* 23, 1992; Pradhan, Mats. Checklist Bryo. Nep.: 36, 2000a; Pradhan & Shrestha, Proc. Int. Seminar on Mountain-Kath: 554, 2003; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 25, 2007b.

Dicranum heteromallum Hedw., Sp. Musc. Frond.*:* 128, 1801.
Aongstroemia crassinervis Hampe, Linnaea **32**: 133, 1863.

Silky Forklet Moss (Eng.).

Plants small, erect, bright green froming dense tuft. Stems erect, rarely branched, about 5-7 mm high. Leaves falcate, crumpled when dry, 2-3 mm long, gradually tapered from a non-sheathing base; costae slightly short-excurrent, margins irregularly serrulate near the apex; costae stout, shortly excurrent, or forming a long awn, basal leaf cells quadrate to elongated rectangular, 22-42x8 µm in size. Plants dioecious. Setae yellowish green in young and dark reddish in maturation, erect up to 12 mm long, capsules brown, oval, slightly curved, smooth, annulus poorly developed, operculum rostrate, bent to one side, peristome reddish brown. Spores spherical, yellowish brown, finely papillose, 12-15 µm in diameter.

Status: Common

Habitat: Soil, bark.

Distribution: Nepal (E, 900-3800 m): Sankhuwasabha (900-1000 m); Bhutan, Caucasus, China (Tibet), Colombia, India, Japan, Korea, North and Central Africa, North America and Turkey.

3. Dicranum Hedw., Spec. Musc. Frond.: 126, 1801.

Plants 1-10 cm or more in high forming loose or more commonly dense tufts, glossy, light to dark green or golden yellow or brown. Stems erect, solitary or few branched; central strand present; tomentose, rhizoids whitish to dark rusty-red. Leaves erect to wide-spreading occasionally falcate-secund, ovate- lanceolate-subulate, concave below, apex narrowly long acuminate or acute, base short decurrent; margins entire or distal half serrate; costae single, entire or distally toothed on back, unistratose, upper cells oblong-linear, strongly porose, smooth; basal or insertion cells golden-yellow; alar region differentiated, cells enlarged, quadrate or short to long rectangular, golden-brown. Plants autoecious or dioecious, perichaetial leaves usually differentiated from the stem leaves. Setae long; capsules erect or inclined and curved, urn cylindrical; opercula long rostrate, ca. equal to urn length; peristome single, teeth 16, vertically striate-papillose. Calyptrae cucullate, smooth and naked. Spores spherical, papillose, 17-23 µm in diameter.Ten species are known from Nepal. One species has been recorded from lowland area.

3.1. Dicranum setchwanicum Broth.: Nog., 1971; Kattel & Adhikari, Mosses Nep.*:* 24, 1992; Pradhan, Mats. Checklist Bryo. Nepal: 37, 2000a; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 25, 2007b.

Plants light green, 3.5 cm long forming loose tufts on substratums. Stems erect with few branched by innovations; central strand present; tomentose and rhizoid ed at the base. Leaves erect to wide-spreading, lanceolate, apex acute, base short decurrent; margins serrulated at the apical region, costae single, wide at the base, laminal cells oblong-linear, smooth, basal cells rectangular; alar differentiated with quadrate to short rectangular, cells. Plants dioecious, perichaetial leaves convolute, usually differentiated from the stem leaves. Capsules erect or slightly curved, Calyptrae cucullate. Spores spherical, papillose, 18-20 µm in diameter.

Status: Rare
Habitat: Soil.
Distribution: Nepal (W, E, 900-2500 m): Kaski (600 m); Bhutan and China.

4. Leucoloma Brid., Bryol. Univ. **2**: 218, 1827.

Plants in loose to dense tufts, dark green to yellowish-green. Stems erect to suberect, rarely branched, central strand absent. Leaves loosely erect-spreading, flexuose and occasionally falcate when dry, linear, ovate to narrowly oblong base, concave below, subtubulose above, apex broadly acute or acuminate, base subauriculate; margin entire to serrulate, usually serrulate at the apical region; costae single, rather weak and slender, upper cells oblong-oval to quadrate, smooth or papillose on back; marginal cells forming a border of few to many rows, long linear, hyaline; lower and basal cells elongate, linear to rectangular, mostly smooth; alar cells differentiated, large and rectangular. Plants dioecious, setae long, slender and occasionally flexuose. Capsules erect, urn obloid, annuli absent; opercula rostrate; peristome single, teeth 16 and distally papillose. Calyptrae cucullate, smooth below, distally roughened and naked. Spores spherical, smooth or papillose.
Only one species has been recorded from lowland region of Nepal.

4.1. Leucoloma taylorii (Schwaegr.) Mitt., Kew J. Bot. **8**: 353, 1856; Mitten, J. Linn. Soc. Bot. Suppl. **1**: 12, 1859; Gangulee, Mosses. E. Ind. & Adj. Reg. **2**: 407-409, 1971; Higuchi & Takaki in Watanabe & Malla, Crypt. Him. **2**: 129, 1990; Pradhan, Mats. Checklist Bryo. Nep.: 37, 2000a; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana : 25, 2007b.

Syrrhopodon taylorii Schwaegr., Spec. Musc. Suppl. **2**(2): 115, 1824.
Cleistostoma taylorii (Schwaegr.) Brid., Bryol. Univ. **1**: 156, 1826.
Leucoloma kurzi Broth. in Gangulee, Mosses E. Ind. & Adj. Reg. **2**: 407, 1971.

Plants erect, scarcely branched with red brown stem up to 15 mm long. Leaves densely cover to the stem, erectopatent and curled when dry. The moist leaves lanceolate, slowly narrowling from a broader sheathing base, 2.5-3 mm long and 0.5 mm wide at the base, apex narrowly pointed, margin smooth, costae excurrent reached up to the pointed apice, reddish brown, distinct, about 60 µm wide at the base. Laminal cells at the apical region small, quadrate, 8-9 µm in diameter, middla laminal cells rectangular, alar bulging out with large rectangular cells 30x10 µm in diameter. Plants acrocarpous, dioecious. Setae erect, reddish brown, 10-12 mm long, capsules reddish brown, straight, cylindrical, 3 mm long and 0.3 mm wide, peristome dicranate. Spores spherical, small, 15-18 µm in diameter.
Status: Rare
Habitat: Tree trunk
Distribution: Nepal (C, 500-2000 m.): Kavre (900-1000 m); Burma and Malay.
Remarks: A southeast Asiatic species described by Wallich from east Nepal.

5. Trematodon Michaux., Fl. Bor. Amer. **2**: 289, 1803.

Plants small, light green to yellowish green, gregarious or in loose tufts. Stems erect, simple or rarely branched; central strand present. Leaves contorted when dry, oblong to oblong-ovate at the base, narrowed abruptly from the clasping base to a long awn; margins entire, usually recurved in the upper part; costae strong, subpercurrent to l-excurrent; upper cells small, subquadrate to short-rectangular; basal cells at the base, elongate, thin-walled, smooth; alar cells not differentiated. Plants monoecious, perichaetial leaves larger than the vegetative ones. Setae long, erect, yellowish to yellowish brown; capsules suberect, usually curved above, cylindric, neck slender, as long as or longer than the urns, usually strumose at the base; opercula obliquely long-rostrate; annuli simple or compound; peristome absent or present, with 16 linear-lanceolate teeth, usually undivided, perforate or forked, vertically striate on outer surface. Calyptrae cucullate and smooth. Spores distinctly papillose, 20-30 µm in size.

Trematodon is characterized by having long-necked capsules and vertically barred peristome teeth. 80 species has been recorded from the world. Nepal represents five species. Three species are described in present investigation.

Key to the species

1. Neck slightly longer than urn, setae long; capsules cylindrical or cygneous ……..…… 2
Neck three times longer than urn, seta short; capsule cygneous ……..…… **3.** *Trematodon subulosus*

2. Capsules erect, urn cylindrical 2.5-3 mm long, neck spongy not curved; spores brown, warty, 14 µm in diameter. ……...……....….. **1.** *Trematodon kurzii*
Capsules inclined, urn short-cylindric, 0.5-2.0 mm long, neck not spongy and curved above; spores 20 µm in diameter.…….……..…….…….. **2.** *Trematodon longicollis*

5.1. Trematodon kurzii Hampe ex Gangulee, Bull. Bot. Soc. Beng. **14**: 12,. 1960; Nog. & Z. Iwats. in Ohashi, Fl. E. Him. **3**: 252, 1975; Kattel & Adhikari, Mosses. Nep.*:* 26, 1992; Pradhan, Mats. Checklist Bryo. Nep.: 38, 2000a; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 25, 2007b.

Plants small, erect, 2-3 mm tall. Leaves erect, long, flexuous, 4-5 mm long, gradually tapering from the base and with laxy sheathing base, margin entire, costa brown, narrow at the base ending slightly below the apex, upper laminal cells rectangular, 20 x 8.5 µm and rectangulat to hexagonal at the base, 80 x 25 µm in diameter, upper marginal cells distinctly papillose. Plants autoecious, perichaetial leaves not differentiated, setae pale yellow, erect, 2-3 cm long, slightly flexuous above and twisted when dry. Capsule slightly nodded or erect, urn cylindrical 2.5-3 mm long and 0.5 mm wide, orange brown, neck spongy, longer than the urn, peristome brown, 0.5 mm long, split at the base into two unequal segments, calyptra cucullate. Spores opaque, yellowish brown, warty, 14 µm in diameter.
Status: Rare

Habitat: Soil
Distribution: Nepal (1000 m): Sankhuwasabha (1000 m); Burma and India (Darjeeling, Sikkim).

5.2. Trematodon longicollis Michx., Fl. Bor. Am. **2**: 289, 1803; Higuchi & Takaki in Watanabe & Malla,, Crypt. Him. **2**: 130, 1990; Pradhan, Mats. Checklist Bryo. Nep.: 38, 2000a; Pradhan, J. Nat. Hist. Mus. **21**: 51, 2002; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 25, 2007b.

Trematodon acutus C. Muell., Syn. Musc. Frond. **1**: 458, 1848.
T. drepanellus Besch., J. Bot. (Desvaux) **12**: 283, 1898.
T. flaccidisetus Card., Beih. Bot. Central bl. **17**: 5, 1904.
T. paucifolius C. Muell., Syn. Musc. Frond. **1**: 459, 1848.
T. stristicalyx Dix., Hong Kong Naturalist. Suppl. **2**: 3, 1933.

Long-necked Moss (Eng.).

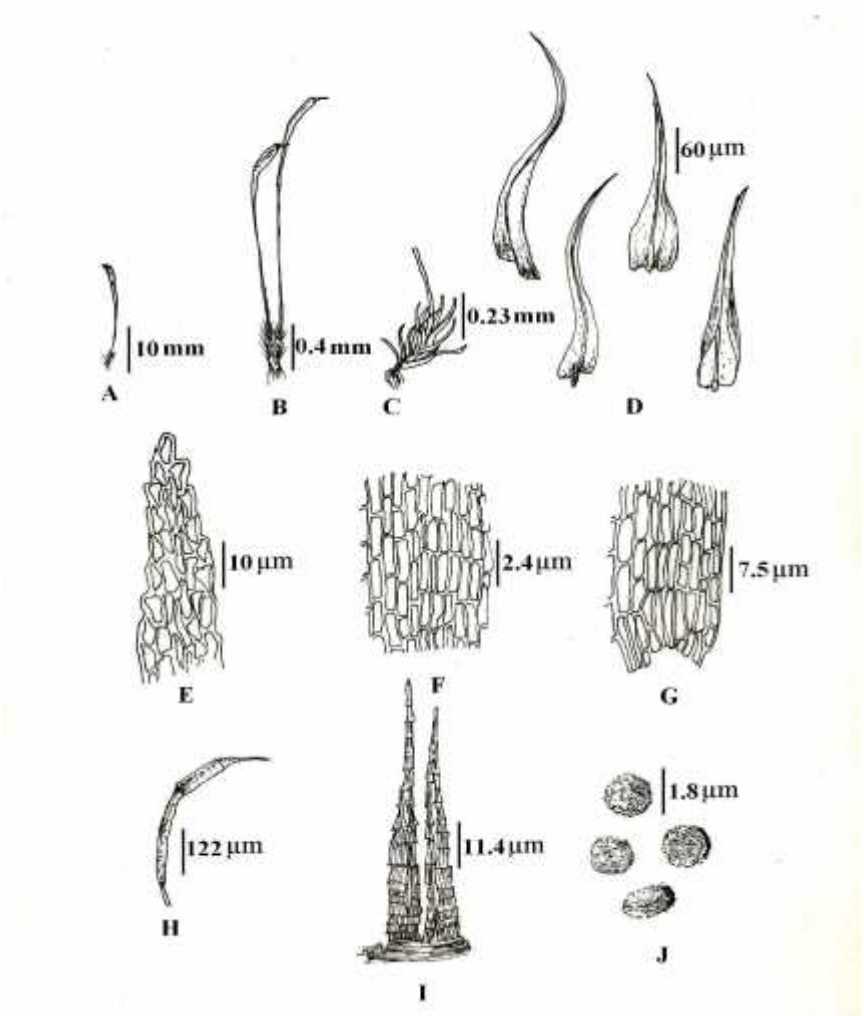

Fig. 34. *Trematodon lingicollis* Michx. (Pradhan NGS 678). A. habit, B. fertile plants, C. plant with a portion of seta, D. leaves, E. apical portion of the leaf, F. median laminal cells, G. basal cells, H. capsule, I. peristome teeth, K. spores.

Plants minute, 2-6 mm tall, yellowish green, gregarious or scattered. Stems erect, simple or rarely branched. Leaves 2-3.6 mm long, contorted when dry, flexuose spreading when moist, oblong to oblong-ovate at the base, gradually narrowed to a long, linear-subulate acumen, blunt at tips; margins plane and entire below, slightly recurved and serrulate above; costae strong, percurrent, not entirely filling the acumen; upper and median cells short to moderately rectangular, 18–24 µm × 8–10 µm, firm or somewhat thick-walled; basal cells in the clasping base, oblong-rhomboidal to long-rectangular, 40-90 µm × 8-13 µm, lax and thin-walled. Plants autoecious. Perichaetial leaves larger than the upper stem leaves. Setae straight, 2-3 cm long, yellow to yellowish brown. Capsules inclined, urn short-cylindric, 1.5-2.0 mm long, neck 3.0-5.0 mm long, curved above, strumose at base, operculum long-rostrate, annuli well developed, deciduous; stomata of two kinds, peristome teeth. lanceolate, reddish, somewhat perforate, vertically striate on lower 2/3 of the teeth, papillose on the upper one third portion. Spores 20 µm in diameter, strongly papillose (Fig. 34).
Status: Common
Habitat: Soil
Distribution: Nepal (W, C, 180-1800 m): Kailali (230 m), Bardia (180-190 m); Burma, Central Myanmar, China, Cuba, Europe, Japan, Kampuchea, Korea, Mexico, New Zealand, Philippines, Siberia, Sri Lanka, South Africa, South America, South America and Thailand.

5.3. Trematodon subulosus Griff., Cal. J. Nat. Hist. **2**: 493, 1842; Pradhan, Mats. Checklist Bryo. Nep.: 38, 2000a; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 25, 2007b.

Plants small, erect, unbranched, 2 mm long with brown stems. Leaves not much change when dry, 1-2 mm long, canaliculate, concave, suddenly tapering from an oval concave sheathing base, apex acute, margin entire, costa brown, end at the apex, laminal cells elongated rectangular at the base, 28 x 7 µm in diameter and short rectangulat at the tip margin, 10 µm in long. Plants autoecious, perichaetial leaves erect, more sheathing. Setae erect or flexuous, brown, 8 mm long. Capsules cygneous, brown, urn horizontal, cylindrical, 0.8 mm long and 0.6 mm in wide, neck spongy, three times longer than urn. Spores round, papillose, deep brown, 14-17 µm in diameter.
Status: Rare, endemic to Himalaya (Gangulee, 1971).
Habitat: Soil
Distribution: Nepal (E, 900 m): Sankhuwasabha (900 m); Bhutan, India (Upper Assam, Punjab) and Myanmar.

5.2.3.1.2. DITRICHACEAE

Plants small, gregarious or in loose tufts, sometimes densely caespitose. Stems erect, simple or branched, central strand present or poorly developed or absent. Leaves usually lanceolate, acuminate or subulate, sometimes sheathing at base, margins plane, reflexed or revolute, entire or serrulate; costae single, narrow, subpercurrent to long-excurrent; cells subquadrate or short-rectangular to linear, mostly smooth or occasionally mammillose; alar cells not differentiated. Sporophytes terminal, setae usually elongate, sometimes very short, erect; capsules often long-exserted, subglobose to cylindric, erect to inclined or curved, asymmetric; opercula often differentiated, conic or long-

rostrate, sometimes absent; annuli mostly differentiated; peristome none or with 16 splited teeth at the base, calyptrae cucullate, rarely conic. Spores small, spherical and minutely papillose.
Three genera and eight species have been recorded in Nepal.

1. Ditrichum Hampe, Flora Jena **50**: 181, 1867a.

Plants tufts, slender. Stem less than 1 cm high. Leaves in several rows, lanceolate to subulate, often with a linear filiformarista, smooth, very rarely papillous, costae broad and strong, usually percurrent or excurrent, basal cells rectangular to oblong, upper cells narrowly rectangular. Plants monoecious or dioecious, setae long, cylindrical, capsules erect to slightly inclined, ovoid to cylindrical, peristome teeth long, erect. Spores smooth and very small.
Three species of *Ditrichum* has been recorded from (Pradhan, 2000a) and one species added from lowland Tarai which is described here as new record to Nepal.

1.1. *Ditrichum tortuloides Grout, Bryologist **30**: 4, 1927; Gangulee, Mosses E. Ind. & Adj. Reg. **2**: 201-202, 1971.

Ambigous Ditrichum Moss (Eng.).

Plants green to yellowish green, rarely branched at the top grows in loose tuft. Stem erect up to 4.5-7 mm high with reddish brown rhizoids at the base. Leaves erectopatent, upper leaves curled and lower leaves appresses to stem when dry. Leaves on the upper portion of stem long, lanceolate, 2.4 x 0.45 µm in size, margin entire narrowly recurved from just beyond the leaf base to mead leaf, apices acute, costae percurrent end at the apex, broad at the base, 50 µm wide. Laminal cells rectangular, 16 x 5 µm at the middle, larger and pellucid towards base, 27 x 11 µm in diameter. Plants acrocarpous and dioecious. Perichaetial leaves little longer than stem leaves, erect, 3 mm long. Setae long, erect, 8-13 mm long. Capsules brown, cylindrical, 1.2 - 2 mm long and 0.4 mm wide, annulus reddish brown, peristome teeth filiform, papillopse, ca. 280- 400 µm long, 43 µm wide. Spores spherical, brown, 10-14 µm in diameter (Fig. 35).
Status: Rare.
Habitat: Soil.
Distribution: Nepal (W, 160 m): Bardia (160 m); Europe, India and North America.
Remarks: *Ditrichum tortuloides* is closely related with *D. ambiguum* known from western part of North America (Ireland & Robinson, 2001). This is the new records for Nepal.

2. Garckea C. Muell., Bot. Zeitung (Berlin) **3**: 865, 1845.

Plants yellowish green, gregarious or in loose tufts. Stems erect, simple, slender. Leaves appressed when dry, erect-patent when moist, crowded and larger above, distant and smaller below, lanceolate; margins plane or slightly incurved, entire throughout; costa single, strong, shortly excurrent; upper cells linear-rectangular, firm-walled, smooth; basal cells rectangular, rather thin-walled; alar cells not differentiated. Plants dioecious. Setae very short, capsules immersed oblong-

ovoid; opercula shortly conic-rostrate; annuli in 1–2 rows of large cells, deciduous; stomata absent; peristome teeth 16, lanceolate, transversally barred near the base, perforate below the middle, densely papillose. Clayptrae mitrate, coarsely mamillose. Spores spherical, densely papillose.

This is a predominant tropical genus. Tong and He (2001) recorded, only one accepted species in the world. Three species has been recorded from Nepal. One species is described here.

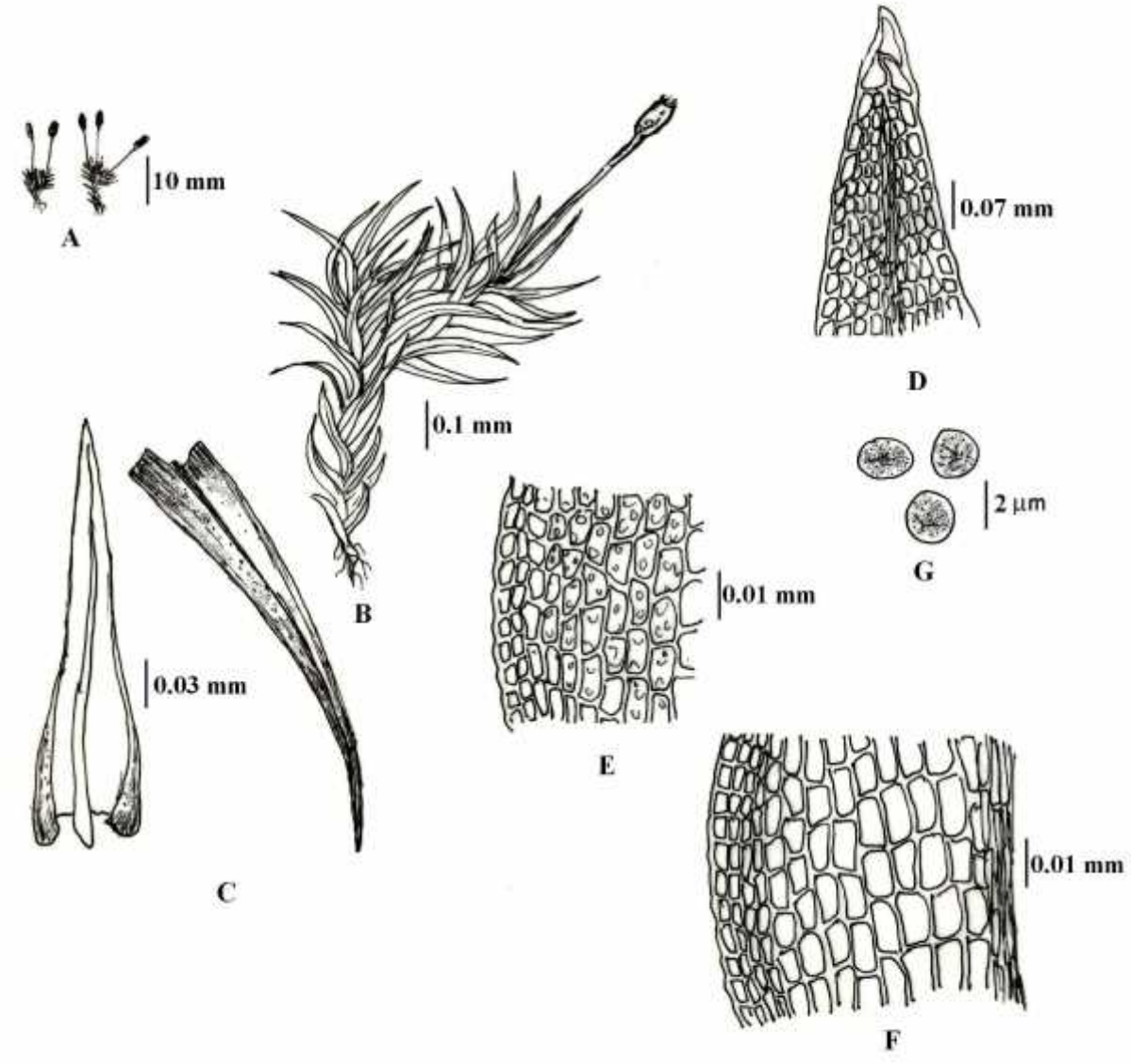

Fig.35. *Ditrichum tortuloides* Grout, (Pradhan NGS 79). A. habit, B. a plant enlarged C. leaves, D. apical portion of the leaf, E. middle portion of the leaf, F. basal portion of the leaf, G. spores.

2.1. Garckea flexuosa (Griff.) Margad. & Nork., J. Bryol. **7**: 440, 1973; Karczm., Lindbergia **7**: 127, 1981; Higuchi & Takaki in Watanabe & Malla, Cryp. Him. **2**: 129, 1990; Kattel & Adhikari, Mosses Nep.*:* 27, 1992; Pradhan, Mats. Checklist Bryo. Nep.: 37, 2000a; Pradhan, J. Nat. Hist. Mus. **19**: 67, 2000b; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 25, 2007b.

Grimmia flexuosa Griff., Cal. J. Nat. Hist. **2**: 492, 1842.
Garckea phascoides C. Muell., Bot. Zeit. (Berlin) **3**: 865, 1845; (Hook.) C. Müll. ex Dozy & Molk., Bryol. Jav. **1**: 9, 1858; Gangulee, Mosses E. Ind & Adj. Reg. **2**: 185-188, 1971; Chopra, Taxo. Ind. Mosses, Bot. Monogr. **10**: 41-43, 1975; Gangulee, Mosses Ind.: 9, 1985.

Vase Fork Moss (Eng.).

Plants small, 1-1.5 cm tall, yellowish green, gregarious forming loose tufts. Stems erect, slender. Leaves appressed when dry, erect-patent when moist, lanceolate, 1.5-2 mm long, gradually narrowed from an oblong-ovate base, margins plane or slightly incurved above, costa strong, shortly excurrent; upper and median cells 25-50 × 4-7 µm, basal cells long, 50-55 × 5-7 µm and thin-walled. Plants dioecious. Perichaetial leaves larger than the stem leaves, 3-4 mm long, oblong-ovate base to a slender acumen. Setae very short, 0.3 mm long; capsules 1.2 mm long, immersed, ovoid to cylindrical, opercula short conic, calyptrae small, mitrate, only covers the tips of opercula, splited at the base. Spores yellowish brown, minutely papillose, 20-25 µm in diameter.
Status: Rare
Habitat: Sandy loamy soil, rocks
Distribution: Nepal (W, E, 500-2000 m): Kaski (800 m); Africa, Australia, Bhutan, Burma, Central and South America, China, Cambodia, India, Darjeelinig, Khasia, Papua New Zuinea, Madagascar, Malaysia, Myanmar, Sri Lanka, Thailand and Vietnam.
Remarks: This species previously known as *Garckea phascoides* widely distributed in south Asia, Malaysia, China (Chen, 1963) to Formosa (Wang, 1970) and Panama (Crum, 1953). Previously it was reported from east Nepal (Noguchi and Iwatsuki, 1975). It is common in tropical region.

5.2.3.1.3. LEUCOBRYACEAE

Plants whitish, grayish or bluish green with dense cushions. Stems erect, simple or branched. Leaves in several rows, thick, fleshy, linear, ligulate or lanceolate with broad base; costae broad, filling most of the leaf base and apex, in cross section with 2 to 10 layers of large, empty, hyaline leucocysts cells, enclosing a single, more or less median layer of smaller green cells (chlorocysts); laminae very narrow, consisting of delicate, hyaline, oblong and linear cells, often restricted to leaf base or extending somewhat above the shoulders as a very narrow inconspicuous border. Plants dioecious, setae terminal, long, erect or inclined, capsule erect, peristome single, consisting of 8 or 16 lanceolate teeth, undivided or bifid, smooth or papillose, or vertically pitted-striolate; opercula conic-rostrate with a long beak. Calyptrae mostly cucullate. Spores small and spherical.

Eleven genera and about 200 species are currently known as leucobryoid mosses, distributed

mainly in the tropical regions. Four genera and 17 species of leucobryoid mosses are known from China. Three species under two genera are described here.

Key to the genera

1. Leaves more or less flat above, chlorocyst cells 3-sided in the upper half; capsules erect, symmetrical ..... **2**. *Octoblepharum*
Leaves canaliculate above, chlorocyst cells 4-sided at the junction; capsule inclined, asymmetrical ……..... **1**. *Leucobryum*

1. Leucobryum Hampe, Linneae. **13**: 42, 1839.

Plants small to robust, 0.5-20 cm high, whitish, grayish or bluish green, in compact or loose cushions. Stems erect, simple or forked; central strand rarely present. Leaves crowded, appressed, or erect-spreading, linear-lanceolate to lanceolate or oblong-ovate to elliptic sheathing base, acute to mucronate at the apex, costa thick, broad filled upto the upper parts of leaves, alar cells rarely differentiated; margins entire to slightly serrulate at the apex. Plants dioecious or autoecious. Perichaetial leaves sheathing at the base, abruptly linear-filiform from shoulders. Sporophytes terminal or lateral. Setae erect, elongate, sometimes clustered; capsules cylindrical, inclined to horizontal, rarely erect, ribbed, often strumose; stomata lacking; opercula long-rostrate; peristome teeth 16, divided to the middle, calyptrae cucullate. Spores small to large and finely papillose.

Leucobryum is a group of whitish to grayish looking mosses found growing on acid substrates. The genus is often used to differentiate various types of forest vegetation in lowland coniferous-broadleaf forests in southern China. There are about 110 species of *Leucobryum* worldwide. Five species are recorded from Nepal.

Key to the species

1. Setae more than 2 cm long; capsules horizontal, ellipsoid ……..... **1.** *Leucobryum bowringii*
Setae less than 2 cm long; capsules slightly inclined, ovoid …….. **2.** *L. mitteni*

1.1. Leucobryum bowringii Mitt., J. Linn. Soc., Bot., Suppl. **1**: 26, 1859; Pradhan, Mats. Checklist Bryo. Nep.*:* 52, 2000a; Pradhan & Joshi, Current Trends in Bryologyin Nath & Asthana: 30, 2007b.

Leucobryum angustifolium Wilson in Par., Index Bryol.: 748, 1897.
L. confine Cardot, Beih. Bot. Centralbl. **19**(2): 97, f. 4. 1905.
L. lutschianum C. Muell. in Salm., J. Linn. Soc. Bot. **34**: 453, 1900.
L. subsericeum Dixon, Hong Kong Natural. Suppl. **2**: 6, 1933.

Plants small, 1-2 cm high, grayish green, often lustrous in soft and dense tufts. Stems erect, simple or branched; central strand poorly developed. Leaves densely tufted on rather short stems, contorted when dry, falling off easily, oblong-ovate to oblong-elliptic at base, lanceolate to linear-lanceolate above, gradually narrowed to subtubulose apices from oblong base; costa thick, filling almost the entire leaf lamina, dorsal side of leaf smooth; leucocysts in 1-2 layers on both sides of

chlorocysts, laminal cells 5-9 (-12) rows of rectangular to linear cells near leaf base, often thick-walled. Plants dioecious. Setae reddish, 2 cm long, capsules horizontal, ovoid to ellipsoid, operculae conic with long beak; annuli none, peristome papillose, calyptrae cucullate.

Status: Rare
Habitat: Soil, rocks, and tree trunks in evergreen broad-leaved forests.
Distribution: Nepal (W, 800 m): Kaski (800 m); Borneo, Celebes, China (Hong Kong), Formosa, India, Indonesia, Japan, Java, Kampuchea, Laos, Malay Peninsula, Malaysia, New Guinea, Philippines, Sri Lanka, Sumatra, Taiwan, Thailand and Vietnam.

1.2. Leucobryum mittenii Besch., J. De. Bot. **12**: 287, 1898; Pradhan, Mats. Checklist Bryo. Nep.: 52, 2000b; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 30, 2007b.

Plants small, unbranched, laxy caespitose. Stems erect, 10 -12 mm tall densely covered with leaves. Leaves erectopatent and slightly cristed when dry, 3.54 mm long and broad ovate base, 0.8 mm wide, upper portion lanceolate becominig tubular by the inflexed margins, costae broad at the base, laminal cells elongated and thin walled. Plants dioecious, setae 18 mm long, capsules ovoid, slightly inclinded, caliptrae cuculate.
Status: Rare
Habitat: Decaying logs.
Distribution: Nepal (W, C, E, 800 m): Kaski (800 m), Chitwan (1000 -1200 m), Makwanpur (230 m), Sankhuwasabha (950 m); Japan and India.

2. Octoblepharum Hedw., Spec. Musc. Frond.: 50, 1801.

Plants whitish to grayish green, in loose to rather dense cushions. Stems short, simple or sparsely branched. Leaves erectopatent, flexuose or reflexed from a slightly sheathing base, ligulate, apex obtuse-apiculate to shortly mucronate, margins entire to slightly serrulate at the apical region; costae broad, thick, filling almost the entire upper lamina, convex on abaxial side in cross section, costal leucocysts in 2–10 layers, the chlorocysts triangular in the upper part of leaves, quadrangular at leaf base in cross section; hyaline lamina cells small, confined to both sides of costa at leaf base. Plants autoecious or dioecious. Setae terminal or lateral, short to elongate; capsules erect, oblong-ovoid to cylindrical, symmetric, opercula conic-rostrate with a long oblique beak. Calyptrae cucullate, smooth, entire at base.

The genus *Octoblepharum* is mainly distributed to the tropical and subtropical regions, also found in temperate region. There are about 10 species of *Octoblepharum* in the world. One species is known from Nepal which is described here.

2.1. Octoblepharum albidum Hedw., Sp. Musc. 50, 1801; Gangulee, J. Bomb. Nat. Hist. Soc. **60** (3): 618-619, 1963; Nog. & Z. Iwats. in Ohashi, Fl. E. Him. **3**: 252, 1975; Gangulee, Mosses Ind. : 18, 1985; D.G. Long, Bryobrothera **1**: 123, 1992; Pradhan, Mats. Checklist Bryo. Nep.: 33, 2000a; Pradhan, J. Nat. Hist. Mus. **19**: 65, 2000a; Nath *et al*., Taiwania **52**(2): 174, 2007.

Eight toothed White Moss (Eng.).

Plants small, grayish green, somewhat glossy, 5-10 mm tall in loose or dense velvety tufts. Stems short, sparsely branched and without central strand. Leaves erect-patent to curved spreading, 4-6 mm long, flattened, strap-shaped to ligulate from an oblong-ovate base, apiculate at the apex; hyaline lamina cells small, appearing only on two sides of costa at the leaf base; margins entire, with minute serration at the leaf apex; costa broad and thick, filling almost the entire upper lamina. Plants autoecious. Setae erect, smooth, yellowish to pale brown, 4 mm long, capsules erect, cylindrical, 2 mm long with operculum, opercula long rostrate, with an oblique beak, peristome teeth 8, yellowish, lanceolate with a broad base, vertically striate; Calyptrae cucullate, smooth, entire at the base. Spores numerous, spherical, grass green-light brown, smooth hyaline margin, 21-27 µm in diameter (Fig. 36).

Status: Common

Habitat: Rotton logs, tree barks and rocks.

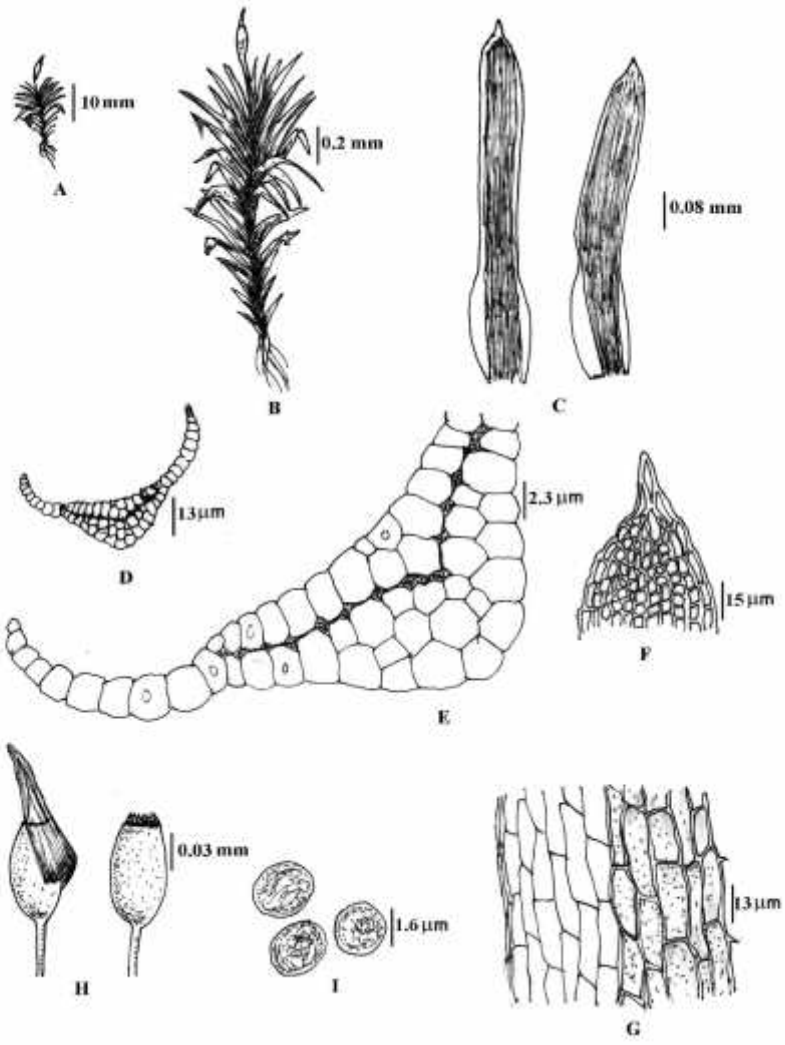

Fig. 36. *Octoblepharum albidum* Hedw. (Pradhan, Pn 412). A. habit, B. the plant enlarged, C. leaves, D. cross section of the leaf at the basal region, E. the same section enlarged, F. apical portion of the leaf, G. basal portion of the leaf, H. capsule with and without calyptra, I. spores.

Distribution: Nepal (C, E, 230-1650 m): Kaski (800 m), Chitwan (350, 1250 m), Makwanpur (250 m), Sankhuwasabha (950 m); Africa, Australia, Bhutan, Burma, Borneo, China, India (Assam, Sikkim, Darjeeling), Indonesia, Java, Kampuchea, Thailand, Malaysia, Myanmar, North and South America, New Guinea, Ocania, Philippines, Sri Lanka, Taiwan and Vietnam.
Remarks: Common species in tropical and sub tropical regions.

5.2.3.2. EUBRYALES

Plants medium sized, 2-10 cm tall, erect when sterile, prostrate on maturation. Leaves broad or narrow, long or short, sharply pointed, blunt or obtuse, costae distinct, cells smooth or papillose, cells small in upper parts of the leaves, elongated towards the margin. Plants acrocarpous, sometimes pleurocarpous due to the pattern of branching. Setae elongated, capsules ovate, rarely globose, lid distinct, peristome double, long and well developed. Eubryales is a large order of Musci. Two families are described here.

5.2.3.2.1. BARTRAMIACEAE

Plants grow in the form of loose to dense tufts. Stems erect, rarely pendent, simple or irregularly branched, often densely tomentose; hyalodermis present or absent, central strand present or absent. Leaves linear to ovate-lanceolate and an oblong-obovate sheathing base, apex acute to obtuse, margins plane to recurved below, dentate to more commonly blunt or sharply serrate, costae single, strong, percurrent to short or long excurrent, upper and middle laminal cells short, rectangular to subquadrate, basal cells larger, mostly rectangular, alar region differentiated with enlarged cells. Gemmae uncommon. Plants autoecious or dioecious. Setae short to elongate, capsules suberect to inclined, asymmetric, annuli absent; opercula conic to short rostrate; peristome single or double. Calyptrae cucullate or conic, smooth and naked, spores papillose.

The family Bartramiaceae represents 386 species (Crosby *et al*., 1999). The family has world wide in distribution. Nepal has the record of 28 species so far. Two genera and five species are described here.

]Key to the Genera

1. Plants green to yellowish brown, costa thin, apical cells with distal papilla; capsules with neck ..... **1**. *Fleischerobryum*
Plants usually whitish to light green, costa strong, apical cell without distal papilla; capsules without neck..... **2**. *Philonotis*

1. Fleischerobryum Loeske, Stud. Morph. System. Laubm.: 127, 1910.

Plants yellowish brown to brownish green with erect, branched and densely tomentose stems, found growing tufts on soil, rocks and boulder stones. Leaves lanceolate, 2-3 mm long with

subulate costae which are thin percurrent to short excurrent. Basal laminal cells larger than middle laminal cells, all leaf cells are less papillose. Capsules long cylindrical or slightly asymmetric, horizontal or pendulous with long necks.

Four species has been known in this genus (Koponen and Norris, 1996). Nepal has the record of one species.

1.1. Fleischerobryum longicolle (Hampe) Loeske, Morph. Syst. Laubm. 127, 1910; Nog. & Z. Iwats. in Ohashi, Fl. E. Him. **3**: 266, 1975; Higuchi & Takaki in Watanabe & Malla, Crypt. Him. **2**: 140, 1990; Kattel & Adhikari, Mosses Nep.*:* 8, 1992; Pradhan, J. Nat. Hist. Mus. **21**: 51, 2002.

Bartramia lingicollis Hampe in C. Muell., Syn. Usc. Frond. **1**: 478, 1848.
Philonotis longicollis (Hampe) Mitt., J. Linn. Soc., Bot. Suppl. **1**: 64, 1859.

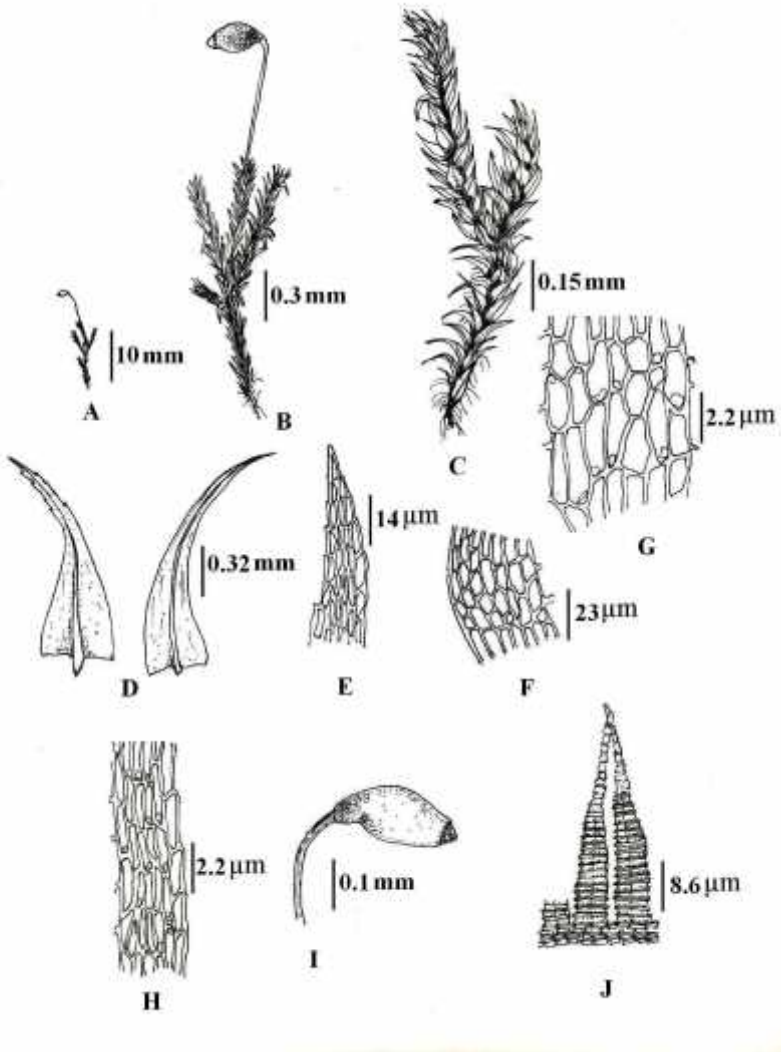

Fig. 37. *Fleischerobryum longicolle* (Hampe) Loeske.(Pradhan NGS 531). A. habit, B. a fertile plant, C. a branch, D. leaves, E. apical portion of the leaf, F. basal portion of the leaf, G. laminal cells in the median region, H. marginal cells in the median region, I. capsule, J. peristome teeth.

Plants erect, dark green, dendroid; stem brown, 2-5 cm tall, densely tomentose by branched multicellular rhizoids; stem cross section shows on layered hyalodermis, one layer of substereidal cortical and thin walled midullar and central cells. Leaves closely appressed the stem when dry and spread when moist, lanceolate, 1.5-2 x 0.5 mm in size with broad ovate base tapering into acuminate apex, entire in recurved part and crenulate by protuding cell corners towards apex, costa greenish brown, percurrent or shortly excurrent, 40-50 µm in diameter at the base, laminal cells elongated, rectangular, 10 x 40 µm and basal cells large, rectangular with papillous at proximal ends, 20-30 x 40-50 µm in diameter, marginal cells 9 x 29 µm in diameter. Plants dioecious, capsules elongate with long neck, setae smooth, dark red, 17 mm long (Fig. 37).

Status: Rare

Habitat: Soil covered rock.

Distribution: Nepal (W, 300-2700 m): Banke (200 m); Bhutan, Burma, Celebis, China, Formosa, India (Darjeeling, Sikkim, Naga Hill), Indonesia, Japan, Java, Malaysia, Papua New Guinea, Philippines, Sumatra and Taiwan.

Remarks: In Nepal, it was reported from the east at 1600- 2700 meter. It is the first record in lowland area growing intermingled with *Plagiochasma appendiculatum* (NGS 716).

2. Philonotis Brid., Bryol. Univ. **2**: 15, 1827.

Plants small to medium sized, forming short dense tufts, rarely solitary, pale to dark green or blackish, usually grow on exposed to shaded seepy or permanently wet sites. Stems erect to suberect, single or few branched, often with terminal short fasciculate branches; rhizoid usually conspicuous, often tomentose. Leaves distant to crowded, ovate to oblong-lanceolate or lanceolate, mostly 2 mm long, apex acuminate, acute to obtuse; margins plane above, often recurved below, denticulate, bluntly to sharply serrate; costae single, strong, often toothed on back, subpercurrent to long excurrent; upper and median cells oblong-linear to rhombic, usually papillose at upper or lower ends, papillae often large, on one or both surfaces; basal cells distinctly larger, rectangular, oblong and lax, smooth or papillose; alar region undifferentiated, margin cells differentiated. Plants dioecious. Setae elongate, smooth and erect. Capsules suberect to inclined, furrowed when dry, urn subglobose, opercula conic; peristome well developed, calyptrae cucullate and spores papillose.

Philonotis represents 169 species worldwide (Crosby *et al.,* 1999). Gangulee (1974) recorded 12 species in Nepal and India. Nepal has the report of 16 species and five varieties of this genus (Pradhan, 2000) of which seven species occur in the lowland.

Key to the species

1. Leaf cells usually opaque, lower end of mid leaf mamillose……..... **5.** *Philonotis seriata*
   Leaf cells translucent, upper end always mamillose ……..…….....…….. 2
2. Leaves linear-lanceolate, distictly acuminate, costa strongly excurrent ……..**7.** *P. turneriana*
   Leaves broad-lanceolate, shortly acuminate, costa shortly excurrent….....……..…… 3

3. Leaf margin crenulate at apical region; cells mamillose at basal region ……..… **1**. *P. falcata*
Leaf margin sharply serrate, cells mamillose throughout……..…….....…..…. 4

4. Plants yellowish green, tomentose; leaves lanceolate with short excurrent costae ……..….. 5
Plant dark green not tomentose; leaves triangular; costae percurrent or excurrent ……...…. 6.

5. Leaves gradually tapering, inner basal laminal cells thin walled sometimes enlarged ……...…..…… **4.** *P. mollis*
Leaves acute to acuminate, inner basal laminal cells thin walled not enlarged. .. **6.** *P. thwaitesii*

6. Leaves ovate-lancelate, costa short excurrent, capsule globose ……....… **2**. *P. fontana*
Leaves triangular, costa percurrent to excurrent, capsule oval…….....… **3.** *P. marchica*

2.1. Philonotis falcata (Hook.) Mitt. var. **falcata**, J. Linn. Soc. Suppl. **1**: 62, 1859; Nog. & Z. Iwats. in Ohashi, Fl. E. Him. **3**: 266, 1975; Higuchi & Takaki in Watanabe & Malla, Cryp. Him. **2**: 140, 1990; Pradhan, Mats. Checklist Bryo. Nep.: 24, 2000b; Koponen *et al.,* Ann. Bot. Fennici **37**: 25, 2000; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 22, 2007b.

Bartramia falcata Hook., Trans. Linn. Soc. London **9**: 317, 27 f. 4. 1808.
Philonotis fontana var. falcata (Hook.) B.S.G., Bryo. Eur. **4**: 49, 1842.
P. subulosa (Griff.) Mitt., *ibid*.: 61, 1842; Chopra, Taxo. Ind. Mosses, Bot. Monogr. **10**: 256, 1975.
P. orthostichacea C. Muell in Par., Index Bryol.*:* 267, 1897.

Plants medium sizes. Stems rigid, 5 cm tall and tomentose at the basal region. Leaves triangular, 5-ranked, falcate second, 1.5 mm long and 0.5 mm wide at the base, margin entire and slightly denticulate at the apical region, costae strong, excurrent, upper laminal cells small, narrowly elongated-rectangular, 7-10 x 20-30 µm in diameter, lower laminal cells short-rectangular, 10 x 30-35 µm. Plants dioecious, perigonia surround a discoid head of Antheridia. Setae erect, red, 3.5 cm long, capsules 3 mm long, sub-spherical and deeply sulcate, peristome double.
Status: Type: Nepal (BM)
Habitat: Wet rocks, lodges and moist grasslands.
Distribution: Nepal (C, 900-2500 m): Kavre (900-1000 m); Bhutan, Burma, China (Tibet), India, Hawaii, Japan, Korea, Philippines, Thailand and Vietnam.

2.2. Philonotis fontana (Hedw.) Brid., Bryol. Univ. **2**: 18, 1827; Nog. *et al.,* Bull. Nat. Sci. Mus. **9** (3): 309, 1966; Noguchi & Z. Iwats. in Ohashi, Fl. E. Him. **3**: 266, 1975; Higuchi & Takaki in Watanabe & Malla, Crypt. Him **2**: 141, 1990; Kattel & Adhikari, Mosses Nep.: 9, 1992; Pradhan, Mats. Checklist Bryo. Nep.: 25, 2000b.

Mnium fontanum Hedw., Sp. Musc.: 105, 1801.
Bartramia fontana (Hedw.) Turner, Muscol. Hibern. Spic.: 107, 1804.

Fountain Apple Moss, Philonotis Moss, Swamp Moss (Eng.).

Plants small to robust, light to dark green or yellowish green in glossy tufts. Stem reddish or reddish brown, densely tomentose proximally, 1-16 cm, erect, simple-irregularly branched or witha subfloral whorl of innovations. Rhizoids reddish brown, smooth. Leaves erect or erect spreading, less catenulate, sometimes falcate, lanceolate to broadly ovate-lanceolate or ovate-subulate, 0.6-3 mm long, gradually to abruptly narrowed to acumen, apex acute to acuminate, occasionally obtuse; margins revolute, serrulate at the apical region or throughout, costae short to long-excurrent, 320 µm wide at base; laminal cells prorulose at proximal ends, distal cells linearto oblong-linear, 15-40× 3-5 µm, basal cells more lax, rectangular to oblong-hexagonal, 24-40 × 7-10 µm near costa. Plants dioecious, perigonia discoid, Sporophyte acrocarpous, setae erect, 5-7 cm, capsules globose to ovoid, 1-3.5 mm long, green in young and yellowish to brown at maturity, urn ribbed, spores ovoid to reniform, papillose, 18-30 µm in diameter.
Status : Common
Habitat: Deeply shaded seepage rocks.
Distribution: Nepal (C, 350-4540 m) : Chitwan (350 m); Caucasus, Central America (Guatemala, Panama), China (West Tibet), Europe, India (Sikkim), Japan, Macronesia, North Africa, North and Central Asia, North Europe and Philippine.
Remarks: This a high altitudinal species (3000-4500 m) and is reported in one locality only at 350 m of Chitwan district, Central Nepal.

2.3. *Philonotis marchica (Willd) Brid., Bryol. Univ. **2**: 23, 735, 1827; Chopra, Taxo. Ind. Mosses, Bot. Monogr. **10**: 256, 1975; Kurschner & Erdag, Turk. J. Bot. **29**: 30, 2005.

Mnium marchicum Hedw., Sp. Musc.: 196, 1801.
Philonotis muehlenbergii (Schwaegr.) Brid., Bryol. Univ. **2**: 22, 6, 1827.

Bog Apple Moss (Eng.).

Plants dendroid, tall, slender, yellowish or bright green in tufts. Stems dark red, erect, simple or forked, 2-6 cm, brown-tomentose below. Leaves 1-2.5 mm long, erect-spreading when dry, somewhat divergent when moist, occasionally spiral, triangular-lanceolate, acuminate, keeled; margins plane or sometimes narrowly revolute, serrulate nearly to base, teeth single; costae percurrent to long-excurrent; distal laminal cells linear oblong, 20-30 × 4-8 µm, basal cells oblong, 18-45 × 6-15 µm. Plants dioecious, perigonia discoid. Setae erect, 1.5-4 cm, capsules erect, more or less oval, surrounded by perichaetial leaves, inclined furrowed when dry, 1-2.5 mm long. Spores papillose, 20-30 µm in diameter.
Status: Rare.
Habitat: Damp soil, rocks, hillsides seeps, brook margins and wet rotton woods.
Distribution: Nepal (W, 610 m): Dang (610 m); Africa, Atlantic Islands (Macaronesia), China, Columbia, Europe, Japan, Korea, Macaronesia, Mexico, North Africa, North America and Turkey.

Remarks: *Philonotis marchica* is recognized by the usually plane, singly serrulate leaf margin and the laminal cells mammillae throughout the leaf and reported as new record for Nepal.

2.4. Philonotis mollis (Dozy & Molk.) Mitt., J. Linn. Soc. Bot. Supp. **1**: 60, 1859; Higuchi & Takaki Watanabe & Malla, Cryp. Him**. 2**: 141, 1990; Pradhan, Mats. Checklist Bryo. Nep.: 25, 2000b; Pradhan & Joshi, Current Trends in Bryology in Nath 7 Asthana: 23, 2007b; Pradhan & Joshi, Nep. J. Pl. Sci. **2**: 30, 2008a.

Bartramia mollis Dozy & Molk., Ann. Sci. Nat. **2**: 300, 1844.
B. secunda Dozy & Molk., Pl. Jungh. **3**: 332, 1854.
Philonotis stolonacea Par., Index Bryol. Suppl: 268, 1900.

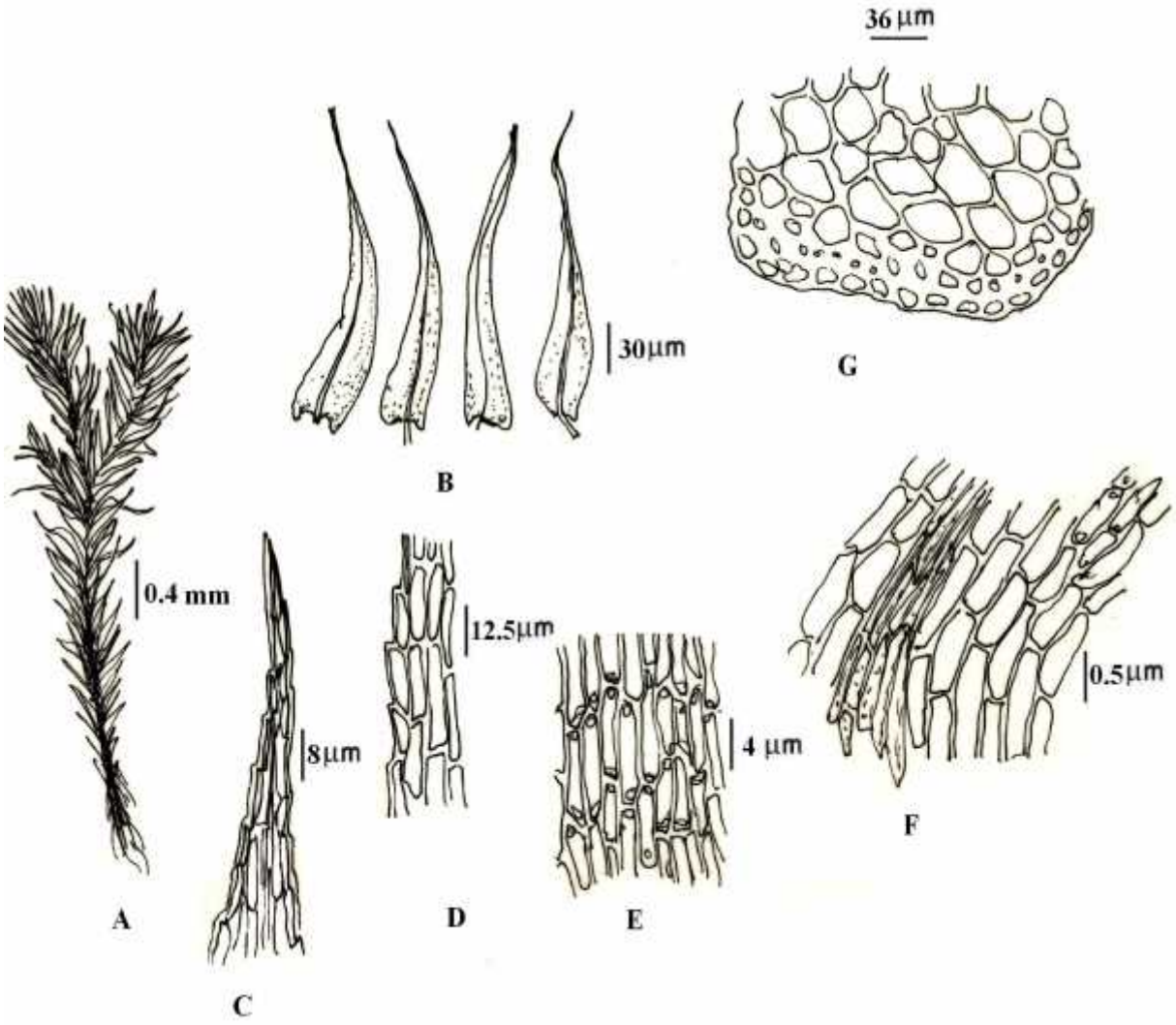

Fig. 38. *Philonotis mollis* (Dozy & Molk.) Mitt., A. vegetative plant, B. leaves, C. apical portion of the leaf, D. leaf of the median region showing marginal cells, E. cells in the median region of the leaf, F.cells towards tostal region. G. cross section of the stem showing internal structure.

Plants dendroid, bright green with soft texture. Stem cylindrical, 1-3 cm tall, dark brown in older part; leaves spreading when dry and erectopatent when wet, lanceolate, long, narrow and gradually tapering at the apical region, 1.5- 2 x 0.5 mm in size with plain margin but serrulate at the apical region and with sharp green point, costa brownish, distinct, excurrent with elongated narrow cells (40 x 8 µm) and 25 µm in diameter, laminal cells reactangular, elongated, 8-10 x 30 -70 µm in diameter, thin walled with mammilla on the ventral upper cells ends, basal cells wider and longer reactangular, 12-75 x 90-100 µm in diameter, stem cross section differentiated into one layer hyalodermis, one layer substereidal certical cells, thin walled medullary and central cells Plants dioecious, capsule brown, shiny and horizontal. Setae smooth (Fig. 38).

Status: Common

Habitat: Rock, soil and cliffs.

Distribution: Nepal (W, C, 250-2000 m): Dang (250-760 m), Rupendehi (500 m), Dhading (400-880 m), Chitwan (250 m); Andamans Island, Bhutan, Borneo, Celebes, China, Indonesia, Japan, Java, Madagascer, Philippines, Papua New Guinea, South India, Sri Lanka, Sumatra, Taiwan, Thailand, Tonkin and Western Malaysia.

Remarks: Koponen and Norris's (1996) specimen is quite small than my specimen which measure upto only 1 cm tall and with laxer areolation in the basal region of the leaf.

2.5. Philonotis seriata Mitt., J. Linn. Soc. Bot. Supp. **1**: 63, 1859; Higuchi & Takaki, Crypt. Him. **2**: 141, 1990; Pradhan, Mats. Checklist Bryo. Nep.: 25, 2000a; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 23, 2007b; Pradhan & Joshi, Nep. J. Pl. Sci. **2**: 30, 2008a.

Philonotis fontana var. *seriata* (Mitten) Kindberg, Bih. K. Svensk. Vet. Ak. Handl. **7**(9): 255, 1883.

Spiral Apple Moss (Eng.).

Plants robust, dendroid in greenish to yellowish green tufts. Stem erect, simple, 3-12 cm. tall, Leaves erect to erect-spreading and imbricate when dry, erect-spreading when moist, plicate, straight or falcate, seriate in 5 spiraled rows, ovate-lanceolate, 1.5-2 mm; margins plane or narrowly revolute, serrulate to denticulate nearly to base, teeth paired or simple; costae robust, percurrent to excurrent, rough abaxially throughout. Laminal cells at the apical region subrectangular, 31 x 8-9 µm in size, basal cells elongated hexagonal to rhomboidal, 40 x 9 µm in size and mammillous. Plants dioecious, acrocarpous. Setae erect, 3-7 cm long, capsules globule, horizontal, furrowed when dry, 2-3 mm in diameter. Spores sub-reniform, papillose, 20-22 µm in diameter

Status: Common

Habitat: Soil.

Distribution: Nepal (W, 780-4250 m): Dang (780 m); Alaska, Canada, Central Asia, Europe, Green Land, India (Kashmir), Japan, Korea, Mangolia, North Africa and North Carolina.

2.6. Philonotis thwaitesii Mitt., J. Linn. Soc. Bot. Supp. **1**: 60, 1859; Higuchi & Takaki, Crypt. Him. **2**: 141, 1990; Kattel & Adhikari, Mosses Nep..*:* 9, 1992; Pradhan, Mats. Checklist Bryo. Nep.: 25, 2000a; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 23, 2007b; Pradhan & Joshi, Nep. J. Pl. Sci. **2**: 30, 2008a.

Philonotis socia Mitt., J. Linn. Soc. Bot. **8**: 51, 1864.
p. sumatrana Dixon, Annls. Bryl. **5**: 32, 1932.
P. appressifolia Dixon, Hong Kong Naturalisty. Suppl. **2**: 18, 1933.
P. tenuicarpa Dixon, J. Jap. Not. **45**(1): 25, 1970.

Small-leaved Apple Moss (Eng.).

Plants yellowish green, small dendroid. Stems erect, green above and brownish tomentose at the base, 10-15 mm tall Leaves dense, stiff, erect but appressed to the stem when dry. Fresh leaves triangular-lanceolate tapering to acute apices, 1.5-2 mm long and 0.5 mm wide at the base, margin finally denticulated, costa short-excurrent. Apical leaf cells linear, elongated, reactangular, mamillous, 20-75 x 4-8 µm in diameter, basal cells quadrate to short rectangular, 15 x 20 µm in diameter. Plants dioecious, perichaetial leaves more or less similar to normal leaves. Setae smooth, dark red at the base and orange red towards the capsule, 14 mm long, capsules globose-subglobose, bright orange and becoming brown and furrowed when dry, 2-3 mm long and 2.5 mm wide with narrow mouth, peristome free, brown 160 µm long and curved inward. Spores spherical, dark brown, 20-25 µm in diameter (Fig. 39).
Status: Common
Habitat: Damp rocks and moist soil.
Distribution: Nepal (250-1000 m): Banke (350 m), Dang (1000-1200 m), Kaski (800 m), Chitwan (250-500 m); Bolivia, Borneo, Columbus, China (Hong Kong), Japan, Korea (Taiwan), Malaysia, New Guinea. South India, Sri Lanka, Sumatra and Thailand.

2.7. Philonotis turneriana (Schwaegr.) Mitt., J. Linn. Soc. Bot. Supp. **1**: 62, 1859; Chopra, Taxo. Ind. Mosses: 256-257, 1975; Nog. & Z. Iwats. in Ohashi, Fl. E. Him. **3**: 266, 1975; Higuchi & Takaki, Crypt. Him. **2**: 141, 1990; Kattel & Adhikari, Mosses Nep.*:* 9, 1992; Pradhan, Mats. Checklist Bryo. Ne*p.*: 25, 2000; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 23, 2007b; Pradhan & Joshi, Nep. J. Pl. Sci. **2**: 30-31, 2008a.

Bartramia turneriana Schwaegr., Sp. Musc. Frond. Suppl. **3**(1): 238, 1828.
B. speciosa Griff., Calcutta J. Nat. Hist. **2**: 513, 1842.
Philonotis nitida Mitt., Proc. J. Linn. Soc.Bot. Suppl. **1**: 62, 1859.

East Asian Apple Moss (Eng.).

Plants medium to robust with dendroid erect stems upto 5 cm long. Leaves stiff, markedly 5-ranked spreading and secund when moist and little on drying, triangular, widest at the base, 1.4-2 mm long

and 0.5-0.6 mm wide at the base, margin plane or slightly serrulated, costae strong excurrent in a long subentire to denticulate arista. Middle laminal cells reactangular, 20-40 x 5-6 µm, smaller

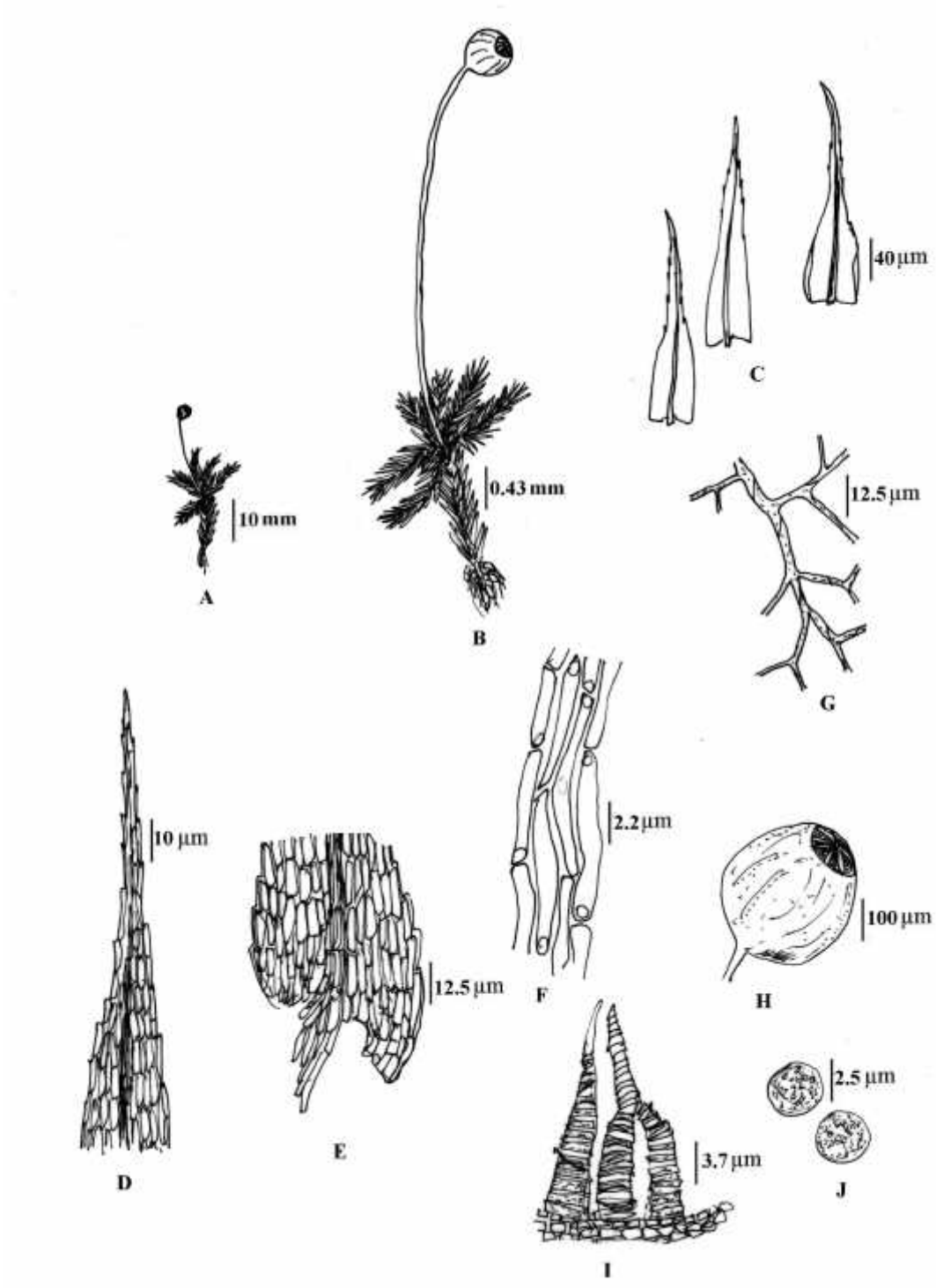

Fig. 39. *Philonotis thwaitesii* Mitt. (Pradhan, NGS 280, 294). A. habit, B. the plant enlarged, C. leaves, D. apical portion of the leaf, E. basal portion of the leaf, F. middle laminal cells, G. rhizoids, H. capsule, I. peristome teeth, J. spores.

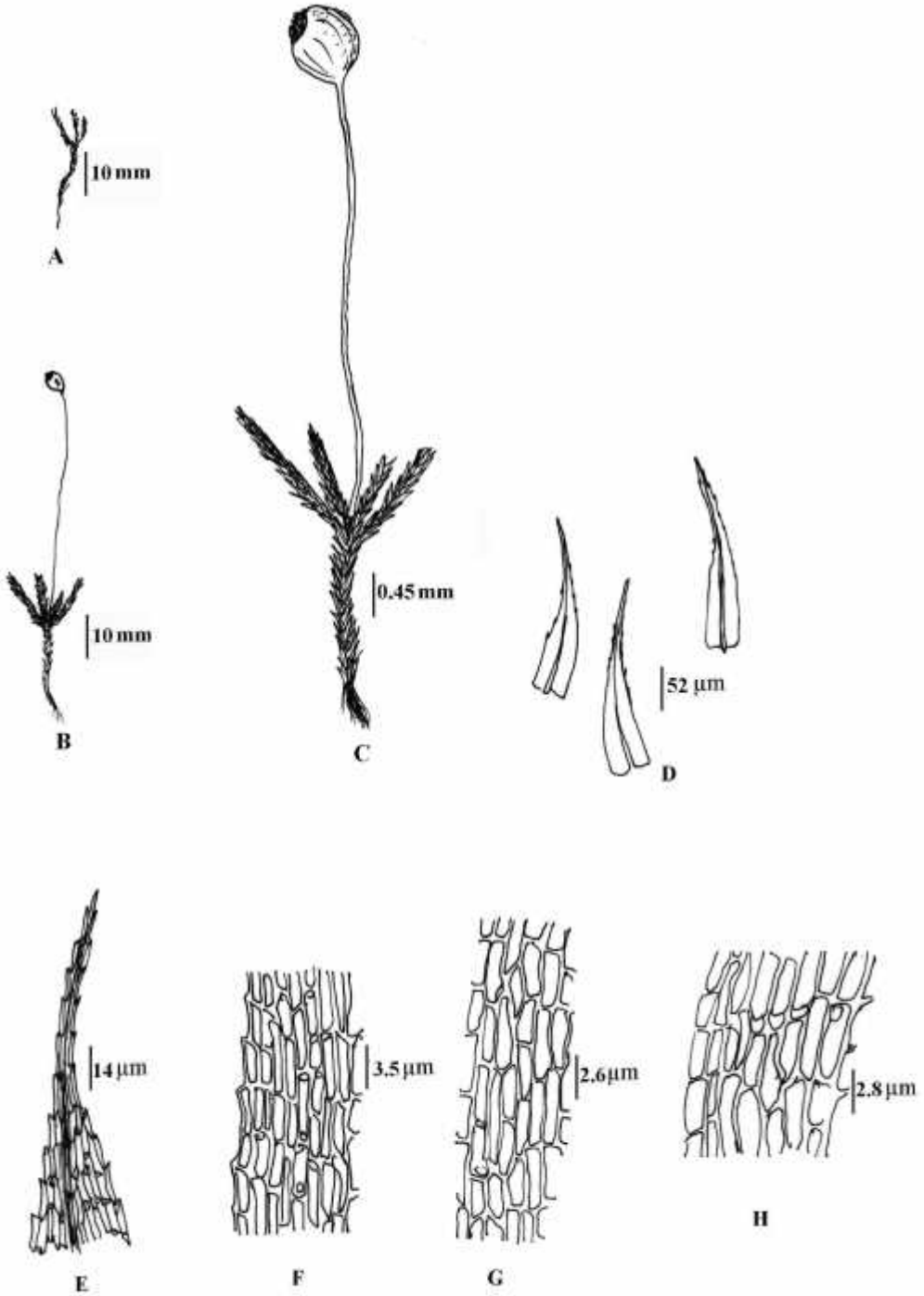

Fig. 40. *Philonotis turneriana* (Schwaegr.) Mitt. (Pradhan, NGS 503). A. habit, vegetative, B. habit, fertile, C. the plant enlarged, D. leaves, E. apical region of the leaf, F. cells at the apical region, G. cells at the median region, H. cells at the basal region.

towards marginal region, strongly prorateto mamillate and shorter and wide at the basal region. Plants dioecious. Male plants more slender than sterile and female plants. Perichaetial leaves little larger than normal leaves. Setae red, 2-3 cm long. Capsules dark brown, inclined or horizontal, 1.5 x 0.5 mm in size. Spores spherical, smooth, yellowish brown, 10-12 µm in diameter (Fig. 40).
Status: Common
Habitat: Soil
Distribution: Nepal (W, C, 120-3100 m): Banke (120 m), Dang (610 m), Chitwan (350-1000 m), Kavre (900-1000 m); Bhutan, Burma, China (Hong Kong), India, Indonesia, Japan, Java, Malaysia, Myanmar, Philippines, Sri Lanka, Sumatra and Taiwan.

5.2.3.2.2. BRYACEAE

Plants small to robust, mostly forming dense tufts. Stems erect, solitary or few branched by innovations or stems connected by stolons (e.g. *Rhodobryum*), densely tomentose and present of central strand. Leaves spirally arranged, equally spaced and occasionally forming a rosette, variously shaped, linear to broadly lanceolate, ovate, oblong or obovate, apex broadly acute to acuminate, occasionally decurrent; margins plane to recurved, entire to serrate distally, costae single, subpercurrent to excurrent; laminal cells smooth, median cells oblong-linear or short to long hexagonal or rhomboidal, basal cells short to long rectangular, alar region undifferentiated; marginal cells similar or with long linear cells if bordered. Gemmae occasionally present. Plants autoecious or dioecious and occasionally synoecious. Perichaetia terminal or appearing lateral. Setae smooth, elongate, single or several in number. Capsules pendulous, occasionally erect or suberect, urn ovoid or pyriform with short or long neck; opercula conic, peristome double or single, calyptrae cucullate, smooth and naked. Spores spherical, often lightly papillose.

Bryums are diverse mosses distributed widely throughout the country. This includes 82 species under seven genera, five varieties and three subspecies in Nepal so far. Four genera and 13 species are described here.

Key to the genera

1. Plants small with scattered leaves ……..……..……..……..…..…….…….. 2
   Plants large with rosette leaves at the top ……..……..…….....…..... 3

2. Capsule oval, pendulus, occasionally erect ……...…….....…..…. **1**. *Bryum*
   Capsule ovoid to pyriform, oftern horizontal ……..……..…..……...…… **3**. *Pohlia*

3. Leaves oblong-lanceolate; costae percurrent or excurrent …..…….……... **1**. *Brachymnium*
   Leaves spathulate with strong excurrent costa ……..... **4**. *Rhodobryum*

1. Brachymenium (Schwaegr.) Hedw., Spec. Musc. Suppl. **2**(1): 131, 1824.

Plants medium to large sized, forming dense tufts, dark green, often lustrous. Stems erect, simple to branched with central strand, occasionally tomentose. Leaves equally distant or crowded distally, erect-spreading when wet, lanceolate, oblong-lanceolate, obovate-oblong, apex short to long acuminate, margins plane above, often reflexed to recurved in lower half, entire to serrulate, costae single, strong, short to long excurrent, awn smooth or toothed, lower and basal cells short rectangular; marginal cells linear and thick-walled, 1-4 rows. Gemmae often present. Plants dioecious, perichaetial leaves terminal often large. Setae elongate, erect to weakly flexuose, slender to stout, smooth. Capsules suberect to erect, urn cylindrical, rarely subglobose, slightly asymmetric, neck usually distinct; opercula conic, rarely rostrate, peristome double, calyptrae cucullate, smooth and naked. Spores spherical and lightly papillose.
Eleven species of *Brachymenium* has been recorded from Nepal (Pradhan and Joshi, 2008b).

1.1. Brachymenium acuminatum Harv. in Hook., Icon. Pl. 1: t. 19 f. 3, 1836; J. Bot. **2**: 10, 1840; Nog. & Z. Iwats. in Ohashi, Fl. E. Him. **3**: 258, 1975; Karcz., Lindbergia **7**: 128, 1981; Higuchi & Takaki, Crypt. Him **2**: 132, 1990; D.G. Long, J. Bot. Linnean Soc. **199**: 1-33, 1995; Kattel & Adhikari, Mosses. Nep.: 12, 1992; Pradhan, Mats. Checklist Bryo. Nep.: 28, 2000a; Pradhan, J. Nat. Hist. Mus. **19**: 64, 2000b; Pradhan & Joshi, J. Nat. Hist. Mus. **23**: 20, 2008b.

Brachymenium filescens Bartr., J. Wash. Acad. Sci. **21**: 292, 1931.

Plants minute, yellowish green, gregarious or in loose tufts. Stem erect, slender, 2-10 mm long. Rhizoids reddish brown, rough, papillose sparse at the base. Leaves appressed to imbricate when dry. Fresh leaves concave, ovate to ovate-lanceolate, 0.5-1 mm long, spices shortly acuinate, margin entire weakly bordered by long, narrow cells, costae percurrent to short excurrent, laminal cells elongated hexagonal to rhomboidal, 40-90 x 10 µm in diameter, basal quadrate to rectangular, alar cells short reactangular. Plants dioecious. Setae long, erect, red, 10-28 mm long, Capsules erect, 2 mm long, elongated pyriform with constricted neck, opercula conic, 0.5 mm long, peristome teeth reddish brown, thickly papillose. Spores 10-15 µm, spherical and smooth.
Status: Rare, Type; Hooker 128H (GL-Arn, lectotype)
Habitat: Soil.
Distribution: Nepal (C, 250-1800 m): Kavre (800 m), Morang (250m); Africa, Australia, Central America, China, Equador, India, Indo-China, Malaysia, South America and South Thailand.
Remarks: *Brachymenium acuminatum* is distinguished by its very small size, percurrent to shortly excurrent costae and lax leaf cells.

2. Bryum Hedw., Spec. Musc Frond: 178, 1801.

Plants small to robust, erect, acrocarpous, green to variously coloured forming loose to dense tufts. Stems erect, tomentose, few to several branched; central strand present. Leaves commonly crowded at the apical region, erect-spreading when wet, ovate-lanceolate to oblong-lanceolate,

apex acute to acuminate, base decurrent, margins usually reflexed to recurved, entire or serrulate, costae single, subpercurrent to long excurrent; laminal cells smooth, upper and median cells rhomboidal- or hexagonal, lower and basal cells short to long oblong or rectangular, thin to thick-walled, marginal cells forming a distinct border of long linear cells. Plants dioecious or autoecious. Perigonia usually bud-like. Perichaetia terminal. Setae elongate, smooth, capsules suberect to more commonly inclined or pendulous, urn short to long oblong or cylindrical pyriform, neck short or long, annuli compound, opercula convex-conic, peristome double, calyptrae cucullate, Spores spherical, smooth to papillose, 10-50 µm and varying in colour.

Chopra (1975) had mentioned more than 80 species which were previously reported from India. Pradhan and Joshi (2008b) has eneumerated 39 species of this genus from Nepal.

Key to the species

1. Plants silvery white; leaves hyaline in upper parts ……..……..…..... 2
   Plants light green; leaves chlorophyllose throughout ……..……. 3

2. Caspsule inclined to pendent; endostome nearly as long as exostome ……... **2**. *Bryum argenteum*
   Capsule erect or subpendent; endostome shorter than exostome …….. **5**. *B. clavatum*

3. Leaves ovate lanceolate, apex acute ……..…….……..…. 4
   Leaves broad and expanded; apices fine hairy ……. **3**. *Bryum capillare*

4. Plant small and delicate less than 2 cm long; leaves less than 1.5 mm long; capsule horizontal ……..... **4**. *Bryum cellulare*
   Plants more than 2 cm long; leaves more than 1.5 mm long; capsule pendulous more or less parallel to setae ……...… **6**. *Bryum coronatum*

5. Upper laminal cells linear-fusiform, 55-90 µm long ……..…… **1.** *Bryum apiculatum*
   Upper laminal cells rhomboidal to hexagonal, 45-55 µm long ……..……..…… 6
6. Leaves more than 2 mm long; capsule dark red ……..……...……..… **7**. *B. dichotomum*
   Leaves less than 2 mm long; capsule reddish brown ……...……. **3.** *Bryum caespiticum*

2.1. Bryum apiculatum Schwaegr., Sp. Musc. Frond. Suppl. **1**(2): 103, 1816; Mitt., J. Proc. Linn. Soc. London*:* 70, 1958; Higuchi & Takaki, Cryp. Him **2**: 135, 1990; Kattel & Adhikari, Mosses. Nep.*:* 13, 1992; Pradhan, Mats. Checklist Bryo. Nep.: 29, 2000b; Pradhan & Shrestha, Proc. Int. Seminar on Mountain-Kath.: 552, 2003; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 24, 2007b; Pradhan & Joshi, J. Nat. Hist. Mus. **23**: 21, 2008b.

Pohlia apiculata (Schwaegr.) H. A. Crum & L. E. Anderson, Mosses E. N. Amer. **1**: 534, 1981.
Bryum nitens Hook., Icon. Pl. **1**: 19, 1836.

Plants acrocarpous, small to medium-sized, yellowish green to reddish brown in loose tufts up to 3 cm high, rhizoids at the base. Leaves1-2 mm long, erect-imbricate and crowded at the apex, each leaf ovate-lanceolate with broad acute apices, margin plane below and slightly seriated above, costa short excurrent in small apiculus, upper laminal cells linear-fusiform, 50-90 µm long, basal cells long-rectangular, 40-60 µm long, alar cells quadrate, 20-25 µm long. Setae long, red, 15-25 mm long, capsules red, 2- 2.5 mm long, oblong-cylindrical, pendent, teeth yellowish orange, spores roughened, 12-16 µm in diameter.

Status: Type, 1832, Wallich 7592 (K-W).

Habitat: Soil.

Distribution: Nepal (W, C, 150-4400 m): Palpa **(**600 m), Chitwan (140 m); Africa, Argentina, Australia, Bolivia, Central America, Colombia, Eastern Asia, Equador, Indo-China, Indian Subcontinent, Maleysia, Vennezuela and West Indies.

2.2. Bryum argenteum Hedw., Sp. Musc. Frond. 181, 1801; Mitt., J.. Linn. Soc. Suppl.**1**: 69 1958; Nog. *et al.*, Bull. Nat. Sci. Mus. **9**(3): 307, 1966; Nog. & Z. Iwats. in Ohashi, Fl. E. Him. **3**: 259, 1975; Karcz., Lindbergia **7**: 128, 1981; Higuchi & Takaki in Watanabe & Malla, Crypt. Him. **2**: 135, 1990; Kattel & Adhikari, Mosses. Nep.: 13, 1992; Pradhan, Mats. Checklist Bryo. Nep.: 29, 2000a; Pradhan, J. Nat. Hist. Mus. **19**: 64, 2000b; Pradhan & Shrestha, Proc. Int. Seminar on Mountain-Kath. : 552, 2003; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 24 2007b; Pradhan & Joshi, J. Nat. Hist. Mus. **23**: 21, 2008b.

Bryum brachyphyllum Taylor in Mitt., J. Linn. Soc., Bot. **12**: 302, 1869.
B. corrugatum Hampe, Bot. Zeitung (Berlin) **27**: 868, 1869.
B. stenopyxis Muell. Hal., Linnaea **42**: 480, 1879.
B. tricolor M.A.Cardenas., Rev. Bryol. **38**: 34, 1911.
B. niveum Herzog, Biblioth. Bot. **88**: 13, 1920.
B. arsenei Ther., Smithsonian Musc. Collec. **78** (2): 16, 1926.

Silver Bryum (Eng).

Plants small, erect, silvery green and rarely branched. Stems 2-8 mm high. Rhizoids papillose, tuft at the base. Leaves broadly ovate, 0.5-1.5 mm long and 1 mm broad, apices apiculate, margin plain or recurved below, unistratose not bordered, nearly entire, costa ends below the apex, upper cells rhomboidal to rectangular and hyaline, middle laminal cells short rhomboidal about 80-100 µm long, basal cells subquadrate to short rectangular. Plants dioecious and acrocarpous. Setae 8-20 mm long, red to brown, capsule oblong cylindrical, pendent, 1-2 mm long, light brown, light green becomes red with age, exothecial cells strongly differentiated, opercula conic-apiculate, 0.5 mm long, teeth papillose, calyptra cucullate. Spores spherical, sooth to faintly papillose, 10 -15 µm in diameter (Fig. 41).

Status: Rare

Habitat: Exposed brick walls, concret walls, exposed rocks etc.

Distribution: Nepal (W, C, 800-5100 m): Kaski (800 m), Chitwan (1000-1200 m); Africa,

Antarctic continent, Argentina, Australia, Brazil, Colombia, C. America, Eastern Asia, Ecuador, Indo-China, Malaysia, Mexico, New Zealand, Peru, South America, Thailand and Venezuela.

Remarks: This species is distinguished from other species with silver green leaves due to the absence of chlorophyll in the upper parts. It has a perfect peristome, strongly differentiated exothecial cells at the capsule mouth. It is very common in subtropical to temperate region but is rare in tropical lowland

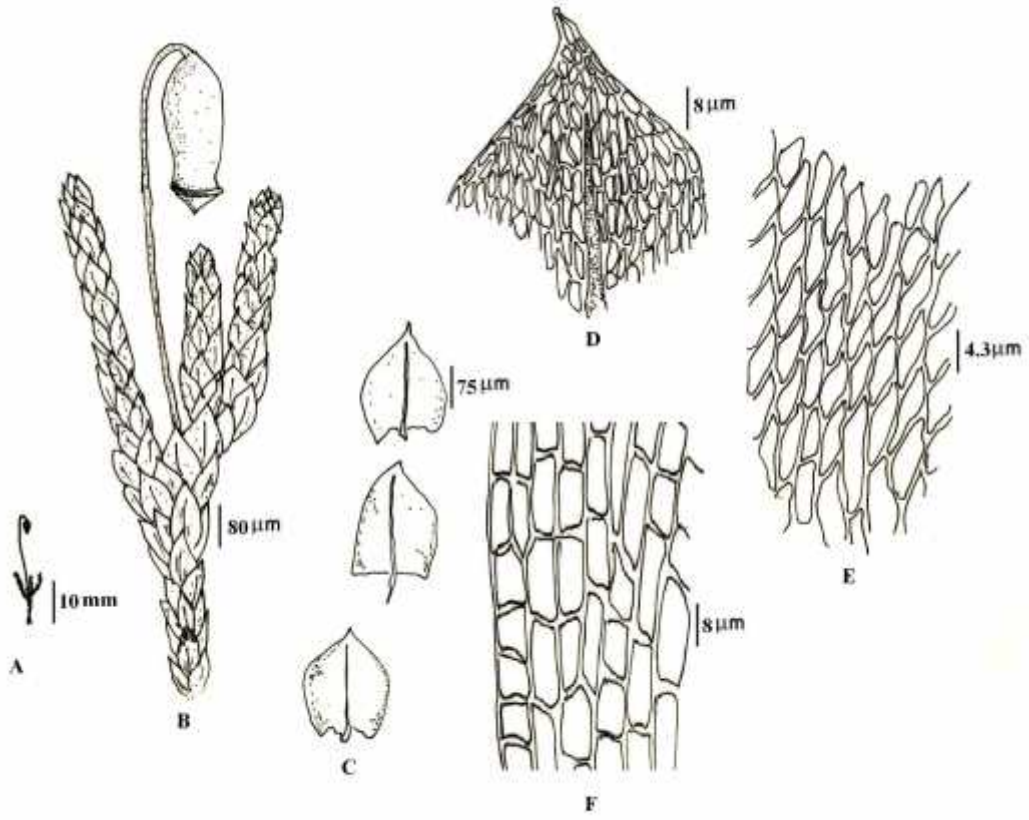

Fig. 41. *Bryum argenteum* Hedw., A. habit, B. fertile plant enlarged, C. leaves, D. apical portion of the leaf, E. middle laminal cells, F. basal portion of the leaf.

2.3. Bryum caespiticum Hedw., Sp. Musc.: 180, 1801; Nog. *et al.*, Bull. Nat. Sci. Mus. **9** (3): 307, 1966; Karcz., Lindbergia **7**: 128, 1981; Higuchi & Takaki in Watanabe & Malla, Crypt. Him. **2**: 136, 1990; Kattel & Adhikari, Mosses Nep.*:* 14, 1992; Pradhan, Mats. Checklist Bryo. Nep.: 29 2000b; Pradhan & Shrestha, Proc. Int. Seminar on Mountain-Kath. : 552, 2003; Pradhan & Joshi, Nep. J. Pl. Sci. **2**: 31, 2008a; Pradhan & Joshi, J. Nat. Hist. Mus. **23**: 21, 2008b.

Tufted Thread moss (Eng.).

Plants small, dark green to brownish green form mats at different habitats. Stem erect, rarely branched up to 3 mm high and 1.5 mm broad with expanded leaves. Leaves dense and crowded at the apical region, leaves ovate-lanceolate, acuminate with long smooth or slightly denticulate point,

margin entire and recurved, border indistinct, costae brownish green, strong, long excurrent, laminal cells at the median region, elongated-hexagonal, 10-12 µm wide, cells at the apical region elongated and the basal region is wide rectangular with several turgit cells. Plants dioecious. Setae long, elongated, capsules reddish brown to chocolate brown, slightly bent towards the seta, spores numerous, minute, spherical, smooth, thin walled, hyaline to light green, 20-22 µm in diameter.
Status: Rare
Habitat: Dry and moist soil, exposed areas in river bank.
Distribution: Nepal (W, C, 300-4800 m): Dang (610 m), Chitwan (240 m); Bhutan, China, India and Turkey.

2.4. Bryum capillare L. ex Hedw., Sp. Musc.*:* 182, 1801; Nog. & Z. Iwats. in Ohashi, Fl. E. Him. **3**: 259, 1975; Higuchi & Takaki in Watanabe & Malla, Crypt. Him. **2**: 136, 1990; Kattel & Adhikari, Mosses. Nep.*:* 14, 1992; Pradhan, Mats. Checklist Bryo. Nep.: 29, 2000b; Pradhan & Shrestha, Proc. Int. Seminar on Mountain-Kath. : 552, 2003; Nath *et al.*, Taiwania **52** (2): 169, 2007; Pradhan & Joshi, J. Nat. Hist. Mus. **23**: 21, 2008b.

Capillary Thread Moss (Eng.).

Plants small to medium, 2-4 cm tall, green to yellowish green, form tuft mats upon substratum. Rhizoids culster at the base. Leaves variable, distant at the base and tuft at the apical region, spread when moist, shrunken and appressed when dry, spathulate, up to 3 x 1.4 mm in size, widest at the base with fine apical point, costae excurrent, stout at the base, margin serrated at the apical region and bordered by elongated, thick walled, brownish to red cells in 1-5 rows, upper laminal cells thin walled, rhomboidal, 40-50 x 35 µm in diameter, basal cells rectangular. Plants dioecious. Sporophytes apical, seta variable in length 15-30 mm long, reddish to straw coloured, capsules cylindrical, elongated, pendulous, 3.5 x 1.5 mm in diameter, peristome perfect and little pecular. Spores 11-25 µm in diameter.
Status: Rare
Habitat: Soil, barks, tree trunks, rocks, etc.
Distribution: Nepal (C, 900-4020 m): Makwanpur (1000 m); America, Australia, Bhutan, Carabbean, Subatlantic Islands, Caucasua, China, Europe, India, Japan, Korea, Macronesia, Malaysia, New Zealand, North and Central Africa, North Vietnam, Siberia, Thailand and Turkey.

2.5. Bryum cellulare Hook. in Schwaegr., Sp. Musc. Suppl **3**(1): 214a, 1827; Mitt., J. Proc. Linn. Soc. Suppl. **1:** 72, 1959; Higuchi & Takaki in Watanabe & Malla, Crypt. Him. **2**: 136 1990; Pradhan, Mats. Checklist Bryo. Nep.: 29, 2000b; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 24, 2007b; Pradhan & Joshi, J. Nat. Hist. Mus. **23**: 21, 2008b.

Brachymenium cellulare (Hook.) A. Jaeger, Ber. Thätigk. St. Gallischen Naturwiss. Ges. **1873-74**: 111, 1875.

Plants small, reddish green, densely tufts. Stems erect about 1 mm long. Leaves ovate-lanceolate,

1.8 x 0.5 mm in size with acute apex and reddish percurrent costae, erectopenent and not changed when dry. Laminal cells subrectangular at the base (9 x 19 µm) becoming rhomboidal to hexagonal at the apex, 98 x 15 µm in diameter. Plants dioecious, capsules horizontal, cylindrical, brownish, 4 mm long and 1.5 mm broad, operculum conical..
Status: Type: Nepal (Moss Flora of Ande)
Habitat: Soil.
Distribution: Nepal (C, 900-1300 m): Makawanpur (1000-1060 m); Australia, Burma, China, Central Africa, Europe, Japan, Peru, Philippines Sumatra a and Turkey.

2.6. Bryum clavatum (Schimp.) C. Muell., Syn. **1**: 292, 1848; Higuchi & Takaki, Cryp. Him. **2**: 136, 1990; Kattel & Adhikari, Nat. Hist. Soc. Nep.: 14, 1992; Pradhan, Mat. Checklist Bryo. Nep.: 29, 2000b; Pradhan & Shrestha, Proc. Int. Seminar on Mountain-Kath.: 552, 2003; Pradhan & Joshi, J. Nat. Hist. Mus. **23**: 21, 2008b.

Pohlia clavata Schimp., Annls Sci. Nat. Bot. Ser. W, **6**: 148, 1836.
Bryum erythrocarpoides Schwaegr., Sp. Musc. Suppl. **1**(2): 100, 1816.
B. erythrocarpum Schwaegr., Sp. Musc. Suppl. **1**(2): 100, 1816.
B. gedeanum Bosch. & Lacey, Bryologia javanica **1**: 147, t. 120, 1860.
B. erythropilumm Fleisch., Musci Fl. Buitenzorg **2**: 553, 1904.
Webera rubripilla Dixon, Farlowia **1**: 32, 1943.

Plants small to robust, glossy, less than 1 cm high, sometimes more than 5 cm. Leaves lanceolate, 3 x-0.8-1 mm in size, laminal cells elomgated hexagonal, costae strong, reddish brown, long excurrent, upper lamoinal cells narrlwly rhomboid to prosenchymatous, variavle, 10-12 um wide and 70-100 µm long, basal laminal cells short rectangular to quadrate, 20 µm in diameter. Plants dioecious.Male and female plants are not differentiated. Perigonia bud like, perichaetial leaves similar to the normal leaves. Sporophytes terminal, seta erect, very variable in height measure 2-4 cm long, capsules sub-pendulous, cylindric to pyriform with short conical neck. Peristomes perfect.
Status: Medium.
Habitat: Rocks.
Distribution: Nepal (W, E, 350-4850 m): Dang (610 m), Sankhuwasabha (310 m); Japan, Java and Papua New Guinea.
Remarks: Previously, this was reported at an altitude of 4850 m, east Nepal and ans is a new record to the Himalaya (Higuchi and Takaki, 1990). This is common in the tropical to warm temperate regions.

2.7. Bryum coronatum Schwaegr., Sp. Musc.Frond., Suppl. **1** (2): 103, 1816; Mitt, J. Proc. Linn. Soc. London*:* 69, 1959; Higuchi & Takaki in Watanabe & Malla, Crypt. Him. **2**: 136, 1990; Kattel & Adhikari, Mosses Nep.: 14, 1992; Pradhan, Mats. Checklist Bryo. Nep.: 29, 2000b; Pradhan, J. Nat. Hist. Mus. **21**: 51, 2002; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 24, 2007b; Pradhan & Joshi, Nep. J. Pl. Sci. **2**: 31, 2008a; Pradhan & Joshi, J. Nat. Hist. Mus. **23**: 21, 2008b.

Bryum gracilifolium Muell. Hal., Linnaea **38**: 390, 1875.
B. microbalanum M.A. Cardenas, Rev. Bryol. **36**: 112, 1909.

Crown moss (Eng.).

Plants small, dark green to bright green, up to 2 cm high forming loose tufts. Leaves 1-3 mm long, spreading and somewhat contorted when dry, erect spreading when wet, ovate to oblong lanceolate, apices acuminate, margin entire recurved below, costa long excurrent, broad reddish brown at the base, cells rhomboidal, thin walled, 55-60 µm long at the apical region and short rectangular at the base. Setae apical, erect but arcuate at the tip, red to purple, 10 to 30 mm long, capsule 1-2.5 mm long, dark red, pendent, oblong-cylindrical with wide mouth. Peristome reddish, densely papillose, spores numerous, spherical, 8-10 µm in diameter.
Status: Most common
Habitat: Burnt wood and logs, exposed brick wall, rocks and soil.
Distribution: Nepal (W, C, E, 170-900 m.): Bardia (220240 m), Dang (630-900 m), Kaski (900 m), Chitwan (150-350 m), Makwanpur (490-500 m), Kavre (800 m), Morang (170 m), Sunsari (300 m); America, Australia, Bhutan, Central & South Africa, China, Colombia, Indian Subcontinent, Japan, Java, Peru, Philippines, Malaysia, New Zealand, Oceania, Sri Lanka, Taiwan and Thailand.
Remarks: Cosmopolitan, tropical to warm temperate parts, often disturbed areas like burnt sites, soil, logs and rocks.

2.8. Bryum dichotomum Hedw., Spec. Musc. 183, 1801; Higuchi & Takaki in Watanabe & Malla, Crypt. Him **2**: 136, 1990; Kattel & Adhikari, Mosses. Nep.: 14, 1992; Pradhan, Mats. Checklist Bryo. Nep.: 29, 2000b; Pradhan & Shrestha, Proc. Int. Seminar on Mountain-Kath: 552, 2003; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 24, 2007b; Pradhan & Joshi, J. Nat. Hist. Mus. **23**: 21, 2008b.

Bryum bicolor Dicks., Pl. Crypt. Brit. **4**: 16, 1801.
B. remotifolium Hampe, Linnaea **32**: 131, 1863.

Bicoloured Bryum (Eng.).

Plants small, yellowish green, 2 mm high. Stem erect with tufted rhizoids at the base, stem epidermal cells rectangular. Leaves erect and spreading when wet, broad ovate to ovate-lanceolate, 1-1.5 mm long with acute apex and entire margin is recurved below, costae short to long, excurrent, apical cells elongate-rhomboidal, thick walled, up to 60 µm long, basal short quadrate to short rectangular, 15-30 µm long. Plants dioecious, setae purplish red, 5-10 mm long, capsules dark red to purplish, pendent, obovate to oblong, 1-3 mm long with short, thick neck, opercula 0.5 mm long, conic apiculate, teeth yellowish brown, spores small, spherical and 10-12 µm in diameter.
Status: Rare
Habitat: Exposed open land.

Distribution: Nepal (W, C, 500 - 4600 m.): Kaski (800 m), Makwanpur (1000 m), Dhanusa (500 m); Africa, Asia, Australia, Brazil, Canada, Central America, China, Colombia, Ecuador, India, Macaronesia, Malaysia, New Zealand, Papua New Guinea and Turkey.
Remarks: Widely distributed in tropical to alpine region (Ochi, 1980; Ochi & Ochyra, 1986).

3. Pohlia Hedw., Sp. Musc. Frond: 171, 1801.

Plants small to medium, dull green or glossy, form loose tufts on soil and barks. Stems erect; few branches by innovations, central strand present. Leaves usually crowded distally, erect to erect-appressed when dry, erect-spreading when wet, lanceolate, ovate to oblong-lanceolate, acute to acuminate; margin plane and reflexed below or near apex, entire to serriated at the apical region, costa single, subpercurrent, laminal cells at the upper and median regions oblong-hexagonal to rhomboidal, perichaetial leaves often differentiated, larger and elongate. Setae elongate, smooth, capsule inclined, oblong to short or long cylindrical-pyriform, opercula conic to conic-apiculate, peristome well developed and double, endostome usually lightly papillose, calyptrae cucullate, smooth and naked. Spores spherical and lightly papillose.

3.1. Pohlia flexuosa Hook., Icon. Plant. Rar. **1**: 19, 1836; Pradhan & Joshi, J. Nat. Hist. Mus. **23**: 22, 2008b.

Pohlia leucostoma (Bosch & Lacey) Broth., Naturl. Pfl. **1**(3): 552, 1903; M. Fleisch., Musci Fl. Buitenzorg **2**: 514, 1904; Nog. & Z. Iwats. in Ohashi, Fl. E. Him. **3**: 262, 1975; Higuchi & Takaki in Watanabe & Malla, Crypt. Him. **2**: 139, 1990; Kattel & Adhikari, Mosses. Nep.: 18 1992; Pradhan, Mats. Checklist Bryo. Nep.: 33, 2000a; Pradhan, J. Nat. Hist. Mus. **19**: 65 2000b; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 24, 2007b.

Plants small, bright green, forming tufts. Stems erect, 2-3 cm long. Fertile stem short with upper leaves forming distinct tufts which are longer than leaves of sterile plants. Leaves on sterile plants triangular-lanceolate up to 2.5 mm long, margin plane at the basal region and slightly dentate above, apex acute, costae excurrent ending in apex. Apical laminal cells narrow, 5-8 x 65-80 µm in diameter, basal cells slightly wider and marginal cells slightly elongated than middle cells. Plants dioecious. Setae long, reddish green, 2-3 cm long, capsules ovoid to pyriform, inclined to horizontal, sometimes pendulous, peristomes double. Oval orange gemmae reported in the upper axil of leaf and yellowish green vermicular gemmae on lower leaf axils.
Status: Rare
Distribution: Nepal (C, E, 550-3400 m.): Kavre (900-1000 m), Sankhuwasabha (1000 m); Bhutan, India, Indonesia, Japan, Hawaii and Southeast Asia.
Remarks: Oval orange gemmae reported at the upper leaf axil and yellowish green vermicular gemmae at lower leaf axil (Ochi, 1985).

4. Rhodobryum (Schimp.) Limpr., Laubm.deutschl. Osterreichs. Schweiz. **2**: 444 1892.

Plants stoloniferous, normally large and conspicuous. The well developed leaves form a rosette at the top. Lower leaves small to vestigial but terminal leaves larger, spathulate with strong costa, percurrent or excurrent, margin dentate above with or without unistratose border. Plants dioecious. The male and female organs born terminally in the apical rosette. Sporophytes usually more than one, usually 5 or more, setae long, capsules ovoid-cylindrical, pendulous or horizontal, neck with stomata, annulus of large cells, outer and inner peristome well developed, papillose, teeth with distinct lamellae, redish brown to yellowish in colour. Spores smooth or lightly papillous.

Of the 36 species worldwide, Mohamed (1984) reduced it into 20 species of them seven species are found in Asia. Nepal has four species, two are described in the present investigation.

Key to the species

1. Plants robust; leaf margin dentate; teeth two ranked ……..…. **1**. *Rhodobryum giganteum*
   Plants medium; leaf margin toothed; teeth one ranked ……..……..…. **2**. *R. roseum*

4.1. Rhodobryum giganteum (Schwaegr.) Par., Ind. Bryol.: 1116, 1898; Nog. *et al.*, Bull. Nat. Sci. Mus. **9** (3): 308, 1966; Chopra, Taxo. Ind. Mosses, Bot. Monogr. **10**: 214, 1975; Mohamed**,** J. Hattori Bot. Lab. **55**: 282-284, 1984; Kattel & Adhikari, Mosses Nep.: 18, 1992; Pradhan, Mats. Checklist Bryo. Nep.*:* 30, 2000a; Pradhan & Joshi, J. Nat. Hist. Mus. **23**: 22, 2008b.

Mnium giganteum Schwaegr., Spec. Musc. Suppl. **2**(2): 20, 158, 1826.
Bryum giganteum (Schwaegr.) Arnott., Mem. Soc. Linn. Paris **5**: 279, 1827; Mitt., J. Proc. Linn. Soc. Suppl. **1:** 75, 1959; Pradhan, J. Nat. Hist. Mus. **19**: 64, 2000b.

Plants robust with erect stems up to 6 cm high arising from the far creepinig underground stolons, stems tomentose at the base and give rosette of leaves at the top. Leaves spathulate, bright green, large up to 2 cm long and 5-6 mm wide, margin strongly dentate and biseriate, apex pointed, costae strong wide at the base, percurrent end just below the apex, in section central strands poorly developed in costa. Laminal cells hexagonal, lacking steroids. Plants dioecious, male and female plants not differentiated. Sporophytes arise one to several from the centre of rosette, seta 6 cm long, erect, capsule cylindrical, 9 mm long, horizontal or pendulous, peristome well developed (Fig. 42).
Status: **Type** as *Bryum giganteum,* Hooker, Nepal (G-Hedwig-Schwaegr.)
Lectotype: *Mnium giganteum,* Br. G. Hooker Nepaul (G-Hedwig-Schwaegr. Syntype)
Nepal, leg. Wallich 239 (BM!-Hooker)
Habit: Soil, rotton logs, tree trunks.
Distribution: Nepal (C, E, 1000-2700 m): Chitwan (1000 m); Bhutan, Burma, China, Formosa, India, Japan, Madagascar, Malaysia, Philippines, Sri Lanka, Sumatra, Taiwan and Thailand.
Remarks*: Rhodobryum giganteum* is the largest of all the Asian grnus where the leaves may attain a length of 2 cm. This species is easily recognised by its large size and biseriate teeth on the upper

margin. This species is widely distributed in tropical to temperate region of Nepal.

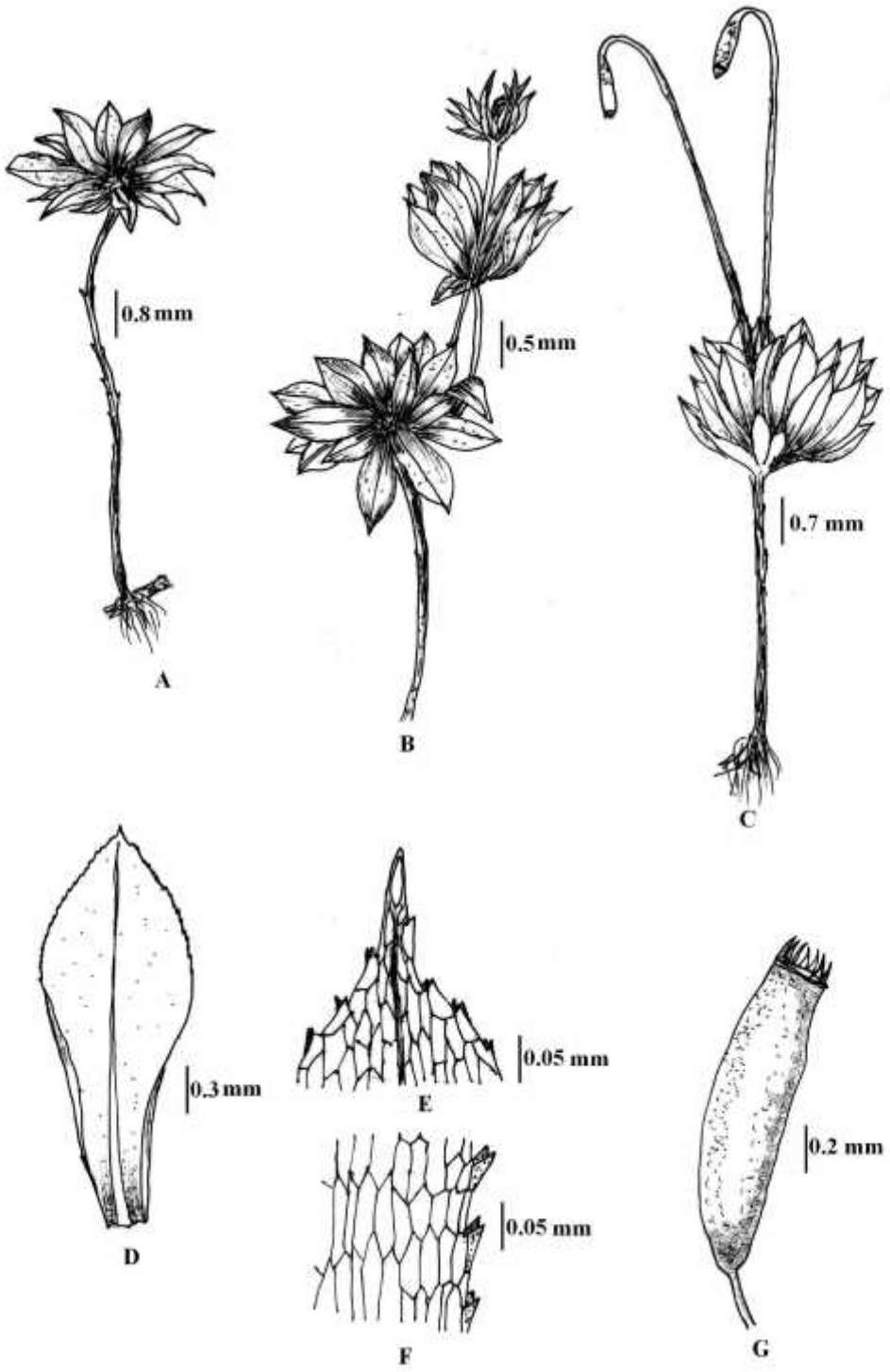

Fig. 42. *Rhodobryum giganteum* (Schwaegr.) Par. (Pradhan, Pn 488). A. vegetative plant, B. branch with subapical innovations, C. a fertile plant, D. leaf, E. apical portion of the leaf, F. marginal and middle laminal cells, G. capsule.

4.2. Rhodobryum roseum (Hedw.) Limpr., Laubm**.** Deutschl. **3**: 444**,** 1892**;** Nyholm, Mosses Fenn. Mosses **1**: 259, 1954; Nog. *et al.*, Bull. Nat. Sci. Mus. **9** (3): 308, 1966; Gangulee, Mosses E. Ind. & Adj. Reg. **4**: 1019, 1974; Kattel & Adhikari, Mosses Nep.: 18, 1992; Pradhan & Joshi, J. Nat. Hist. Mus. **23**: 22, 2008b.

Mnium roseum Hedw., Sp. Musc. : 1801.
Pohlia rosea (Hedw.) Brid., Bryol. Univ. **2**: 817, 1827.
Bryum macrorosula C. Muell.in Broth., Nat. Pfl.ed. 2. **10**: 404, 1924.
B. roseum (Hedw.) Crome, Samml. Deutschl. Laubm.: 47, 1803; Mitt., J. Proc. Linn. Soc. Suppl. **1**: 75, 1959.

Rose Moss; Bryum Roseum (Eng.).

Plants erect develoved from underground stolons (primary stem). Secondary stems with distinctive rosette of translucent leaves at the tips. Leaves with creeping stem small and scale like. The rosette may have 18-22 large leaves which forms an impression of small green rose of 10-12 mm. Leaves 4.5-5 mm long with pointed tips, margins recurved about half a way up and denticulated towards the leaf-tips, costae excurrent extending to the leaf-tips. Laminal cells hexagonal, 45 µm in diameter. Plants dioecious, sporophytes terminal surrounded by rosette of leaves. Setae apical, reddish brown 4 cm long, capsule brown, pendulous, oblong to cylindrical with inconspicuous neck and 5.2 mm long .
Status: Rare
Habitat: Soil covered rocks and humus soil.
Distribution: Nepal (C, 1000-4000m): Makawanpur (1000 m); Alaska, Canada, China, Europe, India, Japan, Korea, North America, Russia and Turkey.
Remarks: In Asia this species is restricted to the subalpine zone (Mohamed, 1984).

5.2.3.3. FISSIDENTALES

Plants erect or ascending. Leaves in a single plane, boat shaped and half clasping the stem, costae distinct, cells small and mostly isodiametric. Plants acrocarpous or pleurocarpous, setae elongate, capsule ovate, erect or curved, operculum and peristome well developed.

5.2.3.3.1. FISSIDENTACEAE

Plants autoecious, dioecious or polyecious, acrocarpous or pleurocarpous, widely distributed in the tropical region to the high mountains, occur on soil, rocks, epiphytes on tree bark and few in water. This family with typical leaf form has well defined mosses.

Fissidentaceae is one of the largest families of mosses which is widely accepted being included into a single genus, *Fissidens* Hedw. Gangulee (1971) had mentioned three more minor genera (*Simplicidens* Herz., *Moenkemeyera* C. Muell. and *Fissidentella* Cardot) in his book.

1. Fissidens Hedw., Sp. Musc. Frond. 1801.

Plants minute to fairly large, green to dark green or reddish brown, saxicolous, lignicolous or aquatic. Stems erect, simple or irregularly branched; rhizoids basal or axillary, with or without axillary hyaline nodules; central strand present or absent. Leaves in two rows, alternate and complanate and consist three parts: the vaginant or sheathing laminae, the apical laminae and dorsal laminae; costae percurrent or excurrent, rarely indistinct or lacking (*Fissidens nymanii);* limbidia usually developed in varying degrees or lacking, leaf cells variable, smooth, mammillose or pluripapillose, irregularly hexagonal to rounded and isodiametric or elongate. Setae long sometimes very short to immersed, capsules erect, symmetrical or inclined, curved and asymmetrical; annuli absent; opercula conic, short to long rostrate; peristome single, red to reddish brown, upper portion divided into two spirally thickened or articulate filaments, calyptrae cucullate. Spores small, spherical and smooth to finely papillose.

The genus *Fissidens* contains both terrestrial and aquatic species, about 900 species worldwide (Wijk *et al.,* 1962; Imura and Iwatsuki, 1988; Iwatsuki *et al.,* 1999). Nepal has the record of 49 species so far (Pradhan, 2000a). Fourty-two taxa are described in this investigation.

Key To The Species

1 Plants dioecious …….. 2
Plants monoecious ……..……. 15

2. Plants semiaquatic; dark green…….……...… 3
Plants terrestrial; light green ……..…… 4

3. Leaves stiffs and no change when dry; costae percurrent …… **34**. *Fissidens strictus*
Leaves not stiff and crisped when dry; costae excurrent …… **30**. *F. plagiochiloides*

4. Plants small, less than 5 mm long ……. 5
Plants medium, more than 10 mm long …….……6

5. Plants small, 0.3-0.5 mm long; leaf pairs 1-3; capsule horizontal …….. **12**. *F. curvatoxiphioides*
Plants more than 5 mm; leaf pairs 5-20; capsule terminal ……..……7

6. Limbidium present …….…….……. 8
Limbidium absent ……..……..18

7. Plants 10-12 mm long; capsule brown, horizontal …….. **11**. *F. curvato-involutus*
Plants 4-6 cm long; capsule orange erect ……..… **1**. *F. anomalus*

8. Limbidium present around leaves……..……. 9

Limbidium restricted to sheathing lamini ……...…….……19

9. Leaves 2 mm or more ……. 10
Leaves less than 1.5 mm long ……..…… **36**. *F. subpalmatus*

10. Leaves narrow lanceolate with acute apex; crisped when dry……...……..11
Leaves broadly ovate, strongly contorted when dry ……..….. **5**. *F. bryoides*

11. Leaf cells smooth, never papillose ……..…….... **13**. *F. diversifolius*
Leaf cells papillose ……..…….. 12

12. Laminal cell with single large papilla ……...……..… **41**. *F. virens*
Laminal cells multipapillae …… 13

13. Laminal cells qudrate to hexagonal, 3.5-10 µm pluripapillose ..... **26** *F. minutus*
Laminal cells rounded to hexagonal, 8 µm long, multipapillose ……..……..…..… 14

14. Laminal cells with multiple and punctuate papillae ……..... **6**. *F. ceylonensis*
Laminal cells round-hexagonal with chlorophyllous multipapillae ..... **18**. *F. intromarginatulus*

15. Leaves more than 2 mm long; axillary hyaline nodules absent …….. 16
Leaves less than 2 mm; axillary hyaline nodules present ……..…….. 21

16. Leaf margin at the apical region crenulate, cells markedly mamillose ……..…… 17
Leaf margin serrulate; laminal cells partially mamillose ……....… **28**. *F. nobilis*

17. Plants yellow to brownish; setae reddish brown; capsule terminal……..…… **19**. *F. involutus*
Plant dark green, setae orange red, capsules horizontal to the setae …….….. **40**. *F. taxifolius*

18. Leaf margin crenulated with cell projection, stem smooth ……...…… **27**. *F. mittenii*
Margin finely serrulate, stem tip zig zag ……..…. **42**. *F. zippelianus*

19. Laminal cells round-hexagonal, moderately thick walled ……...…….…….. 20
Laminal cells round, isodiametric ……..….. **24**. *F. microcladus*

20. Leaves bright green with ripple appearance …….…….……. **20**. *F. javanicus*
Leaves dull green, not rippled ……..…….. **21**. *F. kalimpongemnsis*

21. Plants 3-6 mm long, 12 -14 pairs of leaves……..……..…..… **32**. *F. robinsonii*
Plants size variable, leaf pairs variable ……..……..…… 22.

22. Axillary hyaline nodules absent ……..……...…33

Axillary hyaline nodules present……..…….……..….23

23. Costae percurrent and excurrent ……..…….……...…. 24
Costae excurrent …….……..……..…… 25

24. Costae excurrent end up to the acute apex; margin crenulate at the apical region ……..……26
Costae short excurrent, margin entire throughout ……..…. **3**. *F. biformis*

25. Plants small, upto 3 mm long; peristome teeth bright orange ……...…… **22**. *F. laxus*
Plants more than 5 mm; peristome yellowish brown ……..…….. **29**. *F. oblongifolius*

26. Plants more than 7 mm long, sporophyte terminal …… **4**. *F. bryoides*
Plants less than 6 mm mm long; sporophyte lateral…….……. 27

27. Sheathing lamini very unequal ……..…..….. **12**. *F. curvato-xiphioides*
Sheathing lamini equal …… . …….....28

28. Plants more than 5 mm long; leaves broad about 2 mm long …….…….……..… 29
Plants small, 2 mm long; leaves linear lanceolate more than 2 mm long ….. . **35**. *F. subbryoides*

29. Plants 5-8 mm long; leaves 1.6 mm long …….…....…….. **16**. *F. geppii*
Plants small, less than 8 mm; leaves 1-1.4 mm long ……..…..…… 30

30. Laminal cells qudrate to hexagonal, 3.5-10 µm pluripapillose ..... **26**. *F. minutus*
Laminal cells rounded to hexagonal, 8 µm long, multipapillose ……..……..… 31

31. Laminal cells with multiple and punctuate papillae ……..……..……. **6**. *F. ceylonensis*
Laminal cells round-hexagonal with chlorophyllous multipapillae ……..……..…….. 32

32. Plants with 16-28 pairs of leaves; leaf margin crenulated ..... **38**. *F. sylvaticus var. auriculatus*
Plants with 32-34 pairs of leaves; leaf margin entire ……..... **39**. *F. sylvaticus var. calcuttense*

33. Laminal cells isodiametric; central strand not different …….……..… 34
Laminal cells round-hexagonal, central strand well differentiated. …..…. **17**. *F. gymnogynous*

34. Leaves narrowly lanceolate, 2-2.5 x 0.3 - 0.4 mm long ……....…. **15**. *F. geminiflorus*
Leaves ligulate-lanceolate, 2 x 0.4 mm long …….....…. **32**. *F. robinsonii*

1.1. **Fissidens anomalus** Montin, Ann. Sc. Nat. Bot. ser. **2**, 17: 252, 1842; S. Hatt. in Hara, Fl. E. Him. **3**: 544, 1966; Gangulee, Mosses E. Ind. & Adj. Reg. **2**: 555-557, 1971; Nog. & Z. Iwats. in Ohashi, Fl. E. Him. **3**: 246, 1975; Higuchi & Takaki in Watanabe & Malla, Crypt. Him. **2**: 122, 1990; Kattel & Adhikari, Mosses Nep.*:* 31-32, 1992; Pradhan, Mats. Checklist Bryo. Nep.: 41,

2000a; Li and Z. Iwats., Moss Fl. China **2**: MBG press: 7, 2001; Pradhan & Joshi, Our Nature **4** (1): 61, 2006; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 26, 2007b.

Plants green to dark green, 4-6 x 4-5 mm in size with expanded leaves and gregarious habit. Stem without axillary hyaline nodules, central strand differentiated. Leaves 15–53 pairs, upper leaves much larger and densely arranged, middle and upper leaves narrowly lanceolate, 3-3.7 × 0.8 mm, distinctly crispate when dry, narrowly acute apex; dorsal laminal base rounded, rarely short-decurrent; sheathing laminae 1/2-3/5 of the leaf length, equal or slightly unequal; costa stout, excurrent; margin irregularly dentate near leaf apex, finely crenulate to serrulate, smooth, apical and dorsal laminal cells quadrate, rounded to irregularly hexagonal, 7-11 µm long, distinctly mammillose and obscure; apical laminae 1 celled thick. Plant monoecous. Male inflorescences terminal or lateral. Female inflorescences axillary. Perichaetial leaves ovate-lanceolate. Setae short, 1.5-2.0 mm long, smooth; capsule erect, symmetrical, deep orange or reddish, operculum long rostrate, calyptrae campanulate, spores light brown, spherical and 15-22 µm in diameter.

Status: Rare

Habitat: Soil

Distribution: Nepal (C, 450-2850 m): Nuwakot (450 m); Burma, China, India, Indo China, Indonesia, Java, Philippines, Sri Lanka, Thailand and Vietnam.

1.2.*Fissidens asplenioides Hedw., Spec. Musc.: 156, 1801; Scoot *et al*., Mosses S. Aust.: 90, 1976; Pursell *et al*., Bryobrothera **1**: 49-50, 1992; Pradhan, J. Nat. Hist. Mus. **21**: 51-52, 2002; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 26, 2007b; Pradhan & Joshi, Nep. J. Pl. Sci. **2**: 31, 2008a.

Plants large, bright green densely growing and gregarious habit. Stems 3-5 cm high with 26-38 pairs of leaves. Leaf tip curled inward when dry. Leaves dark green, lanceolate, 2 x 0.4-5 mm, apex pointed, margin crenulated at the apical region, limbidium absent, costa percurrent, slightly bent above the veginant lamina, sheathing lamina 2/3 of the leaf length, basal lamili at the base round, axillary hyaline nodules lacking, laminal cells quadrate to hexagonal, mamillose, 7 x 5 µm in diameter, cells at the basal region near costa larger, rectangular, light green, 9 x 12 µm in diameter. Setae erect, short, 4-5 mm long, capsule brown, very short, about 0.5-1 mm long, opecrulum 1 mm. (Fig. 43).

Status: Rare**.**

Habitat: Soil covered rock.

Distribution: Nepal (W, 320-400 m): Dang (320-610 m); Australia, South India and Sri Lanka. Pursell *et al.* (1992) described it as a Pantropical in distribution.

Remarks: This species is distinguished by having percurrent costa bent just above the vaginant lamina. It was originally described as *Hypnum asplenoides* (Pursell, 1986). New record to Nepal.

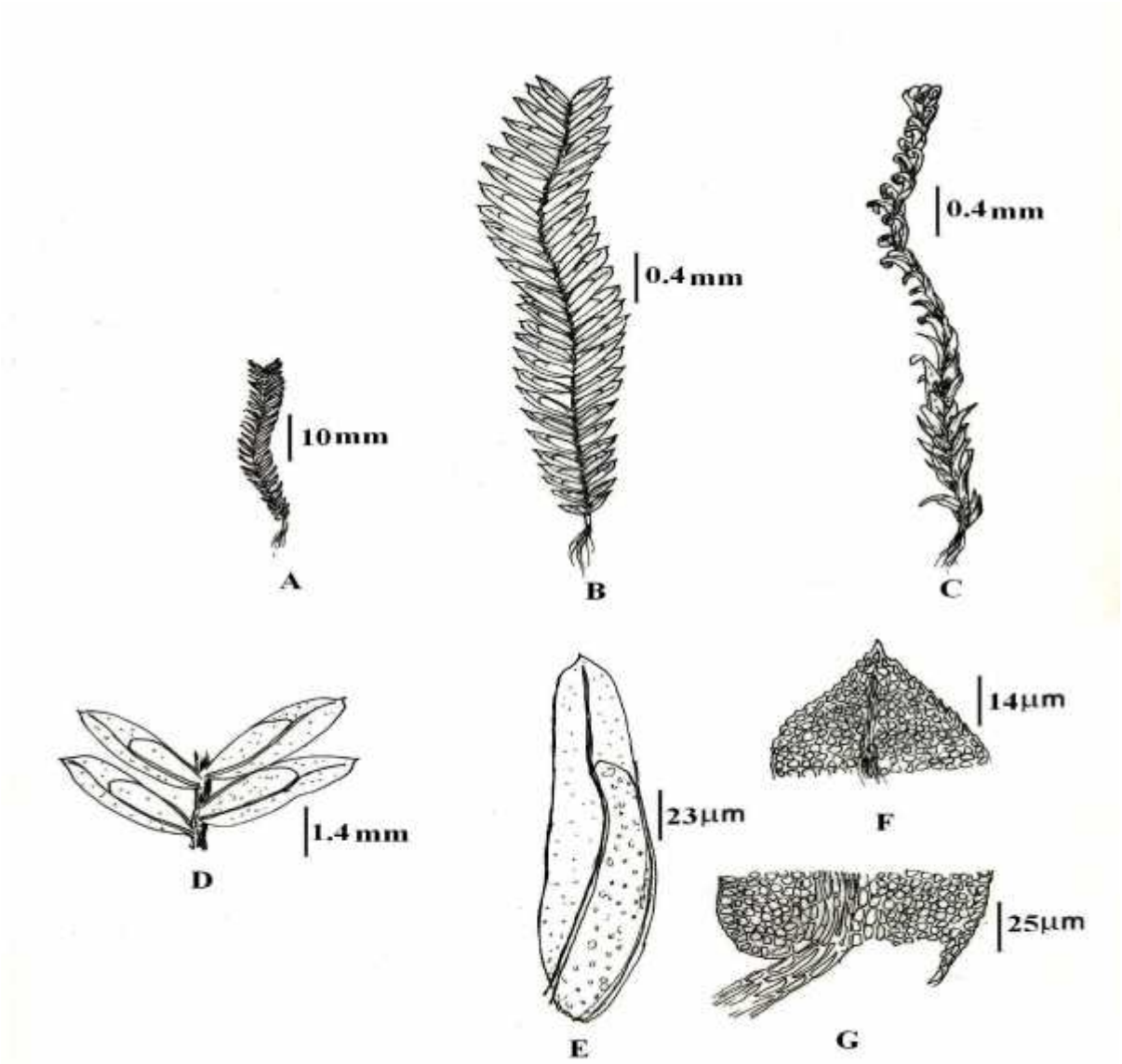

Fig. 43. *Fissidens aspleinoides* Hedw., A. Habit, B. The plant enlarged, C. A dry plant, D, a portion of stem with two pairs of leaves, E. Leaves, F. Apical portion of the leaf, G. basal portion of the leaf.

1.3. Fissidens biformis Mitt., J. Linn. Soc. Bot. Suppl. **1**: 141, 1859; Nog. & Z. Iwats. in Ohashi, Fl. E. Him. **3**: 246, 1975; Gangulee, Mosses E. Ind. & Adj. Reg. **2**: 483-484, 1971; Kattel & Adhikari, Mosses Nep.*:* 31, 1992; Pradhan, Mats. Checklist Bryo. Nep.: 41, 2000a; Pradhan & Joshi, Our Nature **4** (1): 62, 2006.

Fissidens xiphioides Fleisch., Hedwigia **38**: 125, 1899.
F. coorgensis Broth. in Rec., Bot. Surv. Ind. **1**: 316, 1899.

Plants small, 1-3 mm high with 4-6 pairs of leaves, grow mainly in mineral soil. Leaves narrowly oblong-lanceolate, 1.5-2 mm long and 0.2-0.3 mm wide gradually tapering to the acute tip, wider

sheathing laminal base and narrower dorsal laminal base, slightly contorted and curled when dry. Costa prominent, short excurrent ends into minute apices; margin entire, limbidium present all around, one row on dorsal and apical laminal region and wider in sheathing laminal region, leaf cell quadrate to hexagonal, 10-12 µm wide in apical region and larger towards the base (11 x 23 µm). Sporophytes terminal, setae erect, 5 mm long, capsules ovate-cylindrical, 4 x 0.3 mm, operculum conic, peristome normal.

Status: Rare

Habitat: Mineral soil.

Distribution: Nepal (E, 600-2000 m.): Dhankuta (990 m); Java, New Guinea, Philippines, Sri Lanka and South India.

1.2. Fissidens bryoides Hedw., Sp. Musc.: 153, 1801; Gangulee, Mosses E. Ind. & Adj. Reg. **2**: 469-471, 1971; Nog. & Z. Iwats. in Ohashi, Fl. E. Him **3**: 246, 1975; Kattel & Adhikari, Mosses. Nep.: 31, 1992; Pradhan, Mats. Checklist Bryo. Nep.: 41, 2000a; Pradhan & Joshi, Our Nature **4** (1): 62, 2006; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 26, 2007b; Pradhan & Joshi, Nep. J. Pl. Sci. **2**: 31, 2008a.

Dicranum bryoides (Hedw.) Sw., Monthl. Rev. **34**: 538, 1801.
Fissidens schmidii C. Muell., Bot. Zeit. **11**: 18, 1853.
Schistophyllum bryoides (Hedw.) Lindb., Musci Scand.:13, 1879.
Fissidens ciridulus (Sw.) Wahlenb., Gangulee, Mosses E. Ind. & Adj. Reg. **2**: 469-471, 1971.

Lesser Pocket-Moss (Eng.).

Plants bright green, 3 -7 mm high and 3.5 mm wide with expanded leaves. Stem with 8 pairs of leaves, curled slightly when dry; central strand present in the mature stem. Leaves oblong-lingulate, 2 x 0.6 mm in size, apex acute, margin entire, costae percurrent separating symmetrically the apical parts. Limbidium present all around the leaf but thick up to 4 rows in basal lamine at the base. Dorsal laminal region narrowinig at the base, sheathing laminal region occupy half the length of entire leaf and open type. Laminal cells at the apical region round to hexagonal, 8-10 µm in diameter, cells towards costae at the base large, elongate rectangular and 14-15 µm wide. Sporophytes at the apical region, setae reddish brown, 3-4 mm long, capsules erect, 0.5 x 0.3 mm in diameter, operculum long rostrate, peristome teeth dicranate. Spores round, smooth and 13-17 µm in diameter (Fig. 44).

Status: Common

Habitat: Bark and soil.

Distribution: Nepal (W, E, 200-2850 m): Banke (200 m), Dang (410 m); Africa, Caucasus, China, Europe, India, Japan, Java, Malaysia, Myanmar, North and South America, New Guinea, Philippines, Siberia, Sri Lanka and Taiwan.

Remarks: The *Fissidens bryoides* complex is very variable. It is quite difficult to identify their varieties.

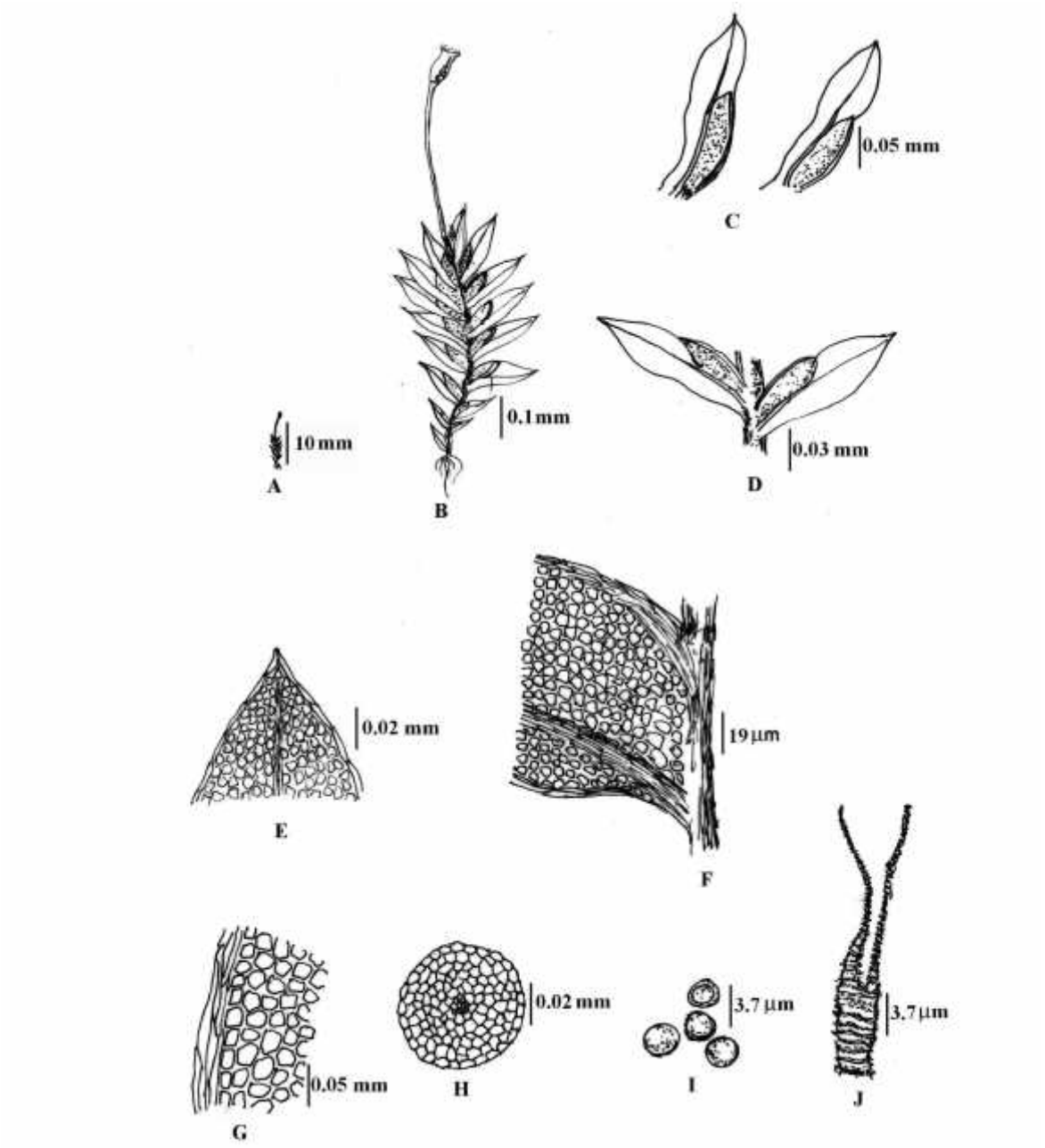

Fig. 44. *Fissidens bryoides* Hedw., A. habit, B. a fertile plant enlarged, C. leaves, D. a portion of stem and a pair of leaf, E. apical portion of the leaf, F. basal portion of the leaf showing limbidium and a portion of stem, G. limbidium and marginal cells, H. cross section of the stem, I. spores, J. Peristome teeth.

1.5. Fissidens bryoides Hedw. subsp. **schmidii** *(*C. Muell.) Norkett, Gangulee, Mosses E. Ind. & Adj. Reg. **2**: 471-472, 1971; Higuchi & Takaki in Watababe & Malla, Crypt. Him. **2**: 123, 1990; Pradhan, Mats. Checklist Bryo. Nep.: 42, 2000a; Pradhan, J. Nat. Hist. Mus. **19**: 68, 2000b; Pradhan & Joshi, Our Nature **4**(1): 62, 2006; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 26 2007b.

Fissidens schmidii C. Muell., Bot. Zeit. **11**: 18, 1853.
F. hasskarlii A. Jaeger, B.S.G Naturw. Ges., **1874 -1875:** 89, 1876.

Plants yellowish green, gregarious in habit. Stems 3-5 mm long and 1-2 mm broad with expanded leaves. Leaves in 7 pairs, smaller towards the base. Plants strongly contorted when dry. Leaves ovate-lanceolate, 2 mm long and 0.5 mm broad in perichaetial leaves. Apex acute, margin smooth with limbidium, dorsal lamina gradually narrows down at the base, sheathing lamina unequal, closed type, costae percurrent, leaf cells quadrate to hexagonal, 8-10 µm in diameter, slightly elongated and larger towards costa at the base. Antheridia conspicuous in axils of leaves. Setae pale brown, 5-6 mm long, capsule inclined with the setae, urn 0.6 x 0.9 mm in size. Spores smooth, pellucide, 8-12 µm in diameter.
Status: Common
Habitat: Tree trunks, rocks and soil.
Distribution: Nepal (C, E, 200-2000 m): Kaski (800 m); Central Africa, Japan, Java, Malaysia, New Guinea, Pakistan, Philippines, Ryukiu and South India and Sri Lanka.

1.6. Fissidens ceylonensis Dozy & Molk., Ann. Sc. Nat. Bot. ser. 3, **2**: 304, 1844; S. Hatt. in Hara (ed.), Fl. E. Him. **1**: 544, 1966; Gangulee, Mosses Ind. & Adj. Reg **2**: 511, 1972; Gangulee, Mosses Ind., Bot. Monogr. **10**: 19, 1985; Higuchi & Takaki in Watanabe and Malla, Crypt. Him. **2**: 123, 1990; Kattel & Adhikari, Mosses. Nep: 31, 1992; Pradhan, Mats .Checklist Bryo. Nep.: 42 2000a; Li and Z. Iwats., Moss Fl. China **2**,. MBG Press*:* 9, 2001; Pradhan & Joshi, Our Nature **4** (1): 62, 2006; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 27, 2007b.

Fissidens intromarginatulus Bartr., Rev. Bryol. Lichénol. **23**: 242, 1954.

Ceylonese Phoenix moss (Eng.).

Plants small, yellowish green, simple or branched, 2-5 mm long, 2-1.5 mm wide with expanded leaves; prostrate and gregarious in habit. Axillary hyaline nodules weakly developed or absent; central strand not differentiated. Leaves in 7–20 pairs, oblong-lanceolate, 0.2-0.8 × 0.2-0.3 mm, apex acute; dorsal laminae base usually wedge-shaped, sheathing laminae 2/3 of the leaf length, equal to slightly unequal; costa lightly yellow, percurrent to slightly excurrent, margins entire, cells on apical and dorsal laminae quadrate to rounded-hexagonal, 7-8 µm long, pluripapillose, limbidia usually on the lower half of vaginant laminae. Plants autoecious. Setae 2-2.5 mm long, smooth, geniculate at base; capsules symmetrical, erect; cylindrical, 0.4-0.5 mm long; peristome 0.2 mm long, 32 µm wide, opercula rostrate, calyptrae mitrate, 0.3 mm long. Spores 11-12 µm in diameter.
Status: Common
Habitat: Soil, rarely on rocks.
Distribution: Nepal (C, E, 300-2100 m): Kaski (800 m), Sankhuwasabha (550 m), Dhankuta (300 m); Borneo, Burma, China, Indonesia, Java, Malaysia, Malay Pen, Moloccas, Myanmar, New Zealand, Philippines, Singapore, South India, Sri Lanka, Sumatra, Thailand and Vietnam.

1.7. Fissidens ceylonensis var. **simplex** (C. Muell.) Nork. in Gangulee, Mosses Ind. & Adj. Reg **2**: 514, 1972; Pradhan, Mats. Checklist Bryo. Nep.: 42, 2000a; Pradhan & Joshi, Our Nature **4** (1): 63 2006; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 27, 2007b.

Fissidens simplex C. Muell. in Par., Ind. Bryol., Suppl. **1**: 31, 1900.

This variety differs from *Fissidens ceylonensis* in having semi-limbidium completely bordering the sheathing lamina. The sheathing lamini of perichaetial leaves very unequal and wide open. Leaves up to 1 mm long and 0.2 mm wide.
Status: Rare
Habitat: Soil, rocks.
Distribution: Nepal (E, 550-1500 m): Sankhuwasabha (550 m); India, Java and Sri Lanka.

1.8. Fissidens crenulatus Mitt., J. Linn. Soc. London: 140, 1958; Gangulee, Mosses Ind. & Adj. Reg. **2**: 504, 1971; Li and Z. Iwats., Moss Flora of China **2**: MBG Press: 24, 2001; Pradhan & Joshi, Our Nature **4** (1): 63, 2006; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 26, 2007b.

Fissidens axilifolius Thwait. & Mitt., J. Linn. Soc., Bot. **13**: 325, 1873.

F. elmeri Broth., Leafl. Philipp. Bot. **2**: 652, 1909.

F. hueckii P. de la Varde, Rev. Bryol. Lichénol. **15**: 145, 1946.

F. sinensis (Rabenh.) Broth., Nat. Pflanzenfam. **1**(3): 356, 1901.

Plants small, light green forming dense tufts. Leafy stems rarely branched, 2-6 mm long, 1-1.5 mm wide; central strand not differentiated. Leaves in 6-15 in pairs, lanceolate, 0.5-1.0 × 0.2-0.3 mm, acute at apex; dorsal laminal base rounded to wedge-shaped; sheathing laminae, 1/2-3/5 of the leaf length, equal to slightly unequal; costae stout, percurrent; margins distinctly serrulate; cells of apical and dorsal laminae quadrate to rounded-hexagonal to elliptical-rectangular, 4-10 µm long, highly mammillose, thick-walled, limbidia often found on the lower half of sheathing laminae of middle to upper and perichaetial leaves. Plants autoecious. Perichaetial leaves slightly longer than stem leaves. Setae reddish brown, 2-5 mm long, capsules dark brown, cylindrical, erect or slightly bent, urns 0.3 mm long; opercula rostrate, 0.2-0.3 mm long; peristome teeth 0.1-0.2 mm long, 28-32 µm wide at base. Spores spherical, 9-15 µm in diameter (Fig. 45).

Status: Common, Type Nepal, Wallich *s. n.* (BM!)

Habitat: Rocks, on soil of forested slopes.

Distribution: Nepal (W, C, E, 175-600 m): Kanchanpur (190 m), Bardia (175 m), Chitwan (300 m), Parsa (200 m); Burma, China, India, Japan, Malaysia, Micronesia, New Guinea, Philippines and Vietnam

Remarks: This species is closely related with *Fissidens virens* due to having limbidium on sheathing laminae, but differs in plant size and laminal cells.

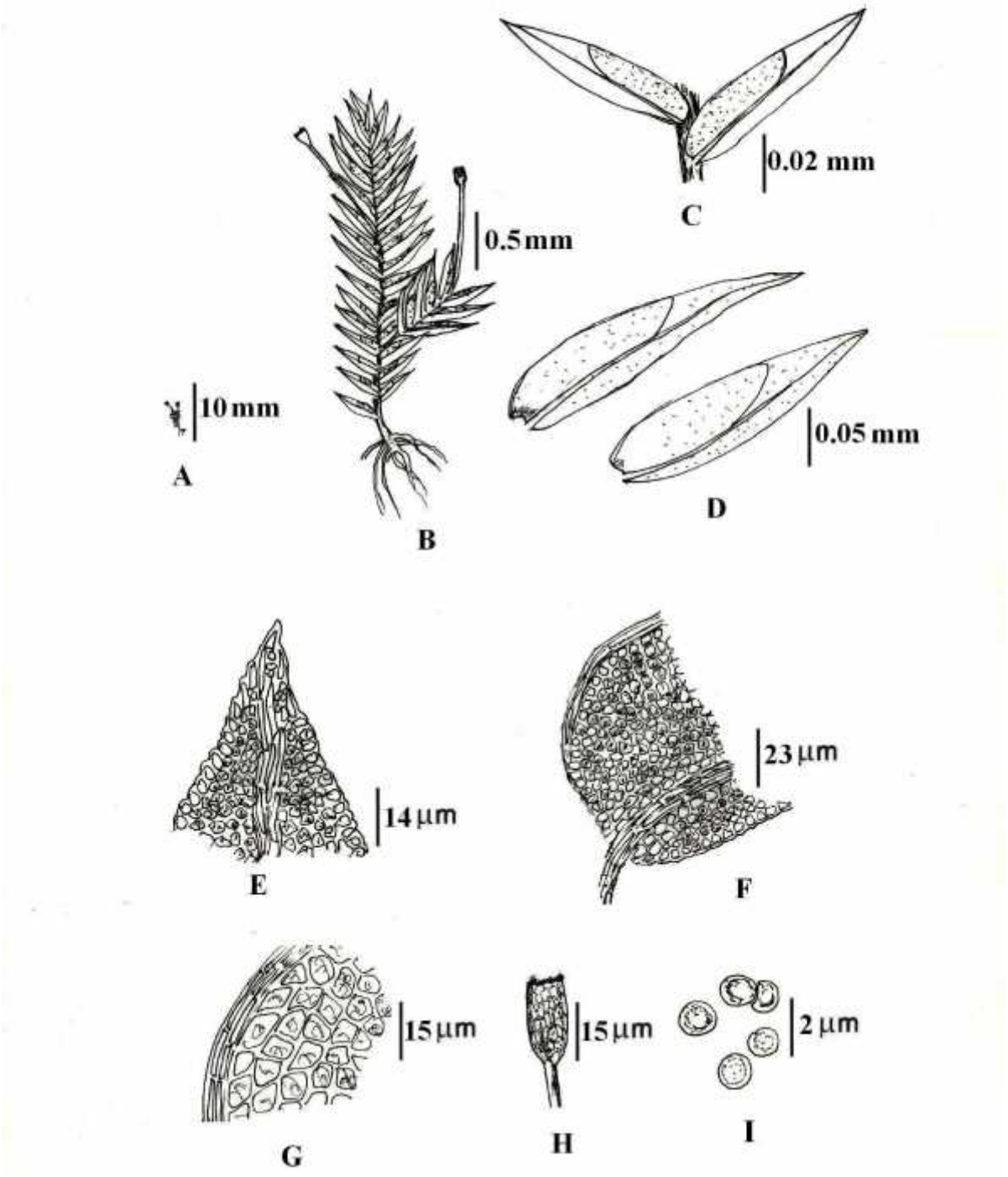

Fig. 45. *Fissidens crenulatus* Mitt. (Pradhan Br 84). A. habit, B. the plant enlarged, C. a portion of stem with leaves, D. leaves, E. apical portion of the leaf, F. basal portion of the leaf, G. a portion of the sheathing lamina with semilimbidium, H. capsule, I. spores.

1.9. Fissidens crenulatus Mitt. var. **crenulatus** Gangulee, Mosses E. Ind. & Adj. Reg. **2**: 504-506, 1972.

Plants small 5 x 1.5 mm in size with 15 pairs of leaves, leaves slightly curled when dry. Leaves oblong-lanceolate, 1.5 x 0.5 mm in size and slightly wide at the base and acute at apex. Sheathing lamini usually ½ of the length of the leaf, apical margin slightly serrulated by the projection of the marginal cells. Perichaetial leaves narrow and slightly longer. Setae terminal, erect, brown and 5 mm long, capsule oval, erect and 0.34 mm in diameter. Spores spherical and 9 -12 µm in diameter.

Status: Rare

Habitat: Soil.

Distribution: Nepal (W, E, 500-600 m): Dang (590 m), Sankhuwasabha (600 m); Burma, China, Japan, Myanmar, New Guinea, Philippines, South India, and Vietnam.

1.10. Fissidens crenulatus Mitt. var. **titalayanus** (C. Muell.) Gangulee, Mosses E. Ind. & Adj. Reg. **2**: 506-507, 1971; Pradhan & Joshi, Our Nature **4**(1): 63, 2006; Pradhan & Joshi, Nep. J. Pl. Sci. **2**: 31, 2008a.

F. titalayanus C. Muell., *Linnaea* **37**: 163 (1872).

Plants small, 2-6 x 2 mm in size with expanded leaves. Stems with 10 pairs of leaves, lightly curled when dry. Leaves oblong-lanceolate, 1.3x0.2 mm in size, costaeexcurrent, slightly flexuous, apical lamini equal, dorsal lamina narrowing at the base, sheathing lamina equal and closed type, Semilimbidium of 1-4 rows of cells present at the margin of sheathing lamina, margin corrugated with projected marginal cells, laminal cells rounded-hexagonal, mammillose, 6 -8 µm in diameter, elongated towards costal base. Plants monoecious. Setae terminal, orange red, 3-5 mm long, capsules brown, small, 0.8 mm long. Spores 9 - 45 µm in diameter.

Status: Common

Habitat: Soil

Distribution: Nepal (W, E, 300-600 m): Dang (290 m), Sankhuwasabha (600 m); India

1.11. Fissidens curvato-involutus Dixon in Not., Roy. Bot. Gard. Edinb. **19**: 279, 1938; Gangulee, Mosses E. Ind. & Adj. Reg. **2**: 548-549, 1971; Higuchi & Takaki in Watanabe & Malla, Crypt. Him. **2**: 123, 1990; Kattel & Adhikari, Mosses Nep.*:* 31, 1992; Pradhan, Mats. Checklist Bryo. Nep.: 42 2000a; Pradhan & Joshi, Our Nature **4**(1): 63, 2006; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 27, 2007b.

Plants dark green found in damp habitat. Stems about 5- 10 mm long and 0.3 mm wide with 14 pairs of leaves, more crowded towards the apex and little distant towards basal region. Leaves curled and

zigzag when dry. Leaves ovate-lanceolate, 2 x 5 mm in diameter, apical lamini symmetrical, dorsal laminal base round, sheathing lamini occupy 2/3 of the entire leaf lengths, limbidium absent, margin entire or slightly crenulating at the apical region due to projecting out the marginal cells, cells quadrate to hexagonal, 10-12 µm gradually larger towards the basal region. Perichaetial leaves quite large. Setae erect, 10-12 mm long, capsules horizontal or bent more or less right angle to the seta, 1.5 x 0.5 mm in size with distinct apophysis. Spores small, brown with fine papillose and 18 µm in diameter.

Status: Common

Habitat: Damp soil

Distribution: Nepal (C, E, 175-3000 m.): Bardia (175 m), Palpa (300 m), Chitwan (140); Burma, India, Thailand and Vietnam.

1.12. Fissidens curvatoxiphioides Dixon & Verd., Arch. in Bot., **1**: 163, 1927; Gangulee, Mosses E. Ind. & Adj. Reg. **2**: 476-478, 1971; Pradhan & Joshi, Our Nature **4**(1): 63, 2006.

Fissidens subxiphioides Broth., Symb. Sin. **4:** 9, 1919.

Plants small. Male plants 0.52 x 0.36 mm with 1 to 2 pairs of leaves, grow at the base of female plants, measure 1 mm long with 3 pairs of leaves; Leaves 1.02 x 0.6 mm, broad at the sheathing laminal portion, sheathing lamina very unequal, much wider than the apical lamina, dorsal lamina ill developed not often reached the lower half of the leaf, leaf apex acute, limbidium all around the leaf one layer in thick, leaf cells elongated, quadrate-hexagonal at the apical region (25 x 8 µm), dorsal laminal cell is more rectangular with wavy wall which at the basal region are much elongated and narrow (30 x 4 µm), cells in the sheathing lamina near costa are elongated (45 x 7 µm); costae precurrent or excurrent. Plants autoecious. Setae terminal, 4-6 mm long, capsules almost horizontal, 0.4 x 0.3 mm in diameter, operculum companulate with short rostrum.

Status: Rare

Habitat: Soil

Distribution: Nepal (E, 600 m): Sankhuwasabha (600 m); China, Burma, Japan, and South India.

Remarks: This species recorded as the smallest *Fissidens* known yet.

13. Fissidens diversifolius Mitt., Musci. Ind. Or.: 140, 1859; Gangulee, Mosses E. Ind. & Adj. Reg. **2**: 492-494, 1971; Pradhan, Mats. Checklist Bryo. Nep.: 42, 2000a; Pradhan & Joshi, Our Nature **4**(1): 63, 2006; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 27, 2007b.

Fissidens plicatulus Thér., Monde Pl., sér. **2, 9**(45): 21, 1907.
F. diversifolioides Gangulee, Bull. Bot. Soc. Beng. **11**: 67, 1959.

Plants small, yellowish green, 4-5 mm high forming tuft. Stems with indistinct axillary hyaline nodules, central strand not differentiated. Leaves in 5-9 pairs; lower leaves small, distant, upper leaves much larger and more densely arranged, oblong-ovate, 1-1.5 × 0.2-1 mm, acute apex; vaginant laminae 2/3-4/5 the leaf length, unequal, margins almost entire, limbidia of upper leaves 1-2 cells wide, 2–3 cells wide on lower half, dorsal laminal base broadly wedge-shaped to rounded, costa

stout, ending a few cells below apex; cells of apical and dorsal laminae quadrate to irregularly hexagonal, 5-10 µm long, smooth, cells of vaginant laminae larger than those of apical and dorsal laminae. Plants autoecious. Setae 2.5-3.0 mm long, capsules erect or inclined, symmetrical; urns light brown, 0.4-0.6 mm long; opercula conic, 0.2 mm long. Spores hyaline, 22-34 µm in diameter.
Status: Rare
Habitat: Soil and rocks.
Distribution: Nepal (E, 550-600 m): Bhutan, Burma, China, India, Japan, Myanmar and South India.

1.14. Fissidens diversifolius Mitt. var. **rubricaulis** (Dixon) Nork. in Gangulee, Mosses E. Ind. & Adj. Reg.**2**: 494-495, 1971; Pradhan & Joshi, Our Nature **4**(1): 63, 2006; Pradhan & Joshi, Current Trends in Bryology in Nath & Asrhana in Nath & Asthana: 27, 2007b.

Fissidens rubricaulis Dixon, J. Bomb. Nat. Hist. Soc. **39**: 772, 1937.

Plants small, unbranched with orange-red stem up to 5-6 mm long and 1.5 mm wide. Leaves 7- 12 in pairs, smaller towards the basal region, not much crumpled when dry. Leaves 1 x 0.3 mm in size. Dorsal lamina narrowing down at the base and disappear at the point of leaf attachment, sheathing lamina unequal open type, margin entire, leaf cell round to hexagonal, 8 µm in diameter. Setae orange red, 5-6 mm long, and two to three develop from the same apical region. Capsules brown, pear shaped, 1-0.45 mm in diameter. Opercula conic, reddish brown. Spores light brown, 35-55 µm in diameter.
Status: Rare
Habitat: Soil.
Distribution: Nepal (E, 750 m): Sankhuwasabha (600 m); India.

1.15. *Fissidens geminiflorus Dozy & Molk., Pl. Jungh.: 316, 1854; Eddy, Malay. Mosses **1**: 73 1988; So, Mosses & Liverworts Hong-Kong **1**: 35, 1995; Z. Iwats. & T. Suzuki, J. Hattori Bot. Lab. **79**: 160, 1996; Li & Z. Iwats., Moss Fl. China **2**: MBG Press : 33, 2001.

Fissidens geminiflorus var. *nagasakinus* (Besch.) Iwats., J. Hattori Bot. Lab. **32**: 272, 1969.
Fissidens nagasakinus Besch., J de. Bot. (Morat) **12**: 292, 1898.

Fissidens irroratus Cardot, Beih. Bot. Centralbl. **19**(2): 99, 1905.

Twin Leaved Phoenix Moss (Eng.).

Plants dark green. 15-20 mm long and 3 mm broad with expanded leaves. Stems brown, prostrate, simple or branched, 8-42 mm long; axillary hyaline nodules often slightly differentiated, central strand not differentiated. Leaf apex and stem tips curled inward when dry. Leaves in 16–50 pairs, middle and upper leaves narrowly lanceolate, 2-2.5 × 0.3-0.4 mm, acute at apex; dorsal laminal base wedge-shaped, rarely rounded, vaginant laminae 2/3 of the leaf length, equal or slightly unequal; costa stout, percurrent ends three cells below, a row of cells at both sides of costa often enlarged, irregularly quadrate to rectangular, smooth, more or less pellucid, margins serrulate at the apical region, cells of apical and dorsal laminae quadrate to rounded-hexagonal, 7-13 µm long,

thick-walled, mammillose, cells isodiametric. Plants dioecious. Perichaetial leaves well differentiated (Fig. 46).

Status: Uncommon

Habitat: Boulder stones near water sources.

Distribution: **Nepal** (W, C, 300-400 m): Kailali (160 m), Chitwan (300 m), Parsa (200 m); China, Indonesia, Java, Japan, Malaysia, Philippines, Sumatra and Vietnam

Remarks: The vauchor No. Pn 203 has 26 -28 pairs of leaves. This species is recorded as new to Nepal.

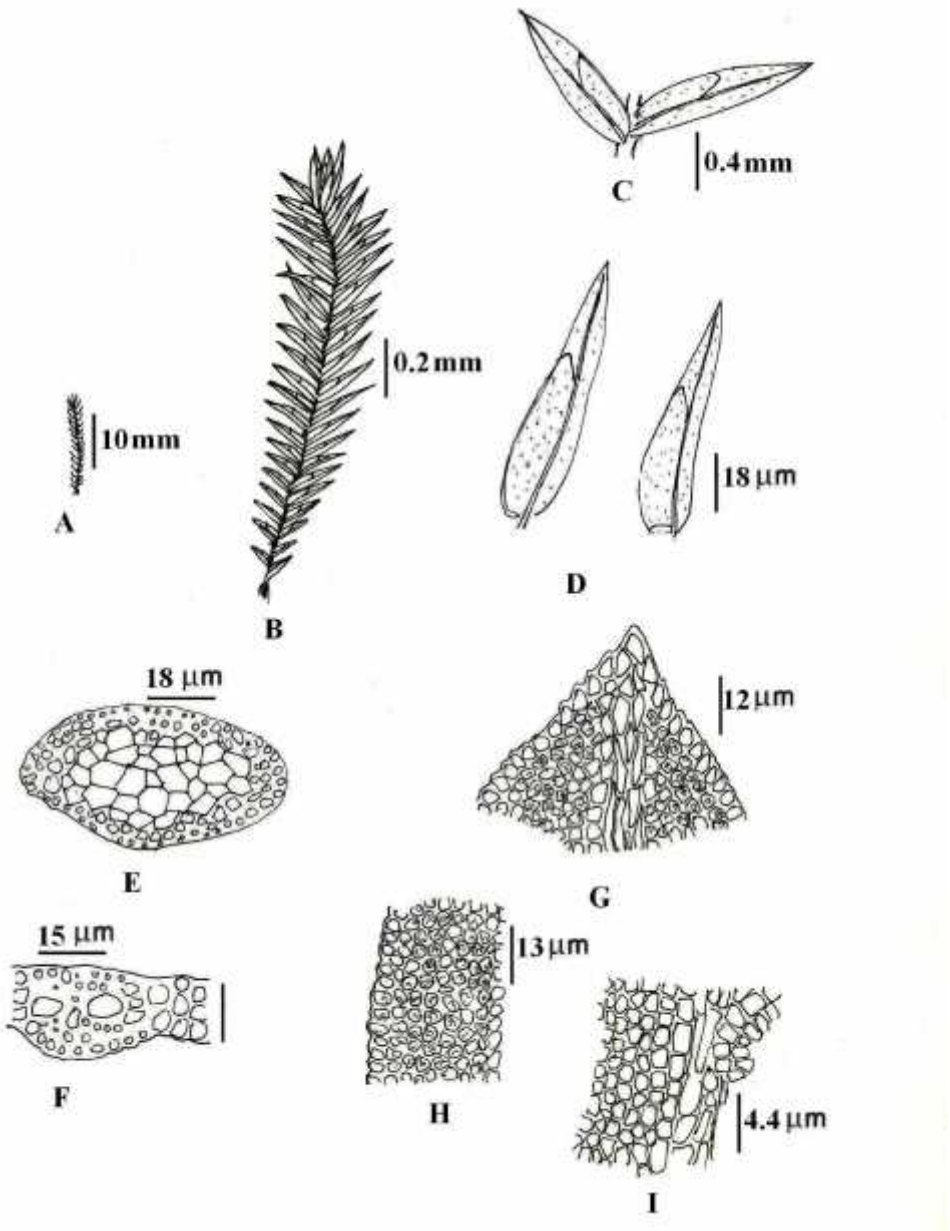

Fig. 46. *Fissidens geminiflorus* Dozy & Molk. (Pradhan NGS 413). A. habit, B. the plant enlarged, C. a portion of stem, D. leaves, E. Cross section of the stem, F. Transverse section of leaf, G. apical portion of the leaf, H. marginal region of dorsal lamini, I. cells near costa.

1.16. Fissidens geppii Fleisch., Musci. Fl. Buitenzorg **1**: 26, 1904; Higuchi & Takaki in Watanabe and Malla Watanabe & Malla, Crypt. Him. **2**: 123, 1990; Kattel & Adhikari, Mosses Nep.: 31, 1992; Pradhan & Joshi, Our Nature **4** (1): 64, 2006; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 27 2007b.

Plants small, unbranched, 3-8 mm long, 1.8–2.2 mm wide with expanded leaves. Stem without axillary hyaline nodules, central strand indistinct. Leaves in 6-13 pairs, usually dense, lowest leaves small, middle and upper leaves lanceolate, 1.4-1.6 mm long, 0.3-0.5 mm wide, apex acute, costa stout, yellowish brown, percurrent; margins entire and slightly serrulate at the apical region, vaginant laminae 2/3 the leaf length, more or less equal, limbidia strong and prominent, yellowish on older leaves, cells of apical and dorsal laminae quadrate to irregularly hexagonal, 7–14 µm long, more or less thick-walled, smooth; cells of vaginant laminae similar to those of apical and dorsal laminae, but longer, with thicker walls toward the base near costa. Plants synoecious. Perichaetial leaves about. 2.5 x 0.5 mm in size. Setae 3.5-4.0 mm long, smooth, capsules erect, symmetrical; urns 0.5-0.6 mm long; opercula rostrate, 0.4 mm long; Spores 10.5-21 µm in diameter.

Status: Medium

Habitat: Rocks and tree trunks.

Distribution: Nepal (W, 600-800 m): Kaski (600 m); Borneo, China, India, Indonesia, Java, Korea, Japan and Sumatra.

1.17. *Fissidens gymnogynus Besch, J. de. Bot. **12**: 292, 1898; Zhu & So, Mosses & Liverworts Hong Kong **2**: 19, 1996; Li & Z. Iwats, Moss Fl. China **2,** MBG Press: 38, 2001.

Naked Capsule Phoenix moss (Eng.).

Plants yellowish green to light brownish green forming tuft on substratums. Stems usually unbranched, sometimes with a few branches at the base, 7-16 mm long, 1.8-3.6 mm wide, axillary hyaline nodules lacking; central strand slightly differentiated. Leaves 9-25 pairs, rather densely arranged, distinctly crisped when dry; the lowermost leaves smaller, becoming larger toward to the middle; middle and upper leaves lingulate to lanceolate, 1.8-2×0.3-0.5 mm, mucronate to acute at apex; base of dorsal laminae rounded to wedge-shaped; sheathing laminae 1/2-3/5 of the leaf length, unequal and open type, costa stout, usually ending a few cells below leaf apex, margins crenulate to slightly serrulate, cells at the apex rounded-rhombic, smooth and thick-walled, forming a lighter region; cells of apical and dorsal laminae hexagonal to rounded-hexagonal, 10-14 µm long, mammillose, obscure; cells of vaginant laminae hexagonal, with thicker and clearer walls. Plants dioecious, archegonia terminal, perichaetial leaves not well differentiated. Setae 2.3 mm long, reddish brown; capsules erect, symmetrical, urns cylindrical, ca. 1 mm long (Fig. 47).

Status: Uncommon.

Habitat: Tree trunks and rocks, rarely on soil.

Distribution: Nepal (W, 200 -300 m): Kailali (220 m), Banke (300 m); China, (Hong Kong), Japan, Korea and Thailand.

Remarks: New record for Nepal.

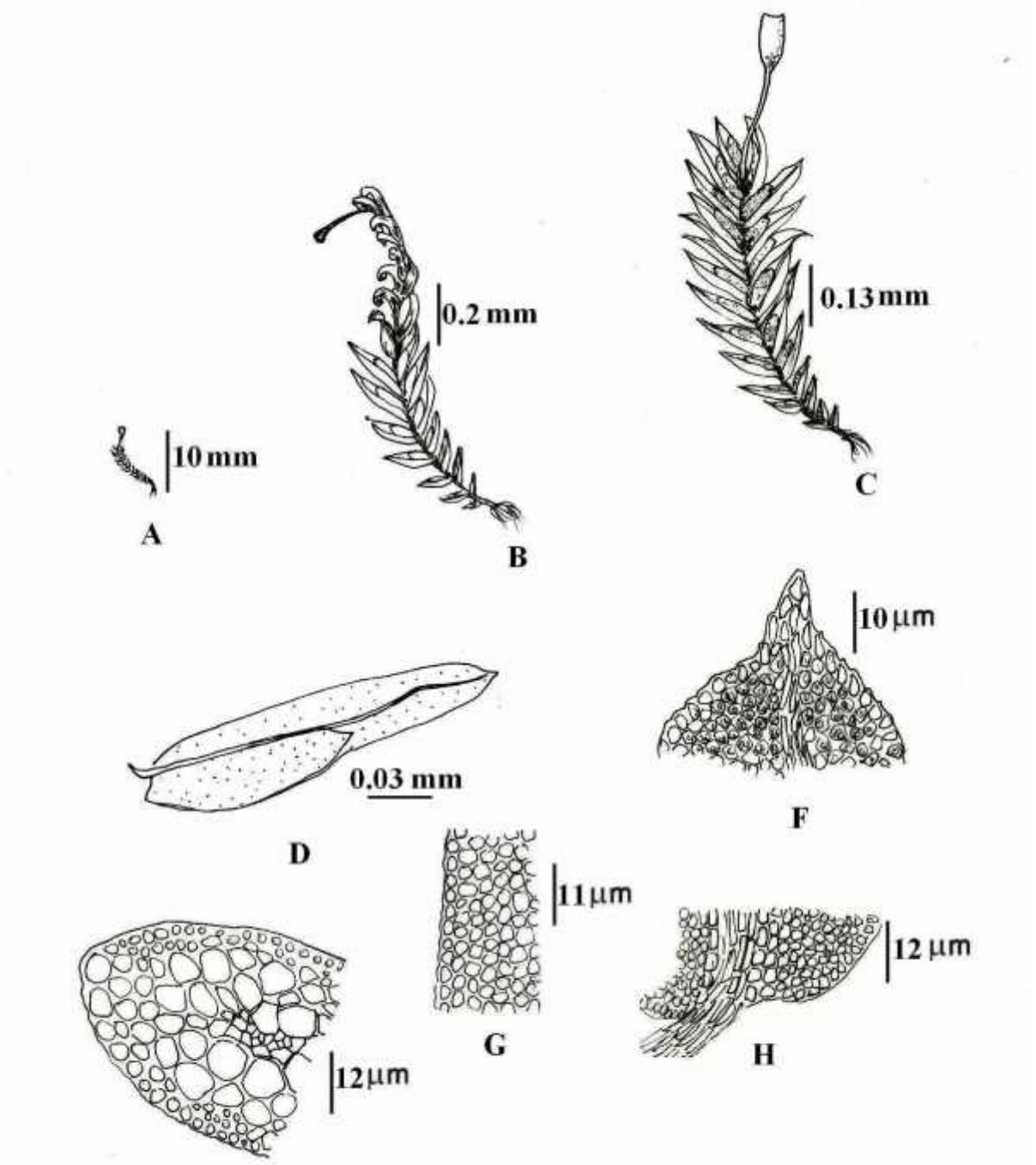

Fig. 47. *Fissidens gymnogynus* Besch. (Pradhan NGS 426). A. habit, B. an enlarged dry palnt, C. an enlarged plant, D. Leaf, E. T.S. of stem, F. apical portion of the leaf, G. marginal region of dorsal lamini, H. basal region of the leaf.

1.18. Fissidens intromarginatulus E. B. Bartram, Rev. Bryol. Lichen. **23**: 242, 1954; Gangulee, Mosses E. Ind. & Adj. Reg. **2**: 510-511, 1971; Pradhan, Mats. Checklist Bryo. Nep.: 42, 2000a; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 27, 2007b.

Plants yellowish green, gregarious in habit, 4-8 mm tall and 2 mm broad with leaves. Stem with 12 pairs of leaves, leaves not curled and contorted when dry. Leaves oblong-lingulate, 1 x 0.3 mm in size, equally broad at apical and basal parts, sheathing laminae unequal and open type. Laminal cells round-hexagonal, chlorophyllose, multipapillae11-12 µm in diameter. Limbidium present which form by 3-4 layers of elongated, pellucid cells around sheathing lamina. Leaves at the basal region round. Plants monoecious, sporophyte apical, setae erect, orange red, 3-4 mm long, capsules brown, cylindrical, 0.4-0.6 mm long and 0.25 mm wide.

Status: Rare

Habitat: Moist soil.

Distribution: Nepal (E, 500-2000 m): Sankhuwasabha (550 m); India, and Upper Burma.

1.19. Fissidens involutus Wils. in Hook., J. Bot. Kew Gard. Misc. **9**: 294, 1857; Wils. ex Mitt., J. Proc. Linn. Soc. Bot., Suppl. **1**: 138, 1859; Nog. in Hara in Ohashi, Fl. E. Him. **1**: 544, 1966; Gangulee, Mosses E. Ind. & Adj. Reg. **2**: 547-548, 1971; Kattel & Adhikari, Mosses Nep.: 31 1992; Z. Iwats. & Suzuki, Haussknechtia Beiheft **9**: 217-218, 1999; Pradhan, Mats. Checklist Bryo. Nep.: 42, 2000a; Li and Z. Iwats., Moss Fl. China **2,** MBG Press: 41, 2001; Pradhan & Joshi, Our Nature **4**(1): 64, 2006; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 27, 2007b.

Fissidens plagiochiloides Besch., J. Bot. (Morat). **12**: 293, 1898.

Fissidens subinteger Broth., Symb. Sin. **4**: 10, 1929.

Plants yellowish green, simple or branched, 10–50 mm long, 2-5 mm wide; stems rigid, axillary hyaline nodules weakly differentiated, central strand slightly differentiated. Leaves in 16-25 pairs, with inrolled apices even when moist; leaves lanceolate, 1.3-4× 0.3–1 mm, acute at apex; base of dorsal laminae rounded; sheathing laminae more or less unequal, 1/2 -3/5 the leaf length; costa stout, brownish red, percurrent, a row of cells on both sides of the costa rectangular; margins finely crenulate, laminal cells at apex smooth, thick-walled, cells of dorsal laminae quadrate to rounded-hexagonal, 3.5-7 µm long, mammillose and obscure; cells of sheathing laminae similar to those of apical and dorsal laminae. Plants dioecious, archegonia terminal on main stems, Perichaetial leaves indistinctly differentiated, slightly narrower and shorter than stem leaves.

Status: Common.

Habitat: Soil

Distribution: Nepal (E, 400-3000 m): Sankhuwasabha (550 m), Sunsari (400 m); Burma, China, India, Japan, Myanmar, Pakistan, Philippines, Thailand and Vietnam.

1.20. Fissidens javanicus Dozy & Molk., *Bryol. Jav.***1**: 11, 1855; Nog. in Hara (eds.), Fl. E. Him. **3**: 544-545, 1966; Gangulee, Mosses E. Ind. & Adj. Reg. **2**: 542-544, 1971; Higuchi & Takaki in Watanabe & Malla, Crypt. Him. **2**: 124, 1990; Pradhan, Mats. Checklist Bryo. Nep.: 42, 2000a; Li & Z. Iwats., Moss Fl. China **2,** MBG Press*:* 42, 2001; Pradhan & Joshi, Our Nature **4**(1): 64, 2006.

Japanese Phoenix Moss (Eng.).

Plants yellowish green to brownish green. Stems simple, erect, 8–18 mm long and 2- 4 mm wide with expanded leaves, axillary hyaline nodules well developed, central strand only slightly differentiated. Leaves in 18–38 pairs, densely arranged; middle to upper leaves linear-lanceolate to lanceolate, 2-3× 0.30-0.5 mm, acuminate at apex, base of dorsal laminae often rounded; vaginant laminae about 2/3 of the leaf length, upper part equal to somewhat unequal, costa stout, slightly excurrent; margins crenulate; margins of apical and dorsal laminae forming a thick band 2–3 cells wide and 2–3 cells thick; margins of vaginant laminae forming a thinner band 2–3 cells wide and 1 cell thick; cells of apical and dorsal laminae sub-isodiametric, 7–9 µm wide, thick-walled, mammillose; cells of vaginant laminae similar to those of apical and dorsal laminae, but slightly larger and well demarcated with thicker cell walls.
Status: Common
Habitat: Soil, rocks and boulder stones.
Distribution: Nepal (W, C, 190-2400 m): Bardia (195 m), Kaski (800 m), Chitwan (300 m), Parsa (200 m); Borneo, Burma, China, India, Indonesia, Japan, Java, Malay Peninsula, Myanmar, New Guinea, Philippines, Sri Lanka, Singapore, Sumatra, Taiwan, Thailand and Vietnam.
Remarks: This species is common in lowland and can be distinguished by its rippled appearance on the leaf laminae. It had been reported from east Nepal at an elevation of 2000-3000 m.

1.21. Fissidens kalimpongensis Gangulee, *Bull. Bot. Beng.,* **11**: 71, 1957; Gangulee, Mosses E. Ind. & Adj. Reg. **2**: 518-520, 1971; Pradhan, Mats. Checklist Bryo. Nep.: 43, 2000a; Pradhan & Joshi, Our Nature **4**(1): 64, 2006; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana : 27, 2007b.

Plants small, yellowish green, erect, 5-10 mm high and 1.5 mm broad with 17 pairs of leaves. Male plants smaller than female plants with narrower leaves. Leaves small, more crowded upward apex, oblong-lingulate, 1 x 0.3 mm in size, dorsal lamina narrowing down at the base, apical portion symmetrical and sheathing lamini occupy 2/3 of the leaf length, unequal and open type. Limbidium present at the sheathing lamini of perichaetial leaves formed by 2-4 rows of elongated pellucid cells. Costae yellowish white, percurrent, laminal cells rounded-hexagonal, 8 µm in diameter, multipapillate. Plants dioecious. Setae erect, 2-4 mm long, capsules orange-brown, erect, urn 0.7-1 mm long. Spores pale white or almost transparent, 10-18 µm in diameter.
Status: Rare
Habitat: Soil
Distribution: Nepal (E, 800 -3000 m): Sankhuwasabha (550 m); India (Darjeeling).

1.22. Fissidens laxus Sull & Lesque, Proc. Am. Ac. Arts. Sc. **4**: 276, 1859; Higuchi & Takaki in Watanabe & Malla, Crypt. Him. **2**: 124, 1990; Pradhan, Mats. Checklist Bryo. Nep.: 43, 2000a; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 27, 2007b.

Lesser Pocket-moss (Eng.).

Plants very small about 3 mm long with rhizoids at the base, leaves dull green, small, lanceolate, 4-5 pairs on stem. Costae excurrent reaching the leaf apex, margin crenulate, apical region symmetrical, sheathing lamini less than half the length of leaf, laminal cells hexagonal. Plants polyocious, setae erect, yellowish green, smooth, 2 mm long and capsules erect, cylindrical, operculum conic with long rostrate, teeth bright orange.

Status: Rare

Habitat: Damp Soil

Distribution: Nepal (W, 800-3000 m): Kaski (800 m), Borneo, Burma, China (Hong Kong), India, Japan, Java, Kampuchea, Malay Pen, Malaysia, Myanmar, Philippines, Singapore, Sri Lanka, Sumatra, Taiwan, Thailand and Vietnam.

Remarks: This is probably the smallest of all *Fissidens* known so far and can visible only when the ring of bright orange peristome teeth of the capsule emerged out from the substratum along other liverworts and mosses.

1.23. Fissidens maceratus Mitt., Trans. of Proc. Royal Soc. of Victoria **19**: 91, 1882; Pradhan & Joshi, Our Nature **4**(1): 65, 2006.

Fissidens splachnobryoides Broth. in Schum. & Lauterb., Fl. Deutsch. Schutz. Suedsee: 81, 1900; Gangulee, Mosses E. Ind. & Adj. Reg. **2**: 462-464, 1971; Nog. & Z. Iwats. in Ohashi, Fl. E. Him. **3**: 247, 1975; Kattel & Adhikari, Mosses Nep*:* 32, 1992; Pradhan, Mats. Checklist Bryo. Nep.: 44, 2000a.

Soft-leaved Phoenix moss (Eng.).

Plants bright green, gregarious in habit, 10 mm x 3 mm in size with expanded leaves with leaf pairs 16, smaller towards the base and more crowded at the apical region. Leaves curled but not crumpled on drying. Leaves oblong-lanceolate, 2 x 0.4 mm in size, acute apex and percurrent costae end far below the apex. Dorsal lamina narrows down to the base, apical lamina symmetrical and sheathing lamina usually equal occupying ½ of the leaf length. Limbidium 1-3 rows with elongated cells present all around the leaf. Cells smooth, oval to hexagonal with round chloro-plastics and 32 x 13 µm in diameter, 65 µm at the bæse of sheathing lamina.

Status: Rare

Habitat: Habitat: Soil covered rock in Sal forest (*Shorea robusta*).

Distribution: Nepal (E, 200-550 m): Sunsari (200-240 m), Sankhuwasabha (550 m); Formosa, Japan, Java, North Borneo, New Guinea, Philippines, South India, Sri Lanka and Upper Burma.

1.24. Fissidens microcladus Thwait. & Mitt., J. Linn. Soc. Bot. **13**: 324, 1873; Higuchi & Takaki in Watanebe & Malla, Crypt. Him. **2**: 124, 1990; Pradhan, Mats. Checklist Bryo. Nep.: 43, 2000a; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 28, 2007b.

Fissidens minutus Thwait. in Mitt, J. Linn. Soc. Bot.**13**: 323, 1873; Gangulee, Mosses E. Ind. & Adj. Reg. **2**: 515-516, 1971.

Plants pale green, small to 2-3 mm tall with 8-10 pairs of leaves. Leaves oblong lanceolate with acute tips. 0.8-1 mm long and 0.2 mm wide. Apical lamini symmetrical, basal laminal base round and sheathing lamini open type occupying 2/3 of the leaf length, costae percurrent, margin serrulate by projecting marginal cells, limbidium present at the sheathing lamini 2-3 rows at the base. Filamentous gemmae (100-300 x 25-40 µm) may produce by rhizoids which may be found on the soil surface. Plants monoecious, Setae geniculate, 1.8 mm long; capsules erect, small, ovate-cylindrical, 0.4 mm long, peristome inflexed when wet, divided more or less 2/3 of their length.
Status: Uncommon
Habitat: Tree trunks, humid rock and sometimes on soil.
Distribution: Nepal (W, C, E, 800-3200 m.): Palpa (900 m), Kaski (800 m), Chitwan (300 m), Kavre (900-1000 m), Sankhuwasabha (750 m); America, Burma, China, India, Japan, Java, Laos, New Caledonia, Philippines, Singapore, Sri Lanka, Sumatra, Taiwan, Thailand and Vietnam.

1.25. Fissidens microcladus Thwait. var. **terrestries** Aust. in Featherman, Rep. Bot. Surv. S. C. Louisiana **2** Rep., 1871; Pradhan & Joshi, Our Nature **4**(1): 65, 2006; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 28, 2007b.

Autoecious or pseudoautoecious, gemmae are produced on rhizoids which are filamentous or irregularly curved 100-300 µm long, 25-40 µm wide and are composed of cylindrical cells, brown or slightly papilose wall (Imura and Iwatsuki, 1988).
Status: Rare
Habitat: Soil
Distribution: Nepal (E, 550m): Sankhuwasabha (550 m), China, India, Japan, Philippines, Singapore, Sri Lanka and Taiwan.

1.26. Fissidens minutus Thwait. & Mitt., J. Linn. Soc. Bot., **13**: 323, 1873; Gangulee, Mosses E. Ind. & Adj. Reg. **2**: 515-516, 1971; Pradhan, Mats. Checklist Bryo. Nep.: 43, 2000a; Pradhan & Joshi, Our Nature **4**(1): 65, 2006; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 28, 2007b.

Fissidens foreauanus Cardot in Dixon & Vard., Rev. Bryol., **49**: 41, 1922.
Fissidens chungii Thér., Ann. Crypt. Exot. **5**: 167, 1932.
Fissidens garberi Lesque & James, Proc. Amer. Acad. Arts Sci. **14**: 137, 1879.

A small plant with simple leafy stems, 2-5 mm long and 1.5 mm wide and without axillary hyaline nodules and central strand not developed. Leaves in 6-10 pairs, upper leaves lingulate, 0.7-1 × 0.20–0.25 mm, rounded to obtuse, rarely acute at apex; base of dorsal laminae wedge-shaped; margins

serrulate; vaginant laminae 2/3 the leaf length, more or less equal; costae percurrent ending below the leaf apex; cells of apical and dorsal laminae quadrate to hexagonal, 3.5-10 µm long, minutely pluripapillose, thin-walled; cells of sheathing laminae similar to those of apical and dorsal laminae; limbidia marginal, one cell thick, usually appearing only on lower one-half of sheathing laminae of upper leaves or perichaetial leaves. Setae short 1.8 mm long, capsules small, erect, 0.5 x 0.1 mm in size. Spores small, 10 -15 µm in diameter.

Status: Rare

Habitat: Rocks and soil.

Distribution: Nepal (E, 200 m): Sunsari (200 m); Africa, America, China, India (Palni), Indochina, Malaysia, Sri Lanka and Taiwan.

1.27. Fissidens mittenii Paris, Index Bryol.: 477, 1896; Nog. & Z. Iwats. in Ohashi, Fl. E. Him. **3**: 247, 1975; Gangulee, Mosses E. Ind. & Adj. Reg. **2**: 531-532, 1971; Kattel & Adhikari, Mosses Nep.: 31, 1992; Pradhan, Mats. Checklist Bryo. Nep. : 43, 2000a; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 28, 2007b.

Fissidens crassinervis Thwaites & Mitt., J. Linn. Soc. Bot., **13**: 323, 1875.

Plants small, yellowish green 5 mm long and 1.5 mm broad. Stems simple with 6 -7 pairs of leaves, erectopatent when dry. Leaves oblong lanceolate, 1 x 0.5 mm in size, apex acute, smooth margin, costae prominent, percurrent or short excurrent. Apical laminae symmetrical with acute tip, sheathing lamina unequal and open type, dorsal lamina narrowing at the base, no limbidium on the sheathing lamina. laminal cells hexagonal, 10 µm in diameter, but larger on the sheathing laminal base near costa. Perichaetial leaves leaves longer, usually with sheathing lamini having abruptly narrowed tips. Setae terminal, erect or geniculated, 3 mm long, capsule cylindrical with wide mouth, 0.4 mm in diameter, operculum conic- rostrate.

Status: Rare

Habitat: Soil and bark

Distribution: Nepal (E, 600): Sankhuwasabha (550-600 m); Burma, Java, Philippines, Singapore, South India, Sri Lanka, Sumatra, Taiwan, Thailand and Vietnam.

28. Fissidens nobilis Griff., Cal. J. Nat. Hist., **2**: 505, 1842; Mitt., J. Linn. Soc. London Suppl. **1**: 137, 1959; Gangulee, Mosses E. Ind. & Adj. Reg. **2**: 550-552, 1971; Nog. & Z. Iwats. in Ohashi, Fl. E. Him. **3**: 247, 1975; Higuchi & Takaki in Watanabe & Malla, Crypt. Him. **2**: 124, 1990; Kattel & Adhikari, Mosses Nep.: 32, 1992; Pradhan, Mats. Checklist Bryo. Nep.: 43, 2000a; Li & Iwatsuki, Moss Fl. China **2,** MBG Press: 49, 2001; Pradhan & Joshi, Our Nature **4**(1): 65, 2006.

Nobel Phoenix Moss (Eng.).

Plants green to brownish green, 18-60 mm long and 5.5-10 mm wide. Stems without axillary hyaline nodules but central strand well differentiated. Leaves in 14–36 pairs, densely arranged throughout except the lowermost ones, middle and upper leaves lanceolate to narrowly lanceolate,

4.7–5.5 mm × 1.0–1.2 mm, apex acute; dorsal laminal base wedge-shaped, sheathing laminae about ½ of the leaf length; costa stout, percurrent; upper half of margin irregularly dentate, the lower half almost entire, bordered throughout with a darker-colored band of 2–5 rows of incrassate, smooth cells, cells of apical and dorsal laminae quadrate to hexagonal, some highly mammillose, 7–14 µm long; cells of sheathing laminae similar to those of apical and dorsal laminae, but usually smooth. Plants dioecious. Perichaetial leaves narrowly lanceolate, 2.5-2.8 mm long. Setae lateral, ca. 6.-7 mm long, smooth; capsules slightly inclined, asymmetrical, opercula rostrate, 0.4-1.3 mm long; peristome teeth, ca. 0.4 mm long, 100 µm wide at base. Spores 11–18 µm in diameter.
Status: Medium
Habitat: Stream banks, rocks and soil
Distribution: Nepal (W, 800-2200 m): Banke (700 m), Kaski (800 m); Borneo, Burma, Celebes, China, Hong Kong, India, Indonesia, Japan, Java, Kanpichea, Korea, Maley Peninsula, Myanmar, New Guinea, Philippines, Sri Lanka, Sumatra, Taiwan, Thailand and Vietnam.

1.29. *Fissidens oblongifolius Hook. f. & Wils., London. J. Bot. **3**: 547, 1844; Z. Iwats. & T. Suzuki, Fragm. Flor. Geobot. **40**(1): 156, 1995; Z. Iwats. & T. Suzuki, J. Hattori Bot. Lab. **79**: 160, 1996; Zhu & So, Mosses & Liverworts Hong Kong **2**: 20, 1996.

Fissidens mangarevensis Mont., Ann. Sci. Nat. Bot. ser. **3, 4**: 113, 1844.
Fissidens filicinus Dozy & Molk., Ann. Sci. Nat., Bot., sér. **3, 2**: 304, 1844.
F. peracuminatus Dixon, Proc. Lnn. Soc. N.S. Wales **55**: 273, 1930.

Oblong leaved Phoenix Moss (Eng.).

Plants small, yellowish green 8-9 mm long and 3 mm broad with expanded leaves. Stem simple with 12-14 pairs of leaves and rhizoids at the base, but So (1996) recorded only 6-7 pairs of leaves on the stem. Leaf tips and stems tips rolled up when dry. Leaves long, lanceolate, yellowish green, entire but slightly serrulate at the apical region due to the projection of marginal cells, margin without boarder, costa excurrent, 34 µm in diameter, hyaline nodules absent, sheathing lamina 2/3 of the leaf lenghth, closed type. Laminal cells green, mammilous, 3 x 8-9 µm in diameter (Fig. 48).
Status: Rare
Habitat: Wet soil and rock intermingled with *Hyophila* sp. (Pn 214).
Distribution: Nepal (C, 250 m): Chitwan (250); China (Hong Kong), Japan and South Pacific.
Remarks: This species is new record for Nepal.

1.30. Fissidens plagiochiloides Besch., J. de Bot., **12**: 93, 1898; Gangulee, *Mosses* E. Ind. & Adj. Reg. **2**: 563-564, 1971; Higuchi & Takaki in Watanabe & Malla, Cryp. Him. **2**: 124, 1990; Pradhan, Mats. Checklist Bryo. Nep.: 44, 2000a; Pradhan & Joshi, Our Nature **4**(1): 66, 2006.

F. pulogensis Broth., Phillipp. J. Sci. C. **5**(2): 141, 1910.
F. deciduaefolius Saksena, Bot. Mag. Tokyo. **47**: 742, 1933.
F. japonicoides Saksena, Bryologist **39**: 4, 1936.

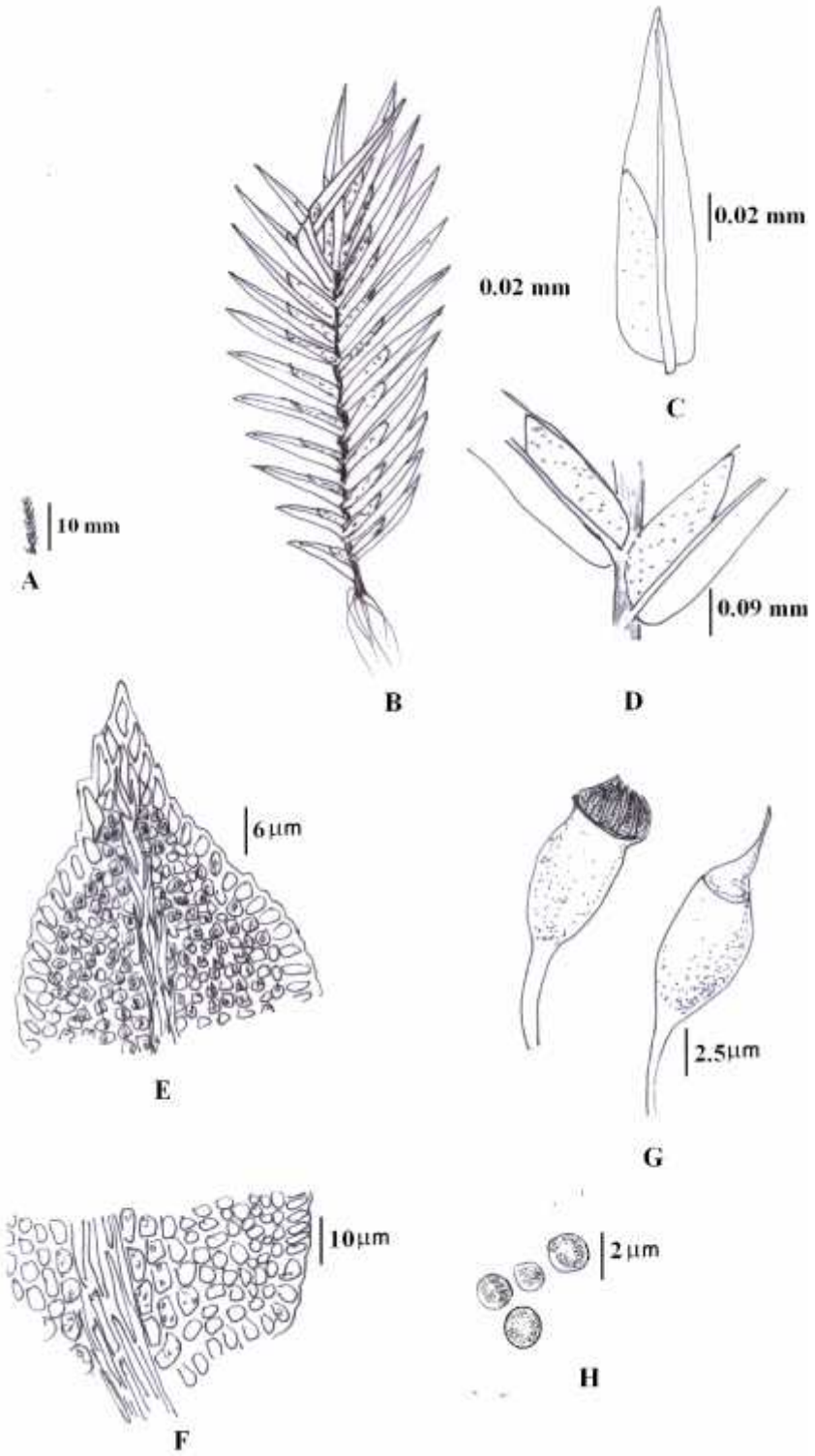

Fig. 48. *Fissidens oblongifolius* Hook. f. & Wils. A. habit, B. plant enlarged, C. leaf, D. a portion of the stem with leaves, E. apical portion of the leaf, F. basal portion of the leaf, G. capsules, H. spores.

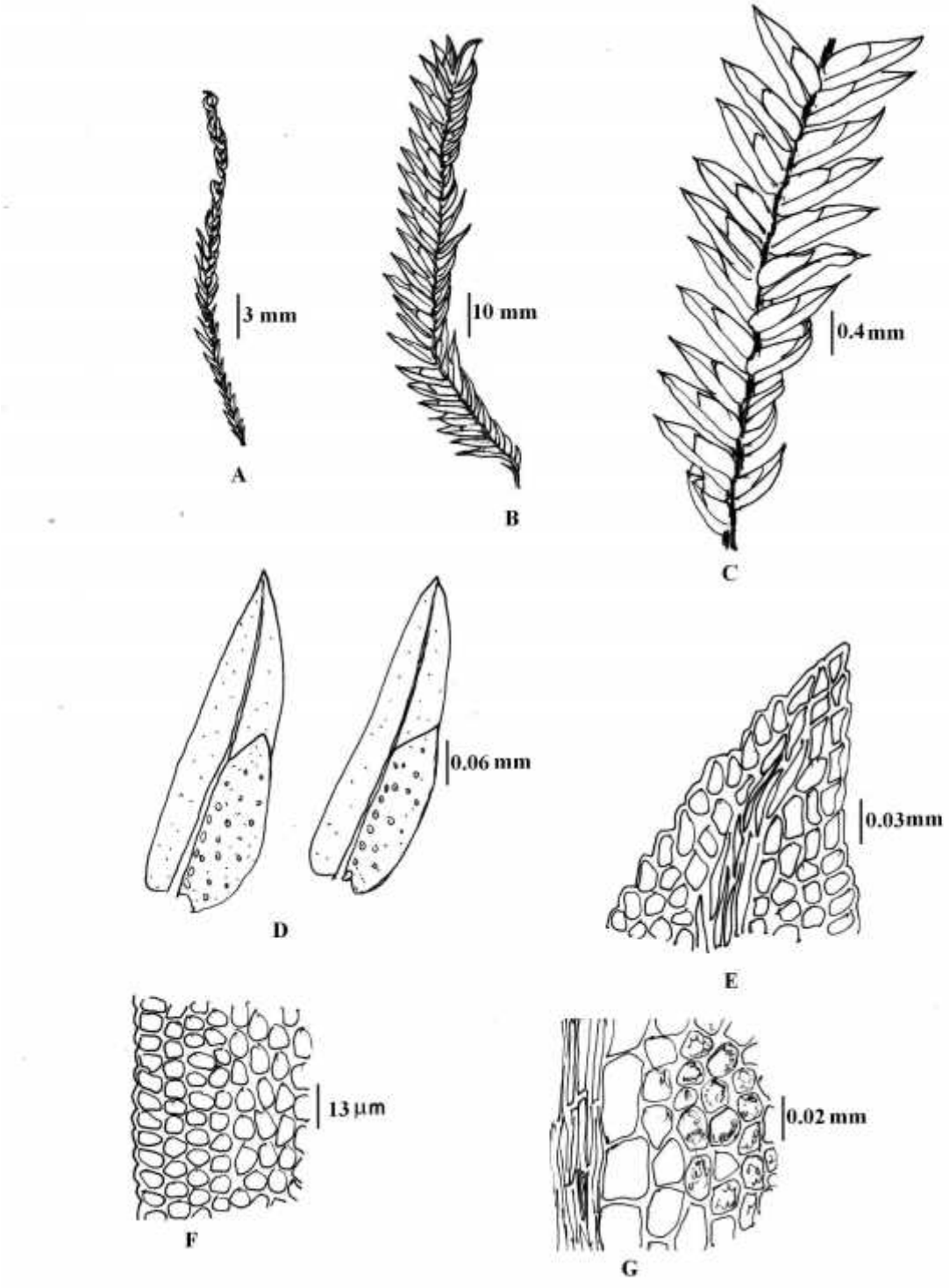

Fig. 49. *Fissidens plagiochiloides* Bescher. A. habit of dry plant, B. a healthy plant, C. a portion of leafy plant, D. leaves, E. apical portion of the leaf, F. marginal region of sheathing lamina, G. cells towards the costal region.

Plants robust, erect, yellowish to dark green, simple or branches up to 4-6 cm long and 4-5 mm broad with expanded leaves growing tufts. Stem rigid, curved when dry and the leaves crisped and sometimes inrolled apex. Leaves ovate-lanceolate, conspicuously wider in the lower half, 3- 4 mm long and 1 mm broad. Costae strong excurrent flexuous wich divide apical lamina into equal half, basal laminal base round, sheathing lamina 2/3 of the entire leaf length, broad at the base and open and close type. Margin smooth and slightly crenulate at the apical region due to projecting the marginal cells, lacks boarder. Laminal cells at the apical region small, hexagonal, mamillose, 5-8 µm in diameter and large quadrate-reactangular, 15-22 µm at the base near costae, marginal cells near sheathing lamina round to oval. Cells mamillose except at the apical region. (Fig. 49).

Status: Rare

Habitat: Stream side and wet rock

Distribution: Nepal (W, C, E, 200-3000 m): Bardia (200-220 m); Borneo, China, Japan, Malaysia, New Guinea and Philippines.

Remarks: This is one of the largest species of *Fissidens* known so far. Gangulee (1971) reported its largest specimen which measured 5-15 cm in size. Norkett (1962) collected it for the first time from Mewa Khola (3000 m) of east Nepal. Recently it was collected from Pharping (1500 m) of Kathmandu, central Nepal (Pradhan k 16). It grows upon stone wall of the pond.

1.31. Fissidens ranchinensis Gangulee, Bull. Bot. Soc. Beng., **11**: 68, 1957; Gangulee, Mosses E. Ind. & Adj. Reg. **2**: 495-497, 1971; Pradhan, Mats. Checklist Bryo. Nep.: 44, 2000a; Pradhan & Joshi, Our Nature **4**(1): 66, 2006; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 28, 2007b.

Plants small, 3-11 mm high and 1 mm wide with expanded leaves. Stems dark brown with 28 pairs of leaves, curled up when dry. Leaves small, ovate-lanceolate, 1x0.4 mm in size, dorsal laminae narrow at the base, sheathing laminae unequal, costae percurrent, end few cells below apex. Laminal cells usually obscure, projecting into conical mammillae, margin corrugated, cells on sheathing lamina chlorophyllous, rounded-hexagonal, 8.5 µm in diameter and slightly longer towards the base. Plants dioecious, perichaetial leaves narrower, cells at the extreme base long rectangular. Setae erect 2-3 mm long, capsules cylindrical brown. Spores spherical, hyaline, 20 -34 µm in diameter.

Status: Rare

Habitat: Humid earth bank and wet cliffs

Distribution: Nepal (E, 550-1800 m): Sankhuwasabha (550 m); South India.

1.32. *Fissidens robinsonii Broth., Philipp. J. Sci. **13 C**: 204, 1918; Gangulee, Mosses E. Ind. & Adj, Reg. **2**: 534-535, 1971; Eddy, Malesian Mosses **1**: 66-68, 1988; Tan & Z. Iwats., Wildenowia **18**: 600, 1989; Pradhan & Joshi, Geobios **34**(2-3): 105-108, 2007a.

Fissidens zippelianus var. *robinsonii* (Broth.) Z. Iwats. & T. Suzuki, J. Hattori Bot. Lab. **67**: 289, 1989; Z. Iwats. & T. Suzuki, Fragm. Flor. Geobot. **40**(1): 156, 1995; Z. Iwats. & T. Suzuki, J. Hattori Bot. Lab. **79**: 159-160, 1996.

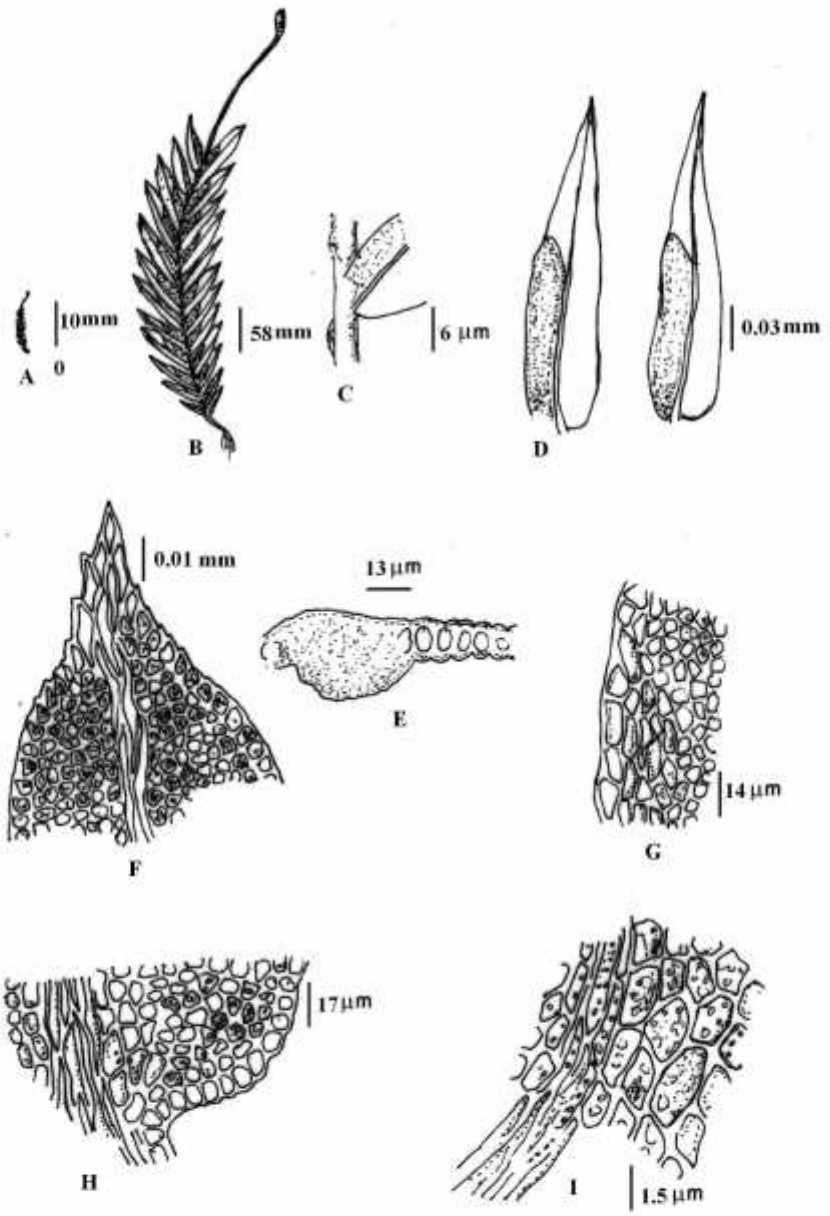

Fig. 50. *Fissidens robinsonii* Broth. (Pradhan NGS 425), A. habit, B. the plant enlarged, C. a portion of stem showing hyaline nodules, D. leaves, E. transverse section of the leaf, F. apical portion of the leaf, G. marginal portion of the leaf in the median region, H. basal portion of the leaf, I. cells towards the basal region.

Plants robust, erect, yellowish to dark green, simple or branches up to 4-6 cm long and 4-5 mm broad with expanded leaves growing tufts. Stem rigid, curved when dry and the leaves crisped and sometimes inrolled apex. Leaves ovate-lanceolate, conspicuously wider in the lower half, 3- 4 mm long and 1 mm broad. Costae strong excurrent flexuous wich divide apical lamina into equal half, basal laminal base round, sheathing lamina 2/3 of the entire leaf length, broad at the base and open and close type. Margin smooth and slightly crenulate at the apical region due to projecting the marginal cells, lacks boarder. Laminal cells at the apical region small, hexagonal, mamillose, 5-8 µm in diameter and large quadrate-reactangular, 15-22 µm at the base near costae, marginal cells near sheathing lamina round to oval. Cells mamillose except at the apical region. (Fig. 50).
Status: Rare
Habitat: Stream side and wet rock
Distribution: Nepal (W, C, E, 200-3000 m): Bardia (200-220 m); Borneo, China, Japan, Malaysia, New Guinea and Philippines.
Remarks: Plants is very much similar with *Fissidens zippelianus* Dozy & Molk.. This is New records for Nepal.

1.33. Fissidens sempefalcatus Dixon, J. Siam. Soc. Nat. Hist. Suppl., **10**: 2, 1935; Gangulee, Mosses E. Ind. & Adj. Reg. **2**: 501-503, 1971; Pradhan, Mats. Checklist Bryo. Nep.: 44, 2000a; Pradhan & Joshi, Our Nature **4** (1): 66, 2006; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 28, 2007b.

Plants bright green stems orange, 5.5 mm long and 2 mm broad with expanded leaves, leaves 17 pairs on stem. Leaves falcate with inflexed tips downwards in the apex when dry, oblong-lingulate, 1.5 x 0.3 mm in size. Limbidium of cartilaginous cells present which narrows towards the apical region. Apical lamina more or less symmetrical, basal lamina narrows down around the base, sheathing lamina 2/3 of the leaf length, both open and close types, costae stout, orange and excurrent, leaf cell round to hexagonal, unipapillous, 8 µm in diameter. Setae orange red, 8-10 mm long developed more than 4 on the apical region of the stem, capsule brown, 0.6 x 0.3 mm in size.
Status: Rare
Habitat: Soil
Distribution: Nepal (E, 550 m): Sankhuwasabha (550 m); Java, South Burma and Thailand.

1.34. *Fissidens strictus Hook. & Wilson, Fl. Tasman. **2**: 167-171, 1859; Scott & Stone, Mosses S. Aust.: 88-90, 1975; Beever, New Zealand Journ. Bot. **33**: 291-294, 1995; Pradhan & Joshi, Our Nature **4** (1): 66-67, 2006.

Plants dark green, 5-10 mm long and 1.5 mm wide with expanded leaves forming blackish green tufts on waterl level. Rhizoids dense at the shoot base. Stems erect, green and without central strand or with very weak central strand, axillary hyaline nodules very weakly developed. Leaves pairs variable on stem usually 15-35 in pairs, overlapped and erectopatent. Leaves dark green, linear, 1.5-2 mm

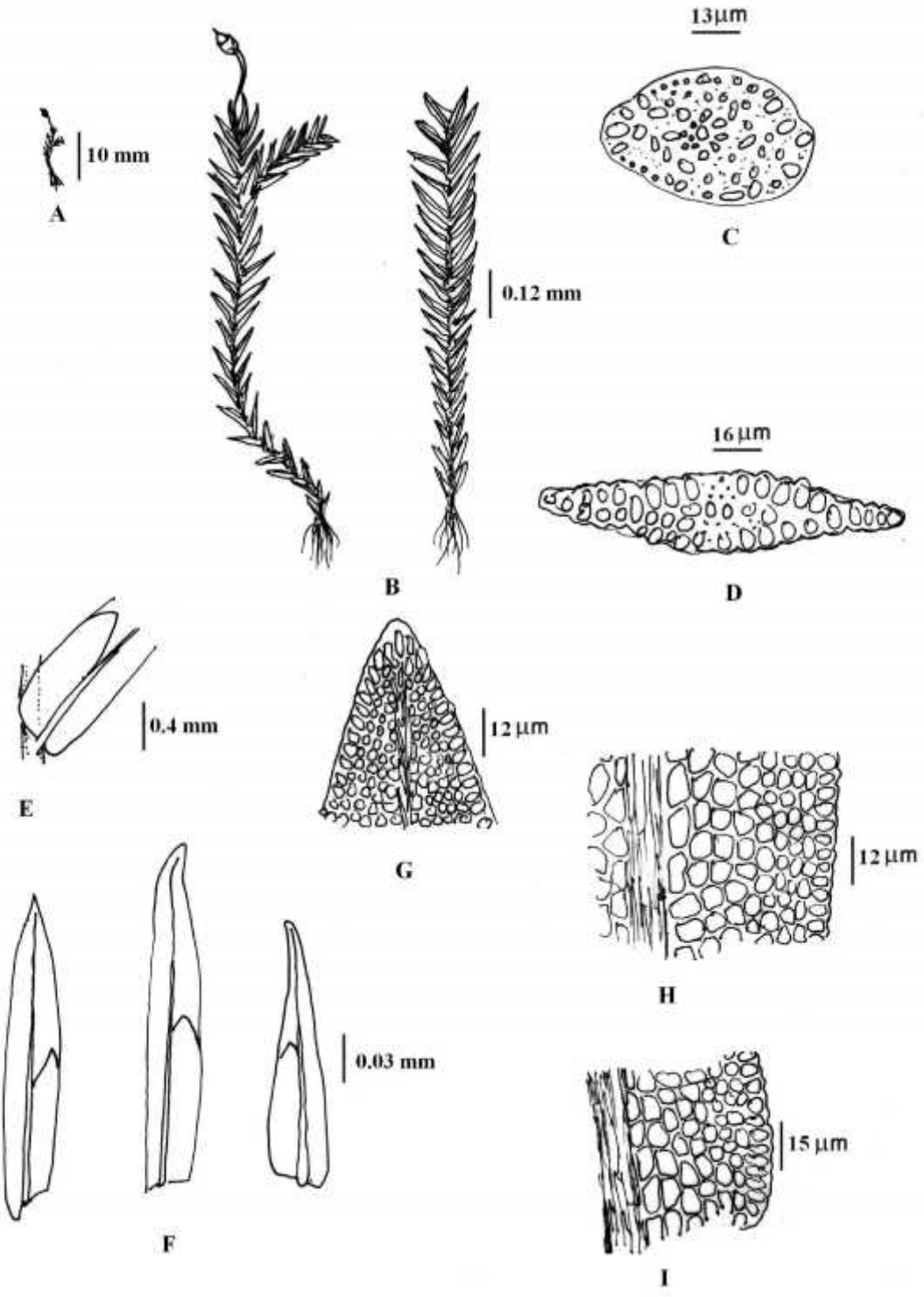

Fig. 51. *Fissidens strictus* Hook. & Wilson (Pradhan NGS 159). A. habit, B. fertile and sterile plants enlarged, C. cross section of the stem, D. cross section of the leaf, E. portion of the leaf and the stem, F. leaves, G. apical portion of the leaf, H. median portion of the leaf, I. basal portion of the leaf.

long and 0.2-0.3 mm in wide, stiff and remain no change even in dry. Leaf apex acute to obtuse, sometimes slightly bent, dorsal laminae bistratose to multistratose near the costa, 8-10 cells wide in the midean region; sheathing laminae ½ of the leaf length, narrow through out and open type, costae white to pale yellow becoming red with the age, percurrent end just below apex, margin crenulate without boarder. Laminal cells at the apical and median region irregular, clear, smooth and without papillose and gradually becoming larger from margin to nerve, usually 8-15 µm long in the median region. Plants dioecious, sporophytes terminal on main shoot, capsules small, pyriform, calyptrae smooth and cuculate (Fig. 51).

Status: Rare.

Habitat: Semiaquatic

Distribution: Nepal (W, C, 340 m): Bardia (340 m); New Zealand and Tasmania.

Remarks: *Fissidens strictus* can be distinguished by having small dark green narrowly linear leaves, stiffy and erect in dry and wet condition, multistratose leaf laminae, very distinct costae and margin without boarder. This species is new record for Nepal.

1.35. Fissidens subbryoides Gangulee**,** Bull. Bot. Soc. Bengal. **11**: 60, 1957; Gangulee, Nova Hedwigia **8**: 141, 1964; Gangulee, Mosses E. Ind. & Adj. Reg. **2**: 467-469, 1971; Higuchi & Takaki, Crypt. Him. **2**: 125, 1990; Pradhan, Mats. Checklist Bryo. Nep.: 44, 2000a; Pradhan & Joshi, Our Nature **4**(1): 67, 2006.

Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 28, 2007b. Plants small, unbranched, 1-4 mm long, 1.5-2.5 mm wide; axillary hyaline nodules weakly differentiated. Leaf tips curled when dry. Leaves in 5-12 pairs, closed towards the apical region and apart towards basal region, linear lanceolate, narrowly acuminate, 2.7 mm × 0.25 mm, base of dorsal laminae narrow, slightly decurrent; vaginant laminae closed, acute at apex; limbidia weak, composed of narrowly elongated cells all round leaf, 1–2 rows of cells on dorsal and apical laminae; costae shortly excurrent; laminal cells smooth, thin-walled, rhomboidal to hexagonal, 7-15 µm long in apical laminae, elongated at base near costa, where they may be up to 25-40 µm long. Plants autoecious, perigonia on short branches from leaf axil at middle of stems; antheridia about 250 µm long. Setae terminal, reddish-brown, up to 6.5 mm long. Capsules erect, symmetrical. Calyptrae smooth.

Status: Uncommon

Habitat: Rocks and soil

Distribution: Nepal (W, C, 300-1000 m): Kaski (800 m), Chitwan (1000 m), Makwanpur (650 m), Sunsari (300 m); Andaman Island, China, India and Japan.

1.36. Fissidens subpalmatus C. Muell., Linnaea 37: 164, 1872; Gangulee, Mosses E. Ind. & Adj. Reg. **2**: 466-467, 1971; Pradhan & Joshi, Our Nature **4**(1): 67, 2006.

Conomitrium subpalmatus (C. Muell.) A. Jaeger, Ber. S. Gall Naturw. Ges. **1874-75**: 125, 1876.

Plants bright green, 3-6 mm long and 2.8 mm broad with 12-14 pairs of leaves, curled and contorted when dry. Leaves oblong-lingulate, acuminate, 1.3 x 0.25 mm in size. Dorsal laminae equally broad

from top to the base and decurrent at the base, apical laminae symmetrical and sheathing laminae more or less 1/2 the leaf length. Single layer of simple limbidium all around the leaf except at the sheathing lamine, costae light brown and usually excurrent. Laminal cells clear, chlorophyllose, rounded hexagonal up to 14 µm in diameter and elongated, 27 µm in diameter near costa at the base. Plants dioecious. Setae orange, 4 mm long, capsules yellowish brown with wide mouth, 0.4 mm high and 0.26 mm broad. Spores spherical, 12-14 µm in diameter (Fig. 52).

Status: Uncomon

Habitat: Moist earth.

Distribution: Nepal (C, 1000 -1200 m): Chitwam (1000-1200 m), Parsa (250 m), Makwanpur (800 m); South India, West Bengal.

Remarks: This species was previously reported from east Nepal by Norkett in 1962.

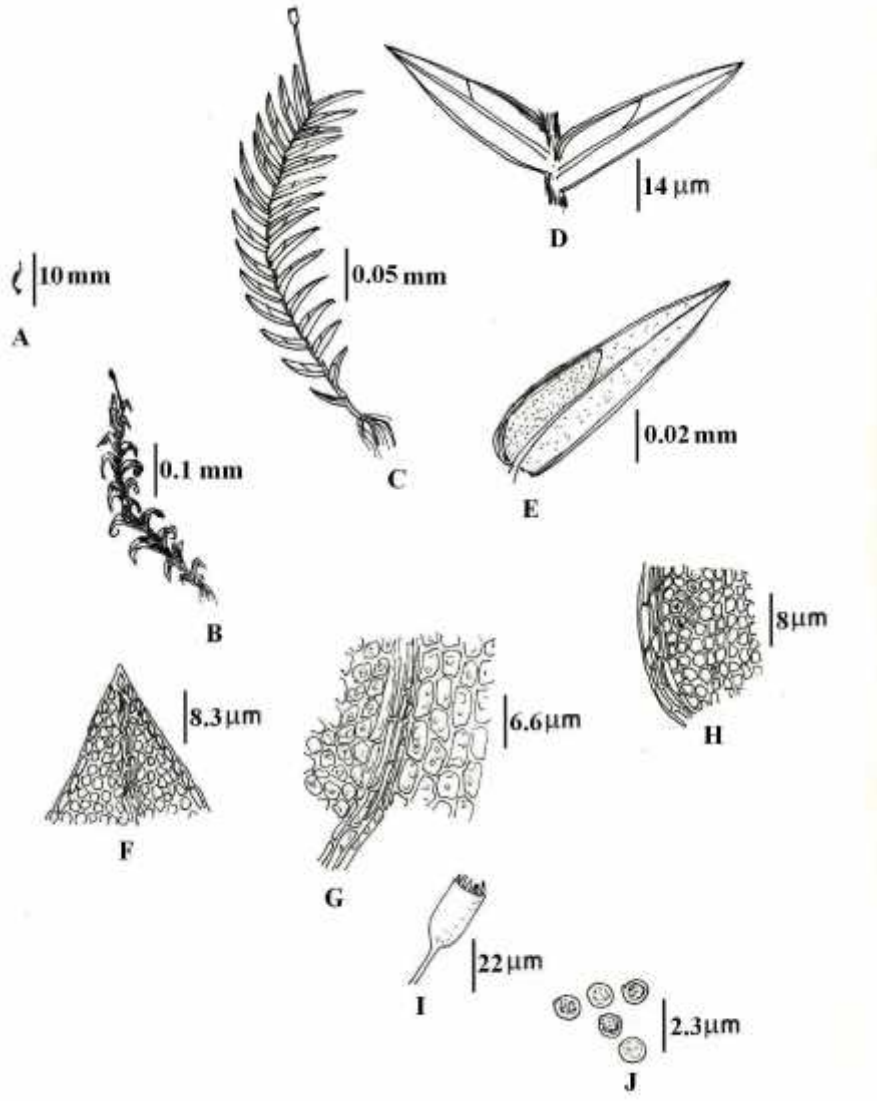

Fig. 52. *Fissidens subpalmatus* C. Muell., A. habit, B.the plant enlarged in dry form, C. fresh plant, D. leaf pair, E. leaf, F. apical portion of the leaf, G. basal portion of the leaf showing coastal cells and basal cells, H. basal region of the leaf showing limbidium, I. capsule, J. spores.

1.37. Fissidens sylvaticus Griff., Cal. J. Nat. Hist., **2**: 507, 1842; Gangulee, Mosses E. Ind. & Adj. Reg. **2**: 335-336, 1971; Nog. & Z. Iwats. in Ohashi, Fl. E. Him. **3**: 247, 1975; Kattel & Adhikari, Mosses. Nep.: 32, 1992; Pradhan, Mats. Checklist Bryo. Nep.: 44, 2000a; Pradhan & Joshi, Our Nature **4**(1): 67, 2006; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 28, 2007b.

Plants bright green to dark green growing tufts, variable in size measuring 2 mm to 30 mm in high, 2 mm wide with expanded leaves and with 5 to 32 pairs of leaves. Leaves more contorted at the apices when dry, oblong-lanceolate, 1-2 x 0.5 mm in size, symmetrical at the apical region, apice acuminate, margin without boarder and serrulate due to projection of the cells, costae excurrent orends just below the apical cell, dorsal lamina gradually tapering at the base. Sheathing laminae ½ or 2/3 of the leaf length, open type, middle laminal cells hexagonal, mammillous and 6-10 µm in diameter, cells in the sheathing laminae quite large, 12-14 µm in diameter, axillary hyaline nodules not seen. Plants dioecious, setae terminal, 4-8 mm long .

Status: Common

Habitat: Forest soil

Distribution: Nepal (W, C, E, 200-1200 m): Bardia (225-450 m), Chitwan (1000-12000 m), Bara (104 m), Dhankuta (300 m), Sankhuwasabha (550 m), Morang (180 m); Algeria, Borneo, Central Africa, Hong Kong, Indo China, Japan, Java, Madagascar, New Guinea, New Zealand, Philippines, Samoa, Sumatra and Vietnam.

1.38. *Fissidens sylvaticus Griff. var. **auriculatus** (C. Muell), Gangulee, Mosses Ind. & Adj. Reg. **2**: 540-541, 1971; Pradhan & Joshi, Our Nature **4**(1): 67, 2006.

Fissidens auriculatus C. Muell., Linnaea **37**: 166, 1872.

Plants small, dark green overlapped forming tuft. Plants 7-20 mm tall, 2 mm wide with expanded leaves. Hyaline nudules on stem not differentiated. Upper leaves and leaf tips curled inwards exposing dorsal stem surface out when dry and no change in lower leaves. Lower leaves smaller than upper leaves. Leaves 16-28 in pairs, oblong-lingulate, apex apiculate, dorsal laminal base round, sheathing lamina occupies 2/3 rd portion of the entire leaf length, apical lamina usually symmetrical, margin crenulated due to projecting mamillose marginal cells, without limbidium. Apical cells somewhat obscure by mamillose growth, middfle laminal cells round to hexagonal, 8-10 µm in diameter, basal cells slightly large upto 12 µm in diameter.

Status: Rare.

Habitat : Semi aquatic upon wet rock around lake edge.

Distribution : Nepal (W, 225 m): Bardia (225 m); Algeria, Burma, Central Africa, China, India, Indo China, Indonesia, Madagascar, New Guinea, Philippines, Samoa and Sri Lanka.

Remarks : This variety is confined to one locality of Bardia of west Nepal. *Fissidens sylvaticus* var. *auriculatus* resembles *F. asplenoides* Hedw. in plant, leaf size and rolling leaf tips. It is new record for Nepal.

1.39. *Fissidens sylvaticus Griff. var. **calcuttense** Gangulee, Mosses Ind. & Adj. Reg. **2**: 538-539**,** 1971; Pradhan & Joshi, Our Nature **4** (1): 67, 2006.

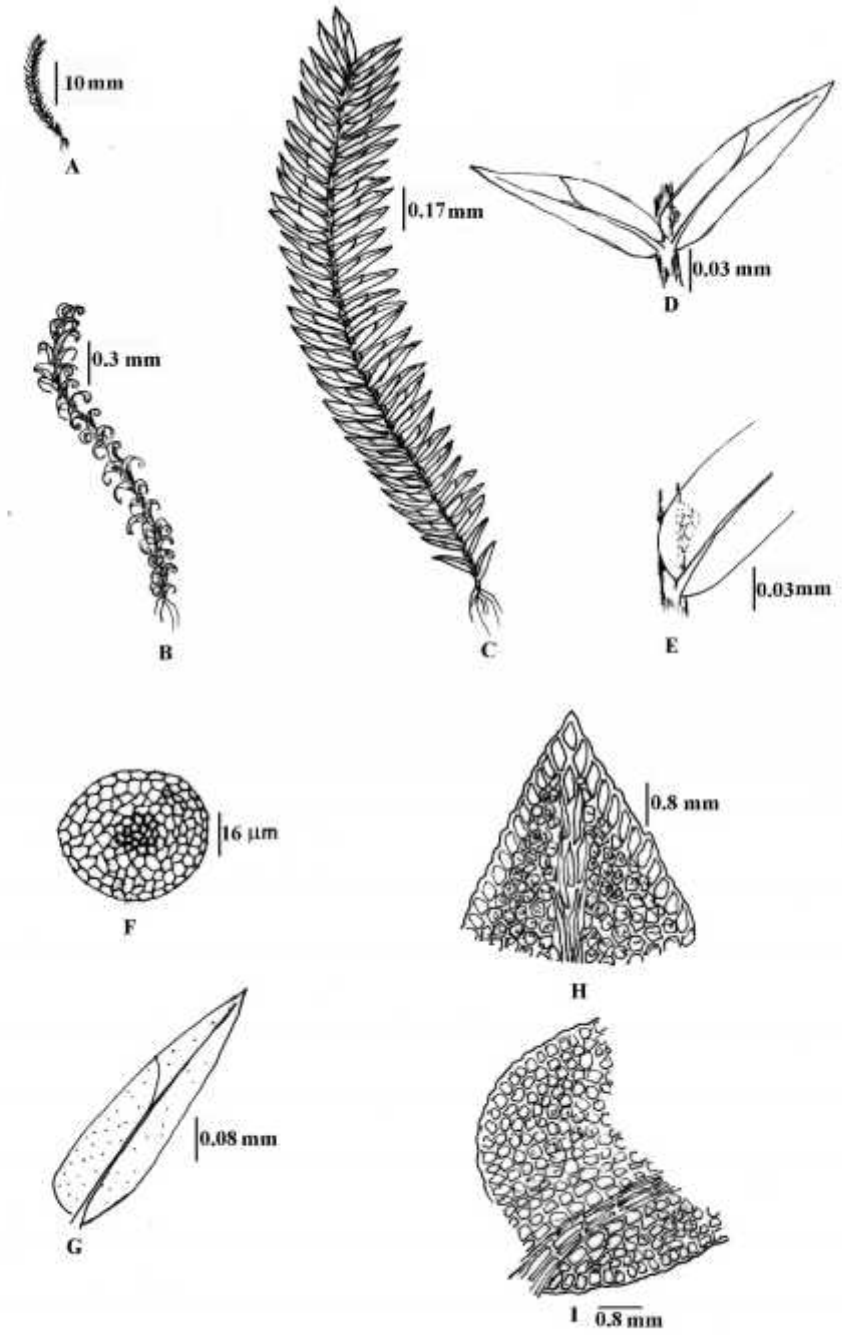

Fig. 53. *Fissidens sylvaticus* Griff. var. *calcuttense* Gangulee (Pradhan NGS 105, 487). A. habit, B. a dry plant, C. the plant enlarged, D. a portion of stem with a pair of leaves, E. a portion of leaf and stem with axillary hyaline nudule, F. cross section of the stem, G. leaf, H. apical portion of the leaf, I. basal portion of the leaf.

Plants medium in size up to 2 cm long and 2-3 mm broad with leaves. Stem with 32-34 pairs of leaves and glandular growth between the stem and sheathing lamini of leaves is observed. Leaves oblong-lingulate, upto 2.5 mm long and 0.5 mm wide in the median region, rolled inwards when dry. Leaf margin entire, costae percurrent ends few cells below apex, margin smooth. Apical laminae symmetrical, sheathing lamini closed type and occupied 2/3 portion of the entire leaf length, basal laminal base round. Cells on apical region convex mamillose, quadrate-hexagonal in the middle, 10-12 µm in diameter and cells in the basal region of sheathing lamini quite large, more or less rectangular near costa, about 15-18 µm long (Fig. 53).

Status: Uncommon

Habitat : Soil

Distribution : Nepal (220 m): Kailali (220 m), Bardia (240 m); India (South Bengal, Orissa)

Remarks: This species is very much identicle with *Fissidens involutus* Wils. by having 34 pairs of leaves, percurrent costae ends few cells below apex, and cells gradually larger towards the costae. It is reported as new record for Nepal.

1.40. Fissidens taxifolius Hedw., Sp. Musc.: 155, 1801; Mitt., J. Linn. Soc. London: 137, 1958; Gangulee, Mosses E. Ind. & Adj. Reg. **2**: 544- 547, 1971; Nog. & Z. Iwats. in Ohashi, Fl. E. Him. **3**: 248, 1975; Higuchi & Takaki in Watanabe& Malla, Crypt. Him. **2**: 125, 1990; Kattel & Adhikari, Mosses Nep.: 32, 1992; Pradhan, Mats. Checklist Bryo. Nep.: 45, 2000a; Pradhan & Joshi, Our Nature **4**(1): 67, 2006; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 29, 2007b.

Fissidens sylvaticus Griff., Cal. J. Nat. Hist., **2**: 507, 1842.

Common Pocket Moss; Split Tooth Moss (Eng.).

Plants bright green to dark green up to 20 mm long and 3 mm broad with 20 -30 pairs of leaves. Leaves not much crumpled but curled at the top when dry. Leaves oblong-lingulate, broadly acuminate, 2.5 x 0.5 mm in size. Dorsal lamina not narrowing at the base, apical lamina symmitrical, sheathing lamina usually unequal and open type, costa excurrent broad at the base, margin slightly serrated from apical to the base due to the projection of marginal cells. Marginal cells of sheathing lamina smaller. Laminal cells quadrate to hexagonal, 8 µm in diameter but larger, 12 µm wide at the base near costa. Setae orange, 12 mm, capsules brown, horizontal, 1.8 mm x 0.8 mm in size and with a ring of bright orange peristome teeth.

Status: Common.

Habitat: Soil.

Distribution: Nepal (W, C, E, 200-2700 m): Bardia (180-225 m), Banke (300 m), Kaski (920 m), Chitwan (1000-1200 m), Parsa (200 m), Makwanpur (230-670 m); Africa, Algeria, America, Borneo, Burma, C. Asia, Europe, Hong Kong, Indo China, Java, Japan, Korea, New Guinea, Madeira, Madagascar, New Zealand, Persia, Philippines, Samoa, South India, Sri Lanka, Sumatra, Thailand and Vietnam.

1.41. Fissidens virens Thwait. & Mitt., J. Linn. Soc. Bot., **13**: 324, 1875; Gangulee, Mosses E. Ind. & Adj. Reg. **2**: 497-498, 1971; Pradhan, Mats. Checklist Bryo. Nep.: 45, 2000a; Pradhan & Joshi, Our Nature **4**(1): 67, 2006; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 29, 2007b.

Plants small, 1.8 mm long and with 5-6 pairs of leaves. Leaves oblong-lanceolate, 1 x 0.2 mm in size, apex acute, and margin corrugated due to the projection of marginal cells, limbidium form by elongated cartilaginous cells on sheathing laminal margin. Apical lamina symmetrical, sheathing lamina ½ the length of entire leaf length, closed type, dorsal lamina sharply sloping down at the base and meet with costa at leaf attachment, so base is rarely round. Costae excurrent reach to the tip, broad at the base. Cells in apical and dorsal laminal region mamillous, regularly arranged and 4-6 µm in diameter, cells in the basal region little longer and 8-10 x 5-6 µm in diameter. Plants dioecious, setae 3-4 mm long, capsules short, funnel shaped when operculum is discharded, 0.3 x 0.2 mm in size.
Status: Rare
Habitat: Soil
Distribution: Nepal (E, 600-1400 m): Sankhuwasabha (600-1400 m), Borneo, India, Java, Sri Lanka, and Vietnam.

1.42. Fissidens zippelianus Dozy & Molk., Zoll., Syst. Verzeichn 29,1854; Higuchi & Takaki in Watanabe & Malla, Crypt. Him. **2**: 125, 1990; Kattel & Adhikari, Mosses Nepal*:* 32, 1992; Pradhan, Mats. Checklist Bryo. Nep.: 45, 2000a; Pradhan & Joshi, Our Nature **4**(1): 67-68, 2006; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 29, 2007b.

Yellow Phoenix Moss (Eng.).

Common in lowland areas, frequently forms a dense mat on the rock surface, tree bases and soil. This species has characteristic zigzag pattern at the stem tip and has hyaline nodules in each leaf tip. Stem erect, simple or branched, 20 mm in high. Leaves bright green, lanceolate with hexagonal mamillose cells, finely serrulated margin, excurrent costa which are loosely arranged on the stem. Setae terminal, 30 mm long, capsules yellowish green, short with long beak.
Status: Common
Habitat: Soil, soil covered rock and tree bases.
Distribution: Nepal (W, C, 230-1500 m): Kaski (800 m), Syanja (900 m), Chitwan (140 m); China, Kampuchea, North Japan, Thailand and Vietnam.

5.2.3.4. FUNARALES

Plants medium to small, erect with usually short stems, gregarious in habit mostly on moist soil, but members of family Splachnaceae are on dungs or decaying animals substrata form loose or dense tufts. Leaves usually broadly lanceolate, sharply pointed or rounded obtuse at apex, often large and crowded in a rosette at the stem apex, costae distinct, sometimes absent, cells large and lax throughout the leaf. Plants acrocarpous, setae long or short, capsules globular or pyriform,

symmetric or gibbose, lid present or absent, peristome double, but often one colony of outer row is well developed, sometimes absent. Three genera under two families are presented here.

Key to the families

1. Peristome teeth deplolepideae and free …… **1**. Funariaceae
   Peristome teeth haplolepideae and united in pair ……**2**. Splachnobryaceae

5.2.3.4. 1. FUNARIACEAE

Plants usually autoecious. Stems simple or branched, usually with central strands, short, erect with crowded broad leaves at the apex. Leaves soft, ovate, concave, margin plane or toothed, costae usually percurrent or excurrent, areolation very lax, cells smooth, rectangular, rhomboidal or hexagonal, elongated towards margins. Setae short or elongated, capsules globular or pyriform, symmetrical or gibbous with or without neck, stomata numerous at the base of the capsule, operculum conical or apiculate, calyptrae cucullate or mitriform, often with inflated and characteristically long beaked.

Brotherus (1924) included 9 genera in this family. Three genera and 8 species are known from Nepal.

Key to the Genera

1. Peristome rudimentary; capsules symmetrical, operculum beaked …… **2**. *Physcomitrium*
   Peristome well developed; capsules asymmetrical, operculum curved ……... **1**. *Funaria*

1. Funaria Hedw., Sp. Musc., 1801.

Funaria is the common genus of family Funariaceae found in different habitat especially on lime rocks and recently burned areas. Plants small, erect and acrocarpous, leaves broad, concave and top rosette of leaves very conspicuous, seta long, twisted down the capsule, capsule with apophysis strongly asymmetric, usually elongated pyriform, peristome deplolepideae, inner peristome teeth hyaline, operculum plano-convex without apiculus and calyptrae cucullate.

More than 100 species of *Funaria* are known in the World. Two species are recorded from Nepal.

1.1. Funaria hygrometrica Hedw., Sp. Musc. 172, 1801; Gangulee, Mosses Ind. & Adj. Reg. **4**: 856-859, 1971; Nog. & Z. Iwats. in Ohashi, Fl. E. Him. **3**: 257, 1975; Karczm., Lindbergia **7**: 128, 1981; Pradhan, Mats. Checklist Bryo. Nep.: 45, 2000a; Pradhan, J. Nat. Hist. Mus. **19**: 69, 2000b; Pradhan, J. Nat. Hist. Mus. **20**: 30-31, 2001; Chaudhary & Sharma, Vasundhara **6**: 35, 2001.

Funaria nepalensis C. Muell., Bot. Ztg. Regensburg **13**: 748, 1855.

F. lonchopelma C. Muell., Hedwigia **38**: 61, 1899.

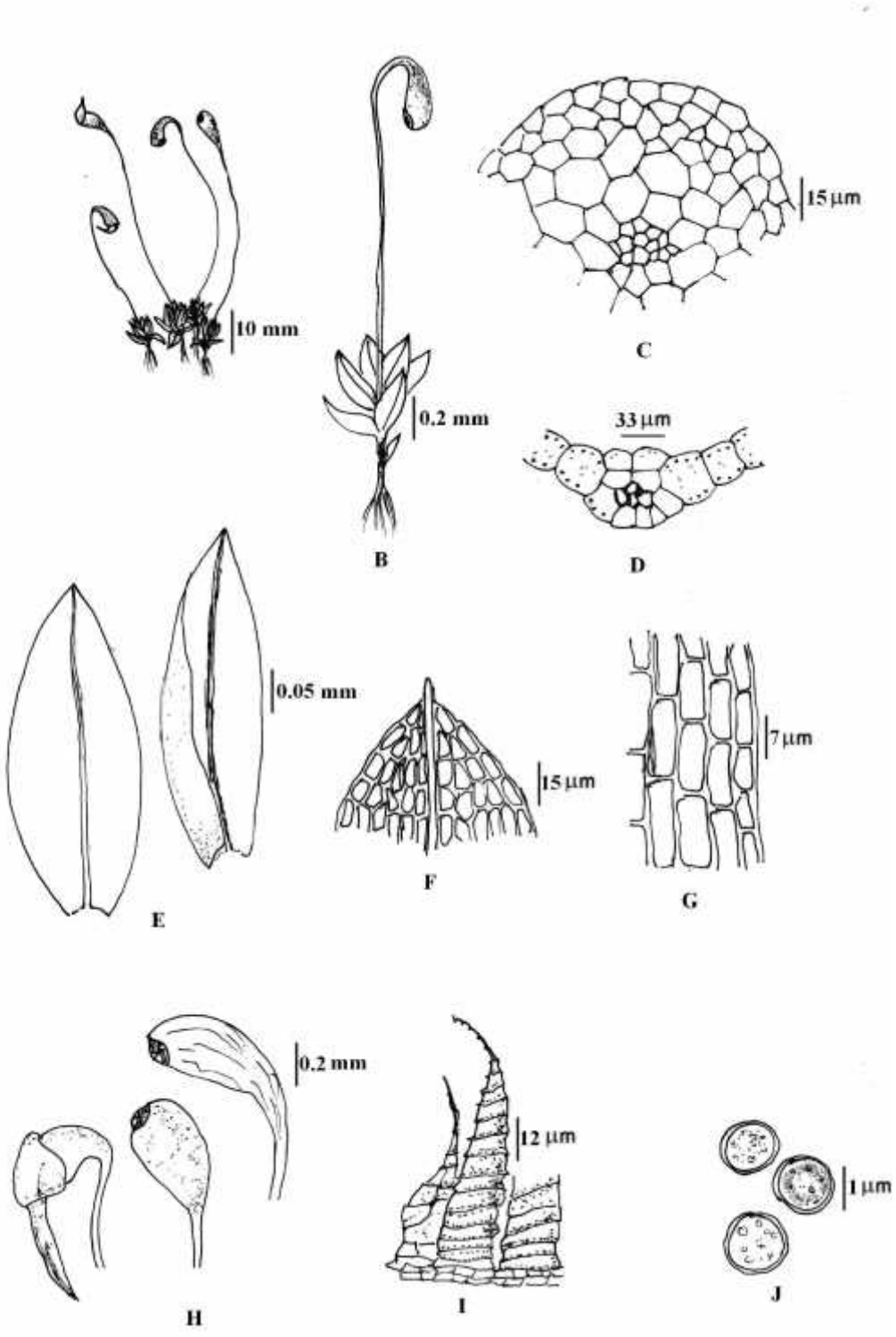

Fig. 54. *Funaria hygrometrica* Hedw. A. habit, B. a fertile plant, C. cross section of the stem showing tissues, D. cross section of the leaf, E. leaves, F. apical portion of the leaf, G. cells in the basal region of the leaf, H. capsules, I. peristome teeth, J. spores.

Curd Moss; Water Measuring Curd Moss (Eng.).

Plants erect, bright green. Stems simple or branched, up to 1 cm high found in tuft. Rhizoids cluster at the stem base. Leaves on the basal region of stem small with poor developed costae, upper leaves large forming a rosette on top, concave, oblong obovate to oblong-lanceolate, erect spreading, 2.5-4 mm long and 1-1.4 mm wide in the middle, margin entire, apex acute, costae strong percurrent to short excurrent. Laminal cells thin walled, sub-hexagonal, more elongated at the base, 110 x 25 µm, smaller towards apex, 40 x 20 µm in diameter. Plants autoecious. Seta apical, erect, strongly arcuate, capsule horizontal to pendulous actuate-pyriform, asymmetrical with narrow mouth, apophysis up to 2 mm diameter, mouth deep red becoming brown with the age. Peristome double, outer peristome teeth brown, spirally arranged, 580 x 90 µm in diameter, inner peristome teeth hyaline. Spores small, spherical (Fig. 54).

Status: Uncommon

Habitat: Moist and exposed brick walls, rocks, tree barks and soil.

Distribution: Nepal (W, C, E, 1000-1500 m): Dang (1000-1300 m), Chitwan (1000 -1200 m); Australia, Africa, Europe, India, Japan, Java, Korea, Mainland China, Myanmar, New Zealand, North and South America, Occania, Pakistan, Siberia, Sri Lanka, Taiwan, Thailand and Vietnam.

Remarks: A common species in Kathmandu Valley but rare at lowland areas.

1. **Phycomitrium** (Brid.) Brid., Br. Univ. 1827.

Acrocarpous, erect, small to medium, yellowish green to pale green plants, tufted to gregarious on moist earth. Stem simple and rarely branched, more or less 1 cm. tall, central strand present, rhizoids at the base. Leaves erect to wide spreading, dense at the top forming rosette, concave, obovate to spathulate, acute to acuminate apex, margin usually bluntly serrulate above, rarely entire throughout, costa slender to moderately stout, sub-percurrent to short excurrent, laminal cells oblong to hexagonal to sub-quadrate to short rectangular, sometimes rhomboidal, thin walled, marginal cells usually elongated with forming a boarder, basal cells becoming larger, laxer and thinner, alar cells not differentiated. Plants dioecious. Sporophytes apical, single from each plant, seta erect, short to elongated, yellowish to reddish brown, smooth, capsule immersed to exerted, turbinate to pyriform, peristome absent, annulus present, operculum apiculate or rostrate, calyptrae usually erect with long beak. Spores spherical, warty to papillae.

Key to the species

1. Apical upper half margin of leaf crenulate ……..... 2
   Margin entire throughout the leaf …….……....… **3**. *Phycomitrium japonicum*

2. Leaves large, broadly ovate; seta 2-8 mm long …….……..… 3
   Lower leaves spatulate, upper leaves lanceolate; seta ca. 15 mm long …… **3**. *P. japonicum*

3. Capsule pyriform with distinct apophysis …….....…. **4**. *Phycomitrium pyriforme*
   Capsule cup shaped with small apophysis ……..…… 4

4. Calyptra with short beak, spores large, 25-40 µm ……...…… **2.** *Phycomitrium eurystomum*
   Calyptra with long beak, spores more than 40 µm ……. **1**. *Phycomitrium cupuliferum*

2.1. * Phycomitrium cupuliferum Mitt., J. Linn. Soc. Bot. **12**: 242, 1869; Allen *et al*., Moss Fl. C. Amer. **2**: 266, 2002.

Plants small, erect, bright green, 2 mm tall and 1 mm wide with expanded leaves forming tuft on substratum. Leaves crisped to the stem when dry. Leaves bright green, ovate, 2 mm long and 1 mm wide in the middle, margin smooth at the basal region and serrated the upper half due to projecting the apical cells. Marginal cells hyaline, elongated, distinct one row at the basal region and two rows at the apical to median region, 58 x 20 µm in diameter. Cells in the apical region elongated, short rectangular in the median region, 21 x 18 µm in diameter. Basal cells clear rectangular, hyaline, thin walled, 79 x 34 µm in diameter. Plants dioecious, acrocarpous. Setae erect, smooth, yellowish brown to orange red and 2-4 mm long, capsules broadly short, cup shaped, brown, 1 x 1 mm in size without operculum, opercula yellowish brown rostrate with short tip, annulus ring orange, teeth not seen, calyptrae brown with long beak, 1.2 x 0.5 mm in size, apophysis distinct. Spores numerous, spherical, brown, papillose, 33-35 µm in diameter (Fig. 55).

Status: Rare.
Habitat: Moist soil near water source
Distribution: Nepal (E, 180 m): Morang (180 m); Central America and Costarica.
Remarks: This species is reported only in eastern Nepal (180 m) as new record for Nepal.

2.2. *Phycomitrium eurystomum Sendth. in Denkschr, Bayr. Bot. Ges. Regersburg, **3**: 142, 1841; Smith, Moss Fl. Britain & Ireland: 334, 1980; Iwatsuki, Bull. Nats. Sci. Mus., Tokyo, Ser. B. **11**(2): 64, 1985; Kurschner & Erdag, Turk. J. Bot. **29**: 30, 2005; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 29, 2007b.

Phycomitrium acuminatum B.S.G., Bryol. Eur., **3**: 247, 1841.

P. acuminatum B.S.G. var. *denticulatum* Rabenh. in Deutschi. Krypt. Fl., **2**: 87, 1848. *Gymnostomum eurystomum* (Sendtn.) Lindb. et. Arn., K. Svensk. Vet. A. Handl. **23**: 58, 1890.

Phycomitrium spurio-acuminatum Dix., Rev. Bryol. Lichenol, **7**: 107, 1934.

Bowl Moss; Norfolk Bladder Moss (Eng.).

Plants small, simple, 3-8 mm high scattered as well as tufted. Leaves cluster at the top, erect spreading, ovate-lanceolate to broadly ovate with acute apex, 3.5 x 1 mm in size. Leaf margin flat, dentate in the upper parts, costa strong, 75 µm wide at the base, percurrent to short

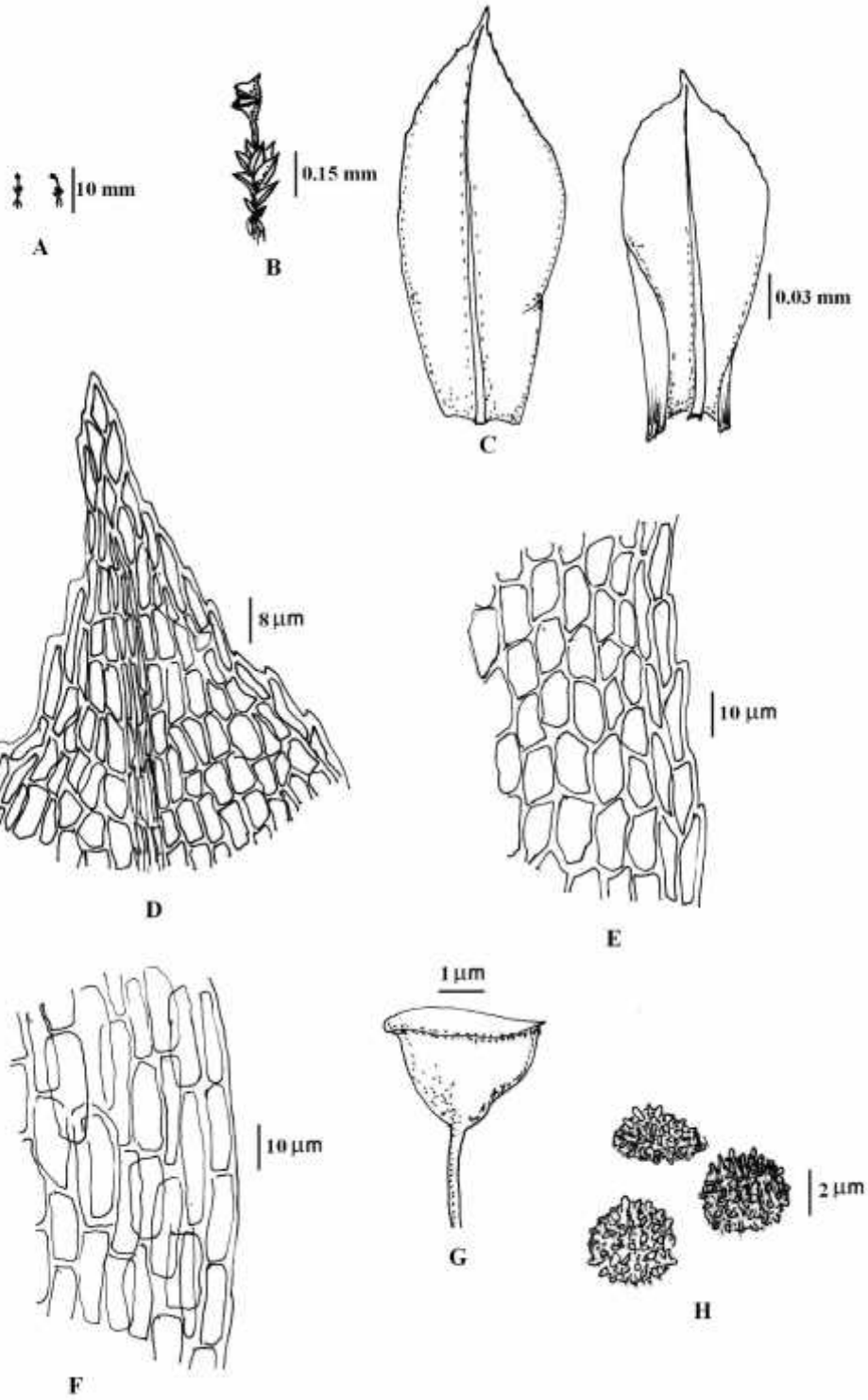

Fig. 55. *Phycomitrium cupuliferum* Mitt. (Pradhan dt 100). A. habit, B. the plant enlatged, C. leaves, D. apical portion of the leaf, E. median portion of the leaf at the marginal region, F. basal portion of the leaf at the marginal region, G. capsule, H. spores.

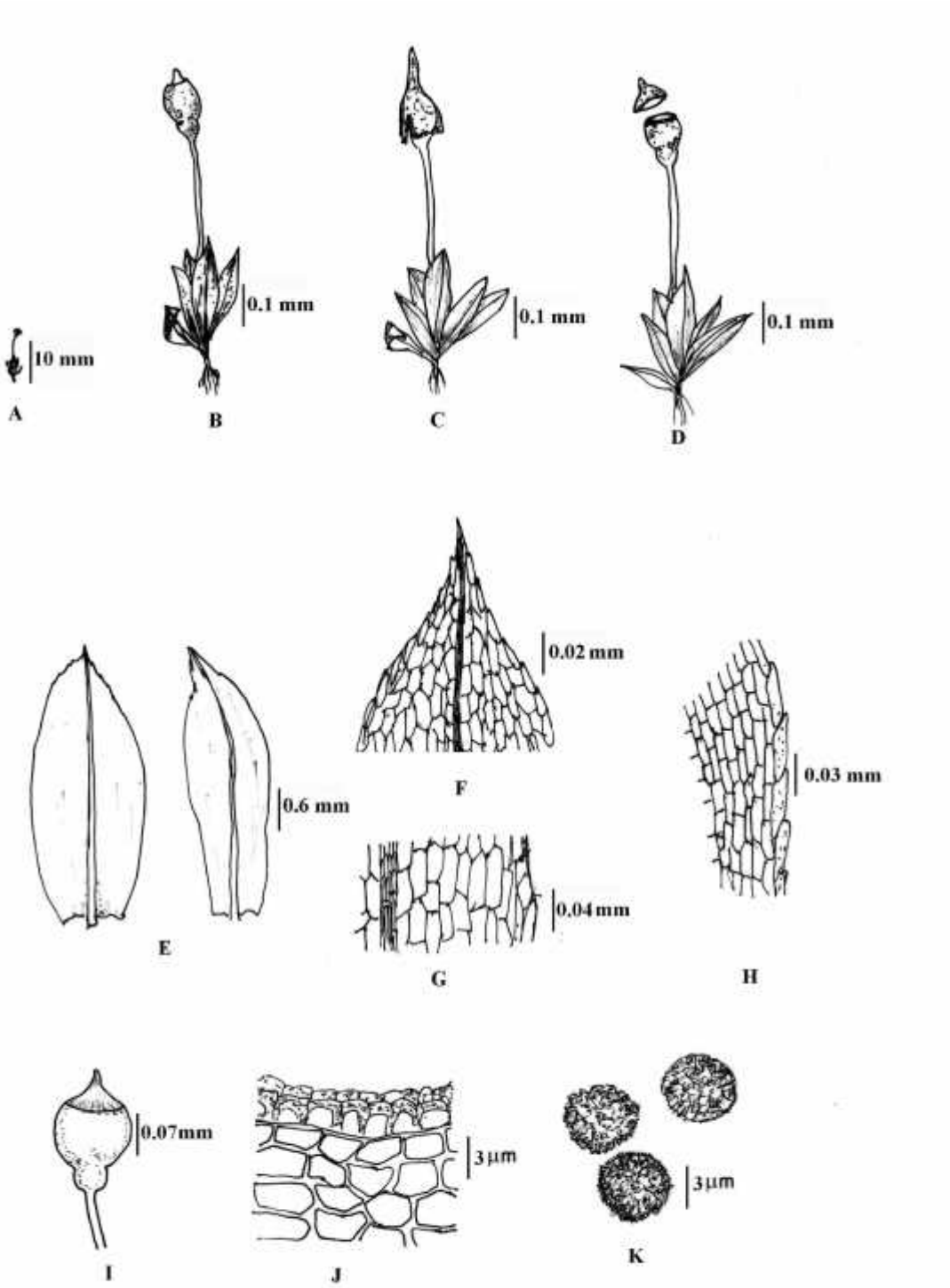

Fig. 56. *Physcomitrium eurystomum* Sendtn. (Pradhan Pn 172). A. habit, B-D. fertile plants, E. leaves, F. apical portion of the leaf, G. basal portion of the leaf, H. marginal portion of the leaf, I. capsule, J. mouth of exothecium, K. spores.

excurrent. Laminal cells thin walled, short rectangular at the apical region, 45 x 23 um in diameter, middle laminal cells rectangular, 60 x 20 µm in diameter, basal cells large rectangular and 150 x 30 µm in diameter, cells in the margin elongated and in one or two rows. Setae slender, 4-8 mm long, capsules short pyriform with short apophysis, 1 mm in diameter, capsule mouth wide when operculum discarded, operculum with short rostrate. Spores round, dark brown, papillose, 25-40 µm in diameter (Fig. 56).

Status: Common.
Habitat: Soil on dried out ponds and river banks.
Distribution: Nepal (W, C, 190-300 m): Bardia (175-190 m), Chitwan (180-300 m); Central & South Africa, China, Formosa, France, Great Britain, India, Japan, Taiwan, Turkey and Vietnam.
Remarks: Common in lowland areas but reported for the first in Nepal.

2.3. Phycomitrium japonicum (Hedw.) Mitt., Trans. Linn. Soc. Bot. Lond. ser **2, 3**: 164, 1891; Iwatsuki, Bull. Nats. Sci. Mus., Tokyo, Ser. B. **11**(2): 64, 1985; Townsend, J. Bryol. **24**: 327, 2002.

Gymnostomum japonicum Hedw., Sp. Musc. **34**. 1f.: 7-9, 1801.

P. limbatulum Broth.et Par., Rev. Bryol. **38**: 53, 1911.

P. nipponense Sak., Bot. Mag. Tokyo, **52**: 1938.

Japanese Bowl Moss (Eng.).

Plants small, simple, bright green, 5-10 mm high on moist soil, large patch on exposed area of the garden. Leaves rosette at the top, erectospreading, appressed to the stem when dry. Leaves ovate-lanceolate to spathulate-lanceolate with acute apex, 4 x 1 mm in size, margin entire throughout and costa almost reaches to apex, laminal cells thin walled, rhomboidal to quadrate to hexagonal at the apical region, 56 x 23 µm and rectangular, hyaline at the basal region, 90 x 45 µm in diameter, marginal cells elongated, capsule cup-shaped, seta long, smooth, up to 15 mm long, spores spherical, light brown to dark brown, opaque, reticulated and smooth margin, 22-30 µm in diameter (Fig.57).

Status: Uncommon
Habitat: Garden soil.
Distribution: Nepal (C, 250 m): Chitwan (150-250 m); Bhutan, China (Hong Kong, Taiwan), India (Sikkim, Assam), Japan and Korea.
Remarks: This is an uncommon species recorded only at Chitwan dristrict.

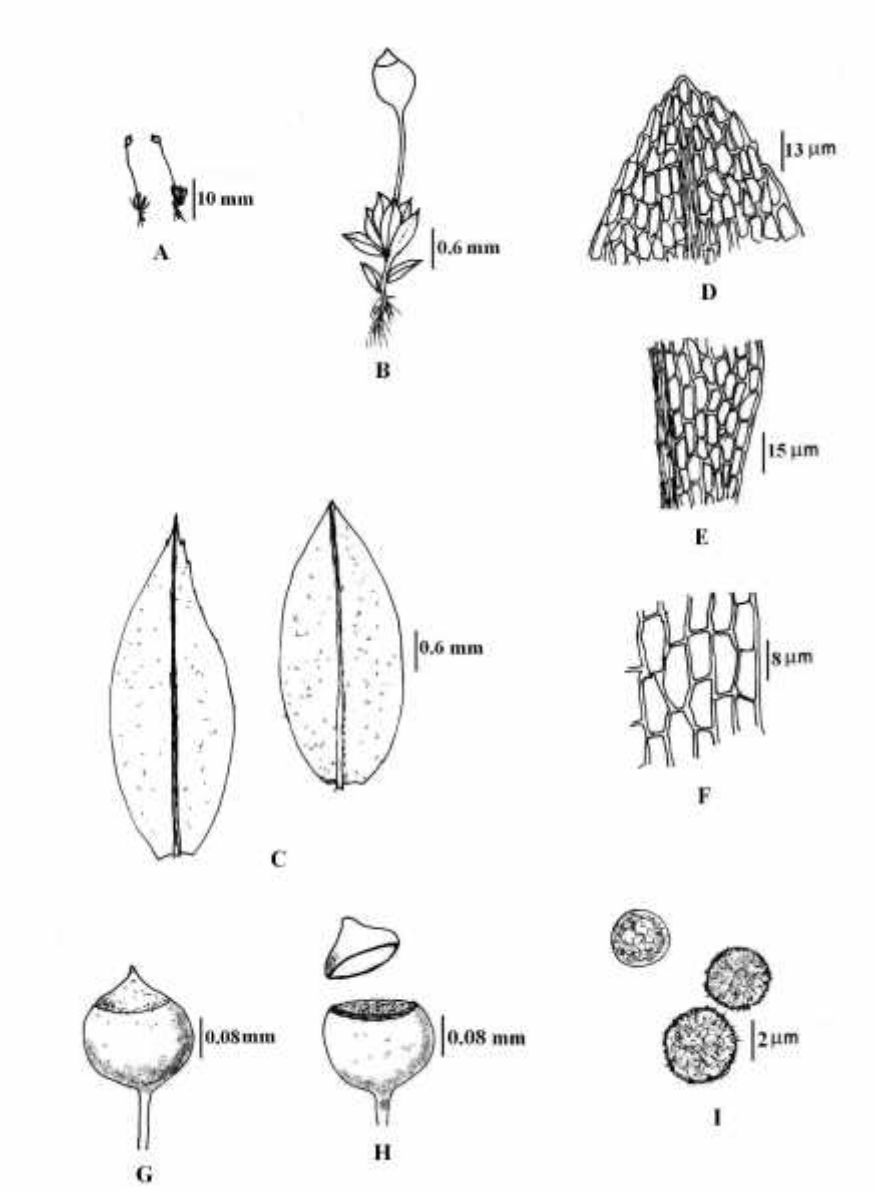

Fig. 57. *Physcomitrium japonicum* (Hedw.) Mitt. (Pradhan Pn 237). A. habit, B. fertile plant, C. leaves, D. apical portion of the leaf, E. basal portion of the leaf, F. cells at the basal region, G. capsule, H. open capsule, I. spores.

2.4. Phycomitrium pyriforme (Hedw.) Hampe, Linnaea **11**: 80, 1837; Nyholm, Moss Fl. Fennoscandia **4**: 170-171, 1974; Eddy, Malasian Mosses **3**: 115-116, 1996; Pradhan, Mats. Checklist Bryo. Nep.: 46, 2000a.

Common Bladder Moss (Eng.).

Plants gregarious on moist soil on forest floor. Plant acrocarpous, yellowish green, unbranched, 5-10 mm tall and 1.5 -2 mm wide with expanded leaves, stem yellowish brown with cluster of leaves at the apical region and rhizoids at the base, central strand present, upper leaves large, obovate-lanceolate and lanceolate at the basal region, apex acute, margin usually bluntly serrulate above, entire at the basal region, costa slender ends just below the apical cell, laminal

cells hexagonal to sub-quadrate to short rectangular, with thin walled, marginal cells usually elongated with forming a boarder, basal cells becoming larger, laxer and thinner, alar cells not differentiated. Sporophytes apical, single from each plant, seta erect, smooth, pinkish to reddish brown, 6 mm long, capsule pyriform with distinct apophysis, yellowish brown to brown in colour, 1 x 1 mm in size, peristome absent, annulus present with two rows of cells, operculum apiculate, calyptras with long beak, spores numerous, spherical, yellowish brown, papillae, 28-35 µm in diameter.

Status: Uncommon.
Habitat: Soil
Distribution: Nepal (C, E, 300 m): Morang (300 m), Sunsari (180 m); Algeria, Caucasus, Europe, Fessoscandia, Macaronesia, Malay Peninsula. Malaysia, Morocco and Philippines.
Remarks: Previously this was reported by Wallich *s.n.* (BM) from central Nepal.

5.2.3.4. 2. SPACHNOBRYACEAE

Plants acrocarpous mostly grow on humus soil. Stems section shows few layers of large cells with thickened walls surrounding a few layers of cells with thinner walls, both layers chlorophyllose, central strand undifferentiated . Leaves oblong to obovate-spatulate, rarely bordered with elongate cells; costa single, medial laminal cells of leaves oblong, smooth or occasionally distinctly mammillose on one or both surfaces. Asexual reproduction by gemmae on axillary rhizoids and by rhizoid tubers. Plants dioecious; perigonia terminal, becoming lateral by innovations, antheridia solitary in leaf axils. Setae single, short, smooth. Capsule erect, symmetric; operculum conic-apiculate; peristome a single, Calyptrae elongate, narrowly conic-cylindric, split from base on one side. Spores spheric, yellowish.

One genus *Splachnobryum* and ca. 26 species have been recorded from the world (Crosby *et al*., 2000)

Splachnobryum has been regarded as the sole genus of the family Splachnobryaceae (Koponen 1981). Previously the genus was placed in the Pottiaceae or in the Splachnaceae. The axillary archegonia, absence of paraphyses, single circle of peristome teeth and the peculiar axillary hairs (mucilage hairs) help define the family.

1. **Splachnobryum** Muell. Hal., Verh. K. K. Zool.-Bot. Ges. Wien. **19**: 503, 1869.

Plants gregarious to tufted, mostly small and soft. Stems erect. Leaves with margins plane to recurved, mostly crenulate distally, sometimes entire, apex rounded; costa short to elongate, ending at midleaf to percurrent or shortly excurrent; distal cells of leaf in ascending rows diverging from costa. Capsules cylindric to pyriform, with stomata at base; peristome set deep inside capsule mouth, the teeth wide-spreading when dry, connivent over the mouth of the capsule when moist. Calyptrae cucullate. Antheridia and sporophytes are uncommon.

Splachnobryum commonly grow on basic substrates in moist situations; they are sometimes tuft-forming mosses.

1.1. Splachnobryum aquaticum Muell. Hal., Linnaea **40**: 291, 1879; Arts, Lindbergia **26**: 79, 2001.

Plants bright green, erect, soft in tauch, rarely branched, gregarious in habit and attached tightly on the substratum. Stems erect, 10-15 mm long and 3 mm wide with expanded leaves, maroon red below and light green above, rarely branched and with rosette of leaves at the apical region. Stem cells in cross section rather large and thin walled and epidermal cells with slightly thick walled, central strand present. Leaves wide spread, obovate to spathulate, 4.5 x 2 mm in size, leaf apex blunt, margin plane and slight concave at the base, costae single ending far below the apex, green, 2 celled thick and with elongated cells, 23 µm in diameter. Cells at the apical region at the marginal region more or less quadrate, 11 x 23 µm in diameter, middle laminal cells elongated hexagonal, 70 x 15 µm in diameter, basal cells short, hexagonal, 45 x 15 µm in diameter. Plants dioecious, acrocarpous. Setae erect, smooth, 5-10 mm long, capsules erect, short cylindrical, symmetrical, opercula conic-cucullate, annulus and teeth present. Spores spherical, yellowish green.

Status: Rare.

Habitat: Swampy soil

Distribution: Nepal (W, 190 m): Bardia (190 m); Africa.

Remarks: This dung loving species was collected from the swampy soil near by water source where accumulation of bulk of Rhino's dung. This is a very rare moss which was previously reported from Nepal by Arts (2001) as new to Nepal.

5.2.3.5. HOOKERIALES

Plants autoecious or dioecious. Male inflorescences lie on stem or branches and female inflorescences on short branchlets. Leaves symmetrical or asymetrical, ovate, obtuse to lanceolate, acuinate, complanate or erect spreadinig, margin entire or serrate, nerve single, double or absent, cells hexagonal to rhboides. Setae erect, long, capsules erect or horizontal, smooth or papillose.

5.2.3.5.1. HOOKERIACEAE

Plants slender to robust forming soft mats. Stems irregularly to pinnately branched. Leaves 4 or 8 rows mostly complanate of variable shapes, mostly asymmetrical, spreading all sides, costae double, single or absent, laminal cells mostly parenchymatous smooth or papillouse, alar not differentiated. Male and fermale plants generally alike. Male inflorescence gemmiform on main stem or on specilized branches, female inflorescences on very short perichaetial branches. Setae smooth or papillose, erect, capsule inclined or horizontal, symmitrical or asymmetrical, ecothecium cells large, peristome double, teeth yellow to yellowish red or purple, linear-lanceolate, operculum finely rostrate, calyptrae conical-mitriform, shortly lobed at the base or fringed with cilia, smooth or papillose or hairy. Spores small.

The species of this family are exclusively occur in the warm region of the world, growing on

decaying logs, but rare in rock and forest floors. Lin and Tan (1995) recorded 27 genera in this family from the world and listed 22 species, 2 subspecies and 7 varieties in China. Nepal has reported six species so far. One species has been described in the present investigation.

1. Hookeria Sm., Trans. Linn. Soc. London **9**: 275, 1808.

Plants bright green, glossy, large, delicate forming soft mats on soil. Stems usually elongated not much branched, complanate. Leaves ovate-lanceolate and complanate, in 5 rows, margin flat and smooth, often bearing gemmae at leaf apex, costae absent, laminal cells lax, thin walled, rhomboidal to hexagonal, reactangular at the marginal region. Plants autoecious. Setae long, lateral, capsules oval with short apophysis, operculae conical with erect beak, calyptrae mitriform, lobed at the basal region. Spores small.

The genus is named for the renowned British botanist William Jackson Hooker (1785-1865). *Hookeria* contains 2-3 species of north temperate affinities; Two species of *Hookeria* has been recorded from Nepal and one species is described from lowland.

1.1. Hookeria acutifolia Hook. & Grev., Edinburgh J.. Sci **2**: 225, f. 5, 1825; Nog. & Z. Iwats. in Ohashi, Fl. E. Him **3**: 272, 1975; Gangulee, Mosses E. Ind. & Adj. Reg. **6**: 1493-1495, 1977; D.G. Long, Bryobrothera **1**: 122, 1992; Pradhan, Mats. Checklist. Bryo. Nep.: 47, 2000a.

Plerygophyllum acuitifolium (Hook.) Grev. in C. Muell, Linnaea 21: 94, 1825.

Hookeria grevilleana Griff., Cal. J,. Nat. Hist. **3**: 276, 1843.

Hookeria lucens (Hedw.) Sm. var. *Acuminata* C. Muell., Sys.**2**: 202, 1851.

Hookeria nipponensis (Besch.) Broth., Nat. Pfl. **1**(3): 934, 1907.

Sharp leaf Hookeria; Pointed-leaved Oily Moss (Eng.).

Plants large, delicate, bright green, glossy forming tuft on moist soil, boulder stones and leaf litter, also found intermingled with *Cyathodium tuberosum* (dt.370). Plants very much similar to leafy liverworts. Stem erect or procumbent, fleshy, spraringly branched and whitest green with overlapping and complanate leaves. Leaves in three rows, glossy, yellowish green, ovate with acute apice, entire margin and without costa, 1.5-2 x 0.6 mm in size, laminal cells hexagonal, thin walled, 90-145 x 20-23 µm in diameter, poor in chloroplastids and embedded at the periphery. Gemmae often present at the leaf apex. Plants autoecious, setae lateral, dark red, smooth and 18-20 mm long, Capsule horizontal to pendent ca. 1.2 mm long with short hypophysis, operculum conic-rostrate, calyptra conic to mitrate, teeth reddish brown, 453 x 113 µm in size. Spores light brown, spherical, smooth, 9-12 µm in diameter.

Status: Rare, Type: Nepal. Wallich.(www.**MOBOT**.org/Bryophytes/Tropicos/AndeMoss Project).

Habitat: On rotton logs.

Distribution: Nepal (E, 180-2850 m): Morang (450 m), Sunsari (180 m); Bhutan, Bolivia, Brazil, China (Hong Kong), Combodia, East Asutralia, Equador, India (Sikkim, Darjeeling, Palni,Khasia), Indonesia, Japan, Java, Korea, Pacific Island, Southern USA., Sri Lanka, Taiwan, Maxico, Venejuela, Vietnam and West Indies.

Remarks: Previously it was recorded from Ilam, 1150 m, and Lamo pokhari, 2800 m of east Nepal. This is the first record from lowland area.

5.2.3.6. HYPN0BRYALES

A very large order comprising all the pleurocarpous mosses common in tropical rain forest. Stems pinnately or bipinnately branched with complanale leaves, symmetrical or nearly so. Capsules erect, inclined or pendulous, peristome double, inner ottern well developed. Members of th seven families under this order have been studied in the present investigation.

Key to the families

1. Alar cells sharply defined, often large and inflated ……..…….....… ……. 2
   Alar cells few and inconspicuous ……..……..……. 3

2. Alar cells numerous, quadrate or transversly enlarged; costae distinct; capsule erect ……..... **2**. Entodontaceae
   Alar cells few, oblong, costa very short or lacking; capsule horizontal ..... **5**. Sematophyllaceae

3. Laminal cells large, wide and thin walled ……...……...…....…. **4**. Hypnaceae
   Laminal cells small, narrow more or less elongated …….…..…….…..… 4

4. Plants glossy; branch leaves and stem leaves different ……..…….…....…… 5
   Plants dull; branch leaves and stem leaves alike …….……...…..….. 6

5. Leaves strongly complanate, decurrent; laminal cells rhomboidal ……... **6**. Stereophyllaceae
   Leaves small, flat with serrulated margin; middle laminal cells rhomboidal and basal cells quadrate ……..……. **3**. Fabroniaceae

6. Branch leaves smaller than stem leaves, scale like; stems without central strand.. **7**. Thuidiaceae
   Branch leaves and stem leaves alike, broadly triangular; stems with well develop central strand ……..……. **1**. Brachytheciaceae

5.2.3.6.1. BRACHYTHECIACEAE

Plants creeping, loosely complanate, pinnately branched irregularly; forming loose to dense mats. Central strand well developed; paraphylla absent; pseudoparaphyllia foliose; radiculose. Leaves crowded to distant, broadly to rather narrowly ovate, ovate- to oblong-lanceolate, often plicate at or near the base or extending beyond median region, apex acute, base often short to long decurrent; margins plane or reflexed, serrate, often near the base; costae single, percurrent, rarely short excurrent; upper and median cells smooth, elongated, mostly fusiform to linear, occasionally vermicular, alar region little differentiated, cells sub-quadrate to oblong-rectangular. Gemmae absent. Plants dioecious, autoecious or rarely synoecious. Perichaetia lateral, setae elongate, smooth or variously papillose throughout or distally. Capsules inclined to horizontal, cylindrical, asymmetric; conic to conic-short or long rostrate, oblique or not, peristome double, calyptrae cucullate, smooth and naked. Spores spherical, usually papillose.

Brachytheciaceae is a large family of class Musci. Japan shelters 13 genera while Nepal has the record seven genera and 28 species.

1. Brachythecium B.S.G., Bryol. Eur. **6**: 5, 1853.

Plants medium to robust, prostrate and creeping forming mats or tufts, glossy green, pale yellow to golden-brown. Stems irregularly to pinnately branched, central strand present, paraphyllia absent; pseudoparaphyllia foliose, radiculose. Stem leaves loosely erect to erect-spreading, ovate-triangular or -lanceolate, less often ovate, generally plicate, concave, apex gradually to abruptly short to long acuminate, often half or fully twisted, base rounded to subcordate, usually decurrent; margins plane to reflexed or recurved toward the base, entire to serrate, costae single, 1/2-2/3 of laminal length, often ending in an indistinct back tooth; laminal cells smooth, thin to thick-walled, apical cells usually linear, median cells linear-vermicular to fusiform, basal cells irregularly rectangular to sub hexagonal, alar region differentiated, cells quadrate to rectangular, gemmae absent. Plants autoecious or dioecious, occasionally polygamous. Perichaetial leaves usually differentiated from stem leaves. Setae elongate, smooth to papillose. Capsules inclined to horizontal, urn oblong-ovoid to cylindrical, slightly curved, asymmetric; annuli differentiated or not; opercula conic-apiculate; peristome double, Calyptrae cucullate, smooth and naked. Spores spherical, lightly papillose, less often nearly smooth.
The genus *Brachythecium* has 257 species distributed all over the world (Gangulee, 1979), 13 species in India (Chopra, 1975) and 11 species in Nepal (Pradhan, 2000b).

Key to the species

1. Plants yellowish to dark green; stems creeping, irregularly pinnately branched ……..……. 2
   Plants yellowish green; stems with many erect short and long branches ……..... **3**. *Brachythecium populeum var. populeum*

2. Costae 3/4 length of the entire leaf length; capsules sub erect; peristome normal ……...……..……..... **1**. *Brachythecium buchananii*
Costae 2/3 of the entire leaf length; capsules horizontal, peristome vary in size ……...…….…… **2**. *Brachythecium garovaglioides*

1.1. Brachythecium buchananii (Hook.) A. Jaeger, Ber. S. Gall. Naturw. Ges. 1876 -77, 1878; Takaki, J. Hattori Bot. Lab. **15**: 18-22, 1955; Wadhwa & Vohra, J. Bomb. Nat. Hist. Soc .**62** (2): 263, 1965; Nog. in Hara. Fl. E. Him **1**: 579, 1966b; Nog. & Z. Iwats. in Ohashi. Fl. E. Him. **3**: 275, 1975; Gangulee, Mosses E. Ind. & Adj. Reg. **7**: 1711-1714, 1978; Higuchi & Takaki, Cryp. Him. In Watanabe & Malla, **2**: 147, 1990; Kattel & Adhikari, Mosses Nepal: 9, 1992; Pradhan, Mats. Checklist Bryo. Nepal: 26, 2000a; Pradhan, J. Nat. Hist. Mus. **19**: 63, 2000b; Koponen *et al.*, Ann. Bot. Fennici **37**: 26, 2000; Pradhan & Shrestha, Proc. Int. Seminar on Mountain-Kath: 552, 2003; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 23, 2007b.

Hypnum buchanani Hook., Trans. Linn. Soc. **9**: 320, 1808.

Plants dark green to yellowish green often dirty green in wide loose patches. Stem slender, creeping, 5 to more cm. long, irregularly pinnately branched, branches soft, 1-2 cm. long, rather loosely imbricate. Stem leaves ovate to ovate-lanceolate acuminate, deeply plicate, almost entire, costa thin 3/4 of the entire leaf length, median leaf cells fusiform-hexagonal, 85 x 8 µm in diameter, sometimes narrowly linear, 97 x 6 µm in size, basal and alar cells short and broader, quadrate to oblong hexagonal. Branch leaves lanceolate gradually tapering into acute, deeply plicate, median leaf cells shorter than those of stem leaves. Plants dioecious. Setae smooth, 2-3 cm long, erect. Capsules oblong-cylindrical, sub-erect, 2.5 x 1 mm in size, peristome normal.
Status: Common
Habitat: Soil and tree trunks.
Distribution: Nepal (C, E, 800-4720 m): Kaski (800 m); Bhutan, Burneo, India (Assam), Indo-china, Japan, Korea and Philippines.
Remarks: Common in eastern region.

1.2. Brachythecium garovaglioides Muell. Hal., Ann. Boty. Fennici. **33**: 285-301, 1996; Sharma *et al.*, Crypt., Bryologie **23**(3): 221-224, 2002; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana*:* 23, 2007b; Pradhan & Joshi, Nep. J. Pl. Sci. **2**: 31, 2008a.

Hypnum wichurae Broth., Hedwigia **38**: 239, 1899.
Brachythecium wichurae (Broth.) Par., Index Bryal. Suppl. **52**: 136-164, 1900; Higuchi & Takaki in Watanaber & Malla, Cryp. Him. **2**: 148 -149, 1990; Kattel & Adhikari, Mosses. Nep.: 10, 1992; Pradhan, Mats. Checklist Bryo. Nep.: 26, 2000b.

Green Silk Moss (Eng.).

Plants yellowish green to bright green in tufts. Main stem creeping, irregularly pinnately branched. Branches spreading and divergent when dry. Leaves broadly ovate-lanceolate or triangular-ovate, 2-3 x 1-1.2 mm in size, apice long acute, often twisted, margin smooth, costa single extends 2/3 of the leaf length. Laminal cells at the apical region long and narrow, 45-88 x 8-12 µm in diameter. Middle laminal and basal cells short and broad measure 55-88 x 8-10 µm and 25-38 x 12-20 µm respectively. Plants pleurocarpous, sporophytes on main stem, capsules inclined or horizontal, dark brown to reddish, oblong to cylindrical, 2.5 x 1 mm, setae smooth and 20 mm long, peristome vary in size ca. 450-550 µm in size, spores spherical, minutely papillose, 11- 15 µm in diameter.

Status: Common

Habitat: Tree trunks.

Distribution: Nepal (W, C, 780-2200 m): Dang (780 m), Kaski (800 m); Burma, China India, Indonesia and Japan.

1.3. Brachythecium populeum (Hedw.) B.S.G. var. **populeum** (Hedw.) B. S. G., Bryol. Eur. **6**: 7, 1853; Higuchi & Takaki in Watanaber & Malla, Crypt. Him **2**: 148, 1990; Kattel & Adhikari, Mosses. Nep.*:* 10, 1992; Pradhan, Mats. Checklist Bryo. Nep.: 26, 2000a; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 23, 2007b.

Matted Feather Moss; Cedar Moss (Eng.).

Plants yellowish green, usually slender forming compact mats. Main stem creeping on which many short and long, erect branches arise, branching pinnately. Leaves erectopatent, appressed to the stem when dry. Branch leaves ovate-lanceolate, concave, 1.5 mm long and 0.6 mm wide at the basal region, apex acute, margin dentate at the apical region, costae strong almost reach to the apex in branched leaves and less than half the length of leaves in stem leaves, laminal cells linear, some what rhomboid in the median region, 39 x 20 µm in diameter, alar differentiated with rectangular cells. Plants dioecious, pleurocarpous. Seta erect, 12-14 mm long, capsules incline to horizontal, operculum conic with short beak.

Status: rare

Habitat: tree trunks.

Distribution: Nepal (C, 900-2000 m): Kavre (900 m); Bhutan.

2. Eurhynchium B.S.G.**,** Bryol. Eur. **5**: 217, 1854.

Plants bright green, usually with erect branches forming tufts on damp soil, rocks and brick walls. Main stem creeping with central strand. Leaves heterophyllous, laxy or closely imbricate, sometimes slightly plicate, broadly triangular to orbicular with acute apex, costae percurrent occupy ½ or 2/3 of the leaf length, middle laminal cells elongated hexagonal, basal cells quadrate or slightly inflated, alar may or may not be differentiated. Plants autoecious or dioecious. Setae smooth or rough and erect. Capsules inclined or horizontal and operculum long rostrate. Five species of *Eurhynchium* has been recorded from Nepal.

2.1. Eurhynchium swartzii (Turner) Curn. in Rabenh., Bryoth. Eur. **12**: 593, 1862; Chopra, Taxo. Ind. Mosses: Bot. Monogr. **10***:* 471, 1975; Gangulee, Mosses E. Ind. & Adj. Reg. **7**: 1739-1741, 1978.

Hypnum swartzii Turner, Musc. Hib.: 151, 1804.
Eurhynchium hians (Hedw.) Lacey, Ann. Mus. Bot. Lugd. Bat. **2**: 299, 1866; Chopra, Taxo. Ind. Mosses: Bot. Monogr. 470, 1975; Pradhan, Mats. Checklist Bryo. Nepal: 27, 2000a.
Eurhynchium hians (Hedw.) Lacey. var. *swartzii* (Turner) C. Cortes, An. Inst. Bot. Cavanilles **11** (1): 228, 1953.

Plants light green or bright green, glossy. Main stems creeping, branched and branches erect, once or twice pinnate. Leaves on main stem sub-complanate, erectopatent, concave, leaves on branches variously ovate with narrow decurrent bases, apex acumen, margin denticulated almost to the base, costae percurrent cover 2/3 -3/4 of the leaf length, laminal cells in the median region elongated, rhombiod- hexagonal, 45 x 8-10 µm in diaeter, alar cells at the base quadrate-rectangular, 38-40 x 11 µm in diameter. Plants dioecious, sporophytes on mail stem, setae erect, rough, 1.5-2 mm long, capsules horizontal, ovate, operculum rostrate.
Status: Rare
Habitat: Soil.
Distribution: Nepal (W, C, 150-2300 m): Bardia (135 m); Africa, Canada, Caucasus, China, Europe, India (Darjeeling, Khasia hill, Simla), Japan, North Aerica, Sri Lanka and Siberia.
Remarks: This was previously reported as *Eurhynchium hians* from Dolakha district, 2100-2300 m, central Nepal

3. Rhynchostegium B.S.G., Bryol. Eur. **5**: 197, 1852.

Plants deep green rarely yellowish green to golden brown, slender to robust usually forming soft, dense tufts on moist ground, somewhat glossy when dry. Stems creeping, irregularly branched, sometimes complanately foliate. Leaves less concave, lanceolate to ovate-lanceolate, usually with short or long and often twisted acumen, margin minutely serrulate all around, costae usually thin, 1/2 or 2/3 of the leaf length, rarely ending in spine. Median leaf cells mostly narrowly fusiform, smooth, not differentiated at apex, alar cells few. Plants autoecious. Perichaetium usually with patent points. Seta smooth, elongated. Capsules ovoid to oblong ovoid and curved. Annulus differentiated. Peristome normal as in *Brachythecium*. Operculum long, conic and calyptrae smooth. Spores small, very finely papillose.

Three species are known from Nepal which includes one species from lowland area.

3.1. Rhynchostegium vagans (Harv.) A. Jaeger, Ber. S. Gall. Naturw. Ges. 1876- 77, 1878; Nog. in Hara, Fl. E. Him **1**: 581, 1966; Nog. & Z. Iwats. in Ohashi, Fl. E. Him **3**: 276, 1975; Gangulee, Mosses E. Ind. & Adj. Reg. **7**: 1751-1752, 1978; Higuchi & Takaki in Watanabe &

Malla, Crypt. Him **2**: 149, 1990; Kattel & Adhikari, Mosses. Nep.: 11, 1992; Pradhan, Mats. Checklist Bryo. Nep.: 27, 2000a; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 23, 2007b.

Hypnum vegans Harv. in Hook., Ic. Pl. Rar. 1.: 24, 1836.
Eurhynchium vagans (Harv.) Bartram in Bishop, Musc. Bull.: 101, 1933.

Plants delicate, much flexuose, slender, elongated, yellowish green forming thin mats. Stems flexuose, stoloniferous, distantly foliate. Leaves ovate-lanceolate, shortly acuminate, 1.4 x 0.55 mm in size, less concave, margin minutely or sharply denticulate above and minutely serrulate below, costa percurrent extend 2/3 of the entire leaf length, median leaf cells linear vermicular, ca. 100 x 5 µm in diameter, apical and basal cells short, branch leaves abruptly short acuminate, costa ending often to a minute spine on the back. Plants dioecious. Perichaetial leaves spiral and spreading, seta smooth, 2-4 cm long, capsule ovoid, large, asymmetrical, urn 2 mm long, annulus broad, operculum conic, 2 mm long, peristome perfect. Spores very small.
Status: Uncommon.
Habitat: Soil and rocks.
Distribution: Nepal (W, E, 600-2200 m): Kaski (800 m), Sankhuwasabha (900 m); Borneo, Burma, Formosa, Hawaii, India, Japan, Java, Laos, Philippine, Sri Lanka, Taiwan and Thailand.

5.2.3.6.2. ENTODONTACEAE

Plants small to medium sized, often glossy, form a flat mats on barks and tree bases. Stems prostrate, elongated and subpinnately branched. Leaves variable in shape, costae delicate, single, never percurrent, sometimes double, very short or absent, laminal cells prosenchymatous with projecting ends, alar cells differentiated , mostly quadrate or rectangular. Plants autoecious or dioecious, male and female plants not differentiated, setae erect, capsules erect and symmetrical, stomata present on the neck region, peristome mostly double, opercula rostrate, caliptrae cucullate, spores small and spherical. Species of this family are common in warm temperate region. Ten genera and 28 species are known from this family in Nepal which includes four genera and four species from the lowland region.

Key to the genera

1. Plants autoecious, robust ……..... 2
   Plants dioecious; slender .....……... *Trachyphyllum*

2.Costae double, short or absent 3
  Costae lacking 4

3. Capsules erect, annulus not differentiated .....**3**. *Erythrodontium*
  Capsules slightly curved, annulus present ……..……..…. **2**. *Entodon*.

4. Leaf base auriculate; operculum obliquely beaked ……..…… **1**. *Campylodontium*
Leaf base not auriculate;operculum large, rostrate …… **4**. *Erythrodontium*

1. Campylodontium Schwaegr. in Hedw., Sp. Musc. Suppl. **3** (1): 211, 1827.

Plants robust. Stems elongated, prostrate, creeping and pinnately branched irregularly, branches tumid. Leaves erecto-patent, plicate, narrowly ovate-lanceolate, margins recurved at the base, entire or minutely serrate in the upper parts, costae lacking, laminal cells narrow, linear and smooth, alar cells quadrate forming sharply defined group. Plants autoecious. Setae thin, tortuose, 1-2 cm long, capsules erect, oblong-cylindric, brown. Annulus persistent. Peristomes deeply inserted, operculums obliquely beaked, spores 20-30 µm in diameter. Only one species is known from Nepal.

1.1. Campylodontium flavescens (Hook.) Bosch & Lacey, Bryol. Jav. **2**: 128, 1865; Nog. in Hara, Fl. E. Him. **1**: 581, 1966; Nog. & Z. Iwats. in Ohashi, Fl. E. Him. **3**: 276, 1975; Chopra, Taxo.Ind. Mosses, Bot. Monogr.: 478, 1975; Higuchi & Takaki in Watanaber & Malla, Crypt. Him. **2**: 149-150, 1990; Kattel & Adhikari, Mosses. Nep.: 27, 1992; Pradhan, Mats. Checklist Bryo. Nep.: 39, 2000a; Pradhan, J. Nat. Hist. Mus. **19**: 67, 2000b; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 25, 2007b.

Plants medium to robust. Stems elongate, creeping irregularly pinnately branched. Leaves appressed to the stem when dry and erecto-patent and spreading when moist, ovate-oblongwith acuminate apex, margins slightly dentate at the apical region, costae absent, laminal cells narrowly linear, alar distinct and with quadrate cells. Plants autoecious, seta erect, 16 mm long, capsule erect, brown, cylindrical, operculum obliquely beaked. Spores spherical and small.
Status: Rare
Habitat: Tree bases
Distribution: Nepal (W, C, 800-3000 m): Kaski (800 m), Kavre (900 m); Burma, Celebes, Central Africa, India (Assam, Sikkim), Indonesia, Java, Madagascar, Malacca, N. Sumatra, Philippines, Queensland and Sri Lanka.

2. Entodon C. Muell., Linnaea **18**: 704, 1844.

Plants bright green to yellowish green, much branched, creeping at the base of tree trunks, soil and rocks. Leaves loosely imbricate, very slightly decurrent, concave, obovate, rounded-obtuse or with a short blunt or acute point, margin plane or recurved at the base, entire or slightly denticulated at the apical region, costae thin, short and double or absent, laminal cells long and narrow, porous and incrassate at the leaf base, cells at basal region quadrate, green or hyaline. Perichaetial leaves erect and gradually narrowed from sheathing base. Setae very long, yellowish to reddish, capsules erect and straight or slightly curved, peristome vertically striate below, sometimes papillose or smooth throughout, inner peristome shorter than outer one, annulus present.

The Entodontaceae contains four genera and ca. 150 species of cool temperate and tropical regions. Nepal has the record of 17 species which includes one species from the lowland area.

Key to the species

1. Setae red, 10-12 mm; capsules erect; spores spherical……..…… **2**. *Entodon prorepens*
   Setae, light brown, 25 mm; capsules curved; spores fine papillose ……...… **1.** *E. favescens.*

2.1. Entodon flavescens (Hedw.) A. Jaeger, Ber. S. Gall. Naturw. Ges. **1876 -77**: 293, 1878.

Entodon rubicundus (Mitt.) A. Jaeger, Ber. S. Gall. Naturw. Ges. 1876-77: 285, 1879; Wadhwa & Vohra, J. Bomb. Nat. Hist. Soc.**62** (2): 263, 1965; Nog. in Hara, Fl. E. Him. **1**: 586, 1966; Nog. & Z. Iwats. in Ohashi, Fl. E. Him. **3**: 276, 1975; Higuchi & Takaki in Watanabe & Malla, Crypt. Him. **2**: 151-152, 1990; Pradhan, Mats. Checklist Bryo. Nep.: 40, 2000a; Pradhan, J. Nat. Hist. Mus. **19**: 68, 2000b; Baniya, J. Pl. Sci.: 150, 2001; Nath *et al*., Taiwania **52**(2): 172, 2007; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 26, 2007b.

Plants yellowish green, glossy, much branched creeping forming dense golden mats on substratum. Stems creeping stem leaves wode ovate, shortly apiculate, 1.8x1.0 mm in size, branch leaves smaller, dense erectopatent all around the stem, appressed to the stem when dry, concave, ovate-lanceolate, margins slightly crenulate at the apical region, costae absent sometime weakly developed as short vain like, two in number. Laminal cells elongated rhomboids, 45 x 6-8 µm in diameter, shorter towards theapical region, basal cells quadrate, hyaline, 20 µm in diameter. Plants dioecious. Sporophytes on main shoot, setae erect, reddish brown, long up to 25 mm long, capsules cylindrical, erect, sometimes little curved, calyptrae cucullate, peristome double, long. Spores spherical with fine papillose, 12-15 µm in diameter.
Status: Rare
Habitat: Tree bark, rocks
Distribution: Nepal (W, C, E, 800-3580 m): Kaski (800 m), Kavre (900 m); Andaman Island, Bhutan, China, East Siberia, Japan, Korea, Myanmar, Philippines, South India (Assam) and USSR.
Remarks: This was reported previously from Namche Bazar, Solukhumbu district of east Nepal at 3580 m (Wadhwa and Vohra, 1965).

2.2. Entodon prorepens (Mitt.) A. Jaeger, Nog. *et al*. in Hara, Fl. E. Him **1**: 586, 1966; Nog. & Z. Iwats. in Ohashi, Fl. E. Him. **3**: 276, 1975; Hu, Bryologist **86**(3): 225, 1983; Higuchi & Takaki in Watanabe & Malla, Crypt. Him. **2**: 151, 1990; Pradhan, J. Nat. Hist. Mus. **19**: 68, 2000b.

Stereodon prorepens Mitt., J. Linn. Soc. Bot. Suppl. **1**: 107, 1859.
S. thomsonii Mitt., J. Linn. Soc. Bot. Suppl. **1**: 107, 1859.
Entodon stenopyxis Ther., Bull.Soc. Sci. Nancy ser. 4, **2**: 713, 1926.

E. mairei Ther. & Copp., Bull. Soc. Sci. Nancy Ser. 4, **2**: 714-715, 1926.
E. latifolius Broth., Symb. Sin. **4**: 113, 1929.

Plants yellowish green form shiny mats on the substratum. Stems creeping, 2-3 cm long, pinnately branched, 0.5-1 cm long, densely foliate. Stem leaves obovate, concave, 1.5 mm long and with two distinct costae, which are unequal and reach 1/3 or 1/2 the leaf lengthone is little shorte than another. Branch leaves ovate with acuminate apex, 1-1.5 mm long and 0.4-0.5 mm wide, margin entire, median leaf cells linear, 55-75 x 6-8 µm in diameter, alar distinct and with quadrate to rectangular cells, 10-20 x 10-14 µm in diameter. Plants dioecious. Setae red, 10-12 mm long, erect, capsules erect, ovate to ovate-oblong, reddish brown, asymmetrical, 1-2 mm long, operculum conic, rostrate, annulus with several rows of thick walled cells, teeth smooth and linear, spores spherical.
Status: Type Nepal (Wallich 752, BM)
Habitat: tree bark, soil and rocks.
Distribution: Nepal (E, 800-2850 m): Dhankuta (800 m); Bhutan, China and India (Assam).

3. Erythrodontium Hampe, Vidensk. Meddr dansk naturh. Foren. Ser 3**, 2**: 279, 1870.

Plants slender to robust, stem elongated, prostrate, branches elongated, julaceous, regularly and closely pinnate. Leaves distant when dry and closely imbricate-appresed when moist, concave, broadly ovate or ovate-oblong, base decurrent, margin entire and slightly curved near the base, costae double, short or absent, laminal cells elliptical, alar cells rounded-quadrate or transversly rectangular. Plants autoecious. Setae 10 - 25 mm long, red or yellow, twisted at upper region when dry. Capsules erect, oblong cylindrical, brown, stomata numerous at the neck region, annulus not differentiated, teeth deeply inserted, orange to purple, distantly articulated, operculum long, rostrate. Spores spherical, papillose and 25 - 30 µm in diameter.

Thirty species have been recorded from the world, only one species known from Nepal and is recorded at 500-3000 meter.

3.1. Erythrodontium julaceum (Schwaegr.) Paris, Index. Bryol.: 436, 1896; Fleisch., Musc. Fl. Buitenz **4**: 1138, f. 189, 1915; Nog. in Hara, Fl. E. Him. **1**: 587, 1966; Chopra, Taxo. Ind. Mosses, Bot. Monogr. **10**: 474, 1975; Karczm., Lindbergia **7**: 129, 1981; Higuchi & Takaki in Watanabe & Malla, Crypt. Him. **2**: 152, 1990; Kattel & Adhikari, Mosses Nep.: 29, 1992; Pradhan, Mats. Checklist Bryo. Nep.: 40, 2000a; Pradhan, J. Nat. Hist. Mus. **19**: 68, 2000b; Nath *et al*., Taiwania **52** (2): 173, 2007; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 26, 2007b; Shakya & Chettri, Nep. J. Pl. Sci. **2**: 43-45, 2008.

Pterogonium aquarrosum Griff., Cal. J. Nat. Hist. **3**: 63, 1843.
Stereodon juliformis Mitt., J. Linn. Soc., Bot. Suppl. **1**: 92, 1859.

Plants bright green, prostrate, creeping, much branched, branchases julaceous. Leaves dessely arranged on stem, broadly ovate, rough in surface, entire margin, apex acute and slightly pointed, base slightly curved, costae double, very short, equal in length, apical laminal cells elliptical and dark, middle laminal cells elliptical and hyaline, alar cells quadrate or transversly rectangular. Plants autoecious and pleurocarpous. Setae very long, erect, 20-22 mm long, twisted spirally when dry. Capsule erect, brown and short cylindrical, caplytra partially cover to the urn, apophysis absent, operculum conic with short beak. Spores spherical.

Status: Common

Habitat: Tree bark.

Distribution: Nepal (W, C, E, 500-3000 m.): Kaski (800 m), Kavre (900-1000 m), Sankhuwasabha (1000 m); Bhutan, Burma, Celebes, Cetral and South Africa, China (Yunnan), Java, Philippines, South India (Assam), Sri Lanka, Sumatra, Thailand, Tonkin and West China.

4. Trachyphyllum Gepp, Cat. Welw. Afr. Pl. **2**(2): 298, 1901.

Plants dark green, slender, pleurocarpous. Stems very long, prostrate, regularly pinnately branched, julaceous branches nearly erect. Leaves imbricate and appressed to the stem when dry and spreading when moist. Leaves broad-ovate, narrowly acuminate, apical margin toothed by projecting the marginal cells, costae short, double, strong at the base, laminal cells elliptic, alar differentiated in cells of many series, cells more or less quadrate and chlorophylose. Plants dioecious, seta erect, 15 mm long, tortuous, thin, yellowish red. Capsules horizontal, asymmetrical, gibbose, ovoid, peristome normal, operculum with short beaked. Spores spherical and 15 µm in diameter.

4.1. Trachyphyllum inflexum (Harv.) A. Gapp., Pl. Welwitsch**. 2**(2): 298, 1901; Nog. in Hara, Fl. E. Him. **1**: 588, 1966; Nog., Lindbergia **1**: 182, 1972a; Chopra, Taxo. Ind. Mosses, Bot. Monogr. **10**: 477, 1975; Kattel & Adhikari, Mosses Nep.*:* 30, 1992; Pradhan, Mats.Checklist Bryo. Nep.: 41, 2000a; Pradhan, J. Nat. Hist. Mus. **21**: 51, 2002; Nath *et al*., Taiwania **52**(2): 171, 2007; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 26, 2007b; Pradhan & Joshi, Nep. J. Pl. Sci. **2**: 31, 2008a.

Hypnum inflexum Harvey in Hook., Icon. Pl. I: t. 24, f. 6, 1836.
Stereodon inflexus (Harvey) Mitt., J. Linn. Soc. Suppl. **1**: 92, 1859.
Entodon inflexus (Harvey) C. Muell., Linnaea **42**: 435 1879.

Plants yellowish-green to dull green, slender froming thin mats on substratums. Stems creeping which give short, erect pinnately branched. Branch leaves dense, patent to spreading, imbricate and appressed to stem when dry, concave, cordate-ovate with short apiculate apex Leaves deltoid or broadly ovate with acuminate apex, 0.8 x 0.5 mm in size, margin entire margin inflexed at the base, costae short and forked. Leaf cells elongate rhomboid, 30 x 5 µm in diameter, alar differentiated with short quadrate to rectangular chlorophyllous cells, 14 µm in diameter. Plants dioecious, sporophytes very rare, setae short, erect, 15 mm long, capsules brown, oval, slightly bent towards

costae, 1 mm long. Peristome normal and double.
Status: Common
Habitat: Barks and moist earth.
Distribution: Nepal (W, C, E, 135-650 m): Bardia (290 m), Dang (290 m), Chitwan (250 m), Sankhuwasabha (550 m); Australia, Burma, Cambodia, India (Sikkim), Java, Madagascar, Malacca, New Caledonia, Philippines and Sri Lanka.

5.2.3.6.3. FABRONIACEAE

Plants glossy to dark green, slender, delicate forminig thin mats on barks and rocks. Main stem branched and creeping without central strand. Leaves erect when dry, erectly spreading when moist, ovate- ovate lanceolate, weakly concave, usually long acuminate, margin plane or serrate, costa single, slender, short or absent, middle laminal cells rhomboidal, basal cells smooth and quadrate. Plants autoecious**.** Perichaetia lateral. Perichaetial leaves usually differentiated. Setae elongate and smooth. Capsules erect, urn ovoid to cylindrical, neck short; stomata at urn base, superficial; annulus may or may not be differentiated; opercula short rostrate or conic-mammillate, oblique or straight; peristome set below the mouth, single or double, exostome teeth 16, paired or separate, Calyptrae cucullate, smooth or rough distally and naked. Spores spherical to ovoid, fine to coarse papillose.

This family contains about 8 genera and about 100 species in the world, widely distributed in temperate and tropical regions. Two genera are known from Nepal.

1. Fabronia Raddi, Atti. Acc. Sc. Siena **9**: 230, 1808.

Plants slender, bright green to glossy form silky mats on tree trunk. Stems creeping, branches ascending, short and dense. Leaves small, ovate-lanceolate, abruptly narrowed leaves with long acuminate apex and weak single costa, the perichaetial leaves larger than stem leaves, and rather fragile single peristome is the distinctive feature of *Fabronia*. Plants autoecious. Perichaetia lateral; perichaetial leaves usually larger and longer than stem leaves. Setae somewhat elongate, about 2 mm long, erect to slightly curved and smooth. Capsules erect, urn turbinate to ovoid; stomata few at the base of urn, opercula conic-mammillate; peristome single, exostome teeth 16 in 8 pairs. Calyptrae cucullate and smooth. Spores spherical to ovoid and coarsely papillose.

This genus is found at the lower to middle elevations, often in open sites, especially in semi-dry areas of the tropical region. It grows on trunks and branches of trees. Three species from this genus are known from Nepal and one species is described here.

1.1. Fabronia schensiana C. Muell., Nuov. Giorn. Bot. Ital. n. ser. **4**: 262, 1897; Nog. & Z. Iwats. in Ohashi, Fl. E. Him. **3**: 273, 1975; Gangulee, Mosses E. Ind. & Adj. Reg. **7**: 1555, 1978.

Plants minute, yellowish green and branched. Main stem creeping. Leaves not dense, laxly, erecto-patent, erect when dry. Oblong-lanceolate, about 1 mm long and 0.2 mm wide with narrow subulate apex, margin flat, dentate almost throughout, costa single reaching half of the leaf length, laminal cells rhomboidal, 40 x 8 µm, few cells at the apex very long, basal cells near the costa rectangular and 2-3 rows of cells towards the margin. Plants autoecious. Seta erect, 2.5 mm long, capsules erect, urn cup shaped, rough in surface, 0.6 mm long.
Status: Rare
Habitat: Tree bark.
Distribution: Nepal (E, 1000-1200 m): Dhankuta (1000 m); China and India.

5.2.3.6.4. HYPNACEAE

Plants small to mostly medium sized and forms mat. Stems creeping and spread to ascending, regularly or irregularly pinnate or bipinnately branched. Leaves ovate-lanceolate or triangular, apex acute to acuminate, rarely rounded or truncate; margins plane, occasionally recurved below, entire to serrulate; costae short and forked, or less often absent; median cells rhomboidal to linear, smooth or papillose by projecting cell angles; alar region undifferentiated or more often differentiated with cells oval or small and quadrate and generally not inflated. Plants autoecious or dioecious. Perichaetia lateral and differentiated. Setae elongate, smooth, rarely roughened or papillose. Capsules erect to more commonly inclined or pendulous, ovoid to cylindrical or obloid-cylindrical, symmetric or asymmetric and curved; opercula conic-short to long rostrate, oblique; peristome double, exostome teeth 16, calyptrae cucullate, naked and smooth. Spores spherical.

The Hypnaceae contain some 30-40 genera and nearly 1000 species in the world. Nepal has listed 23 genera and 59 species (Pradhan, 2000b).

Key to the genera

1. Plants moderately robust, glossy……... 2
   Plants medium, dull yellow……..……..…..… **4**. *Pseudotaxiphyllum*

2. Leaves falcate-secund, alar cells present ……..…… 3
   Leaves ovate-lanceolate, alar cells weakly develop……..… **1**. *Ectropothecium*

3. Capsule horizontal; peristome well developed hypnoid. …….…....…….. **3**. *Hypnum*
   Capsule erect or horizontal; peristome double or single ……..…… 4

4. Capsule erect or suberect without apophysis, peristome single…….....….. **5**. *Taxiphyllum*
   Capsule suberect with distinct apophysis, peristome double …….…..…..… **2.** *Isopterygium*

1. Ectropothecium Mitt., J. Linn. Soc., Bot. **10**: 180, 1868.

Plants glossy, light green to yellowish-green, forms mats on the substratums. Stems spreading, irregularly to regularly pinnately short branched; central strand weakly developed. Stem leaves weakly to strongly falcate-secund, narrow to broadly ovate-lanceolate, apex short to long acuminate; margins entire to reflexed, distally serrulate, costae absent or short and forked, laminal cells smooth, median cells linear; basal cells shorter and broader, narrowly oblong, basal marginal cells few, quadrate to short rectangular. Alar absent or weakly differentiated. Branch leaves smaller, ovate to oblong-lanceolate or lanceolate-subulate, weak to strongly falcate-secund. Plants autoecious, perichaetia lateral and differentiated ovate-oblong and abruptly long acuminate to subulate. Setae elongate, slender and smooth. Capsules inclined or pendulous, urn ovoid, strongly constricted below mouth when deoperculate, opercula mammillate; calyptrae cucullate, smooth and naked, peristome double. Spores spherical and lightly papillose.

Ectropothecium is one of the most difficult genera of mosses to recognize. They have greater diversity in tropics (Iwatsuki, 1992) and pantropical in distribution.. A total of 214 accepted species recorded in the world (Wijk *et al.,* 1962). Nepal has the record of four species from the lowland Tarai.

1.1. Ectropothecium cygnicollum (Mitt.) A. Jaeger, Ber. S. Gall. Naturw. Ges., **1877-78**: 259, 1880.

Stereodon cygnicollum Mitt., J. Proc. Linnean Soc. Bot., Suppl. **2**: 100, 1839.

Plants glossy light green to yellowish-green, procumbent, branched, densely growing and form mats on the substratums. Leaves narrow to broadly ovate-lanceolate, apex acute, costae short, alar not differentiated. Plants autoecious. Capsules pendulous, asemmetrical, calyptrae cucullate, spores spherical.
Status: Rare
Habitat: Rocks and soil surface covered by forest litter.
Distribution: Nepal (E, 500 m): Sunsari (180 m); India (Sikkim, Darjeeling, Madhya Predesh and Nicobar Island) and Thailand.

1.2. Ectropothecium cyperoides (Hook.) A. Jaeger, Ber. S. Gall. Naturw. Ges. **1877-78**: 259, 1880; Higuchi & Takaki in Watanabe & Malla, Crypt. Him. **2**: 155, 1990; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 29, 2007b.

Hypnum cyperoides Hook. ex Harv., Icones Plantarum **1**: 23, 1836.

A rare species. Its collection has been made from Kaski of west and central Nepal at 230- 1000 by Higuchi in 1988. The current research could not make its collection at the same locality.
Habitat: Soil.
Distribution: Nepal (W, C, 230-1200 m): Kaski (800 m), Makwanpur (230 m), Kavre (900-1000

m); Bangladesh, Borneo, Bhutan, India (Assam), Java, Micronesia, Myanmar, Philippines and Thailand.

Remarks: Common in tropical and Subtropical region.

1.3. Ectropothecium sikkimensis (Renauld & Cardot) Renauld & Cardot, Bull. Soc. R. Bot. Begl. **41** (1):109, 1905; Wadhwa & Vohra, J. Bomb. Nat. Hist. Soc.**62** (2): 264, 1965; Higuchi & Takaki in Watanabe & Malla, Crypt. Him. **2**: 156, 1990; Higuchi & D.G. Long, Bull. Natn. Sci. Mus., Tokyo, Ser. B, **22**(1): 11-12, 1996; Pradhan, Mats. Checklist Bryo. Nep.: 48, 2000a; Higuchi & D.G. Long, Bull. Natn. Sci. Mus., Tokyo, Ser. B, **28**(2): 40, 2002; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 29, 2007b.

This species was previously reported by Higuchi (1978) from east, central and west Nepl. In the present study this species was not seen in the areas of central and west Nepal where previous collections were made**.**

Status: Commom

Habitat: Moist rocks.

Distribution: Nepal (W, C, E, 800-4100 m): Kaski (800 m); Bhutan, India (Sikkim, West Bengal).

Remarks: It was previously reported upto Cho Oyu peak, 4100 m of East Nepal (Wadhwa and Vohra, 1965).

1.4. Ectropothecium zollingeri (C. Muell.) A. Jaeger, Ber. S. Gall. Naturw. Ges. **1877-78**: 272, 1880; Higuchi & Takaki in Watanabe & Malla, Crypt. Him. **2**: 156, 1990; Higuchi & D.G. Long, Bull. Natn. Sci. Mus., Tokyo, Ser. B, **22**(1): 12, 1996; Pradhan, Mats. Checklist Bryo. Nepal*:* 48 (2000); Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 29, 2007b.

Plants with ovate-lanceolate, asymmetrical leaves, apex acute, costae forked, laminal cells in the median region smooth to prostrate cells.

Habitat: Soil

Distribution: Nepal (C, 230-1000 m): Makwanpur (230 m), Kavre (900 m); Bhutan, Borneo, Celebes, China, Hawaii, India (Assam, West Bengal), Japan, Java, Laos, Malay Pen, New Caledonia, New Guinea, Taiwan and Thailand.

2. Hypnum Hedw., Spec. Musc. Frond.: 236, 1801.

Plants bright green to gloden yellow or brown, glossy and creeping in habit. Stems more or less elongated, mostly prostrate and pinnately branched, central strannds weakly developed, the branches without central strands. Stem-leaves usually crowded, loosely erect, falcate-secund and in most species leaves apparently arranged in two rows giving the stems somewhat flattened appearence. Leaves ovate or cordate-lanceolate, costae double or very short or absent, apex short or long acuminate, margins plane or slightly refluxedat the base. Leaves cells small or narrow linear, alar cells differented as quadrate, thin walled cells. Plants dioecious. Perichaetia usually

differentiated. Setae usually elongated up to 2 cm long, capsules erect or inclined to horizontal, oblong to cylindric, operculum short, apiculate, calyptrae cucullate, peristome double. Spores spherical, green, lightly papillose or smooth.

This is a large genus of family Hypnaceae, which contains nearly 50 species distributed worldwide with the highest diversity found in the Northern Hemisphere; five species in the Neotropics (Ando, 1972). Twenty four texa has been recorded from Nepal (Pradhan, 2000a).

2.1. Hypnum albescens Hook. in Schwaegr., Sp. Musc. Suppl. **3**(1): 226b, 1828; Mitt., J. Proc. Lennean Soc. Lond.: 104 (1959); Pradhan, Mats. Checklist Bryo. Nep.: 48, 2000a; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 30, 2007b.

Isopterygium albescens **(**Hook.) A. Jaeger., Ber. S. Gall. Naturw. Ges. **1876-77**: 439, 1878; Higuchi & Takaki in Watanabe & Malla, Crypt. Him..**1**: 173, 1988; Higuchi & Takaki in Watanabe & Malla, Crypt. Him. **2**: 157, 1990; Pradhan, Mats. Checklist Bryo. Nep.: 48, 2000a.

Status: Syntype Nepal (Wallich, 3164, BM).
http://internt.nhm.ac.uk/jdsml/botany/databases/mosses/mosses_detail.dsml?BARCODE=BM000850809
Habitat: Soil
Distribution: Nepal (C, E, 550-1500 m): Sankhuwasabha (550 m); Borneo, Celebes, Hawaii, India, Japan, Java, Malaysis, Philippines, Sri Lanka and Sumatra, Taiwan, Thailand, Vietnam.
Remarks: Widely distributed in Southeast Asia and common in Kathmandu Valley.

2.2. Hypnum cupressiformae Hedw., Spec. Musc.: 291, 1801; Pradhan, J. Nat. Hist. Mus. **19**: 70, 2000b; Higuchi & D.G. Long, Bull. Natn. Sci. Mus., Tokyo, Ser. B, **28**(2): 42, 2002.

Stereodon cupressiformae Brid., Br. Univ., 1827.

Cypres-leaved Plait Moss (Eng.).

Plants robust, bright green, lossy, much branched and procumbent forming dense thick patch Stems brown, irregularly pinnetely branched. Leaves on older branches brownish. No change in size and shape of leaves even in dry. Leaves small, bright green, glossy, falcate-lanceolate, 1 x 0.4 mm in size, costae absent but sometimes with very short indistinct nerve seen, margins serrulate up to the half of the entire length. Laminal cells rhomboidal, elongated, 50 x 3 µm in diameter, basal cells short rhomboidal, 26 x 6 µm in diameter. Plant dioecious, sporophyte erect on main stem, capsule curved right angle to the seta, operculum conic, dark maroon in colour. Spores numerous, spherical, green, smooth, 11-12 µm in diameter.
Status: Common
Habitat: Sandy soil.
Distribution: Nepal (280-1500 m): Chitwan (180 m); Africa, Canada, Caucasus, Central and

South America, China, Europe, Japan, India (Sikim, Palni, Khasia), New Zealand, Siberia and Turkey.
Remarks: This was first reported from Plulchowki, 1500 m, Central Nepal (Pradhan 2000b).

2.3. Hypnum pleumaformae W. Wilson, London J. Bot. **7**: 277, 1848; Pradhan, Mats. Checklist Bryo. Nep.*:* 49, 2000a; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 30, 2007b; Pradhan & Joshi, Nep. J. Pl. Sci. **2**: 31-32, 2008a.

Hypnum macrogynum Bersch , Ann. Sci. Nat. Bot. 7 ser. **15**: 91, 1892.

Big Feather Moss (Eng.).

Plants bright green, much branched, more than 5 cm long, creeping moss boulder stoneand moist wall. Leaves ovate, falcate and glossy with acute apice , smooth margin and with faint costa or without costa, cells hexagonal with perinoids on periphary, 94 x 15 µm in diameter, basal few rows of cells hyaline and recangular, 15 x 12 µm in diameter. Sporophyte on main stem, setae erect, 18-20 mm long, capsules horizontal, 1.8 x o.8-1 mm in size, operculum conic, orange red, teeth septate, spores sphrical, dull yellow, 9-12 µm in diameter.
Status: Common
Habitat: Rocks and Stream banks

Distribution: Nepal (W, C, E, 120-2020 m): Bardia (290 m), Dang (350-1000 m), Chitwan (150-1250 m), Makwanpur (1000 m), Dhanusa (200 m), Morang (180 m); Assam, Burma, China, Formosa, India (Sikkim), Japan, Madagascar, Malaysia, North & South Africa and South China.

3. Isopterygium Mitt., J. Linn. Soc., Bot. **12** (1): 21, 497, 1869.

Plants slinder, glossy, creeping and form soft mats on substratum. Stems prostrate, rarely erect, frequently stoloniform and without central strand. Leaves of both stem and branches alike, mostly complanate. Dorsal and ventral leaves obliquely appressed usually asymmetrical. Leaves oval-oblong or ovate or oblong-lanceolate with short or long acuminate apece, margin entire or faintly dentate, costae double and forked, very short or sometimes absent. Laminal cells narrow rhomboids, smooth or papillae in the upper angles of the cells, alar cells weakly differentiated or absent. Gemmae occasionally present on simple or branched stems, which are filamentose, multicellular and papillose. Plants autoecious or dioecious. Setae long, twisted on drying. Capsules suberect or horizontal with a distinct neck, urn ovoid to oblong-ovoid or cylindric, symmetrical or rarely gibbose, smooth, peristome double, calyptrae cucullate, operculum conic or rostrate. Spores spherical, slightly papillose.

Isopterigium is widely distributed species in the tropics and temprate regions. 200 species has been recorded in the world (Moss flora of Ande, MBG project). Only one species is described here in present investigation

3.1. Isopterygium minutirameum (C. Muell.) A. Jaeger, Ber. S. Gall. Naturw. Ges. **1876-77**: 434 (1878); Zhu & So, Mosses Hong Kong **2**: 56 (1996); Pradhan; Mats. Checklist Bryo. Nep. : 60, 2000a.

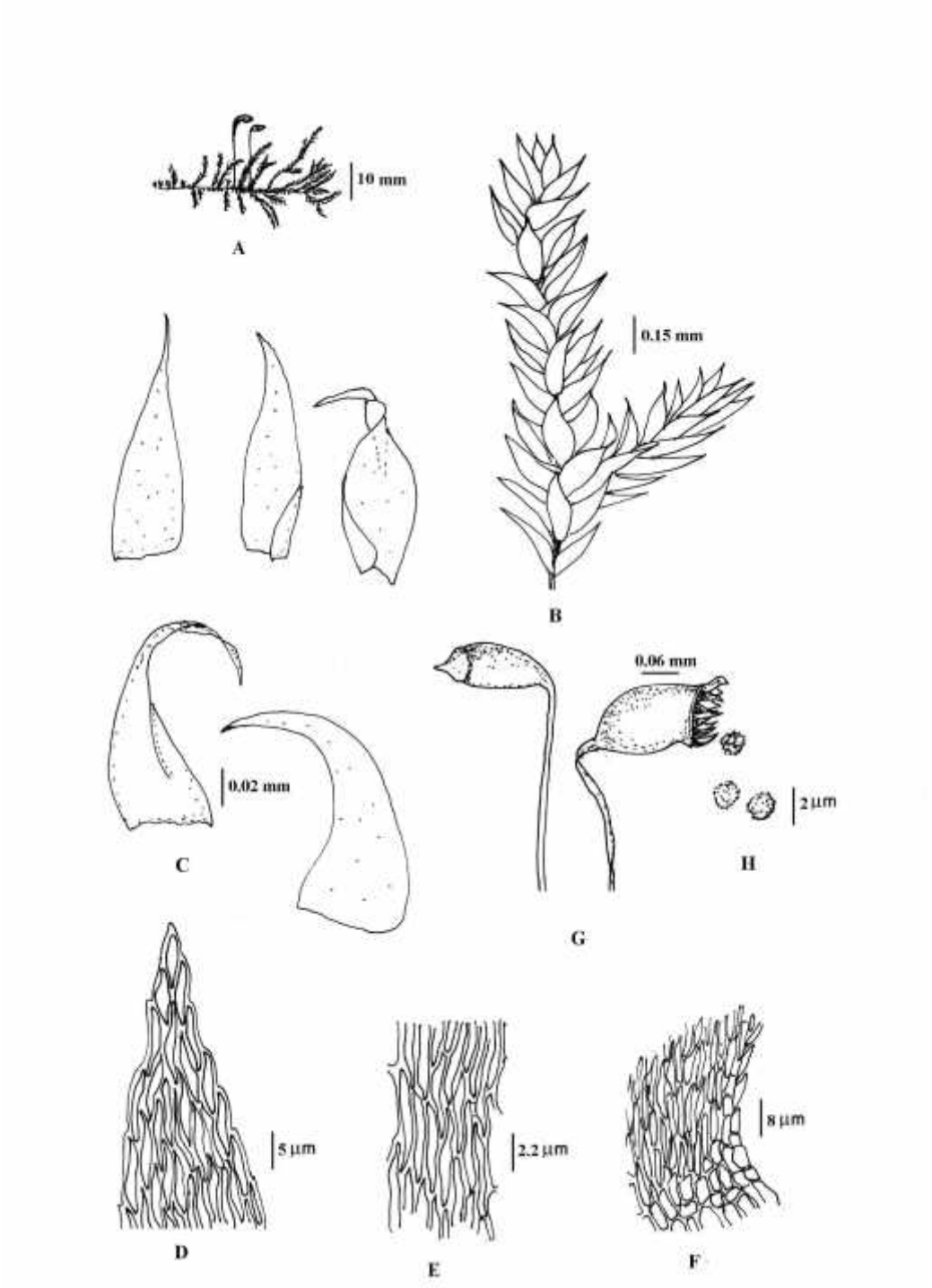

Fig.58. *Isopterygium minutirameum* (C. Muell.) A. Jaeger, (Pradhan c 388). A. habit, B. a branch enlarged, C. leaves, D. apical portion of the leaf, E. laminal cells in the median region, F. basal portion of the leaf, G. capsules, H. spores.

Small Feather Moss (Eng).

Plants yellowish green to bluish green, pleurocarpous pinnately branched forming thin mat. Leaves not crisped even in dry. Leaves cluster at the apical region of the branches. Leaves concave, ovate-lanceolate, 1 mm log and 0.4 mm wide, terminal leaves spreading and piliform and flexuose, margin entire, costa absent, laminal cells rhomboidal to hexagonal without papillae, 44 x 6 µm in diameter, alar not differentiated but cells little larger, pale green, leaf tip acute. Sporophytes on main stem; setae erect, yellowish to red, 12-20 mm long, capsules horizontal, cylindrical, light brown, 1.5 mm long and 0.8 mm wide, operculum conic. Spores sprical, slightly papillae, 10-12 µm in diameter (Fig. 58)
Status: Common.
Habitat: Twigs, soil.
Distribution: Nepal (C, E, 104-300 m): Chitwan (140-300 m), Parsa (104 m), Morang (150 m); Borneo, India, Indonesia, Japan, Hong Kong, Philippines, Queensland, Malacca, Sri Lanka, Sumatra and Thailand.
Remarks: Common in lowland.

4. Pseudotaxiphyllum Z. Iwats., J. Hattori Bot Lab. **63**: 448, 1987.

Plants often complanate, light to yellowish-green, dull to glossy mats. Stems 2--3.5 cm, creeping, simple and irregularly branched, cortical cells small, thick-walled, central strand sometimes present; rhizoids smooth, in clusters, axillary hairs not observed; pseudoparaphyllia lacking. Leaves of stem and branches similar, somewhat rigid, crowded and imbricate, erect-spreading to squarrose, often complanate, smooth or undulate, flat or concave, symmetric to asymmetric, not decurrent, ovate-lanceolate or oblong-lanceolate, acute to acuminate; margins plane to serrate to serrulate; costa short and double or lacking; cells firm-walled, often flexuose, linear-fusiform, smooth, alar regions not or distinctly differentiated with numerous quadrate to short-rectangular cells. Plants dioecious or sometimes autoecious. Setae smooth, elongate, straight or sometimes curved, twisted, red to reddish brown. Capsules cernuous to pendulous, straight to subarcuate, dark brown to dark red, smooth to wrinkled, contracted below mouth and wrinkled at neck when dry; opercula conic to short-rostrate, shorter than urn; annulus present. Calyptra cucullate, smooth, naked. Spores spherical to ovoid, minutely papillose.

Distribution of this plant found from tropical to temperate regions.

4.1. Pseudotaxiphyllum distichaceum (Mitt.) Z. Iwats., J. Hattori Bot. Lab. **63**: 449, 1987; Higuchi & Takaki in Watanabe & Malla, Crypt. Him. **2**: 159, 1990; Pradhan & Joshi, Current Trends in Bryology in Nath Asrhana: 30, 2007b.

Pseudotaxiphyllum moss (Eng.).

Plants forn in thin loose mats on substratumms. Plants light to yellowish green, glossy. Stems 25 mm, complanate, simple or irregularly branched. Leaves semi-flaccid to rigid, distant, squarrose,

complanate, smooth, 0.3-1.8 × 0.2-0.6 mm, ovate to oblong-lanceolate, often cultriform, asymmetric, acuminate; margins plane or narrowly recurved at base, serrate to serrulate distally, serrulate to entire, costa usually strong, short and double; median cells smooth, 48-100 × 4-7 µm; alar cells undifferentiated or 1-3 marginal cells quadrate to rectangular. Plants autoecious, setae 10 mm long, capsule horizontal, ovoid, ca. 1.3 mm; operculum conic.
Status: Uncommon
Habitat: Soil
Distribution: Nepal (W, 800-2100 m): Kaski (800 m); Burma, India, N. and C. America and Sri Lanka.

5. Taxiphyllum Fleisch., Musci Fl. Buitenzorg **4**: 1434, 1923.

Plants moderately robust, stem with elongate branched, leaves complanate with short or lon acuminate apices, margine minutely serruladed through out the entire leaves, costae double, short or absent, laminal cells elongate-rhomboid, mostly with angled extended as papillae. Plants dioecious, setae about 10 mm long, capsules erect or horizontal, peristome haploid, operculum with long rostrate. Only one species is described here.

5.1. Taxiphyllum taxirameum (Mitt.) Fleisch., Musc. Fl. Buitenz. **4**: 1435, 1923; Higuchi & Takaki in Watanabe & Malla, Crypt. Him. **1**: 174, 1988; Higuchi & Takaki in Watanabe & Malla, Crypt. Him. **1**: 174, 1990; Higuchi & Takaki in Watanabe & Malla, Crypt. Him. **2**: 160, 1990; Pradhan, J. Nat. Hist. Mus. **19**: 73, 2000b; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 30, 2007b.

Scale-leaf Moss (Eng.).

Plants right green to yellowish green, glossy and creepinig in habit. Stems usually 2-4 cm long produces irregular branches. Leaves light green, slightly glossy, two rows along the stem, oblong-lanceolate, gradually tapering to a pointed tip, Margin almost entire, costae indistinct, leaves cells elongated, rhomboidal. Plants dioecious, pleurocarpous. Setae erect, 10-12 mm long, capsules yellowish brown, oblong and suberect.
Status: Common
Habitat: Soil and tree barks.
Distribution: Nepal (W, C, 500-2400 m): Banke (500 m), Kaski (800 m), Chitwan (1000 m); America, Bangladesh, Bhutan, Burma, China, Formosa, India, Indo-China, Indonesia, Japan, Java, Korea, Laos, Myanmar, New Guinea, Philippines, Siberia, Sri Lanka, Sumatra, Taiwan, Thailand and Vietnam.
Remarks: Widely distributed in Southeast Asia.

5.2.3.6.5. SEMATOPHYLLACEAE

Plants large, slender usually bright green and glossy. Leaves spreading erect or loosely imbricate, straight or sometimes curved, concave, ovate-lanceolate, gradually narrowed into a short or long

point, margin plane or recurved, entire sometimes denticulate, costae short, double or absent, cells in the median region usually elongated. Stem rounded in cross section and mostly without central strand. Plants autoecious or dioecious. Setae elongated, capsules oval to cylindrical, straight to curved, stomata present at the base of the capsule, annulus usually persistent, peristome well developd to imperfect, calyptrae cucullate, operculum with long fine beak.

Plants are epiphytic in habit and grow usually on barks and twigs of trees, rare on rocks. Their distribution is common in tropical and subtropical region of the world. Nepal has the record of 27 species of this family (Pradhan, 2000a). Three species from each genus has been described here.

Key to the genera

1. Plants forming dense mats, dioecious …… 2
   Plants forming dense or thin mats, autoecious ……..……...……. 3

2. Leaves broadly deltoid with dentate margin, double costae and acuminate apices ……..…….…… **1**. *Foreauella*
   Leaves ovate-lanceolate, margins smooth, costae not distinct …….....… **3**. *Taxithelium*

3. Capsule erect to horizontal, calyptrae conic with a long beak, opercula rostrate …….. **2**. *Sematophyllum*
   Capsules inclined to horizontal, calyptrae cucullate, opercula conic ……..…. **3**. *Taxithelium*

1. Foreauella Dixon & P. Varde, Archs Bot. Bull. Mens. **1**(1-9): 175, 1927.

Plants yellowish green or bright green, robust forminig caespitose mats on the substratums. Stems creeping, densely branched, branches short and simple. Leaves appressed to the stem, broadly deltoid from an obovate base, apex acuminate, margin slightly dentate at the apical region due to projecting the marginal cells, costae double and short, laminal cells at the apical region and median region rhomboid to flexuose, basal cells hexagonal-flexuose, strongly chlorophyllose, alar cells differentiated with one to three rows of subquadrate hyaline cells. Plants dioecious, setae 15 mm long, flexuose and thick, capsules broadly ovoid when moist and subcylindric when dry, inclined or horizontal, annulus persistent, peristome broadly deltoid, papillose, faintly trabeculate, opercula conic. Spores brown, warty and 20-22 µm in diameter. Only one species of *Foreauella* is described here.

1.1. Foreauella orthothecia (Schwaegr.) Dixon et P. Vard., J. Bot. **75**: 129, 1937; Higuchi & Takaki in Watanabe & Malla, Crypt. Him. **2**: 154, 1990; Pradhan; Mats. Checklist Bryo. Nep.: 69, 2000a; Pradhan, J. Nat. Hist. Mus. **19**: 75, 2000b.

Hypnum curvatirameum Hamp. in Dixon, Revue. Bryol., N.S. **2**(1): 24, 1929c.
Stereodon orthothecius (Schwaegr.) Mitt., J. Linn. Soc., Bot. Suppl. **1**: 101, 1859.

Plants bright green, creeping, much branched and fromiing dense mats. Branches short, crowded, tumid, curved at the tips and often all pointiing in the same direction. Leaves lanceolate with obovate bases, costae double, short, margin slightly dentate apical region, apex acuminate, cells rhomboid, alar differentiated. Plants dioecious, setae long, capsules short-oblong, strongly inclined. Spores sphrical and warty.

Status: Rare

Habitat: trunk, branches and bases of trees.

Distribution: Nepal (C, 230-1800 m): Makwanpur (230 m); China, India, Laos, Myanmar and Philippines.

Remarks: Noguchi (1972) has included this species under the family Hypnaceae.

2. Sematophyllum Mitt., J. Linn. Soc., Bot. **8**: 5, 1865.

Plants small to robust, glossy forming dense mats. Stems creeping, branched, densely foliate. Leaves oval to oblong-elliptic, erect to spreading, no costae, apices acuminate sometimes hair-points, entire or slightly toothed, middle laminal cells elongated. Plants autoecious, setae elongate, smooth or rough, capsules small, erect or horizontal, calyptrae convex-conic with a long beak, opercula rostrate. Spores small to mediumin size. Only one species is described here.

23. Sematophyllum subhumule (C. Muell.) Fleisch. ssp. **subhumili** (C. Muell.) Fleisch., Musci Fl. Buitenzorg **4**: 1264, 1923; Higuchi & Takaki in Watanabe & Malla, Crypt. Him. **2**: 154, 1990; Pradhan; Mats. Checklist Bryo. Nep.: 69, 2000a; Pradhan, J. Nat. Hist. Mus. **19**: 75, 2000b; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 31, 2007b.

Japanese Signal Moss (Eng.).

Plants yellowish green, creeping, forming tufts on substratum. Stems procumbent producing sub-erect branches about 5 mm long. Leaves dense on stem, yellowish green, concave, lanceolate with acute tips, leaf bases usually contracted, margins entire, costae absent, laminal cells elongated, alar cells large. Plants autoecious, setae reddish brown, 10-12 mm long, capsules oblong and brown.

Status: Rare

Habitat: Tree trunks

Distribution: Nepal (W, 200-1500 m): Banke (200 m); Burma, India, Java, Sri Lanka and Thailand.

Remarks: Common in subtropical region.

3. Taxithelium Spruce ex Mitt., J. Linn. Soc., Bot. **12**(4): 241, 496, 1869.

Plants robust to medium size, slender, corticolous forming thin mats or tufts on substratum. Stems creeping, regularly pinnately branched, branches small, usually complanate. Leaves ovate-lanceolate with short or long apices, margins smooth, costae not distinct, laminal cells linear,

seriate-papillose, alar cells differentiated. Plants autoecious rarely dioecious, setae long, smooth, rarely upward papillose. Capsules inclined to horizontal, ovoid, gibbose when dry and empty, sometimes curved, annulus persistent, peristome double, teeth coherent at the base, dagger shaped, transversly striate and yellowish brown, opercula conic, calyptrae cucullate. Spores small to medium in sized.

Chopra (1975) has described two species of *Taxithelium* from Nepal. One species is described here.

Taxithelium nepalense (Schwaegr.) Broth., O. Warbung. Mousunia **1**: 171, 1900a; Gangulee, Ind. Mosses*:* 89, 1985; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 31, 2007b.

Stereodon nepalense (Schwaegr.) Mitt., J. Linn. Soc., Bot. Suppl. **1**: 100, 1859.

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Nepalese Nipple Moss (Eng.).

Plants robust, yellowish green, dull to glossy forming tufts. Main stems long, creeping, irregularly branched of various length. Leaves dense, erectopatent, appressed to the stem when dry; glossy, strongly concave, ovate-lanceolate with acute apex, 1 x 0.5 mm in size, margin slightly dentate at the apical region, costae absent, leaf cells spindle shaped, 38 x 6 µm in diameter, shorter towards the apical region, alar and basal cells smooth rectangular, larger than basal cells. Plants autoecious, rarely dioecious, setae erect, smooth, 15-18 mm long, capsules inclined or horizontal, curved and constricted under mouth when dry, 1.3 x 0.5 mm in size. Opercula conic, calyptrae cucullate, peristome double, teeth coherent at the base, dagger shaped and brownish yellow. Spores small, 13-20 µm in diameter .

Status: Common

Habitat: Tree trunks

Distribution: Nepal (W, 118-200 m): Bardia (118-200 m); Burma, India, Bangladesh, Borneo, Java, Kampuchea, Laos, Malaysia, Mainland China, New Guinea, Philippines, Sri Lanka, Sumatra, Tasmania, Thailand and Vietnam.

Remarks: Common in tropical region of Nepal.

5.2.3.6.6. STEREOPHYLLACEAE

Plants small to medium sized, glossy, light to dark green, forming loose to dense mats. Stems creeping or spreading, simple to few irregularly branched; central strand present or absent. Leaves weakly to strongly complanate, lanceolate, oblong or oblong-ovate, apex obtuse to acute or acuminate; margins entire to serrulate; costae single, 1/2-2/3 lamina length, or ecostate. Leaf median cells rhombic, rhomboidal to linear, smooth or papillose, alar region differentiated, Plants autoecious. Setae elongate, smooth and reddish in colour, capsules inclined to horizontal, urn ovoid-short cylindrical, asymmetric, opercula conic-short rostrate, usually oblique; peristome double, distally papillose, Calyptrae cucullate, smooth and naked. Spores spherical, papillose.

The Stereophyllaceae contain seven genera and about 30 species largely confined to the tropics (www. MOBOT. Org/bryophytes/TROPICOS, Moss Fl. Ande). Most of the genera were previously associated with the Plagiotheciaceae (Buck & Ireland, 1985). Chopra (1975) included this family in Plagiotheciaceae as subfamily Stereophylloideae. The genus *Entodontopsis* with five species are described here.

1. Entodontopsis Broth., Die Nat. Pfl. **1**(3): 895, 1907.

Stereophyllum Mitt., J. Linn. Soc., Bot. Suppl. **1**: 117, 1859.

Plants glossy, light green forming loose on barks. Stems prostrate, creeping, irregularly branched. central strand absent. Leaves bright green, glossy, crowded, lanceolate to ovate- lanceolate, 2.5 mm long, concave with short point, margin entire, costae single end in the middle of the leaf. Laminal cells rhombic to linear, basal cells short, with or without papillose, alar cells differentiated, cells generally quadrate or irregular parenchymatous, hyaline or opaque. Plants autoecious, rarely dioecious. Setae long, slender and wiry and about 14 mm long. Capsules inclined or horizontal, urn ovoid, asytmmetric, often contracted below the mouth. Annulus revoluble, peristome double, usually perfect sometimes cilated, opercula conic-rostrate, usually short, calyptrae cucullate, smooth and naked. Spores spherical, 16-15 µm in diameter.

This genus is common in tropical and subtropical region growing on trees, rocks and sometimes on forest floor and recorded 18 species in the world (www. MOBOT. Org/bryophytes/TROPICOS, Moss Fl. Ande). Five species are presented here, among them two are reported as new to Nepal.

Key to the species

1. Leaves more or less acuminate; costae end far below leaf apex … **4**. *Entodontopsis tavoyense*
   Leaves not acuminate; costae end ½ the length of entire leaf length ……..……...… 2

2. Leaves markedly asymetrical, margin plane ……..……...…..…… 3
   Leaves not asymetrically marked; margin inflexed ……...……..…… **1**. *E. anceps*

3. Capsule with small apophysis, peristome teeth curved inward; spores, 23 µm. **2**. *E. leucostega*
   Capsule without apophysis, mouth wide; spores 23-36 µm ……..…… **5**. *E. wightii*

1.1. Entodontopsis anceps (Bosch & Lacey) W.R. Buck & Ireland, Nova Hedwigia **41**: 103, 1985; Townsend, J. Bryol. **24**: 327, 2002; Nath *et al*., Taiwania **52**(2): 171, 2007; Pradhan & Joshi, Nep. J. Pl. Sci. **2**: 32, 2008a.

Stereophyllum anceps (Bosch. & Lacey) Broth., Nat. Pfl. **1**(3): 898, 1907; Nog., Lindbergia **1**: 182, 1972: Chopra, Taxo. Ind. Mosses, Bot. Monogr. **10**: 485, 1975.

Plants bright green, irregularly branched, creeping tightly on the substratum forming dense mats.

Stems prostrate, irregularly branched, complanate with crowded leaves. Leaves bright green, glossy, ovate with acute point. Lateral leaves generally asymmetrical, lower margin inflexed at one side, costae strong, single reach below the apex reaching upto half the length of the leaf. Laminal cells rhombic to linear 150 x 10 µm in diameter, basal cells rectangular, hyaline, 25 x15 µm in diameter. Plants dioecious, pleurocarpous. Setae erect, sooth, dark brown to reddish brown, 8-10 mm long, capsules ovate, brown, and slightly inclined. Apophysis distinct, peristome teeth free, light green, 180 µm long and 50 µm wide at the base. Spores spherical, brown and smooth.
Status: Common.
Habitat: Tree bark growing with *Trachyphyllum influxum* (Pradhan NGS 539).
Distribution: Nepal (W, C, 200-300 m): Dang (190 m), Chitwan (150-200 m); Bangladesh, Burma, Indonesia (Java), Mainland China, Philippines, South India, Sri Lanka, Thailand and Vietnam.
Remarks: Its distribution in Indonesia in Java Island first reported by Fleischer (1900) and in Philippines by Tan and Iwatsuki (1991).

1.2. Entodontopsis leucostega (Brid.) W.R. Buck & Ireland, Nova Hedwigia **41**: 103-104, 1985; Nath *et al*., Taiwania **52**(2): 171, 2007.

Leskea leucostega Brid., Bryol. Univ. **2:** 333, 1827.
Stereophyllum decorum (Mitt.) Wijk. & Marg., Taxon **9**: 52, 1960; Chopra, Taxo. Ind. Mosses, Bot. Monog*r*. **10**: 487, 1975.

Plants bright green, creeping. Stems creeping, irregularly branched, older branches dark green. Leaves ovate-lanceolate, 2 x 1 mm in size, broad at the base, margin smooth, costae single extends more than half the length of the leaf. Laminal cells at the apical region elongated rhomboidal, 98 x 9 µm in diameter, alar cells rectangular 45 x 17 µm in diameter. Sporophytes on the main stem, erect. Setae erect, 7 mm long. Capsules slightly bent towards setae, 1.8 x 0.5 mm in size, teeth hyline, curved inward, spores dark brown, spherical, 23 µm in diameter.
Status: Most common
Habitat: Tree bark, exposed roots and rocks.
Distribution: Nepal (W, C, 195-300 m): Kanchanpur (200-300 m), Kailali (195 m), Banke (260 m), Dang (290 m), Chitwan (200-1250 m); Bolivia, Central India, Colombia, Equadar, Thailand and Venezuela.
Remarks: This is the most common species in lowland Tarai which forms bright green mats on tree barks.

1.2. Entodontopsis setschwanica (Broth.) W.R. Buck & Ireland, Nova Hedwigia **41**: 103-104, 1985.

Hypnum setschwanicum (Broth.) Ando, Hikobia **6**: 211, 1973; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 30, 2007b.
Stereophyllum setschwanicum Broth., Sber. Acad. Wiss. Wien, Math.-Naturwiss. Kl. Abt. I, **133**: 581, 1924; Chopra, Taxo. Ind. Mosses, Bot. Monogr. **10**: 487, 1975.

Plants light green, much branched with creeping stems. Sporophytes arise from main stem.
Satatus: Rare
Habitat: Barks, Rocks
Distribution : Nepal (W, E, 200- 1000 m): Kailali (200 m), Sankhuwasabha (1000 m); Szechwan

1.4. Entodontopsis tavoyense (Hook. f.) W.R. Buck & Ireland, Nova Hedwigia **41**: 103-104, 1985; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 31, 2007b.

Stereophyllum tavoyense (Hook.) A. Jaeger, ibid.: 279, 1836; Chopra, Taxo. Ind. Mosses, Bot. Monogr. **10**: 487, 1975.

Plants bright green to yellowish green, glossy, creeping. Stems 2-2.5 cm long, much branched and tightly creeping on substratums. Leaves bright green, glossy, 0.8 x 0.5 mm in size, no change even in dry, ovate-lanceolate with smooth margin but slightly crenulated at the apical region, costae single, percurrent ends far below apex, broad at the base. Apical cells hyaline, hexagonal, middle laminal cells rhomboid, 190 x 10 µm in diameter, basal cells rectangular, hyaline, 20 x15 µm in diameter. Plants dioecious, pleurocarpous. Setae erect, sooth, dark brown to reddish brown, 8-9 mm long, capsules ovate, brown, 0.8 x0.5 mm in size and slightly inclined. Apophysis distinct, peristome teeth free, light green, 180 µm long and 50 µm wide at the base. Spores spherical, dull brown and smooth.
Status: Common
Hasbitat: Tree barks
Distribution: Nepal (W,. C, 145-200 m): Kailali (190 m), Bardia (150-200 m), Chitwan (250-300 m); Bangladesh, Burma, Mainland China, India and Thailand.
Remarks: Recorded in many localities in lowland.

1.5. Entodontopsis wightii (Mitt.) W. R. Buck & Ireland, Nova Hedwigia **41**: 106, 1985.

Stereophyllum wightii (Mitt.) A. Jaeger, ibid.: 279, 1836; Chopra, Taxo. Ind. Mosses, Bot. Monogr. **10**: 487, 1975.

Plants bright green to yellowish green, brownish at the base, creeping and tightly attach to the substratum. Stems 1-2 cm long, many branched, procumbent and densely covered with leaves. Leaves crisped when dry. Leaves ovate-lanceolate, yellowish green, glossy with smooth margin slightly concave at the basal region, 1.5-1.8 mm long and 0.5-0.8 mm wide, apex acute, costae single, extend up to half of the leaf length, broad at the base, 58 µm in diameter. Leaf cells at the apical region short rhomboid, 23 x 9 µm in diameter, cells in the median region elongated rhomboid, 175 x 6 µm in diameter. Few rows of cells at the basal region rectangular, thick walled 18 x 15 µm in diameter. Plants dioecious, pleurocarpous. Setae erect, smooth, dark red to maroon red, 10-12 mm long, capsules brown to yellowish brown, cylindrical, smooth, 1.5 x 0.5 mm in size, erect or slightly inclined, apophysis absent, mouth wide, peristome hyaline. Spores

yellowish green, spherical, slightly papillose and 23-36 µm in diameter.
Status: Common
Habitat: Tree barks
Distribution: Nepal (W, C, 150-300 m): Kailali (240 m), Chitwan (150-300 m): Bangladesh, Mainland China, India, Java, Myanmar, Thailand, Sri Lanka and Vietnam.
Remarks: This is a common species in lowland areas which grow as epiphytic mostly on Sal trees.

5.2.3.6.7. THUIDIACEAE

Plants small to large sized and rather robust, forming loose to dense mats, dull olive to dark green, yellowish-green to-brown, or golden. Stems 1-3 pinnately branched; central strand present; paraphyllia scattered or dense, margins plane distally, recurved or reflexed below, entire to serrulate- or crenulate-papillose; costae single, usually strong and projecting back, percurrent to excurrent; median cells oval to isodiametric, uni- or pluripapillose back or both surfaces, papillae short or long and often curved; branched leaves broadly to somewhat narrowly ovate or ovate-short lanceolate, apex acute to obtuse; costae often ending below apex. Monoecious or dioecious. Perigonia lateral; leaves ovate to short ovate-lanceolate. Perichaetia lateral; leaves usually differentiated, ovate-lanceolate and margins may or may not be ciliated. Setae elongate, smooth to papillose. Capsules suberect to horizontal, urn cylindrical, usually curved; opercula short to long rostrate, oblique; peristome double, calyptrae cucullate, spores spherical, smooth to more commonly papillose.

This is a large family includes ca seven genera and more than 150 species in tropical and temperate regions (Buck and Crum, 1990). Nepal has the record of 39 species till date (Pradhan, 2000a). This text includes 11 species.

1. Haplocladium (C. Muell.) C. Muell., Nuov. Giorn. Bot. Ital. n. ser., **3**: 116, 1896.

Plants yellowish to brownish green. Main stems slender, pinnately branched, creeper forming loose or dense tufts on substratums. Central strand present. Leaves dense, spread over all sides, cordate to lanceolate, costae single, long, end to the acute apex, margin plane or dentate. Laminal cells ovate-hexagonal-rhomboidal and usually unipapillate. Paraphyllia usually present. Sporophytes on main shoot, setae long, usually erect, capsule elongated, horizontal or inclined, operculum conical, calyptra cucullate and peristome normal. Spores spherical, small and fine papillose. Seven species of *Haplocladium* has been reported from Nepal.

Key to the species

1 Leaves ovate-lanceolate, apex acuminate; setae pale brown…..... **1**. *Haplocladium angustifolium*
Leaves ovate-cordate, apex apiculate; setae reddish yellow…….. **2**. *Haplocladium larminatii*

1.1. Haplocladium angustifolium (Hampe & C. Muell.) Broth., Nat. Pfl., **1**(3): 1008, 1907; Nog., Fl. E. Him. **2**: 253, 1972; Nog. & Z. Iwats. in Ohashi, Fl. E. Him. **3**: 274, 1975; Chopra, Taxo. Ind. Mosses. Bot. Monogr. **10**: 433-434, 1975; Gangulee, Mosses E. Ind. & Adj. Reg. **7**: 1605-1607, 1978; Pradhan, Mats. Checklist Bryo. Nep.: 72, 2000a; Pradhan, J. Nat. Hist. Mus. **19**: 76, 2000b; Pradhan, J. Nat. Hist. Mus. **21**: 54, 2002; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthan**a**: 31, 2007b.

Hypnum angustifolium Hamp. C. Muell., Bot. Zeit., 13: 88, 1855.
Thuidium pulchellum De Not., Cronac. Briol. Lugd. Bat., **2**: 42, 1867.
T. scopula (Mitt.) A. Jaeger, ibid. **1876**-**77**: 257, 1878.
Haplocladium rubicundulum C. Muell., Nuov. Giorn. Bot. Ital. n. ser., **5**: 208, 1898.
H. subulaceum (Mitt.) Broth., Nat. Pfl., **1**(3): 1008, 1907.
H. microcarpum Card., Bull. Soc. Geneve ser. 2, **3**: 282, 1911.
H. hakonicum C. Muell. in Reim., Hedwigia, **76**: 267, 1936.

Narrow-leaved Small Feather Moss (Eng.).

Plants yellowish green to brownish green forming dense tufts. Main stem pinnately branched and central strand present. Leaves on main stems large ovate to lanceolate with long acuminate apex and ovate base, 1.5 mm long and 0.5 mm wide at the base, margin slightly dentate due to projecting marginal cells. Branched leaves similar but smaller in size, 0.8 mm lonng and 0.3 mm wide. Laminal cells at the apical region more or less rhomboidal, 8-10 µm in diameter, papillose. Cells in the median region irregularly rectangular and cells at the base near costa are pellucid, elongated rectangular and 12 x 9 µm in diameter. Sporophytes on main shoot, seta long, 12-15 mm long, capsule horizontal, ovate-cylindrical, 2 mm long and 0.5 mm wide, operculum conic, calyptrae cucullate, peristome normal, endostome and exostome equally tall. Spores with fine papillose and 11 to 18 µm in diameter.
Status: Common
Habitat: Tree bark.
Distribution: Nepal (W, C, 300-2500 m): Bardia (140 m), Dang (780 m); Bhutan, Burma, Central & South Africa, China, India, Jamaica, Japan, Italy, Korea, Maxico, Siberia, Switzerland, Taiwan and Vietnam.

1.2. Haplocladium larminatii (Broth. & Par.) Broth., Engler and Prantl., Nat. Pfl. ed. ***2***, 11: 320, 1925; Pradhan & Joshi, Nep. J. Pl. Sci. **2**: 33, 2008a.

Hypnum microphyllum Hedw., Spec. Musc.: 269, 1801.
Haplocladium microphyllum (Hedw.) Broth., Nat. Pfl. **1**(3): 1007, 1907; Gangulee, Mosses. E. Ind. & Adj. Reg. **7**: 1607-1609, 1978; Pradhan, Mats. Checklis Bryo. Nepal: 73, 2000a.

Small Leaved Feather Moss (Eng.).

Plants dark green to yellowish green much branched forming thick mat. Stem long, creeping up to 8 -10 cm long producing pinnate to bipinnate branches. Branched leaves ovate-cordate with long apiculate, 1x 0.2 m in size, costae stout, excurrent, margin minutely serrulated due to the projection of marginal cells, laminal cells papillose more or less hexagonal, 6 x 9-12 µm in diameter with one or 2 papillae, basal cell rectangular, hyaline, 12 x 15 µm in diameter and alar not differentiated. Plants pleucarpous, sporophytes on main stem, seta long, erect, reddish yellow, 10-24 mm long, capsules horizontal, cylindrical, green and 3 mm long, peristome normal; spores spherical, small.
Status: Common
Habit: Bark and moist forest floor.
Distribution: Nepal (W, 120-1070 m): Bardia (120-135 m), Dang (780 m); Bhutan, Canada, China, Cuba, Europe, Formosa, India, Jamaica, Japan, Korea, Mexico, South America, Siberia, Sweden, Taiwan, Thailand and Vietnam.
Remarks: This species is known from lot of Synonyms.

2. Herpetineuron (C. Muell.) Card., Beih. Bot. Zbl. **19**(2): 127, 1905.

Plants robusts and stiff. Stems simple or branched and branches sometimes flagellate. Leaves quinquifarious, irregularly imbricate when dry and erecto-patent in moist, shortly decurrent, concave, oblong-lanceolate, shortly acuminate, margin reflexed near the base, plane or serrate above, costae strong, markedly flexuose above, percurrent, laminal cells small, more or less rounded to quadrate, smooth and rich in chlorophyll, thick walled and basal cells not elongated. Plants dioecious. Seta 10-15 mm long, straight, twisted and red when dry, capsules erect, symmetrical, cylindrical with small mouth. Annulus present. Teeth narrow, linear-lanceolate, papillose, inner peristome yellowish, finely papillose and operculum conic.

2.1. Herpetineuron toccoae (Sull & Lesq.) Card., Beih. Bot. Centralbl. **19**: 127, 1905; Nog. *et al*, Fl. E. Him. **2**: 253, 1972; Nog. & Z. Iwats. in Ohashi, Fl. E. Him **3**: 274, 1975; Chopra, Taxo. Ind. Mosses. Bot. Monogr. **10**: 429, 1975; Gangulee, Mosses. E. Ind. & Adj. Reg. **7**: 1587-1589, 1978; Karczm., Lindbergia **7**: 129, 1981; Pradhan, Mats. Checklist Bryo. Nep.: 73, 2000a; Pradhan, J. Nat. Hist. Mus. **19**: 76, 2000b; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 31, 2007b.

Anomodon toccoae Sull. & Lesque, Music Bor. Am.: 52, 1856.
Anomodon devolutus Mitt., Musci Ind. Or.: 127, 1859.
Herpetineuron wichurae (Broth.) Card., ibid., 1905.
H. attenuatum Okam., J. Coll. Sc. Imp. Univ. Tokyo, **38**(4): 54, 1916.

Ram's Horn Moss (Eng.).

Plants yellowish green to dark green in dense tufts. Main stem creeping and branched attached to the substratum by long rhizoids. Stems more than 5 cm long and central strand present. Secondary branches erect, simple, about 2 cm tall and with characteristic circinate tips, mostly whitest in color

when dry. Upper leaves dense, 5 rows, erectopatent to erect, hook like curved and somewhat imbricate when dry. Leaves ovate-lanceolate, often plicate at the base, up to 2.5 mm long and 0.8 mm wide at the base, apex acute, margin flat, entire below and dentate above, costae strong, characteristically flexuose at the top, ending almost to the tip. Laminal cells small, thick walled, smooth, rounded to quadrate-rhomboid, 10x5 µm in diameter, some cells at the base hyaline, large, 25x12 µm in diameter near costal base. Sporophytes at the apical region of the branches. Setae erect, 10-12 mm long, capsules erect, cylindrical, 2.5 mm long and 0.5 mm wide, operculum conic, calyptra cucullate, peristome double, endostome teeth narrow lanceolate, papillose. Spores small.
Status: Uncommon
Habitat: Boulders, Rocks, tree trunks.
Distribution: Nepal (C, E, 800-1720 m): Kavre (900 m), Sankhuwasabha (800 m); Australia, America, Bhutan, Brazil, Celebes, Formosa, India (Sikkim, Darjeeling), Japan, Maxico, New Caledonia, Sri Lanka, New Caledonia and Sumatra.
Remarks: Pantropical species common in warm temperate region except Europe and Siberia.

3. Thuidium B.S.G., Bryol. Eur. **5**: 177, 1852.

Plants olive to dark green, yellowish-brown or golden, forming loose to dense coarse mats,. Stems and branches creeping to sub-ascending, 1-3 pinnately branched; central strand well developed; paraphyllia numerous, branched and usually strongly papillose; often densely tomentose. Leaves and branches usually strongly dimorphic; stem leaves broadly ovate-short to long lanceolate, apex broad to narrow short to long acuminate, occasionally ending in a long hyaline capillary hair point; margins often strongly incurved at base, partially inflexed or erect above, serrate or serrulate in distal 2/3; costae strong, ending below acumen or long excurrent; median cells oval-rhombic to rather elongate, unipapillose, rarely pluripapillose, papillae confined to lamina back; lower and basal cells elongate; branch leaves ovate-short lanceolate, cell papillae 2-3, projecting on back of lamina. Dioecious. Perichaetial leaves elongate, lanceolate to oblong-lanceolate and lateral in position. Setae elongate, smooth. Capsules inclined to horizontal, urn cylindrical, asymmetric; opercula conic-short rostrate; peristome double, exostome teeth 16, Calyptrae cucullate, smooth and naked. Spores spherical and papillose.

The genus *Thuidium* is easy to recognized due to having one papilla in each cell. The leaves are more or less triangular with heart-shaped base which is long and acuminate. They are very plicate and the strong midrib ends into the tip of the leaf. There are 200-240 species of *Thuidium* worldwide. Nepal has the report of 16 species, six lowland species are described here.

Key to the species

1. Plants autoecious; paraphylla simple ……..…….…. 2
   Plants dioecious; paraphylla branched ……...……...……...……...… 4

2. Setae 12 mm, scabrous throughout ……..……. **5**. *T. plumulosum*

Setae smooth, less than 2 cm long ……..…… 3

3. Plants delicate; branch leaves appress to stem when dry ……..…… **4**. *T. kuripanum*
Plants slinder; branch leaves spread to stem when dry …… **6**. *Thuidium tamariscinum*

4. Plants robust; stems with central strand ……..……. 5
Plant medium feathery apparence; central strand not distinct …… **2**. *T. glaucinoides*

4. Plants 15 cm long; costae percurrent ……..…..…… **3**. *T. glaucinum*
Plants more than 15 cm long; costae excurrent ……..…… **1**. *T. cymbifolium*

1.1. Thuidium cambifolium *(*Dozy & Molk.) Dozy & Molk., Bryol. Jav., **2**: 115, 1865; Nog. in Hara, Fl. E. Him. **1**: 579, 1966; Nog. *et al*., Fl. E. Him. **2**: 253, 1972; Nog. & Z. Iwats. in Ohashi, Fl. E. Him **3**: 274, 1975; Gangulee, Mosses E. Ind. & Adj. Reg. **7**: 1647-1648, 1978; Higuchi & Takaki in Watanabe & Malla, Crypt. Him. **2**: 144-145, 1990; Kattel & Adhikari, Mosses Nep., 70, 1992; Pradhan, Mats. Checklist Bryo. Nep.: 73, 2000a; Pradhan, J. Nat. Hist. Mus. **19**: 76, 2000b; Pradhan & Shrestha, Proc. Int. Seminar on Mountain: 559, 2003; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 31, 2007b.

Hypnum cambifolium Dozy & Molk., Ann. Sc. Nat. Bot. ser. 3, **2**: 306, 1844.
Leskea cymbifolia (Dozy & Molk.) Mitt., Musci. Ind. Or.: 133, 1859.
Thuidium japonicum Dozy & Molk., Ann. Mus. Bot. Lugd. Bat., **2**: 297, 1866.
Hypnum casuarinum C. Muell., Linnaea, **38**: 569, 1874.
Thuidium subpycnothallum Card., Bull. Soc. Bot. Geneve ser. 2, **3**: 284, 1911.
T. viridiforme Card., ibid.*:*284, 1911.
T. paraviride Sak., Bot. Mag. Tok., **57***:* 350, 1943.

Large Fern Moss (Eng.).

Plants large, yellowish green to deep green sometimes blackish when old, forming dense mat, creeping with bi to tripinnate branched and central strand present. Stem leaves erectopatent, ovate-lanceolate triangular, costae excurrent ending into a short arista, 3 mm long with arista and 1 mm wide. Branch leaves erectopatent, ovate-lanceolate, concave with acute apex, upto 0.5 mm long and 0.3 mm broad, margin irregularly crenulate or entire. Laminal cells more or less rhomboidal, 12 x 8 µm in diameter with single papilla, basal cells elongated, 20 x 9 µm in diameter. Plants dioecious, pleurocarpous; seta erect, smooth, yellowh brown, up to 5 cm long; capsule yellowish brown, inclined to drooping, ovate-cylindrical, 3.2. m long and 1.5 mm wide, operculum conic-rostrate, peristome normal, 0.8 mm long, calyptra cucullate and smooth. Spores spherical, smooth, small and 7-10 µm in diameter.
Status: Rare
Habitat: Barks and Soil.
Distribution: Nepal (W, 900-4500 m): Kaski (900 m); Australia, Borneo, Burma, Mainland China,

Hong Kong, India (Sikkim,), Japan, Java, Korea, Laos, Malaysia, New Guinea, Oceania, Philippines, Sri Lanka, Sumatra, Taiwan, Thailand and Vietnam.
Remarks: Very common in subtropical to temperate region but rare in tropical region.

3.2. Thuidium glaucinoides Broth., Phillip. J. Sc. C. **3**: 26, 1908; Higuchi & Takaki in Watanabe & Malla, Crypt. Him. **2**: 145, 1990; Pradhan, Mats. Checklist Bryo. Nep.: 74, 2000a.

Greyish Fern Moss (Eng.).

Plants bright to pale green, pinnately branched and form feathery appearence forming dense mats. Stems robust, long creeping with pinnate branches of 10 mm long, Leaves broadly ovate-lanceolate to triangular with excurrent costae, leaf apices not end into pointed tips, margin serrulate, leaf cells papillose with thick walled. Plants dioecious, sporophytes on main stems, setae long and capsules slightly inclined.
Status: Rare
Habitat: Rocks, soil and tree bases.
Distribution: Nepal (W, 800 m): Kaski (800 m); Borneo, Burma, China, India, Japan, Kampuchea, Laos, Malay Peninsula, New Guinea, Sumatra, Taiwan, Thailand and Vietnam.
Remarks Rare species and recorded only in Pokhara at 800 m.

3.3. Thuidium glaucinum (Mitt.) Bosch et Lacey, Bryo. Jav. **2**: 117, 1865; Nog in Hara., Fl. E. Him. **1**: 579, 1966; Nog. *et al.*, Fl. E. Him. **2**: 253, 1972; Nog. & Z. Iwats. in Ohashi, Fl. E. Him. **3**: 274, 1975; Gangulee, Mosses E. Ind. & Adj. Reg. **7**: 1642-1643, 1978; Karczm., Lindbergia **7**: 129, 1981; Higuchi & Takaki, Crypt. Him. **2**: 145, 1990; Kattel & Adhikari, Mosses Nep.: 70, 1992; Pradhan, Mats. Checklist Bryo. Nep.: 74, 2000a; Pradhan, J. Nat. Hist. Mus. **19**: 77, 2000b; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 32, 2007b.

Laskea glaucina Mitt., Musci. Ind. Or.*:* 133, 1859.
Thuidium cochlearifolium Reim. & Sak, Bot. Jahrb., **64**: 549, 1931.
T. laticuspis Sak., Mot. Mag. Tok., **60**: 87, 1947.

Plants robust up to 15 cm long, yellowish to brownish green forming dense mats on substratums. Branching regularly bipinnate, central strand absent. Paraphylla rare. Stem leaves erect, concave, ovate to triangularly ovate, shortly acuminate, 1-1.5 mm long and 0.3 mm broad. Branch leaves dense, erectopatent, strongly appressed to stem , concave, ovate-lanceolate and acute apex, 0.5 x 0.3 mm in size, margin crenulate and costae percurrent. Leaf cells quadrate to rhomboid, 5-9 µm wide, basal cells elongated. Plants dioecious, sporophytes on main stem. Upper perichaetial leaves long with whip-shaped acuminate tip. Setae vary upto 4.5 cm long, capsules ovate-cylindrical, horizontal, 3 x 1 mm in size, operculum conic-rostrate, 1 mm long, peristome teeth normal, spores small, sperical with fine papillose and 16-20 µm in diameter.
Status: Uncommon
Habitat: Barks.

Distribution: Nepal (W, C, E, 600-1800 m): Makwanpur (600 m), Kaski (800 m); Bhutan, Borneo, Burma, Celebes, China, India, Japan, Java, Kampuchea, Malaysia, Korea, Papua New Guinea, Philippines, Sri Lanka, Sumatra, Taiwan, Thailand and Vietnam.
Remarks: Tropical and Subtropical Asia and common species at Kathmandy Valley (Higuchi and Takaki, 1990). In eastern Nepal, it has been recorded only one locality of Ilam at an elevation of 1100 m on bark (Higuchi 18329).

3.4. Thuidium kuripanum (Dozy & Molk.) R. Watanabe, J. Jap. Bot. **62**: 90, 1987; Higuchi & Takaki, Crypt. Him. **2**: 145-146,1990; Pradhan, Mats. Checklist Bryo. Nep.: 74, 2000a; Pradhan, J. Nat. Hist. Mus. **19**: 77, 2000b.

This report has made by Higuchi from Hetauda- Bharatput, Makwanpur district of central Nepal at 800 m in 1988. The current study lakes its collection in Makwanpur district.
Status: Rare
Habitat: Barks
Distribution: Nepal (C, 230-2000 m); Borneo, Celebes, India, Java, Laos, Malay Peninsula, Myanmar, New Guinea, Philippines, Sri Lanka, Sumatra and Thailand.
Remarks: Its distribution is found from lowland tropical region to subtropical region. This is a common species at Kathmandy Valley (Higuchi and Takaki, 1990).

3.5. Thuidium plumulosum (Dozy & Molk.) Dozy & Molk., Bryol. Jav. **2**: 118, 1865.

Hypnum meyenianum Hamp., Icon, Musc.: 8, 1844.
Hypnum kuripanum Dozy & Molk., Zoll. Syst. Verz.: 29, 1855.
Thuidium pelekioides Broth., Bot. Jahrb., **17**: 479, 1893.
Thuidium meyenianum (Hamp.) Dozy & Molk., Bryo. Jav., **2**: 121, 1865; Nog. *et al.*, Fl. E. Him. **2**: 253, 1971; Nog., Lindbergia **1**: 180, 1972; Nog. & Z. Iwats. in Ohashi, Fl. E. Him. **3**: 274, 1975; Gangulee, Mosses E. Ind. & Adj. Reg. **7**: 1621-1623, 1978.

Plants yellowish to brownish green, delicate, wiry forming dense mats. Main stems slender, creeping, dark brown, bipinnately branched with branches in one plane which arise vertically from the main stems. Stem leaves distant, suddenly narrowed into a long acumen apex and cordate bases, upto 0.8 mm long and 0.3-0.5 mm wide at the base. Branched leaves usually small, close, erecto-spreading, concave, ovate with acute point, 0.2 x 0.1 mm in size, crenulate margin due to projectinig the marginal cells, cells hexagonal with single chloroplast, 4-7 x 6 µm in diameter. Dried plants identical to the dried leafy liverworts. Plants autoecious, Sporophytes on main shoots, setae long, scabrous throughout, 2 mm long, capsules horizobntal, ovate-cylindrical, curved at the base, 1.5 mm long, caliptrae cucullate, smooth.
Status: Uncommon
Habit: Bark
Distribution: Nepal (C, E, 200-1250 m): Chitwan (1000- 1200 m), Sunsari (250 m); Asia, Australia, Bangla Desh, Borneo, Burma, India, Japan, Java, Kampuchea, Laos, Mainland China,

Moluccas, New Guinea, Oceania, Philippines, Sri Lanka, Solomon Island, Sumatra, Taiwan, Thailand, and Vietnam.
Remarks: Common in tropical and subtropical regions of Nepal.

3.6. Thuidium tamariscellum (C. Muell.) Bosch et Lacey., Bryo. Jav. 2: 20, 1865; Nog. & Z. Iwats. in Ohashi, Fl. E. Him. **3**: 274, 1975; Gangulee, Mosses E. Ind. & Adj. Reg. **7**: 1637-1639, 1978; Higuchi & Takaki in Watanabe & Malla, Crypt. Him. **2**: 146, 1990; Pradhan, J. Nat. Hist. Mus. **19**: 77, 2000b.

Common Tamarisk Moss (Eng.).

Plants large, deep green, much branched, feathery forming dense mat. Main stems stiff, cylindrical, dark brown here and there due to reddish brown paraphyllum, 3-4 cm long and with bipinnate branches measure about 5-6 mm high. Stem leaves erectopatent, small and ovate. Branched leaves dense, ovate-lanceolate, concave with acute apex, leaf margin not distinct, costa green broad at the base extend 2/3 of the entire leaf, leaf 0.2 x 0.3 mm in size, leaf cells hexagonal with single pointed papilla, 8 x 10 µm in diameter. Plants autoecious. Sporophyres on main shoot, setae erect, 15 mm long, capsules ovate-cylindrical, 1 mm long and inclined.
Status: Common
Habitat: Tree trunks, barks.
Distribution: Nepal (C, E, 200-1500 m): Chitwan (200 m), Samkhuwasabha (200 m); Bhutan, Borneo, Burma, Europe, Denmark, India, Jamaica, Japan, Java, Laos, Mainland China, Norway, Philippines, Sumatra, Sweden, Taiwan, Thailand and Vietnam,
Remarks: Comon in lowland and subtropical region. This is a common species at Kathmandu Valley (Higuchi and Takaki, 1990) and sporophytes not recorded inpresent collection.

5.2.3.7. ISOBRYALES

Most of the pleurocarpous mosses which are acrocarpous at the begining are included in this order. Middle laminal cells short. Peristome double, the endostome ring of peristome has not been developed. Two species under one family are described here.

5.2.3.7.1. CRYPHAEACEAE

Plants forming loose to dense tufts on twigs. Stems erect or creeping, stiff, irregular to regular pinnately branched. Leaves appressed to erect when dry, erect-spreading when wet, ovate to ovate-lanceolate, apex acute to acuminate; margins recurved, entire distally and irregularly serrate at the apical region, costae single, strong, 1/2 to fully excurrent; apical cells oval to oblong-oval; median cells oval to elongate or rhomboidal, smooth to slightly bulging unipapillose, thick-walled; alar region differentiated, cells numerous, quadrate to short rectangular. Plants autoecious. Perichaetia lateral, perichaetial leaves usually longer than stem leaves and sheathing sporophytes. Setae short and smooth. Capsules immersed, erect, urn broadly ovoid to ovoid-short cylindrical or globose,

symmetric to asymmetric, stomata usually at urn base; annuli present, opercula conic-rostrate, peristome double or single, calyptrae cucullate or conic-mitrate, smooth or roughened. Spores spherical to ovoid and papillose.

Distinguishing features of the family include the rather stiffly erect or loose pendent, irregularly branched secondary stems, thick-walled, oval to oblong laminal cells, well differentiated alar cells and immersed capsules. Ca. 100 species are distributed in tropical and subtemterate region of the world (Manuel, 1981). Three species are known from Nepal of them two are described here.

Key to the genera

1. Laminal cells quadrate- round hexagonal; peristome absent or poorly developed .. **1**. *Erpodium*
2.Laminal cells long, oval-oblong-elliptical; peristome double …….… **2**. *Sphaerotheciella*

1. Erpodium (Brid.) Brid., Bryol. Univ. **2**: 788, 1827.

Plants small to moderately robust, slender, dull light to dark green forming dense mats on substratums. Stems elongated, creeping, generally with irregularly pinnately branched. Leaves appressed to the stem when dry and spreading when moist, ovate, ovate-oblong, 0.5-1 mm long, concave, apex acuminate to acute or rounded, laminal cells smooth or pluripapillose, apical cells elongate or isodiametric, median cells quadrate - to hexagonal-rounded and horizontally arranged or oblate, marginal cells small and quadrate, alar region differentiated with oblong cells. Perichaetial leaves envelop the sporophyte. Setae short, 0.2-0.8 mm long. Capsules immersed to short exserted, erect to subinclined, urn short-cylindrical, 0.8-1.5 mm long; opercula conic-rostrate; peristome absent or poorly developed, calyptrae mitrate-short campanulate. Spores smooth to lightly papillose.

Wijk *et al.* (1969) recorded 23 species in this genus in the world. Nepal has the record of one species only.

1.1. Erpodium magniferae C. Muell., Linnaea **37**: 178, 1872; Chopra, Taxo. Ind. Mosses, Bot. Monogr. **10**: 265, 1975; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 26, 2007b.

Erpodium bellii Mitt., J. Linn. Soc. **13**: 307, 1873.

Plants slender, pale green, branched and creeping. Leaves densely arranged on stem, erectopatent, ovate, concave, short acuminate, costae absent, margin entire all around, laminal cells in the apical region rhomboidal-hexagonal, oval-hexagonal in the median region, 45 x 20 µm in diameter, cells in the alar region hexagonal-rhomboidal. Plants autoecious. Sporophytes apical on short branches. Setae very short, erect, capsules small, erect, cylindrical, 0.5x0.3 mm in size and peristome absent. Spores sherical and 30-40 µm in diameter.
Status: Rare

Habitat: Barks.
Distribution: Nepal (E, 255-765 m.): Sankhuwasabha (780 m); India and Thailand.

2. Sphaerotheciella M. Fleisch., Hedwigia **55**: 282, 1914.

Plants medium size, light to dark green, forming suberect tufts on twigs. Stems irregularly pinnately branches, branches to 2 cm long, main stems about 10 cm long. Leaves erect when dry, spreading when wet, ovate to ovate-short lanceolate, 1.0-2.2 mm long with acute apex, margins revolute below, irregularly serrate to weakly crenulate distal or entire, costa rather strong, 3/4-4/5 lamina length; upper and median cells long oval to oblong-elliptical, smooth, inner basal cells elongate, alar region differentiated, cells obliquely arranged, subquadrate and smooth. Plants autoecious, perichaetia lateral and setae very short. Capsules with urn ovoid to ellipsoidal, 1.0-1.5 mm long; stomata absent; opercula conic; peristome double, calyptrae short mitrate and smooth. Spores endosporic and appear multicellular.

Three species from this genus are known in Nepal. Only one species of this genus has been described here.

2.1. Sphaerotheciella sphaerocarpa (Hook.) M. Fleisch., Hedwigia **55**: 282, 1914; Nog. in Hara, Fl. E. Him. **1**: 567, 1966; Nog. & Z. Iwats. in Ohashi, Fl. E. Him **3**: 267, 1975; Chopra, Taxo. Ind Mosses, Bot. Monogr. **10**: 302, 1975; Kattel & Adhikari, Mosses Nep.*:* 19, 1992; Pradhan, Mats. Checklist Bryo. Nep.: 34, 2000a.

Cryphaea sphaerocarpa (Hook.) Brid., Musc. Recent. Suppl. **4**: 139l, 1819.

Plants dark brown, leathery, pleurocarpous with irregular branching. Leaves densely imbricate closely attach to the stem, dense at the apical region, each leaf ovate with excurrent brown costa and entire margin. Marginal cells generally one celled thick, quadtate rectangular, 16 µm in diameter, cells close to costa are rhomboidal with chloroplast, 8 x 82 µm in diameter, cells close to margin are hexagonal to rectangular with distinct nucleus, 15 x 4 µm in diameter, apical cell ellipsoidal with intercellular speces, 18 x 6 µm in diameter.
Status: Vary Rare
Habitat: On twigs with lichens
Distribution: Nepal (168-3400 m): Kanchanpur (168 m); Bhutan, China and India (Sikkim).
Remarks: Previously this was reported only from east Nepal at an altitude of 2600-3000 m.

5.2.3.8. POLYTRICHALES

Polytrichales is a common order of moss, which includes many Himalayan and mountaineous species. Leaves with a thick median part showing lower and high longitudinal lamellae or plates of cells. Two species of *Pogonatum* from the family Polytrichaceae are described here.

5.2.3.8.1. POLYTRICHACEAE

Plants small to robust, often stiff and wiry varying from 0.5-30 cm in high. Stems erect, solitary or few branched. Leaves oblong to ligulate-lanceolate, narrow to broad lanceolate with sheathing base; margins plane, erect or incurved or folded, often serrate to spinose, teeth single or double; costae single, usually strong, narrow to nearly width of limb, percurrent to long excurrent, limb cells isodiametric, thick-walled; sheathing base cells mostly elongate-rectangular; lamellae on adaxial side, in continuous or discontinuous rows over the costa, few to several cells high, terminal lamella cells variously shaped, rounded, truncate, U-shaped or pyriform and smooth or papillose. Plants dioecious rarely autoecious. Setae mostly elongate, stout and wiry. Capsules suberect to inclined, urn cylindrical or 2-4-angled; opercula usually long rostrate, oblique; peristome single, teeth mostly 32 or 64, joined terminally to an exserted, flat columella. Calyptrae smooth to slightly scabrous distally, or densely hairy. Spores often irregular variously ornamented.

The Polytrichaceae contain about 20 genera and 300 species worldwide. About 42 species have been described from Nepal and two species are recorded from the lowland areas.

1. Pogonatum P. Beauv., Mag. Encycl. **5**: 329, 1804.

Plants small to large, 10-15 cm long, solitary or forming tufts, dark green to reddish-brown or blackish. Stems erect, often branched. Leaves crowded at the apical region, contorted or crispate when dry, mostly differentiated weakly between the sheath and limb, base slightly expanded and the limbs oblong-lanceolate or lingulate-lanceolate from the ovate to short oblong base; margins plane, limbs dentate to somewhat sharply serrate; costae weak to mostly strong, percurrent; median cells isodiametric, thick-walled, lamellae extending over lamina and costa, rarely vestigial, 2-6 cells high, terminal cells single or paired, truncate, rounded or pear-shaped. Plants dioecious. Perichaetia terminal. Setae elongate, stout and smooth. Capsules suberect to inclined, urn short to long cylindrical, terete, opercula conic-mammillate and peristome teeth 32. Calyptrae hairy densely. Spores variously ornamented.

Pogonatum contains 52 species distributed worldwide. In Nepal 24 species have been recorded which includes two species from the lowland Tarai. The genus is characterized by densely hairy calyptra, cylindrical capsules with 32 peristome teeth, roughened-papillose exothecial cells and absence of stomata.

Key to the species

1. Plants more than 3 cm; border cells of lamellae strongly differentiated; setae upto 5 cm long ……..…. **1**. *Pogonatum microstomum*
   Plants less than 3 cm; border cells of lamellae not well differentiated; setae upto 3 cm long ……..…… **2**. P. *neesii*

1.1. Pogonatum microstomum (R. Br.) Brid., Bryol. Univ. **2**: 745, 1827; Nog. *et al.*, Bull. Nat. Sci. Mus. **9**(3): 360, 1966; Gangulee, Mosses E. Ind. & Adj. Reg.**1**: 143-144, 1969; Mitt., J. Proc. Linn. Soc. Suppl. **1:** 151, 1959; Wadhwa & Vohra, J. Bomb. Nat. Hist. Soc. **62**(2): 264, 1965; Chopra, Taxo. Ind. Mosses*:* 25, 1975; Kattel & Adhikari, Mosses Nep: 56, 1992; Pradhan, Mats. Checklist Bryo. Nep.: 62, 2000a; Pradhan, J. Nat. Hist. Mus. **19**: 74, 2000b; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 30, 2007b.

Plants dark green, 3.5 - 4 cm high with long lanceolate leaves crowded towards the apical region. Leaves 8 mm long and 1mm broad, margin serrulated, costa brown, broad at the base, strongly toothed at the back. Leaves appressed to the stem when dried. Plants dioecious, Sporophyte on the apical region, Seta very long, 5 cm, reddish brown, smooth, capsule 4-5 mm long and 2 mm broad covered completely with hairy calyptra., spores numerous, pale white, spherical, 10 -16 µm in diameter and annular ring red .
Status: Rare
Habitat: shaded soil, rocks
Distribution: Nepal (C, 350-3800 m.): Sunsari (600 m); Australia, Bhutan, Burma, China, E. Asia, Formosa, India, Indonesia, Philippines, Sikkim, Sri Lanka, Taiwan and Vietnam.
Remarks: This species is common in subtropical to temperate regions, but rare in tropical region.

2. 2. Pogonatum neesii (C. Muell.) Dozy & Molk., *Bryol. Javan.* **1**: 40, 1856; Nog. & Z. Iwats. In Ohashi, Fl. E. Him. **3**: 245, 1975; Kattel & Adhikari, Mosses. Nep.*:* 56, 1992; Pradhan, Mats. Checklist Bryo. Nep*:* 62, 2000a; Pradhan, J. Nat. Hist. Mus. **19**: 74, 2000b.

Neesii's Hair Moss (Eng.).

Plant acrocarpous, dark green, erect rarely branched and about 25-30 mm tall. Leaves dark green, thick, lanceolate wide spreading when moist and contorted and slightly recurved when dry, leaf base concave, margin coarsely dentate with a tooth at regular initervals, costae thick and indistinct, laminal cells round. Plants dioecious. Male plants with reddish leaves near the tips. Setae long, reddish brown to dark red, up to 30 mm long, capsules horizontal or suberect and calyptra hairy.
Status: Rare
Habitat: Moist soil and shaded crevices.
Distribution: Nepal (E, 600-2800 m): Sunsari (600 m); Australia, Bhutan, Borneo, Burma, Causasus, Celebes, China, India, (Sikkim), Japan, Java, Kampuchea, Korea, Laos, Malay Peninsula, Malaysia. Papua New Guinea, Philippines, Sri Lanka, Sumatra, Taiwan, Thailand and Vietnam.

5.2.3.9. POTTIALES

Pottiales is a large order of musci which shows peristome teeth usually split into filaments. Plants generally terrestrial in habit. Stems erect, leaves in many rows, costate, which may be percurrent or excurrent; alar cells absent. Setae long, erect, capsule erect, cylindrical and symmetrical. Two families with eleven genera and 23 species are described here.

Key to the family

1. Gemmiferous leaves often differentiated from vegetative leaves; gemmae common, borne exclusively on leaves ……..... **1**. Calymperaceae
   Gemmiferous leaves not differentiated from vegetative leaves; gemmae uncommon
   …….. **2**. Pottiaceae

5.2.3.9.1. CALYMPERACEAE

Plants small to robust, tufted usually on trees and logs, sometimes on rocks and soil. Stems erect or with ascending-erect branches, stems very short, rhizoids mostly scanty, brown to red or dark red or purple. Leaves crowded, sheathing at base, leaf margins thickened, often toothed thickened border often enclosing stereoid cells, costae strong, convex on back, often papillose or spinose on one or both sides, percurrent to excurrent, frequently with clusters of gemmae at tip, cells of upper laminae green, mostly isodiametric, smooth to papillose; lower laminal cells large, internally and externally porous. Gemmiferous leaves often differentiated from vegetative leaves; gemmae common, uniseriate, fusiform to clavate to filamentous, borne exclusively on leaves. Plants dioecious rarely monoeious. Perichaetial leaves in reduced form. Setae erect, elongated or short, capsules cylindrical; annuli lacking; opercula rostrate; peristome lacking, or present with 16 jointed smooth or papillose teeth, often reduced and imperfect. Calyptrae cucullate and deciduous, or envelop the capsule, persistent and open by vertical slits, rarely very small. Spores small, spherical and papillose

Thirty one taxa of the Calymperaceae are known from China and 56 species from Neotropical region. Fives species are recorded in Nepal. Two genera from this family is described here.

Key to the genera

1. Leaves lamina without hyaline border; peristome absent ……..…... **1**. *Calymperes*
Leaves lamina with hyaline boarder; peristome present ……..…… **2**. *Syrrhopodon*

1. Calymperes Sw. in Web., Tab. Exhib. Calyptr. Operc. Gen. 2, 1813.

Plants small to medium sized, green to dark green occasionally blackish, erect, branched often epiphytic forming dense tufts. Stems erect, mostly branched. Leaves lanceolate to lingulate or oblong spatulate, curled and curved when dry. Costae stout, usually gemminiferous on the tips of upper leaves, laminal cells small, chlorolhyllose and papillose, marginal cells elongated forming border, basal cells hyaline. Gemmae terminal on leaves. Plants dioecious, Perichaetia terminal, setae erect, very short, capsules oblong-cylindrical and without stomata. Calyptre large, campanulate, covered complete capsule. Peristome absent, operculum shortly rostrate and perforated. Spores spherical, smooth, papillose.

Calymperes is a large pantropical genus of acrocarpous mosses distinguishable from other genera of this family by the possession of a persistent and enveloping calyptra. Brotherus (1924) enumerated 200 species in this genus. Nepal has the records of three species, of which one species occurs in tropical lowland area.

1.1. Calymperes erosum C. Muell., Linnaea **21**: 182, 1848; Kattel & Adhikari, Mosses Nepal: 19, 1992; Pradhan, Mats. Checklist Bryo. Nep.: 33, 2000a; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 24, 2007b.

Calymperes hampei Dozy & Molk., Bryol. Javanica **1**: 48, 1856.
C. burmense Hampe in Besch., Annls. Sci.nat. Bot. ser. 8, **1**: 267, 279, 1895.
C. naumannii Besch., Annls. Sci. Nat. Bot., ser. 8, **1**: 267, 1896.
C. stenogaster Besch., Annls. Sci.Nnat. Bot., ser. 8, **1**: 268, 1896.
C. thyridioides C. Muell. Hal. in Paris, Index Bryol. Suppl*:* 86, 1900.
C. subcrassilimbatum P. Varde, Svensk. Bot. Tidskr. **51**: 159, 1957.

Plants yellowish green, erect, 1- 4 cm tall forming mats. Rhizoids brown to glossy blackish red. Leaves incurled and hooked inward when dry and erect spreading when moist. Leaves, lingulate to narrowly lanceolate, 4-5 mm long, 1 mm wide, spreading with sheathing base, apex very variable, typically obtuse or bluntly mucronate with percurrent costa in normal leaves and excurrent in gemmiferous leaves and bears gemmae all around it, costae thick and contain well defined bands of stereid cells, margin more or less thickened and toothed distally. Laminal cells chlorophyllous, more or less isodiametric, quadrate to short rectangular, 5-15 x 5-8 µm in size, frequently multiform papillae; 12 rows of leucocyst cells in 12 rows on either side of the costa, upper leucocysts and lower laminal cells are projecting out. Plants dioecious. Setae reddish, 2-3 mm long.
Status: Common
Habitat: Tree trunks
Distribution: Nepal (C, 200-900 m): Makwanpur (230 m); Burma, China, Colombia, Ecuador, Malaysia, Sri Lanka, Venezuella. common in lowland areas.

2. Syrrhopodon Schwaegr., Sp. Musci. Suppl. **2**(1): 110, 1824.

Plants pale to dark green, grow in dense tufts or cushion usually epiphytic on barks. Stem erect, dark brown, simple or branched 4-10 cm. tall. Central strand lacking. Rhizoids dense on older parts, leaves variable, usually narrow with broader, erect sheathing base, lanceolate to linear-lanceolate, leaf margin usually bordered, costae strong, percurrent or end in the apex, upper leaf cells usually papillous and basal cells hyaline and large. Gemmiferous leaves sometimes differentiated from vegetative leaves, gemmae fusiform or filamentous. Plants dioecious. Male and female plants not differentiated. Perichaetia terminal. Setae thin, variable in length usually 4-15 mm long; capsules cylindrical, calyptrae campanulate rarely mitrate, subulate-rostrate, peristome simple, narrow, coarsely papillous and 16 in number. Spores papillose and spherical.

The genus is characterized by the emergent to exserted capsule, presence of a peristome in some of the species, Calyptrae cucullate, rarely campanulate. Species exhibit a hyaline border. *Syrrhopodon* is a widespread and diverse genus common in tropical to subtropical region mainly epiphytic in habit. Two species are known from Nepal and only one species has been recorded from lowland Tarai.

2.1. Syrrhopodon gardneri (Hook.) Schwaegr., Spec. Musci Frond. Suppl. **2**(1): 110, 1824; Gangulee, J. Bomb. Nat. Hist. Soc. **60**(3): 623-624, 1963; Gangulee, Mosses Ind.: 20, 1985; Chopra, Taxo. Ind. Mosses, Bot. Monogr. **10**: 103, 1975; Eddy, Malasian Mosses **2**: 81-82, 1990; Pradhan, Mats. Checklist Bryo. Nep.: 34, 2000a.

Calymperes gardneri Hook., Musci exot. **2**: 146, 1818.
Cleisostoma gardneri Brid., Bryol. Univ. **1**: 155, 1826.
Syrrhopodon fastiguatus Dozy & Molken , Plant Junghuhn. **3**: 334, 1854.
S. gardneri var. *fastiguatus* (Dozy & Molk.) Dozy & Molk., Bryologia Javanica **1**: 55, 1855.
S. nymannii Fleisch., Musci Fl. Buitenzorg **1**: 213, 1904.
S. curranii Broth., Philipp. J. Sci. **C**. **5**: 142, 1910.

Plants small to median sized, olive green to brown, 4-5 cm tall growing as tuft. Rhizoids dark red often conspicuous and clothing proximal portion of stems. Leaves curled and slightly contorted when dry and spreadiing when moist. Leaves abruptly narrowed to linear, 4-5 x 0.8 mm in size, apex varying from subacute to obtuse, costae prominent, usually ending a little below the leaf tips, ; margins of upper laminae thickened and coarsely toothed in two rows, margins of lower laminae coarsely toothed, cancellinae ending in acute angles distally, their distal cells sharply demarcated from adjacent green cells of upper laminae. upper laminal cells small, thick walled, isodiametric, rounded to quadrate, 6-8 µm wide in mid limb, leucocysts about 8 rows on either sides of the costa. Gemmae frequent on adaxial tip of the costae. Plants dioecious, setae 5-7 mm long, erect, fruiting rare.
Status: Type Gardner *s.n.*, Wallich *s.n.* (Holotype, BM).
Habitat: Tree trunks, decaying logs, rocks and soil (Rare).
Distribution: Nepal (850-2000 m); Bhutan, Borneo, China, India, Indonesia, Japan, Java, Malaysia, Malay Peninisula, New Guinea, Philippines, Sri Lanka, Sumatra and Vietnam.

5.2.3.9.2. POTTIACEAE

Plants small to medium-sized or large, often turf-forming in loosely caespitose patches, dull greenish above and brownish below. Stems erect, simple or irregularly branching; central strand mostly developed, sometimes absent. Leaves in several rows, usually contorted, or appressed when dry, often narrowly lanceolate to linear-lanceolate, or ovoid, triangular to elliptic or ligulate; apices usually acuminate or acute, occasionally obtuse or rounded; bases usually ovate to oblong, sometimes sheathing; margins entire or dentate above, costa single, well developed, percurrent to shortly excurrent or awned, upper leaf cells generally small, subquadrate, quadrate

or hexagonal, rarely short-rectangular, lower cells mostly smooth, rectangular, generally thin-walled, alar regions not differentiated. Dioecious or autoecious. Setae terminal, elongate, erect, capsules erect, symmetric, ovoid to cylindric, peristome single, consisting of 16, erect, calyptrae smooth, spores spherical, small and densely papillose.

Pottiaceae is the largest family of order Pottiales, widely distributed in temperate regions of the world, with a small number of species and genera occurring in tropical and arctic region. Most species of the Pottiaceae occur on calcareous habitats especially on rocks and disturbed soil. Brotherus (1924b) described 71 genera under this family which were separated into five subfamilies. Norris and Koponen (1989) recorded 37 species in 20 genera in western Malaysia. In Nepal, 49 species has been listed collected from lowland to high mountain (Pradhan, 2000a). Nine genera and twenty one species from this family are described here.

Key to the genera

1. Peristome teeth absent ……..……..…....…….. 2
   Peristome present ……..…..……. 4

2. Sporophytes on lateral shoot ……..…….....…. **1**. *Anoectangium*
   Sporophytes terminal on shoot ……..……... 3

3. Leaves spathulate or lingulate, leaf margin flat ……..…... **6**. *Hyophila*
   Leaves linear-lanceolate, leaf margin involute …….……... **1**. *Anoectangium*

4. Peristome teeth short and undivided ……..……. 5
   Peristome teeth long and divided at the base …….…….……...… **3**. *Bryoerythrophyllum*

5. Peristome teeth spirally twisted ……..…..…… 6
   Peristome teeth erect ……..…….....….. **4**. *Didymodon*

6. Plant small with spathulate leaf base …… **9**. *Wiessia*
   Plant medium with oval leaf base ……...…… 7

7. Peristome teeth short, not completely one turn of spiral …….……..…..…… 8
   Peristome teeth long and with more than one turns …….…….……. 9

8. Leaf margin unbroken, costa rough at the back ……..…..…. **8**. *Semibarbula*
   Leaf margin in the lower half serrulated, costa smooth at the back ……..……**7**. *Oxystegus*

9. Plant softer with thinner leaf base ……..…. **5**. *Hydrogonium*
   Plant stiffer with thicker leaf base …….……..… **2**. *Barbula*

1. Anoectangium Schwaegr., Sp. Musc. Frond., Suppl. **1**.: 33, 1811.

Plants slender, small to medium, bright green to yellowish green and densely tufted. Stems erect, simple, rarely branched, usually tomentose at the base, central strand weakly differentiated or absent; outer cortical cells small and thick-walled. Leaves densely arranged, erect, obliquely appressed or contorted when dry, lanceolate, oblong-lanceolate to ovate-lanceolate or ligulate, acute or gradually acuminate, margins flat, entire, sometimes crenulate at the base, costa strong, percurrent or shortly excurrent, upper leaf cells rounded-quadrate or rounded-hexagonal, thick-walled and multi-papillae. Plants dioecious; male and female inflorescences terminal on short lateral branches. Setae elongate, smooth, yellowish brown or reddish brown, more or less twisted. Capsules erect, oblong to short-cylindrical, opercula obliquely long-rostrate and peristome absent. Calyptrae cucullate, smooth. Spores spherical, yellowish brown and pluripapillose.

The genus *Anoectangium* consists of 56 species worldwide. This genus is distributed mainly in warm and moist habitats of the tropics to mountains of the world. Four species recorded from Nepal and one species is described hare as new.

1.1. *Anoectangium bicolor Renauld. & Cardot, Bull. Soc. R. Bot. Belg., **41**(1): 19, 1905; Gangulee, Mosses E. Ind. & Adj. Reg. **3**: 637-638, 1972; Chopra, Taxo. Ind. Mosses, Bot. Monogr. **10**: 114, 1975.

Plants erect yellowish green at the top and brownish red below showing distinctly bicoloured. Stems 12-25 mm long and 3-4 mm wide with expanded leaves usually forked or dichotomously branched above. Leaves bright green, ovate-lanceolate, 2.2 x0.5 mm in size, margin smooth, costae end to the apex, apex blunt. Apical cells more or less quadrate, papillose, 7-8 µm in diameter, middle laminal cells similar to the cells of apical region, basal cells rectangular, light brown, larger towards costal region, 35-78 x12-15 µm in diameter. Sporophytes erect, arise from lateral side of the branch, setae erect, smooth, light brown, 7-8 mm long, capsules erect, ovate, brown, 0.8-1 mm long and 0.5 mm wide, apophysis not distinct, mouth wide, peristome not seen. Spores spherical, light brown, 9-12 µm in diameter (Fig. 59).

Status: Rare

Habitat: Soil.

Distribution: Nepal (W, E, 180-1250 m): Dang (1000 1200 m), Sunsari (180 m); India (Darjeeling, Kumaon, Sikkim).

Remarks: Gangulee (1972) recorded it as a Himalayan species. It was recorded from Sunsari district at lowland of 180 m and 1000-1250 m of Dang district. This is reported as new record for Nepal.

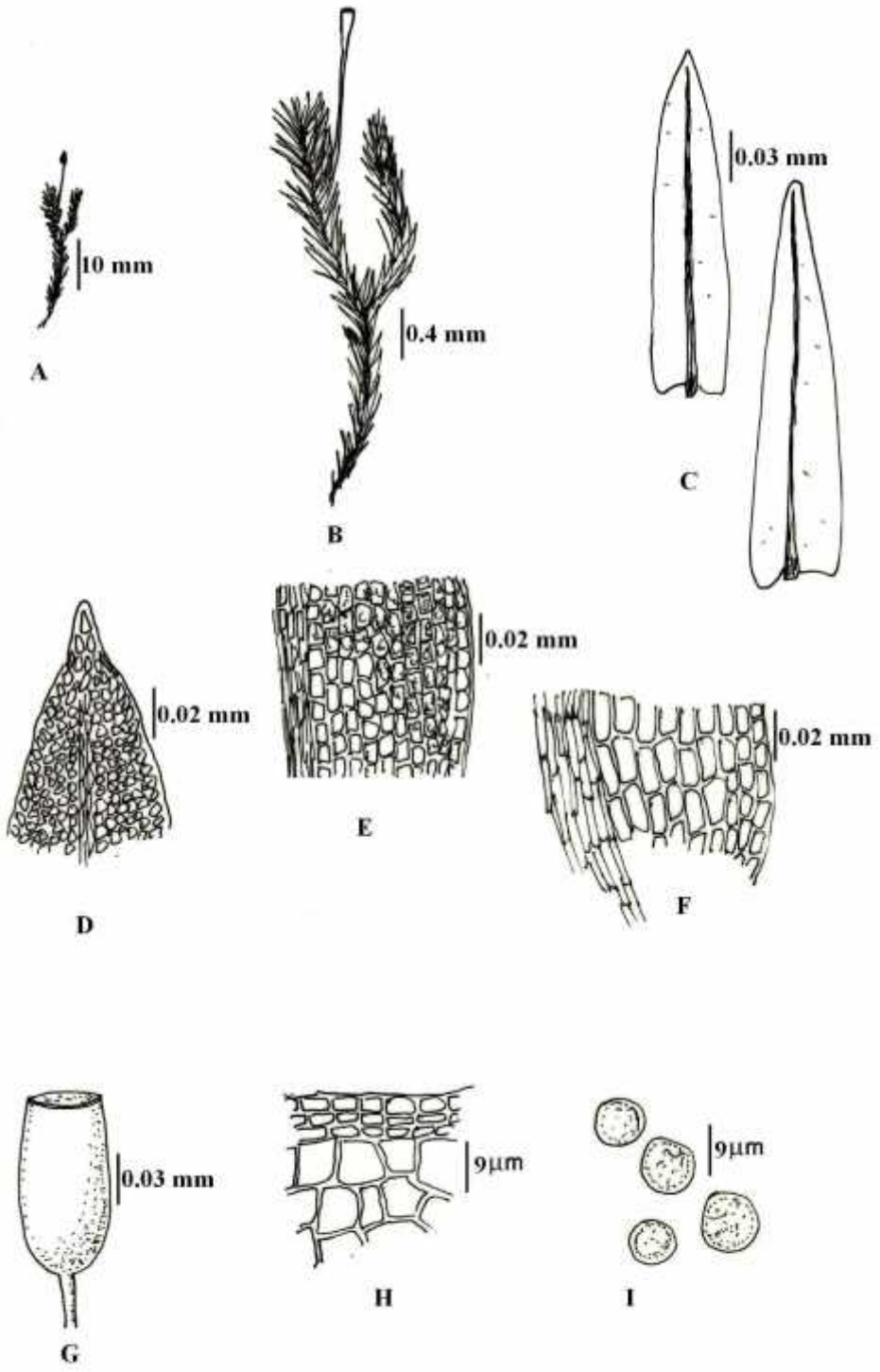

Fig. 59. *Anoectangium bicolor* Renauld. & Cardot, (Pradhan dt 351). A. habit, B. the plant enlarged, C. leaves, D. apical portion of the leaf, E. middle laminal portion of the leaf, F. basal portion of the leaf, G. capsule, H. urn at the apical portion, I. spores

2. **Barbula** Hedw., Sp. Musc. Frond. 1801.

Plants small, slender to robust, green, yellowish green to yellowish brown or reddish brown, loose or densely tufted or forming cushions. Stems erect, simple or irregularly branched, central strand differentiated. Leaves appressed or contorted when dry, erect-spreading in moist; squarrose, ovate, ovate-lanceolate to linear-lanceolate, or narrow-ligulate to oblong-triangular, acuminate to acute or rounded obtuse, margins entire, costa stout, percurrent to shortly excurrent, seldom short-awned, rarely ending below apex; upper leaf cells small, usually rounded-hexagonal to short-rectangular, unipapillose or multi-papillose or occasionally smooth; basal cells usually differentiated as short-rectangular, smooth and hyaline. Gemmae sometimes developed axillary on stalks or in leaf axils. Plants dioecious. Setae elongate, yellowish to sometimes reddish, smooth; capsules erect, rarely inclined, oblong-ovoid to long-cylindrical, rarely curved; peristome teeth 32, slender, filiform, usually twisted counter clockwise, rarely straight, densely papillose; opercula conic, short-to long-rostrate. Calyptrae cucullate. Spores small, spherical, yellowish green to light reddish brown, smooth or weakly papillose. Six species of Barbula has been recorded from Nepal.

Key to the species

1. Plants small, unbranch ……. 2
   Plants large rubost, rarely branched …….… **4**. *Barbula javanica*

2. Plants 0.8-1 mm long; leaves carinate-ligulate, margin bordered by 1-3 rows of elongated, hyaline cells in the middle ……..……..…….…… 3
   Plants 9 mm long; leaves linear-lanceolate, margin without borser cells ……..…….…….. 4

3. Parechaetial leaves shortet than vegetative leaves; laminal cells irregular quadrate ……... **5**. *B. marginatula*
   Parechaetial leaves not differentiated with vegetative leaves; laminal cells quadrate ……..…… **6**. *B. tenuirostris*

4. Plants dark brown; stem tomentose; leaves ovate-lanceolate …….....…. **2**. *B. flavicans*
   Plants yellowish brown; stem reddish, smooth; leaves lanceolate ……..…… 5

5. Gemmae on the leaf axils; peristome teeth linear, erect to twisted ……..……. **3**. *B. indica*
   Gemmae absent; peristome teeth filiform, spirally twisted ……..…. **1**. *B. constricta*

2.1. Barbula constricta Mitt., Musci Ind. Or.: 33, 1859; Gangulee, Mosses E. Ind. & Adj. Reg. **3**: 702-703, 1972; Gangulee, Mosses Ind.: 25, 1985; Pradhan, Mats. Checklist Bryo. Nep.: 64, 2000a; Chaudhary & Sharma, Vasundhara **6**: 35, 2001.

Barbula altipes C. Muell., ibid, **4**: 254, 1897.
Barbula magnifolia C. Muell., ibid, **4**: 255, 1897.

Plants erect, yellowish green-dark green, 18-25 mm high forming dense tufts. Stems dark brown usually dichotomously branched, laxy covered by erect spreading leaves, crumpled when dry. Leaves ovate-lanceolate with point tips 1-2 mm long and 0.5 mm broad, costae percurrent or short excurrent, broad at the base measure 75 µm wide at the base, margin recurved, entire. Laminal cells quadrare, papillous and 6-7 x 7 µm in diameter, basal cells towards costae large, reactangular, 20 x 12 µm in diameter and towards margin are small 9 x 6 µm in diameter. Plants dioecious, setae erect, smooth, 8-10 mm long, capsules erect, brown, elliptical, 2.5-0.6 mm in size, Peristome teeth filiform, papillose, yellowish brown, spirally twisted for one turn, operculum conic. Spores spherical, smooth, yellowish brown, 10-11 µm in diameter.
Status: Rare
Habitat: Soils and river banks
Distribution: Nepal (C, E, 250-3000 m): Chitwan (250 m), Morang (280 m); India, Japan, Java, Upper Burma, North and South China and Philippines.
Remarks: Plant shows following distinct characteristics- dichotomous branching, papillouse laminal cells, narrow acute apex and undifferentiated leaf margin. This species was also reported from Baroya Khimty-Yhakma Khola, 2500 -3000 m of east Nepal (Noguchi, 1966).

2.2. Barbula flavicans D.G. Long, J. Bryol. **18**: 356, 1994.

Tortula flavescens Hook. & Grev., Edin. J. Sci. **1**: 297, 1824.
Barbula fuscescens C. Muell., Syn. Musc. **1**: 831, 1849; Gangulee, Mosses E. Ind. & Adj. Reg. **3**: 710-711, 1972.

Plants with dense tuft on soil. Plant small, unbranched, 10-12 mm tall and 2 mm wide with expanded leaves, Stems dark brown, crowded leaves at the apical region, tomentose, rhizoids brown and 14 µm in diameter. Leaves ovate-lanceolate, 2.5 x 0.8 mm in size with entire margin and excurrent costa, costa brown, 79 µm in diameter, laminal cells quadrate to rectangular, basal cells hyaline and rectangular 26-41 x 12 µm in diameter. Sporophyte not seen.
Status: Rare.
Distribution: Nepal (E, 180 m): Morang (180 m); Bhutan.
Remarks: Previously reported from east Nepal by Wallich (7576). The name *Barbula fuscescens* C. Muell. has been widely used for the moss up to the present time (Wijk *et al*.,1969; Chopra 1975, Gangulee, 1969-1980; Zander, 1993). Long (1994) kept it as the name of *Barbula flavicans.*

2.3. Barbula indica (Hook.) Spring. in Steud., Nomencl. Bot. **2**: 72, 1824; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana : 30, 2007b; Pradhan & Joshi, Nep. J. Pl. Sci. **2**: 32, 2008a.

Tortula indica Hook., Musci Exot. **2**: 135, 1819.

Barbula orientalis (Web.) Broth., Nat. Pflanzenfam. **1** (3): 409, 1902.
Semibarbula indica(Hook.) Herz. ex Hilp., Beih. Bot. Centralbl. **50** (2): 626, 1933.
Hydrogonium setschwanicum (Broth.) P.C. Chen, Hedwigia **80**: 246, 1941.
Semibarbula orientalis(Web.) Wijk & Marg., Taxon **8**: 75, 1959.

Bread moss, Eastern Pott Moss (Eng.).

Plants dark green to yellowish green, rarely branched, 20-25 mm tall growing as tuft. Dried plants with reddish brown stem and contorted leaves. Stem erect, simple with central strand and rhizoids at the base. Perichiteal leaves long, lanceolate , 1.8-2 mm long and 0.4 0.5 mm broad, costa stout, percurrent to shortly excurrent, coarsely papillose on dorsal surface. Upper laminal cells small, rounded-quadrate to hexagonal, 10–16 × 8–14 µm, rather thin-walled, obscure, multi-papillose; middle laminal cells 15 x 6 µm and 25 x 10 µm at the base. Gemmae present on leaf axils. Plants dioecious, acrocarpous; setae erect, smooth, 12-13 mm long, dark brown at the base and yellowish brown towards the capsule. Capsules erect, yellowish brown, oblong-ovoid to cylindrical, 1 x 0.4 mm in size, peristome teeth linear, erect to twisted, dark brown, densely papillose, 450 µm long; opercula conic-rostrate, spores numerous, spherical, entire, thin walled and 10-12 µm in diameter.
Status: Common
Habitat: Old brick walls, sandy soil, forested ground and dried rocks
Distribution: Nepal (W, C, E, 350-1600 m): Dang (290-350 m), Makwanpur (670 m), Sunsari (800 m); China, Formosa, India, Indonesia, Japan, Malaysia, New Guinea, Philippines, South India, Sri Lanka and Southeast Africa.

2.4. Barbula javanica Dozy & Molken, Ann. Sc. Nat. Bot. Ser. 3. **2**: 300, 1844; Nog. & Z. Iwats. in Ohashi, Fl. E. Him. **3**: 254, 1975; Pradhan, Mats. Checklist Bryo. Nep.: 64, 2000a.

Hydrogonium javanicum (Dozy & Molk.) Hilp., Beil. Bot. Centralbl. **50**(2): 623, 1933.
Barbula sublaevifolia Tayama, Act. Phytotax. Geobot. **6***:* 102, 1937
.
Plant bright green, erect, acrocarpous, 2.5-3 cm tall and 2-3 mm broad with expanded leaves. Dried plants somewhat lustrous with involute and crispete leaves. Stem dark brown, erect, rarely branched in the apical region. Rhizoids purple-red, tomentous on stem, 20 µm in diameter. Leaves ovate-lanceolate, 2.5 -3 x 0.8-1 mm in size with entire margin and percurrent costa ends just below the apex, 146 µm in diameter at the base, apical cell 18 x 6 µm in diameter, middle laminal cells more or less quadrate, papillous, 6 x 6-9 x 6 µm in diameter, basal cells rectangular, hyaline, 32-53 x 12 µm in diameter, cells gradually become smaller towards margin. Sporophyte and capsule erect, spores spherical, light brown and 8-18 µm in diameter.
Status: Uncommon
Habitat: Sandy soil.
Distribution: Nepal (E, 180-1550 m): Sankhuwasabha (800 m); China, India, Japan, Java, Philippines and Sri Lanka.
Remarks: Previously this species was reported from Bir Gaun Dingla, 1550 m, east Nepal (1972).

2..5. Barbula marginatula C. Muell. ex. Gangulee, Nova Hedwigia, **12**: 424, 1966; Gangulee, Mosses E. Ind. & Adj. Reg. **3**: 699-700, 1972.

Plants very small, dark green unbranched, 0.8-1 mm long. Leaves long, ligulate dense at the apical region and short and thin towards basal region, erectopatent and slightly crispate when dry. Leaves upto 2.5 mm long 0.5 mm wide at the base, costae yellowish brown, 45 µm wide at the base and is extended into a short apiculus, margin smooth with two ot three rows of elongated rectangular cells 28-30 x 5 µm in size, laminal cells irregularly quadrate with papillose 6-8 µm wide, basal cells rectangular, thin walled, hyaline and 56 µm in diameter. Plants dioecious, setae erect, yellowish above and orange at the base; capsules erect, light brown, peristome teeth long, filiform and twisted.
Status: Uncommon
Habitat: Brick walls
Distribution: Nepal (C, 600-700 m): Makawanpur (670 m); China and India.

2.6. Barbula tenuirostris Brid., Bryol. Univ. **1**: 826, 1827; Gangulee, Mosses. E. Ind. & Adj. Reg. **3**: 707-708, 1972.

Large patch of plants on exposed dried rock. Plant dried, dark green to brownish, 14 mm high, branched, acrocarpous with sporophyte. Leaves lanceolate with wider base, dark green with distinct costa, margin entire, costa dark brown, broad (79 µm in diameter), laminal cells qudrate to rectangular, basal cells rectangular and highly papillous, 26-43 x 6 µm in diameter. Seta dark red, smooth, erect, 14 mm long, capsule brown to reddish brown, erect, cylindrical, teeth long, spiral, spores spherical, brownish green, 15 µm in diameter.
Status: Rare.
Distribution: Nepal (C, E, 350-400 m): Chitwan (350-400 m); India, Japan, Philippines and Marian Island.
Remarks: First collected from east Nepal by Wallich.

3. Bryoerythrophyllum P.C. Chen, Hedwigia. **80**: 4, 1941.

Plants yellowish green to brown, gregarious or loosely caespitose. Stems simple or branched, densely foliate; central strand usually present. Leaves appressed, curved-contorted or crisped when dry, erect-spreading when moist, oblong-ovate to oblong-elliptic, narrowly lanceolate, or ligulate, gradually acute to broadly acute at the apex; margins plane or recurved, usually irregularly dentate above the mid-leaf, often with 3-4 rows of marginal cells reddish brown, pellucid, with fewer papillae, thus showing a distinct differentiated border; costa strong, ending at the apex or shortly excurrent, median and upper leaf cells green, rounded-quadrate or irregularly rounded-hexagonal, with numerous round or C-shaped or satellite papillae; basal cells elongate, irregularly rectangular, smooth, hyaline, often reddish. Gemmae frequently present in leaf axils and on rhizoids. Plants dioecious or monoecious. Perichaetial leaves differentiated, usually sheathing in the lower half. Setae elongate, twisted or straight, purple when old; capsules short-cylindrical, yellowish brown,

reddish when old; annuli differentiated, of 1-2 rows of vesiculose cells; peristome teeth filiform, erect or twisted, densely papillose, sometimes with rudimentary teeth; opercula obliquely rostrate, calyptrae cucullate. Spores spherical, light brown and finely papillose.

The genus consists of some 27 species in the world (Crosby *et al.* 2000) including five species from Nepal.

Key to the species

1. Plant more than 5-10 mm, leaf margin entire ……. 2
   Plant medium, less than 20 mm long; leaf margim detate at the upper half ……..
   ……..……..……..… **2**. *Bryoerythrophyllum recurvirostrum*

2. Seta very short, about 1.5 mm long; spores 21-25 µm in diamaer ……..…… **3**. *B. rubrum*
   Seta 7-8 mm long; spores large, 23-34 µm in diameter…….....… **1**. B. *inaequalifolium*

1.2. Bryoerythrophyllum inaequalifolium (Tayl.) Zander, Bryologist **83**: 232, 1980; D. G. Long, Bryobrothera **1**: 123, 1992.

Barbula inaequalifolium Tayl., London J. Bot. **5**: 49, 1846.
Didymodon confortifolia (Mitt.) Par., Index Bryol. ed. 2, **2**: 69, 1904.
Barbula confortifolia Mitt., Musc. Ind. Or.: 36, 1859; Gangulee, Mosses E. Ind. & Adj. Reg. 3: 693-694, 1972; Nog. & Z. Iwats. in Ohashi, Fl. E. Him. **3**: 253, 1975; Pradhan, Mats. Checklist Bryo. Nep.: 64, 2000a.

Plants small, dark green to reddish green, upto 6-10 mm tall forming tuft on substratums. Stem red, erect, rarely branched, sclerodermis and central strand present. Rhizoids red. Leaves erect, spirally incurved when dry and erect spreading when wet, ovate- lanceolate, 0.8-1.5 mm long and 0.5 mm wide with blunt apices; margins unistratose, revolute to the apex, entire, no bordered, weakly decurrent at the base; costae percurrent or ending 1-2 cells below the apex, smooth at back except near the apex, laminal cells rectangular 23 -35 x 10 -12 µm in diameter near the base, apical cells irregularly quadrate, 3-4 celled gemmae seen attached to the leaf apex. Plants dioecious. Perichaetia terminal, perichaetial leaves elongated and sheathing. Setae red, erect, smooth, 7-8 mm long, capsules erect, small, cylindrical, brown 2-3 mm long, smooth, operculum blunt, calyptrae cucullate, peristome free, brown, 227 x 45 µm in size, spores numerous, spherical, yellowish green, smooth and 23-34 µm in diameter.
Status: Rare (Endemic to Himalaya)
Habitat: Soil, concret wall, bark.
Distribution: Nepal (C, 250-2600 m): Chitwan (250 m); Bhutan, China (Tibet), Macaronesia, Malaysia, Maxico, North, Central and South America, Spain, various localities of Southeast Asia and tropical Africa.

3.2. Bryoerythrophyllum recurvirostrum (Hedw.) P.C. Chen., Hedwigia **80**: 255, 1941; Chopra, Mosses Ind., Bot. Monogr. **10**: 149, 1975; Nog. & Z. Iwats. in Ohashi, Fl. E. Him**. 3**: 254, 1975; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 31, 2007b; Pradhan & Joshi, Nep. J. Pl. Sci. **2**: 32 , 2008a.

Weissia recurvirostra Hedw., Spec. Musc. Frond. 71. 1801.

Didymodon submicrostomus Dixon, Rev. Bryol. Lichénol. **7**: 106, 1934.

Didymodon rubellus Bruch & Schimp. in B.S.G., Bryol. Eur. **2**: 137, 1846; Chopra, Taxo. Ind. Mosses, Bot. Monogr. **10**: 147, 1975.

Red Bread Moss (Eng.).

Plants small to medium, reddish green to brown, 0.5-2 cm high in loose or dense tufts. Stems erect, simple or branched, branching irregular and central strand present. Rhizoides reddish brown. Leaves narrowly ovate-lanceolate, slightly contorted when dry and erect spreading when moist, apiculate apice, unistratose margin which is dentated and folded near apex; costa percurrent to subpercurrent, densely papillous, laminal cells irregularly quadrate, pluriplpillose, 8-12 x 8-12 µm in diameter, alar cells not differentiated. Setae orange red to reddish brown, 5-15 mm long, capsule cylindrical, erect, peristome erect, 16 in number, light yellow to hyaline, 240 µm long, calyptra cucullate. Spores greenish, papillose, 14-16 µm in diameter .
Status: Uncommon
Habitat: Rocks, soil cover rocks and sometimes upon rotten trees.
Distribution: Nepal (W, C, 300-410 m): Dang (410 m), Chitwan (300 m); Australia, Caucasus, Central. Asia, China, East Siberia, Europe, Iran, Japan, New Guinea, North & Central America, North Africa, Oceania, Pakistan, Russia and West Tibet.

3.3. *Bryoerythrophyllum rubrum (Jur. ex Geh.) P.C. Chen, Hedwigia. **80**: 258, 1941; Li & Z. Iwats. Moss Fl. China **2**: 142, 2001.

Didymodon ruber Jur. ex Geh., Rev. Bryol. **5**: 28, 1878.

Plants slender, yellowish green to reddish brown in loose tufts. Stems erect, 6-12 mm long and 1 mm broad with spreading leaves. Leaves crisped when dry, spreading when moist. Leaves narrowly ovate-lanceolate, sheathing at the base, 6-12 mm long and 1 mm broad narrowly acuminate at the apex; margin entire, recurved, borders not differentiated; excurrent ends at the leaf tip, 15 µm at the apical region 32 µm at the basal region, margin without boarder, laminal cells at the apical region more or less round to quadrate densely papillose, 8-9 x 7 µm in diameter, cells in the median region 12 x 6 µm in diameter, basal cells hyaline, rectangular, 21-35 x 7-8 µm in diameter. Sporophyte erect areses from the axil of the stem, setae erect, short, 1.5 mm long. Capsules dull brown, erect, small, 0.6 x 0.2 mm in size, calyptrae cucullate, operculum long-rostrate, peristome teeth erect, filiform with rough surface, 9 µm in diameter (Fig. 60).

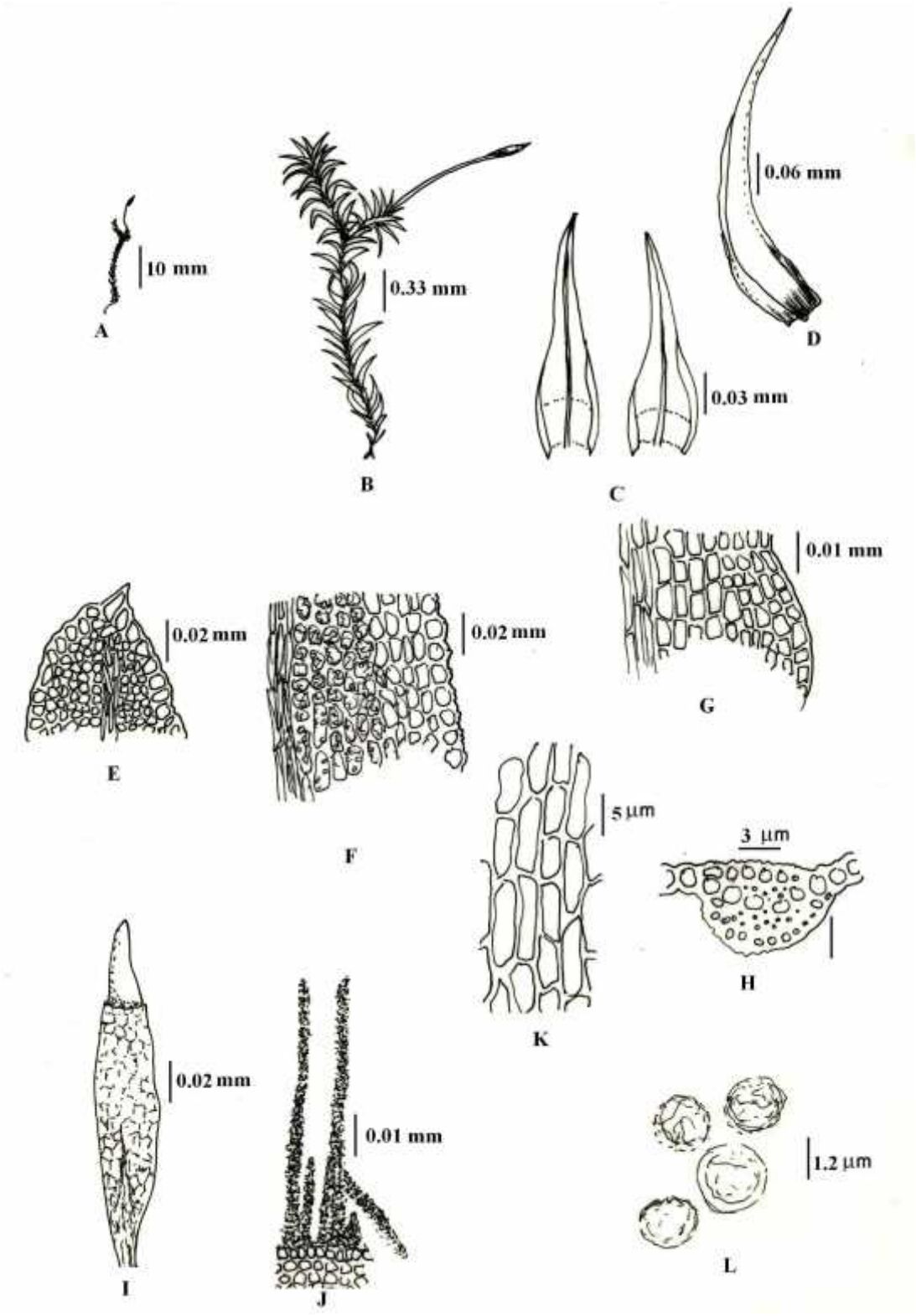

Fig. 60. *Bryoerythrophyllum rubrum* (Jur. ex Geh.) P.C. Chen (Pradhan dt 368). A. habit, B. the plant enlarged, C. leaves, D. perichaetial leaf, E. apical portion of the leaf, F. middle portion of the leaf, G. basal portion of the leaf, H. cross section of the costa, I. capsule, J. peristome teeth, K. cells of the middle laminal region, L. spores.

Status: Rare
Habitat: Rocks, soil.
Distribution: Nepal (E, 180 m): Morang (130 m), Biratnagar (180 m); China, Europe, Japan and Russia.
Remarks: The plant with irregular toothed leaf margin due to not bearing boarder; capsule with filiform teeth and conic apical cell. This species is new record for Nepal.

4. Didymodon Hedw., Spec. Musc.: 104, 1801.

Plants erect forming dense tufts. Stems brown, central strand usually present, hyalodermis not differentiated. Leaves yellowish brown, lanceolate with acute apex, brown, excurrent or percurrent or end just below the apex, margin entire rarely toothed in uppor portion, narrowly recurved, laminal cells round-quadrate or rhomboidal, thick walled, smooth or papillose, basal cells more or less enlarged, irregularly round to oblong. Leaves loosely appressed to the stem when dry. Plants dioecious. Perichaetial leaves more or less differentiated. Setae erect, reddish brown at the basal region and pale brown above; capsules ovoid to cylindrical, peristome teeth erect or sinistrorse, 16 or 32 in number, annular ring well differentiated, 1-3 rows, operculum with long beaked, caliptrae cucullate. Spores spherical, yellowish brown to pale green.

4.1. **Didymodon constrictus** (Mitt.) Saito, J. Hattori Bot. Lab. **39**: 514-516, 1975.

Barbula constricta Mitt., J. Linn. Soc. Bot. suppl. **1**: 33, 1859.
Barbula nipponica Nog., J. Jap. Bot. **27**: 286, f. 53, 1952.
Barbula nipponica Nog. var. *gracillis* Nog., J. Jap. Bot. **27**: 286, 1952.

Plants erect, dark green to brownish green. Stem brown, erect, thin, 2-4 cm long and 136 µm wide. Leaves more or less appressed to the stem when dry, broad lanceolate to lanceolate, light brown, 1.5 mm long and 0.2-0.5 mm wide, acute apex and narrowly recurved smooth margin, costae percurrent end just below apex, laminal cells rounded to short rectangular 7-12 x 9-15 µm in size, thin walled gradually larger towards the base. Plants dioecious. Perichaetial leaves ovate-lanceolate slightly larger than the stem leaves. Seta reddish brown, erect, 8-14 mm long; capsules cylindrical, 1.5-2 mm long and 0.5 mm wide, peristome teeth sinistrorse, 32 in number, operculum 1mm long, calyptra cucullate. Spore spherical, pale green, 10-12 um in diameter.
Status: Common (Type Sikkim and Nepal, J. D. Hooker 170 (NY).
Habitat: Boulder stone
Distribution: Nepal (W, 160 m): Bardia (160 m); Burma, China, Indonesia, Japan and Pakistan
Remarks: Common in lowland

5. Hydrogonium (C. Muell.) A. Jaeger, Ber. Thaetigk. St. Gallischen Naturwiss. Ges. 1877-78: 405, 1880.

Plants usually grayish green in dense tufts. Stems erect or inclined, simple or branched; central strand present. Leaves appressed, rarely contorted when dry, erect-spreading when moist, triangular to ovate-lanceolate or ligulate, acute or blunt at the apex, margins mostly plane, occasionally revolute, entire, rarely serrulate near the apex; costa stout, percurrent to shortly excurrent with 2 stereid bands in cross section; cells of adaxial surface of costa quadrate to short-rectangular, papillose or smooth, thin-walled, upper leaf cells loose, usually quadrate to hexagonal, thin-walled, mostly smooth, rarely mammillose or papillose, basal cells rectangular, smooth, hyaline. Gemmae usually present, in various shapes. Plants dioecious, perichaetial leaves smaller than stem leaves, not sheathing at the base. Setae slender, straight, yellowish; capsules erect, cylindrical; annuli differentiated; peristome teeth linear, usually erect, rarely twisted counter clockwise; opercula long conic-rostrate. Calyptrae cucullate, smooth. Spores spherical, brownish and finely papillose.

This species is common in tropical and subtropical regions of the world, most commonly on calcareous rocks in moist habitats. Nepal has recorded previously two species and one more new recorded from lowland regions. *Hydrogonium arcuatum* and *H. subpellucidum* both are common in lowland Nepal which is drescribed in the present investigation.

Key to the species

1. Plants more than 2 cm long, costa rough on its back.… …… **2**. *Hydrogonium subpellucidum*
   Plant less than 2 cm, cosra smooth …….. **1**. *Hydrogonium arcuatum*

5.1. Hydrogonium arcuatum (Griff.) Wijk. et. Marg., Taxon **7**: 289, 1958; Chopra, Taxo. Ind. Mosses, Bot. Monogr. **10**: 144, 1975; Gangulee, Mosses Ind.: 25, 1985; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 31, 2007b; Pradhan & Joshi, Nep. J. Pl. Sci. **2**: 32, 2008a.

Barbula arcuata Griff., Cal. J. Nat. Hist., **2**: 491, 1842.
Hydrogonium comosum (Dozy & Molk.) Hilp., Beih. Bot. Centralbl. **50** (2): 622, 1933.
Barbula comosa Dozy & Molk., Ann. Sci. Nat., Bot., sér. **3, 2:** 299, 1844..

Bread Moss (Eng.).

Plants yellowish green, stiff in dense tufts. Stems erect simple, about 10 mm tall, rarely branched, radiculose at the base. Leaves erectopatent when dry, ovate or triangular-lanceolate, 2 x 0.5 mm in size, gradually acuminate at the apex; margins entire, plane or weakly revolute, costae stout, yellowish brown, percurrent or ending just below the apex. Apical laminal cells quadrate to pentagonal, smooth, thin-walled, 6-12 µm wide, basal cells irregularly rectangular, thin-walled, smooth, hyaline and 35x5 µm in diameter. Plants dioecious, acrocarpous with erect sporophytes, setae erect, reddish brown, 12-14 mm long, twisted when dry, capsules erect, brown, cylindrical, 2 x 0.5 mm in size, operculum conic-rostrate, calyptrae cucullate, covering only the tip of the

capsules. Peristome teeth filiform, papillose, reddish brown, 1 mm long, spirally twisted one to more turns. Spores sperical to oval, yellowinh brown, 12-13 µm in diameter.

Status: Common

Habitat: Rocks, soil, river banks and bases of tree trunks.

Distribution: Nepal (W, C, 250-350 m): Bardia (250 m), Dang (250- 335 m), Bara (600 m); Central America, China, India, Indonesia Japan, Malay, Malaysia, Morocco, North & South Burma, New Guinea, Oceania and Philippines.

5.2. *Hydrogonium subpellucidum (Mitt.) Hilp., Belh. Bot. Central bl., 50 (**2**): 627, 1933; Chopra, Taxo. Ind. Mosses, Bot. Monogr. **10**: 147, 1975; Pradhan & Joshi, Nep. J. Pl. Sci. **2**: 32, 2008.

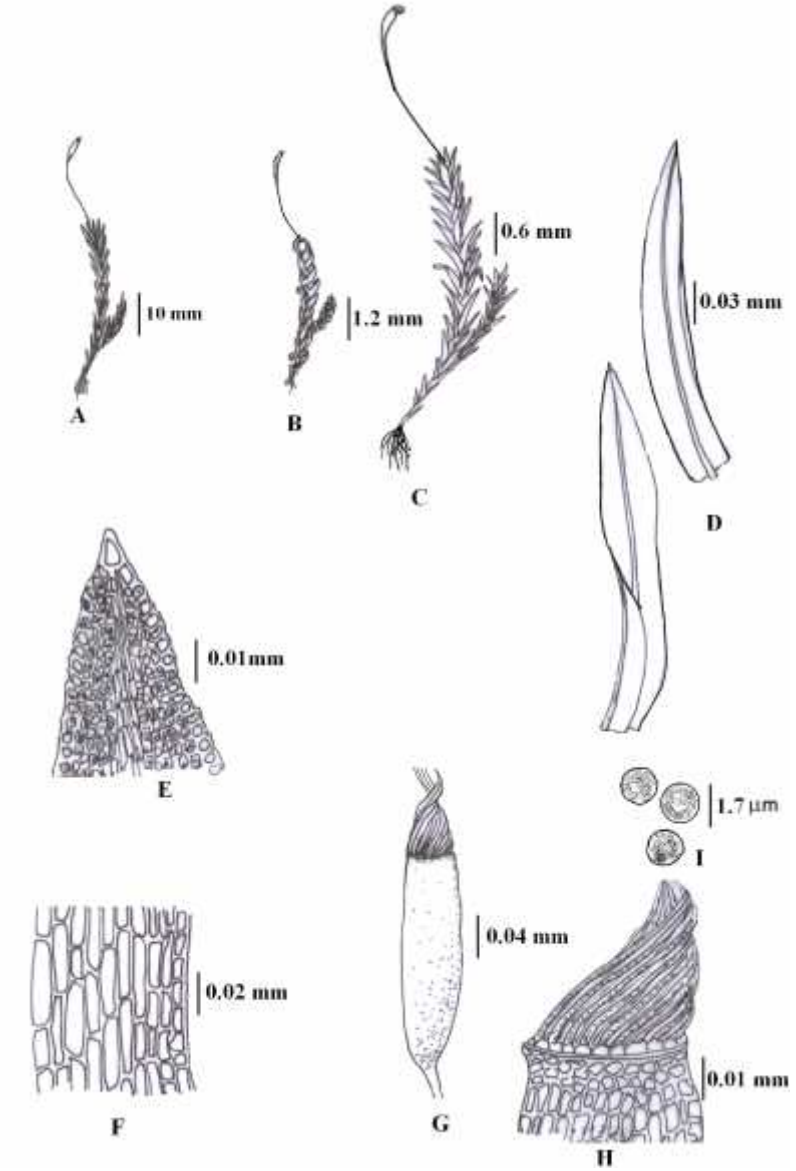

Fig.61. *Hydrogonium subpellucidum* (Mitt.) Hilp. (Pradhan NGS 555). A. habit, B. dry plant, C. the plant enlarged, D. leaves, E. apical portion of the leaf, F. basal portion of the leaf, G. capsule with peristome, H. a portion of the capsule enlarged, I. spores

Barbula subpellucida Mitt., J. Proc. Linn. Soc., Bot., Suppl. **1**: 35, 1859.

Hydrogonium subpellucidum var. *hyaloma* Herz., J. Hattori. Bot. Lab. **14**: 20, 1955.

Plants medium-sized, 30-45 mm high, soft, bright green to yellowish green, in dense tufts Stems simple or branched, more than 2 cm tall; central strand weakly differentiated. Leaves involute to contorted when dry, erect-spreading when moist, lanceolate-lingulate, 1.6–3.0 × 0.5-0.8 mm, rather suddenly narrowed to an acute apex; margins plane, entire in the lower half, serrulate in the upper half; costa stout, percurrent, roughened or papillose on the back; upper leaf cells rounded quadrate to hexagonal, 10-20×7-12 µm, thin-walled, distinctly papillose; basal cells narrowly rectangular, 34-90×10-22 µm, smooth, hyaline. Plants dioecious, Perichaetial leaves not much differentiated. Setae slender, ca. 15 mm long, yellowish brown to reddish, more or less twisted; capsules erect, ovoid-cylindrical, peristome teeth linear, slightly twisted and counter clockwise (Fig. 61).

Status: Rare

Habitat: Rocks and shaded grounds.

Distribution: Nepal (W, 320 m): Dang (320 m); Africa, Asia, China, Europe, India, Indo- China, Oceania, South & North America and Wester Tibet.

Remarks: New record to Nepal.

6. Hyophila Brid., Bryol. Univ. **1**: 760, 1827.

Plants small, 5-10 mm tall, light green upper part, red to reddish brown or dark green below growing in dense tufts, somewhat lustrous when dry. Stems acrocarpous, erect, simple, rarely branched; central strand present or absent. Leaves usually rosulate, incurved or contorted when dry, oblong-elliptic to oblong-spatulate or oblong-lanceolate to lanceo-ligulate, blunt to rounded-obtuse or weakly apiculate at the apex; margins entire or serrulate; costa stout, percurrent to shortly excurrent; upper leaf cells small, quadrate to rounded-hexagonal, smooth or papillose; basal cells rectangular, smooth, hyaline. Dioecious or autocious. Perichaetial leaves smaller than or similar to stem leaves. Setae erect elongate, reddish brown below and pale brown towards the capsule, capsules erect, oblong-cylindrical; annuli differentiated, deciduous; peristome absent; opercula conic-rostrate, usually with long oblique beak, calyptrae cucullate, smooth, peristome teeth absent. Spores spherical, small and smooth.

Gangulee (1972) has recorded 121 species of *Hyophila* worldwide. Five species are described here.

Key to the species

1. Rhyzoidal gemmae absent ……..… 2
   Rhyzoidal gemmae present ……..……..…..…… **2**. *Hyophila apiculata*

2. Leaves narrow spatulate, more or less constricted above base, 0.5 mm wide in the middle, laminal cells smooth on both the surface..... **1**. *Hyophila acutifolia*
   Leaves elliptical to broad-spatulate, not constricted above base, more than 0.7 mm wide in the

middle, laminal cells mammillous on adaxial surface 3

3. Leaf margin serreted at the apical region, apex acute to obtuse ..... **3**. *Hyophila involuta*
Leaf margin entire, apex spathulated ..... 4.

4. Leaves long lanceolate, hyaline leaf base very short, operculate cuculate with long beak
..…..… **4**. *Hyophila nymaniana*
Leaf spathulate, hyaline leaf base narrower, opercula conic-rostrate with erect long-beak ..... **5**. *Hyophila spathulata*

6.1.*Hyophila acutifolia Saito**,** J. Hattori Bot. Lab. **39**: 470 - 471, 1975.

Plants growing on exposed brick wall gregarious in habit. Plant small, 3.5 mm long and 1 mm wide with the expanded leaves. Stem unbranched, brown with crowded leaves at the apical region. Rhizoids reddish brown, 7-8 µm in diameter. Rhizoidal gemmae present, variable in shaped, 40- 82 x 32-35 µm in diameter. Leaves narrow spatulate, 1.5-2 x 0.2 mm in size, with distinct brown costa extends upto the acute apex , 34 µm in diameter in the median region, margin entire through out. Laminal cells in the apical region papillous, quadrate, 6 µm in diameter, laminal cells in the median region smooth, papillous, 6-12 x 6-10 µm in diameter. Sporophytes erect born on apical region; setae erect, short, yellowish green, 6 mm long; capsules short, ovoid, 1 mm long (Fig. 62).
Status: Rare
Distribution: Nepal (E, 800 m): Dhankuta (800 m); Japan.
Remarks: This species was reported for the first time in Nepal. The plant with narrow spatulate leaves, smooth laminal cells, smooth cells of the adaxial surface of the costa and the presence of small capsule are distinct features of this species. This species is new record for Nepal.

6.2. *Hyophila apiculata Fleisch., Musci Fl. Buittenzong **1**: 325, 1904; Eddy, Malaysian Mosses **2**: 200-201, 1990.

Plant small, yellowish green to yellowish brown, unbranched, erect, acrocarpous, 3 -5 mm tall and 2 mm broad with spreading leaves, forming velvety tuft on exposed wall. Leaves tuft at the apical region and margin inrolled when dry. Stem short, dark brown, rhizoids at the basal region of the stem. Leaves ovate- spatulate, 2.5 x 0.8 mm in size, margin entire and costae excurrent, broad at the base, 79 µm in diameter at the base. Apical cells more or less quadrate, 6-7 µm in diameter, middle lamional cells more or less rectangular, thin walled, basal cells rectangular hyaline. Sporophyte erect and apical, seta erect, lower half bright red and upper half yellowidh brown, 7-10 mm long, capsule cylindrical, light to dark brown, 2 mm long with operculum and 0.4 mm wide, peristome not seen. Spores spherical, yellowish brown to pale brown, thin walled, 12 µm in diameter (Fig. 63).
Status: Rare
Distribution: Nepal (180 m): Morang (180 m); India (Darjeeling, endimic, Kurz 2374).
Remarks: This species was reported for the first time in Nepal. The plant with narrow spatulate

leaves, smooth laminal cells, smooth cells of the adaxial surface of the costa and the presence of small capsule are distinct features of this species.

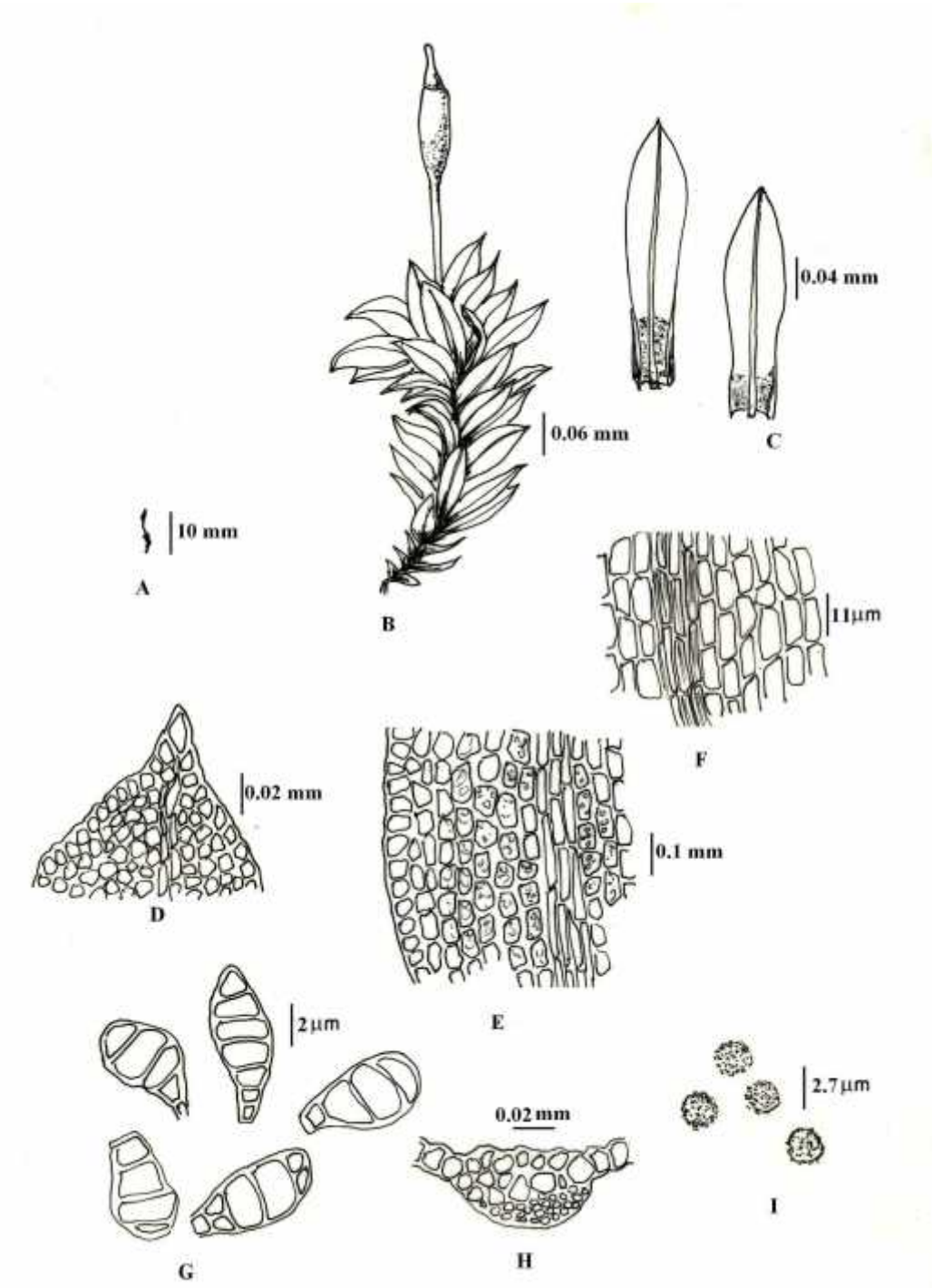

Fig. 62. *Hyophila acutifolia* Saito (Pradhan Dt 385). A. Habit, B. the plant enlarged, C. leaves, D. apical portion of the leaf, E. median portion of the leaf, F. basal portion of the leaf, G. gemmae, H. cross section of the costa at the basal region, I. spores.

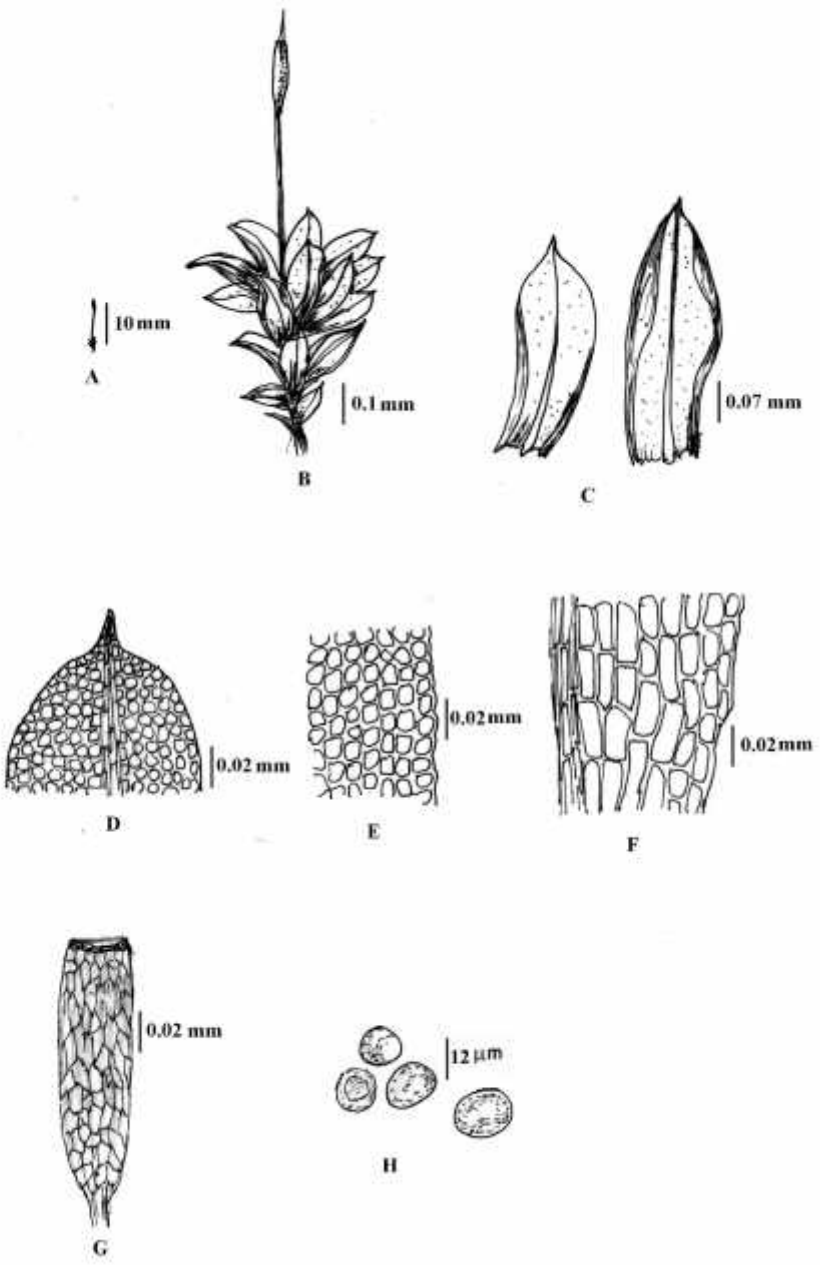

Fig. 63 . *Hyophila apiculata* Fleisch., A. habit, B. the plant enlarged, C.leaves, D. apical portion of the leaf, E. middle portion of the leaf, F. Basal portion of the leaf, G. capsule, H. spores.

6.3. Hyophila involuta (Hook.) A. Jaeger, Ber. Sci. Gall. Naturw. Ges. **1871-72**: 354, 1873; Noguchi & Z. Iwats. in Ohashi, Fl. E. Him**.** **3**: 255, 1975; Gangulee, Mosses Ind. & Adj. Reg. **3**: 681-683, 1972; Gangulee, Mosses Ind., Bot. Monogr. **20**: 24, 1985; Pradhan, J. Nat. Hist. Mus. **19**: 74, 2000b; Li & Z. Iwats., Moss Flora of China **2**, MBG Press: 191, 2001; Nath *et al*., Taiwania **52** (2): 173, 2007; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 31, 2007b; Pradhan & Joshi, Nep. J. Pl. Sci. **2**: 32, 2008a.

Gymnostomum involutum Hook., Musci Exot. **2**: 154, 1819.
Hyophila tortula (Schwaegr.) Hampe, Bot. Zeitung (Berlin) **4**: 267, 1846.
Hyophila micholitzii Broth., Öfvers. Forh. Finska Vetensk.-Soc. **35**: 39, 1893.

Inrolled Potted Moss (Eng.).

Plants small, 4 to 14 mm high, yellowish green in dense tufts. Stems erect, simple or branched; central strand absent. Leaves involute to subtubulose when dry, erect to wide-spreading when moist, oblong-ovate to oblong-spatulate, 1.7-3.0 × 0.6-0.8 mm, broadly acute to obtusely apiculate, slightly reflexed at the base, margin serrate in the upper half; costa stout, percurrent to shortly excurrent; upper leaf cells small, subquadrate to rounded hexagonal, 5-8 × 5-7 µm, somewhat thick-walled, not papillose, slightly mammillose on the ventral surface; basal cells short-rectangular, 28-62 x10-18 µm, pale or hyaline. Gemmae present. Plants dioecious. Setae 10 15 mm long, yellowish green to redish brown, erect; capsules erect, cylindrical, operculum conic-rostrate with long beak, annuli present. Spores 9-10 µm in diameter.
Habitat: Calcareous rocks, soil and grasslands
Distribution: Nepal (W, C, E, 200-1300 m): Bardia (200 m), Dang (1000 m), Chitwan (300 m), Parsa (180 m), Sunsari (800-1300 m); Africa, North, Central and South America, Asia, Borneo, Burma, Celebes, China, Europe, India, Japan, Java, Kampuchea, Korea, Laos, Malaysia, New Guinea, Occania, Philippines, Russia, Sri Lanka, Sumatra, Taiwan, Thailand and Vietnam.

6.4. *Hyophila nymaniana (Fleisch.) Menzel, Willdenowia. **22**:198, 1992; Z. Iwats. & Li, Moss Fl. China **2**: 193, 2001.

Glyphomitrium nymanianum Fleisch., Musci Buitenzorg **1**: 372. f. 69, 1904.
Hyophila rosea Williams, Bull. New York Bot. Gard. **8**: 341, 1914.

Rosette Pott Moss (Eng.).

Plants small to medium-sized, 4 to 15 mm high, in dense tufts. Stems erect, rarely branched, densely foliateat the apical region. Leaves oblong-elliptic- long lanceolate, 2.2 x 0.8 mm in size, often keeled, contorted with in-rolled margins when dry, erect-spreading when moist; margins plane, sometimes revolute in the lower half; costa stout, brown broad at the base, shortly excurrent as an apiculus, highly papillose on the back; upper leaf cells small, rounded-hexagonal, mammillose on both sides or papillose; basal cells larger, smooth, more or less hyaline. Gemmae global, consisting of 3-4 cells. Plants dioecious. Sporophytes erect, setae red, 8-14 mm long; capsules erect, cylindrical, ca. 2.0-2.5x1.0 mm in size, operculum cuculate (Fig. 64).
Status: Rare
Habitat: Soil cover rocks, tree bases.
Remarks: New record for Nepal.

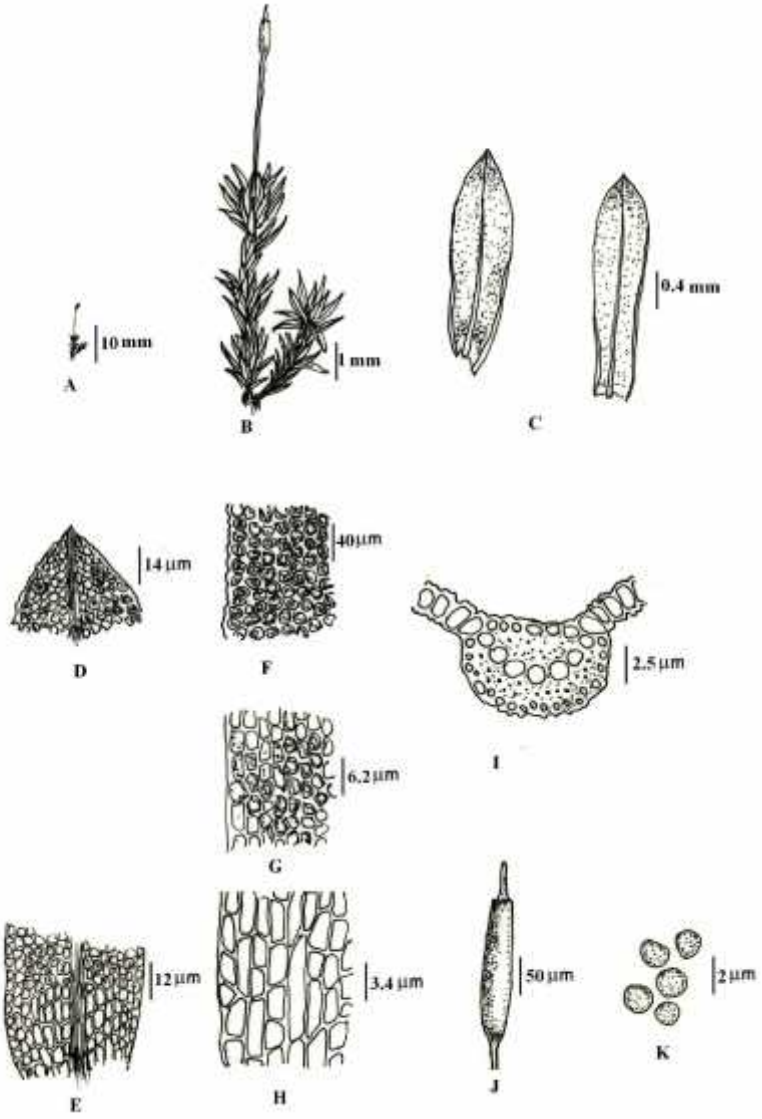

Fig. 64. *Hyophila nymaniana* (Fleisch.) Menzel, A. habit, B. the plant enlarged, C. leaves, D. apical portion of the leaf, E. Basal portion of the leaf, F. portion of apical leaf showing apical cells, G. cells in the median region of the leaf, H. cells at the basal region of the leaf, I. T.S. of leaf in the median region, J. capsule, k. spores.

6.5. Hyophila spathulata (Harv.) A. Jaeger, Ber. S. Gall. Naturn. Ges. **1871-72**: 353, 1873; Nog. in Hara, Fl. E. Him. **1**: 553, 1966; Noguchi & Z. Iwats. in Ohashi, Fl. E. Him**. 3**: 256, 1975; Li & Z. Iwats., Moss Fl. China **2**: 195, 2001; Pradhan & Joshi, Current Trends in Bryology in Nath & Asthana: 31, 2007b.

Gymnostomum spathulatum Harv. in Hook., Icon. Pl. Rar. **1**: 17, 1836.
Desmatodon spathulatus (Harv.) Mitt., J. Proc. Linn. Soc., Bot., Suppl. **1**: 39, 1859.
Pottia spathulata (Harv.) C. Müll., Syn. Musc. Frond. **1**: 559, 1849.

Plants dark green, erect, unbranched rarely branched up to 5-15 mm high, forming dense tufts on tree bark and on orchid root. Stems erect with rosset of spathulate leaves at the apical region. Leaves spathulate, 2 x 0.8 mm in size with acute apex, margin entire and costae reddish brown, broad at the base, percurrent, ending just below the apex. Upper leaf cells small, quadrate to hexagonal, thin-walled, chlorophyllous and 9 x 7.8 broad µm in diameter, basal cells shortly rectangular, more or less hyaline, 44 x 14.6 µm in diameter. Plants dioecious. Setae straight, yellowish brown, 16-17 mm long, capsules small, erect, ovoid- cylindrical, reddish brown, 2.2 x 0.4 mm in size, opercula conic-rostrate with erect long-beak, peristome teeth very short. Spores numerous, smooth, spherical, brown, 12 µm in diameter.
Status: Rare, Wallich *s.n.* - Type (Gengulee, 1972; Z. Iwats. & Li, 2001).
Habitat: Rocks, soil and epiphytic in habit.
Distribution: Nepal (145-2400 m); China, India, Indonesia, Japan, Java, and Sri Lanka.

7. Oxystegus (Limpr.) Hilp., Beih. Bot. Zbl. **50**(2): 666-667, 1933.

Plants dark green, erect, branched forminig tufts. Lower leaves oblong-lanceolate, apex acuminate, margine crenulate due to papillae marginal cells, costae percurrent or short excurrent, smooth at the base, upper leaves usually less developed, laminal cells thin walled, upper cells quadrate, densely and coarsely papillose, basal cells smooth and hyaline and elongated. Peristome teeth erect and undivided.

The genus somewhat resemble with the genera *Tortella* and *Trichostomum*, but differs from former in having crenulate leaf margin and by its undivided peristome teeth while *Trichostomum* has divided peristome teeth.

7.1. Oxystegus cylindricus (Brid.) Hilp. in Beih., Bot. Centralbl. **50**(2): 620, 1933; Gangulee, Mosses E. Ind. & Adj. Reg. **3**: 655, 1972.

Weissia cylindrica Bruch ex Brid., Bryol. Univ. **1**: 806, 1827.
Barbula longifolia Griff., Cal. J. Nat. Hist. **2**: 490, 1842.
Didymodon cylindricus (Brid.) B.S.G., Bryol. Eur., **2**: 510, 1842.
Tortula cylindrica (Brid.) Mitt., Musc. Ind. Or.: 28, 1859.
Oxystegus longifolius (Griff.) Hilp., Beih. Bot. Centralb., **50**(2): 667, 1933.

Plants erect yellownish green, brownish yellow below, forming tufts intermingle with other oss (dt 345). Stems slender, 15-25 mm long and 3 mm wide with expanded leaves and rearly branched. Leaves uniformly spreading in wet and curled when dry. Leaves lanceolate-lingulate, longer in the apical region, 3-4 x 1 mm in size,argin smooth, costae light brown, percurrent and end few cells below apex. Leaf bases perpendicular to costae. Laminal cells in the middlae quadrate to rectangular, highly papillose, 12 x 9 µm in diameter. Basal cells rectangular, hyaline, thin walled 21-47 x 12-15 µm in diameter. Plants dioecious, acrocarpous. Seate erect, yellowish green and 15 mm long, capsules brown, cylindrical, erect or slightly curved, 3.5 mm long and 0.8 mm in

diameter, opercula conic with long beak, capsule mouth wide, peristome teeth deep brown with articulated joint, highly papillose. Spores spherical, light brown and 10-12 µm in diameter.
Status: Rare
Habitat: Soil.
Distribution: Nepal (E, 180-3650 m): Sunsari (180 m); Africa, America, Burma, Central Asia, China, Europe, India, Japan and Sri Lanka.

8. Semibarbulla Hilp., Beih. Bot. Zbl. **50**(2): 626, 1933.

Plants yellowhish green, robust, forming tufts. Stems erect, simple or dichotomously branched. Leaves twisted and appressed to the stem when dry and erectopatent when moist, lingulate-lanceolate, obtuse from a broad base and recurved, costae strong, percurrent or projectinig as a small apiculus and very rough at the back. Apical laminal cells quadrate, densely papillose, basal cells thin walled and translucent. Perichaetial bracts longer, setae erect, capsules ovoid to cylindrical, operculum obliquely beaked, peristome lightly twisted. Spores spherical with varying size. One species is described here.

8.1. Semibarbulla ranuii Gangulee, Nova Hedwigia **8**(1-2): 148-149, 1964; Chopra, Taxo. Ind. Mosses, Bot. Monogr. **10**: 142, 1975.

Plants acrocarpous, dark green with unbranched brown stem growing on wet earth. Sterile plant up to 14 mm long, leaves lanceolate – very long, up to 2 mm long and 0.4 mm wide, erectopatent when moist and curled when dried, margin smooth usually flat, costae stout, excurrent with short apex, costal back rough, leaf apex broadly acuminate, laminal cells small, rectangular, chlorophyllose and multipapillose, slightly large at the base. Basal cells hyaline, 12 x 42 um in size, alar not differentiated. Plants dioecious, sporophytes on the apical region, setae yellowish brown, erect, 7 mm long, capsule brown, erect, cylindrical, 1.7 x 0.5 mm broad, peristome teeth usually spirally twisted.
Status: Uncommon
Habitat: Moist earth.
Distribution: Nepal (200-320 m): Banke (280 m); India

9. Weissia Hedw., Sp. Musc. Frond. 1801.

Plants small, usually 12 mm high, bright green or yellowish green, in dense tufts. Stems erect, short, simple or irregularly branched, central strand present. Leaves often crowded at stem tips, contorted-curved or crisped when dry, spreading or occasionally reflexed when moist, long-ligulate, oblong or triangular-lanceolate to narrowly lanceolate, sheathing at base, upper lamina often channeled, sharply acute or acuminate at apex; margins strongly incurved or involute above the leaf base, entire or crenulate by projecting papillae, costa rather stout, usually shortly excurrent, ending in sharply mucronate tips, upper leaf cells subquadrate to hexagonal, thin to evenly thick-walled, papillose, with bifid or branched papillae, basal laminal cells sharply differentiated, rectangular,

sometimes forming a V-shaped leaf base, mostly thin-walled, smooth, hyaline. Plants autoecious or dioecious. Perichaetial leaves not much differentiated from stem leaves. Setae short or elongate, straight, yellowish brown, capsules erect or slightly inclined, oblong-ovoid to oblong-elliptic or cylindrical; annuli none or differentiated, opercula conic-rostrate, with a rather long, straight or obliquely beak or operculae not differentiated, peristome teeth 16, short or rudimentary. Calyptrae cucullate, smooth. Spores spherical, yellowish brown to brown, papillose.

9.1. *Weissia edentula Mitt., J. Proc. Linn. Soc. Bot. Suppl. **1**: 27, 1859; Saito, J. Hattori Bot. Lab. **39**: 421, 1975; Norris & Koponen, Acta Bot. Fenni. **87:** 137, 1989; Li & Z. Iwats., Moss Fl. China **2**: 247, 2001.

Hymenostomum edentula (Mitt.) Besch., Bull. Soc. Bot. Fr. **34**: 95, 1887.
Hymenostomum leptotrichaceum (C. Muell.) Par., Index Bryol. Suppl.: 189, 1990.

Weissia leptotrichacea C. Muell., Nuovo Giorn. Bot. Ital., n. ser. **4**: 259, 1897.

Weissia platyphylloides Card., Beih. Bot. Centralbl. **19**(2): 90-92, 1905.

Weissia semipallida C. Muell., Nuovo Giorn. Bot. Ital., n. ser. **5**: 185, 1898.

Plants small, greenishbrown, unbranched, acrocarpous in dense tuft on substratum. Stems erect, central strand well developed, irregularly branched, 3-5 mm tall and 0.5 mm wide with leaves. Rhizoids plale brown, 12 µm wide at the base, smooth and extensively branched, arisinig on stem priarily at adaxial costa insertion. Leaves often crowded at stem tips, contorted-curved when dry, spreading when moist, narrowly lanceolate, 1-3 mm long, 0.4 mm wide, sheathing at base, upper lamina often channeled, acuminate at apex; margins moderately incurved, entire or crenulate by projecting papillae, costae light green, rather stout, shortly excurrent, ending in sharply mucronate tips, 57 µm wide at the base, middle laminal cells qudrate, highly papillous, 6 -6.4 x 5.8-6 µm in diameter, basal cells reactangular with straight lateral walls, hyaline, 15-35 x 6-12 µm in diameter. Plants autoecious. Sporophytes erect, terminal. Setae light brown, erect, 2-6 mm long, capsules erect, oblong-ovoid, 1-0.6 mm long and 0.2 mm wide, operculum conic, teeth lacking (Fig. 65).
Status: Rare.
Habitat: Forest flore, tree bases, rocks, brick walls and soil.
Distribution : Nepal (200 m): Jhapa (200 m); Australia, China, India, Japan, Malaysia, Philippines, Polynesia, Sri lanka, and Vietnam.
Remarks: This is the new records for Nepal. The species has wide variation with plant and leaf sizes and shapes. Norris and Koponen first recorded it from Western Malaysia (1989).

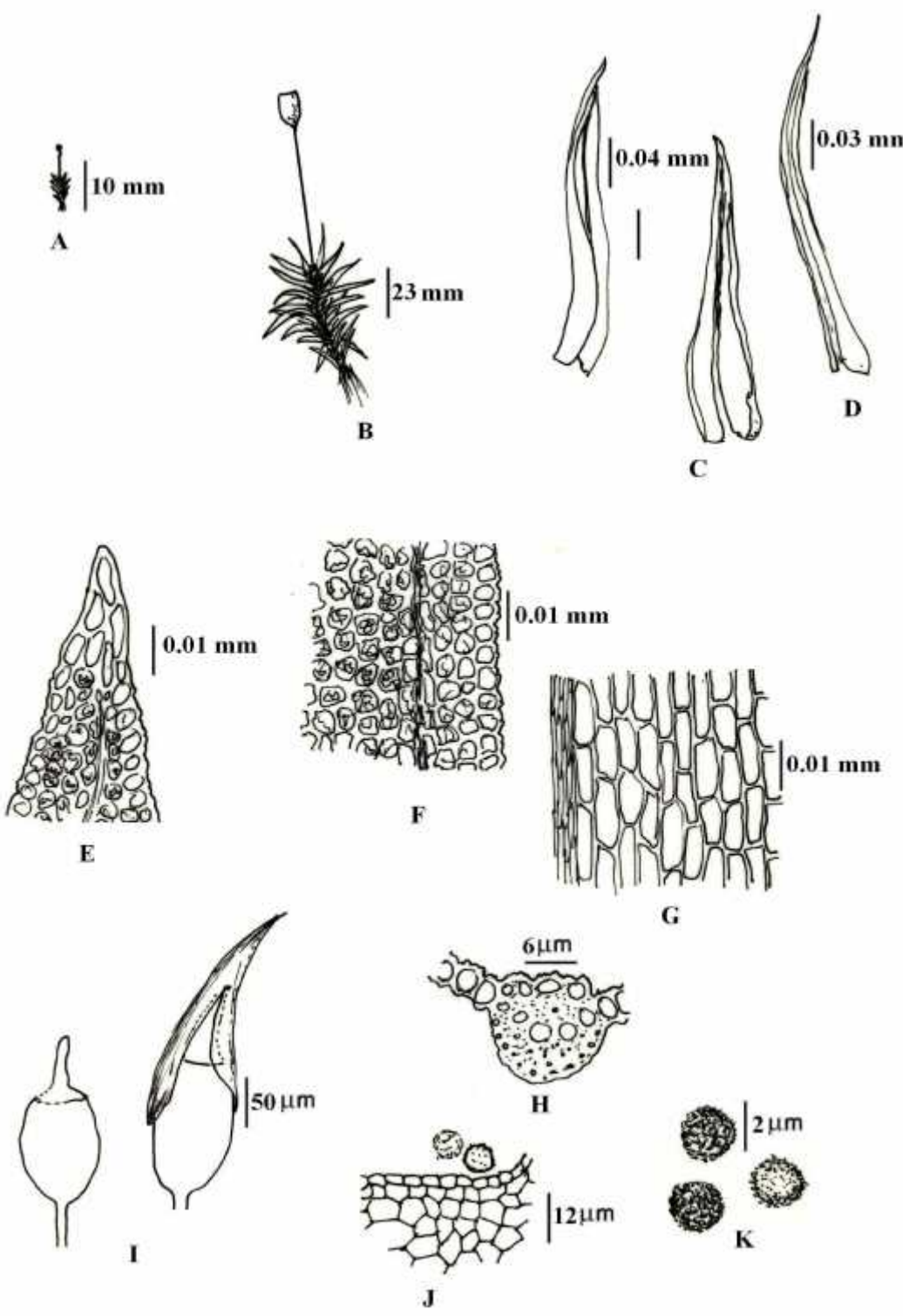

Fig. 65. *Weissia edentula* Mitt. (Pradhan dt 371). A. habit, B. the plant enlarged, C. leaves, D. perichaetial leaf, E. apical portion of the leaf, F. middle laminal portion of the leaf, G. basal portion of the leaf showing basal cells, H. cross section of the leaf at the basal region, I. capsules, J. urn at the apical region, K. spores

Bryophytes species Below 1000 m.

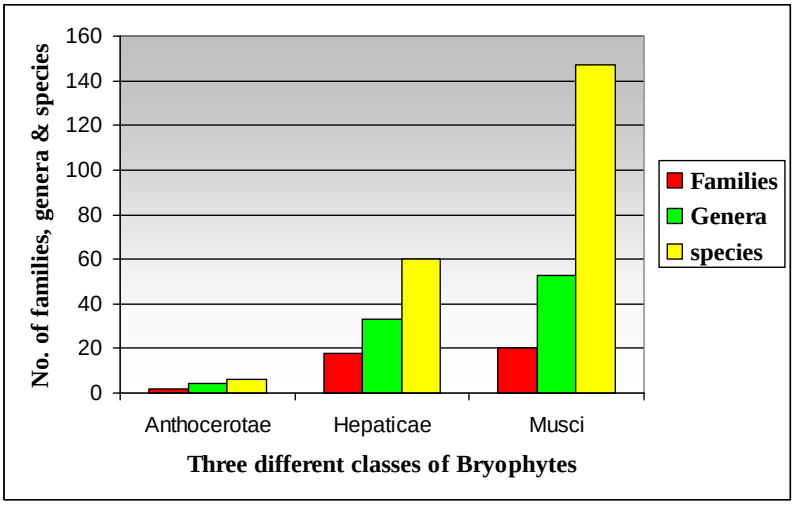

Fig. 66. Diversity in Three different classes

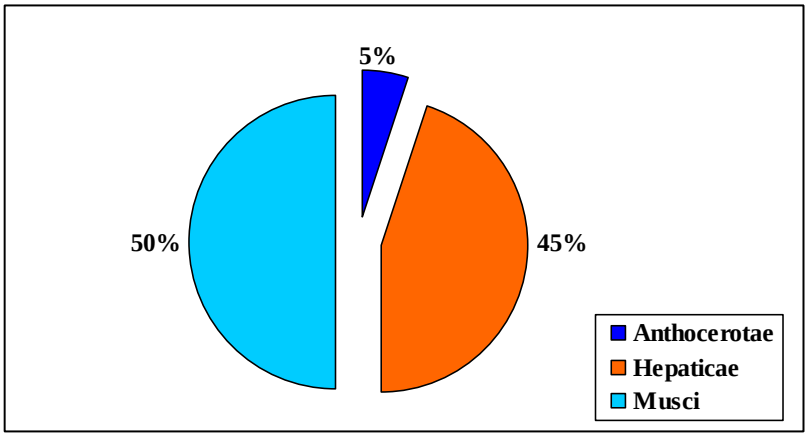

Fig. 67. Percentage of families representation in three different Classes

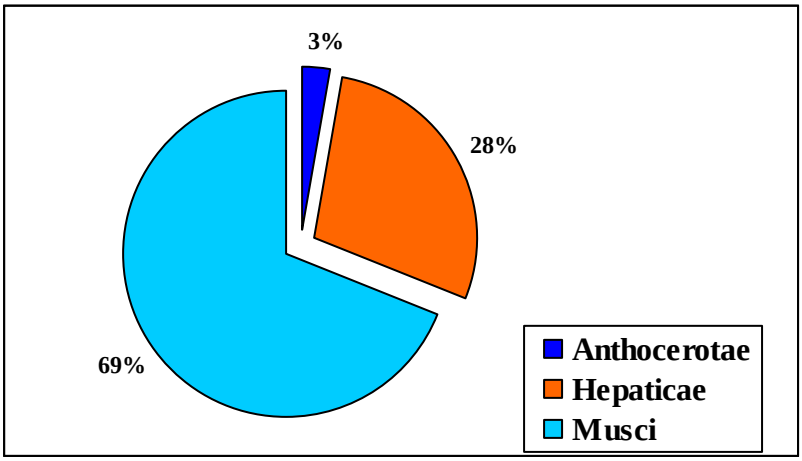

Fig. 68. Percentage of species representations in three different Classes

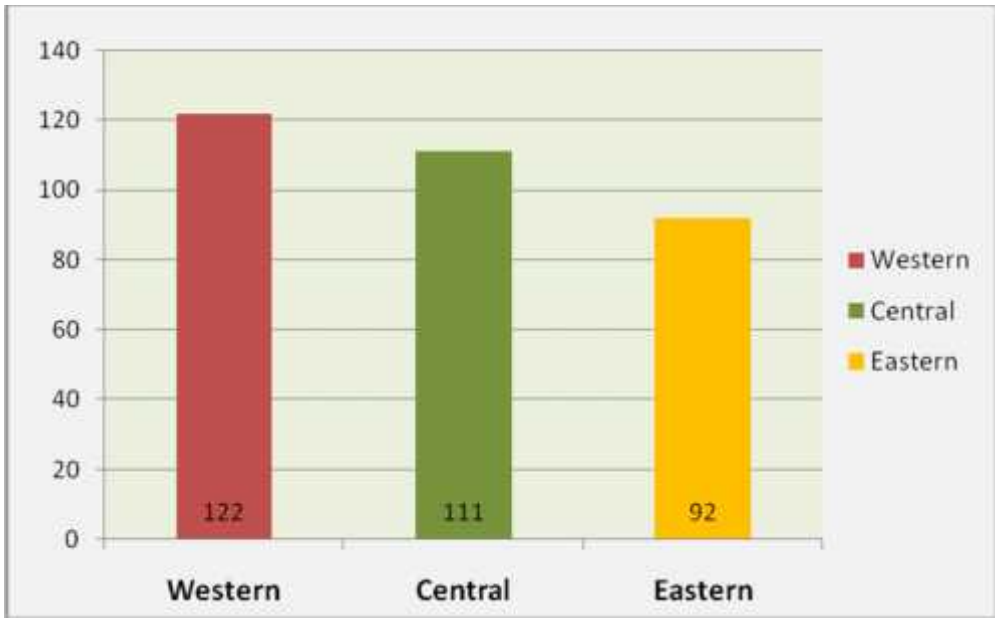

Fig. 69. Diversity in three different regions of lowland Tarai

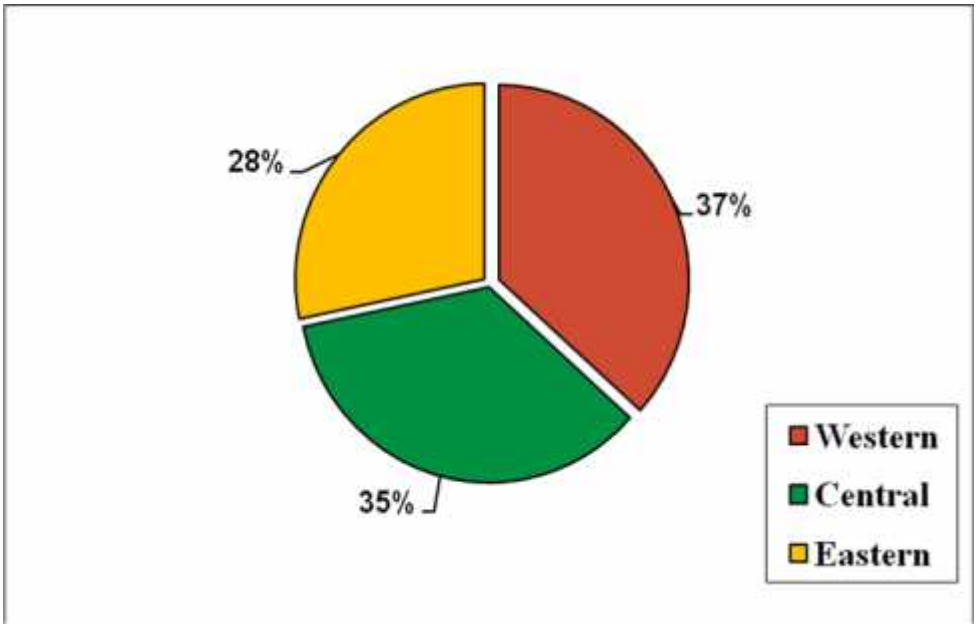

Fig.70. Percentage of Bryoflora in three different regions of lowland Tarai

6. Discussion

The lowland bryophytes are categorized into 90 genera and 213 species from the selected 5000 perfect specimens collected at various localities and habitats of the Tarai and Churia hills (below 1000 m). Altogether 40 families of all the three classes (Musci, Hepaticae and Anthocerotae) were identified in this work. This can be said to be the first extensive work as very least information was available on lowland and Churia bryophytes till date or before the initiation of this work. This research also added 30 more new records to the overall list of the country besides exploring out many significant and interesting data on their distribution.

In lowland to Churia (below 1000 m), bryophytes are distributed in a wide variety of habitats. The forest species of this plant is mostly seen in mesic areas where tree or fern's canopy are common. Species diversity was reported high in the mixed forest of tropical zone. Sal forest (*Shorea robusta*) has good representation of epiphytic species like *Frullania muscicola, Entodontopsis anceps, E. leucostega, E. tavayensis, Trachyphyllum nepalensis,* etc besides many species of *Thuidium*. These bryophytes can be seen growing upon barks of *Shorea robusta, Terminaria chebula, Mallotus philippines,* etc. Mesic parts at Ghodaghodi Lake (220 m), Kailali and Bish Hazzar Lake (280 m) of Chitwan district represented good diversity of Hepaticae and Anthocerotae. The Siwalik range below 1000 m has also been considered as a good site for the species richness of bryophytes. Koshi Tappu Wildlife Reserve of east Nepal has displayed less diversity mainly due to its open, disturbed and poor habitats non-preferable to many species. Notable species reported in this area are *Barbula constricta, Bryoerythrophyllu rubrum, Syrrhopodon gardeneri, Hyophila involuta, Hyophila kurziana,* etc.

Of the total 40 families, 2 belonged to Anthocerotae, 18 Hepaticae and 20 Musci (Appendix I). The total species record in this research counts 213 species, of them 6 species are Anthocerotae, 60 species of Hepaticae and 147 species of Musci. The analyzed data showed a total of 90 genera of which four are Anthocerotae, 33 Hepaticae and 53 Musci (Fig. 66). In this study 30 species are reported as new records to Nepal (Appendix III).

Analyzing all the recorded species, musci showed high diversity of 69 %, Hepaticae 28 % and Anthocerotae 3 % while family record of musci counts 51 %, Hepaticae 44 % and anthocerotae 5 %. (Fig. 67 and Fig. 68). Tarai represents about 18.5 % of the entire country.

The distribution of bryophytes in three regions of Nepal viz. west, central and east show remarkable variation in their diversity. Comparatively, the western and central regions came up with the diversity of 122 and 111 species respectively while eastern region represented 92 species only (Fig. 69). This in percentage record is 37%, 35% and 28 % respectively (Fig. 70). This study also showed one species of anthocerotae, four species of hepaticae and 22 species of musci all sharing common habitats over Tarai regions (Appendix I1).

Anthocerotae is the least studied class specially in Tarai and Siwalik with the record of six species under four genera and two families. Among five species of Anthocerotaceae, *Anthoceros chambensis, Anthoceros formosae* and *Anthoceros punctatus* are rare species while *Phaeoceros laevis* is very common and *Folioceros assamicus* is a new record to Nepal.

The class Hepaticae has three distinct orders, 18 families, 33 genera and 60 species in lowland Nepal. The order Jungermanniales has been reported to be the largest order with 9 families, 18 genera and 34 species. The reported species of Marchantiales belongs to 6 families, 10 genera and 21 species, and Metzgeriales represent 4 genera, 5 species belonging to 3 families. Nine species of Hepaticae are reported as new records to Nepal (Appendix III).

Jungermanniaceae is the dominant family of the order Jungermanniales which includes 15 species under four genera. *Jungermannia exertifolia*, *Jungermannia infusca* and *Jungermannia pumila* are new records to Nepal. All the species of *Jungermannia* except *Jungermannia tetragona* are rare in lowland areas. Pocock *et al*. (1985) studied swollen rhizoids in some hepatics (seven species) of montane rain forest in Peninsular Malaya. They found fungal hyphae within the swollen tips. *Jamesoniella autumnalis* is a rare species which is recorded only from a specific locality of central Nepal (Yoda 11595 in 1963).

David Long, a well known British bryologist, made extensive research on bryophytes of Nepal but his work was concentrated mostly in the east Himalayas. One of his notable works is the report of *Jamesoniella nipponica*. at 3446 m in Ghunsa forest (Taplejung) of eastern Nepal (Long, 1989). Kumar and Udar (1985) have described *Jamesoniella nipponica* collected in the Himalaya of India.

Frullaniaceae is another common family with the record of three species in the lowland. *Frullania muscicola* is a common species in tropical to subtropical region of the country, while *F. dilatata* is a rare species and a new addition to the list of Bryoflora species of Nepal, it was collected from the bark of a *Shorea robusta* tree in the Bardia National Park (340 m.) of west Nepal. This species has not been reported elsewhere in central and eastern Nepal. Lal and Parihar (1979) in their published work have included some species of mosses which are found in Nepal as well. These include *Frullania muscicola* and *F. ericoides.*

Frullania is a well distributed taxa in Nepal. Records of sixteen Nepalese *Frullania* taxa have been made so far. *Frullania pseudoshenxiana* var. *darjeelingensis*, *Frullania asposinensis, Frullania. parihariі* and its form *intermedia* are new to Nepal and *Frullania higuchi* is described as new to the science (Yuzawa and Koike, 1994). This was collected at Dhunche (2000 m) of the Langtang National Park in central Nepal. They described 14 species of *Frullania* collected by Higuchi in Nepal. Hattori (1975) has published a revision of Indian species of *Frullania* based upon Mitten's publication (1861). Distribution, taxonomy and morphology of *Frullania* have been presented precisely in his paper. Similarly, Hattori (1979) in his work on *Frullania* taxa of Ceylon has included *Frullania polyptera* and *Frullania ericoides*, both exist in the Siwalik

(Churia) lower part of eastern Nepal. Thaithong and Hattori (1977) have published a paper on the morphology, distribution and ecology of the species of *Frullania* found in India, some Nepalese species like *Frullania apiculata* var. *obtusata*, *F. himalayansis*, *F. nepalensis*, *F. retusa*, *F. subclavata*, and *F. wallichiana* are also included in their paper. Among reported 16 species of *Frullania* (Yuzawa and Koike, 1994), *Frullania aposinensis*, *F. ericoides* and *F. muscicola* also occur in lowland at 800-1000 m.

Geocalycaceae is the next common family in Tarai and Siwalik which represents two species under the genus *Heteroscyphus*. Piippo (1990) recorded 10 species of *Heteroscyphus* with other species of Geocalycaceae. *Heteroscyphus planus* and *Heteroscyphus tener* are the next two species added to the Chinese list. *Heteroscyphus planus* has been reported as new record to Nepal. *Heterocyphus argutus* is a fairly common species across east west Tarai. *Chiloscyphus polyanthus* is the first record from western Tarai region.

Piippo *et al.* (1997) listed 149 species of Hepaticae from Sichuan, China. Their list included 16 species of Hepaticae reported from lowland Tarai of Nepal. *Calypogeia neesiana* is the one and is a new record to Nepal. This species was collected from Bardia and Banke districts at 200-400 m, west Nepal.

The next common family is Lejeuneaceae which includes six species under five genera. All these species are rare in lowland areas. The rare *Lopholeujunea abortiva* is restricted to a single locality at 320 m of Churia range in Kailali district of the west. *Acrolejeunea pusilla* is recorded new to Nepal. Among the species of *Lejeunea* occurring in Nepal, *Lejeunea proliferens* and *Lejeunea patens* var *uncrenata* are treated as new synonyms of *Lejeunea cocos* and *Lejeunea parva* respectively. Masami (1971) made some nomenclature changes with some *Lejeunea* species based on his study in the Himalayan regions of South Asia. This includes *Lejeunea wallichiana*, *L. longiloba*, *L. stevensiana* and *L. princes*. *Lejeunea wallichiniana* which occur in the temperate parts of eastern Nepal. *Lejeunea ulicina* has been recorded as the smallest species among the *Lejeunea* species.

Mastigolejeunea humilis is a rare species and is confined to the Dharan of eastern region only. Its status is very critical and needs suitable conservation measures. *Lopholejeunea sikkimensis* is a widely distributed species of Lejeuneaceae in the Himalayas (Mizutani, 1976, Mizutani *et al*, 1995, Awasthi *et al*, 2000 and Zhu and Long 2003). *Lopholejeunea sikkimensis* is now under the name of *Lopholejeunea nigricans*(http://www.mobot.org/MOBOT/tropicos/most/checklist.shtml).

Plagiocheliaceae is one of the largest families of hepaticae, which includes seven genera. Among them, *Plagiochila* is the largest and most difficult genus with about 1800 species worldwide (Inoue and Schuster, 1971). Nepal has the record of 47 species. Its diversity gradually increases from the Siwalik to the temperate zone and decreases at the subalpine to the alpine regions. The alpine zone displays five species of this genus. So (1988) has published a checklist of *Plagiochila* (Hepaticae) of Asia. In part I, about 480 species of *Plagiochila* are included and in part II, the

recognized species in Asia are listed which includes 132 species. This study came up with the collections of two species of *Plagiochila* from the Tarai region only. *Plagiochila parvifolia* in the name of *Plagiochila phalangea* was collected at Taplejung of the east by Hattori in 1963. So and Grolle (1999) later revised this name and considered *Plagiochila phalangea* as a synonym. This is a Type species (Isotype, Wallich 1820) from Nepal. *Plagiochila nepalensis* Lindenb. has also been considered as a Type species (holotype, Wallich 1820) and was collected from the Mul Pokhari of Taplejung district (Hattori, 1963).

Aytoniaceae is the dominant family comprising nine species under four genera. *Asterella* is a cosmopolitan and large group of chambered liverwort with its wide distribution across country. This genus is primarily defined by the presence of a pseudoperianth, a cage-like structure surrounding each capsule in the carpocephalum. Long (2006b) made taxonomic revision of the genus *Asterella* and described 16 species from Eurasia. Of them *Asterella grollei, A. wallichiana, A. khasiana, A. leptophylla, A. multiflora* and *A. mussuriensis* ssp. *mussuriensis* are distributed in Nepal, but he did not mention the occurrence of *A. brumeana* in Nepal. *A. mussuriensis* ssp. *mussuriensis* was recorded from the central and eastern subtropical to temperate forests and *A. leptophylla* from the west, central and eastern Nepal at 2200- 4300 m (Long, 2006b). Among the four species of *Asterella* of lowland, *Asterella multiflora* and *A. wallichiana* are the common species and *A. blumeana* is rare and *A. khasyana* is a fairly common species. The anomalous behavior of the female receptacle of *Asterella khasyana* was also studied (Pande *et al.*, 1953). Normally, the stalk of carpocephalum is about 3-9 mm long, but in abnormal condition it is in reduced form. *Plagiochasma appendiculatum* and *P. pterospermum* are dominant species which grow on soil, concrete walls, boulders and tree bases. *Plagiochasma appendiculatum* collected at Rajasthan was reported bearing abnormal receptacle (Bapna, 1971).

Shrivastava *et al*. (1986) made remarkable study on the status of *Plagiochasma intermedium* in India. This is a common species growing in various parts of the country with minor local variations. A critical assessment of the taxonomically significant characteristics show that the plants growing in western Himalaya, Nepal, India and peninsular India are devoid of elators, thickening bands are all referable to this species. The Scanning Electronic Microscope (SEM) details of the spore also confirm this conclusion (Shrivastava *et al.* 1986). *Mannia fragrans* was reported previously from the Kaski district of central Nepal (Higuchi 15441). Two species of *Mannia* are recorded in Nepal.

The next dominant families are Marchantiaceae and Ricciaceae. Four species of *Riccia* from Ricciaceae have also been recorded. The aquatic species *Riccia fluitans* is common in Tarai and Siwalik. *Riccia crystallaina* and *Riccia pathankotensis* are the rare species. *Riccia glauca* so far is reported in Pandav Nagar (300 m) of the Chitwan District. This species formed rosette on moist forest floor and sand beds of riverine area. This is a new record to Nepal.

Four species of *Marchantia* have been recorded in Nepal. *Marchantia emarginata* and *Marchantia polymorpha* are the most popular species distributed over all the districts of lowland

to Siwalik regions. *Marchantia papillata* subspecies *grossibarba* is a common species with deeply dichotomously branched thallus and was collected in the western and central regions at 200 to 800 m. It is more specific and confined mostly to the Siwalik (490 m) of the Makwanpur district. *Marchantia palmata* is now the synonym of *Marchantia emarginata* which has been reported from the lowest elevation of 250 m in Dang district of the west, its distributional range has been noticed up to 1500 m in various localities of the central region. *Marchantia paleacea* was previously collected in Siwalik range at 550 m of the central Nepal (Long 21645).

The interesting *Monosolenium tenerum* (Monosolenaceae) which has a good commercial market in western countries was spotted at 118 m in Betahani Village of west Bardia (Pradhan *et al.*, 2007). This is monospecific complex thalloid liverwort and is a new record to Nepal. The monotypic genus *Monosolenium tenerum* was first described by William Griffith (1849) in his posthumous publication. In recent years, it becomes an important aquarium plant (Gradstein *et al*., 2003) and is now readily available in the market. Singh and Singh (2007) recently reported this species in Dehradun, India. In our study, this species was found growing on moist shaded soil along a forest stream in mixed deciduous forest of *Shorea robusta, Dalbergia sissoo* and *Bauhinia vahlii*. This plant was shaded by ferns such as *Sphaerostephanos appendiculatus* and *Dryopteris cochleata*. No further record has been made except this specimen.

Udar and Singh (1976) described *Cyathodium tuberculum* from the Darjeeling (East Himalaya) of India. Later, its status has been identified as common in Nepal. The lowland areas of Jhapa, Sarlahi, Janakpur, Parsa and Chitwan districts house this species under the common status. Only two species of *Cyathodium* has been reported in Nepal. *Cyathodium cavernarum* has recently been reported as new record and was collected in Swayambhu of central Nepal. (Long, 2006a).

Dumortiera hirsuta was previously been collected at 450-800 m of the Sankhuwasabha and Sunsari districts of the east. and Kavre (900 m) of the central region. Recently its collection comes from the Kaski, at the entrance of the famous Mahendra cave. It also occurs at Gadhi (1000 m) of Chitwan district. This species prefers shaded sites of rocks and soil.

Metzgeriales is the least studied order which includes five species, four genera and three families. All the species of this order are rare in Nepal. Three species of *Aneura* occur in Nepal. Among them *Aneura blasioides* was previously reported in central Nepal at 600-900 m. (Furuki and Higuchi, 1990).

Riccardia species is very diverse and is represented by five species in Nepal. The distribution of *Riccardia cardotii* was noticed at the range of 600-1950 m. It occurs at 1150 m in Ilam of the east Furuki and Higuchi (1990) made its first report in Nepal. The recent collection was made at 1000-1200 m in the Gadhi of Chitwan district. *Riccardia multifida* ranges its distribution at 600-3000 m in the central and eastern regions.

Kuwahara made a short survey on Himalayan Metzgeriaceae in 1965. The family Metzgeriaceae includes eight described species so far, of them *Metzgeria conjugata* was recorded previously at 2800-3000 m of the east (Hattori, 1975a). Recently, it is reported at 1000 m in Kabtar-Churia range of Makwanpur district. This is a rare species and was collected upon rock cliffs.

The only member of the family Pallaviciniaceae is an interesting liverwort. This liverwort displays ribbon like thallus and is a semi aquatic species. About 30 species of this family occur in the world and Nepal is represented by one species called *Pallavicinia lyellii.* This rare species was collected at Simal Dhap (300 m.) of Chitwan dristrict. Grolle and Piippo (1986) and Long and Grolle (1990) mentioned it as a common species occuring mostly in the subtropical and temperate climates. The steroid of *Pallavicinia lyellii* is used for antifungal activity (Sushiba and Subramonium, 2005).

The class Musci includes 147 species under 9 orders and 20 families. Eubryals, Fissidentales, Hypnobryales and Pottiales are the largest orders with records of 20 species, 42 species, 42 species and 23 species respectively. Twenty species of this class are recorded as new to the country.

Dicranales is a large order which includes three families like Ditrichaceae, Dicranaceae and Leucobryaceae. Members of Dicranaceae occur in lowland to Siwalik, of which *Campylopus schimperi* is a new record. This was collected for the first time in Amala Chuli Gadhi at 1000-1200 m of central Nepal. This is a rare moss collected upon wet rocks. *Campylopus nilghiriensis* is moderately distributed in central and eastern regions. *Campylopus* species are well represented in the central and western lowland and Siwalik areas. This species has been collected at Bardia and Chitwan districts only. Frahm's work (1984) on this species indicates that *Campylopus nilghirensis* is identical partly with *Campylopus gaughii*. *Campylopus laetus* is reduced to a variety of *Campylopus umbellatus*. Frahm (1975) made revision with some taxa of *Campylopus* species, *Campylopus introflexus* is the synonym with *Campylopus lepidophyllus*.

Dicranella heteromalla is a common moss collected in the east only. *Dicranum setchwanicum* is a data deficient moss, its occurence in lowland needs verification. *Trematodon longicollis* is a widely distributed species especially in the western and central regions. *Trematodon subulosus* is rare and an endemic species to the Himalaya (Gangulee, 1971). Its report is confined to the Mewa Khola (900 m, 03.1952, 1820a, BM!) of the east only. Among the two species of Ditrichaceae, *Ditrichium tortuloides,* a rare species, is a new record and was collected at the Bardia National Park of west Nepal. *Garckea flexuosa* has its previous report from the central part.

Two genera and three species of Leucobryaceae were recorded in this study. *Leucobryum bowringii* and *L. mittenii* were previously collected in lowland and *Octoblepharum albidum* has wide distribution across east to the west lowland.

Order Eubryales of Musci includes families like Aulacomniaceae, Bartramiaceae, Bryaceae, Catoscopiaceae, Meesiaceae, Mniaceae and Timmaceae. Bartramiaceae and Bryaceae have been considered in this work. Six genera and 20 species are recorded in this order.

Bartramiaceae includes 386 species (Crosby *et al*., 1999) which grow in diverse habitats. The genus *Fleischerobryum* with one species and *Phelonotis* containing seven species are recorded in this investigation. Loeske (1910) described the genus *Fleischerobryum* and showed differences from *Philonotis* on the basis of its capsule. *Fleischerobryum* has long cylindrical or slightly asymmetric horizontal or pendulous capsules with a long neck while capsule of *Philonotis* is ovoid or gibbous with short neck. *Fleischerobryum* and *Philonotis* have common status in Nepal. *Fleischerobryum longicolle* was reported for the first time in west Tarai. This genus has been revised and includes two species *F. longicolle* and *F. macrophyllum* so far. Koponen (1998) studied the *Philonotis* species of China which also included five species of Nepal Tarai. *Philonotis Fontana*, *Philonotis mollis*, *Philonotis thwaitesii*, *Philonotis seriata* and *Philonotis turneriana* are commonly distributed species in Tarai land. *Philonotis maichica* is a rare species and occurrs at 610 m in Dang district of the midwest where it appeared as a patch upon moist ground and is a new record. *Philonotis falcata* var. *falcata* and *Philonotis turneriana* are the typed species and are deposited at the British Museum of London.

Bryaceae is the largest family of the order Eubryales. Areas below 1000 m displayed diversified *Bryum* spp. under good status. The diversity of Bryaceae represents seven genera, 82 species, five varieties and three subspecies in Nepal (Pradhan & Joshi, 2008b). Of them, four genera and 12 species occur in lowland areas. All the recorded species of Bryaceae are rare in lowland except *Bryum coronatum*, which do not exceeds its range above 1000 m. Among such species, *Brachymnium acumatitum* (Hooker 128H (GL-Arn, lectotype!), *Bryum apiculatum* (Wallich, 1832!), *Bryum cellulare* and *Rhodobryum gigantium* are the typed species deposited in BM and Glasgow University Herbarium. *Rhodobryum gigantium* and *Rhodobryum roseum* are confined strictly below 1000 m. *Bryum argenteum* has been reported as a fairly common species in subtropical to subalpine regions and is rare in lowland areas. In Tarai, its report comes from Upper Dang Gadhi (1000-1200 m) and Chitwan of central Nepal. *Bryum caespiticum*, *Bryum cellulare*, *Bryum dichotomus* are the rare species of Tarai. Chopra (1975) keep *Bryum giganteum* as the synonym of *Rhodobryum giganteum*, but Higuchi and Takaki (1990) mentioned *Rhodobryum* as a subgenus of *Bryum*. The absence of guard cells in the nerve indicates it to be *Rhodobryum* (Chopra, 1975). *Pohlia* and *Rhodobryum* are reported rare in Tarai, their distribution goes upto 900-1000 m.

Fissidens is a monotypic genus of the family Fissidentaceae which is diversified with 900 species worldwide (Imura and Iwatsuki, 1988; Ishihara and Iwatsuki, 1992) and includes 49 species across country. The lowland record includes 42 species hitherto. *Fissidens asplenioides, Fissidens geminiflorus, Fissidens gymnogynus, Fissidens oblongifolius, Fissidens robinsonii, Fissidens strictus, Fissidens sylvaticus* var. *auriculatus* and *Fissidens sylvaticus* var. *calcuttense* are new records to the country. *Fissidens asplenioides* is confined to Dang district only at 300-600 m. The

record of *Fissidens geminiflorus* comes from the western Kailali and central Chitwan districts only. *Fissidens gymnogynus* was seen forming a large patch upon moist substrates at Tharubash forest of Banke and Ghodaghodi lake of Kailali districts respectively. It is a rare species and none of its further record has been made. *Fissidens oblongifolius* was collected at 250 m in Jugedi village of Chitwan district of central Nepal. *Fissidens robinsonii* occurs in many of the Asian countries. It was reported for the first time in Nepal in Ghodaghodi Lake of Kailali district at 220 m and east Morang Belbari at 180 m. (Pradhan and Joshi 2007a). Norris and Koponen (1987) regarded *Fissidens robinisonii* to be the synonyme of *Fissidens zippelianus* due to presence of narrow lanceolate leaves with sharp acuminate apex. Iwatsuki and Suzuki (1995, 1996) considered *Fissidens zippelianus* var. *robinsonii* to *Fissidens robinsonii. Fissidens robinsonii* is very much identical to *Fissidens zippelianus* due to having axillary hyaline nodulated stem and strongly mammillate leaf cells. The various species of bryoflora show very interesting features of Godwanaland distribution which were later spread from the Asian land mass. This can be exemplified by the presence of *Fissidens asplenioides* in Alabama and North Carolina of USA. This species might been shifted to USA during the separation of period of Gondawana land mass from Asia. This common species has been reported in many countries of the world. In Nepal, it exists commonly in the lowland forest patches of west and central regions. *Fissidens sylvaticus* var. *auriculatus* and *Fissidens sylvaticus* var. *calcuttense* both varieties have been collected from the Danab Tal of Bardia National Park upon mesic rocks (Pradhan and Joshi, 2006). *Fissidens strictus* is semiaquatic and was collected from the Danab Tal at 340 m of the Bardia National Park as a new record to Nepal. Its aquatic adaptation in fast flowing water has been described from New Zealand by Beever (1995).

Fissidens curvato- xiphioides is a rare species and is recorded as the smallest known *Fissidens* so far (Pradhan and Joshi, 2006). The male and female of this small plant share the common habitat. Male plants are 0.52 x 0.36 mm in size and grow at the base of the female plants (1 mm long). The sterile plant grows up to 3 mm long with 8-12 leaves pair. *Fissidens plagiochiloides* is one of the largest species of *Fissidens* known so far. Norkett collected it for the first time from the east Nepal (Mewa Khola, 3000 m) in 1962. It was also collected from a large patch in the Bardia National Park of the farwest and Shesh Narayana - Pharping (1500 m) of Kathmandu Valley (Pradhan k 16).

Three genera and eight species of Funariaceae are known in Nepal. Of them, two genera and five species are described here. *Funaria hygrometrica* is rare species in Tarai while *Physcomitrium* is a very common genus in this region. Four species of *Phycomitrium* are recorded in Tarai so far. Among new records to the country are *Phycomitrium cupuliferum* and *Phycomitrium eurystomum. Physcomitrium japonicum* was previously recorded at the Chitwan district of central Nepal (Townsend, 2002).

Splachnobryum aquaticum is an interesting species which was collected in the Bardia National Park at 190 m where Sal forest is dominant. This is a rare species, no other locations represented

this species. Chopra (1975) has kept this genus under the family Spalchnaceae and subfamily Splachnobryoideae.

Hookeriaceae is the least studied family of the order Hookeriales. *Hookeria acuitifolia* is the only species recorded in lowland of the Sunsari and Morang districts of the east. It is a Type species collected from the east by Wallich.

Hypnobryales is the largest order of musci, which comprises 7 families, 20 genera and 38 species. Vohra (1980) collected new taxa of this order from the Himalayas. Brachytheciaceae, Entodontaceae, Fabroniaceae, Hypnaceae, Sematophyllaceae, Stereodontaceae and Thuidiaceae are included under the order Hypnobryales. This study traced out five species of Brachytheciaceae which are categorized into three genera only. *Brachythecium buchananii* and *Brachythecium populeum* var. *populeum* though common elsewhere are rare in lowland areas. *Brachythecium garovaglioides* is a common species in lowland. *Eurhynchium swartzii* is a rare species in lowland which forms a dense mat on the moist soil specially in the Bardia National Park of west Nepal. The diversity of *Rhynchostegium vagans* can be ranked average but is distributed widely in the subtropical to temperate regions.

Entodontaceae represented four genera and five species in this work. *Campylodontium flavescens* is a rare species and is recorded at 800-1000 m of the central Nepal. It is a fairly common species in the subtropical to temperate regions. *Entodon prorepens* is the Type species (Wallich 752) collected at the Dhankuta and Sunsari districts of the east. *Entodon rubicundus* is also rare at 1100-3000 m.of the east. *Erythrodontium julaceum* is a common species distributed in central and eastern regions at 500-3000 m. Due to its rough leaf surface it has the ability to trap heavy dust particles (Richardson, 1981; Halleraker *et al.*, 1998) and hence can accumulate much amount of metal than other moss species (Shakya and Chettri, 2008). *Trachyphyllum inflexum* is also a common moss of the lowland and none of its record comes from the higher region. It is distributed at 135- 660 m in the west, central and eastern regions. The family Fabroniaceae has a single genus *Fabronia* which includes *Fabronia schensiana*. This is a rare species and its distribution is confined to 1000 m only.

Hypnaceae is the largest family with five genera and 10 species so far. The genus *Ectropothecium* has four species, *Hypnum* with three species and *Isopterygium*, *Pseudotaxiphyllum* and *Taxiphyllum* contain single species each. *Hypnum cupressiformae, Hypnum pleumaformae* and *Taxiphyllum taxirameum* are widely spread species over Tarai region. *Hypnum albescens* and *Hypnum setchwanicum* are the rare species in Nepal. *Hypnum cupressiformae* has been recorded for the first time in the central region (Pradhan, 2000b). *Isopterygium minutirameum* occurs in the mesic area at 104 m of Parsa, the lowest altitude recorded and 290 m of the Dang district.

Sematophyllacea is a least studied family in the lowland region. Only three species under three genera have been recorded in this work. *Sematophyllum subhumule* has been found widely distributed over the Siwalik to Tarai regions. *Taxithelium nepalensis* is a common species and is

prevalent in many localities of the Bardia districts. Zhu and So (1996) recorded its wide distribution across tropical regions of Asia. Gangulee (1985) recorded it from the eastern region. *Forwauella orthothecia* is an epiphytic species. The previous collections were made in the Kavre and Makwanpur districts at 230-1000 m by Higuchi in 1988. The taxonomy and nomenclature of Sematophyllaceae was not understood clearly till the work of Buck (1983). According to him, *Leskea caespitosa* is transferred into *Sematophyllum lamprophylla*, which is a widely spread species in central Nepal and its record comes from the different forest patches of Kathmandu valley including potential areas like Gokarna, Suryabinayak and Godavari.

Members of Stereophyllaceae are glossy, epiphytic with creeping habit. It is interesting to note the record of five species in a single genus *Entodontopsis*. *Entodontopsis anceps, E. tavoyense, E. leucostega* and *E. setschwanica* are recorded for the first time from the lawland Tarai. Except *Entodontopsis setschwanica,* rest of the species are common in the lowland area. *Entodentopsis anceps* was reported at 290 m of the midwest and Chitwan district in *Dalbergia* dominant mixed forest. *Entodentopsis leucostega and Entodentopsi tavoyense* are the dominant species in Tarai. *Stereophyllum decorum* is now with the synonym of *Entodentopsis leucostega. Hypnum setschwanicum* has the synonym of *Entodontopsis setschwanica* and was recorded at a locality of the Kailali district, its previous record comes from the Sankhuwasabha district of the east (Yoda, 11562). *Entodontopsis wightii* though common is a new record to Nepal.

Thuidiaceae is the largest family of order Hypnobryales. This study brought out a list of three genera and nine species across Nepal. *Haplocladium angustifolium* and *Haplocladium larminatii* are the common species distributed widely in the western and central regions but is not recorded in the east. *Herpetineuron toccoae* is recorded in the central and eastern regions at 800-900 m. Its diversity goes upto an elevation of 1800 m. It has flexuose strong costa. This country represents eight species of *Thuidium* so far. *Thuidium cambifolium* is rare in lowland, and is recorded only in a locality of the Kaski distrct of the west, it is also spread over upper temprate and alpine regions of the country. *Thuidium glaucinoides, Thuidium kuripanum* and *Thuidium plumulosum* are reported as the rare species in the lowland areas. *Thuidium tamariscellum* though common in Tarai is rarer at the high land areas.

An interesting study done by Watanabe (1977) clarified that *Haplocladium himalayanum* is a synonym of *Haplocladium strictulum* and *Thuidium burmense* is a synonym of *Thuidium rubiginosum*. Three of its species had been thought to exist in the Himalayas, later, these were recognized as *Thuidium contortulum, Thuidium cymbifolium* and *Haplocladium angustifolium.* Species mentioned by Vohra (1970), *Thuidium meyenianum* occurs at 200 to 240 meter of elevation in Dharan of eastern Nepal.

Isobryales and Polytrichales are the least studied orders of the lowland. *Sphaerotheciella sphaerocarpa* of the family Cryphaeaceae was also noted in the lowland. This species though rare was recorded in the Suklaphanta Wildlife Reserve of the farwest. Its previous report comes from the east at 2600- 3000 m. Two species of *Pogonatum* from the Polytrichaceae are investigated in

this study. *Pogonatum microstomum* is a rare species in the lowland and occurs mainly in two localities at 350 m and 1275 m of the Chitwan district. It was previously recorded at 3800 m. *Pogonatum neesii* was previously collected at 600 m of east Nepal. This species is smaller than the *Pogonatum microstomum.* The pale white hairy calyptrae is the characteristic of this genus.

The Pottiaceae is one of the largest family of the order Pottiales. Fourty-nine species of Pottiaceae have been reported in Nepal so far (Pradhan, 2000a). The present work includes two families, 11 genera and 23 species of this order. Nine genera and 21 species of this family are known from the lowland region. Among them, *Anoectangium bicolor, Bryoerythrophyllum rubrum, Hydrogonium subpellucidium, Hyophila acuitifolia, H. apiculata, H. nymaniana* and *Weissia edentula* are found as new record to the country. *Hyophila involuta, H. spathulata* and *Didymodon constrictus* are recorded as the Type species.

Many interesting species like *Anoectangium bicolor, Barbula indica, Bryoerythrophyllum rubrum, Hydrogonium arcuatum, Hydrogonium subpellucidum, Hyophila involuta and Semibarbula ranuii* were recorded at 300 -1000 m of the Dang Valley. The next interesting species *Hyophila apiculata* was collected in Biratnagar of the Morang district at 180 m, this is very much similar to *H. spathulata.* A good diversity was represented by *Semibarbula ranuii* at 320 m and 200 m of the Dang and Banke districts respectively. This species was reported on the stream bank where no threat has been found so far. *Bryoerythrophyllum rubrum* was collected at 300 m in the moist forest of the Chitwan district and *Weissia edentula* was recorded at various altitudinal levels of the east. This species has maintained its status under the common category. *Calymperum erosum* and *Syrrhopodon gardeneri* are the two mosses of Calymperaceae of the order Pottiales. Its distribution has been recorded in central Nepal at 200-900 m.

Anthocerotae represents one order, two families, four genera and six species. Likewise, Hepaticae has three orders, 18 families, 32 genera and 60 species. Jungermanniales is the largest order of Hepaticae with 18 genera and 34 species under 9 families. The Marchantiales is the second largest order of Hepaticae with 10 genera and 21 species under 6 families. Similarly, Metzgeriales has 4 genera, 5 species under 3 families. Musci represented 9 orders, 20 families, 54 genera and 147 species in this study. The order Dicranales has three families, 9 genera and 13 species. Similarly, Eubryales has two families, 6 genera and 20 species. Likewise, Fissidentales has a single family, one genus and 42 species. Order Funarales includes two families, three genera and six species while Hookeriales has one family, one genus and one species i.e. *Hookeria acutifolia*. Hypnobryales is represented by seven families, 20 genera and 38 species. Isobryales is the least studied order which includes one family, two genera and two species. Polytrichales contains two species under one family. The order Pottiales comprises two families and 23 species

This research brought a list of 30 species which are investigated as new records to Nepal. About 50 % of the overall species are rare and equal half i.e. 50 % of the remaining species are common with no threats so far (Appendex III).

7. Conclusion

Among Anthocerotae, three species were found rare. *Folioceros assamicus* is a very rare species and a new record made from the Siwalik area of central Nepal. Jungermanniales has been reported to be the largest order with 9 families, 18 genera and 34 species. Geocalycaceae is a fairly common family in Tarai which has four distinct species under the genera *Heterocyphus*, *Chilocyphus* and *Lophocolea*. This research is based mainly below 1000 m where mixed forest of *Shorea robusta* is prevalent. Many epiphytic species were also reported in this work, among them *Frullania muscicola, Entodontopsis anceps, E. leucostega, E. tavayensis, Trachyphyllum nepalensis,* etc were the popular species.

The interesting *Monosolenium tenerum* was spotted at 118 m in Betahani Village of the west Bardia (Pradhan *et al.,* 2007d). This monospecific complex thalloid liverwort is a new record to Nepal. This species has been recognized carrying greater commercial values in western countries.

Fissidentales, Hypnobryales and Pottiales are the highly diversified orders in lowland region. Species record in these orders include 42, 38 and 23 respectively.

In this study, the rich and diversified species were noted in western and central districts in proportion to the eastern region. The western lowland represented 37 % of the entire species, central with 35 % and eastern with 28 % only. The western region provided many preferable habitats than the eastern and central regions. The temperature and rainfall specially in November to March are optimum for the good growth of diverse species. The eastern region receives heavy precipitation when monsoonal rain first enters into the east normally in the second week of June. In lower areas of the east the habitat destruction is very high besides high amount of rainfall and more drought condition in winter and premonsoonal time, this has influenced the growth of bryofloral species with less diversity than the western and central regions. Of the entire species record, 18.5 % come from the lower belt below 1000 m of elevation.

8. Summary

This is an original work conducted mainly for the study of the distribution and taxonomy of the bryophytes of the lowland districts lying below 1000 m of elevations across country. This work covered almost all the potential districts of Tarai which included Kanchanpur, Kailali, Banke and Bardia of far west, Dang, Palpa of the mid-west, Nawalparasi, Chitwan, Parsa, Bara, Makwanpur, and Dhanusa of the central region and Siraha, Sunsari, Morang and Jhapa of the eastern region.

Direct observation and collections were made across east-west lowland belts. The essential field data like ecology, altitude, time, date and month of every collected specimen were recorded. The identification was done at the Natural History Museum and Central Department of Botany, Tribhuvan University. National Botanical Research Institute, Luckhnow, India was also visited where Nepalese species were compared with Indian species for correct identification. All the required help of the senior bryologist of NBRI was obtained for this purpose. In this work, lists of the Chinese, Indian, Malaysian, Thai and Japanese bryophytes were also consulted. The status assessment of the collected species is based upon field data, abundance, literatures, IUCN Red List, CITES Appendices and Protected list of the country.

Of the entire species record, 18.5 % come from the lower belt below 1000 m of elevation.
This belonged to 40 families, 13 orders and three classes. Of the total 40 families, two families belonged to Anthocerotae, 18 Hepaticae and 20 to Musci. A least diversity of Anthocerotae was found which represented six species only. Likewise, 60 species have been recorded from the Hepaticae and 147 species from the Musci. This study also brought a list of 30 species which are new records to the country.

Of the total record, 112 species have been found rare as compared to national status scale. *Sphaerotheciella sphaerocarpa* is a very rare species reported in this work. This was collected at a single locality in the Suklaphanta Wildlife Reserve of Kanchanpur District. This study also analyzed 62 common and 20 fairly common species. *Isopterygium minutiramium* was recorded at the lowest known altitude of 104 m in the Parsa district of central Nepal.

Recommendations have been made to conserve rare and threatened species in their natural settings. Records of some previous findings are also incorporated in this work but without taxonomic description. Sketch drawings of some significant, rare and new report are also included.

9. Recommendation

Tarai and Siwalik regions were studied extensively for the distribution of bryophytes which revealed many new data about their habitats, status, threats and conservation issues. The main problems lying for bryophytic survey and its conservation is the lack of sufficient expertise in this field.

Increasing rate of deforestation and continuing process of urbanization have left direct impact upon many species of this plant eventually leading them into endangerment or putting them at the verge of extinction. If no conservation attention is paid prehand such species may disappear completely before being documented.

On the basis of this study, the following recommendations can be made to conserve bryofloral species in their natural surroundings.

a. The basic approach is to conduct extensive survey and documentation of the extant species. This should be followed frequently by monitoring under the established guidelines.
b. Rare, endangered and valuable species of this plant need rehabilitation to other areas where least disturbances can be found. Such species by tissue culture technology may increase their number in wild.
c. The local communities should be educated about the significant value of bryophytes so to make them aware to conserve this plant in wild.
d. Students and botanists should be diverted to study and conserve bryophytes in the country. Graduate students should be encouraged for bryophytic research for their dissertation work.
e. The knowledge on the sustainable use of bryophytes is totally lacking in Nepal. Its use is great with wide range of commercial market as shown by various communities in India who are engaged in utilizing bryophytes for their sustainability. So local communities should be educated on this aspect. This may increase the value of bryophytes in our society which can be helpful to conserve such species under a managed way.
f. Informative course on bryophytes should be designed and introduced into school curriculum.
g. International researchers should be encouraged to conduct research on Nepaleses bryophytes. This may help to bring with advanced methodology in research and conservation.
h. Bryophyte Research Section should be established in the Central Department of Botany or Natural History Museum of Nepal. This section should be enriched with all the published documents of bryophytes besides reference specimens. This should also be allocated with regular fundings for field research.
i. Nepal Government should give priority to conserve bryophytes in their Action Plan.

j. Conservation organizations and Nepal Government should take initiation to assess status categories of every bryofloral species and develop effective conservation policies to conserve this plant in the nation. Native expertise should be mobilized in this work.
k. Bryophyte is a good indicator of the environmental change. So native Bryologists should be motivated as an investigator in the Environment Impact Assessment (EIA) programmes implemented prior to the constructions of the physical and hydro-power plants in the country. This helps to save rare and endangered species from being demolished out.
l. Representation of the Nepalese bryologist should be made in the Species Survival Commission (SSC) and other conservation organizations; this helps to develop suitable conservation schemes which can be relevant to conserve this plant under scientific way.
m. Bryophyte is a least popular plant in Nepal, many peoples even do not know what this plant is? So information on this plant needs wide dissemination among the public circle through publications, media and education. This may create curiosity and interest to them which can be fruitful to bring their community participation for its effective conservation.
n. Protected lists of CITES, Government and IUCN should be updated regularly with recent findings.

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Appendix I

I: Taxonomy Representation in Tabulated Form

Class	Orders	Families	Genera	No of species	Total species
Anthocerotae	Anthocerotales	Anthocerotaceae	*Anthoceros*	3	6
			Foliioceros	1	
			Phaeoceros	1	
		Notothyladaceae	*Noththylas*	1	
Hepaticae	Jungermanniales	Calypogeiaceae	*Calypogiea*	1	1
		Cephaloziaceae	*Odontoschima*	1	1
		Frullaniaceae	*Frullania*	3	3
		Geocalycaceae	*Chilocyphus*	1	4
			Heteroscyphus	2	
			Lophocolea	1	
		Jungermanniaceae	*Jamesoniella*	1	15
			Jungermannia	12	
			Mylia	1	
			Nardia	1	
		Lejeuneaceae	*Acrolejeunea*	2	6
			Cololejeunea	1	
			Lejeunea	1	
			Lopholejeunea	1	
			Ptychanthus	1	
		Lepidoziaceae	*Bazzania*	1	1
		Plagiochilaceae	*Plagiochila*	2	2
		Porellaceae	*Porella*	1	1
	Marchantiales	Aytoniaceae	*Asterella*	4	9
			Mannia	1	
			Plagiochasma	3	
			Reboulia	1	
		Marchantiaceae	*Marchantia*	4	4
		Monosoleniaceae	*Monosolinium*	1	1
		Ricciaceae	*Riccia*	4	4
		Targioniaceae	*Cyathodium*	1	2
			Targionia	1	
		Wiesnerellaceae	*Dumortiera*	1	1
	Metzgeriales	Aneuraceae	*Aneura*	1	3
			Riccardia	2	
		Metzgeriaceae	*Metzgeria*	1	1
		Pallaviciniaceae	*Pallavicinia*	1	1
Musci	Dicranales	Dicranaceae	*Campylopus*	2	8
			Dicranella	1	
			Dicranum	1	
			Leucoloma	1	
			Trematodon	3	
		Ditrichaceae	*Ditrichum*	1	2
			Garckea	1	
		Leucobryaceae	*Leucobryum*	2	3
			Octoblepharum	1	
	Eubryales	Bartramiaceae	*Fleischerobryum*	1	8

			Phelonotis	7	
		Bryaceae	*Brachymnium*	1	12
			Bryum	8	
			Pohlia	1	
			Rhodobryum	2	
	Fissidentales	Fissidentaceae	*Fissidens*	42	42
	Funariales	Funariaceae	*Funaria*	1	5
			Physcomitrium	4	
		Splachnobryaceae	*Splachnobryum*	1	1
	Hookeriales	Hookeriaceae	*Hookeria*	1	1
	Hypnobryales	Brachytheciaceae	*Brachythecium*	3	5
			Eurhynchium	1	
			Rhynchostegium	1	
		Entodontaceae	*Campylodontium*	1	5
			Entodon	2	
			Erythrodontium	1	
			Trachyphyllum	1	
		Fabroniaceae	*Fabronia*	1	1
		Hypnaceae	*Ectropothecium*	4	10
			Hypnum	3	
			Isopterygium	1	
			Pseudotaxiphyllum	1	
			Taxiphyllum	1	
		Sematophyllaceae	*Foreauella*	1	3
			Sematophyllum	1	
			Taxithelium	1	
		Stereophyllaceae	*Entodontopsis*	5	5
		Thuidiaceae	*Haplocladium*	2	9
			Herpetoneuron	1	
			Thuidium	6	
	Isobryales	Cryphaeaceae	*Erpodium*	1	1
			Sphaerotheciella	1	1
	Polytrichales	Polytrichaceae	*Pogonatum*	2	2
	Pottiales	Calymperaceae	*Calymperum*	1	2
			Syrrhopodon	1	
		Pottiaceae	*Anoectangium*	1	21
			Barbula	6	
			Bryoerythrophyllum	3	
			Didymodon	1	
			Hydrogonium	2	
			Hyophila	5	
			Oxystegus	1	
			Semibarbula	1	
			Weissia	1	

Appendix II

II. Recorded species in lowland Terai

Classes	Orders	Families	Latin names	Status
Anthocerotae	Anthocerotales	Anthocerotaceae	*Anthoceros chambensis* Kashyap	Rare
			Anthoceros formosae Steph.	Rare
			Anthoceros punctatus L.	Uncommon
			**Folioceros assamicus* D. C. Bhardwaj	Rare /New
			Phaeoceros laevis (L.) Prosk.	Common
		Notothyladaceae	*Notothylas levieri* Schiffn.	Rare
Hepaticae	Jungermanniales	Calypogeiaceae	**Calypogeiea neesiana* (Mass & Carest) K. Muell.	Rare/New
		Cepahaloziaceae	*Odentoschima denudatum* (G. Marten) Dumort.	Rare
		Frullaniaceae	**Frullania dilatata* (L.) Dumort.	Rare/New
			Frullania ericoides (Nees ex Mart.) Mont.	Rare
			Frullania muscicola Steph.	Common
		Geocalycaceae	*Chilocyphus polyanthus* (L.) Corda	Uncommon
			Heteroscyphus argustus (Reinw. *et al*.) Schiffn.	Common
			**Heteroscyphus planus* (Mitt.) Schiffn.	Uncommon/ New
			Lophocolea minor Nees	Rare
		Jungermanniaceae	*Jamesoniella autumnalis* (D.C.) Steph.	Rare
			Jungermannia appressifolia Mitt.	Rare
			Jungermannia comata Nees	Rare
			Jungermannia confertissima Nees	Common
			**Jungermannia exertifolia* Steph.	Uncommon/ New
			Jungermannia hyalina Lyell	Uncommon
			**Jungermannia infusca* (Mitt.) Steph.	Rare /New
			Jungermannia macrocarpa Steph.	Rare
			Jungermannia minutiverrucosa Amakawa	Rare
			**Jungermannia pumila* With.	Rare/New
			Jungermannia subulata A. Evans	Rare
			Jungermannia tetragona Lindenb.	Common
			Jungermannia truncata Nees	Common
			Mylia taylorii (Hook.) Gray	Rare

			Nardia assamica (Mitt.) Amakawa	Rare
		Lejeuneaceae	**Acrolejeunea pusilla* (Steph.) Grolle & Gradst.	Rare/New
			Acrolejeunea recurvata Gradst.	Rare
			Cololejeunea raduliloba Steph.	Rare
			Lejeunea ulicina (Taylor) Gottsche *et al.*	Rare
			Lopholejeunea nigricans. (Lindenb.) Schiffn *L. sikkimensis* Steph.	Common
			Ptychanthus strictus (Lehm. & Lindenb.) Nees	
		Lepidoziaceae	*Bazzania tridens* (Reinw. *et al.)* Trev.	Rare
		Plagiochilaceae	*Plagiochila nepalensis* Lindenb.	Rare
			Plagiochila parvifolia Lindenb.	Rare
		Porellaceae	*Porella campylophylla* (Lehm. & Lindenb.) Trev.	Rare
	Marchantiales	Aytoniaceae	*Asterella brumeana* (Nees) Pande	Rare
			Asterella khasiana (Griff.) Pande *et al.*	Common
			Asterella multiflora (Steph.) Pande *et al.*	Common
			Asterella wallichiana (Lehm. & Lindenb.) Grolle	Most common
			Mannia fragans (Balb.) Frye & L. Clark.	Rare
			Plagiochasma appendiculatum Lehm. & Lindenb.	Most common
			Plagiochasma pterospermum C. Massal.	Most common
			Plagiochasma simlensis Kashyap	Rare
			Reboulia hemispherica (L.) Raddi	Common
		Marchantiaceae	*Marchantia emarginata* Reinw. *et al.*	Common
			Marchantia paleacea Bertol.	Uncommon
			Marchantia papillata Raddi ssp. *grossibarba* (St.) Bischl.	Medium
			Marchantia polymorpha L.	Common
		Monosoleniaceae	**Monosolenium tenerum* Griff.	Rare/New
		Ricciaceae	*Riccia crystallina* L.	Rare
			Riccia fluctans L.	Common
			**Riccia glauca* L.	Uncommon/ New
			Riccia pathankotensis Kashyap	Rare
		Targioniaceae	*Cyathodium tuberosum* Kashyap	Common
			Targionia hypophylla L.	Rare

		Wiesnerellaceae	*Dumortiera hirsuta* (Sw.) Nees	Rare
	Metzgeriales	Aneuraceae	*Aneura blasioides* (Horik.) Furuki	Rare
			Riccardia cardotii (Steph.) Pande & S.C. Srivast.	Rare
			Riccardia multifida (Linn.) Gray	Rare
		Metzgeriaceae	*Metzgeria conjugata* Lindb.	Rare
		Pallaviciniaceae	*Pallavicinia lyellii* (Hook.) Carruth.	Rare
Musci	Dicranales	Dicranaceae	*Campylopus nilghiriensis* (Mitt.) A. Jaeger	Medium
			**Campylopus schimperi* Milde	Rare/New
			Dicranella heteromalla (Hedw.) Schimp.	Common
			Dicranum setchwanicum Broth.	Rare
			Leucoloma taylorii (Schwaegr.) Mitt.	Rare
			Trematodon kurzii Hampe ex Gangulee	Rare
			Trematodon lingicollis Michx.	Common
			Trematodon subulosus Griff.	Rare
		Ditrichaceae	**Ditrichum tortuloides* Grout	Rare, New
			Garckea flexuosa (Griff.) Margad. & Nork.	Rare
		Leucobryaceae	*Leucobryum bowringii* Mitt.	Rare
			Leucobryum mittenii Besch.	Rare
			Octoblepharum albidum Hedw.	Common
	Eubryales	Bartramiaceae	*Fleischerobryum longicolle* (Hampe) Loeske	Uncommon
			Philonotis falcata (Hook.) Mitt. var. *falcata*	Type (BM)
			Philonotis fontana (Hedw.) Brid.	Common
			**Philonotis marchica* (Willd.) Brid.	Rare/New
			Philonotis mollis (Dozy & Molk.) Mitt.	Common
			Philonotis seriata Mitt.	Common
			Philonotis thwaitesii Mitt.	Common
			Philonotis turneriana (Schwaegr.) Mitt.	Common
		Bryaceae	*Brachymnium acuminatum* Harv.	Type (Hooker, 128H)
			Bryum apiculatum Schwaegr.	Type, Wallich 7592
			Bryum argenteum Hedw.	Rare
			Bryum caespiticum Hedw.	Rare
			Bryum capillare L. ex Hedw.	Rare
			Bryum cellulare Hook.	Type
			Bryum clavatum (Schimp.) C. Muell.	Rare

			Bryum coronatum Schwaegr.	Most common
			Bryum dichotomum Hedw.	Rare
			Pohlia flexuosa Hook.	Rare
			Rhodobryum giganteum (Schwaegr.) Par.	Rare
			Rhodobryum roseum (Hedw.) Limpr.	Rare
	Fissidentales	Fissidentaceae	*Fissidens anomalus* Monten	Rare
			**Fissidens asplenioides* Hedw.	Uncommon/ New
			Fissidens biformis Mitt.	Rare
			Fissidens bryoides Hedw.	Common
			Fissidens bryoides Hedw. ssp. *schimidii* (C. Muell.) Nork.	Common
			Fissidens ceylonensis Dozy & Molk.	Common
			Fissidens ceylonensis var. *simplex* (C. Muell.) Nork.	Rare
			Fissidens crenulatus Mitt.	Common
			Fissidens crenulatus Mitt. var. *crenulatus* Gangulee	Common
			Fissidens crenulatus Mitt. var. *titalayanus* (C. Muell.) Gangulee	Common
			Fissidens curvato-involutus Dixon	Rare
			Fissidens curvato-xiphioides Dixon & Verd.	Rare
			Fissidens diversifolius Mitt.	Uncommon
			Fissidens diversifolius Mitt. var. *rubricaulis* (Disk.) Nork.	Uncommon
			Fissidens geminiflorus Dozy & Molk.	Rare/ New
			Fissidens geppii Fleisch.	Rare
			**Fissidens gymnogynus* Besch.	Rare/ New
			Fissidens intromarginatulus E.B. Bartran	Rare
			Fissidens involutus Wils.	Common
			Fissidens javanicus Dozy & Molk.	Common
			Fissidens kalimpongensis Gangulee	Rare
			Fissidens laxus Sull & Lesq.	Rare
			Fissidens maceratus Mitt.	Rare
			Fissidens microcladus Thwait. & Mitt.	Rare
			Fissidens microcladus var. *terrestries* Aust.	Rare
			Fissidens minutus Thwait. & Mitt.	Rare
			Fissidens mittenii Par.	Rare
			Fissidens nobilis Griff.	Rare

			**Fissidens oblongifolius* Hook. F. & Wilson	Rare/ New
			Fissidens plagiochiloides Besch.	Rare
			Fissidens ranchinensis Gangulee	Rare
			**Fissidens robinsonii* Broth.	Common/ New
			Fissidens sempefalcatus Dixon	Rare
			**Fissidens strictus* Hook. & Wilson	Rare/New
			Fissidens subbryoides Gangulee	Rare
			Fissidens subpalmatus C. Muell.	Rare
			Fissidens sylvaticus Griff.	Common
			**Fissidens sylvaticus* Griff. var. *auriculatus* (C. Muell.) Gangulee	Common, New
			**Fissidens sylvaticus* Griff. var. *calcuttense* Gangulee	Common/ New
			Fissidens taxifolius Hedw.	Uncommon
			Fissidens virens Thwaits. & Mitt.	Rare
			Fissidens zippelianus Dozy & Molken	Common
	Funaliales	Funariaceae	*Funaria hygrometrica* Hedw.	Rare
			**Phycomitrium cupuliferum* Mitt.	Rare/ New
			**Phycomitrium eurystomum* Sendth.	Common/ New
			Phycomitrium japonicum (Hedw.) Mitt.	Uncommon
			Phycomitrium pyriforme (Hedw.) Hampe	Rare
		Splachnobryaceae	*Splachnobryum aquaticum* Muell. Hal.	Rare
	Hookeriales	Hookeriaceae	*Hookeria acuitifolia* Hook. & Grev.	Rare
	Hypnobryales	Brachytheciaceae	*Brachythecium buchananii* (Hook.) A. Jaeger	Common
			Brachythecium garovaglioides Muell. Hal.	Common
			Brachythecium populeum var. *populeum* (Hedw.) B.S.G.	Rare
			Eurhynchium swartzii (Turne) Curn.	Rare
			Rhynchostegium vegans (Harv.) A. Jaeger	Uncommon
		Entodontaceae	*Campylodontium flavescens* (Hook.) Bosch. & Lacey	Rare
			Entodon flavescens (Hedw.) A. Jaeger	Rare

			Entodon prorepens (Mitt.) A. Jaeger	Uncommon
			Erythrodontium julaceum (Schwaegr.) Par.	Common
			Trachyphyllum inflexum (Harv.) A. Gapp.	Common
		Fabroniaceae	*Fabronia schensiana* C. Muell.	Rare
		Hypnaceae	*Ectropothecium cygnicollum* (Mitt.) A. Jaeger	Rare
			Ectropothecium cyperoides (Hook.) A. Jaeger	Rare
			Ectropothecium sikkimensis (Renauld & Cardot) Renauld & Cardot	Uncommon
			Ectropothecium zollingeri (C. Muell.) A. Jaeger	Uncommon
			Hypnum albescens Hook.	Rare
			Hypnum cupressiforme Hedw.	Common
			Hypnum pleumaformae W. Wilson	Common
			Isopterygium minutirameum (C. Muell.) A. Jaeger	Common
			Pseudotaxiphyllum distichaceum (Mitt.) Z. Iwats.	Uncommon
			Taxiphyllum taxirameum (Mitt.) Fleisch.	Common
		Sematophyllaceae	*Foreaulla orthothecia* (Schwaegr.) Dixon & P. Vard.	Rare
			Sematophyllum subhumile (C. Muell.) Fleisch. ssp. *subhumili* C. Muell.) Fleisch.	Rare
			Taxithellium nepalenses (Schwaegr.) Broth.	Common
		Stereophyllaceae	*Entodontopsis anceps* (Bosch & Sande Lacey) W.R. Buck & Ireland	Common
			Entodontopsis leucostega (Brid.) W.R. Buck & Ireland	Most common
			Entodontopsis setschwanica (Broth.) W.R. Buck & Ireland	Rare
			Entodontopsis tavoyense (Hook. F.) W.R. Buck & Ireland	Common
			Entodontopsis wightii (Mitt.) W.R. Buck & Ireland	Common
		Thuidiaceae	*Haplocladium angustifolium* (Hampe & C. Muell.) Broth.	Common
			Haplocladium larminatii (Broth. & Par.) Broth.	Common
			Herpetoneuron toccoae (Sull & Lesque) Cardot	Uncommon
			Thuidium cambifolium (Dozy & Molk.) Dozy & Molk.	Common

			Thuidium glaucinoides Broth.	Common
			Thuidium glaucinum (Mitt.) Bosch et Lacey	Uncommon
			Thuidium kuripanum (Dozy & molk.) W. Watanabe	Rare
			Thuidium plumulosum (Dozy & Molk.) Dozy & Molk.	Uncommon
			Thuidium tamariscellum (C. Muell.) Bosch et Lacey	Common
	Isobryales	Cryphaeaceae	*Erpodium magniferae* C. Muell.	Rare
			Sphaerotheciella sphaerocarpa (Hook.) M. Fleisch.	Very rare
	Polytrichales	Polytrichaceae	*Pogonatum microstomum* (R. Br.) Brid.	Uncommon
			Pogonatum neesii (C. Muell.) Dozy& Molk.	Rare
	Pottiales	Calymperaceae	*Calymperum erosum* C. Muell.	Common
			Syrrhopodon gardneri (Hook.) Schwaegr.	Type, Gardner (BM)
		Pottiaceae	**Anoectangium bicolor* Renauld & Cardot	Rare/ New
			Barbula constricta Mitt.	Rare
			Barbula flavicans D.G. Long.	Rare
			Barbula indica (Hook.) Spring.	Common
			Barbula javanica Dozy & Molk.	Uncommon
			Barbula marginatula C. Muell.	Rare
			Barbula tenuirostris Brid.	Rare
			Bryoerythrophyllum inaequatifolium (Tayl.) Zander	Rare
			Bryoerythrophyllum recurvirostrum (Hedw.) P.C. Chen	Uncommon
			**Bryoerythrophyllum rubrum* (Jur. ex Geh.) P.C. Chen	Rare/ New
			Didymodon constrictus (Mitt.) Saito	Uncommon
			Hydrogonium arcuatum (Griff.) Wijk. & Marg.	Commom
			**Hydrogonium subpellucidum* (Mitt.) Hilp.	Rare/ New
			**Hyophila acuitifolia* Saito	Rare/ New
			**Hyophila apiculata* Fleisch.	Rare/ New
			Hyophila involuta (Hook.) A. Jaeger	Common
			**Hyophila nymaniana* (Fleisch.) Menzel	Rare/ New
			Hyophila spathulata (Harv.) A. Jaeger	Uncommon
			Oxystega cylindricus (Brid.) Hilp.	Rare
			Semibarbula ranuii Hilp.	Uncommon

			**Weissia edentula* Mitt.	Rare/ New

Appendix III

III. Species recorded as New to Nepal

S. No.	Families	Latin Names	Regions	Districts	Proper locality	Elevation m	Voucher Number
1	Anthocerotaceae	*Folioceros assamicus* D.C. Bhardwaj	C	Bara	Hetauda-Amlehjung	600	c 349
2	Calypogeiaceae	*Calypogiea neesiana* (Mass. & Carest.) K. Muell.	W	Bardia	Danab Tal, BNP	220	NHS 477, 485
3	Frullaniaceae	*Frullania dilatata* (L.) Dumort.	W	Bardia	Ratamati	340	NGS 468
4	Geocalycaceae	*Heterocyphus planus* (Mitt.) Schiffn.	C	Bara	Hetauda-Amlehjung	600	c 391, c 393
5	Jungermanniaceae	*Jungermannia exertifolia* Steph.	C	Chitwan	Daughat - Phedi forest	300	Pn 134
6		*Jungermannia infusca* (Mitt.) Steph.	C	Chitwan	Jugedi	200	Pn 211
7		*Jungermannia Pumila* With.	C	Chitwan	Upperdang Gadhi	1000	Pn 367
8	Lejeuneaceae	*Acrolejeunea pusilla* (Steph.) Grolle & Gradst.	C	Chitwan	Bish-Hazzar Tal	280	Pn 250, 297, 459
9	Monosoleniaceae	*Monosolenium tenerum* Griff.	W	Bardia	Betahani	118	NGS 142
10	Ricciaceae	*Riccia glauca* L.	C	Chitwan	Pandav Nagar	300	Pn 314
11	Dicranaceae	*Campylopus schimperi* Milde	C	Chitwan	Amalachuli-Gadhi	1000	Pn 345
12	Ditrichaceae	*Ditrichium tortuloides* Grout	W	Bardia	Thakurdwara	160	NGS 79
13	Bartramiaceae	*Philonotis marchica* (Willd.) Brid.	W	Dang	Dammar Gaun	610	NGS 495
14	Fissidentaceae	*Fissidens asplenioides* Hedw.	W	Dang	Dammar Gaun	610	NGS 510
15		*Fissidens gemminiflorus* Dozy & Molken	W, C	Kailali, Parsa, Chitwan	Mangalsera, SWR	160-300	NGS 413, c 512, Pn 203
16		*Fissidens gymnogynus* Besch	W	Banke, Kailali	Ghodaghodi lake; Jugedi	180-300	NGS 381; Pn 426
17		*Fissidens oblongifolius* Hook.	C	Chitwan	Jugedi	250	Pn 266
18		*Fissidens robinsonii* Broth.	W	Kailali, Morang	Ghodaghodi Lake; Belbari	180-210	NGS 425; dt 313
19		*Fissidens strictus* Hook. & Wilson	W	Bardia	Danab Tal	340	NGS 159
20		*Fissidens sylvaticus* var. *auriculatus* (C. Muell.) Gangulee	W	Bardia	Danab Tal	225	NGS 482

21		*Fissidens sylvaticus* var. *calcuttense* Gangulee	W	Kailali	Ghodaghodi lake	220	NGS 105
22	Funariaceae	*Physcomitrium cupuliforme* Mitt.	E	Morang	Biratnagar	180	dt 100
23		*Physcomitrium eurystomum* Sendth.	W	Bardia Chitwan	Lalmati, Parewa Odar, Bankatti	190-190	NGS 213; Br 109; Br 101
24	Pottiaceae	*Anoectangium bicolor* Renauld & Cardot	W, E,	Dang, Sunsari	Ramari Koshi Tappu	180-1000	NGS 713 dt 351
25		*Bryoerythrophyllum rubrum* (Jur. ex Geh.) P.C. Chen	E	Morang	Biratnagar	180	dt 372
26		*Hydrogonium subpellucidium* (Mitt.) Hilp.	W	Dang	Jamunabash	320	NGS 555
27		*Hyophila acuitifolia* Saito	E	Morang	Biratnagar-Dharan	600	dt 385
28		*Hyophila apiculata* Fleisch.	E	Morang	Biratnagar	180	dt 377
29		*Hyophila nymaniana* (Fleisch.) Menzel	C	Chitwan	Jugedi	200	Pn 214
30		*Weissia edentula* Mitt.	E	Jhapa	Chandragadhi	200	dt 371

Appendix IV

IV. Distribution of Bryophytes below 1000 m of Elevation

S. NO.	Families	Latin names	Three different regions			Altitude (meter)	Remarks
			W	C	E		
ANTHOCEROTAE							
1	Anthocerotaceae	*Anthoceros chambensis* Kashyap	+	+		190-545	
2		*Anthoceros formosae* Steph.			+	180	
3		*Anthoceros punctatus* L.	+	+		200-1000	
4		*Folioceros assamicus* D. C. Bhardwaj		+		600	
5		*Phaeoceros laevis* (L.) Prosk.	+	+	+	190-1000	
6	Notothyladaceae	*Notothylas levieri* Schiffn.			+	180-200	
HEPATICAE							
1	Calypogeiaceae	*Calypogeiea neesiana* (Mass & Carest) K. Muell.	+			220-420	
2	Cepahaloziaceae	*Odentoschima denudatum* (G. Marten) Dumort.	+		+	180-200	
3	Frullaniaceae	*Frullania dilatata* (L.) Dumort.	+			340	
4		*Frullania ericoides* (Nees ex Mart.) Mont.	+	+		800-1000	
5		*Frullania muscicola* Steph.	+	+		260-800	
6	Geocalycaceae	*Chiloscyphus polyanthus* (L.) Corda	+			350	
7		*Heteroscyphus argustus* (Reinw. *et al*.) Schiffn.	+	+		230-780	
8		*Heteroscyphus planus* (Mitt.) Schiffn.		+		600	
9		*Lophocolea minor* Nees		+		600	
10	Jungermanniaceae	*Jamesoniella autumnalis* (D.C.) Steph.		+		600	
11		*Jungermannia appressifolia* Mitt.	+	+		300	
12		*Jungermannia comata* Nees	+			800	
13		*Jungermannia confertissima* Nees		+		350	
14		*Jungermannia exertifolia* Steph.		+		300	
15		*Jungermannia hyalina* Lyell		+		260	
16		*Jungermannia infusca* (Mitt.) Steph.		+		200	
17		*Jungermannia macrocarpa* Steph.		+		200	
18		*Jungermannia minutiverrucosa* Amakawa			+	1000	
19		*Jungermannia pumila* With.		+	+	1000	
20		*Jungermannia subulata* A. Evans	+			800	
21		*Jungermannia tetragona* Lindenb.	+	+	+	250-900	
22		*Jungermannia truncata* Nees	+	+	+	320-1000	

23		*Mylia taylorii (*Hook.) Gray		+		200	
24		*Nardia assamica* (Mitt.) Amakawa			+	200	
25	Lejeuneaceae	*Acrolejeunea pusilla* (Steph.) Grolle & Gradst.		+		180-250	
26		*Acrolejeunea recurvata* Gradst.			+	955	
27		*Cololejeunea raduliloba* Steph.		+		900-1000	
28		*Lejeunea ulicina* (Taylor) Gottsche *et al.*	+			800	
29		*Lopholejeunea nigricans*. (Lindenb.) Schiffn *L. sikkimensis* Steph.	+	+	+	290-1000	
30		*Ptychanthus strictus* (Lehm. & Lindenb.) Nees	+		+	700-800	
31	Lepidoziaceae	*Bazzania tridens* (Reinw. *et al.)* Trev.	+		+	800-1000	
32	Plagiochilaceae	*Plagiochila nepalensis* Lindenb.			+	700	
33		*Plagiochila parvifolia* Lindenb.			+		
34	Porellaceae	*Porella campylophylla* (Lehm. & Lindenb.) Trev.			+	1000	
35	Aytoniaceae	*Asterella brumeana* (Nees) Pande	+			780	
36		*Asterella khasyana* (Griff.) Pande *et al.*	+		+	190-920	
37		*Asterella multiflora* (Steph.) Pande *et al.*	+	+	+	118-690	
38		*Asterella wallichiana* (Lehm. & Lindenb.) Grolle	+	+	+	180-1200	
39		*Mannia fragans* (Balb.) Frye & L. Clark.	+			800	
40		*Plagiochasma appendiculatum* Lehm. & Lindenb.	+	+	+	200-780	
41		*Plagiochasma pterospermum* C. Massal	+	+	+	240-780	
42		*Plagiochasma simlensis* Kashyap	+			200	
43		*Reboulia hemispherica* (L.) Raddi	+	+	+	355-1000	
44	Marchantiaceae	*Marchantia emarginata* Reinw. *et al.*	+	+	+	150-900	
45		*Marchantia paleacea* Bertol.		+		550	
46		*Marchantia papillata* Raddi ssp. *grossibarba* (St.) Bischl.	+	+		220-800	
47		*Marchantia polymorpha* L.	+	+	+	130-1000	
48	Monosoleniaceae	*Monosolenium tenerum* Griff.	+			118	
49	Ricciaceae	*Riccia crystallina* L.		+		900-1000	
50		*Riccia fluctans* L.	+	+		230-1000	
51		*Riccia glauca* L		+		300	
52		*Riccia pathankotensis* Kashyap		+		250	
53	Targioniaceae	*Cyathodium tuberosum* Kashyap	+	+	+	120-800	
54		*Targionia hypophylla* L.	+			200-300	
55	Wiesnerellaceae	*Dumortiera hirsuta* (Sw.) Nees	+	+	+	370-1000	
56	Aneuraceae	*Aneura blasioides* (Horik.) Furuki	+			600-920	
57		*Riccardia cardotii* (Steph.) Pande & S.C. Srivast.	+	+		800-**1200**	
58		*Riccardia multifida* (Linn.) Gray	+			600-900	

59	Metzgeriaceae	*Metzgeria conjugata* Lindb.		+		1000	
60	Pallaviciniaceae	*Pallavicinia lyellii (*Hook.) Carruth		+		300	
MUSCI							
1	Dicranaceae	*Campylopus nilghiriensis* (Mitt.) A. Jaeger	+	+	+	800-**1200**	
2		*Campylopus schimperi* Milde		+		1000-**1200**	
3		*Dicranella heteromalla* (Hedw.) Schimp.			+	900-1000	
4		*Dicranum setchwanicum* Broth.	+			800	
5		*Leucoloma taylorii* (Schwaegr.) Mitt.		+		900-1000	
6		*Trematodon kurzii* Hampe ex Gangulee			+	1000	
7		*Trematodon lingicollis* Michx.	+			180	
8		*Trematodon subulosus* Griff.			+	900	
9	Ditrichaceae	*Ditrichum tortuloides* Grout	+			160	
10		*Garckea flexuosa* (Griff.) Margad & Nork.	+	+		500-800	
11	Leucobryaceae	*Leucobryum bowringii* Mitt.	+			800	
12		*Leucobryum mittenii* Besch.	+			800	
13		*Octoblepharum albidum* Hedw.	+	+	+	230-950	
14	Bartramiaceae	*Fleischerobryum longicolle* (Hampe) Loeske	+			300-350	
15		*Philonotis falcata* (Hook.) Mitt. var. *falcata*		+		900-1000	
16		*Philonotis fontana* (Hedw.) Brid.		+		350	
17		*Philonotis marchica* (Willd.) Brid.	+			610	
18		*Philonotis mollis* (Dozy & Molk.) Mitt.	+	+		250-880	
19		*Philonotis seriata* Mitt.	+			780	
20		*Philonotis thwaitesii* Mitt.	+	+		250-**1200**	
21		*Philonotis turneriana* (Schwaegr.) Mitt.	+	+		120-1000	
22	Bryaceae	*Brachymnium acuminatum* Harv.		+		250-800	
23		*Bryum apiculatum* Schwaegr.	+	+		150-600	
24		*Bryum argenteum* Hedw.	+	+		800-**1200**	
25		*Bryum caespiticum* Hedw.	+	+		140-612	
26		*Bryum capillare* L. ex Hedw.		+		1000-1060	
27		*Bryum cellulare* Hook.		+		900	
28		*Bryum clavatum* (Schimp.) C. Muell.	+		+	350-612	
29		*Bryum coronatum* Schwaegr.	+	+	+	140-900	
30		*Bryum dichotomum* Hedw.	+	+		500-800	
31		*Pohlia flexuosa* Hook.		+	+	900-1000	
32		*Rhodobryum giganteum* (Schwaegr.) Par.		+		1000	
33		*Rhodobryum roseum* (Hedw.) Limpr.		+		1000	
34	Fissidentaceae	*Fissidens anomalus* Monten		+		450	
35		*Fissidens asplenioides* Hedw.	+			320-400	
36		*Fissidens biformis* Mitt.			+	600	
37		*Fissidens bryoides* Hedw.	+		+	200-410	

38		*Fissidens bryoides* Hedw. ssp. *schimidii* (C. Muell.) Nork.	+		+	800-1000	
39		*Fissidens ceylonensis* Dozy & Molk.	+		+	300-800	
40		*Fissidens ceylonensis* var. *simplex* (C. Muell.) Nork.			+	550	
41		*Fissidens crenulatus* Mitt.	+	+	+	175-600	
42		*Fissidens crenulatus* Mitt. var *crenulatus* Gangulee	+		+	510-590	
43		*Fissidens crenulatus* Mitt. var *titalayanus* (C. Muell.) Gangulee	+		+	290-600	
44		*Fissidens curvato-involutus* Dixon	+	+	+	175-**1200**	
45		*Fissidens curvato-xiphioides* Dixon & Verd.			+	600	
46		*Fissidens diversifolius* Mitt.			+	550	
47		*Fissidens diversifolius* Mitt. var. *rubricaulis* (Disk.) Nork.			+	600-750	
48		*Fissidens geminiflorus* Dozy & Molk.	+	+		160-400	
49		*Fissidens geppii* Fleisch.	+			600-800	
50		*Fissidens gymnogynus* Besch.	+			200-300	
51		*Fissidens intromarginatulus* E.B. Bartran			+	550	
52		*Fissidens involutus* Wils.			+	400-550	
53		*Fissidens javanicus* Dozy & Molk.	+	+		195-200	
54		*Fissidens kalimpongensis* Gangulee			+	550-900	
55		*Fissidens laxus* Sull & Lesque	+			800	
56		*Fissidens maceratus* Mitt.			+	200-550	
57		*Fissidens microcladus* Thwait. & Mitt.	+	+	+	500-950	
58		*Fissidens microcladus* var. *terrestries* Aust.			+	550	
59		*Fissidens minutus* Thwait. & Mitt.			+	200	
60		*Fissidens mittenii* Par.			+	550-600	
61		*Fissidens nobilis* Griff.	+			700-800	
62		*Fissidens oblongifolius* Hook. F. & Wilson		+		250	
63		*Fissidens plagiochiloides* Besch.	+			200-220	
64		*Fissidens ranchinensis* Gangulee			+	550	
65		*Fissidens robinsonii* Broth.	+			180-220	
66		*Fissidens sempefalcatus* Dixon			+	550	
67		*Fissidens strictus* Hook. & Wilson	+			340	
68		*Fissidens subbryoides* Gangulee	+	+	+	650-1000	
69		*Fissidens subpalmatus* C. Muell.		+		250-1200	
70		*Fissidens sylvaticus* Griff.	+	+	+	180-1200	
71		*Fissidens sylvaticus* Griff. var. *auriculatus* (C. Muell.) Gangulee	+	+	+	104-1200	
72		*Fissidens sylvaticus* Griff. var. *calcuttense* Gangulee	+			220-225	
73		*Fissidens taxifolius* Hedw.	+	+		180-1000	
74		*Fissidens virens* Thwaits & Mitt.			+	600-1000	
75		*Fissidens zippellanus* Dozy & Molk.	+	+		140-900	
76	Funariaceae	*Funaria hygrometrica* Hedw.	+	+		1000-1200	

77		*Phycomitrium cupuliferum* Mitt.			+	180-	
78		*Phycomitrium eurystomum* Sendth.	+	+		180-300	
79		*Phycomitrium japonicum* (Hedw.) Mitt.		+		250	
80		*Phycomitrium pyriforme* (Hedw.) Hampe			+	180-300	
81	Splachnobryaceae	*Splachnobryum aquaticum* Muell. Hal.	+			190	
82	Hookeriaceae	*Hookeria acuitifolia* Hook. & Grev.			+	180-450	
83	Brachytheciaceae	*Brachythecium buchananii* (Hook.) A. Jaeger	+			800	
84		*Brachythecium garovaglioides* Muell. Hal.	+			780-800	
85		*Brachythecium populeum* var. *populeum* (Hedw.) B.S.G.		+		900	
86		*Eurhynchium swartzii* (Turne) Curn.	+			135	
87		*Rhynchostegium vegans* (Harv.) A. Jaeger	+		+	800-900	
88	Entodontaceae	*Campylodontium flavescens* (Hook.) Bosch. & Lacey	+	+		800-1000	
89		*Entodon flavescens* (Hedw.) A. Jaeger	+	+		800-1000	
90		*Entodon prorepens* (Mitt.) A. Jaeger			+	800	
91		*Erythrodontium julaceum* (Schwaegr.) Par.	+	+	+	600-1000	
92		*Trachyphyllum inflexum* (Harv.) A. Gapp.	+	+	+	134-550	
93	Fabroniaceae	*Fabronia schensiana* C. Muell.			+	1000	
94	Hypnaceae	*Ectropothecium cygnicollum* (Mitt.) A. Jaeger			+	180-500	
95		*Ectropothecium cyperoides* (Hook.) A. Jaeger	+	+		230-1000	
96		*Ectropothecium sikkimensis* (Renauld & Cardot) Renauld & Cardot	+			340-800	
97		*Ectropothecium zollingeri* (C. Muell.) A. Jaeger		+		230-900	
98		*Hypnum albescens* Hook.			+	550	
99		*Hypnum cupressiforme* Hedw.		+		180	
100		*Hypnum pleumaformae* W. Wilson	+	+	+	120-**1250**	Highest altitude
101		*Isopterygium minutirameum* (C. Muell.) A. Jaeger		+	+	**104**-300	Lowest altitude
102		*Pseudotaxiphyllum distichaceum* (Mitt.) Z. Iwats.	+			800	
103		*Taxiphyllum taxirameum* (Mitt.) Fleisch.	+	+		500-800	
104	Sematophyllaceae	*Foreaulla orthothecia* (Schwaegr.) Dixon & P. Vard.		+		230-1000	
105		*Sematophyllum subhumile* (C. Muell.) Fleisch. ssp. *subhumili* C. Muell.) Fleisch.	+			200	
106		*Taxithellium nepalense* (Schwaegr.)	+			118-200	

		Broth.					
107	Stereophyllaceae	*Entodontopsis anceps* (Bosch & Sande Lac.) W.R. Buck & Ireland	+	+		200-290	
108		*Entodontopsis leucostega* (Brid.) W.R. Buck & Ireland	+	+		195-300	
109		*Entodontopsis setschwanicum* (Broth.) W.R. Buck & Ireland	+		+	1000	
110		*Entodontopsis tavoyense* (Hook. F.) W.R. Buck & Ireland	+	+		145-300	
111		*Entodontopsis wightii* (Mitt.) W.R. Buck & Ireland	+	+		150-300	
112	Thuidiaceae	*Haplocladium angustifolium* (Hampe & C. Muell.) Broth.	+	+		142-780	
113		*Haplocladium larminatii* (Broth. & Par.) Broth.	+			120-780	
114		*Herpetoneuron toccoae* (Sull & Lesque) Cardot		+	+	800-900	
115		*Thuidium cambifolium* (Dozy & Molken) Dozy & Molk.	+			900	
116		*Thuidium glaucinoides* Broth.	+			800	
117		*Thuidium glaucinum* (Mitt) Bosch & Lacey	+	+		600-800	
118		*Thuidium plumulosum* (Dozy & Molk.) Dozy & Molk.		+	+	200-1000	
119		*Thuidium kuripanum* ((Dozy & Molk.) W. Watanabe		+		230	
120		*Thuidium tamariscellum* (C. Muell.) Bosch & Lacey		+	+	200-350	
121	Cryphaeaceae	*Sphaerotheciella sphaerocarpa* (Hook.) M. Fleisch.	+			168	
122	Erpodiaceae	*Erpodium magniferae* C. Muell.			+	255-765	
123	Polytrichaceae	*Pogonatum microstomum* (R. Br.) Brid.	+	+		350-800	
124		*Pogonatum neesii* (C. Muell.) Dozy& Molk.			+	600	
125	Calymperaceae	*Calymperum erosum* C. Muell.		+		230-900	
126		*Syrrhopodon gardeneri* (Hook.) Schwaegr.			+	825	
127	Pottiaceae	*Anoectangium bicolor* Renauld & Cardot	+		+	180-**1250**	
128		*Barbula constricta* Mitt.		+	+	180-250	
129		*Barbula flavicans* D.G. Long.			+	180	
130		*Barbula indica* (Hook.) Spring.	+	+	+	350-800	
131		*Barbula javanica* Dozy & Molk.			+	800	
132		*Barbula marginatula* C. Muell.		+		650	
133		*Barbula tenuirostris* Brid.		+	+	400	
134		*Bryoerythrophyllum inaequatifolium* (Tayl.) Zander		+		250	
135		*Bryoerythrophyllum recurvirostrum* (Hedw.) P.C. Chen	+	+		300-410	
136		*Bryoerythrophyllum rubrum* (Jur. ex Geh.) P.C. Chen			+	180-200	

137		*Didymodon constrictus* (Mitt.) Saito	+			160	
138		*Hydrogonium arcuatum* (Griff.) Wijk. & Marg.	+	+		250-600	
139		*Hydrogonium subpellucidum* (Mitt.) Hilp.	+			320	
140		*Hyophila acuitifolia* Saito			+	800	
141		*Hyophila apiculata* Fleisch.			+	180	
142		*Hyophila involuta* (Hook.) A. Jaeger	+	+	+	200-1000	
143		*Hyophila nymaniana* (Fleisch.) Menzel		+		200	
144		*Hyophila spathulata* (Harv.) A. Jaeger	+		+	145	
145		*Oxystega cylindricus* (Brid.) Hilp.			+	180	
146		*Semibarbula ranuii* Hilp.	+			142-300	
147		*Weissia edentula* Mitt.			+	200	

W= 122; C = 111; E = 92

Appendix V

V. SPECIMENS EXAMINED

ANTHOCEROTALES

1. Anthoceros chambensis Kashyap **W. Nepal:** ***Nawalparasi***, Triveni, 190 m, 7.11.2004, Pradhan Pn 429b (NHM). C**. Nepal:** ***Nuwakot***, Trisuli, 545 m, 22.03.1977, Shrestha 10 (NHM!).

2. Anthoceros formosae Steph. **E. Nepal:** ***Morang***, Biratnagar, 180 m, 12.1982, Jha & *al. s.n.* (MMAC).

3. Anthoceros punctatus L. **W. Nepal:** ***Nawalparasi***, Tribeni, 200 m, 20.12.2004, Pradhan Pn 429 (NHM). **C. Nepal:** ***Chitwan***, The way of Amala Chuli,Uppar Dang Gadhi, 1000 m, 6.11.2004, Pradhan Pn 352, Pn 362 (NHM). ***Nuwakot***, Trisuli, 545 m, 22.03.1977, Shrestha (NHM).

4.*Folioceros assamicus D.C. Bhardwaj **C. Nepal:** ***Bara***, Hetauda- Amlekhjung, 600 m, 27° 35.475'N; 84° 47.814'E, 26. 11.2004, Pradhan c 394 (NHM).

5. Phaeoceros laevis (L.) Prosk. **W. Nepal:** ***Kanchanpur***, Mangalshera, SWR, 190 m, 06.01.2001, Pradhan *et al.* 45 (NHM, NBRI), 47 (NHM, NBRI), 48 (NHM). ***Dang***, Sishne Khola, 760 m, 09.11.2001, Pradhan 290 (NHM). **C. Nepal:** ***Chitwan,*** Simal Dhap, 300 m, 20.12. 2003, Pradhan Pn 259 (NHM). ***Bara,*** Pathlaiiya to Amlekhjung, 200 m, 26.11.2004, Pradhan *et al*. c 507 (NHM); Agricultural farm, Kailaiya, 200 m, 26.11.2004, Pradhan c 508 (NHM). ***Parsa***, Nirmal Basti, PWR, 250 m, 02.12.2004, Pradhan c 506 (NHM). ***Makwanpur,*** Vindraban Garden-Hetauda, 320 m, 04.12.2004, Pradhan *et al.* c 506 (NHM); Way to Daman, 1000 m, 29.11.2004, Pradhan *et al.* c395 (NHM). **E. Nepal:** ***Morang***, Belbari, 180 m, 23.11.2003, Pradhan *et al.* e 326 (NHM). **E. Nepal:** Dumure, 1000 m, 04.1963, Yoda 11947 (TNS).

6. Notothylas levieri Schiffn. **E. Nepal:** ***Morang***, Panchkanya, 200 m, 07.1983, Jha *et al. s.n*. (MMAC). ***Sunsari***, KTWR, 180 m, 24.12.2003, Pradhan dt 400 (NHM).

JUNGERMANNIALES

1.*Calypogiea neesiana (Massal. & Carest.) K. Muell. **W. Nepal: B*ardia,*** Danab Tal, BNP, 220 m, 06.11.2001, Pradhan NGS 485 (NHM). ***Banke***, Daurali Danra, RBNP, 420 m, 06.11.2001, Pradhan NGS 477 (NHM).

2. Odontoschima denudatum (G. Martens) Dumort. **W. Nepal: B*ardia,*** Daukura-Babai River Bank, BNP, 200 m, 26.02.2003, Pradhan Br. 28 (NHM); **E. Nepal:** ***Morang,*** Pirai-Biratnagar, 180 m, 16.10.2003, Pradhan *et al.* dt 383 (NHM).

3. *Frullania dilatata (L.) Dumort. **W. Nepal: *Bardia,*** Ratamati, BNP, 340 m, 06.11.1988, Pradhan NGS 468 (NHM).

4. Frullania ericoides (Nees ex Mart.) Mont. **W. Nepal: *Kaski,*** Matepani, 800 m, 09.1988, Higuchi 15523 (NICH); **C. Nepal: *Kavre,*** Barhabise, 900-1000 m, 11.1988, Higuchi 15293 (NICH).

5. Frullania muscicola Steph. **W. Nepal: *Bardia,*** Ratamati, BNP, 340 m, 06.11.2001, Pradhan NGS 464 (NHM, NBRI); ***Kaski***, Matepani-Pokhara, 800 m, 09.1988, Higuchi 15579 (NICH); **C. Nepal: *Chitwan,*** Simal Dhap, 260 m, 15.12. 2003, Pradhan Pn 196 (NHM).

6. Chiloscyphus polyanthos (L.) Corda in Opiz Correns Dumort. **W. Nepal: *Dang,*** Bhalubang, Lalmatia VDC, 350 m, 10.11.2001, Pradhan NGS 563 (NHM).

7. Heteroscyphus argutus (Reinw. et al.) Schiffn. **W. Nepal: *Dang,*** Sishne Khola, 780 m; 28°00.411'N; 82°14.468'E, 25.01.2001, Pradhan NGS 315 (NHM), NGS 356 (NHM). **C. Nepal: *Chitwan,*** Bishhazar Tal, CNP, 280 m, 11.12.2003, Pradhan Pn 44, Pn 45 (NHM). ***Bara***, Hetauda- Amlekhjung, 600 m, 27° 35.475'N; 84° 99.314'E, 26.11.2004, Pradhan et al. c394 (NHM). ***Parsa***, Mahadev Khola, PWR, 230 m, 02.12.2004, Pradhan c 502 (NHM).

8. *Heteroscyphus planus (Mitt.) Schiffn. **C. Nepal: *Bara***, Hetauda- Amlekhjung, 600 m, 27° 35.475'N; 84° 99.314'E, 26.11.2004, Pradhan *et al.* c-391, c-393 (NHM).

9. Lophocolea minor Nees **C. Nepal: *Kavre,*** Dolalghat, 600 m, 06.1963, Yoda 11980 (TNS).

10. Jamesoniella autumnalis (D.C.) Steph. **C. Nepal: *Kavre,*** Dolaghat, 600 m, 08.06.1963, Yoda 11595 (TNS).

11. Jungermannia appressifolia Mitt. **W. Nepal: *Palpa,*** Burwal-Tansen, 300 m, 09.1988, Higuchi 18511 (TNS). : **C. Nepal: *Makwanpur***, Hetauda, 230 m, 09.1988, Higuchi, 18480 (TNS).

12. Jungermannia comata Nees **W. Nepal: *Kaski,*** Pokhara, 800 m, 15.08.1988, Higuchi 15205 (TNS).

13. Jungermannia confertissima Nees **C. Nepal: *Makwanpur***, Hetauda, 350 m, 19.09.2002, Pradhan *et al*. c 483 (NHM).

14.*Jungermannia exsertifolia Steph. **C. Nepal: *Chitwan,*** Deughat-Phedi forest, 300 m, 15.12.2003, Pradhan Pn 134 (NHM).

15. Jungermannia hyalina Lyell **C. Nepal: *Chitwan,*** Drupa Post, CNP, 260 m, 13.12.2003, Pradhan Pn 64 (NHM).

16. *Jungermannia infusca (Mitt.) Steep. **C. Nepal, *Chitwan,*** Jugedi, 200 m, 20. 12.2003, Pradhan Pn 211 (NHM).

17. Jungermannia macrocarpa Steph. **C. Nepal, *Chitwan,*** Jugedi, 200 m, 20. 12.2003, Pradhan Pn 261 (NHM).

18. Jungermannia minutiverrucosa Amakawa **E. Nepal: *Sankhuwasabha,*** Bir Gaun-Dingla, 1000 m, 01.07.1972, Amakawa *s.n.* (TI).

19. *Jungermannia pumila With. **C. Nepal: *Chitwan,*** Uppar Dang Gadhi, 1000-1275 m, 04.11.2004, Pradhan Pn 367 (NHM); **E. Nepal: *Morang,*** Belbari, 180 m, 23.11.2003, Pradhan *et al.* dt 332 (NHM).

20. Jungermannia subulata A. Evans
W. Nepal: *Kaski,* Pokhara-Matepani, 800 m, Amakawa and Itagawa 15549, 11. 1988, Higuchi 15549 (TNS).

21. Jungermannia tetragona Lindenb. **W. Nepal: *Kaski,*** Pokhara-Phewa lake, 800 m, Higuchi 15478, 11.1988 (TNS). **C. Nepal: *Chitwan,*** Siddhi, 300 m, 07.11.2004, Pradhan Pn 419 (NHM). ***Parsa***, Nirmal Basti, PWR, 250 m, 02.12.2004, Pradhan c 493 (NHM). ***Kavre***, Barhabise, 900-1000 m, 11.1988, Higuchi, 15276 (TNS). **E. Nepal: *Sunsari***, Dingla -Dobhan, 730 m, 2001, Long 16402 (E!).

22. Jungermannia truncata Nees **W. Nepal: *Dang***, Jamunabash, Ganga Paraspur VDC, 320 m, 27°45.086'N, 82°34.145'E, 09.11.2001, Pradhan NGS 558 (NHM); ***Kaski***, Pokhara- Phewa lake, 800 m, 11.1988, Higuchi 15481 (TNS). **C. Nepal: *Chitwan,*** Uppardang Gadhi, 1000-1250 m, 05.11.2004, Pradhan Pn 473 (NHM). **E. Nepal: *Sunsari,*** Dharan, 730 m, 26°50'N; 87°18'E, 26.08.1989, Long 16402 (E!); ***Sankhuwasabha***, Tamur river between Sinwa and Tawa, 1000 m, 02.09.1989, Long 16544 (E!).

23. Mylia taylorii (Hook.) Gray **C. Nepal: *Chitwan,*** Jugedi, 200 m, 20.12.2003, Pradhan Pn 261 (NHM).

24. Nardia assamica (Mitt.) Amakawa **E. Nepal: *Morang,*** 200 m, 20.02. 2004, Pradhan dt 389 (NHM).

25. *Acrolejeunea pusilla (Steph.) Grolle & Gradst **C. Nepal, *Chitwan,*** Bish Hazar Tal, CNP, 180 m, 10.11.2004, Pradhan Pn 259, Pn 297, Pn 457 (NHM); Ram Nagar, 250 m, 13 09.2004, Pradhan Pn 458 (NHM).

26. Acrolejeunea recurvata Gradst. **E. Nepal: *Sankhuwasabha***, Arun Valley, Arun river below Num, 955 m, 27°34'N; 87°17'E, 22.09.1991, Long 20475 (E,).

27. Cololejeunea raduliloba Steph. **C. Nepal, Kavre,** Bahrabise**,** 900-1000 m, 1988, Higuchi 15334 (TNS).

28. Lejeunea ulicina (Taylor) Gottsche *et al.* **W. Nepal: *Kaski,*** Pokhara-Matepani, 800 m, 1988, Higuchi 15532 (TNS).

29. Lopholejeunea nigricans (Lindenb.) Schiffn. **W. Nepal: *Dang*** De Gaduwa- Jamunabash, 290 m;

27°46.988'N; 82°33.468'E, 9.09 2001, Pradhan NGS 570 (NHM, NBRI); ***Kaski***, Pokhara- Matepani, 800 m, 11.988, Mizutani 15532 (TNS). **C. Nepal:** ***Chitwan,*** Simal Dhap, 300 m, 20.12.2003, Pradhan Pn 191(NHM). **E. Nepal:** ***Sankhuwasabha***, Tamur River between Sinwa and Tawa, 1000 m, 02.1989, Long 16534 (E!).

30. Ptychanthus striatus (Lehm. & Lindenb.) Nees **W. Nepal:** ***Kaski,*** Pokhara, 800 m, 09.1988, Higuchi 15484 (TNS). **E. Nepal:** Mul Pokhari-Dumhan, 700 m, 1963, Hattori *s.n*. (TI).

31. Bazzania tridens ((Reinw. et al.) Trev. **W. Nepal:** ***Kaski,*** Pokhara, 800 m, 09.1988, Higuchi 15514 (TNS). **E. Nepal:** ***Sankhuwasabha,*** Rabong La and Temi, 1000 m, Hara *et al*, 237944 (NICH).

32. Plagiochila nepalensis Lindenb. **E. Nepal:** ***Taplejung***, Mul Pokhari, 700 -2400 m., 30.10.1963, Hattori *s.n*. (TI).

33. Plagiochila parvifolia Lindenb. **E. Nepal:** ***Taplejung***, 700-2700 m, 10.1963, Hattori *s.n.*, (TI).

34. Porella campylophylla (Lehm. & Lindenb.) Trev. **E. Nepal:** ***Sankhuwasabha,*** Tamur river side, 1000 m, 09.1989, Long 16548 (E).

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35. Asterella blumeana (Nees.) Pande **W. Nepal:** ***Dang,*** Sishne Khola, 780 m, 28°01.889'N; 82°32.849'E, 25.01.2001, Pradhan NGS 284 (NHM).

36. Asterella khasyana (Griff.) Pande *et al.*, **W. Nepal:** ***Kailali,*** Brahmadev-Churiya range, 600 m, 02.11.2001, Pradhan NGS 401(NHM). ***Bardia,*** Parewa Odar, 190 m, 23.03.2003, Pradhan Br 110 (NHM). **E. Nepal:** ***Sankhuwasabha,*** Arun Valley below Num, 920 m, 27°34' N; 87°17'E, 22.09.1991, Long 20478 (E).

37. Asterella multiflora (Steph.) Pande *et al*. **W. Nepal:** ***Kanchanpur,*** Ringauna, SWR, 190 m, 15.01.2001, Pradhan NGS 67 (NHM, E); ***Kailali,*** Ghodaghodi lake, 220 m, 17.01.2001, Pradhan NGS 112 (NHM, E). ***Bardia,*** Betahani, BNP, 118 m, 28°27.731'N; 81°14.681'E, 18.01.2001, Pradhan NGS 144 (NHM); Karnali river bank, BNP, 136 m, 20.01.2001, Pradhan NGS 184 (NHM); Khair Bhatti, BNP, 200 m, Pradhan NGS 460 (NHM); Parewa Odar, 200 m**,** Pradhan Br 118, 16.03.2003 (NHM). ***Dang,*** Masot Khola, 340 m, 27°55.556'N; 82°30.970'E, 25.01.2001, Pradhan NGS 271 (NHM, E); Sishne Khola, 550 m, 27.01.2001, Pradhan NGS 306 (NHM); Damar Gaun, 690 m, 08.11.2001, Pradhan NGS 505 (NHM, E), NGS 508 (NHM, E); Amelia, 335 m, 08.11. 2001, Pradhan NGS 516 (NHM, E); Bhojpur, 550 m; 28°02.211'N; 82°98.282'E, 27.01.2001, Pradhan NGS 306 (NHM). **C. Nepal:**). ***Chitwan,*** Maghauli, west of Tiger Top, 200 m, 27°83'N; 84°04'E, 07.03.1996, Watson 96-19 (E); Chitwan National Park, H.Q., 180 m, 12.12.2003, Pradhan Pn 84 (NHM); Jayanti Mandir-Daughat, 250 m, 15.12.2003, Pradhan Pn 105 (NHM). ***Parsa,*** Adhabhar H.Q., PWS, 220 m, 02.12.2004, Pradhan c 491 (NHM)

38. Asterella wallichiana (Lehm. & Lindenb.) Grolle **W. Nepal:** ***Kailali***, Brahmadev-Churia range, 600 m, 02.11.2001, Pradhan NGS 404 (NHM); Shamjhanapur Makta Kamaiya Basti, 360 m, 08.06. 2003, Pradhan NGS 681 (NHM, E). ***Bardia,*** Danab Tal, BNP, 340 m, 19.01.2001, Pradhan NGS 162 (NHM, E);

Chepang Post-Babai Daurali, BNP, 450 m, 23.01.2001, Pradhan NGS 230 (NHM, E); Babai-Chepang Post, BNP, 670 m, 23.01.2001, Pradhan NGS 235 (NHM); Parewa Odar, BNP, 190 m, 04.03.2003, Pradhan Br 138 (NHM, E). ***Dang***, Sishne Khola, 1000 m; 28°01.880'N; 82°32.849'E, 25.01.2001, Pradhan NGS 282 (NHM); Lamahi, 410 m; 25 Jan. 2001, Pradhan NP 267 (NHM); Deurali Danda, 750 m; 28°00.411'N; 82°14.468'E, 08.11.2001, Pradhan NGS 511 (NHM); Amelia, 335 m, 08.11.2001, Pradhan NGS 518 (NHM, E); Bhalubang, 312 m; 27°50.413'N; 82°45.705'E, 08.11.2001, Pradhan NGS 536 (NHM); Jamunabash, Ganga Paraspur VDC, 320 m, 27°45.086'N; 82°34.145'E, 09.11.2001, Pradhan NGS 559 (NHM); Badahara, Gowardia VDC, 315 m, 09.11.2001, Pradhan NGS 530 (NHM, E); ***Gulmi***, Andhi Khola, 510 m, 27°55'N; 83°26'E, 04.10.1999, Lye 17513 (E). **C. Nepal:** ***Parsa,*** Nirmal Basti, PWR, 250 m, 02.12.2004, Pradhan & al c 492 (NHM). ***Chitwan,*** Sukhevar Post, CNP, 250 m, 13.12.2003, Pradhan Pn 79 (NHM); Phedi forest Deughat, 300 m, 15.12.2003, Pradhan Pn 131 (NHM); Uppardang Gadhi, 1250 m, 05.11.2004, Pradhan Pn 344 (NHM); Tribeni, 200 m, 07.11.2004, Pradhan Pn 342, Pn 344, Pn 432 (NHM). ***Makwanpur***, Siwalik range- Hetauda, 490 m, 29.10.1989, Long 21636 (E). **E. Nepal:** ***Sankhuwasabha,*** Piluwa Khola, 275 m, 27°13'03" N; 87°14' 39" E, 24.09.2001, Long 30266 (E!), ***Sunsari***, Koshi Tappu Wildlife Reserve, 180 m, 06.01.2004, Pradhan dt 389 (NHM).

39. Mannia fragrans (Balb.) Frye & L. Clark. **W. Nepal:** ***Kaski,*** Pokhara, Phewa Lake, 800 m, Higuchi 15441, 11.1988 (TNS).

40. Plagiochasma appendiculatum Lehm. & Lindb. **W. Nepal:** ***Bardia,*** Khauraha Panta, BNP, 200 m, 20.01.2001, Pradhan NGS 204 (NHM, E). ***Dang,*** Masot Khola, 340 m, 25.01.2001, Pradhan NGS 274 (NHM, E) ; Sishne Khola, 780 m; 28°00.411'N; 82°14.468'E, 09.11.2001, Pradhan NGS 292 (NHM, E), 25.01.2001, Pradhan NGS 529 (NHM); Damar Gaun, Phulbari VDC, Ward No. 1, 660 m; 28°01.876'N; 82°13.868'E, 08.11.2001, Pradhan NGS 504(NHM); Lalmatia, 760 m, 27°50.441'N; 82°40.982'E, 2.01.2001, Pradhan NGS 706 (NHM, E). ***Kaski***, Pokhara-Mahendra Cave, 920 m, 09.1988, Higuchi 18642 (TNS). ***Nawalparasi***, Tribeni, 200 m, 09.11.2004, Pradhan Pn 435 (NHM). **C. Nepal:** ***Chitwan,*** Narayani Safari Park, 240 m, 21.12.2003, Pradhan Pn 239. **E. Nepal:** ***Morang,*** Belbari, 300 m, 23.11. 2004, Pradhan dt 303 (NHM).

41. Plagiochasma pterospermum C. Massal. **W. Nepal:** ***Dang,*** Lamahi, 410 m, 25.01.2001, Pradhan NGS 268 (NHM); Sishne Khola, 780 m, 28°00.411'N; 82°14.468'E, 25.01.2001 (NHM), Pradhan NGS 314 (NHM). **C. Nepal:** ***Bara***, Hetauda- Amlekhjung, 600 m, 27° 35.475'N; 84° 47.814'E, 26.11.2004, Pradhan c-389 (NHM); ***Chitwan,*** Khagari Khola, 240 m, 09.12.2003, Pradhan Pn 11 (NHM); Bageshwori Mandir-Daughat, 280 m, 15.12.2003, Pradhan Pn 125 (NHM); Shakti Khor, 290 m, 07.11.2004, Pradhan 327 (NHM); Siddhi, 350 m, 07.11.2004, Pradhan Pn 397, Pn 411 (NHM).

42. Plagiochasma simlensis Kashyap **W. Nepal:** ***Banke***, Jigeri, 200 m, 03.06.2003, Pradhan NGS 352 (NHM).

43. Reboulia hemisphaerica (L.) Raddi **W. Nepal:** ***Dang***, Sishne Khola, 780 m, 25.01.2001, Pradhan *et. al*. NGS 284 (NHM, E), Pradhan *et al.* NGS 320 (NHM, E). **C. Nepal:** ***Chitwan,*** Shakti Khor, 355 m, Pradhan Pn 327, 07.11.2004 (NHM). **E. Nepal:** ***Sankhuwasabha,*** Tamur river side, 1000 m, 09.1989, Long 16546 (E!). ***Morang***, Belbari, 180 m, 25.12.2004, Pradhan *et al.* dt 300 (NHM).

44. Marchantia emarginata Reinw. *et al*. **W. Nepal:** ***Bardia***, Danab Tal, BNP, 240 m, 19.01.2001, Pradhan NGS 175 (NHM); Khauraha Phanta, RBNP, 200 m, 20.01.2001, Pradhan NGS 203 (NHM). ***Dang*** Katuwa Khola, 690 m, 28°03.021'N; 82°29.105'E, 25.01.2001, Pradhan NGS 278 (NHM); Sishne Khola, 760 m, 9.09.2001, Pradhan NGS 300 (NHM); Lalmatia, 272 m, 27°50.411'N; 82°40.982'E, 28.05.2003, Pradhan NGS 603 (NHM); Raji Khola, Purandhara, Hapure VDC, 700 m, 28°11.514'N; 82°06.290'E, 30 05.2003, Pradhan NP 627 (NHM). ***Nawalparasi***, Tribeni, m, 09.11.2004, Pradhan Pn 463 (NHM). **C. Nepal:** ***Chitwan***, Lami Tal, 200 m, 16 12. 2003, Pradhan Pn 52 (NHM); Simal Dhap, 300 m, 12.2.2003, Pradhan Pn 187 (NHM); Siddhi, 350 m, 7 10.2004, Pradhan Pn 467 (NHM); Pandav Nagar, RCNP, 300 m, 02.11.2004, Pradhan Pn 316 (NHM); Sona Khola, Balmiki Ashram, 300 m, 08.11.2004, Pradhan Pn 442 (NHM). ***Parsa,*** Nirmal Basti, PWR, 250 m, 02.12.2004, Pradhan c496 (NHM); Mahadev Khola, 220 m, PWR, 250 m, 02.12.2004, Pradhan c 503 (NHM). ***Kabre,*** Barhabise, 900 m, 25 06.1990, Pradhan (NHM). **E. Nepal:** ***Sankhuwashava***, Panchkhal, 1000 m, 06.1963, Yuda 11920 (TNS); ***Jhapa***, Damak 150m, 10.10.2002, Pradhan dt 361 (NHM).

45. Marchantia paleacea Bertol. **C. Nepal:** ***Makwanpur***, Hetauda-Siwalik range, 550 m, 29.10.1989, Long 21645 (E!).

46. Marchantia papillata Raddi subsp. **grossibarba** (St.) Bischl. **W. Nepal:** ***Kailali,*** Ghodaghodi Lake, 220 m, 08.06.2003, Pradhan NGS 690 (NHM, E). ***Kaski***, Pokhara-Phewa Lake, 800 m, 09.1988, Higuchi 15455 (TNS). ***Nawalparasi***, Triveni, 250 m, 08.11.2004, Pradhan Pn 442 (NHM). **C. Nepal:** ***Chitwan***, CNP, Pandav Nagar-Pandheri Khola, 250 m, 03.11.2004, Pradhan Pn 316 (NHM). ***Parsa***, Nirmal Basti, PWR, 250 m, 02.12.2004, Pradhan c 495 (NHM). ***Makwanpur***, Siwalik range, 490 m, 09.1989, Long 16548 (E!).

47. Marchantia polymorpha L. **W. Nepal:** ***Bardia***, Khauraha Phanta, 200 m, BNP, 20.01.2001, Pradhan NGS 186, 211 (NHM). ***Dang,*** Sishne Khola, 1000 m, 28°01.880'N; 82°32.849'E, 25.01.2001, Pradhan NGS 283, NGS 316 (NHM); Ramari, 1350 m, 28°17.164'N, 29.05.2003, Pradhan NGS 614 (NHM). ***Kaski,*** David Fall, 800 m, 07.2001, Pradhan k 10 (NHM). ***Nawalparasi,*** Tribeni, m, 10.11.2004, Pradhan Pn 430 (NHM). **C. Nepal:** ***Parsa***, Nirmal Basti, PWR, 250 m, 02.12.2004, Pradhan c 494 (NHM). ***Kavre***, Panchkhal, 1000 m, 04.1963, Yoda 11920 (TNS). **E. Nepal:** ***Morang,*** Biratnagar, 130 m, 21.11.2002, Pradhan *et al.* dt 250 (NHM).

48. *Monosolenium tenerum Griff. **W. Nepal:** ***Bardia,*** Betahani, 118 m, 28°27'N; 87°14'E, BNP, 18.01.2001, Pradhan *et al.* NGS 142 (NHM, E).

49. Riccia crystallallina L. **C. Nepal:** ***Kavre,*** Bahrabise, 900-1000 m, 07.1988, Furuki 15256 (TNS).

50. Riccia fluitans L. **W. Nepal:** ***Kanchanpur***, Brahmadev, 230 m, 15.01.2001, Pradhan NGS 52 (NHM). ***Dang,*** Shewar Khola , 684 m, 28°03.021'N; 82°29.105'E, 25.01.2001, Pradhan NGS 176 (NHM)). **C. Nepal:** ***Chitwan,*** Khagari Khola, 250 m, 09.12.2003, Pradhan Pn 9 (NHM); Bish Hazar Tal, 250 m, 11.12. 2003, Pradhan Pn 43 (NHM); Rhui Khola, Bankatta, 280 m, 13.12.2003, Pradhan Pn 81, 82 (NHM). ***Kavre***, Barhabise, 900-1000 m, 11.1988, Higuchi, 15243 (TNS).

51. *Riccia glauca L. **C. Nepal:** ***Chitwan,*** Pandav Nagar, 300 m, 02.11.2004, Pradhan Pn 314 (NHM).

52. Riccia pathankotensis Kashyap **C**. **Nepal**: ***Chitwan,*** Balmiki Ashram, 250 m, 08.11.2004, Pradhan Pn 446 (NHM).

53. Cyathodium tuberosum Kashyap **W. Nepal:** ***Rupendehi,*** Butwal- Siddhi Baba Mandir, 300 m, 10.06.2003, Pradhan NGS 708 (NHM, E); ***Kaski,*** Barahi Mandeer- Phewa Lake, 800 m, 06.07.2001, Pradhan k4 (NHM); Gupteshwor Mahadev- Pokhara, 800 m, 14.07.2001,Pradhan k 32 (NHM). **C. Nepal:** ***Chitwan***, Bageshwori Mandir-Daughat, 250 m, 15.12.2003, Pradhan Pn 126 (NHM); Safari Narayani Park-Narayanghad, 260 m, 21.12.2003, Pradhan Pn 232 (NHM); Ampbari-Bankatta, 300 m, 02.11.2004, Pradhan Pn 455 (NHM); Rampur, 240 m, 12.11.2004, Pradhan Pn 449 (NHM). ***Parsa***, Pathlaiya, 120 m, 27° 486.17'N; 85° 01.917'E, 27.11.2004,Pradhan c-397 (NHM); Nirmal Basti, PWR, 250 m, 02.12.2004, Pradhan c 497 (NHM). ***Makwanpur***, Hetauda, 320 m, 19.09.2002, Pradhan *et al*. c-485 (NHM); Vindrabhan-Hetauda, 320 m, 04.12.2004, Pradhan *et al.* c 504 (NHM). **E. Nepal:** ***Morang,*** Urlabari, 300 m, 08.11. 2002, Pradhan dt 390 (NHM).

54. Targionia hypophylla L. **W. Nepal:** ***Banke***, Tharubash-Chisapani Kha, BNP, 200 m, 30.10.2001, Pradhan NGS 367 (NHM); ***Butwal***, Tansen, 300 m, 11.1988, Higuchi 18513 (TNS).

55. Dumortiera hirsuta (Sw.) Nees in Reinw. *et al*. **W. Nepal:** ***Kaski,*** Mahendra Cave- Pokhara, 800 m), 14.06.2001, Pradhan k 30 (NHM). **C. Nepal:** ***Chitwan***, Uppardang Gadhi, 1000 m, 05.11.2004, Pradhan Pn 375 (NHM). ***Kavre***, Bahrabise, 900 -1000 m, 08.1988, Higuchi 15252 (TNS); **E. Nepal:** ***Sankhuwasabha***, Tumling Tar-Khandbari, 825 m, 25.09. 2001, Long 30280 (E); ***Sunsari***, Bhattabhung - Dharan, 450 m, 12.1982, Jha *et al., s.n.* (MMA).

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56. Aneura blasioides (Horik.) Furuki **W. Nepal:** ***Palpa,*** Tansen- Waling, 600 m, 11.1988, Higuchi 18516 (TNS). ***Kaski,*** Pokhara -Mahendra Cave, 920 m**,** 11.1988, Higuchi 18646 (TNS).

57. Riccardia cardotii (Steph.) Pande & S. C. Srivast. ex Srivast. & Udar W**. Nepal:** ***Kaski,*** Pokhara Phewa lake, 800 m, 09.1988, Higuchi 15476 (TNS). **C. Nepal:** ***Chitwan***, Shakti Khor-Upperdang Gadhi, 1000-1250 m, Pradhan Pn 367 (NHM).

58. Riccardia multifida (Linn.) Gray **W. Nepal:** ***Kaski,*** Pokhara, 900 m, 08-09.1988, Higuchi 18521, 18637 (TNS); Begnas Lake, 600 m, 08-09.1988, Higuchi 18637 (TNS).

59. Metzgeria conjugata Lindb. **C. Nepal:** ***Makwanpur,*** Kabtar-Churiya range, 1000 m, 26.11.2006, Pradhan *et al*. c 398 (NHM).

60. Pallavicinia lyellii (Hook.) Carruth. **C. Nepal:** ***Chitwan,*** Simal Dhap, 300 m, 20.12.2003, Pradhan Pn 258, Pn 260 (NHM).

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1. Campylopus nilghiriensis (Mitt.) A. Jaeger **W. Nepal:** ***Kaski***, Pokhara-Matepani, 800 m, 07.09.1988, Higuchi 15548 (TNS). **C. Nepal:** ***Chitwan,*** Chandibhanjyang, 1000-1200 m, 06.11.2004, Pradhan Pn 465 (NHM); **E. Nepal:** ***Sankhuwasabha***, Sim-Chotala-Gram, 900 m, 20.08.1988, *s.n.* (TI).

2.*Campylopus schimperi Milde. **C. Nepal:** ***Chitwan,*** Amala Chuli Gadhi, 1000-1200 m, 04.11.2004, Pradhan Pn 345 (NHM).

3. Dicranella heteromalla (Hedw.) Schimp. **E. Nepal:** ***Sankhuwasabha,*** Basantapur-Dor, 900-1000 m, 09.1972 (TI).

4. Dicranum setchwanicum Broth. **W. Nepal:** ***Kaski***, Phewa Lake, 800 m, 06.09.1988, Higuchi 15506 (TNS).

5. Leucoloma taylorii (Schwaegr.) Mitt. **C. Nepal:** ***Kavre***, Bahrabise, 900-1000 m, 01.091988, Higuchi 15328 (TNS). ***Dhanusa,*** Janakpur-Sindhulimadi, 500 m, 05.10.1986, Takaki 56511 (TNS).

6. Trematodon kurzii Hampe ex Gangulee **E. Nepal:** ***Sankhuwasabha*** Dingla Dobhan, 1000 m, 02.07.1972 (TI).

7. Trematodon longicollis Michx. **W. Nepal:** ***Kailali,*** Daiji, 230 m, 3.11.2001, Pradhan NGS 676 (NHM). ***Bardia***, Khaurab Taal, BNP, 180 m, Pradhan NGS 113, 18.01.2001, Babai River bed, 190 m, 27.02.2003, Pradhan Br 82 (NHM).

8. Trematodon subulosus Griff. **E. Nepal:** Mewa Khola, 900 m, 03.1952, 1820a (BM!).

9. *Ditrichum tortuloides Grout **W. Nepal:** ***Bardia***, Thakurdwara, BNP, 160 m, 16.01.2001, Pradhan NGS 79 (NHM).

10. **Garckea flexuosa** (Griff.) Margad. & Nork. **W. Nepal:** ***Kaski***, Phewa Lake, 800 m, 06.09.1988, Higuchi 15506 (TNS). **C. Nepal:** ***Chitwan***, Bharatpur-Tadi, 500 m, 26.09.1986, Takaki 56143 (TNS).

11. Leucobryum bowringii Mitt. **W. Nepal:** ***Kaski,*** Phewa Lake-Pokhara, 800 m, 09.1988, Higuchi 15554 (TNS).

12. Leucobryum mittenii Besch. **W. Nepal:** ***Kaski,*** Phewa Lake-Pokhara, 800 m, 09.1988, Higuchi 15494 (TNS).

13. Octoblepharum albidum Hedw. **W. Nepal:** ***Kaski***, Phewa Lake, 800 m, 25.06.2001, Pradhan K40 (NHM). **C. Nepal:** ***Chitwan,*** Amala Chuli, Gadhi, 1000-1250 m, 04.11.2004, Pradhan Pn 346 (NHM); Badar Khola- Shakti Khor, 375 m, 5.11.2004, Pradhan Pn 381 (NHM); Siddhi, 350 m, 6.11.2004, Pradhan Pn 412 (NHM). ***Makwanpur,*** Hetauda-Bharatpur, 230 m, 11.1988, Higuchi 18492 (TNS). **E. Nepal:**

Sankhuwasabha, Dingla-Doban, 950 m, 02.07.1972, s.n. (TI); Tamur river above Dobhan, 800 m, 1.09.1989, Long 13533 (E!). **Nepal:** Wallich 6572 **(***Jap. Expd*.)

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14. Fleischerobryum longicolle (Hampe) Loeske **W. Nepal:** ***Banke***, Chepang Post, BNP, 350 m, 30.10.2001, Pradhan NGS 531 (NHM). Daurali Danda, BNP, 300 m, 6.11.2001, Pradhan NGS 478, 497 (NHM).

15. Philonotis falcata (Hook.) Mitt. var. **falcata C. Nepal:** ***Kavre***, Bahrabise, 900-1000 m, 01.09.1988, Higuchi 15270 (TNS).

16. Philonotis fontana (Hedw.) Brid. **C. Nepal:** ***Chitwan,*** Siddhi, 350 m, 07.11.2004, Pradhan Pn 418 (NHM).

17. *Philonotis marchica (Willd) Brid. **W. Nepal:** ***Dang,*** Damar Gaun, Phulbari VDC, Ward No.1, 610 m, 28°01.266'N; 82°13.735'E, 8.11.2001, Pradhan NGS 495(NHM).

18. Philonotis mollis (Dozy & Molk.) Mitt. **W. Nepal:** ***Dang,*** Sishne Khola, 760 m, 25.01.2001, Pradhan NGS 299 (NHM). Bhalubang, 250 m, 09.11.2001, Pradhan NGS 526, Chainpur, 240 m, 08.11.2001, Pradhan NGS 537 (NHM). ***Rupandehi***, Butwel-Tansen, 500 m, 9.11.1988, Higuchi 18508 (TNS). **C. Nepal:** ***Dhading,*** Naubise, 400- 880 m, 09.1988, Higuchi 15424 (NGS). ***Chitwan***, Daughat, 250 m, 9.12.2003, Pradhan Pn 8 (NHM).

19. Philonotis seriata Mitt. **W. Nepal:** ***Dang,*** Sishne Khola, 780 m, 28° 01.880'N; 82° 32.349'E, 25.01.2001, Pradhan NGS 288 (NHM).

20. Philonotis thwaitesii Mitt. **W. Nepal:** ***Banke***, Chepang Post, BNP, 350 m, 25.01.2001, Pradhan NGS 335 (NHM); ***Dang,*** Sishnae Khola, 1000-1100 m, 28°01.880'N; 82°32.849'E, 25.01.2001, Pradhan NGS 280 281, 294 (NHM). ***Kaski,*** Matepani-Pokhara, 800 m, 07.09.1988, Higuchi 15557 (TI). **C. Nepal:** ***Chitwan,*** Mugling**,** 500 m, 26.09.1986, Takaki 56161 (TNS). Ghaumaune, 500 m, 22.12.2003, Pradhan Pn 244 (NHM), Ganeshthan-Bharatpur, 250 m, 15.12.2003, Pradhan Pn 151 (NHM).

21. Philonotis turneriana (Schwaegr.) Mitt. **W. Nepal,** ***Banke***, Nepal-India boarder, 120 m, 29.10.2001, Pradhan NGS 360 (NHM); ***Dang,*** Damar Gaun, Phulbari VDC, Ward No.1, 612 m, 28°01.266'N; 82°13.735'E, 08.11.2001, Pradhan NGS 503 (NHM). Jamunabash, Ganga Paraspur VDC, 320 m, 27°45.080'N; 82°34.145'E, 10.11.2001, Pradhan NGS 568 (NHM); **C. Nepal:** ***Chitwan,*** Siddhi, 350 m, 07.11.2004, Pradhan Pn 418 (NHM); Mugling, 1000 m, 09.1986, Takaki 56174 (TNS); ***Kavre***, Barhabise, 900-1000 m, 01.09.1988, Higuchi 15295 (TNS).

22. Brachymenium acuminatum Harv. **C. Nepal:** ***Sindhupalchowk,*** Lamosagu-Bahrabise, 800 m, 31.07.1988, Higuchi 15230 (TNS). **E. Nepal:** ***Morang,*** 250 m, 22.09.1961, Norkett 5226a (BM!).

23. Bryum apiculatum Schwaegr. **W. Nepal:** ***Palpa,*** Palpa, 600 m, 09.1988, Higuchi 18514 (TNS). **C. Nepal:** ***Chitwan,*** Rapti river side, CNP, 140 m, 27°34'19"N; 84°29'16"E; 03.2002, Townsend T92/317 (E).

24. Bryum argenteum Hedw. **W. Nepal:** ***Kaski,*** Pokhara, 800 m, 09.1988, Higuchi 15515 (TNS). Patale Chhano-Pokhara, 800 m, 2001, Pradhan k 28 (NHM). **C. Nepal:** ***Chitwan***, Upparang Gadhi, 1000-1200 m, 05.11.2004, Pradhan Pn 472 (NHM).

25. Bryum caespiticum Hedw. **W. Nepal:** ***Dang,*** Damar Gaun, Phulbari VDC, Ward No.1, 612 m, 28°01.266'N; 82°13.735'E, 08.11.2001, Pradhan NGS 572 (NHM). Dhan Khola, 595 m, 27°46.878'N; 82°48.239'E, 26.01. 2003, Pradhan NGS 590 (NHM); **C. Nepal:** ***Chitwan,*** Marat Khola, Pandav Nagar-Bankadta, CNP, 140 m, 27° 33' 02" N; 84°21' 03" E, 02.11.2004, Pradhan Pn 321 (NHM).

26. Bryum capillare L. ex Hedw. **C. Nepal:** ***Makwanpur***, On the way Hetauda - Daman, 1000-1060 m, 27°32'31" N; 85°02'03" E, 27.11.2004, Pradhan *et al.* c 520 (NHM).

27. Bryum cellulare Hook. **C. Nepal:** ***Kaski,*** Pokhara, 900 m, 09.1988, Takaki 56185 (TNS).

28. Bryum clavatum (Schimp.) C. Muell. **W. Nepal:** ***Dang,*** Damar Gaun, 612 m, 28°01.266'N, 82°13.735'E., 08.11.2001, Pradhan NGS 502 (NHM). **E. Nepal:** ***Sankhuwasabha,*** Mahamabedi Khola-Tamur Bridge, 370 m, 06.1972 (TI).

29. Bryum coronatum Schwaegr. **W. Nepal:** ***Bardia,*** Danab Taal, BNP, 240 m**,** 20.01.2001, Pradhan NGS 164, NGS 171(NHM, NBRI); Parewa Odar, BNP, 222 m, 27.02.2003, Pradhan Br 76 (NHM). ***Dang,*** Ghorahi, 900 m, 27°55.556'N; 82°30.970'E, 25.01.2001, Pradhan NGS 275(NHM). Beljhundi, 630 m, 26.01.2001, Pradhan NGS 301 (NHM). ***Kaski***, Pokhara, 900 m, 7.09.1988, Higuchi 15517 (TNS). **C. Nepal:** ***Chitwan***, Simal Dhap, 260 m, 20.12. 2003, Pradhan Pn 186 (NHM); Karsigriha-Bishhazar Tal, CNP, 200 m, 01.11.2004, Pradhan Pn290, Pn 293 (NHM); Bankadta, 140 m, , 27° 33' 02"N; 84°21'03"E, 02.11.2004, Pradhan Pn 300 (NHM); Sishau Danda, 350 m, 5.11.2004, Pradhan Pn 328 (NHM); Nibuwatar-Siddhi, 350 m, 7.11.2004, Pradhan Pn 426 (NHM). ***Makwanpur,*** Vrindawan Botanial Garden, 490 m, 19.08.2002, Pradhan *et al*. c 362 (NHM); Hetauda (East of town), 500 m, 27°25'59" N; 85°02'45" E, 19.09.2002, Pradhan c-484 (NHM). ***Kavre***, Lamosngu-Barhabise, 800 m, 31.08.1988, Higuchi 15234 (TNS). ***Dhanusa,*** Janakpur, 500 m, 09.1986, Takaki 58517 (TNS). **E. Nepal:** ***Morang,*** Biratnagar, 170 m, 07.11.1988, Higuchi 18458 (TNS). ***Sunsari***, Tarahara, 300 m, 25.12. 2003, Pradhan dt 401 (NHM).

30. Bryum dichotomum Hedw. **W. Nepal:** ***Kaski,*** Pokhara, 800 m, 27.09.1986, Takaki 56189 (TNS). **C. Nepal:** ***Makwanpur***, On the way to Daman, 1000 m, 27.11.2004, Pradhan *et al.* c 519 (NHM). ***Dhanusa,*** Janakpur, 500 m, 09.1986, Takaki 58517 (TNS).

31. Pohlia flexuosa Hook. **C. Nepal:** ***Kavre,*** Barhabise, 900-1000 m, 01.09.1988**,** Higuchi 15283 (TNS). **E. Nepal:** ***Sankhuwasabha***, 1000 m, Norkett *s.n. (*BM).

32. Rhodobryum giganteum (Schwaegr.) Par. **C. Nepal:** ***Chitwan***, Upperdang Gadhi, 1000 m, 8.11.2004, Pradhan Pn 488 (NHM).

33. Rhodobryum roseum (Hedw.) Limpr. **C. Nepal:** ***Makwanpur,*** Daman, 1000 m, 27 .11.2004, Pradhan *et al.* c 489 (NHM).

FISSIDENTALES

34. **Fissidens anomalus** Montin **C. Nepal:** Chilime Khola, 450 m, 07.1949, Polunin 121a (BM!).

35. *Fissidens aspleinoides Hedw. **W. Nepal:** ***Dang,*** Jamunabash, Gangaparaspur VDC, 320 m, 09.11.2001, Pradhan NGS 548, 549, 584 (NHM). Damar Gaun, 610 m, 09.11.2001, Pradhan NGS 510 (NHM).

36. Fissidens biformis Mitt. **E. Nepal:** ***Dhankuta***, Hile-Chitre, 990 m, 05.06.1972, Iwatsuki *s.n.* (TI). E. Nepal, 600 m, 02.1962, Norkett 5841 (BM!).

37. Fissidens bryoides Hedw. **W. Nepal:** ***Banke***, Naya Gaun -Dhakeri, 200 m, 03.06.2001, Pradhan *et al.* NGS 339 (NHM). ***Dang***, Lamahi, 410 m, 25.01.2001, Pradhan *et al.* NGS 269 (NHM). **E. Nepal:** ***Dhankuta***, Shanghu, 1580 m, 19 11.1961, Norkett 7773 (BM); Topke Gola-Shewaden, 2850 m, 28.06.1972, Iwatsuki *s.n*. (TI).

38. Fissidens bryoides Hedw. ssp. **schmidii** (C. Muell.) Norkett **W. Nepal:** ***Kaski***, Pokhara, Phewa Lake, 800 m, 06.08.1988, Higuchi 15438 (TNS); **E. Nepal:** Dingla Doban, 1000 m, 0 2.07.1972, Iwatsuki (TNS).

39. Fissidens ceylonensis Dozy & Molk. **W. Nepal:** ***Kaski***, Pokhara-Matepani, 800 m, 02.09.1988¸ Higuchi 15577 (TNS). **E. Nepal:** ***Sankhuwasabha,*** Tumling Tar, 550 m, 11.12.1961, Norkett 8983 (BM!). ***Dhankuta***, Dharapani, 300 m, 1963, Hattori *s.n.* (TI).

40. Fissidens ceylonensis var. **simplex** (C. Muell.) Nork. **E. Nepal:** ***Sankhuwasabha,*** Tumling Tar-Arun river, 550 m, 23.12.1961, Norkett 9046 (BM).

41. Fissidens crenulatus Mitt. **W. Nepal:** ***Kanchanpur***, Suklaphanta Wildlife Reserve, SWR, 190 m, 14.01.2001, Pradhan NGS 28 (NHM), ***Bardia***, Bargadha Ghat, BNP, 174 m, 28.02.2003, Pradhan Br 84, Br 85 (NHM). **C. Nepal:** ***Chitwan***, Bankadta, 300 m, 27° 33' 02" N; 84°21' 03" E, 13.12.2003, Pradhan Pn 87 (NHM). ***Parsa***, Adhabar Reserve HQ, PWR, 200 m, 02.12.2004, Pradhan c 511 (NHM). **E. Nepal**: Nepal, 600 m, 11.1962, Norkett 8816 (BM).

42. Fissidens crenulatus Mitt. var. **crenulatus** Gangulee **W. Nepal:** ***Dang,*** Damar Gaun, Phulbari VDC, Ward No. 1, 590 m, 08.11.2001, Pradhan 510 (NHM); **E**. **Nepal**: 600 m, 11.1962, Norkett 8816 (BM!).

43. Fissidens crenulatus Mitt. var. **titalayanus** (C. Muell.) Gangulee **W. Nepal:** ***Dang,*** De Gadawa, 290 m, 27°46.988'N, 82°33.968'E, 09.11. 2001, Pradhan NGS 543 (NHM). **E. Nepal:** Nepal, 600 m, 11.1962, Norkett 9995 (BM!).

44. Fissidens curvato-involutus Dixon **W. Nepal: Bardia**, Bargadha Ghat-Parewa Odar, 175 m, 28.02.2003, Pradhan Br 98 (NHM). ***Palpa***, Butwal-Tansen, 300 m, 09.11.1988, Higuchi 18512 (TNS). **C. Nepal:** **C*hitwan***, Pandav Nagar-Bankadta, CNP, 140 m, 27° 33' 02" N; 84°21' 03" E, 02.11.2004,

Pradhan Pn 320 (NHM). **E. Nepal:** Nepal, 600-1200 m, 01.1962, Norkett (BM!).

45. Fissidens curvato-xiphioides Dixon & Verd. **E. Nepal:** ***Sankhuwasabha,*** Arun river bed, 600 m, 01.1961, Norkett 9053 (BM).

46. Fissidens diversifolius Mitt. **E. Nepal:** ***Sankhuwasabha***, Tumiling Tar, 550 m, 15.12.1961, Norkett 8881 (BM!).

47. Fissidens diversifolius Mitt. var. **rubricaulis** (Dixon.) Nork. **E. Nepal:** ***Sankhuwasabha,*** Tumling Tar, 600-750 m, 12.12.961, Norkett 8770, 8881 (BM).

48. *Fissidens geminiflorus. Dozy & Molk. **W. Nepal:** ***Kailali,*** Mangalsera, 160 m, 03.11.2001, Pradhan NGS 413 (NHM). **C. Nepal:** ***Chitwan***, Simal Dhap, 300 m, 20.12.2003, Pradhan Pn 203 (NHM). ***Parsa***, Charbhaiya, PWR, 200 m, 02.12.2004, Pradhan c 512 (NHM).

49. Fissidens geppii Fleisch.**W. Nepal:** ***Kaski***, Pokhara- Begnas Lake, 600 m, 11.11.1988, Higuchi 18635 (TNS).

50. *Fissidens gymnogynus Besch **W. Nepal:** ***Banke,*** Tharubash, Chisapani Kha, BNP, 300 m, 31.10.2001, Pradhan NGS 381 (NHM); ***Kailali***, Ghodaghodi Lake, 220 m, 28 41.135 'N; 80 52.725'E, 03.11.2001, Pradhan NGS 426 (NHM).

51. Fissidens intromarginatulus E.B. Bartram **E. Nepal:** ***Sankhuwasabha***, Tumling Tar, 550 m, 21.12.1961, Norkett 6461 (BM!).

52. Fissidens involutus Wilson **E. Nepal:** ***Sankhuwasabha***, Tumling Tar, 550 m, 21.12.1961, Norkett 9626 (BM); ***Sunsari***, Dhankuta, 400 m, 24.02.1966, Norkett 9990 (BM).

53. Fissidens javanicus Dozy & Molk.. **W. Nepal:** ***Bardia***, 02. 03. 2003, Parewa Odar, 195 m, Pradhan Br 123 (NHM). ***Kaski***, Pokhara, 800 m, 10.11.1988, Higuchi 18614 (TNS). **C. Nepal:** ***Chitwan,*** Simaldhap, 300 m, 20.12.2003, Pradhan 267 (NHM). Pandav Nagar, 300 m, 02.11.2004, Pradhan Pn 318 (NHM). ***Parsa***, Adhabar Reserve HQ, PWR, 200 m, 02.12.2004, Pradhan c 510 (NHM).

54. Fissidens kalimpongensis Gangulee **E. Nepal:** ***Sankhuwasabha***, Tumling Tar, 550 m, 21.12.1961, Norkett 9025 (BM); ***Sunsari***, Dharan, 900 m, 17.09.1961, Norkett 5060 (BM!).

55**. Fissidens laxus** Sull & Lesque **W. Nepal:** ***Kaski***, Pokhara, Phewa Lake, 800 m, 06.08.1988, Higuchi 15944 (TNS).

56. Fissidens maceratus Mitt. **E. Nepal:** ***Sunsari***, Dharan 200-240 m, 01.06.1972, Iwatsuki, *s.n.*(TI). ***Sankhuwasabha***, Tumling Tar, 550 m, 07.12.1961, Norkett 8742 (BM).

57. Fissidens microcladus Thwait. & Mitt. **W. Nepal:** ***Palpa***, Dobhan, 900 m, 30.11.1962,

Norkett 9689 (BM); ***Kaski ,*** Pokhara, Phewa Lake, 800 m, 06.11.1988, Higuchi 15443 (TNS); **C. Nepal:** ***Chitwan***, Bharatpur-Tadi, 500 m, 26.09.1986, Takaki 56165 (TNS). ***Kavre,*** Barhabise, 900-1000 m, 01.09.1988, Higuchi 15336 (TNS). **E. Nepal:** ***Sankhuwasabha,*** Arun Velley, 753 m, Stainton 1526b (BM!).

58. Fissidens microcladus Thwait. & Mitt. var. **terrestries** Aust.**E. Nepal**: ***Sankhuwasabha***, Tumling Tar, 550 m, 13.12.1961, Norkett 8829 (BM).

59. Fissidens minutus Thwait. & Mitt. **E. Nepal:** ***Sunsari***, Dharan-Ghopa Camp, 200 m, 27.02.1962, Norkett 10226 (BM!).

60. Fissidens mittenii Paris **E. Nepal:** ***Sankhuwasabha***, Tumling Tar, 550-600 m, 23.12.1961, Norkett 7761 (BM).

61. Fissidens nobilis Griff. **W. Nepal:** ***Banke***, Daurali Danda- way to Chepang Post, BNP, 700 m, 06.11.2001, Pradhan NGS 715 (NHM); ***Kaski***, Pokhara, 800 m, 10.11.1988, Higuchi 1859 (TNS); Gupteshwar Mahadev-Pokhara, 800 m, 15, 06.2000, Pradhan k 34 (NHM).

62. *Fissidens oblongifolius Hook. f. & Wils. **C. Nepal:** ***Chitwan,*** Jugedi, 250 m, 20.12.2003, Pradhan Pn 262, Pn 266 (NHM).

63. **Fissidens plagiochiloides** Besch. **W. Nepal:** ***Bardia***, Budhi Khola-Parewa Odar, BNP, 220 m, 27.02.2003, Pradhan Br 54 (NHM); Parewa Odar, BNP, 200 m, 02.03.2003, Pradhan Br 111 (NHM).

64. Fissidens ranchinensis Gangulee **E.** ***Sankhuwasabha***, Tumling Tar, 550 m, 07.11.1961, Norkett 8459 (BM!).

65.*Fissidens robinsonii Broth. **W. Nepal:** ***Kailali*** Ghodaghodi Lake, 220 m, 28° 41’135” N; 80° 52’725” E, 03.11.2001 Pradhan NGS 425 (NHM, NBRI), 10.11.2001, Pradhan NGS 576 (NHM); **E. Nepal:** ***Morang,*** Belbari-Betani, 180 m, 23.11. 2003, Pradhan *et al.* dt 313 (NHM).

66. Fissidens sempefalcatus Dixon **E. Nepal:** ***Sankhuwasabha***, Tumling Tar, 550 m, 07.12.1961, Norkett 8742 (BM).

67. ***Fissidens strictus** Hook. & Wilson **W. Nepal:** ***Bardia***, Danab Tal, BNP, 340 m, 20.01.2001, Pradhan *et al.* NGS 159 (NHM).

68. Fissidens subbryoides Gangulee **W. Nepal:** ***Kaski,*** Matepani-Pokhara, 800 m, 07.09.1988, Higuchi 15520 (TNS). **C. Nepal:** ***Chitwan,*** Kadam Chautara, Gadhi, 1000 m, 05.11.2004, Pradhan Pn 378 (NHM). ***Makwanpur,*** Siwalik Range, 650 m, 04.12.2004, Pradhan et *al.* c 513 (NHM). **E. Nepal:** ***Sunsari,*** Ghopa Camp, 300 m, *s.n.*, Norkett 9996A (BM!).

69. Fissidens subpalmatus C. Muell.**C. Nepal:** ***Chitwan***, Chautara- Uppardang Gadhi, 1000-1200 m, 04.11.2004, Pradhan Pn 455 (NHM). ***Parsa,*** Nirmal Basti, PWR, 250 m, 02.12.2004, Pradhan c 514 (NHM). ***Makwanpur,*** Siwlik Range, 800 m, 27°31’39”N; 85°05’19”E, 04.12.2004, Pradhan *et al.* c

515 (NHM).

70. Fissidens sylvaticus Griff. **W. Nepal:** ***Bardia,*** Danab Tal, 225 m, BNP, 06.11.2001, Pradhan NGS 482 (NHM). Ledi khola, 450 m, 08.1954, PSW 6813b, (BM!). **C. Nepal:** ***Chitwan***, Uppardang Gadhi 1200 m, 04.11.2004, Pradhan Pn 456 (NHM). ***Bara,*** Terai high way-Pathlaiya, 104 m, 27°18.601'N; 85°01.917''E, 26.11.2004, Pradhan c396 (NHM). **E. Nepal:** ***Dhankuta***, 300 m, 02.1962, Norkett 9994 (BM). ***Sankhuwasabha***, Tumling Tar, 550 m, 07.12.1961, Norkett 8741 (BM). ***Morang***, Belbari-Betani, 180 m, 23.11.2003, Pradhan *et al*. dt 327 (NHM).

71. *Fissidens sylvaticus Griff. var. **auriculatus** (C. Muell), Gangulee **W. Nepal:** ***Bardia,*** Danab Tal, BNB, 225 m, 28°21'92"N ; 81°25'93"E, 06.11.2001, Pradhan NGS 482 (NHM, NBRI).

72. *Fissidens sylvaticus Griff. var. **calcuttense** Gangulee
W. Nepal: ***Kailali,*** Ghodaghodi Lake, 220 m, 17.01.2001, Pradhan NGS 105 (NHM, NBRI); ***Bardia,*** Danab Tal, BNP, 225 m, 06.11.2001, Pradhan NGS 487 (NHM)

73. Fissidens taxifolius Hedw. **W. Nepal:** ***Bardia***, Gularia, 181 m, 01.11.2001, Pradhan *et al.* NGS 400 (NHM); Danab Tal, 225 m, BNP, 06.11. 2001, Pradhan *et al.* NGS 482, 487 (NHM)**.** ***Banke,*** Tharubash, 300 m, BNP, 30.10.2001, Pradhan *et al*. NGS 371 (NHM). ***Kaski,*** Mahendra Cave, Pokhara, 920 m, 11.11.1988, Higuchi 18643 (TNS). **C. Nepal:** ***Chitwan***, Uppardang Gadhi, 1000-1200 m, 05.11.2004, Pradhan Pn 456 (NHM). ***Parsa***, Adhaibar Reserve HQ, PWR, 200 m, 02.12.2004, Pradhan c 517 (NHM); Mahadev Khola, PWR, 200 m, 02.12.2004, Pradhan c 519 (NHM). ***Makwanpur***, Hetauda-Bharatput, 230 m, 08.11.1988, Higuchi 18478 (TNS); Siwlik Range, 670 m, 27°21'32"N; 85°0'07"E, 04.12.2004, Pradhan *et al.* c 516 (NHM).

74. Fissidens virens Thwait. & Mitt. **E. Nepal:** ***Sankhuwasabha***, Tumling Tar 600-1400 m, 12.12.1961, Norkett 8742 (BM!).

75. Fissidens zippelianus Dozy & Molk. **W. Nepal:** ***Kaski,*** Pokhara, 800 m, 11.1988, Higuchi 18525 (TNS). ***Syanja***, 900 m, 09.11.1988, Higuchi 18524, (TNS). **C. Nepal:** ***Chitwan***, Bankadta, CNP, 140 m, 27°31'45"N; 84°15'03"E, 02.11.2004, Pradhan Pn 450 (NHM).

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76. Funaria hygrometrica Hedw. **W. Nepal:** ***Dang***, Ramari, Ward No.1, 1000-1350 m, 29.05.2003, Pradhan NGS 618 (NHM); **C. Nepal:** ***Chitwan,*** Uppardang Gadhi, 1000-1200 m, 0511.2004, Pradhan Pn 374 (NHM).

77. *Phycomitrium cupuliferum Mitt. **E. Nepal:** ***Morang***, Biratnagar, 180 m, 26.12.2003, Pradhan dt. 100 (NHM).

78. *Phycomitrium eurystomum Sendth. **W. Nepal:** ***Bardia,*** Lalmati, BNP, 190 m, 20.01.2001, Pradhan NGS 213 (NHM). Bankatti, 175 m, 01.03.2003, Pradhan Br 101 (NHM); Parewa Odar, BNP, 195 m, 02.03.2003, Pradhan Br 109 (NHM). **C. Nepal:** ***Chitwan,*** Devital, Tiger Top, CNP, 180 m, 27°32'32"N; 84°07'36"E, 10.12.2003, Pradhan Pn 19 (NHM); Mugling, 300 m, 18.12.2003, Pradhan Pn 172 (NHM); Jute Pani, 200 m, 19.12.2003, Pradhan Pn 176 (NHM); Simal Dhap, 300 m,

20.12.2003, Pradhan Pn 202 (NHM).

79. Phycomitrium japonicum (Hedw.) Mitt. **C. Nepal: *Chitwan,*** Narayani Safari Park, 250 m, 21.12.2003, Pradhan Pn 237 (NHM); Tiger Tops, 150 m, 11.03.1992, Townsend T92/305.

80. Phycomitrium pyriforme (Hedw.) Hampe **E. Nepal: *Morang***, Koshi Tappu Wildlife Reserve, KTWR, 300 m, 2911.2004, Pradhan *et al.* dt-393 (NHM). ***Sunsari***, Tarahara, 180 m, 23.12.2003, Pradhan dt. 204, 205, 206 (NHM).

81. Splachnobryum aquaticum Muell. Hal. **W. Nepal: *Bardia,*** Parewa Odar, BNP, 190 m, 02.03.2003, Pradhan Br 117 (NHM).

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82. Hookeria acutifolia Hook. & Grev. **E. Nepal: *Morang,*** Urlabari, 450 m, 16.08.2004, Pradhan dt 370 (NHM). ***Sunsari,*** **Koshi** Tappu wildlife Reserve, 180 m, 11. 08. 2004, Pradhan *et al.* dt 345 (NHM).

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83. Brachythecium buchananii (Hook.) A. Jaeger **W. Nepal: *Kaski***, Matepani-Pokhara, 800 m, 07.09.1988, Higuchi 11587 (TNS).

84. Brachythecium garovaglioides Muell. Hal. **W. Nepal: *Dang***, Sishne Khola, 780 m, 28° 01.880'N; 82° 32.349'E, 25.01.2001, Pradhan NGS 287 (NHM, NBRI). ***Kaski,*** Phewa Lake, 800 m, 06.09.1988, Higuchi 18624 (TNS).

85. Brachythecium populeum (Hedw.) B.S.G. var. **populeum** (Hedw.) B. S. G. **C. Nepal: *Kavre***, Barhabise, 900 m, 01.09.1988, Higuchi 15265 (TNS).

86. Eurhynchium swartzii (Turner) Curn. **W. Nepal: *Bardia***, Bagaura, BNP, 135 m, 18.01.2001, Pradhan NGS 118 (NHM, NBRI).

87. Rhynchostegium vagans (Harv.) A. Jaeger **W Nepal: *Kaski,*** Phewa lake, 800 m, 06.09.1988, Higuchi 15491 (TNS). Begnas Lake-Pokhara, 600 m, 11.11.1988, Higuchi 18629 (TNS). **E. Nepal: *Sankhuwasabha,*** Doban, 900, 02.07.1972, *s.n.* (TI).

88. Campylodontium flavescens (Hook.) Bosch & Lacey. **W. Nepal: *Kaski,*** Matepani-Pokhara, 800 m, 07.09.1988, Higuchi 15536 (TNS). **C. Nepal: *Kavre,*** Barhabise, 900-1000 m, 01.09.1988, Higuchi 15287 (TNS).

89. Entodon flavescens (Hedw.) A. Jaeger **W. Nepal: *Kaski***, Phewa lake-Pokhara, 800 m, 06.09.1988, Higuchi 15504 (TNS). **C. Nepal: *Kavre***, Barhebise, 900-1000 m, 03.10.1988, Higuchi 16937 (TNS).

90. Entodon prorepens (Mitt.) A. Jaeger **E. Nepal: *Dhankuta***, Teku Nala-Dhankuta, 800 m, 04.06.1972, *s.n* (TI).

91. Erythrodontium julaceum (Schwaegr.) Paris **W. Nepal: *Kaski,*** Phewa Lake-Pokhara, 800 m, 06.09.1988, Higuchi 15431 (TNS). **C. Nepal: *Kavre***, Bahrabise, 900-1000 m, 01.09.1988, Higuchi

15241 (TNS); **E. Nepal:** ***Sunsari,*** Pindeshwor, 600 m, Jha *et al. sn.*, 11.1983; ***Sankhuwasabha,*** Tamur river between Sinwa and Tawa, 1000 m, 02.09.1989, Long 16540 (E); Tumling Tar-Khandbari, 550 m, 17.09.1989, Long 20296 (E).

92. Trachyphyllum inflexum (Harv.) A. Gapp. **W. Nepal:** ***Bardia,*** Khairbhatti, BNP, 290 m, 05.11.2001, Pradhan NGS 456, 458 (NHM); Bagaura, 134 m, BNP, 18.01.2001, Preadhan NGS 126 (NHM). Parewa Odar, 234 m, 02.03.2003 Pradhan Br 126 (NHM), ***Dang***, De Gaduwa, 290 m, 27°46.988'N,82°33.968'E, 09.11.2001, Pradhan NGS $539_{(1)}$ (NHM). **C. Nepal:** ***Chitwan***, Thakurbari, 250 m, 08.11.2004, Pradhan Pn 448 (NHM). **E. Nepal:** ***Samkhuwasabha,*** Arun Valley between Tumling Tar-Khandbari, 550 m, 17.09.1989, Long 20297 (E!).

93. Fabronia schensiana C. Muell.**E. Nepal:** ***Dhankuta***, Teku-Nala-Dhankuta, 1000-1070 m, 04.06.1972, *s.n.* (TI); Dhankuta 1000, 09.1961, Norkett 310956 (BM).

94. Ectropothecium cygnicollum (Mitt.) A. Jaeger **E. Nepal:** ***Sunsari,*** Panchkanya, 180 m, 11.1983, Jha *et al. s.n*. (MMC).

95. Ectropothecium cyperoides (Hook.) A. Jaeger **W. Nepal:** ***Kaski,*** Phewa Lake, 800 m, 06.09.1988, Higuchi 15469 (TNS); Matepani, 800 m, 07.09.1988, Higuchi 15529 (TNS); Begnas lake, 600 m, 11.11.1988, Higuchi 18633 (TNS). **C. Nepal:** ***Makwanpur***, Hetauda-Bharatpur, 230 m, 08.11.1988, Higuchi 18479 (TNS). ***Kavre***, Barhabise, 900-1000 m, 01.08.1988, Higuchi 15292 (TNS).

96. Ectropothecium sikkimensis (Renauld & Cardot) Renauld & Cardot **W. Nepal:** ***Kaski,*** Matepani-Pokhara, 800 m, 07.09.1988, Higuchi 15551(TNS).

97. Ectropothecium zollingeri (C. Muell.) A. Jaeger **C. Nepal:** ***Makwanpur,*** Hetauda-Bharatpur, 230 m, 08.11.1988 Higuchi 18498 (TNS). ***Kavre***, Barhabise, 900 m, 01.09.1988, Higuchi 15251 (TNS)

98. Hypnum albescens Hook. **E. Nepal:** ***Sankhuwasabha,*** Dobhan-Tamur river, 550 m, Norkett 9642a (BM!), 02. 1962.

99. Hypnum cupressiformae Hedw. **C. Nepal:** ***Chitwan,*** Dhakre Khola, Tiger Top, CNP, 180 m, 10.12.2003, Pradhan Pn 34 (NHM).

100. Hypnum pleumaformae W. Wilson **W. Nepal:** ***Bardia***, Kherbhatti, 290 m, BNP, 04.11.2001, Pradhan NGS 455 (NHM). ***Dang,*** Sishne Khola belt, 1000 m, 28°01.880'N; 82°32.849'E, 25.01.2001, Pradhan NGS 293 (NHM); Badahara, 350 m, 27°48.492'N; 82°42.469'E, 09.11.2001 Pradhan NGS 532 (NHM). **C. Nepal:** ***Chitwan,*** Gaviel farming, CNP, 150 m, 27°34'15"N; 85°29'59"E, 12.12.2003, Pradhan Pn 63 (NHM); Ban Kadtha-Pandav Nagar, CNP, 180 m, Pradhan Pn 315 (NHM); Shakti Khor-Sherbasi-Gadhi, 1000-1250 m, 04.11.2004, Pradhan Pn 354 (NHM). ***Makwanpur,*** Kabtar-Churiya, on the way to Daman, 1000 m,, 26.11.2004, Pradhan *et al.* c 387 (NHM). ***Dhanusa***, 200 m, 10.10.2005, Pradhan dt. 374 (NHM). **E. Nepal:** ***Morang,*** Koshi Toppu Wildlife Reserve, 120 m, 26° 42.5'N; 87° 06'E, 16.08.2002, Pradhan *et al*. dt 356 (NHM).

101. Isopterygium minutirameum (C. Muell.) A. Jaeger **C. Nepal:** ***Chitwan,*** Jarneli Post, CNP, 140 m, 27°31'21"N; 84°29'04"E, 12.12.2003, Pradhan Pn 61 (NHM); Sukhibar Post, CNP, 140 m, 27°31'21"N; 84°29'04"E, 13.12.2003, Pradhan Pn 67 (NHM); Simal Dhap, 300 m, 20.12.2003, Pradhan Pn 197 (NHM). ***Parsa,*** Pathlaiya, 104 m, 27 18.691'N; 85 01.917'E, 26.11.2004, Pradhan c-388 (NHM). **E. Nepal:** ***Morang***, Govendapur, 150 m, 9.11.2002, Pradhan dt 373, dt 390 (NHM).

102. Pseudotaxiphyllum distichaceum (Mitt.) Z. Iwats. **W. Nepal:** ***Kaski,*** Phewa Lake-Pokhara, 800 m, 06.09.1988, Higuchi 15472 (TNS); Matepani, 800 m, 07.09.1988, Higuchi 15553 (TNS).

103. Taxiphyllum taxirameum (Mitt.) Fleisch. **W. Nepal: *Banke,*** Babai-Daurali, 500 m, 23.01.2001, Pradhan NGS 240 (NHM). ***Kaski,*** Phewa Lake-Pokhara, 800 m, 09.1988, Higuchi 15437 (TNS, KATH). **C. Nepal: *Chitwan***, Mugling, 1000 m, 26.09.1986, Takaki 56170 (TNS).

104. Foreauella orthothecia (Schwaegr.) Dixon et P. Vard. **C. Nepal: *Makwanpur***, Hetauda-Bharatpur, 230 m, 08.11.1988, Higuchi 18488 (TNS). ***Kavre***, Barhabise, 900-1000 m, 01.09.1988, Higuchi 14343 (TNS).

105. Sematophyllum subhumule (C. Muell.) Fleisch. ssp. **subhumili** (C. Muell.) Fleisch. **W. Nepal: *Banke***, Chisapani Kha, BNP, 200 m, 30.10.2001, Pradhan NGS 366 (NHM, NBRI).

106. Taxithelium nepalense (Schwaegr.) Broth. **W. Nepal: *Bardia***, Betahani, 118 m, BNP, 18.01200, Pradhan NGS 137 (NHM); Khauraha Phanta, BNP, 200 m, 01.2001, Pradhan NGS 187 (NHM); Teen Muhan, Parewa Odar, 188 m, BNP, 28.02.2003, Pradhan Br 100 (NHM). (Detn: L. Ellis, June 2003).

107. Entodontopsis anceps (Bosch & Sande Lacey) W.R. Buck & Ireland **W. Nepal: *Dang,*** De Gaduwa, 290 m, 09.11.2001, Pradhan NGS 539 (NHM).). **C. Nepal: *Chitwan,*** Tiger Tops, 150 m, 11.03.1992, Townsend T92/297; Ram Nagar, 200 m, 11.11.2004, Pradhan Pn 53 (NHM).

108. Entodontopsis leucostega (Brid.) W.R. Buck & Ireland **W. Nepal: *Kanchanpur,*** SWR, 200 m, 13.01.2001, Pradhan NGS 3 (NHM). Churia-Siwalik range-Chisapani, BNP, 300 m, 18.01.2001, Pradhan NGS 128, NGS 133 (NHM); Danab Tal, 240 m, 19.01.2001, Pradhan NGS 164 (NHM);06.11.2001, Pradhan NGS489 (NHM); Kherbhatti, 290 m, BNP, 28° 33.922'N, 81°22.084'E, 05.11.2001, Pradhan NGS 459 (NHM). ***Banke***, Samsherjung, 260 m, 24.01.2001, Pradhan NGS 254 (NHM). ***Bardia***, ***Kailali***, Banbheda VDC, 195 m, 28°47.890'N, 80°40.283'E, 03.11.2001, Pradhan NGS 418 (NHM). ***Dang,*** De Gaduwa, 290 m, 09.11.2001, Pradhan NGS 538 (NHM). **C. Nepal: *Chitwan,*** Geshsthan-Bharatpur, 200 m, 15.12.2003, Pradhan Pn 156 (NHM); Lothar forest, 200 m, 21.12.2003, Pradhan Pn 230, Pn 299 (NHM); Upperdang Gadhi, 1000-1275 m, 05.11.2004, Pradhan Pn 373 (NHM); Ram Nagar, 250 m, 11.11.2004, Pradhan Pn 459 (NHM).

109. Entodontopsis setschwanica (Broth.) W.R. Buck. & Ireland **W. Nepal: *Kailali,*** Chisapani, 198 m, 28°37.764'N; 81°16.948'E, 18.01.2001, Pradhan NGS 550 (NHM). **E. Nepal: *Sankhuwasabha,*** Panchkhal, 1000 m, 06.1963, Yoda 11562 (TNS).

110. Entodontopsis tavoyense (Hook. f.) W.R. Buck & Ireland **W. Nepal: *Kailali***, Singhapur, SWR, 190 m, 17.12.2001, Pradhan NGS 22 (NHM); Chisapani Ka, BNP, 300 m, 18.01.2001, Pradhan NGS 133 (NHM). ***Bardia,*** Khauraha Khola, BNP, 200 m, 20.01.2001, Pradhan NGS 212 (NHM); Baghaura, BNP, 145 m, 05.11.2001, Pradhan NGS 444 (NHM). **C. Nepal: *Chitwan,*** Dev Ghat-NarayanGadh, 250 m, 09.12.2003, Pradhan Pn 12 (NHM); Bish Hazar Tal, CNP, 300 m, 11.12.2003, Pradhan Pn 40 (NHM).

111. Entodontopsis wightii (Mitt.) W.R. Buck & Ireland **W. Nepal: *Kailali,*** Danab Tal, BNP, 240 m, 19.01.2001, Pradhan NGS 169 (NHM). **C. Nepal: *Chitwan,*** Drupa Post, CNP, 150 m, 13.12.2003, Pradhan Pn 72 (NHM); Simal Dhap, 300 m, 20.12.2003, Pradhan Pn 200 (NHM).

112. Haplocladium angustifolium (Hampe & C. Muell.) Broth. **W. Nepal: *Bardia,*** Bagaura, 142 m, BNP, 18.01.2001, Pradhan NGS 122 (NHM); ***Dang,*** Sishne Khola, 780 m, 25.01.2001, Pradhan NGS 287 (NHM). **C. Nepal: *Dumre,*** Dhading, 300 m, 09.1986, Takaki 56176 (TNS).

113. Haplocladium larminatii (Broth. & Par.) Broth. **W. Nepal: *Bardia***, Betahani, BNP, 120-

135 m, 28 27.731'N; 81 14.681'E, 18.01.2001, Pradhan NGS 143, NGS 329 (NHM). ***Dang,*** Sishne Khola, 780 m, 28°00.411'N; 82°14.468'E, 25.2001, Pradhan NGS 286 (NHM).

114. Herpetineuron toccoae (Sull & Lesq.) Cardot **C. Nepal: *Kabre,*** Barhabise, 900 m, 09.1988, Higuchi 15320 (TNS); **E. Nepal: *Sankhuwasabha,*** Tamur river between Sinwa and Tawa, 800 m, 2 .09.1989, Long 16537 (E!).

115. Thuidium cambifolium *(*Dozy & Molk.) Dozy & Molk. **W. Nepal: *Kaski,*** Syanja- South- East Pokhara, 900 m, 09.1988, Higuchi 18525 (TNS).

116. Thuidium glaucinoides Broth. **W. Nepal: *Kaski,*** Phewa lake-Pokhara, 800 m, 06.09.1988, Higuchi 15493, 15498 (TNS).

117. Thuidium glaucinum (Mitt) Bosch & Lacey **W. Nepal: *Kaski,*** Phewa lake-Pokhara, 800 m, 06.09.1988, Higuchi 15471 (TNS). **C. Nepal: *Makwanpur,*** Hetauda-Churia, 600 m, 19.09.2002, Pradhan *et al.* C 390 (NHM).

118. Thuidium plumulosum (Dozy & Molk.) Dozy & Molk. **C. Nepal: *Chitwan,*** Upperdang Gadhi, 1000-1250 m, 04.11.2004, Pradhan Pn 385 (NHM). **E. Nepal: *Sunsari***, South of Dharan, 200-240 m, 01.06.1972, *s.n.* (TI). East Nepal, 200-240 m, Wallich *s. n.* (TI).

119. Thuidium kuripanum ((Dozy & Molk.) W. Watanabe **C. Nepal: *Makwanpur,*** Hetauda-Bharatpur, 230 m, 08.11.1988, Higuchi 18500 (TNS, NICH).

120. Thuidium tamariscellum (C. Muell.) Bosch et Lacey **C. Nepal: *Chitwan,*** Bachhauli, ward No.6, 200 m, 16.12.2003, Pradhan Pn 142 (NHM). **E. Nepal: *Sankhuwasabha,*** Mohamabedi Khola-Tamur Bridge, 350 m, 03.06.1972 , *s. n.* (TI)

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121. Erpodium magniferae C. Muell. **E. Nepal: *Sankhuwasabha***, Arun Valley, 765 m, 17.09.1989, Long 20299 (E!); Arun river bank-Kharare, 255 m, 26.09.2001, Long 30268 (E).

122. Sphaerotheciella sphaerocarpa (Hook.) M. Fleisch. **W. Nepal: *Kanchanpur,*** Captenghat, SWR, 168 m, 06.06.2003, Pradhan NGS 678 (NHM, E).

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123. Pogonatum microstomum (R. Br.) Brid. **W. Nepal: *Kaski,*** Pokhara, 800 m, 15.06.2001, Pradhan k 25 (NHM). ***Chitwan***, Upperdang Gadhi, 1000-1275 m, 04.11.2004, Pradhan Pn353 (NHM); Siddhi, 350 m, 06.11.2004, Pradhan Pn 424 (NHM).

124. Pogonatum neesii (C. Muell.) Dozy & Molk, **E. Nepal: *Sunsari,*** Dharan-Dhankuta road, 600 m, 11.1983, Jha *et al. S.n*, (MMC).

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125. Calymperes erosum C. Muell. **C. Nepal:** ***Makwanpur,*** Hetauda-Bharatpur, 230 m, 11.1988, Higuchi 18493 (TNS). ***Chitwan***, Mugling, 300 m, 27°44'54"N; 84°28'06"E, 18.12.2003, Pradhan Pn 487 (NHM). ***Kavre***, Bahrabise, 900 m, 09.1988, Higuchi 15331 (TNS).

126. Syrrhopodon gardneri (Hook.) Schwaegr. **E. Nepal:** ***Sankhuwasabha,*** Tumling Tar-Khandbari, 825 m, 25.09.2001, Long 30285 (E).

127. *Anoectangium bicolor Renauld & Cardot **W. Nepal:** ***Dang,*** Ramari, 1000-1250 m, 29.05.2003, Pradhan NGS 713 (NHM). **E. Nepal:** ***Sunsari,*** Koshi Tappu, 180 m, 29. 05. 2004, Pradhan dt 351 (NHM).

128. Barbula constricta Mitt. **C. Nepal:** ***Chitwan,*** Sona Khola- Balmiki Ashram, 250 m, Pradhan Pn 441 (NHM), 11.2004; **E. Nepal:** ***Morang,*** Koshi Tappu Wildlife Reserve, 180 m, 26° 452'N; 87°06'E, 16.08.2002, Pradhan *et al* dt 367 (NHM).

129. Barbula flavicans D.G. Long **E. Nepal:** ***Morang,*** Biratnagar, 180 m, 06.2004, Pradhan dt 388 (NHM).

130. Barbula indica (Hook.) Spring. **W. Nepal:** ***Dang,*** Dernata, Bhalubang, 350 m, 27°51.559'N; 82°47.548'E, 10.11. 2001, Pradhan NGS 567 (NHM); De Gaduwa, 290 m, 27°46'98"N; 82°33'468''E, 09.11.2001, Pradhan NGS 524, 542 (NHM). **C. Nepal:** ***Makwanpur,*** On the way Hetauda-Birgunj, 670 m, 27°21'32"N; 85°0'07"E, 19.09.2002, Pradhan *et al*. c-386 (NHM); Vrindawan Botanical Garden, 490 m, Pradhan *et al.*, 19.08.2002, Pradhan *et al.* dt 358 (NHM). **E. Nepal:** ***Sunsari***, Dhankuta, 800 m, 14.02.2004, Pradhan *et al.* dt 379 (NHM).

131. Barbula javanica Dozy & Molken **E. Nepal:** ***Sankhuwasabha,*** Dingla-Doban, 800 m, 02.07.1972, s.n. (TI). ***Morang,*** Biratnagar, 180 m, 06.2004, m, Pradhan *et al*.dt 352 (NHM).

132. Barbula marginatula C. Muell. ex. Gangulee **C. Nepal:** ***Makwanpur,*** On the way Hetauda, 670 m, 27°21'32"N; 85°0'07"19.09.2002, Pradhan *et al.* c-390 (NHM).

133. Barbula tenuirostris Brid. **C. Nepal:** ***Chitwan,*** Shati Khor-Gadhi, 400 m, 04.11.2004, Pradhan Pn 333 (NHM); Badar Khola-Shakti Khor, 355 m, 5.11.2004, Pradhan Pn 385 (NHM). **E. Nepal**, Wallich *s.n.(*E!).

134. Bryoerythrophyllum inaequalifolium (Tayl.) Zander **C. Nepal:** ***Chitwan,*** Jute Pani, Sakun Tole, Ward No 7, 250 m, 19.12.2003, Pradhan Pn 177 (NHM).

135. Bryoerythrophyllum recurvirostrum (Hedw.) P.C. Chen **W. Nepal:** ***Dang,*** Lamahi, 410 m, 25.01.2001, Pradhan NGS 266 (NHM); **C. Nepal:** ***Chitwan***, Pandav Nagar, 300 m, 02.11.2004, Pradhan Pn 306 (NHM).

136. *Bryoerythrophyllum rubrum (Jur. ex Geh.) P.C. Chen **E. Nepal: *Morang,*** Kusahar, 180 m, 17.08.2002, Pradhan *et al.* dt 386 (NHM); Biratnagar, 180 m, 19.11.2002, Pradhan *et al.* dt 372 (NHM).

137. Didymodon constrictus (Mitt.) Saito **W. Nepal: *Bardia,*** Parewa Odar, BNP, 165 m, 25.02.2003, Pradhan Br 5 (NHM).

138. Hydrogonium arcuatum (Griff.) Wijk. et. Marg. **W. Nepal: *Bardia,*** Chisapani, BNP, 250 m, 30.10.2001, Pradhan 524 (NHM); ***Dang,*** Amelia, 335 m, 27°59.388'N, 82°731.050'E, 08.11.2001, Pradhan NGS 515 (NHM); Bhalubang, Nortinala, Sonpur VDC, 250 m, 09.11.2001, Pradhan NGS 524 (NHM). **C. Nepal: *Bara,*** Hetauda-Amlekhjung, 600 m, 26.11.2004, Pradhan et al. c 392 (NHM).

139. *Hydrogonium subpellucidum (Mitt.) Hilp. **W. Nepal: *Dang,*** Jamunabash, 320 m, 27°45.080'N; 82°34.145'E, 09.11.2001, Pradhan NGS 555 (NHM).

140. *Hyophila acutifolia Saito **E. Nepal: *Dhankuta***, 800 m, 14.02.2004, Pradhan *et al.* dt 385 (NHM).

141. *Hyophila apiculata Fleisch. **E. Nepal: *Morang,*** Biratnagar, 180 m, 08.11.002, Pradhan dt 377 (NHM).

142. Hyophila involuta (Hook.) A. Jaeger **W. Nepal: *Bardia***, Kuwabhatt, BNP, 200 m, 05.11.2001, Pradhan 453 (NHM); ***Dang,*** Sishne Khola, 1000 m, 28°01.880'N; 82°32.849'E, Pradhan NGS 295, 25.01.2001, Pradhan NGS 297 (NHM). **C. Nepal: *Chitwan***, Pandav Kuwa, 300 m, 02.11.2004, Pradhan Pn 311 (NHM); ***Parsa,*** Charbhaiya, PWR, 180 m, 02.12.2004, Pradhan c 518 (NHM. **C. Nepal: *Sunsari,*** Teku-Nala Dhankuta, 800-1000 m, 04.06.1972, *s.n.* (TI).

143. *Hyophila nymaniana (Fleisch.) Menzel **C. Nepal: *Chitwan,*** Judegi, 200 m, 20.12.2003, Pradhan Pn 214 (NHM).

144. Hyophila spathulata (Harv.) A. Jaeger **W. Nepal: *Bardia,*** Bagaura**,** BNP, 145 m, 5.11.2001, Pradhan NGS 443 (NHM).

145. Oxystegus cylindricus (Brid.) Hilp. **E. Nepal: *Sunsari,*** Koshi Tappu Wildlife Reserve**,** 180 m, 29. 05.2004, Pradhan *et al.* dt 392 (NHM).

146. Semibarbulla ranuii Gangulee **W. Nepal: *Banke,*** Chisapani Kha, BNP, 200 m, 30.10.2001, Pradhan NGS 364 (NHM); Bagaura, BNP, 142 m, 18.01.2001, Pradhan NGS 318 (NHM); ***Dang,*** Badahara, Goberdia VDC, 320 m, 27° 48.492' N; 82° 42.469'E, 09.11.2001, Pradhan NGS 569 (NHM).

147. *Weissia edentula Mitt. **E. Nepal: *Jhapa,*** Chandra Gadhi, 200 m, 10.11.2002, Pradhan dt 371 (NHM).

Appendix VI

VI. Collecting sites in Five different regions of Lowland Tarai

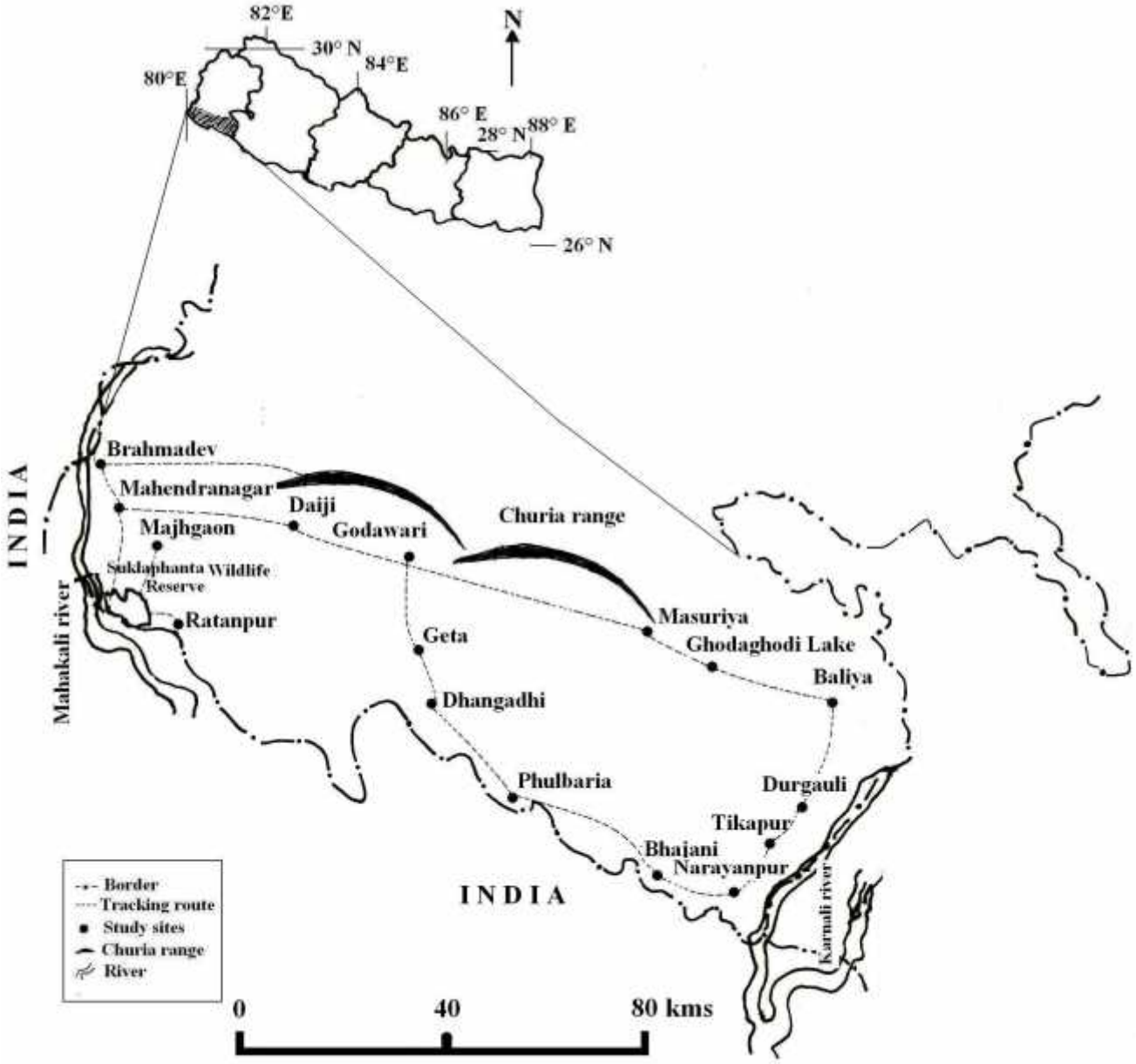


Fig. 71. Map showing collecting sites in Far Western Region of lowland Tarai

Fig. 72. Map showing collecting sites in Mid Western Region of lowland Tarai

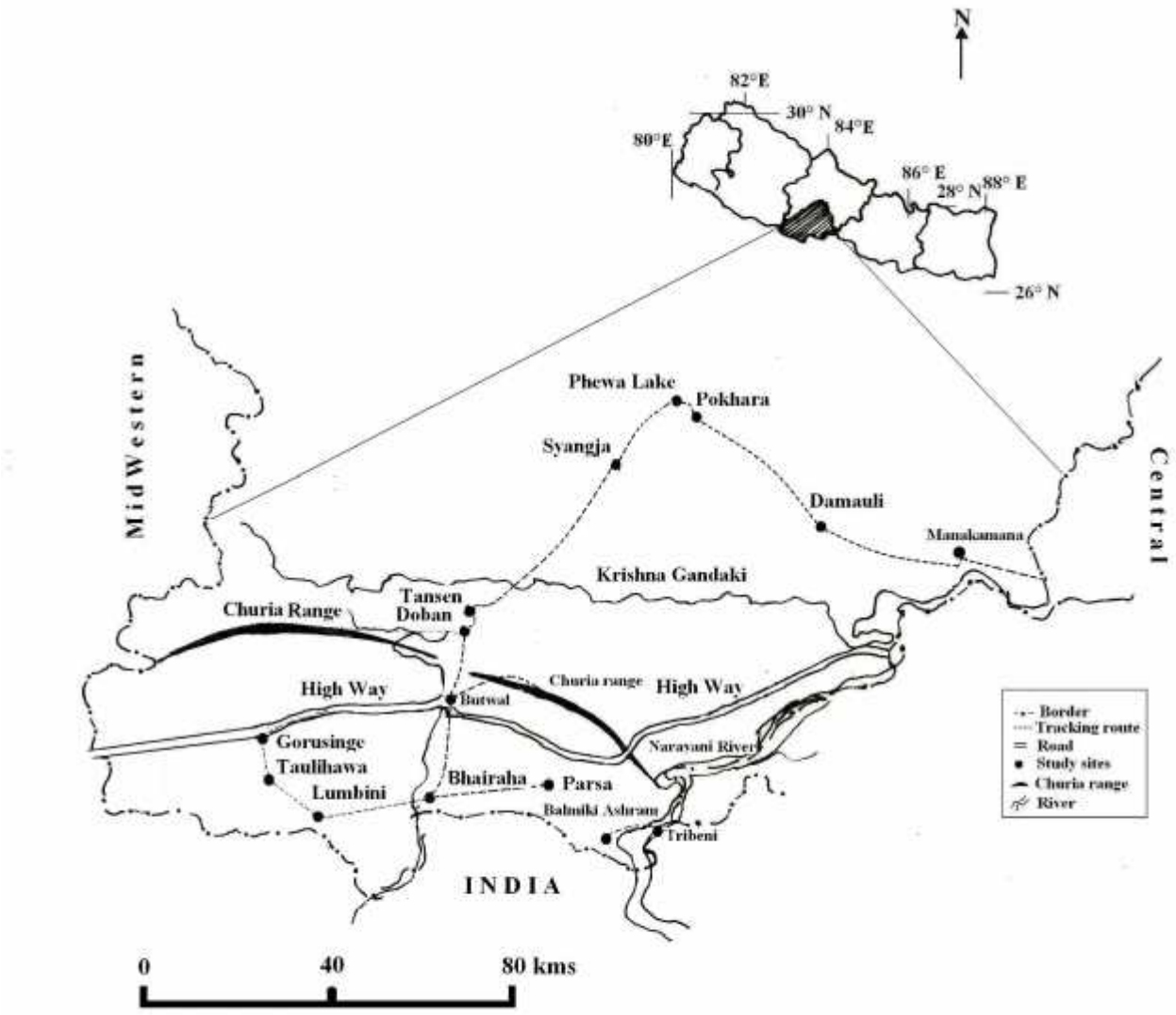


Fig. 73. Map showing collecting sites in Western Region of lowland Tarai

Fig. 74. Map showing collecting sites in Central Region of lowland Tarai

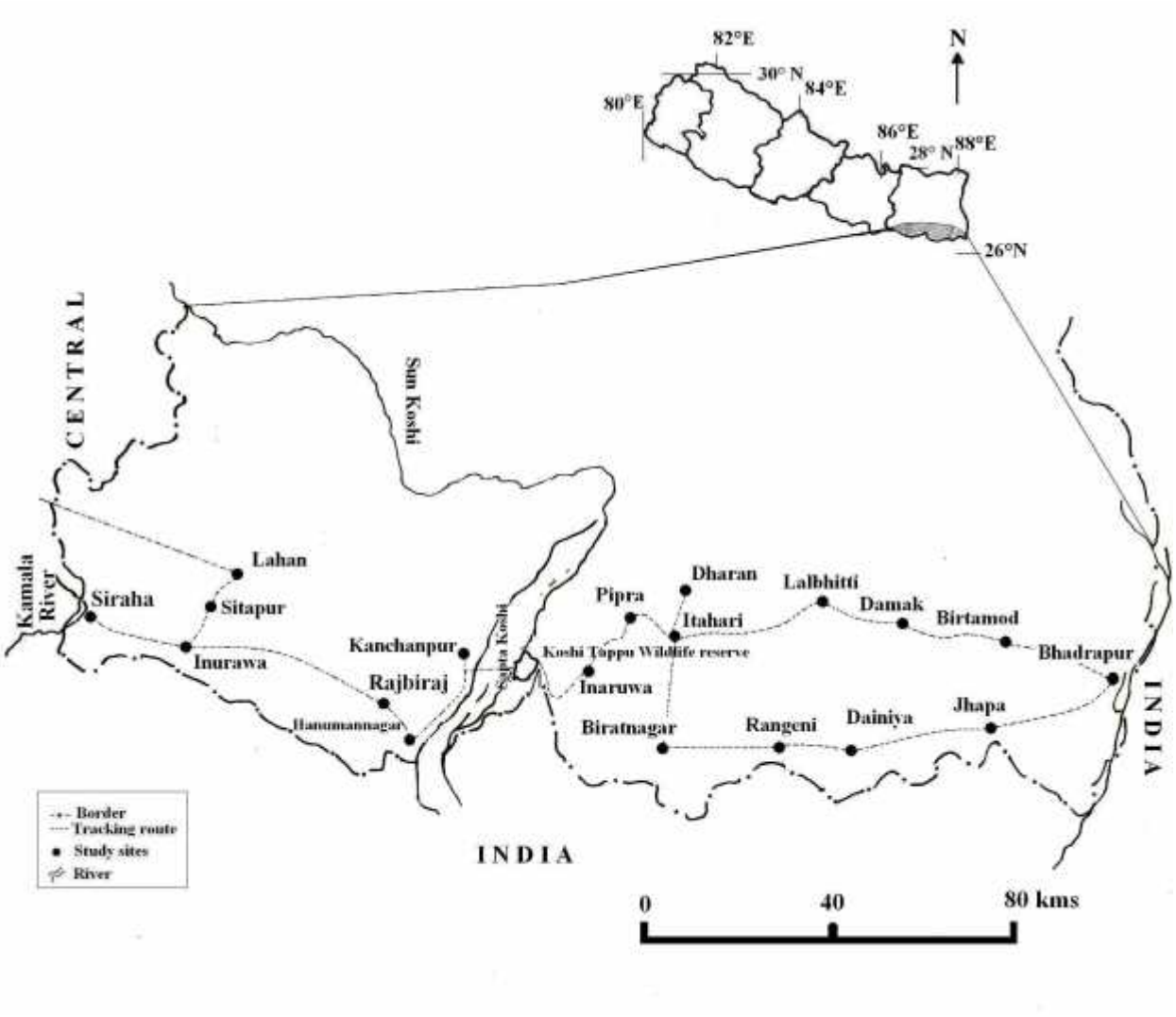


Fig.75. Map showing collecting sites in Eastern Region of lowland Tarai

A

B

C

D

.

E

F

Plate 1. A. *Anthoceros punctatus* L., B. *Anthoceros formosae* Steph., C. *Folioceros assamicus* D.C. Bhardwaj (Vegetative thallus), D. *Folioceros assamicus* with capsules, E. *Phaeoceros laevis* (L.) Prosk., F. *Notothylas levieri* Schffn.

C

D

E

F

Plate 2. A. *Jamesoniella autumnalis* (D.C.) Steph., B. *Jungermannia exertifolia* Steph., C
Jungermannia pumula With., D. *Jungermannia hyalina* Lyell, E. *Jungermannia tetragona* Lindenb., F. *Mylia taylorii* (Hook.) Gray

5

6

A

B

C

D

Plate 3. A. *Odontoschima denudatum* (G. Martens.) Dumort., B. *Chilocyphus polyanthus* (L.) Corda, C. *Acrolejeunea pusilla* (Steph.) Grolle & Gradst., D. *Calypogiea neesiana* (Mass. & Carest.) K. Muell., E. *Frullania dilatata* (L.) Dumort., F. *Frullania muscicola* Steph.

A

B

C

D

E

Plate 4. A. *Asterella multiflora* (Steph.) Pande *et al*., B. *Asterella wallichiana* (Lehm. & Lindenb.) Grolle, C. *Plagiochasma pterospermum* C. Massal., D. *Reboulia hemisphaerica* (L.) Raddi, E. *Dumortiera hirsuta* (Sw.) Nees, F. *Riccia glauca* L., G. *Riccia fluitans* L.

A

B

C

D

Plate 5. A. *Monosolenium tenerum* Griff., B. *Marchantia papillata* ssp. *grossibarba* (St.) Bischl., C. *Marchantia polymorpha* L. (Vegetative thalli), D. *Marchantia polymorpha* L. (Female thalli), E. *Marchantia emarginata* Reinw. *et al.* (Male thalli), F. *Marchantia emarginata* Reinw. *et al.* (Female thalli)

A

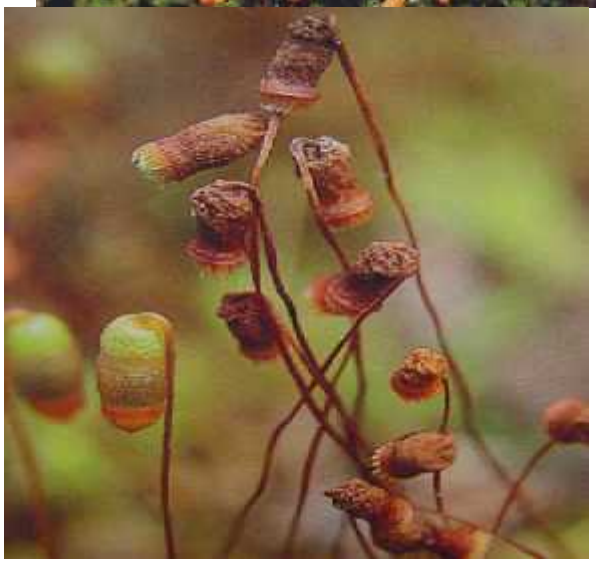
B

C

D

Plate 6. A. *Riccardia multifida* L.**,** B. *Pallavicinia lyellii* (Hook.) Carruth.**,** C. *Metzgeria conjugata* Lindb. (Vegetative thallus)**,** D. *Metzgeria conjugata* Lindb. (Thallus with sporophytes)

A



B

C

D

F.

F

Plate 7. A. *Bryum cellulare* Hook., B. *Bryum dichotomus* Hedw., C. *Bryum argenteum* Hedw., D. *Rhodobryum roseum* (Hedw.) Limpr., E. *Philonotis marchica* (Willd.) Brid.,
F. *Philonotis seriata* Mitt.

A

B

C

D

E

F

G

Plate 8. A. *Physcomitrium pyriforme* (Hedw.) Hampe, **B.** *Physcomitrium japonicum* (Hedw.) Mitt., C. *Funaria hygrometrica* Hedw., D. *Octoblrpharum albidum* Hedw., E. *Trematodon longicolle* Michx., F. *Hypnum pleumaformae* W. Wilson, G. *Fissidens nobilis* Griff.