

**MOSSES OF IDDUKI IN WESTERN GHATS,
INDIA**

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FOR THE AWARD OF DEGREE OF
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Dedicated to
Baba Ajit Singh Ji
My Beloved Family
Sanavar
and
Supervisor Dr. P.L. Uniyal

DECLARATION

(As required under clause 13 of ordinance IV, University of Delhi, Delhi)

It is certified that the work embodied in the thesis entitled, “**Mosses of Idduki in Western Ghats, India**”, is original and has not been submitted for any degree or diploma of this or any other University.

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Chapter 1
Introduction

INTRODUCTION

Bryophytes, the 'amphibians of the plant kingdom', occupy almost all kind of habitats in almost all parts of the globe. They are a group of plants that ventured first on the barren land during the origin and evolution of land plant. Even though neglected for the lack of direct economic importance or an unassuming nature; they play important role in ecosystem dynamics, nutrient cycling, soil binding, providing microhabitats for other plants and animals, fills gaps in the habitats and promote plant succession, etc. They also serve as ideal study material giving insight into the plant evolution, monitoring the ecosystem health and pollution levels. However, the studies on this group are completely lesser in India and most of them are confined to the Himalayas. Even though the Southern India despite with its blessed climatic and geographical features of Western Ghats is equally rich as Himalayas, still remains bryologically under explored.

Bryophytes are a diverse and distinct group of primitive plants with about 23,000 species (grouped under nearly 960 genera) (Shaw and Goffinet, 2008) making it the second largest phylum of land plants after angiosperms. They are small, herbaceous plants; their individuals grow closely packed together in the form of mats or cushions on rocks, soils, or as epiphytes on the trunks and leaves of trees. They constitute a distinctive component of the forest ecosystem particularly in cooler northern and southern latitudes and extremely humid climates of both temperate and tropical regions.

Bryophytes are smaller than the most other plants with average height of the plant being 6-7cm. However, *Dawsonia superba* which is endemic to New Zealand is the tallest known moss, may reach a height of about 70 cm (Sainsbury, 1955), and *Polytrichum commune*, when grows in a wet conditions, can be nearly as tall as 50 cm. The length of hanging axis of *Meteorium* can reach up to 80cm and reclining axis of aquatic moss *Fontinalis* may be up to 1m. On the other hand some of the taxa are quite small ranging down to such tiny plants as species of *Cephaloziella* and some mosses are barely visible to the naked eyes such as species of *Ephemerum* and *Micromitrium*.

The life cycle of bryophytes remain unique as it displays two alternating generations. They possess short lived, dependent sporophytic phase and the dominant gametophytic phase. The life cycle is far removed from the dominance of the haploid generation found in most green algae and from the over-whelming dominance of the sporophyte generation that occurs throughout the pteridophytes. A haploid spore germinates to produce filamentous, ovoid, spherical or plate like stage which precedes the formation of the leafy shoots or thalloid gametophores. The green gametophores live for few months to several years, and bear antheridia and archegonia. Fusion of motile male gametes from an antheridium and egg in archegonia gives rise to sporophyte generation. The diploid phase develops polarity and differentiates into a basal foot, a stalk-like seta, and a distal spore-producing organ, the capsule. The sporogenous tissue after meiotic divisions leads to the formation of spores. The dehiscence and spore dispersal, entailing the formation and functioning of structures such as elaters of liverworts and the peristome of mosses are some unique features. In bryophytes the food reserves consist of mainly starch (built of amylose and amylopectin units, an important feature of their metabolism,) also resemble land plants and green algae. The cell walls comprise of cellulose microfibrils embedded in a matrix of polygalacturonic acid residues and hemicelluloses but unlike some of the cell wall of vascular plants, lack true lignins (Hebant 1977). The presence of sporopollenin or sporopollenin like compounds in spores may also be seen as evidence for the presence of land plants or their immediate ancestors (Rick & Crane 1978).

Bryophytes are poikilohydrous plants; their growth and sexual reproduction depends on external water and is therefore favored by a humid microclimate. They show a wide range of physiological and dispersal adaptations (Smith 1982; Proctor 1981; Bates and Farmer 1992). Various modes of reproduction play an important role in the life cycle of bryophytes especially in stands within high disturbance (Bisang 1996). Bryophytes are able to absorb water over their entire surface (ectohydric) and easily lose it to the atmosphere in dry weather. Some forms such as *Tortula ruralis* may survive long periods of desiccation without being damaged while others are ephemerals and remain as spores during severe water deficit. The dried plants can resume photosynthesis and respiration within a short period of time after rehydration.

Poikylhydric mosses are able to survive complete desiccation for months and even for years without irreversible damage and recover their full activity as soon the water supply is sufficient. The importance of bryophytes in modifying their environment and affecting the life of other organisms is quite pronounced, even if it is usually inconspicuous and difficult to access quantitatively.

SPECIES RICHNESS AND DISTRIBUTION

Bryophytes are a heterogeneous division of the plants kingdom, which includes the three classes: the liverworts (Hepaticopsida), hornworts (Anthocerotopsida) and the mosses (Bryopsida) (Schuster, 1984). Hepaticopsida (Liverworts) are a group of thalloid and distichous leafy forms of about 14 orders, 74 families, 330 genera and 8,000 species (Stotler, 2000). Anthocerotopsida (Hornworts) are a small group of thalloids having a single order Anthocerotales, 2 families, and 11 genera with nearly 150 species (Renzaglia and Vaughn, 2005). Bryopsida (Mosses) are the largest group of leafy forms, with over 21 orders (with Hypnales being the largest order with 44 families), 117 families, 650 genera and 14,000 species (Buck and Goffinet, 2000). Mosses, a species rich group, has achieved remarkable success in colonizing diverse habitats i.e. soil (terrestrial), rocks (lithophytes), trunks and twigs (epiphytic), leaves (epiphylls), bushes, stream banks, muddy edges of rivers and lakes, under water falls (aquatic) and dark caves (e.g. *Schistostega pennata*). The efficient dispersal methods and short life cycle of ephemeral species (e.g. *Physcomitrella*, *Phascum*) enable them to colonise even the habitats available for short durations. Bryophytes are absent in the marine environment. Only a few highly specialized species such as *Schistidium maritimum* grow in other salt-rich habitats. Although a great number of bryophyte genera and species are cosmopolitan and distributed throughout the climatic regions, many do exhibit a disrupted or narrow range. The latter represent the uncommon, rare and endemic bryophytes. Their conservation is critically dependent on the protection of their natural habitats.

India one of the 12-megabiodiversity countries of the world, possesses a large area and a variety of phytoclimatic conditions which contribute to great

diversity of the plant species. Pande (1958) divided these zones into 6 bryogeographical regions namely – 1. The Himalayan Region including (i) The West Himalayan Territory, (ii) The East Himalayan Territory, 2. The Punjab and the West Rajasthan Plains, 3. Central India and the Gangetic Plains, 4. Southern zone including (i) the West Coast Region, (ii) the East Coast Region. Majority of moss flora lies in four major zones viz. Western Himalaya has 722 species, Eastern Himalaya has 788 species, South India has 592 reported species, while central India has 59 species. Of these 194 species of mosses are reported to be endemic to India (Pande, 1958; Chopra, 1998). Bryophytes are cosmopolitan in distribution and occupy every habitat in mesic forests, bank of streams, tropical rain forests, tundra vegetation, desert boulders and form dominant vegetation in arctic system. They are popularly known as “pioneers” of succession on substrate that occupy barren land and make it habitable by attracting a variety of organisms. A vast survey on bryophytes distribution was performed by Reid 1998; Reyers *et al.* 1999 in Austrian landscapes to highlight the most important habitat types for bryophyte species richness.

GROWTH FORMS

Plants have evolved various adaptive strategies for balancing the benefits and costs of having a high affinity for resources, plasticity of growth allocation and mycorrhizal symbiosis. The adaptation by bryophytes according to habitat and their environment is a significant character and it is determined and classified by their shoot morphology. The growth in particular is a relatively constant characteristic of some plant species. The general appearance of colonies of mosses is largely governed by the growth forms of their shoots and some species always present a characteristic appearance but others are much more variable in this respect. Using a system of classifying growth forms into types it is possible to demonstrate correlations of certain types and variation in habitat conditions. The general form adopted by colonies of mature plants is of chief importance and since this is determined by shoot morphology, it is referred to as “growth-forms” (Du Rietz 1940). Gimingham and Robertson (1950) described the classification of growth forms based on morphology only.

Classification of Growth Forms

The life forms of bryophytes are closely connected with light and water. Under different environmental conditions one species may exhibit different types of growth forms:

Cushions: Systems with erect shoots radiating in more or less compact dome-shaped groups. The shoot radiate from a central point of origin, branches similar adopting same direction of growth as main shoot. Branching appears from near apex of shoot and adding to the size of the cushion. Large Cushions normally attain a diameter of over 5 cm as found in *Leucobryum glaucum*, *Schistochila*, *Andreaea*, *Amphidium*, *Orthotrichum* sp. Small Cushions normally attain less than 5 cm diameter such as *Grimmia*, *Ulota*, *Plagiopus*, *Octoblepharum*, *Calymperes* and *Syrrhodon* sp.

Turfs: System with the parallel upright shoot and branches forms the pile of shoots. The main shoot is erect and the direction of growth is vertical. *Sphagnum* sp are example of this class. In tall Turfs, the upright shoots are generally unbranched and form turfs of considerable height (>5cm). Tall Turfs especially grow on temperate forest floors. *Sphagnum* sp is an example of this class. The short shoots are up to 1 cm tall, stand close together and grow on after ripening of the sporogonia by means of regenerative shoots. E.g. *Bryum argentium*, *Ceratodon purpureus* forms shorts turfs. In Open turf mosses, the shoot is short, distinctly separate from one another, often produced by persistent protonema or rhizoid strand. *Polytrichum aloides*, and *Trematodon* sp. are examples of this class.

Canopy Form: Dendroid systems producing a raised leafy canopy: The erect portion of the shoot is unbranched below with scale leaves and normal leaves usually abundant on branch at the tip forming canopy. Unbranched dendroids are terrestrial forms in which the leafy branches are present only at the tips of main shoot such as *Dawsonia*, *Pogonatum*, and *Climacium*. Branched dendroid may be epiphytic or terrestrial, have frequently branched, erect, leafy shoot e.g. *Hypnodendron*, *Rhodobryum dendroids*, *Plagiomnium undulatum*.

Mats: The shoot system forms a dense and interwoven mat, extending horizontally over the substratum. The main shoots creeping over substratum often with rhizoids.

There is abundance of lateral branches with limited growth. They grow on rocks and bark of trees and also on leaves (epiphyllous) in tropics. The mat forms exist in *Brachythecium*, *Plagiothecium*, *Homalothecium*, *Taxithelium*. In Rough Mats, the main shoots adhere to substratum with abundant short erect laterals and the branches are in various directions. The mat can be readily stripped from substratum e.g. *Brachythecium rivulare*, *B. albicans*. The branches are closely interwoven, lying chiefly in same plane as main shoot in smooth Mats. The smooth mat taxa are *Frullania tamarisci*, *Hypnum cupressiforme*. In thread forms the delicate, creeping irregularly and sparingly branched shoots sometimes form open mats. This form is adopted by many species when occurs sparingly among other vegetation. E.g. *Eurhynchium praelongum*.

Thalloid Mats: The thalloid taxa form the overlapping dorsiventral thalli as found in *Conocephalum conicum*, *Pellia epiphylla*, *Symphogyna*, *Dumortiera*, Marchantiaceae and Metzgeriaceae.

Wefts Forms: Systems developed as a result of the loose inter-twining of straggling shoots and branches often arching, ascending and luxuriant. The shoots are long straggling and generally robust and the rhizoids are usually sparse. The laterals branches are often arching or ascending. They occur on forest floor, rotten trunks or trees. A new layer is formed growing every year over previous year shoots. Weft forming bryophytes are many such as Entodontaceae, Hylocomiaceae, *Thuidium*, *Rhacopilum*, *Bazzania*, *Ptilidium*, *Trichocolea*, *Lepidozia*.

Pendants: The main shoots hang down from the branches and twigs of trees like a beard and laterals shoots remain short and stand out horizontally. Some taxa of pendant forms are Phyllogoniaceae, *Meteiorium*, *Meteioriopsis*, *Cryptolepton*, *Pilotrichopsis*, *Calyptothecium*, *Bryopteris flaccida*.

Tails: These bryophytes are mostly shade loving and of creeping habit and generally grow on the vertical substratum like trunk and rocks. The shoots stands out, slightly branched and usually radially leafed. Tail forms are founds in *Leucodon*, *Cyathophorum*, *Endotrichella*, *Schistochila*, *Plagiochila*.

Fans Forms: Some creeping mosses growing on a vertical base (trees trunks, rocks) throw branches towards one side in the same plane, project horizontally to obliquely downwards and usually have flattened leaves. Fan forms are displayed by *Thamnobryum*, *Echinodontium*, *Bryopteris*, *Archilejeunea thysananthus*, *Plagiochila* and Neckereceae.

Feather Forms: The secondary stems are more or less pinnately branched and are placed dorsiventrally. They are epiphytic or saxicolous e.g. *Hypopterygium*, *Neckeropsis*, *Callicosta bipinnata*, *Bryopteris*.

Annuals Forms: The gametophytes stops growing once it has produced gametangia and dies after the production of sporogonium without any production of regenerative shoots. They are the pioneer bryophytes occur on open mineral soils. The taxa of this category are *Buxbaumia*, *Phascum*, *Sphaerocarpus*, *Calobryum*, *Riccia* and *Physcomitrium*.

Protonemal Bryophytes: These taxa have the persistent protonema and leafy shoots are minute and scattered found in *Ephemeropsis*, *Micromitrium*, *Protocephalozia*, *Schistostegea*.

Bracket Mosses: These mosses display horizontal shoots and grow mainly as epiphytes e.g. *Leiomela*, *Spiridens*.

Moss Balls (kugel-mosses): These are a special form of cushion in Iceland are called joklamys (glacier mice) in the tundra region. The stone contains mosses rolled by winds and the shoots keep on growing from all sides giving appearance of a ball.

Mostly it is very uncertain to place a moss or a moss assemblage under one or other life forms. It is observed that one and same type moss can show two different life forms, e.g. In *Plagiomnium undulatum* the sterile shoots are fan like while the fertile shoots looks like a dendroids. *Bazzania trilobata* forms tall turfs according to environmental conditions.

HABITAT

Generally evergreen forests have a great variety of habitats in reference to bryophytes. These forests provide hyperhumid conditions, humus and variety of substrata to flourish the diversity of microhabitat. Bryophytes are ecologically significant components of these forests. They occupy the humid soil, living or dead logs, branches, leaves and sometimes on lava rocks also. Several techniques of numerical classification have been used for the complete vegetational classification for vascular plants (Oliveira 1995; Dias 1996) and non vascular plants viz. bryophytes (Gonzalez- Mancebo 1991). The distribution of bryophytes are effected first by microclimatic factors i.e. Rain fall and temperature, latitude and altitude (Pitkin 1975; Sveinbjörnsson and Oechel 1992) and then by micro environmental conditions like shade, humidity, humus and temperature (Yarranton and Beasleigh 1969). The bryophyte vegetation may be effected by side factors e.g. age of the soil, rocks, composition of forest soil, moisture content (McCune 1994; Sillett and Neitlich 1996) and by substratum like its pH and its humus status (Wolsely and Aguirre-Hudson 1997; Batty *et. al.* 2003). The studies reported in this connection shows that they can survive even considerable internal variations in climatic factors and vegetation types (Dias 1996; Dias *et. al.* 2004)

A number of bryophytes differ approximately from most seed plants in their ecological tolerance as they grow even on hard surface e.g. on bark, rock, bare soil while the seed plants may not. This tolerance is the significant character of bryophytes by which they survive successfully. Bryophytes have an ability to change the rough surfaces by their growth, to a substratum adding humidity and humus that becomes suitable for colonization to seed plants. Later on these initial bryophytic colonies are eliminated due to the growth of higher plants but other bryophytes grow under these flowering plants. Bryophytes are very useful, for the growth of seed plants, as they are able to change the substratum suitable for the growth of seed plants. Mostly they are of terrestrial habit but a few aquatic forms are also found such as *Ricciocarpus natans* and *Riella* species. Species of *Sphagnum*, *Riella* and *Riccia fluitans* form floating mats. Some bryophytes are saprophytic in nature as *Cryptothallus* and *Buxbaumia*. Bryophytes are abundantly found in humid areas and in rainy seasons but in draught

or unfavorable climatic conditions they prefer niches such as crevices of rocks, grooves of tree bark and some times near the shady streams also for their survival. Because of their ability to absorb water within no time when wet and revive they are known as “Resurrection plants”. Epiphytic bryophytes play an important role in the ecology of forest communities and they are more abundant in tropical angiosperm forest. These epiphytic bryophytes are found in such forests, where availability of water and nutrients are rich. Thus these broad leaves forest create a good environment for these lower plants. The adaptation of these epiphytic bryophytes is suitable for such habitat because they need irregular surface of bark and twigs and depression on branches as well as they require fissures for their establishment, which provide a place for them as well as humus and moisture. In alpine regions, bryophyte species diversity is very high within a limited space. It is also observed that where organic material rich soil is present there is the richer bryoflora, along with the vascular plants. In arid and semi arid zones, the bryoflora vegetation is limited. Mostly they occur in the shelter of rocks. In arid zones bryophytes survive in unfavorable conditions in the form of protonema, or the apical part of the gametophore as latent structure (this apical part survives with the help of scales, which provide mineral nutrition and moisture). Generally, bryophytes play important role in modifying their environment and thus affecting the life of other organisms.

Site Indicator

Bryophytes are good site indicators, because a specific seed plant community provides a favorable microenvironment to specific bryophytic vegetation. Thus, it can be useful in characterizing a site in some areas as the particular bryophyte vegetation can inform us about the specific tree vegetation even after the vascular plant vegetation has been destroyed by any means. They can also indicate the past existence of a forest or non-forest vegetation and can be used to improvise plantation programme of a particular vascular plants in that area. They are also useful for biogeochemical panorama, as the mosses such as *Mielichhoferia*, *Merceya*, *Barbula* and *Scopelophila* represent to be related with Copper rich substrata. The patches of *Hyophila* , *Oxystegus* and *Zygodon* indicates iron hematite bearing substrates at the particular site. Bryophytes are suitable pollution indicator because of their habitat

diversity, structural simplicity, totipotency and rapid rate of multiplication which show the type and quality of environment. Thus they appear to be ideal organism for pollution study. As some bryophytes are very sensitive to pollution there is an absence of mosses mostly epiphytic ones due to the air pollution caused by different gases coming out from the industries. Some bryophytes have capability to absorb the pollutants in large quantity than absorbed by other higher plants of the same site. This absorbing capacity is due to the lack of cuticle, presence of single cell thick lamina and large surface area by volume ratio.

Bryophytes of Special Habitat

Epilithic (Saxicolous) Bryophytes: These bryophytes grow only on rocks and have some special adaptation requirements, perhaps for a more permanent habitat, need of less water and their competitive capability to grow on such substrata. Some of these epilithic bryophytes are e.g. *Tortella*, *Gymnostomum*, *Grimmia*, *Seligeria*, *Porella platyphalla*, etc.

Desert Bryophytes: Some bryophytic communities may grow on mobile sand; they can disappear over night and may reappear shortly after a shower of rain or humidity. E.g. *Ceratodon*.

Disturbed Soil and Road Cut Surfaces: Some species of bryophytes grows on freshly disturbed soil and on road cutting etc. e.g. *Funaria*, *Bryum*, *Barbula*, *Tortula*, *Polytrichum*.

Calcicoles and Calcifuges: Calcicole (calcium loving) bryophytes are found on rocks which bear calcium carbonate and where waters flow over or percolates through these rocks. They have 3-4 times greater calcium exchange capacity (Bates, 1978). Some calcicoles occur on the least acid types of tree bark. Those bryophytes which grow on potassium containing substrata are known as calcifuge (calcium hating) species. Calcifuges live on substrata with an acid reaction or in soft waters. Calcicoles taxa- *Grimmia anodon*, *Philonotis*, *Fissidens*, *Hydrogonium*, *Gymnostomum* etc. Calcifuges taxa- *Andreaea rothii*, *Marsupella emarginata*, *Scapania undulata* etc.

Fire Mosses: Generally, grasslands and temperate and tropical forest catch fire through many natural and manmade means. The fires deposit a large amount of ashes on these places, which greatly change the soil texture. The pH rises from 5-6 to 8-10, which accumulates a high percentage of potassium, phosphates and magnesium along with nitrogen and other organic matter. After an interval of time, some species of bryophytes grow there on the burn sites. The pioneer moss communities found there are of *Funaria hygrometrica* which is rapidly dominant along with *Ceratodon purpureus*, *Bryum argenteum*, etc.

Coprophilous Bryophytes: The coprophilous taxa are most frequent in nutrient poor substrata. e.g., many members of family Splachnaceae are adapted to live on such substrata. *Splachnum* sps are exclusively coprophilous.

Epixylic Bryophytes: These are pleurocarpous mosses seen in humid montane forest on dead logs or wood, forming a carpet. Thallose and foliose hepatics such as *Cephalozia*, *Lophocolea*, *Symphyogyna*, *Reboulia*, *Aneura* and *Reccardia* also appear on the dead wood.

Epizoic Bryophytes: Some bryophytes grow on living insect's body in the tropical forest. In very humid mossy montane forest at an altitude of 2000-3000 feet, a community of *Clolejeunea*, *Metzgeria*, *Microlegeneea*, *Odontolejeunea* and *Daltonia angustifolia* found living on the backs of certain weevils (*Gymnopholus* and other genera) (Gressitt *et al.*, 1968)

Animal Association

The degree to which different taxonomic groups show resemblance in diversity patterns has attracted increased attention, yet such studies on stream biota are lacking. Environmentalists correlate the species richness patterns of bryophytes, micro invertebrates and fishes in streams. Bryophytes and micro invertebrates display the strongest degree of resemblance, but even this relationship has a relatively weak predictive power. The chemical constituents of bryophytes play an important role to form such association. Bryophytes form an attractive habitat for many invertebrates, which get shelter and many invertebrates regularly spend a part of their life cycle in

association with bryophytes specially in adverse conditions e.g. *Frullania* and *Herbertus* give shelter to a number of rotifers, nematodes, invertebrates and algae in their lobules (leaf). Aquatic mosses are the best habitat for the deposition of eggs of snails. Insects suck juice from the cells of gametophores and sporangia. Spider, mites, millipedes, centipedes and ants make their shelter within these mosses. This activity of invertebrates within bryophytes helps in the mineral cycling which promote the growth of this vegetation. These invertebrates also help in the transfer of antherozoids from antheridia to archegonia and help in spore dispersal e.g. in coprophilous taxa Splachnobryaceae. Many birds use mosses for the construction of their nests. The shoots of pleurocarpous mosses are collected by birds for nest construction. Mosses are lighter in weight in comparison to other vegetation and can be easily woven into desire pattern.

BRYOPHYTES AND ECOSYSTEM

Mosses form one of the dominant plant communities in temperate and tropical system, which give more than 50% of active biomass (Groombridge 1992). These are most important bioindicators (Bargagli *et al.* 1995; Hedenas 1991; Steinnes 1995). Besides these play complex ecological role in terrestrial as well as in aquatic ecosystems (Brown and Bates 1990; During and Van 1990).

Bryophytes are more frequent in the gymnosperm forest floor in comparison to angiosperm forest. It has been observed that epiphytic bryophytes have a tendency to grow abundantly in angiosperm forest in comparison to gymnosperm forest. The angiospermic flora of the temperate climate displays the prosperous bryophytic vegetation. The lack of epiphytic bryophytes on the bark of conifers is because of low nutrient conditions, specially acid reactions and accumulation of resin. On the other hand rich vegetation of bryophytes is found in the mixed oak-conifer forest. Epiphytic bryophytes play a very important role in the water balance and humus formation in gymnospermous forest floor. The litter of the forest when decomposes helps to grow some mosses which later on helps in the germination of seeds of higher plants. In tropical rain forest the bryophytes grow in small patches or somewhere separate and are closely attached like a mat on roadside banks e.g., *Bryum*, *Cythodium*,

Marchantia, *Philonotis*, *Plagiochasma*, and *Targionia* are common to be cited. These bryophytes form a shield over the bare soil and help to stabilize the habitat.

Threatening of Bryophytes

Threatening process creates loss of habitat at macro as well as micro level. The main cause of threatening to these lower plants is conversion of forested land into agricultural land and anthropogenic developmental activities like rehabilitation, construction of roads and dams, pollution, etc. All these activities are fully responsible for the loss of bryophytic habitat. The change in climate creates unfavourable conditions such as dried soil, loss of humidity and drier microclimate are responsible for the loss of bryophytes. The unplanned forest management further enhances the loss of these valuable lower plants, viz., the forest fire either natural or by man, causes a subsequent drought which effects the growth of bryophytes and other plants.

IMPORTANCE OF BRYOPHYTES

Bryophytes have proved to be of some economic values as well (Flowers 1957; Pant and Tewari 1989; 1990). Bryophytes with a wide ranging scientific interest are excellent experimental material for studying many fundamental biological problems. The bryophytes are good indicators of the state of soil, water and air and the potential use of their chemical components as biologically active agents are remarkable. There has been an outburst of research in cell biology, genetics, experimental biology, physiology, palaeoecology, plant geography and ecology using bryophytes because of the manageable size, readily available in most seasons and lending themselves well to culture under axenic conditions, growing fairly fast and completing their life cycles in a short period of time. Mosses are used as moisture retainer for green house crops, seedlings and garden soil. They are also used in horticulture as they increase the water storage and moist the soil. Fresh *Sphagnum* is mixed with soil and spread over the ground by which moisture is formed and it helps to grow the crops. *Hypnum*, *Leucobryum*, *Octoblepharum*, *Sphagnum* and *Thuidium* are widely used in propagation of plants viz., orchids, mushrooms and ferns. *Sphagnum* and other pleurocarpous mosses are also used as packing material for

transportation of seedlings. Mosses have a specific character to restore minerals from percolating through rainwater thus maintaining soil fertility.

Bryophytes contain terpenoids and flavonoids which deter many insects and pests and also prevent growth of microorganisms. They can be used as effective pesticide. Thirty to forty species of bryophytes have been recognized as of medicinal value, viz., *Asterella*, *Bryum*, *Mnium* and *Philonotis* are used to cure cuts, burns and wounds. Paste of *Rhodobryum* is used to cure cardiovascular diseases, *Polytrichum* is used to cure fever and as a laxative agent, *Haplocladium* is used to cure tonsillitis, bronchitis and other diseases. *Fissidens* is an antibacterial agent, it is used to cure swollen throat (Glime, 2007).

Most of the bryophytes contain volatile oils, lactones, terpenoids and amino acids. Many bryophytes have such compounds to cure the wounds, fever, tonsillitis, bronchitis, etc. Many polyphenolic compounds and non-ionized organic acids are present in bryophytes which have antibiotic properties against gram-positive and gram-negative bacteria (Saxena 2004). Many of the compounds such as diplophyllin, kaurens, tulipinoide and zaluzanin isolated from bryophytes are found to be very effective in cytotoxic and antitumor activities (Belkin *et al.*, 1953).

Mosses are used to decorate the shop window displays, *Hylocomium* is used as green carpet for floral exhibitions and making moss roses, *Climacium* is used to make a lady's hat and also used to make albums out of pressed mosses and framed art work also used in small aquaria. Some large dendroid mosses like *Bartramia*, *Climacium*, *Hypnum*, *Polytrichum*, *Racomitrium*, *Rhizogonium* and *Rhodobryum* are used in drawing room for decoration as they give lush green colour. Many mosses are widely used in landscaping and to beautify the gardens, avenues, road side and tracks etc. (Glime *et al.*, 2001).

Despite of so much of importance of mosses, the study on bryophytes are meager in India. This is mainly because of a feeling that it is a difficult group for identification, small size of whole plant, special terminologies used in description, microscopic structure of plant organs. Till date considerable studies made on the systematic position of mosses are still insufficient. In India, the limited systematic

studies have discovered more than 2000 species of rich moss flora, which is about 10% of the global moss species diversity (Groombridge 1992). “Mosses of Eastern India and Adjacent Regions” by H.C. Gangulee and “Taxonomy of Indian Mosses” by R.S. Chopra are the main standard reference work on Indian mosses. Studies on mosses of Western Ghat especially Idukki district have become important in view of large scale developmental activities in a rich biodiversity area. The mosses have good potential in sustainable development of the country as well as conservation of both plant and animal diversity. Interest in biodiversity and conservation biology is rapidly increasing with respect to lower plants (Hedenäs and Söderström 1992; Hallingback and Hodgetts 1995; Tan *et al.* 1999; Kautz and Grradstein 2001; Sabovljevic *et al.* 2001). More analysis is required to identify the ecological conditions that control diversity and rarity patterns of Bryophytes. The investigation on soil condition and landscape features that control bryophytic diversity and rarity at a regional scale is urgently needed. There is a need for detailed studies on mosses of different phytogeographical regions of the country for their utilization for human welfare. It was in this view to fill this gap in our knowledge; the present work has been undertaken. Visiting the area in different months of the year has provided the opportunity to investigate these plants in different habitats, microhabitats and niches. The aim of this study is to record the species richness and to find out the habitat preference of different species so that their substrate relationships and indicator value (if any) could be ascertained.

About one-third of world’s bryophyte flora is present in Tropical biome with high levels of endemism. Bryophytes appear to be an “Ecological Keystone” group in the temperate rain forests, where the forest-patches and corridors is almost conferred by variety of Bryophytes. Present study gives an insight into the peculiarities of distribution of bryophytic elements in the southern part of Western Ghats. Keeping in tune with Prof. Gangulee’s suggestion (1980) that the moss flora must be studied intensively district by district, the Idukki district was selected for an assessment of bryophytic vegetation in Idukki district of Kerala which lies at an altitude of 300 to 1600m in the Western Ghats which is one of the megadiversity hot spots. The district Idukki abounds river banks, cut gorges, perennial streams, springs, brooks, marshes,

stretches of limestone terrain, forest glades and submontane tracts. It offers an exquisite variety of habitats for the preponderance of a luxuriant expansion of bryoflora.

The present work aims at following objectives:

- Survey of mosses of Idukki district through field studies and available literature.
- Documentation and enriching herbarium of mosses of Idukki district.
- To provide illustrations of preferably all the mosses of Idukki district for easy identification.
- Preliminary evaluation of mosses for their habitat preference.
- To bring out illustrated moss flora of Idukki district.

Chapter 2
Review of Literature

REVIEW OF LITERATURE

Dillenius's *Historia Muscorum* (1741), was the first ever work dealing with taxonomy of bryophytes, which also included algae, lichen, lycopods, etc. Linnaeus (1753) in his *Species Plantarum*, which is considered as the beginning for the principle of priority for *Sphagnum* included some Indian mosses also. Hedwig's (1801) *Species Muscorum* is considered for applying the priority in case of other mosses. Mitten's (1869) *Musci Austro-Amaricani* and Spreuce's (1884-1886) *Hepaticae Amazonicae et Andinae*, formed the foundation for American Bryology. During early part of the present century, bryophytes collected mainly by missionaries, from different parts of the world including the tropics. Mitten (1869), Mueller (1905-1916) and others worked them out in Europe but who had never seen these plants in living condition.

The term 'mosses' was used by Jussieu (1836) to include true mosses. However, the remaining groups were not known at that time. It was Brown (1866) who introduced the term "Bryophyta" a Greek word derived by combining 'Bryon' = moss, 'phyton' = plant and treated under 'Acotyledonae' which included algae, fungi, lichen and mosses, but not the liverworts. Eichler (1883) divided Bryophytes into two classes, the Hepaticae to include all liverworts and Musci to include all mosses. Engler (1892) subdivided each of the two classes into three orders. Hepaticae was divided into Marchantiales, Jungermanniales and Anthocerotales and Musci into Sphagnales, Andreaeales and Bryales. The anomalous position of Anthocerotales as an order of the class Hepaticae was pointed out by many investigators very early. However, it was Howe (1899) who gave the class status to the order Anthocerotales. He named it Anthocerotes and divided the bryophytes into three classes viz., Hepaticae, Anthocerotes and Musci. Many eminent Hepaticologists such as Smith (1955) and Schuster (1958, 1966) have accepted the system of Howe (1899) with a modification of the term Anthocerotes as Anthocerotae. The studies on the mosses of India is said to have commenced when the road to Nepal was opened. Buchanan Hamilton a Medical Officer in British Embassy in 1802, first collected mosses from Nepal the first step towards our knowledge of the moss flora of this region. The first

paper on the mosses of this region *Musci Nepalensis* was published in 1808 by Hooker, who later (1818-1820) described several species for the first time. Two papers followed this on Indian muscology jointly published by Hooker and Greville (1825). Schwaegrichen (1811- 1842) included some Indian mosses in his supplement to Hedwig's *Species Muscorum*. Royle (1839) reproduced the catalogue of Wallich, which contains a list of 113 species of mosses mainly from Nepal, of which 55 species listed by Royle himself from Mussoorie (Western Himalayas). This also includes a brief note on hepatics and liverworts. Wallich (1841) enumerated 148 mosses collected in East Indies, with reference to the figures of new species published in Hooker's *Icones Plantarum*. Montagne (1842a & b) published an account of the mosses from the Nilgiris. Subsequently Griffith (1842, 1843) published an account of a number of mosses and liverworts from Khasia hills in Meghalaya. Collections of liverworts from the Himalayas by Wallich and Wight were also included in the *Synopsis Hepaticarum* of Gottsche *et al.* (1844, 1847).

The first noteworthy contribution to Indian bryology in its early days can be found in Griffith's (1849a & b) *Notulae* and *Plantae Asiaticae*. The *Icones Plantarum Asiaticarum*, which was based on his collections during 1835-1838, was published posthumously. His discovery of the remarkable monotypic liverwort *Monoselenium tenerum* Griff. attracted attention all over the world. Mitten and Wilson (1857) enumerated the mosses collected by J.D. Hooker and Thomson from India. Mitten's (1859) *Musci Indiae Orientalis* was the most important comprehensive work embodying all the Indian species known at that time. He recorded nearly 800 species belonging to 85 genera and 19 families including a large number of novelties. Later Mitten (1860, 1861) published *Hepaticae Indiae Orientalis* a comprehensive treatment of Indian Liverworts, which included the diagnoses of several new plants, and a detailed list of all Indian liverworts known till date. This work was mainly based on collections by Hooker from the Himalayas, the Khasia Hills, by Hooker and Thomson and from Sri Lanka by Gardner and Thwaites respectively.

Mueller (1853, 1854a & b, 1869-1870, 1871, 1878) brought out several articles on the Indian mosses. Hampe (1872-1873) described some Sri Lankan mosses based on Beccari's collection. Mitten (1873) published an account of the mosses of

this Island collected by Thwaites describing a number of new species under the joint authorship of Thwaites and Mitten. Reference to mosses from India can also be seen in the publications of Jaeger (1870-1879).

In the post-Mitten period, much progress has been made through direct and indirect contributions. Brotherus (1898) described a few mosses from North Western Himalayas. Subsequently in 1899, he published an account of 96 species of mosses from Coorg in the Western Ghats including 20 novelties. Schiffner in 1898 brought out an exhaustive list of species recorded until then from East India.

Stephani's *Species Hepaticarum* (1906-1924) in six volumes, a world monograph on liverworts, included description of a large number of taxa from India, Myanmar, Sri Lanka and adjoining Indian territories such as Nepal, Madura and the Andaman and Nicobar Islands. Even though the status of the plants included in this treatment were questioned by the modern bryologists, this work still remains as a valuable reference to the present workers. Other noteworthy contributions in this period were those of Mueller's (1901) "*Scapaniae Indiae Orientalis*" and Gola's (1914) on Kashmir Hepatics. Contributions by Dixon (1910, 1930, 1942), Bruehl (1931), Bartram (1955, 1960) and Robinson (1956) on Indian hepatics also added further information.

MUSCI

The floristic study of the mosses in the richly distributed Indian subcontinent received little attention throughout the past probably because of non-availability of literature. Even though the Hepaticae received attention of Indian bryologists since Kashyap (1914), researchers on Indian mosses began only after a decade or two. However, contribution of scientists from abroad is continued even during the early half of this century.

During the first half of this century, Dixon published a number of new species and genera. Most of his contributions were based on collections made by others from different parts of the country. Dixon (1909a) described the species *Brachymerium turgidum* collected by L.J. Sedgewick from Lonavala in the Western Ghats. It was

followed by the publication of a very valuable account of the mosses from the Western Ghats collected by G.B. Savery and sent to him by L.J. Sedgewick from various parts of the southern region of Bombay Presidency (Dixon, 1909b), this included two new species viz., *Pterobryopsis maxwelli* Cardot & Dixon and *P. kavarensis* Cardot & Dixon. Dixon (1910) described the new genus *Merceyopsis* Broth. & Dixon, closely related to *Merceya* in the arrangement of cells in the nerve of the leaf. Sedgewick (1910, 1911, 1913) compiled a list of 71 mosses collected by him, Maxvel, Kirtikar and Woodrow from Mahabaleswar, Kanara, Panchgani and Purandhar in Western India and identified by Dixon. In 1911, Dixon proposed a new genus *Hyphilopsis*, based on a collection by Sedgewick from Purandhar and described *Orthotrichum griffithii* Mitt. & Dixon, *Brachymenium fischeri* and *Bryum sachyadrense*. In 1912, the new genus *Bryosedgewickia* of Entodontaceae from Purandhar was proposed by Dixon and described three new species each of *Pogonatum*, *Forsstroemia* and *Lindbergia* alongwith a list of many mosses from various parts of India. He in 1914a enumerated 42 species belonging to 34 genera of mosses from Abor hills of Assam. Dixon (1914b) reported 58 species of mosses including 40 genera collected by C .E.C. Fischer and others from South India and Ceylon, which include three new species viz., *Campylopus pseudogracilis* Cardot & Dixon, *Taxithelium vivicolor* Broth. & Dixon, *Barbella questei* Cardot & Dixon, and two new varieties viz., *Stereophyllum ligulatum* (C. Muell.), *A. Jaeger* var. *sedgewickii* Broth. & Dixon and *Lieverella fabroniaceae* var. *dilatinerve* Cardot & Dixon.

In 1921, Dixon assigned Sedgewick's collections from North Kanara into 43 species of mosses under 27 genera. During 1922, he proposed seven new genera of mosses of which *Beddomiella funarioides* Dixon was from the Nilgiri hills. Dixon (1925) described *Grimmia somervellii* Dixon from the Himalayas based on the collections made by T.H. Somervell, and later (Dixon, 1928) proposed a new genus *Homaliopsis* from Palni hills, collected by Foreau. Dixon (1931) published six new genera, of which *Nanothecium* a member of Entodontaceae was collected by Foreau in 1929 from the Kannan Devan Hills in Travancore, *Orthotheciadelphus* (Entodontaceae) collected from North West Himalayas by R.L. Bardhwar in July 1928 and *Hydrocryphae* (Cryphaceae) from Abor hills in Assam, collected by F.

Kingdonward. In 1937, Dixon reported 208 species of mosses of Naga hills in Assam based on the collection made by Dr. N.L. Bor between 1933-1936 which include one new genus and 40 new species. Dixon and Badhwar (1938) described 17 new mosses from Northwest Himalayas. In 1942, Dixon instituted 16 new species of acrocarpous mosses from North-western Himalayas.

Brotherus (1909-1910) described a new genus *Hageniella* Broth. with *H. sikkimensis* Broth. from Sikkim and later he (Brotherus, 1928) provided an account of 106 species and 6 varieties of the mosses of Kashmir collected by Borelli and Duthie.

Varde (1922, 1923a & b, 1924) published an account of mosses collected by Foreau, Andre, Roine and Velle from Madura in Southern India. Subsequently Varde (1925) described 14 new species and reported 32 mosses new to Southern India based on the collections made by Foreau from the then Madura district. Varde (1928) and Dixon and Varde (1927) described a large number of new species and proposed two new genera viz., *Foreauella* and *Trigonodictyon*.

In 1929, Bruehl and Sarkar described the mosses of Bengal. Blatter (1929) listed the mosses collected from the Bombay Presidency. Fleischer (1929) while listing some mosses from Southern India described the new species. *Thuidum dodabettense*. Foreau (1930, 1931) presented some notes of the bryological geography for the Presidency of Madras, which includes a family-wise list of 323 species and varieties, of which 4 genera, 95 species and 15 varieties were the new discoveries during 1908-1927 from this area. Later, He (1961, 1964) compiled the result of the survey on the Moss Flora of Palni hills and enumerated 424 species. Bruehl (1931) published a census of Indian mosses in which he enumerated 2,471 species including about 1,500 species of the Indian continent.

Gupta (1933) studied the structure of *Physcomitriellopsis indica* Dixon collected from Banaras. Sharma (1949) published an account of the Indian *Sphagnum* including the endemism of species and their economic importance. He enumerated 17 species of *Sphagnum*, out of this seven were indigenous. The majority of them occur in the eastern Himalayas, Sikkim, Bhutan and Khasi hills. Bartram (1955) enumerated collections of mosses by Steward from North Western Himalayas. Ochi in 1956

supplemented this list. Deb (1955) reported 35 species of mosses belonging to 28 genera and 17 families, from Manipur with a note on their habitats. Chopra *et al.* (1956) published a preliminary list of mosses of Mussorie consisting of 143 species belonging to 77 genera and 27 families. Noguchi (1958) studied a collection of mosses from Southern India, made by T.S. Rao from Kodaikanal, Coonoor and Ootacamund and enumerated 27 taxa including a new variety in his revision of the family Trachypodaceae of India. Chopra and Sharma (1959) studied the life history of *Oligotrichum semilamellatum*.

Gangulee (1957, 1959, 1960, and 1961) in his series of papers on the mosses of eastern India described the members of Fissidentales (1957), Ditrichaceae (1959), Dicranaceae (1960) and Leucobryaceae (1961) respectively. Gangulee (1985) in his Handbook of Indian Mosses enumerated 100 species including Acrocarpous and Pleurocarpous mosses with colour plates. Chopra in 1960 listed 158 species of mosses belonging to 68 genera under 25 families from Nainital. Wadhwa and Vohra (1963) from Garhwal recorded the genus *Atonia* for the first time from India with a detailed account of *A. rigida*. Foreau in 1964 reported *Bryum coronatum* Schwaegr. from Idukki district of Kerala and *B. curyphyllum* Dixon & P.Varde, *Philonotis subrigida* var. *adpressa* Cardot & P. Varde and *Physcomitrium insigne* Dixon & P. Varde from Kerala but without mentioning the precise localities.

Ochi (1964a) enumerated some species of the family Bryaceae and Bartramiaceae from Darjeeling and Sikkim including one new species and a new variety. Robinson (1956) described *Theriotia kashmirensis* Robinson and *Tortula websteri* Robinson together with a list of 60 species including 40 mosses and 20 liverworts collected from Kashmir. Srivastava (1966) listed 137 species of mosses belonging to 70 genera and 27 families from Kumaon. Chopra and Kanta (1966) reported 17 species of mosses from Delhi, of which *Bryum kinggraeffi* was a new record to India.

Vohra and Wadhwa (1964) reported 60 species of mosses under 35 genera and 13 families collected from Nilkanth and Chaukhamb. Wadhwa and Vohra in 1965

reported 36 species of mosses under 26 genera and 15 families based on collections of expedition to Chooyu.

Chopra in 1967 studied the relationship between mosses and liverworts and concluded that the differences between the two groups outweigh the resemblances and hence neither of the taxa were derived from the other. Srinivasan (1968) gave a general account of ecology and distribution of Indian liverworts and mosses. Further he listed species which are common with the various continents and insular areas. Dabhade (1969) reinvestigated the four species of *Bryum* from Western India providing their taxonomic details, habit and range of distribution. Later, He (1970) reported *Funaria nutans* (Mitt.) Broth. from Khandala as a new record to Western India. Mohamed *et al.* (1986) reported 42 species of mosses from Mahabaleswar, Pune and Khandale in north Western Ghats.

Vohra (1969a) described the new species *Habrodon kashmiriensis* Vohra, along with illustrated account of six other species from Kashmir, Tehri and Dehra Dun. Subsequently Vohra (1969b, 1970) enumerated 165 species of mosses from Western Himalayas, of these three species were new to India and five were new to Western Himalayas.

Raghavan and Wadhawa (1968) reported 28 species of mosses belonging to 21 genera and 16 families from Agumbe-Hulical ranges in the Shimoga district of Karnataka state. This list included two new records to India and Southern India. They (1970) presented a key to mosses of Agumbe including two species viz., *Bryosedgwickia densa* (Hook.) Bizot & P. Vard and *Dendropogonella rufescens* (A. Schimp.) Britt., as new records for India.

The report of the genus *Buxbaumia* (Udar *et al.*, 1970b) from the Western Himalayas was an addition to the moss flora of India. Udar *et al* (1970c) described *B. himalayensis*. Vohra (1974) described a new species *Plagiothecium dehradunense* from the northwestern Himalayas. Srinivasan in 1974 published an account of the anatomical and morphological aspects of 64 species of mosses, collected from Palni, Gingi, Yercaud, Thirupathi, Kodaikanal, Nilgiris, Thiruvananthapuram and Mysore.

Chopra (1975) published his monumental work “Taxonomy of Indian Mosses” which includes nearly 2000 species belonging to 329 genera under 56 families. He also included the collections from the neighbouring regions such as Pakistan, Nepal, Bhutan and western and southeastern Tibet as most of the species extend to other regions also. Vohra in 1977 critically reviewed the studies on bryophytes done in Botanical Survey of India with reference to Musci and provided the location of large number of collections of Indian mosses, deposited in foreign countries. During his study on the order Hypnobryales (Musci) in the Himalayas, Vohra (1978) described a new species, *Lescurea darjeelingensis* and a new variety, *Haplocladium microphyllum* ssp. *capillatum* var. *bhutanicum*. Subsequently Vohra(1979) made a few new combinations in Hypnobryales and added two species to Indian bryophytic flora. Gangulee (1969-80) made valuable contributions on the mosses of eastern India and adjacent regions. His work, “Mosses of Eastern India and adjacent regions - A Monograph”, provided a well-illustrated, detailed taxonomic account, and the distribution map of each species dealt with. This is the first of its kind in India and certainly forms the basic reference manual to study the Indian mosses.

Vohra (1981a) reported the Indian endemic species *Pogonatum hexagonum* Mitt. from Silent Valley of Kerala State. Subsequently, Vohra (1981b) mentioned about his 250 collections of mosses from Mulla Periyar and its catchment area in the Idukki district of Kerala State. Chopra and Kumar (1981) published a well-illustrated taxonomic account of 65 mosses of Western Himalayas and adjacent plains. Bhatla (1981) studied the effect of pH in gametangial formation in the moss *Bryum argenteum* Hedw. and found that the change in pH of the medium was one of the after-effects of the gametangial formation, rather than its cause i.e., the change in pH has no role in the onset of reproduction phase.

Vohra *et al.* in 1982 published a list of 83 species of mosses collected from Silent Valley. They could also locate the fruiting material of *Handeliobryum setschwanicum* Broth. for the first time. Vohra (1983) gave a detailed description on the Hypnobryales suborder Leskeineae of the Himlayas. He described and illustrated 42 genera and 161 species from Himalayas out of the 45 genera and 177 species occurring in India. Among the 161 species, 44 are endemic in this area. Buck (1984)

provided the taxonomical and nomenclatural notes on the West Indian Hypnaceae which also include two new species and three varietal combinations.

Pant and Tewari (1983, 1988) made an assessment of bryophytic vegetation of Nainital and surroundings based on substrate preferences of genera and species. Bapna (1980) reported the occurrence of *Fissidens* in Rajasthan.

Chopra and Bhatla (1983) found that bryophytes exhibit maximal gametangial initiations in a definite pH range and the nutritional status of the medium has variable effect on gametangial induction. Vashishta and Chopra (1986) in the experimental studies on bryophytes in India provided a review of studies on gemmae, apogamy, apospory, callus induction and its differentiation and protoplast isolation and culture. Kumra (1995) conducted in vitro studies on *Bryum coronatum* and *Funaria hygrometrica* Hedw.

Cytochemical studies on the developing sporophyte in the moss *Physcomitrium cyathicaipum* Mitten were carried out by Ekalavya (1987). Mehra (1988) carried out studies on the effect of some growth regulators on the formation and behaviour of protonemal gemmae in the moss *Hyophila involuta* (Hook.) A. Jaeger and found that the auxins delay the germination of gemmae. Babbar (1988) conducted similar studies in *Philonotis lancifolia* Mitt. and *Trematodon brevicalyx*. The development and behaviour of protonemal gemmae in vitro in two gemmiferous mosses, *Trematodon brevicalyx* and *Semibarbula orientalis* has been made by Babbar and Chopra (1995). Mitra (1995) studied the morphology of moss protonema for understanding the morphogenetic changes, which occur during growth and development of protonema.

Ellis (1992a) made studies on the species *Fissidens ceylonensis* Dozy & Molk. and compared with related taxa such as *F. ceylonensis* var. *acutifolius* Dixon & P. Varde and *F. kawarensis* Dixon. Ellis (1992b) studied the taxonomy of some taxa of Calymperaceae occurring in the Indian Peninsula.

Vohra and Aziz (1997) reported 37 species of mosses from Great Nicobar Island. Among them *Taxithelium verneiri* (Duby) Besch. was a new record for India

and 17 species occurring in the mainland were new additions to the Island flora. *Leucophanes nicobaricum* C. Muell. & Gangulee and *Trichosteleum punctipapillosum* Gangulee, endemic to the island so far represented by the type material only, recollected after more than a century. Ochyra (1998b) discussed the identity of two species of *Hygroamblystegium* endemic to northern India. Narayan *et al.* (2001) illustrated, morphotaxonomic details of eight species of mosses belonging to six genera and six families from Great Himalayan National park, Himachal Pradesh.

Fossil remains and fossil studies on this group are rare. Pant and Singh (1991) attempted to distinguish the spores of Hepaticae and Anthocerotales from iso-or microspores of Pteridophytes and pollen grains of Gymnosperms and Angiosperms for the identification of possible fossil spore dispersal of bryophytes reported from different geological horizons. Chandra (1995) recovered a good assemblage of bryophytes from the early Permian sediments of India as impressions along with the typical Glossopteris flora for the first time. Both Hepaticae and Musci are represented by newly designated form genera and species. Naming of the fossil bryophytes, the possibility of preservation, spore distribution, probable habitat and evolutionary aspects have also been discussed by Chandra (1995). Pant (1995) discussed the palynology of bryophytes.

Ecological studies on this group are very meager in India. Negi and Gadgil (1997) studied the species diversity and community ecology of mosses of Garhwal Himalaya and concluded that the microhabitat and altitude seem to be the major ecological factors governing species diversity and composition. Negi (2001) studied the ecology of bryophytes of Chopta-Tunganath in the Garhwal Himalaya. Nath *et al.* (2000) discussed the role of bryophytes in soil management and in rock binding.

Dhabade and Patil (2001) have done SEM studies of spores of two species of *Bryum* and seven species of *Fissidens* from the Western Ghats. Parihar (2001) presented a method of preparation of a perpetual taxonomic cross-reference dictionary of the bryophytes, for this a system of numeration of each taxon has been adopted. Chaudhary and Deora (2001) provided an illustrated account of 25 species of mosses belonging to 18 genera and 8 families from Mt. Abu. Among them 23 species occur in

Western Himalaya, 19 in eastern Himalaya and 15 in South India. Pant (2001) highlighted the diverse habitat for bryophytes and given a checklist of the bryodiversity of Kumaun Himalaya pointing the need to explore and study the diverse species.

Saxena *et al.* (2001) highlighted the usefulness of bryophytes as subjects of biomonitoring studies and called for the establishment of bryophyte bank for environmental monitoring in India. Tewari (2001) described the distribution of “copper mosses” *Scopelophila ligulata* (Spruce) Spruce and *S. cataractae* (Mitt.) Broth. in Kumaon Himalaya and mentioned the plant-substrate relationship and indicator value of these two species. Kapoor and Bhatla (2001) studied the biochemical regulation of protonema differentiation in *Funaria hygrometrica*.

Pandey *et al.* (2001) studied the accumulation of heavy metals such as copper, chromium, lead, zinc, nickel and cadmium in bryophytes from the banks of Ganga. They found high concentration of heavy metals and which may be accumulated from the polluted waters of the river. Singh (2001) discussed the status, vulnerability and conservation of the Indian liverworts. He suggested an action plan for the conservation and monitoring and advocated the need for capacity building in its taxonomy and integration of the regional herbaria has been emphasized.

Daniel and Daniel (2003) added *Fissidens griffithii* to Indian bryoflora from Kanyakumari district of Tamil Nadu. He described six species viz., *Fissidens kalimpongensis* Gangulee, *F. leptopelma* Dixon, *LeptoLejeunea sikkimensis* Udar & U.S.Awasthi, *L. himalayensis* Pande & Misra, *Radula madagascariensis* Gottsche and *Leucobryum juniperoideum* (Brid.) C. Muell. as new record to Peninsular India.

Nair *et al.* (2004) recorded *Bryum tuberosum* Mohamed & Damanhuri, which was known earlier from the Peninsular Malaysia, as a new record for India from Uduppi of Karnataka State. Singh and Nath (2004) added an epiphytic liverwort *Frullania rotundistipula* Steph. from Khasi hills, Meghalaya to the Indian bryoflora. Singh and Singh (2004) added *Lejeunea flava* (Swartz) Nees to the bryoflora of Western Himalaya a species already known from Eastern Himalaya to Indian flora.

Pande and Joshi (2004) assessed the species composition, phytosociology, pattern of biomass and net primary production of bryoflora growing on decaying logs in the evergreen conifer forest of silver fir of Nanda Devi Biosphere reserve in Central Himalaya.

BRYOPHYTE STUDY WITH SPECIAL REFERENCE TO KERALA

The first record on the bryophytes of Kerala may be that appeared in Van Rheede's (1678-1703) monumental work on South Indian plants, *Hortus Malabaricus*. He described and illustrated one moss from Kerala as 'poovan-peda' (vol.12, t.37, p. 71, 1693). Nicolson et al. (1988) later identified it as *Bryum bicolor* Dickson, in contradiction to the earlier interpretation as *B. coronatum* Schwaegr which is now treated as synonym of *B. dichotomum* (Ochi, 1985). Dixon (1914b), while reporting the mosses collected by C.E.C.Fischer and others from South India and Sri Lanka, mentioned one species, *Erythrodonium julaceum* (Schwaegr.) Par. as collected from Attappadi (Palakkad district). Bruehl's (1931) exhaustive compilation, the Census of Indian Mosses, contain 2,471 species belonging to 371 genera of which three species are from Kerala viz., *Fissidens zippelianus* Dozy & Molk. from the Travancore, *Webera rostrata* (C.Muell.) Broth, from the Malabar and *Brachymenium fischeri* Cardot & Dixon from the Attappadi hills. Dixon (1931) published six new genera of which *Nanothecium foreaui* Dixon & P.Varde was collected by Foreau in 1929 from the Kannan Devan hills in Travancore (Southern Kerala).

A new species *Anthoceros koshii*. was described by Khanna (1936) based on the collections made by T.K. Koshy from Peerumedu in Idukki district. Asthana and Srivastava (1991) opined that according to the taxonomic description and illustration made by Khanna (1936) this species approaches *A. bharadwajii* Udar & A.K.Asthana. Chopra (1938b) in his notes on South Indian Hepatics mentioned two species viz., *Riccia cruciata* Kashyap and *Aspiromitus erectus* Kashyap from the Travancore. Kachroo and Bapna (1963) also reported on the occurrence of *Riccia cruciata* Kashyap from the Travancore area. Kachroo (1956) while studying the morphology of the genus *Pallavicinia*, collected *P. ambigua* (Mitt.) Steph., from the Travancore area.

Foreau (1964) reported *Bryum coronatum* Schwaegr. from Idukki district and *B. curyphyllum* Dixon & P.Varde, *Philonotis subrigida* var. *adpressa* Cardot & P.Varde and *Physcomytrium insigne* Dixon & P. Varde from Kerala. Bhardwaj (1965a) gave a detailed description of *Anthoceros mamillisporus* (D.C.Bharadwaj) D.C.Bhardwaj and *A. dixitiamus* (Mahabale) Prosk. *A. mamillisporus* (D.C.Bhardwaj) D.C.Bhardwaj collected from the Kottayam district. Bhardwaj (1965b) studied the morphology of the genus *Phaeoceros* and compared it with *Anthoceros*. Kachroo (1967a) described a new species of *Anthoceros* viz., *A. shivanandani* from Kerala. Bhardwaj (1973) transferred the species reported by Stephani as *Aspiromitus* to *Folioceros* of which *F. spinisporus* (Steph.) D.C.Bhardwaj was collected from Kottayam district.

Srinivasan's report (1974) on South Indian mosses contain 64 species, but include only one species viz., *Fissidens schmidii* C .Muell. from Thiruvananthapuram district of Kerala. Chopra (1975) reported a few species such as *Megalostylium brevisetum* Dozy & Molk., *Leucoloma brevifolium* Dixon & P.Varde, *Hymenostylium validinerve* Dixon & P.Varde, *Tortula schmidii* (C.Muell.) Broth., *Trichostomum minusculum* Dixon & P.Varde and the monotypic endemic genus *Nanothecium foreaui* Dixon & P.Varde, *Homalothecium nilgheriense* (Montin) Robinson and *Stereophyllum subacuminatum* Dixon & P.Varde from the Kannan Devan hills of Travancore. *Leucoloma malabarensense* Besch. ex Ren. & Cardot from the Malabar area and *Syrrhopodon leucophanoides* Cardot & P.Varde from Kerala were also mentioned by Chopra (1975).

Vohra (1981a) described *Pogonatum hexagonum* from Silent Valley as an endemic moss to India. Subsequently, he (1981b) mentioned about his 250 collections of mosses from Mulla-Periyar and its catchment area, in the Idukki district. Vohra *et al*, (1982) reported 83 species of mosses from the Silent Valley National Park, among which, 43 were epiphytes. They also proposed about the occurrence of three new species, one in the genus *Pinnatella* and two in *Fissidens*. Another interesting finding of them was the recording of the sporophytes of *Handeliobryum setschwanicum* Broth, from the area. Udar and Kumar (1983) described the South Indian endemic species *Radula pandei* Udar and Kumar from Agumbe and Mercara of Karnataka and

Mukkali-Silent Valley of Kerala. Udar and Jain(1984) listed 14 species of Marchantiales belonging to eight genera from Thrissur, Idukki, Wayanad and Kottayam districts. This collection was the first investigation on the liverworts of Kerala. Udar and Awasthi (1984) collected *Schiffneriolejeunea indica* (Steph.) Udar & U.S.Awasthi (*S. pulopenangensis* (Gottsche) Gradst.) from Kottayam and Mannarkkad in Kerala. This was followed by a report of *Acrolejeunea sikkimensis* (Mizut.) Gradst. from Kottayam (Awasthi, 1984). Awasthi and Srivastava (1985) also reported the same species from Kerala State.

Awasthi and Udar (1984) reported that *Mastigolejeunea humilis* (Gottsche) Schiffn. has a wide range of distribution in Kerala. Udar and Kumar (1985) while studying the family Cephaloziellaceae in South India recorded *Cephaloziella kiaerii* (Austin) Arnell., the sole representative of the genus in South India, from Silent Valley, Munnar and Ponmudi areas. Recently Nair & Madhusoodanan (2001) collected this species from the Eravikulam National Park in the Idukki district of Kerala. A monotypic genus of the family, *Cylindrocolea tagawae* (N.Kitag.) Schust., has also been reported for the first time from Ponmudi of Thiruvananthapuram district by Udar and Kumar (1985). Udar and Shaheen (1985) studied the genus *Ceratolejeunea* in India and reported the occurrence of *C. singaporensis* (Lindenb.) Schiffn. from Lakkidi in Kerala.

Srivastava and Asthana (1986) described the new species *Folioceros udarii* from Silent Valley. A taxonomic revision of the genus *Calymperes* in Southern India and neighboring islands (Andaman & Nicobar Islands) by Ellis (1989) includes two species viz., *Calymperes lonchophyllum* Schwaegr. and *C. tenerum* C Muell from Ponmudi. Rajeevan (1990) described 76 species of mosses and 19 species of liverworts from the high ranges of Idukki including five new species viz., *Diaphanodon ganguleei*, *Fissidens choprai*, *Macromitrium vohrai*, *Pohlia foreaui* and *Pterobryopsis keralensis* and three new varieties *Entodon macroporus* var. *indica*, *Philonotis hastata* (Duby) Wijk. & Marg. var. *idukkiensis* and *Calycularia crispula* Mitt. var. *udarii* and one new record for India viz., *Fissidens hollianus* Dozy & Molk. This work forms an important detailed study on the taxonomy and morphology of bryophytes in Kerala.

Asthana and Srivastava(1991) in their monographic studies on the Anthocerotales of India recorded *Anthoceros bharadwajii* Udar & A.K.Asthana, *A. subtilis*, *A. erectus* Kashyap, *Folioceros spinisporus* (Steph.) D.C.Bhardwaj and *Phaeoceros laevis* (L.) Prosk. subsp. *laevis* Prosk. from Idukki district. Ellis (1992a), while studying the family Fissidentaceae of South India reported *Fissidens ceylonensis* Dozy & Molk., from Kallar in Thiruvananthapuram district, a common species of Kerala and *F. ceylonensis* var. *acutifolius* Dixon & P.Varde from Kumali in Idukki district.

Asthana *et al.* (1995) in their well-illustrated morpho-taxonomic account of the genus *Cheilolejeunea* in India described a new species *C. ghatensis* from Ponmudi in the Thiruvananthapuram district. They also reported two species viz., *C. serpentina* (Mitt.) Mizut. and *C. imbricata* (Nees) S.Hatt. from Lakkidi of Wayanad district. Nath and Asthana (1998) recorded *Frullania squarrosa* (R.Bl. & Nees) Dumort., and *F. tamarisci* (L.) Dumort. respectively from Wayanad and Idukki districts.

Srivastava and Sharma (2000) enumerated 29 species of Liverworts and Hornworts including a new one, *Texilejeunea indica* from Silent Valley. This also includes four species of Metzgeriales, 17 Jungermanniales, 5 Marchantiales and 3 Anthocerotales. Awasthi *et al.* (2000) in the well illustrated and detailed account of the genus *Lopholejeunea* (Spruce) Schiffn. of India, recorded 5 species viz., *L. abortiva* (Mitt.) Steph., *L. indica* Udar & U.S.Awasthi, *L. sikkimensis* Steph., and *L. subfusca* (Nees) Steph. (all from the Lakkidi area of Wayanad district) and *L. javanica* (Nees) Schiffn., (from the Silent Valley of Palakkad district) from Kerala. They also described a new variety *L. abortiva* var. *doliiformis* Awasthi *et al.*, from Achilatti forest of Palakkad district.

A preliminary exploration made by Nair and Madhusoodanan (2001) for bryophytes in the Eravikulam National Park, Idukki district, situated in the high altitude mountainous areas with grassland and shola vegetation, reported 19 species including liverworts and mosses, of which, 6 were new records to Kerala. In an extended study by Madhusoodanan *et al.* (2002) reported 115 species including 87 mosses and 28 liverworts from the same area. As a baseline data for the studies on the

bryophytes of Kerala, Nair and Madhusoodanan (2002) made a review on the bryophyte studies done in Kerala. Nair et al. (2002) discussed a preliminary account on the diversity of the bryophytes of Kerala, with brief history, its importance and implications of conservation. Easa (2003) in a compilation on the bryophytes of Kerala reported 232 species including 63 liverworts and 169 mosses. Madhusoodanan and Nair (2003) reported *Ricciocarpos natans* (L.) Corda from Wayanad district and *Notothylas levieri* Schiffn. ex Steph. from Palakkad district of Kerala, as new records for South India. Nair and Madhusoodanan (2003) presented hitherto unexplored bryodiversity of Wayanad district giving a checklist of 100 species including 72 mosses, 25 liverworts and 3 hornworts. Among these 6 species viz., *Entodon flavescens* (Hook.) A.Jaeger. & Sauerb., *Eurhynchium vagans* (A.Jaeger) E.B.Bartram, *Floribundaria walkerii* (Ren. & Cardot) Broth., *Heteroscyphus coalitus* (Hook.) Schiffn., *Marchantia linearis* L. & L. and *Ricciocarpos natans* (L.) Corda were new records for South India and 12 species viz., *Aerobryum speciosum* (Dozy & Molk.) Dozy & Molk., *Ectropothecium compressifolium* (Mitt.) A.Jaeger, *E. skkimense* (Renauld & Cardot) Renauld & Cardot, *Hymenostylium recurvirostre* (Hedw.) Zant., *Hyophila nymaniana* Fleisch.) Menzel, *Jungermannia (Plectocolea) macrocarpa* Steph., *Lejeunea obfusca* Mitt., *Macromitrium ferrei* Cardot & Ther., *Meteoriopsis divergens* (Mitt.) Broth., *Neckeropsis fimbriata* (Harv.) Fleisch., *Papillaria crocea* (Hampe) A.Jaeger and *Schoenobryum concavifolium* (Griff.) Gangulee were new for Kerala.

Nair *et al.* (in press) described seven little known species of *Plagiochila* (Dumort.) Dumort. viz., *P. arbuscula* (Brid. ex Lehm. & Lindenb.) Lindenb., *P. beddomei* Steph., *P. chinensis* Steph., *P. devexa* Steph., *P. fruticosa* Mitt., *P. parvifolia* Lindenb. and *P. sciophila* Nees. ex Lindenb. from Eravikulam National Park in South India. Among these, *P. arbuscula* (Brid. ex Lehm. & Lindenb.) Lindenb. is a new record for India and *P. chinensis* Steph., *P. devexa* Steph., *P. durelii* Schiffn. and *P. fruticosa* Mitt. were new records for South India.

Madhusoodanan and Nair (2004) made an account of eight species of pleurocarpous mosses viz., *Chaetomitriopsis glaucocarpa* (Schwaegr.) Fleisch., *Cryptopapillaria fuscescens* (Hook.) Jaeger, *Diaphanodon blandus* (Harv.) Ren. &

Cardot, *D. procumbens* (C.Muell) Ren. & Cardot, *Hedwigidium integrifolium* (P. Beauv.) Dixon, *Racopilum orthocarpum* Wils. & Mitt., *Symphyodon perrottetii* Montin and *Trachypus bicolor* Reinw. & Cardot, from the Eravikulam National Park. Among them *Chaetomitriopsis glaucocarpa* was a new record for South India and four species viz., *Hedwigidium integrifolium*, *Racopilum orthocarpum*, *Diaphanodon procumbens* and *Diaphanodon blandus* were new to Kerala. A checklist of bryophytes collected from the Vellarimala situated in the Western Ghat mountains of Kozhikode district, Kerala was presented by Nair and Madhosoodanan (in press). This preliminary survey reports the occurrence of 53 species of mosses and leafy liverworts and the need for conservation was discussed.

From this overview, it is evident that except for some sporadic collection reports, the Kerala state remains bryologically almost unexplored or underexplored. A few publications in the first half of the century based on the collections by others from Central Travancore, and the contributions by Udar and his associates at Lucknow (Udar & Awasthi, 1984; Udar & Jain, 1984; Udar & Shaheen, 1985; Srivastava & Srivastava, 1989, Asthana *et al.*, 1995 and Srivastava & Sharma, 2000) are the only works on liverworts of this region. The collection of a moss by Foreau from Kannan Devan hills (Dixon, 1931), a few mosses worked out by Srinivasan (1968) from Thiruvananthapuram, 250 mosses collected from Mulla-Periyar by Vohra (1981a) followed by Vohra (1981b), Vohra *et al.* (1982) and Rajeevan (1990) are the only works on the moss flora of this State.

It is evident from the review that in the northern India the taxonomical study on the bryophytes is rather comprehensive and for the past two decades, they have studied the applied aspects of bryophytes such as the antimicrobial activities, palynology, cytology, pollution detection, etc. in detail. The bryological studies in South India are meager (Manju *et al.* 2005).

Chapter 3
Area of Study

LOCATION

Located in the middle part of Kerala, it borders the districts of Pathanamthitta to the south, Kottayam to the southwest, Ernakulam to the northwest and Thrissur to the north and Coimbatore, Dindigul and Theni Districts in Tamilnadu to the east. It lies between 9° 15' and 10° 21' of north latitude and 76° 37' and 77° 25' of east longitudes. With an area of 5105.22 sq. km Idukki ranks first among the districts in the state in respect of area, forming 13 percent of the total area of the state. It extends by 115km. from south to north and 67km. from east to west.

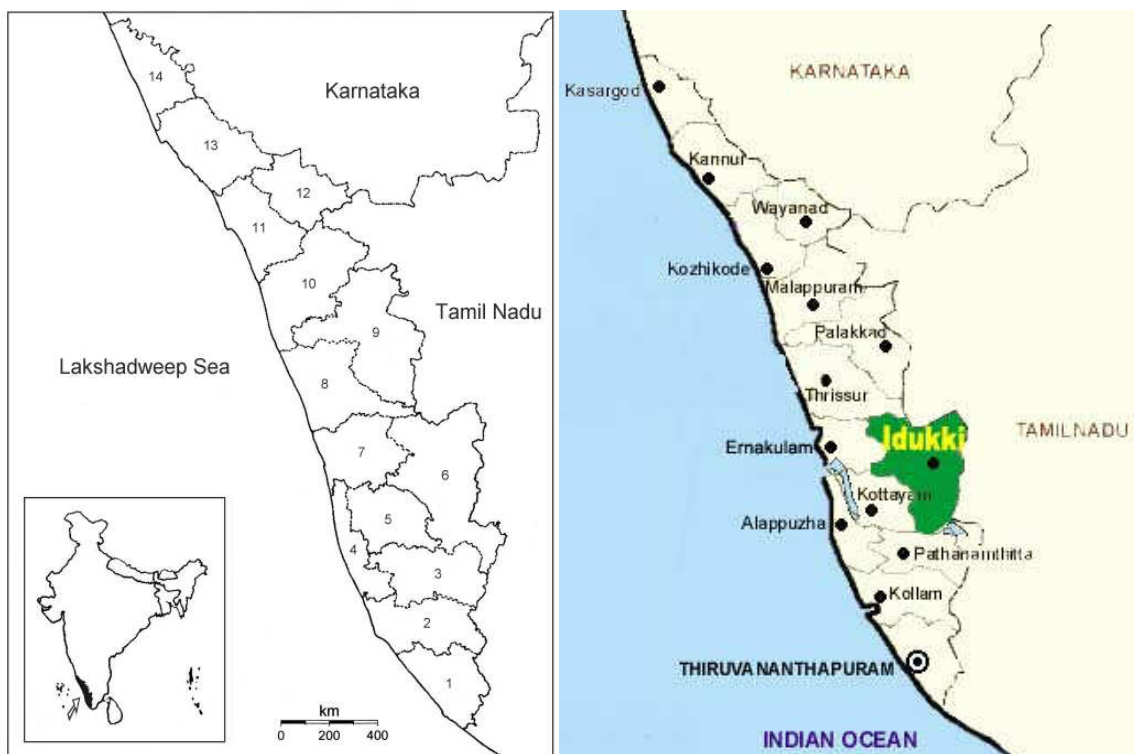


Fig. 3.1: Map of India showing the State of Kerala and Idukki District in Kerala

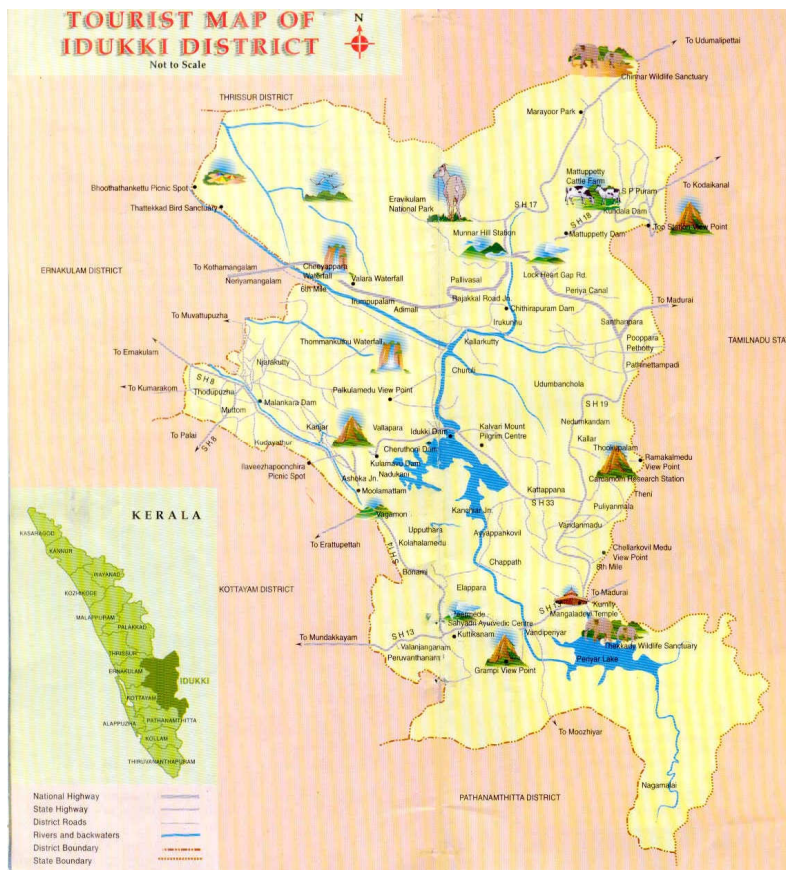


Fig. 3.2: Map of Idukki District

GEOGRAPHY

Rugged mountains and forests cover about 97% of the total area of the District. Idukki has many unique topographical and geographical characteristics. There is only a strip of Middle land (3%) in the western part of the district. Low land area is totally absent in the district. More than 50% of the area of the district is covered by forest.

GEOLOGY AND SOIL

History reveals that Idukki was known for its availability of iron ore, graphite, china clay, bauxite, mica and precious stones. The Geological Survey of India has reported that there are graphite deposits in Thodupuzha taluk. Granite deposits are found through out the district. The soil of this district are classified into laterite, forest and hilly soils. The laterite soil occurs in Western sector of Thodupuzha, Peermade and Devicolam taluks. The forest and hilly soils occur in Udumbanchola taluk and eastern sector of Devicolam, Peermade and Thodupuzha taluks.

Table 3.1: Altitude wise Distribution of Land Pattern and Percentage of Land Area

Altitude (Above Mean Sea Level)	Land Pattern	Percentage of Land Area
20m - 100m	Midland	4.5
100m - 300m	Mid – upland	7.5
300m - 600m	Upland	12.1
600m - 1200m	Western Ghat High Range	48.3
1200m – Above	Top Western Ghat High Range	24.5

There are 14 peaks in the district which exceed a height of 2000 meters above M.S.L. They are Anamala, Eravimala, Tathumala, Chenthavara, Kumarickal, Karimkulam, Devimala, Perumal, Ghudoor, Kabhula, Devicolam, Anchanad, Sabarimala and Karimala. Anamudi, the highest peak in India south of Himalayas, is in the Kuttampuzha Panchayat of Adimali Block, in the K.D.H Village of Devikulam taluk. The estimated height of the peak is 2817 meters. 13 other peaks in the district exceed a height of 2,000 m (6,562 ft). The Periyar, Thodupuzhayar and Thalayar are the important rivers of the district. As the district lies mostly in the highland, it is covered with dense forest, steep hills, and deep valleys. Because of the undulating topography large area of the district is not suitable for scientific cultivation.

FOREST COVER

Most part of the district is covered with forest and they fall in five forest divisions viz. Chalakudi, Malayattur, Munnar, Kottayam and Game sanctuary. More than 45% of the district is under natural forest. The important types of trees found in forest are Rosewood (*Dalbergia latifolia*), Teak (*Tectona grandis*), Irul (*Xylia xylocarpa*), Ebony (*Diospyrus ebenum*), Akil (*Dysoxylum malabaricum*) and Maruthu (*Terminalia paniculata*), Thembavu (*Terminalia curemulata*), Aini (*Artocarpus hirsutus*), Plavu (*Artocarpus integrifolia*), Venga (*Pterocarpus morsupium*), Venthekkku (*Stromia lunceolata*), Manjakadamb (*Adina cordifolia*).

FOREST TYPES AND STATUS

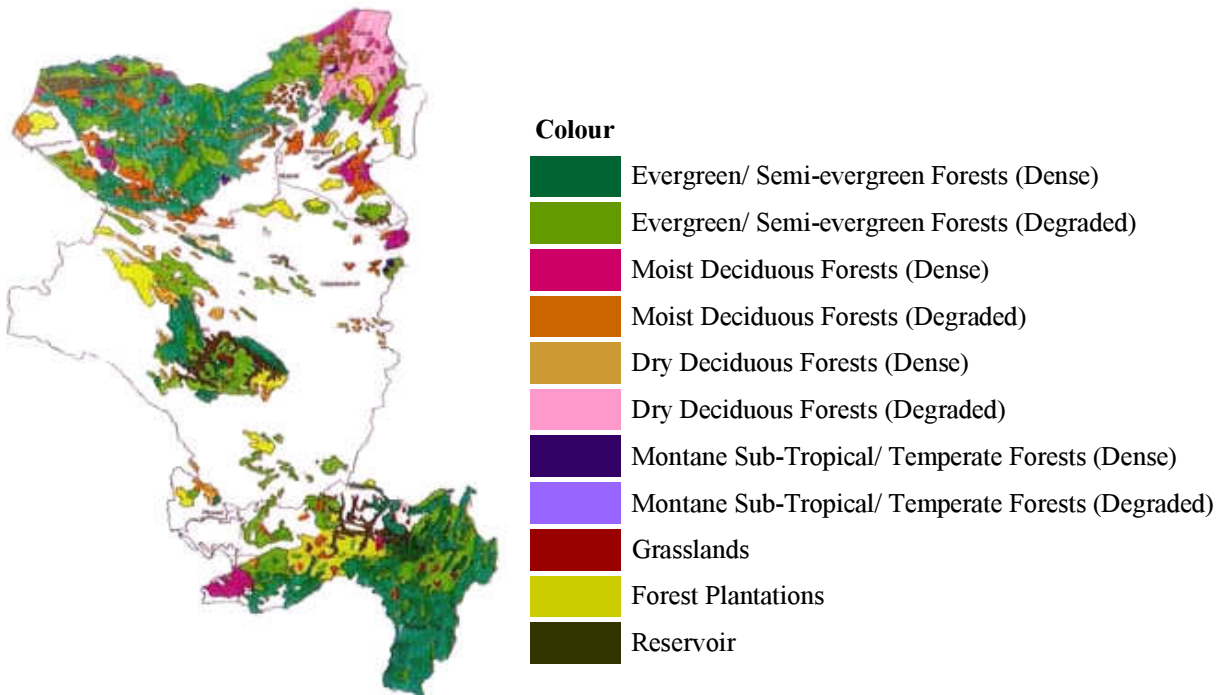


Fig. 3.3: Map of Idukki District showing Forest Types and Status

RIVERS

The important rivers of the district are Periyar, Thodupuzhayar and Thalayar. Periyar which is 277km. long is the second longest river of Kerala. It originates from Sivagiri in the southeast part of the district and touches all the taluks of the district. The Periyar is harnessed at various points in its course for generating electricity and for irrigation purpose. Mullaperiyar dam, Idukki Hydro-electric project, Idamalayar Hydro electric project and the proposed lower periyar are constructed across the Periyar. Kundala Dam, Mattupetty Dam, Munnar head works, ponmudi dam and the kallarkutty Dam are constructed across the various tributaries of Periyar. There are a few natural lakes in the district. They are Eravikulam and Devikulam lakes in Devikulam taluk, Elavizhapunchira, in Thodupuzha taluk.

CLIMATE

The climate in the district undergoes a sudden variation as we go from West to East. The western parts of the district comprising midland area experiences moderate climate, temperature varying between 21° C to 27° C with minimum seasonal variation.

The eastern parts also known as High Ranges of the district located in the highland have a comparatively cold climate with temperature varying between minus 1° C to 15° C in november/january and 5° C to 15° C during March/April.

As in the case of other districts of kerela this district also receives plenty of rains from both the South- West monsoon (Edavapathy) during June-August and the North-East monsoon (Thulavarsham) during October - November. The normal rainfall is 3265 mm. The former is more predominant with June experiencing the maximum rainfall. Annual rainfall in this district vary from 250 cms to 425 cms. Munnar, Devikulam, Pallivasal, Vellathooval etc. are places getting high rainfall while Marayoor, Kanthalloor, Vattavada, Thalier etc experience low rainfall. Marayoor and Kanthalloor are virtually rainshadow areas lying the eastern side of western ghats.

Table 3.2: Seasonal Winds and Average Rainfall of the Study Area

Seasonal Winds	Wind Speed
Ramakkal medu	30.04 Km/h
Panchali medu	20.06 Km/h
Koalahala medu	18.04 Km/h



Average Rainfall (in mm/area)		
Month	Idukki	Kerala
July	1025.10	625.96
August	478.80	337.06
September	616.70	329.35
October	369.50	320.61
November	120.00	97.17
December	142.90	88.42
January	18.40	12.56
February	29.30	8.37
March	13.30	13.49
April	215.10	134.34
May	89.90	71.01
June	711.30	592.10

Chapter 4
Materials and Methods

MATERIALS AND METHODS

Present work on Mosses of Idukki involves systematic collection by intensive and extensive field trips which were made from April 2005 to April 2009. Plants were scraped out from the substrata with the help of a sharp-edge knife. Terrestrial species were collected with the substratum and bulk of the soil particles were removed leaving a thin film. Most of the areas of the district were explored, giving special emphasis to Munnar Hills and surrounding areas. The field data were also noted down such as the locality, date, altitude, macro habitat, microhabitat, substratum, associated species, etc. When the bulk of specimen contained more than one species, each one is separated for the ease of detailed taxonomic studies and for storage in herbaria. The herbarium was prepared by air drying the collected specimens. Dried specimens were stored in brown paper packs or small cellophane bags for future storage. The herbarium specimens of each species were prepared following standard field and herbarium methods (Forman & Bridson, 1989). The properly labeled packets were arranged according to the classification of Gangulee (1969) and were deposited in the University of Delhi herbarium.

Fresh materials were subjected for taxonomic treatment whenever possible. Dried specimens were soaked in cold water to regain its original shape before analyzing. The external features of the specimen were studied using stereo dissection microscope. Also the wet specimens were photographed under laboratory conditions. Internal structures were studied and photographed with elaborate details using compound microscope and attached camera.

Photographs are provided for each species with details as much as possible. Whole plant photographs were taken to illustrate habit, leaf whole mount and sections were photographed using digital camera fitted with microscope attachment. Apical, middle and basal parts of leaf were photographed in detail to facilitate precise identification. Longitudinal section of capsule were studied and photographed in detail to show peristome and exothecium wherever possible. All the illustrations are made to the scale.

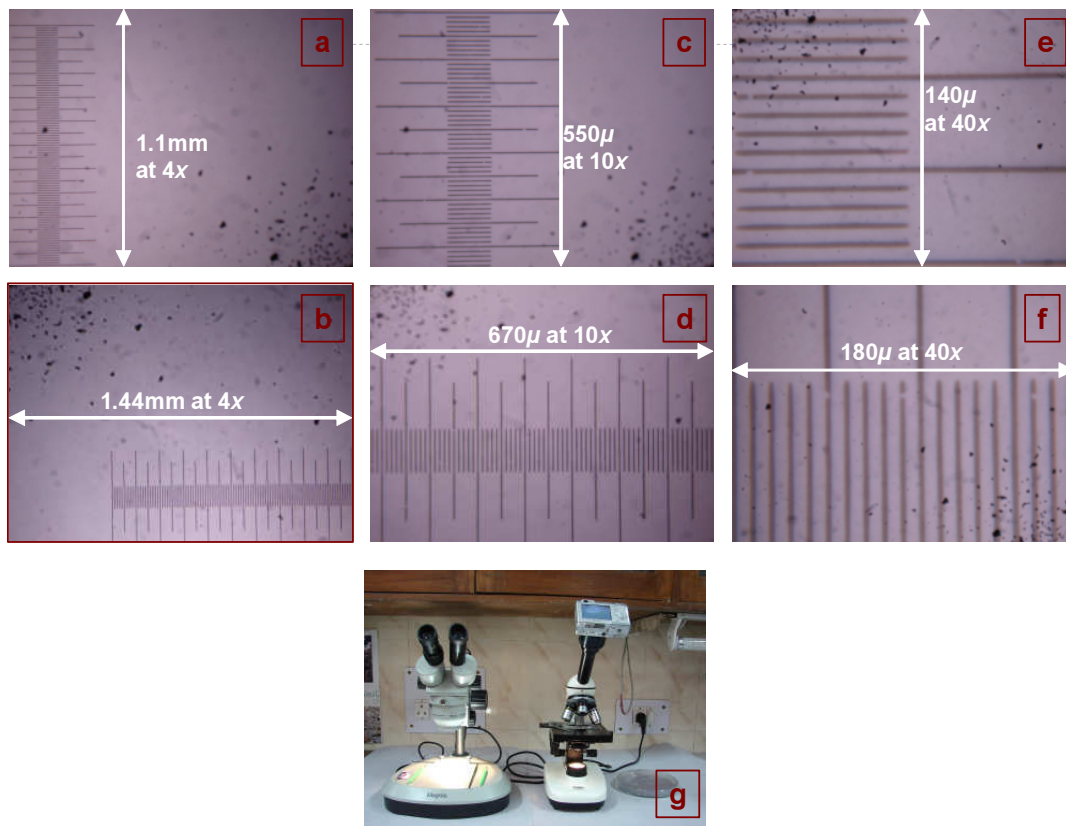


Fig. 4.1: All the photographs in compound microscope have been taken at three magnifications viz. 4x, 10x & 40x. Apart from this 10x magnification of ocular lens and 3x optical magnification of the camera remains common to all photographs. Measurements at different magnifications are as follows: (a) at 4x magnification the total lateral length of photograph would be 1.1mm. (b) at 4x magnification the total horizontal length of photograph would be 1.44mm. (c) at 10x magnification the total lateral length of photograph would be 550μ , (d) at 10x magnification the total horizontal length of photograph would be 670μ , (e) at 40x magnification the total lateral length of photograph would be 140μ , (f) at 40x magnification the total horizontal length of photograph would be 180μ , (g) the microscopes, attached with digital camera.

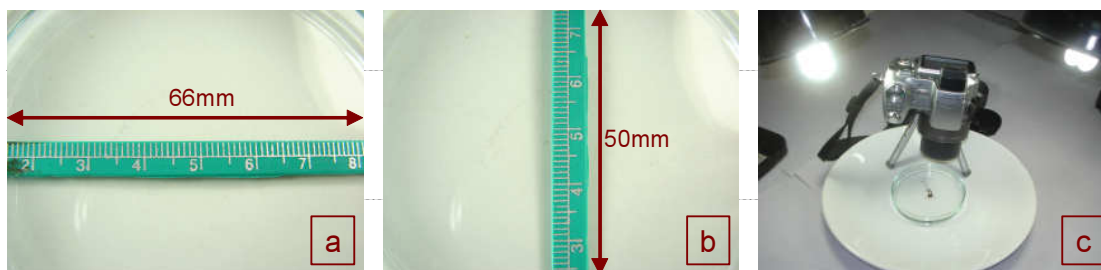


Fig. 4.2: (a) Total horizontal length of photograph is 66mm. (b) Total lateral length of photograph is 50mm. (c) camera with the set up used for measurement

Instruments Used

Microscopes: Stereo Dissection microscope- Magnus MS24 No.70; 0713

Compound microscope- Magnus MLM No.70; 702487

Cameras: Digital still camera- Sony DSC-H1 No.5444868

Digital still camera- Sony DSC-W7 No.2478522

Miscellaneous objects such as cellophane bags, needles, paint, brush (zero size), glass slides, cover slips, sharp edge knife, etc. were used during the research.

Chapter 5
Taxonomic Description

TAXONOMIC DESCRIPTION

In mosses the identification is based on combinations of various characters of life-forms, shape and size of the laminal cells, alar cells, type of peristome, features of endostome and exostome, and shape and size of the capsule. However, lamina cells are most important feature for identification. Polytrichaceae are characterized by nematodontous peristome teeth, lamellae on the dorsal lamina, small rounded thick-walled cells and a sheathing base of leaf. In Ditrichaceae, leaves are lanceolate to long subulate and lamina cells are rectangular, thin-walled and smooth, and peristome are fragile, fully formed and papillose. Leaves with strong nerve and sheathing base, rectangular middle and quadrate basal lamina cells, and haplolepidous, arthrodontous peristome are found in Dicranaceae. Features of Leucobryaceae are the presence of angular hyalocysts and chlorocysts in the lamina cells and rounded small capsule. Fissidentaceae show distichous arrangement of leaves and two clasping lamina; true lamina and apical lamina. Calymperaceae is distinguished by hyaline sheathing base with rectangular smooth cells (cancellines), six-sided green laminal cells. Pottiaceae is identified by the presence of small, thick-walled, rounded papillose cells and haplolepidous, filliform, arthrodontous peristome. In Funariaceae, lamina cells are large, rectangular to rhombic and epicranoid, diplolepidous peristome. The distinctive characters of Bryaceae are rhombic, large lamina cells and metacranoid peristome. Mniaceae consist of mostly robust and perennial plants with leaves having strong nerve and rounded to six-sided thick-walled, large cells. The lamina cells of the leaves of Bartramiaceae are thin and quadrate with distinct papillae and capsule is always large and rounded.

Most of the Orthotrichaceae are cushion or turf forming epiphytes. Leaves are ovate-lanceolate with rounded thick walled papillose middle and rectangular basal cells. In Cryphaeaceae, leaves are imbricate-appressed and lamina cells are isodiametric and rounded. Taxa of Trachypodaceae are epiphytic, leaves show auriculate base, strongly toothed margins, coiled apex and small, rhombic, papillose lamina cells. Special features of Pterobryaceae are creeping primary stem with erect dendroid secondary stems and smooth prosenchymatous leaves with more or less

distinct alar cells. In Meteoriaceae, the secondary stem is pendant, leaves are squarrose and recurved with linear lamina cells. The members of Fabroniaceae are slender, with appressed leaves. Lamina cells are prosenchymatous, rhombic with quadrate cells at the base. In Leskeaceae, paraphyllia are present, nerve ends below the apex and lamina cells are rounded, papillose. Thuidiaceae are weft forming mosses with irregularly pinnate secondary stems and dimorphic leaves. Lamina cells are small, rounded and highly papillose. Lamina cells in the leaves of Amblystegiaceae are narrow linear and smooth, and alar cells are distinctly differentiated. Leaves of Brachytheciaceae are ovate to chordate with nerve ending in the mid leaf and lamina cells are narrow rhombic with quadrate alar cells. Entodontaceae are characterized by julaceous stem with enervate leaves and linear lamina cells with quadrate alar cells. In Plagiotheciaceae, leaves are distinguished as upper, lower and lateral, ovate, concave and acute. Lamina cells are rhombic to linear and alar cells are sub-quadrate. Sematophyllaceae is characterized by large, inflated, thick walled coloured alar cells and linear lamina cells. Members of Hypnaceae are glossy plants with regularly pinnate secondary branches. Cells of lamina are narrow linear and sometimes papillose, and small quadrate alar cells.

Division: Musci

Class: Peristomiopsida

Key to sub-classes of Peristomiopsida:

- | | | |
|----|---|---------------|
| 1a | Leaves lamellose; margin toothed, peristome nematodontous | Polytrichidae |
| 1b | Leaves without lamellae; margin entire or toothed, peristome orthodontous | Bryidae |

Sub-class: Polytrichidae

Order: Polytrichales

Family: Polytrichaceae

1. POLYTRICHACEAE

Key to genera of Polytrichaceae:

- | | | |
|----|--|--------------------|
| 1a | Lamellae few four to six on the midrib region | <i>Atrichum</i> |
| 1b | Lamellae numerous on the whole lamina | 2 |
| 2a | Neck not separated from the urn; the latter circular in T.s. | <i>Pogonatum</i> |
| 2b | Neck separated from the urn; the latter angular in T.s. | <i>Polytrichum</i> |

Key to species of *Atrichum*:

- | | | |
|----|---|-----------------------|
| 1a | Lamellae very short as to appear lacking on casual examination | <i>A. longifolium</i> |
| 1b | Lamellae always tall and distinct | 2 |
| 2a | Back of leaf almost smooth, marginal teeth short | <i>A. aculeatum</i> |
| 2b | Back generally rough with teeth, leaf margin distinctly serrate | <i>A. obtusulum</i> |

Atrichum aculeatum Card. & P. Vard. in P. Vard. Revue bryol. 50:25. 14, 1923

Paroicous, polyoicous or dioicous. Stem with a polytrichoid central strand, simple. Leaves crowded; upper leaves erecto-patent to patent, flat to keeled-concave, more or less transversely undulate, on drying mostly crisped, form a non-sheathing base, lingulate to narrow linear-lanceolate; border narrow with large sharp teeth which are often two-ranked, the back of lamina frequently rough with oblique rows of small teeth. The lamellae confined to the nerve and consisting of smooth uniform cells, not crenulate at the free margins; nerve narrow, percurrent ; cells rich in chlorophyll, upper rounded or six-sided, smooth, those near the base mostly rectangular. Sporogonia up to 6 form a perichaetium. Seta elongate, straight. Capsule somewhat inclined, mostly long, cylindrical short and obovate, never angular; neck very small, constricted, without stomata; cells of the exothecium without pits. Operculum long-beaked. Calyptra narrow, smooth, roughened towards the tip by minute teeth. Lamellae always tall and distinct. Back of leaf almost smooth. Marginal teeth long.

DISTRIBUTION of *Atrichum aculeatum*: Kashmir (Pahlgam), South India.

Collection Site: Devikulam (1700m.)

Herbarium No. 13267

Figure: **Plate-1[A]**

Atrichum longifolium Card. & Dix. ex Gangulee

Atrichum longifolium Card. & Dix. in Herb. ined.

Plants large, soft, yellowish green. Stems simple, up to 6cm. tall, individual branches ± 1.5 cm. wide with leaves. Leaves laxly on stem, erectopatent to erect-spreading, curled and twisted when dry, undulating on the margins, narrow lingulate from a non-sheathing, slightly wider base up to 1.5cm. long, 1.44mm. wide at base and 1.2mm. wide at middle of lamina. Lamina not spinose on back. Leaf margin 2 and 3-layered, formed of elongated cartilaginous cells, developing sharp double teeth on the leaf edge at least two-thirds down lamina length. Costa prominent, ± 0.22 mm. wide at base, toothed on tip back, ends in spines at leaf apex. Lamellae not developed, only vein upper surface at middle lamina shows about 4 large cells tending to separate and appearing as rudimentary lamellae. T.s. of costa shows the usual two stereide bands. Leaf base cells thick walled but transparent, up to $\pm 32 \times 16 \mu$ wide; upper cells rounded-quadrate or hexagonal, $\pm 16 \mu$ wide. Seta usually single, erect, ± 3 cm. long. Capsule erect or slightly bent, long, cylindrical, smooth, ± 7 mm. long and 1.2 mm. in diameter. Peristome with brown striations and incurved tips, $\pm 240 \mu$ high and 60μ wide. Spores rounded, light brown, 10.8 to 14μ in diameter. Operculum conic-rostrate, ± 4.8 mm. long. Calyptra cucullate.

DISTRIBUTION of *Atrichum longifolium*: Darjeeling-Sureil (2,000 m.), East Nepal (2,500 m.)

Endemic in this area. But present report from Idukki extends its distribution to south India.

Collection Site: Attukadu (1500m.)

Herbarium No. 13268

Figure: **Plate 1[B]**

Atrichum obtusulum (C. Muell.) Jaeg. in Ber. S. Gall. Naturw. Ges. (1877-78) : 453 (1880)
Catharinea obtusula C. Muell. in Flora, 61 : 81 (1878)

Paroicous, antheridia in separate cluster within female inflorescence. Plants robust, soft. Stems proliferating through tip, densely covered with leaves, up to 4.2cm. long (with proliferation) and 1.1cm. wide with leaves. Dry leaves curled irregularly. Lower leaves small; upper flat, wavy, narrowly lingulate form a non-sheathing base, up to 0.65cm. long and 0.15cm. broad. Lamina with rough teeth in oblique lines up to middle on back; margin multi-layered, cartilaginous, rough, doubly toothed. Costa thin, toothed on back, ending in spines below tip of leaf. Lamellae restricted to ventral face of costa usually 4 (2 to 3 cells high); end cells smooth, thin walled, rounded. Leaf base cells thick walled, rectangular, up to 60×22 μ. Upper lamina cells hexagonal to rounded, 16-24μ wide. Marginal cells narrow, elongated, up to 89μ long. Setae two to six within a perichaetium, up to 2.2cm. long. Capsules somewhat bent, long, cylindrical, smooth, up to 0.6cm. long and 0.06cm. in diameter. Peristome teeth 32. Spores rounded, 8-11μ in diameter.

DISTRIBUTION of *Atrichum obtusulum*: East Nepal (2,000m.), Sikkim (3,300m.), Khasia Hills (Upper Shillong 1,800 m.), Naga Hills (2,500 m.), W. Himalaya (Kashmir, Himachal, Punjab, U. P. Himalaya), Central China.

An Indo-Chinese species.

Collection Site: Kannimalai (Munnar, 1600m.)

Herbarium No. 13269

Figure: **Plate 2[A]**

Key to species of *Pogonatum*:

- | | | |
|----|--|-------------------------|
| 1a | Leaves crumpled, curled or rigid when dry, not tufted | |
| 1b | Leaves stiff, tufted, often clinging to stem forming a bud like structure, Leaf margin smooth | <i>P. perichaetiale</i> |
| 2a | End cells of lamellae not exceptionally differentiated | 3 |
| 2b | Border cells of lamellae strongly differentiated, end cells of lamellae divided, smooth | <i>P. microstomum</i> |
| 3a | Leaves crumpled or curled when dry | 4 |
| 3b | Leaves rigid, may be bend when dry | 5 |
| 4a | Plants of moderate size (rarely exceeding 4 cm.), end cells of lamellae rounded, capsule surface rough | <i>P. aloides</i> |
| 4b | Plants larger (may be about 8 cm.), leaf serration covers leaf base | <i>P. cirratum</i> |
| 5a | End Cells of lamellae depressed | <i>P. stevensii</i> |
| 5b | End cells of lamellae rounded, not much differentiated, long slender palnts | <i>P. leucopogon</i> |

- Pogonatum aloides*** (Hedw.) P. Beauv. in Prodr.: 84 (1805)
Polytrichum aloides Hedwig in Sp. Musc.: 96 (1801)
Polytrichum aloefolium Scop. (1772) nom. inval.
P. rubellum Menz. ex. Brid. in J. f. Bot., 1800 : 287 (1801)
P. dicksonii Turn. in Musc. Hib.: 90 (1804) as var.
P. laterale Crom. (non Brid.) in Samml. Deutsch. Laubm. Nachl., 1: 46 (1805) as var.
P. minimum Crom. in Samml. Deutsch. Laubm. Nachl., 2 : 48 (1806) as var.
P. dicarpon Brid. in Mant. Musc.: 201 (1819) nom. nud. in synonym.
P. defluens Brid. in Mant. Musc.: 200 (1819) nom. illeg. as var.
Pogonatum nanum Lindb. (non Hedw.) P. Beauv. in Not. Saellsk. F. Fl. Fenn. Foerh. 9: 139 (1868)
P. approximans Schimp. in Besch. in Cat. Mouss. Algerie: 29 (1882) nom. nud. in synonym.
P. mnioides Hag. in K. Norsk. Vid. Selsk. Skrift., 1913 : 30 (1914) nom. inval.

Plants short-stemmed with rosette leaves at top resembling miniature aloe plants and hence the name *aloides*. Dioicous, terrestrial. Stems simple, up to 3.5cm. long and 0.8cm. wide with leaves. Leaves scale-like in lower region; upper leaves incurved and curled when dry, dark green, erect-spreading, lanceolate, up to 6mm. long and 1mm. broad at the middle, wide sheathing base, apex acuminate, lamina margin sharply toothed. Costa percurrent or excurrent in a tooth, toothed on back above. Lamellae numerous covering almost the entire ventral surface of leaf, 5 to 6 cells high; end cells round, thin walled. Basal sheathing leaf cells rectangular, up to $74 \times 10.5 \mu$. Upper lamina cells more or less rounded-quadrate, up to 9μ wide, comparatively thick walled. Seta straight, scarlet, one from a perichaetium, up to 2.6cm. long. Capsule slightly inclined, brown, grooved when dry, up to 6mm. long and 0.9mm. in diameter, rough surfaced, exothelial cells with mamilliose projections, columella with 5 to 6 rays. Peristome teeth 32, with brown striations. Operculum concave-conical. Spores rounded, hyaline, 7 to 11μ in diameter. Calyptra felty, covering the whole capsule.

DISTRIBUTION of *Pogonatum aloides*: East Nepal (1,500-1,800m.), Bhutan (Mariabasti, 1,400m.), Ceylon, Thailand, Indochina, Eastern Tibet, Japan, Siberia, Europe, Caucasus, North America, North and Central Africa, Darjeeling, Kurseong (1,300m.-2,100m.), Tiger Hill (2,500m.), Kalimpong, Bagora, Birch Hill, Phalut

(1,300-3,100m.), Sikkim (Gangtok, 1,500m.), Khasi & Jayantiya Hills (900 to 1,550m.), Shillong Peak (2,000m.), North East Frontier Area, Western Himalaya, South India (W. Ghats, Nilgiri).

Cosmopolitan in the temperate Northern Hemisphere.

Collection Site: Munnar (1600m.)

Herbarium No. 13271

Figure: **Plate 2[B]**

Pogonatum cirratum (Sw.) Brid. in Bryol.Univ.,2 : 110 (1827)

Polytrichum cirratum Sw.in J. f. Bot. 1800(2) : (1802)

P.leucomitrium Reinw. Et Hornsch.in Nov. Act. Ac. Leop. Car., 14 : 732 (1829)

P.convolutum Hedw. var. *cirratum* (Sw.) C. Muell.in Syn., 1 : 213 (1849)

Pogonatum contortum (Brid.) Lesq. var. *cirratum* (Sw.) Par. in Ind. Bryol.:979 (1898)

Pogonatum contortum (Brid.) Lesq. var.*robustum* Dix. in J. Bomb. Nat. Hist. Soc., 39: 795 (1937)

Pogonatum macrophyllum Doz. & Molk. var. *darjeelingense* Gangulee in Nov. Hedwigia, 12 : 418 (1966)

Dioicous. Plants robust, usually unbranched, dark green, 8.5cm. or on tall and about 2cm. broad with leaf spread. Basal leaves smaller, scale-like gradually becoming larger upwards. Leaves curled, incurved and hook-like curved when dry, erect-spreading when moist, concave-folded, linear lanceolate lamina form a short, wider, sheathing base; ± 1.2 cm. long, leafbase ± 1.7 mm. wide and less than 2mm. high, lamina up to 1.1mm. wide at middle. Leaf margin lighter in colour, serrated with reddish, sharp teeth from tip to almost the end of the leaf base. Lamina 2 to 4 layers thick, covered by lamellae leaving out only a small margin. Lamellae up to 4 cells ($\pm 30\mu$) high on the midrib, only 1 or 2 cells high elsewhere; all lamellar cells thin-walled and the top cells rounded not differentiated. Leafbase cells rectangular, up to $72 \times 8\mu$. Upper lamina cells thick-walled, ovate-quadrangle, $\pm 13\mu$ wide. Side spines about 46μ long. Costa prominent, planoconvex, percurrent ending in spine. Seta erect, ± 4.4 cm. long. Capsule erect, $\pm 4 \times 1.8$ mm. with conic-rostrate calyptra 2.5mm. high. Capsule wall smooth. Peristome teeth with low peristome membrane $\pm 240\mu$ high, each tooth 60μ wide at base. Spores small, smooth, translucent, 8 to 11μ in diameter.

DISTRIBUTION of *Pogonatum cirratum*: East Nepal (2,000-2,750m.), Thailand, Laos, China, Malay, Sumatra, Molucca, Java, Borneo, Celebes, Amboina, New Guinea, Oceania, South Africa, Darjeeling, North East Frontier Areas (3,000m.)

A Palaeotropic species.

Collection Site: Matupatti (1700m.)

Herbarium No. 13272

Figure: **Plate 3[A]**

Pogonatum leucopogon Ren. et Card. in Bull. Roy. Bot. Soc. Belg., 34 : 65 (1895)

Comparatively slender plants up to 3cm. high, often more elongated by proliferation, about 0.7cm. broad with leaves. Simple red-brown stem, radiculose with rhizoids below. Leaves smaller and scale-like at base; upper erect-spreading, narrow lanceolate from a paler, wider sheathing base, incurved and clinging to stem when dry, ± 4.5 mm. long with base. Leaf base about 1/3 total leaf length, ± 1 mm. wide, concave and sheathing. Apex bluntly pointed. Margin denticulate from tip down about half the lamina length. Costa per-current. deep red-brown, teeth on back not prominent. Lamellae numerous covering almost the entire ventral surface of lamina, 4 to 5 cells high, cells smooth, thinwalled, ovate-round, $\pm 14\mu$ in diameter, end cell not differentiated. Leaf base cells rectangular, up to $48 \times 16\mu$, of a lighter transparent brown colour, feebly incrassate. Upper lamina cells on the paler margin of the same light brown colour with, similar walls but more or less quadrate, 10 to 14μ wide with a bigger cell of a deep red-brown colour forming each tooth. Seta red-brown, apical, erect, single, ± 2.4 cm. long. Capsule brown, erect, cylindrical with the mouth not narrower, urn ± 4.5 mm. \times 1.5mm. in diameter, capsule wall rough with tubercles, specially in the lower half but not as much as in *P. aloides*. Peristome teeth 32, brown, each with paler margin and brown striations inside.

DISTRIBUTION OF *Pogonatum leucopogon*: Darjeeling(2,000m.), Kurseong (1,500m.), Senchal (2,500m.), N.E.F.A.

Endemic to India.

Collection Site: Devikulam (1700m.)

Herbarium No. 13273

Figure: **Plate-3[B]**

Pogonatum microstomum (Schwaegr.) Brid. in Bryol. Univ., 2 745 (1827)
Polytrichum microstomum R. Br. ex Schwaegr. in Sp. Musc. Suppl., 2(2): 10 (1826)
Polytrichum microstomum R. Br. in Trans. Linn. Soc. Lond., 12 : 569 (1819) nom. nud.
Polytrichum minutum R. Br. ex Brid. in Bryol. Univ., 2 : 127 (1827) nom. nud. in
synon. err. pro. *P. microstomum*
Pogonatum minutum Brid. in Bryol. Univ., 2: 127 (1827) nom. illeg.
Polytrichum urnigerum Griff. (non. Hedw.) in Not.: 389 (1849)
Pogonatum paucidens Besch. in Rev. Bryol.. 18: 89 (1891)
Polytrichum paucidens (Besch.) C. Muell. in Gen. Musc. Fr.: 175 (1900).

Robust, coppery green plants in lax tufts. Stems innovating, 5cm. or more long and about 1.8cm. wide with leaves, with pale tomentum below. Lower leaves small, scale-like. Upper leaves rigid, appressed and somewhat incurved when dry, erect-spreading; lanceolate from an ovate, yellowish, wider, slightly sheathing base; up to 9.5mm. long and 1.9mm. broad; apex sharply acute; margin sharply toothed nearly to base of lamina; costa reddish brown, strongly toothed on back above. Lamellae numerous, covering most of the ventral face, 2 to 5 cells high; end cells thin or thick walled, much larger and divided to base into two flask-shaped forks. Basal leaf cells rectangular, up to $92 \times 18.5 \mu$; transversely placed near shoulder; narrower towards margin. Upper leaf cells rounded-quadrate, $\pm 15 \mu$ broad. Seta upto 3 cm. long, sometimes 2 or 3 from one perichaetium. Capsule erect, reddish-brown, up to 6mm. long and 2.5mm. in diameter, exothecial cells thickwalled columella solid, 4 to 5 rayed. Peristome teeth 32 with brown striations. Spores rounded, 9 to 14.5μ in diameter. Operculum broadly convex with a short beak. Felty calyptra covering the whole capsule.

DISTRIBUTION OF *Pogonatum microstomum*: East Nepal (3,250m.), Polunin, (2,600 to 3,650m.), Yoda (1,800 to 3,800m.), Norkett, Bhutan, Ludlow (3,700m.), Darjeeling, Sepoydura (1,800m.), Ghoom, Senchal (1,900 to 3,350m.), Sikkim, Kankola (4,250m.), K. & J. Hills, Naga Hills, Western Himalaya, South India (Nilgiri, Palni, Western Ghats), Ceylon, China (Szechuan, Yunnan), Formosa, Tonkin, Philippines.

A South-east Asiatic species.

Collection Site: Eravikulam (1800m.)

Herbarium No. 13274

Figure: **Plate 4[A]**

Pogonatum perichaetiale (Mont.) Jaeg. in Ber. S. Gall. Naturw. Ges., 1873 - 74: 257 (1875)

Polytrichum perichaetiale Mont, in Ann. Sc. Nat. ser.. 2, 17 : 252 (1842)

Pogonatum integerrimum Hamp. in Par. in Ind. Bryol.: 982 (1898) *nom. nud.*

Polytrichum integerrimum C. Muell. in Gen. Musc. Fr.: 181 (1900) *nom. nud.*

Pogonatum hirsutum Hamp. in Herb. *ined.*

Small stiff plants with stems up to 1.5cm. long and 0.65cm. broad with the tufted leaves. Leaves incurved and clinging to stem when dry. Lower leaves small; upper thick, lanceolate from an ovate, slightly sheathing, wider, hyaline base, up to 9mm. long with the base and 1.1mm. broad in the lamina. Apex sharply acute; margin entire. Costa thick, excurrent in a sharp point. Lamellae numerous, covering almost the entire ventral face, 4 to 7 cells high; end cells larger, thickwalled, smooth, quadrate. Basal leaf cells rectangular, thin-walled, up to $100 \times 18 \mu$, narrower towards margin. Upper leaf cells thick-walled, square to hexagonal, up to 18μ wide; one row of cells on the margin small and highly thickwalled. Seta long, purple, up to 1.2cm. long, one from each perichaetium. Capsule straight, ovate-cylindrical, up to 4.5mm. long and 2.5mm. in diameter, more or less 4-angled when dry, exothecial cells thickwalled, columella solid with 4 to 5 rays. Peristome teeth 16 with brown striations. Spores round, 6.5 to 10μ in diameter. Calyptra felty, light brown, covering the whole capsule.

DISTRIBUTION OF *Pogonatum perichaetiale*: East Nepal (3,600m.), (3,600 to 4,700m. towards Mt. Gaurishankar), Norkett, Bhutan-Ludlow(3,300m.), China (Setchwan), Darjeeling, Sandakphu-Phalut (3,100-3,300m.), Mane bhanjong (2,200m.), Kalimpong (1,800m.), Tiger Hill (2,700m.), Sikkim (4,800m.), Western Himalaya, South India (Nilgiri).

An Indo-Chinese species.

Collection Site: Eravikulam (1800m)

Herbarium No. 13275

Figure: **Plate 4[B]**

Pogonatum stevensii Ren. et Card. in Bull. Soc. Roy. Bot. Belg., 34 : 65, (1895)

Plants small. Stem simple, up to 3.2cm. long and 0.55cm. broad with leaves. Leaves scale-like in the lower part; upper leaves irregularly flexuose at the tips when dry, stiff, green, erectopate, lanceolate from a hyaline wider sheathing base, up to 10mm. long and 1.2mm. broad; apex sharply acute; margin sharply toothed up to middle. Costa percurrent, toothed at the back above. Lamellae numerous, covering most of the ventral surface, 5 to 6 cells high, end cells larger and usually notched in the middle, thinwalled. Basal leaf cells large rectangular, up to $92 \times 14 \mu$. Upper cells small, rounded-quadrate, $\pm 12 \mu$ wide. Seta single, erect, up to 4.4cm. long. Capsule inclined, smooth, plicate when dry, up to 5cm. long and 1.5cm. in diameter, exothecial cells smooth. Peristome teeth 32 with, brown striations. Spores rounded, hyaline, 7 to 14μ in diameter. Calyptra felty, covering the whole capsule.

DISTRIBUTION of *Pogonatum stevensii*: East Nepal, Bhutan, Darjeeling, Kalimpong, Peshok Road, (1,300-2,150 m.), Khasia Hill, Upper Shillong (1,800 m.), Manipur, Western Himalaya (Chakrata)

Endemic in the Himalaya. But present report from Idukki extends its distribution to south India.

Collection Site: Attukadu (1500m.)

Herbarium No. 13276

Figure: **Plate 5[A]**

Polytrichum densifolium Wils. ex Mitt. in Musc. Ind. or.: 155 (1859)

Polytrichum dasyphyllum C. Muell. in Gen. Musc. Fr.: 181 (1900) *nom. illeg. incl. sp. prior*

Robust, reddish, unbranched plants, ± 2.6 cm. high. Leaves reddish brown, forming a denser tuft above, gradually shorter below, erectopate when moist, erect and appressed to stem when dry, ± 5.5 mm. long, narrow (± 0.55 mm. wide) lanceolate from a short (not more than 1/5 of leaf length), wider (± 0.8 mm. wide), ovate-oblong, concave, sheathing base. Leaf tip acute with the costa ending in a sharp awn-like point; margin serrate to about 2/3 down the lamina. Apical cells of serration up to 61μ long; lamina cells quadrate to somewhat elongated, $\pm 12 \mu$ wide and 12 to 15μ high, incrassate with indented walls.

Basal leaf cells rectangular, thin walled, up to $50 \times 14 \mu$ near costa, shorter ($\pm 28 \mu$ long) towards margin and with a completely transparent marginal wing $\pm 56 \mu$ wide with about 11 rows of elongated rectangular, hyaline cells. Lamellae numerous; end cells $\pm 15 \times 14 \mu$, rounded, smooth, larger, thin walled, 4 to 5 cells high. Perichaetial leaves with higher convolute bases. Seta erect, red-brown, ± 4.3 cm. long. Capsule erect when young, completely covered by the fibrous calyptra; mature capsule red-brown, elongated cubical, ± 4.4 mm. long and 1.75mm. in diameter, horizontal; apophysis short and abruptly narrowing into the seta. Peristome teeth 64, pale in colour, ± 0.25 mm. long and 0.063mm. wide at base and 0.038mm. wide at the upper middle.

DISTRIBUTION of *Polytrichum densifolium*: Alpine Sikkim, S. E. Tibet.

An Indo-Chinese species.

Collection Site: Munnar (1600m.)

Herbarium No. 13277

Figure: **Plate 5[B]**

Sub-class: Bryidae

Key to the orders of Bryidae:

- | | | |
|----|--|---------------|
| 1a | Acrocarpous mosses | 2 |
| 1b | Pleurocarpous mosses. Peristome when present, double. Processes alternate with the teeth | 6 |
| 2a | Peristome when present, single (Haplolepideae) | 3 |
| 2b | Peristome when present, usually double (Diplolepideae) | 5 |
| 3a | Leaves distichous, each with dorsal wing, cells usually rectangular to linear, smooth. Peristome teeth 16, two pronged; dorsal layer thin, mostly clearly longistriate | Fissidentales |
| 3b | Leaves mostly elongate | 4 |
| 4a | Cells of leaves usually rectangular to linear, smooth. Peristome teeth 16, two pronged; dorsal layer thin, mostly clearly longistriate | Dicranales |
| 4b | Cells of leaves predominantly more or less isodiametric and papillose. Peristome teeth two pronged, mostly with thickened papillose dorsal layer | Pottiales |
| 5a | Processes of the endostome on same radii as the teeth of the exostome, lamina cells wide rectangular | Funariales |
| 5b | Processes of the endostome alternate with the teeth of the exostome | Eubryales |
| 6a | Either growth habit acrocarpous, with cells in the middle of the leaf short, rounded, elliptic (not rectangular or rhombic); in the peristome teeth, the outer layer thicker or inner thinner, or growth habit pleurocarpous and lamina cells linear rhombic or short, nerve present | Isobryales |

- 6b Stem radial, seldom complanate leafy. Leaves symmetrical or nearly so, not bordered, single-nerved or enervate; cells smooth or papillose, parenchymatous in some but prosenchymatous to linear in many; alar absent or defined. Capsule erect, inclined or cernuous or pendulous; peristome double, inner often well-developed; calyptra smooth Hypnobryales

Order: Dicranales

Key to the families of Dicranales:

- 1a Leaves multi-stratose, cells usually differentiated into chlorocysts and leucocysts Leucobryaceae
 1b Leaves either uni-stratose or if multi-stratose without such differentiation. Nerve present 2
 2a Leaf base generally not sheathing, if so, leaves in two rows; alar cells generally not distinct Ditrichaceae
 2b Leaf base generally sheathing, alar cells generally distinct Dicranaceae

2. DITRICHACEAE

Key to the genera of Ditrichaceae:

- 1a Upper cells of the leaves elongate, leaves in several rows. Peristome teeth divide into two filiform, papillose crura nearly to the base. Capsule on drying not ribbed 2
 1b Upper cells of the leaves quadrate. Marginal cells in one layer. Capsule on drying more or less distinctly ribbed *Ceratodon*
 2a Capsule exerted, peristome present *Ditrichum*
 3a Operculum differentiated *Garckea*
 3b Operculum not differentiated *Pleuridium*

Pleuridium tenue Mitt. in Musc. Ind. Or. : 7 (1859).

Phascum tenue Wils. in Kew J.Bot., 9: 290 (1857) *nom. nud.*

Small, simple, gracile plants with brown stems ± 2.9 mm. long and 1.8mm. wide with patent, falcate (somewhat flexuose and clinging to stem when dry) leaves. Leaves canaliculate, ± 2 mm. long, lanceolate-subulate from a wider (± 0.2 mm. broad at base), concave, sheathing base. Costa brown, not very prominent at base, filling up the whole of the upper subulate part of the leaf. Leaf margin entire except fine denticulations at tip. Leaf cells elongate, irregularly rectangular (up to $50 \times 11 \mu$) at base, shorter ($\pm 20 \times 4 \mu$) and often with pointed ends at tip. Perichaetial leaves longer and erect. Seta brown, apical, 3.7mm. long. Capsule brown, slightly nodding, erect

when dry, ovate-cylindrical, ± 1.26 mm. long and 0.29mm. in diameter with a transparent, pointed tip but no differentiation of peristome and operculum (cleistocarpic).

DISTRIBUTION OF *Pleuridium tenue*: Sikkim, Kinchinjhau(17,000 ft.), Western Himalaya.

A Himalayan species.

Collection Site: Adimali (1300m.)

Herbarium No. 13278

Figure: **Plate 6[A]**

Garckea flexuosa (Griff.) Margad. & Nork. in J. Bryol., 7: 440 (1973)

Garckea phascoides (Hook.) C. Muell. in Bot. Zeit., 3 : 865 (1845)

Dicranum phascoides Hook. in Misc. Bot., 1: 39 (1829)

Grimmia flexuosa Griff, in Cal. J. Nat. Hist., 2 : 492 (1842)

G. comosa Doz. & Molk. in Ann. Sci. Nat. Bot. Ser. 3, 2 : 304 (1844)

Garckea bescherelli C. Muell. in Besch. in Ann. Sci. Nat. Bot. Ser. 6, 9 : 340 (1880)

G. hildebrandtii C. Muell. in Flora, 69 : 510 (1886)

Weisia flexuosa Hamp. in Par. in Ind. Bryol.: 507 (1896) *nom. nud. in synon.*

Garckea comosa (Doz. & Molk.) Wijk & Marg. in Taxon, 9: 190 (1960)

Dioicous. Yellow-green, in dense loose tufts preferring sandy soil. Stem erect, sometimes branched, up to 2.2mm. long. Leaves crowded in comal tufts at tips, sparse below; narrow lanceolate, erectopate at top, more adpressed to stem below, slenderly acuminate. Lower leaves (L1) shorter, upper leaves (L2) longer (up to 2mm.) and often twisted at tip. Dry leaves with recurved tips. Margins entire. Leaf-cells prosenchymatous, thin-walled, $\pm 118 \times 15 \mu$. at base. Costa well marked, excurrent. Perichaetial leaves not differentiated. One or more terminal sporogonia hidden within leaves with very short seta (± 0.5 mm.long) showing a smaller ovoid vaginula. Archegonia deep brown, ± 0.16 mm. long. Capsule short cylindrical (± 1 mm. long and 0.45mm. in diameter). Operculum conic-rostrate, ± 0.5 mm. long. Calyptra small campanulate, scabrous. Peristome teeth 16, $\pm 140 \mu$ high, red-brown, coarsely

papillose, inserted below rim, irregularly cleft into 2 or more segments. Spores spherical, brown, papillose, 20-26 μ in diameter.

DISTRIBUTION of *Garckea flexuosa*: East Nepal, Bhutan, Ceylon, Burma, Thailand, Indochina (incl. Vietnam), Malaysia, Sumatra, Java, Philippines, New Guinea, Japan, Australia, Oceania, Madagascar, Central America (Panama), Darjeeling, N.E.F.A., Khasia Hills, Sylhet, Tripura State, North Bengal Plains, Lateritic West Bengal (Midnapore), Great Andaman Is., South India.

Cosmopolitan in the tropics of both hemispheres.

Collection Site: Adimali (1300m.)

Herbarium No. 13279

Figure: **Plate 6[B]**

Key to the species of *Ditrichum*:

- | | | |
|----|---|--------------------------|
| 1a | Plants 1 to 1.5cm tall | 2 |
| 1b | Small plants, 0.5cm or less tall | 4 |
| 2a | Plants fairly sturdy with high sheathing perichaetial leaves | <i>D. heteromallum</i> |
| 2b | Plants slender, leaves very small | 3 |
| 3a | Slender plants with clear, long, split (sometimes irregularly) peristome teeth | <i>D. pusillum</i> |
| 3b | Sterile plants with some very small cells at leaf base | <i>D. darjeelingense</i> |
| 4a | Peristome teeth twisted in a tuft. Plants with extremely short stems but long, narrow, lax leaves. | <i>D. tortuloides</i> |
| 4b | Peristome teeth clearly split to base but not spirally twisted. Plants with extremely short stems but long, narrow, lax leaves. | <i>D. tortipes</i> |

Ditrichum darjeelingense Ren. & Card. in Bull. Soc. Roy. Belg., 41 : 51(1905).

Fissidens darjeelingense (Ren. et Card.) Syndow in Bot. Jahresber.. 33: 61 (1906).

Slender, unbranched, dense caespitose, yellow-green plants up to 1cm. long and 1.75mm. wide with leaves. Leaves erectopate, adpressed to stem when dry, up to 1.75mm. long, lanceolate in a narrow subula from a wider (± 0.455 mm. wide) amplexicaul base. Margin smooth, slightly involute at base, finely denticulate at tip. Costa light brown, $\pm 125\mu$ wide at base, covering most of subula, percurrent. All leaf cells thin-walled, rectangular; cells at leaf base shorter ($\pm 14 \times 10\mu$) and irregular, mixed with some longer (up to $33 \times 9\mu$) cells; upper leaf cells more regularly elongated

and narrower ($\pm 33.5 \times 4 \mu$); slightly shorter ($\pm 28 \times 4 \mu$) at the mildly denticulate tip. Distinct from allied species with long plants by its shorter leaf with amplexicaul base.

DISTRIBUTION of *Ditrichum darjeelingense*: Darjeeling.

Collection Site: Poyankutti (1200m.)

Herbarium No. 13280

Figure: **Plate 7[A]**

Ditrichum heteromallum (Hedw.) Britt. in N. Amer. Flora, 15 : 64 (1913)

Weisia heteromalla Hedw. in Sp. Musc.: 71(1801)

Didymodon homomallus Hedw. in Sp. Musc.: 105 (1801)

Grimmia heteromalla (Hedw.) Web. et Mohr in Ind. Mus. Pl. Crypt., 2 (1803)

Grimmia homomalla (Hedw.) Sm. in Fl. Britt., 3 : 1194 (1804)

Bryum unilaterale P. Beauv. in Prodr.: 50 (1805)

Didymodon heteromallus (Hedw.) Hook. and Tayl. in Musc. Brit.: 68 (1818)

Gymnostomum homomallum Brid. in Bryol. Univ., 1 : 757 (1827)

Trichostomum homomallum (Hedw.) B.S.G. in Bryol. Eur., 2 : 130 (1843)

Leptotrichum homomallum (Hedw.) Hamp. in C. Muell. in Syn., 1 : 453 (1848)

Diaphanophyllum homomallum Lindb. in Oefv. K. Vet. Ak. Foerh., 19 : 605 (1863)

Ditrichum homomallum (Hedw.) Hamp. in Flora. 50 : 182 (1867)

Trichostomum heteromallum Lindb. ex Aust. in Bull. Torr. Bot. Cl., 6 : 74 (1876)

Plants laxly gregarious, pale or yellowish green. Stem simple but usually branched by proliferation, up to 1 cm. tall. Leaves secund to subsecund, lanceolate subulate from a broader ovate-rectangular base. Margin almost flat, may be slightly recurved in the subular region. Top leaves up to 3 mm. long. Lower leaves smaller ± 1.8 mm. Nerve filling a greater part of subula, finally excurrent with minute denticulations in the apex. Basal leaf cells irregularly rectangular, lax, up to $73 \times 13.5 \mu$. Upper cells shorter, somewhat thickened and irregular (13.5 to 27μ long and $\pm 5.5 \mu$ broad) at shoulder; thickened and rather narrow but long ($\pm 2.16 \mu$) at the top of subula. Perichaetial leaves longer (± 3.5 mm.) and sheathing, erect. Seta almost straight, ± 1.8 cm. long. Capsule ovate-oblong, ± 1.37 mm. long and 0.37 mm. in diameter, smooth. Operculum conical, obtuse, ± 0.325 mm. high. Peristome fragile.

DISTRIBUTION of *Ditrichum heteromallum*: N.E.F.A., Western Himalaya (U.P.), Europe, Japan, North America, South America, North Africa.

Almost cosmopolitan.

Collection Site: Thattekad (1200m.)

Herbarium No. 13281

Figure: **Plate 7[B]**

Ditrichum pusillum (Hedw.) Hamp. in Flora, 50 : 182 (1867)

Didymodon pusillus Hedw. in Sp. Musc.: 104 (1801)

Trichostomum pusillum (Hedw.) Sm. in Fl. Brit.. 3 : 1237 (1804)

Leptotrichum pusillum (Hedw.) Hamp. in Linnaea. 20 : 74 (1817)

Ditrichum tenue (Hedw.) Hamp. in Flora, 50 : 182 (1867)

Slender green plants in dense tufts with simple or branched stems 1 to 2cm. high. Leaves small (up to 1.3mm. long), erectopatent to erect becoming more pressed to stem when dry, lanceolate from a much broader (± 0.45 mm. broad) triangular base, concave by folding along costa. Margin flat below, recurved near tip. Leaf tip only very minutely denticulate. Nerve clearly defined throughout, broader at base ($\pm 84\mu$), slightly excurrent. Leaf cells elongated, irregularly rectangular, comparatively lax at base (27 to $30\mu \times \pm 11\mu$), narrower at middle leaf ($\pm 30 \times 7\mu$), $\pm 21.6 \times 5\mu$ at tip. Perichaetial leaves erect, half-sheathing. Seta more or less erect, ± 1.65 cm. long. Capsule erect cylindrical, ± 1.73 mm. long and 0.36 mm. in diameter. Peristome teeth split to base, filiform, papillose, $\pm 144\mu$ long.

DISTRIBUTION of *Ditrichum pusillum*: Upper Assam, Europe, Siberia, Central Asia, North Africa, North America.

A North Hemisphere species.

Collection Site: Munnar (1600m.)

Herbarium No. 13282

Figure: **Plate 8[A]**

Ditrichum tortipes (Mitt.) Kuntze in Rev. Gen. Pl., 2 : 835 (1891)

Leptotrichum tortipes Mitt, in Musc. Ind. Or.: 10 (1859).

Trichostomum delicatulum Wils. in Kew. J. Bot. 9: 321 (1837) *nom. nud.* in part.

Ditrichum longicrura Ren. & Card. in Bull. Soc. R. Bot. Belg., 38: 10 (1900).

Monoicous plants in loose tufts. Short (up to 3.2mm.), unbranched brown stems with erectopate leaves which cling to stem when dry. Leaves up to 2mm. long; with elliptical base ± 0.43 mm. broad, about 1/3 the length of the whole leaf; narrowing into a canaliculate subula; margin smooth; leaf tip slightly denticulate. Costa of a deeper brown colour traceable from base to apex, filling up the greater part of the subula. Leaf base cells pellucid, rectangular, up to $84 \times 16 \mu$; upper leaf cells when distinct, seen to be also elongated but shorter and narrower ($\pm 8.4 \mu$ wide). Perichaetial leaves slightly longer. Slender, apical, brown seta up to 13mm. long, straight when moist, slightly flexuose when dry. Capsule brown, slightly bent, asymmetrical, cylindrical, ± 1.4 mm. long and 0.36mm. in diameter with a conical operculum ± 0.43 mm. high. Peristome teeth brown, split; limbs papillose, $\pm 488 \mu$ high. Spores brown, round, 8.4 to 9μ in diameter.

DISTRIBUTION of *Ditrichum tortipes*: Darjeeling, Western Himalaya (Garhwal), South India (Palni).

Collection Site: Munnar (1600m.)

Herbarium No. 13283

Figure: **Plate 8[B]**

Ditrichum tortuloides Grout in Bryologist, 30 : 4 (1927)

Plants in loose tufts. Shoots small (± 48 mm. high in fertile and ± 6 mm. in sterile stems). Leaves erectopate with somewhat falcate upper parts, when dry the lower parts cling to stem while the upper parts are curled. Upper leaves longer, ± 2.6 mm. long, lanceolate from a broader base (± 0.47 mm. broad) narrowing into a canaliculate subula where the lamina may be traced to the tip. Leaf margin smooth below, serrulate at tip. Costa clear from base to apex, $\pm 50 \mu$ wide at base, percurrent. Leafbase cells pellucid, lax, rectangular, $\pm 27 \times 10.8 \mu$ narrower towards vein and margin; midleaf cells also rectangular, $\pm 16 \times 6 \mu$ with slightly thicker walls; apical cells $\pm 135 \times 54 \mu$. Perichaetial leaves slightly

longer (± 3 mm.), erect, half- sheathing but not much differentiated from the adjacent lower leaves. Seta slender, erect, ± 1 cm. long. Capsule brown, erect, symmetrical, cylindrical, ± 1.58 mm. long and 0.36mm. in diameter. Urn mouth with an annulus of red-brown $\pm 50\mu$ high cells. Peristome teeth neatly split to base, filiform, papillose, arising as a tuft from the interior of the urn mouth and the whole tuft showing a spiral twist, $\pm 480\mu$ high. Spores pellucid brown, 8 to 9.5μ in diameter.

DISTRIBUTION of *Ditrichum tortuloides*: Europe, North America, K. & J. Hills, Western Himalaya (Ranikhet).

A Northern Hemisphere species.

Collection Site: Thattekad (1200m)

Herbarium No. 13284

Figure: **Plate 9[A]**

Ceratodon purpureus (Hedw.) Brid. in Bryol. Univ., 1: 480 (1826)

Dicranum purpureum Hedw. in Sp. Musc.: 136 (1801)

Dicranum purpurascens Hedw. in Sp. Musc.: 137 (1801)

Bryum bipartitum Dicks. ex With. in Syst. Arr. Brit. P1. ed. 4, 3 : 318 (1801)

Dicranum celsii Hedw. in Sp. Musc. 149 (1801)

Bryum celsii (Hedw.) With. in Syst. Arr. Brit. P1.: 797 (1801)

B. papillosum Dicks. in P1. Crypt. Brit., 4: 12 (1801)

B. strictum Dicks. in P1. Crypt. Britt.. 4 : 13 (1801)

B. tenue Dicks. ex With. in Syst. Arr. Brit. P1. ed. 4, 3 : 811(1801)

Dicranum intermedium Hedw. in Sp. Musc.: 138 (1801)

Mnium purpureum (Hedw.) With. in Syst. Arr. Brit. P1. ed. 4, 3 : 786 (1801)

Barbula saussuriana Brid. in Bot. Zeit. Regensburg. 1 : 215 (1802)

Dicranum bipartitum (With.) Roth ex Brid. in Musc. Rec., 2 : 51(1803)

B. palustre Brid. ex Schum. in Enum. P1. Saell., 2 : 59 (1803)

Trichostomum basiflorum Schrank ex Schrad. in J. f. Bot. 1801: 196 (1803)

T. tortum Schrank ex Schrad. in J. f. Bot. 1801: 196 (1803)

T. papillosum (Dicks.) Sm. in Fl. Brit.. 3: 1238 (1804)

Dicranum strictum (Dicks.) Sm. in Fl. Brit.. 3 : 1218 (1804)

Tortula saussuriana (Brid.) P. Beauv. in Prodr.: 93 (1805)
Didymodon papillosus (Dicks.) Brid. in Spec. Musc., 1 : 160 (1806)
D. purpureus (Hedw.) Hook. and Tayl. in Musc. Brit.: 65 (1818)
Dicranum longisetum Brid. in Mant. Musc.: 66 (1819)
Barbula conica Spreng. in Syst. Veg.. 4 : 323 (1827)
Trichostomum purpureum (Hedw.) De Not. in Syll.: 189 (1838)
T. conicum Hamp. in C. Muell. in Syn.. 1 : 575 1849 as var.
Ceratodon jawanicus Doz. et Molk. in P1. Jungh., 3 : 337 (1854)
Trichostomum krintjingianum Doz. et Molk. in Zoll. in Syst. Verz.: 31 (1855)
Ceratodon convolutus Reichd. in Verh. Zool. Bot. Ges. Wien. 18 : 194 (1868) as var.
C. brasiliensis Hamp. in Vid. Medd. Nat. For. Kjoebenh. ser. 3, 4 : 39 (1872)
C. capensis Schimp. In Jaeg. in Ber. S. Gall. Nat. Ges. 1870-71: 460 (1872)
C. condensatus Shimp. in Jaeg. in Ber. S. Gall. Nat. Ges. 1870-71: 462 (1872) *nom. nud*
C. amblyocalyx C. Muell. ex Aongstr. in Oefv. k. Vet. Ak. Foerh.. 33 : 50 (1876) as var.
C. minor Aust. in Bot. Gaz.. 2 : 89 (1877) as var.
C. conicus (Hamp.) Lindb. in Musci Scand.: 27 (1879) as var.
C. graefi Schlieph. in Limpr. in Laubm. Deutschl., 1 : 487 (1887) *nom. nud. in synonym.* as var.
C. dimorphus Philib. in Rev. Bryol, 15 : 28 (1888) as var.
C. heterophyllus Kindb. in Ottawa Natural., 5: 179 (1892)
C. columbiae Kindb. in Rev. Bryol.. 23 : 20 (1896)
C. microcarpus C. Muell, in Flora. 82 : 449 (1896)
C. sinensis C. Muell, in Nuov. Giorn. Bot. Ital. n. ser., 3: 104 (1896)
Barbula helvetica Kindb. in Bull. Soc. Bot. Ital. 1896: 15 (1896)
Ceratodon conicus C. Muell, in Hedwigia. 38 : 98 (1899) *hom. illeg.*
C. xanthocarpus Hornsch. ex C. Muell, in Hedwigia. 38 : 98 (1899)
C. brevifolius Mild. ex Par, in Ind. Bro1. Suppl. 100 (1900) as var.
C. delicatulus C. Muell, in Abh. Naturw. Ver. Bremen. 16 : 498 (1900) as var.
C. flavisetus (Limpr.) C. Muell, in Gen. Musc. Fr. : 402 (1900) as var.
Hypnum recurvulum Stirt. in Ann. Scott. Nat. Hist.. 9 : 180 (1900)
Ceratodon moravicus Podp. in Oesterr. Bot. Zeistr.. 52 : 258 (1902) as var.
C. vialis Stirt. in Ann. Scott. Nat. Hist.. 16: 105 (1905)
C. minutifolius Card, in Compt. Rend. Ac. Sc. Paris. 153 : 602 (1911) as var

- C. arcticus* (Kindb.) Roth. in Hedwigia. 53 :132 (1913) as var.
C. microphyllus Card. and Rechin in Roth in Hedwigia. 53 : 132 (1913) as var.
C. purpurascens (Hedw.) Jenn. in Man. Moss. W. Pennsylv.: 57 (1913)
C. cookii C. Muell. in Dix. in N. Z. Inst. Bull.. 3 : 51 (1914) as var.
C. crassinervis Amann in Fl. Mouss. Suisse. 2 : 379 (1918) *hom. illeg.*
C. mollis Amann in Bull. Murithienne, 40 : 44 (1919)
C. wallayanus Giac. in Atti Ist Univ. Lab. Critt. Pavia ser. 5, 9: 191 (1950) as var.

Dioicous. Tufted plants with branched stems. 2 or 3cm. high. Leaves erectopatent, sometimes spreading in the upper halves, laxly imbricate at base; appressed to stem in the lower part and flexuose in the upper part when dry. Upper leaves ± 2.34 mm. long, ovate-lanceolate from a broad (± 0.5 mm.) base, concave, margin revolute throughout the length but usually flat at the acuminate, slightly denticulate tip. Costa clear from base to apex, $\pm 84\mu$ wide at base, percurrent. Leaf basal cells pellucid, rectangular, $\pm 40.5 \times 13.5\mu$; more or less quadrate at middle height, 7 to 9μ long and $\pm 8\mu$ broad; apical cells smaller rectangular, 7 to 18μ long and $\pm 8\mu$ broad. Perichaetial leaves slightly longer, erect, half-sheathing. Seta erect, dark brown, ± 2.4 cm. long. Capsule horizontal, brown, ovate-cylindrical, slightly curved and asymmetrical, ± 2.1 mm. long and 0.8mm. in diameter at middle, coarsely ribbed when dry, minutely strumose at base. Operculum conical, ± 0.5 mm. high. Annulus prominent. Peristome teeth red-brown, cleft to base into two equal, filliform forks, papillose, bordered tip to middle height by wider inner layer of plates, closely articulated at base, $\pm 468\mu$ high. Spores smooth, pellucid, round, 13 to 13.5μ in diameter.

DISTRIBUTION of *Ceratodon purpureus*: East Nepal (4820 m.), Darjeeling (Batasi & Phalut), Upper Assam (Misamari), Kashmir, Western Himalaya, South India, Ceylon, Thailand, Tajikistan, Europe (including Arctic circle), Siberia, China (Shen-Shi), Japan, Java, North America (including Greenland, Alaska), Brazil, Chili, Antarctica, North, Central and South Africa, Madagascar, Australia, New Zealand, Oceania.

A cosmopolitan species.

Collection Site: Kothamangalam (1300m)

Herbarium No. 13285

Figure: **Plate 9[B]**

3. DICRANACEAE

Key to the genera of Dicranaceae:

- | | | |
|----|--|------------------------|
| 1a | Neck of the capsule as long as urn or even longer, inner cells of the nerve not chlorophyllous | <i>Trematodon</i> |
| 1b | Capsule with a short or indistinct neck, inner cells of the nerve not chlorophyllous | 2 |
| 2a | Peristome teeth undivided | <i>Rhabdoweisia</i> |
| 2b | Peristome teeth divided | 3 |
| 3a | Lamina becoming gradually thinner from the nerve towards margin; stomata absent | 4 |
| 3b | Lamina uniformly thick, stomata present | 9 |
| 4a | Seta invariably erect, not cygneous at any stage | 5 |
| 4b | Seta cygneous while young, later it may remain so or become erect and tortuous | 6 |
| 5a | Peristome teeth irregularly split | <i>Microdus</i> |
| 5b | Peristome teeth regularly dicranate to base | <i>Dicranella</i> |
| 6a | Guide cells absent from the nerve; steroidal bands enclosed by hyaline, empty cells | <i>Campylopodia</i> |
| 6b | Guide cells present, with 1 or 2 steroidal bands | 7 |
| 7a | Leaves shortly subulate; stomata indistinct, without stomata | <i>Microcampylopus</i> |
| 7b | Leaves longly subulate; stomata present on the distinct apophysis | 8 |
| 8a | Leaves bordered | <i>Dicranodontium</i> |
| 8b | Leaves not bordered, alar cells coloured and persistent | <i>Campylopus</i> |
| 9a | Alar cells and perichaetial bracts not distinct | <i>Anisothecium</i> |
| 9b | Alar cells differentiated and perichaetial bracts sheathing, steroidal bands absent from the nerve | <i>Dicranoweisia</i> |

Key to the species of *Trematodon*:

- | | | |
|----|---|---------------------|
| 1a | Seta 8-10 mm. long ; neck not distinctly differentiated | <i>T. schmidii</i> |
| 1b | Seta 20-25 mm. long; neck distinctly defined and long | 2 |
| 2a | Capsule very short and wide | <i>T. subulosus</i> |
| 2b | Capsule long and narrow | <i>T. kurzii</i> |

Trematodon kurzii Hamp. ex Gangulee in Bull. Bot. Soc. Beng., 14:12 (1960)

Trematodon kurzii Hamp. in herb. *ined.*

Autoicous. Small plants with stems 2 to 3mm. high. Leaves erect, flexuose, upper leaves ± 4.6 mm. long, gradually tapering from a broad, laxly sheathing base to an elongated, canaliculate, entire apex. Costa brown, narrow at base, gradually broadening to fill up the major part of the leaf above, ending slightly below apex. Lamina cells rectangular (sometimes hexagonal) at base ($\pm 80 \times 25 \mu$ near costa), smaller rectangular ($\pm 20 \times 8.4 \mu$) above and still smaller near apex; top cells distinctly

papillose and subobscure. Perichaetial leaves not differentiated. Seta pale yellow-brown, erect, slightly flexuose above (twisted when dry), 2 to 3.2cm. long. Capsule slightly nodding or erect, urn cylindrical-less than 3mm. long and ± 0.5 mm. in diameter, orange-brown in colour, abruptly contracted into a narrow cylindrical, spongy neck longer (up to 1.5 times) than the urn; struma not developed or imperceptively so. Peristome teeth brown, ± 0.4 mm. high, split to base into two unequal segments, papillose, showing vertical striations and nodes. Spores opaque, yellow-brown, warty, only $\pm 14\mu$ in diameter. Annulus broad. Operculum conic-rostrate, almost smooth, pale brown, smaller than urn in length (± 1.4 mm. high). Calyptra cucullate, entire at base, reaching the middle of urn (± 3.3 mm. long).

DISTRIBUTION of *Trematodon kurzii*: Darjeeling, Burma.

An Indoburmese species.

Collection Site: Athirapalli (1200m.)

Herbarium No. 13286

Figure: **Plate 10[A]**

Trematodon schmidii C. Muell. Bot. Ztg Regensburg 11:40, 1853.

Autoicous, rarely dioicous, frequently pseudo-autoicous. Gregarious or loose-tufted. Leafy shoot short, often profusely innovating at the base. Leaves mostly from sheathing bases, abruptly or gradually lanceolate, subulate; nerve nearly percurrent to shortly excurrent; cells at the base elongate; upwards short, rectangular to rhomboid or 4-6 sided and nearly quadrate, smooth. Perichaetial bracts highly sheathing. Seta elongate, mostly erect, yellow. Capsule with more or less long clavate neck and often curved. Annulus differentiated. Peristome teeth perfectly normal, flat, lanceolate, sometimes undivided and perforated, sometimes upwards unequally forked, rarely divided into two nodose prongs. Operculum with a long oblique beak. Calyptra inflated, cucullate. Upper leaf cells 7-10 μ broad; spores up to 30 μ . Seta 8-10mm. long; neck not distinctly differentiated.

DISTRIBUTION of *Trematodon schmidii*: Nilgiri and Palni hills (Perumalmalai).

Collection Site: Adimali (1300m.)

Herbarium No. 13287

Figure: **Plate 10[B]**

Trematodon subulosus Griff. in Cal. J. Nat. Hist., 2 : 493 (1842)

T. sabulosus Griff. in Cal. J. Nat. Hist., 2 : 493 (1842) Corrected Griff. in Notul. Pl. As., 2 : 4; 3 (1849)

Autoicous. Antheridia terminal on small terrestrial shoots. Small unbranched plants with about 2mm. high brown stems. Leaves patent, not much changed when dry, ± 1.8 mm. long, canaliculate, suddenly tapering from an oval, concave, sheathing base (± 0.36 mm. wide) which is about half the total leaf length; upper narrow lamina also canaliculate; apex acute; margin entire, sometimes revolute. Costa brown, prominent, filling up more than half the upper narrow lamina. Leaf cells elongate rectangular at base (up to $89 \times 17 \mu$ near costa), narrow rectangular ($\pm 28 \times 7 \mu$) above, may be as short as 10μ long at tip margin. Perichaetial leaves erect, more sheathing, not otherwise much differentiated. Seta brown, erect or flexuose, ± 8 mm. long. Capsule cygneous, brown; urn horizontal, cylindrical, 0.8mm. long and 0.6mm. in diameter (Roth has shown a narrower capsule abruptly contracting into a vertical, narrow, paler spongy apophysis which is about 3 times as long as the urn (± 2.34 mm. long), not strumose. Peristome teeth orange, papillose, spirally striated showing nodes, irregularly cleft, $\pm 250 \mu$ high. Spores round, papillose, deep brown, 14 to 17μ in diameter.

DISTRIBUTION of *Trematodon subulosus*: Bhutan, Upper Assam (Misamari), Western Himalaya (Punjab foot hills).

Endemic in the Himalaya. But present report from Idukki extends its distribution to south India.

Collection Site: Kallar (1200m.)

Herbarium No. 13288

Figure: **Plate 11[A]**

Anisothecium molliculum (Mitt.) Broth. in Nat. Pfl., 10 : 177 (1924)

Leptotrichum molliculum Mitt. in Musc. Ind. Or.: 11(1859)

Leptotrichum patulum Mitt. in Musc. Ind. Or.: 11(1859)

Dicranum patulum Wils. in Kew J. Bot.. 9 : 295 (1857) nom. nud.

Dicranella patula (Mitt.) Jaeg. in Ber. S. Gall. Naturw. Ges. 1870-71: 381 (1872)

Dicranella mollicula (Mitt.) Jaeg. in *ibid.*, same page.

Dichodontium molliculum (Mitt.) Broth. in Nat. Pfl., 1(3): 316 (1901)

Dichodontium patulum (Mitt.) Broth. in ibid., same page.

Anisothecium patulum (Mitt.) Broth. in Nat. Pfl., 11 : 525 (1925)

Dioicous plants often mixed with other mosses. Stems branched or unbranched, brown, up to 3.6mm. long and 3.6mm. wide with the squarrose to patent leaves. Leaves more squarrose when dry, ovate-lanceolate, carinate, gradually narrowing into an acute point from a broader, sheathing, concave base; margin dentate in the upper part. Costa prominent, deeper brown, vanishing slightly below the leaf tip. Leaf cells brown, thin walled, each with one small papilla on the upper part; basal cells wide rectangular, thin walled, up to $56 \times 22 \mu$, a near costa where papillae are absent, smaller towards margin; upper laminal cells smaller, up to $25 \times 8 \mu$ at apex but often still smaller on the edge. Perichaetial leaves erect. Seta red-brown, apical (may become lateral by innovations), erect (twisted when dry), ± 6 mm. long. Capsule oval, light brown, asymmetrical although erect, substrumose, ± 1.1 mm. long and 0.47mm. in diameter. Operculum conic-rostrate, slightly inclined to one side, ± 0.9 mm. high. Peristome teeth reddish, dicranate.

DISTRIBUTION of *Anisothecium molliculum*: Darjeeling, Sikkim, Western Himalaya.

A Himalayan species.

Collection Site: Attukadu (1500m.)

Herbarium No. 13289

Figure: **Plate 11[B]**

Microdus brasiliensis (Dub.) Ther. in Bull. Herb. Boiss. ser 2, 7: 277 (1907).

Weisia brasiliensis Dub. in Mem. Soc. Phys. Hist. Nat. Geneve, 7: 412 (1836)

Didymodon pomiformis Griff. in Cal. J. Nat. Hist., 2 : 508 (1842)

Leptotrichum pomiforme (Griff.) Mitt. in Musc. in. Or.: 8 (1859)

Aongstroemia pomiformis (Griff.) C. Muell. in Linnaea. 36 : 12 (1869)

Dicranella pomiformis (Griff.) Jaeg. in Ber. S. Gall. Naturw. Ges. 1870—71: 372 (1872)

Microdus pomiformis (Griff.) Besch. ex Par. in Ind. Bryol.: 805 (1894)

Dicranella brasiliensis (Dub.) Bartram in Philipp. J. Sci., 68 : 34 (1939)

Dioicous. Small tufted plants. Stem simple or forked, upto 7mm. long. Leaves erect or falcate, slightly flexuose when dry, smaller and laxer below. Lower leaves lanceolate, upper ones lanceolate-acuminate from an ovate base and up to 2.3mm. long. Margin smooth. Leaf cells elongate rectangular (upto $42 \times 10 \mu$ at base, slightly smaller above). Costa brown, prominent, covering $\frac{1}{3}$ to $\frac{1}{4}$ of the breadth of the leaf ($\pm 80 \mu$ wide) at base, percurrent or short excurrent. Seta yellow, erect (twisted when dry), 5 to 7mm. long. Capsule small, ovoid to globose, ± 0.7 mm. long and 0.5mm. in diameter, smooth surfaced. Peristome teeth short, very irregularly cleft, not striolate. Operculum conic-rostrate, longer or as long as capsule, slightly oblique. Spores faintly papillose, brown, 14 to 18μ in diameter.

DISTRIBUTION of *Microdus brasiliensis*: Darjeeling, Sikkim, Khasia Hills, Chhotanagpur, Ceylon, Upper and Lower Burma, Java, Philippines, Brazil.

Widely distributed.

Collection Site: Matupatti (1700m.)

Herbarium No. 13290

Figure: **Plate 12[A]**

Key to the species of *Dicranella*:

- | | | |
|----|---|----------------------|
| 1a | Spores 17 to 20μ , peristome striation distinctly spiral | <i>D. spiralis</i> |
| 1b | Spores 20 to 25μ | <i>D. macrospora</i> |

Dicranella macrospora Gangulee in Nov. Hedwigia, 8 : 145 (1964)

Dicranella macrospora Dix. in sched.

Caespitose plants with usually unbranched brown stems ± 1 cm. long. Leaves erectopate, divaricate (bending to one side and falcate when dry), tapering into a long canaliculate subula from a broader (± 0.3 mm. broad), concave, sheathing base. Lower leaves shorter (± 2.2 mm. long), upper leaves longer (up to 2.9mm. long). Lamina traceable to tip, margin smooth except one or two denticulations at tip. Basal leaf cells elongated rectangular, thinwalled, up to $80 \times 14 \mu$, upper cells shorter and narrower, $\pm 50 \times 5.6 \mu$ below tip, even shorter at extreme tip. Costa brown, covering about $\frac{1}{5}$ (or even less) of leaf lamina at base, filling greater part of subula above, percurrent. Seta brown, apical, erect, ± 7.6 mm. long. Capsule brown, cylindrical,

slightly asymmetrical, ± 1.1 mm. long and 0.5mm. in diameter; exothecial cells rather irregularly rectangular, up to $42 \times 22 \mu$, thinwalled. Spores deep brown, coarse papillose, 19.6 to 25.2μ in diameter.

DISTRIBUTION of *Dicranella macrospora*: Assam.

Endemic in this area. But present report from Idukki extends its distribution to south India.

Collection Site: Munnar (1600m.)

Herbarium No. 13291

Figure: **Plate 12[B]**

Dicranella spiralis (Mitt.) Jaeg. in Ber. S. Gall. Naturw. Ges., 1877—78: 374 (1880)

Leptotrichum spirale Mitt. in Musc. Ind. Or.: 158 (1859)

Aongstroemia spiralis (Mitt.) C. Muell. in Gen. Musc. Fr.: 325 (1900)

Anisothecium spirale (Mitt.) Broth, in Nat. Pfl. 2nd Ed., 10 : 177 (1924)

Slender yellow-green plants. Stems up to 8mm. high, usually forked below apex. Leaves erectopate, laxer below, up to 25mm. long, narrowing down from a wide semisheathing base into a subula entirely filled up by the excurrent costa above. Apex almost smooth-margined. Basal leaf cells narrow rectangular (up to $42 \times 7 \mu$), narrower near apex. Costa brown, $\pm 50 \mu$ wide in mature leaf, rather ill-defined at base. Seta red-brown, spirally flexuose when moist, straight but twisted when dry. Capsule red-brown, almost horizontal when moist, short cylindrical, symmetrical, ± 1 mm. long and 0.5mm. in diameter, indistinctly furrowed when dry. Peristome teeth 16, red-brown, $\pm 300 \mu$ high, split to about two-thirds down, papillose specially at tip, showing spiral striations. Operculum long rostrate, bent to one side, shorter than capsule. Spores yellow, faintly papillose, 17 to 20μ in diameter.

DISTRIBUTION of *Dicranella spiralis*: Darjeeling, Sikkim, Western Himalaya.

A Himalayan species.

Collection Site: Munnar (1600m.)

Herbarium No. 13292

Figure: **Plate 13[A]**

Key to the species *Microcampylopus*:

- 1a Leaves long, awl-shaped, pointed, capsule with stomata *M. khasianum*
1b Leaves short, pointed, capsule without stomata *M. subnamus*

Microcampylopus khasianus (Griff.) Giese & Frahm. in Lindb. 11:125-133 (1985)

Campylopodium khasianum (Griff.) Par. in Index Bryol.: 237 (1894)

Dicranum khasianum Griff. in Cal. J. Nat. Hist., 2:496 (1842)

Campylopus tenuis Wils. in Kew J. Bot., 9:296 (1857) *nom. nud.*

Leptotrichum khasianum (Griff.) Mitt. in Musc. Ind. Or.: 8 (1859)

Dicranella khasiana (Griff.) Jaeg. in Ber. S. Gall. Naturw. Ges., 1870-71: 372 (1872)

Aongstroemia khasiana (Griff.) C. Muell. in Gen. Musc. Fr.: 318 (1900)

Dioicous. Small tufted terrestrial plants often mixed with other mosses, specially *Pogonatum* spp. Stems erect, usually unbranched, upto 1.2cm. long. Leaves lax below, more crowded at top of female plant, upto 5.5mm. long, shorter towards base of plant, abruptly narrowing down from a short (about $\frac{1}{3}$ of leaf length), erect, broad, sheathing base into a long, slender subula composed mainly of the excurrent costa, leaf lamina extending to $\frac{1}{3}$ or more of leaf length where it is canaliculate. Leaf tip pointed, almost hyaline. Leaf erect-spreading when moist, more flexuose when dry. Basal leaf cells narrow rectangular, pellucid, upto 85μ long. A patch of shorter, irregular cells at leaf base shoulder. Top cells also narrow elongated but somewhat smaller than at base. Costa brown, covering $\frac{1}{3}$ leaf breadth (upto 100μ wide) but not very well defined at base. Seta brown, usually strongly cygneous whether moist or dry but may be rather straight when dry in some specimens; stiff ± 5 mm. long. Capsule brown to red-brown, ± 1.4 mm. long and 0.6mm. in diameter, surface very rough, longitudinally furrowed when dry, with a very short apophysis showing stomata. Peristome teeth red-brown, vertically striped and split into two up to below the middle, ± 0.25 mm. long. Operculum conic-rostrate, shorter than the capsule length. Calyptra pale, split, cucullate, with smooth base. Spores brown, very warty papillose, 22.5 to 28μ in diameter.

DISTRIBUTION of *Microcampylopus khasianum*: East Nepal, Darjeeling, Sikkim, Khasia Hills, South India, Ceylon.

An Indo-Ceylonese species.

Collection Site: Rajamalai (1600m.)

Herbarium No. 13293

Figure: **Plate 13[B]**

Microcampylopus subnanus (C. Muell.) Fleisch. in Musci Fl. Buitenz., 1 :60 (1902)

Dicranum subnanum C. Muell. in Bot. Zeit., 17 :190 (1859)

Campylopus subnanus (C. Mull.) Jaeg. in Ber. S. Gall. Naturw. Ges., 1870-71:415 (1872)

Caespitose, terrestrial, green plants with brown stems. Usually small (about 0.4mm. high) but may be up to 1cm. Leaves smaller below (up to 1.5mm. long), upper ones in comose tufts, semi-erect when moist, appressed to stem when dry, ± 3 mm. long in Java specimen but up to 4.1mm. in South India. Sheathing leaf base broad, rectangular ovate, up to 0.5mm. wide, covering a little less than $\frac{1}{3}$ of the total leaf length. Suddenly narrows down into a narrow subula and ends in a sharp point which is not distinctly denticulate. Costa about $\frac{1}{4}$ of the leaf lamina at base, covers most of the subula above. Leaf base cells hyaline rectangular (up to $72 \times 15 \mu$), near the leaf base shoulder irregularly quadrate, slightly thick walled; marginal cells on subula narrow elongate ($\pm 34 \times 8 \mu$ at tip). Perichaetial leaves highly sheathing. Seta apical, brown, cygneous when moist, flexuose erect when dry, ± 3 mm. long in Java specimen and ± 4.5 mm. in South India. Capsule horizontal or drooping in moist plant, brown, ovoid with smooth surface, ± 1.2 mm. long and 0.6mm. in diameter without any stomata on the short apophysis. Peristome teeth dicranate. Spores brown, warty papillose, 22.5 to 25 μ in diameter. Operculum conic-rostrate, may be bent to one side, half the urn in height. Calyptra cucullate with smooth edge.

DISTRIBUTION of *Microcampylopus subnanus*: Darjeeling, Sikkim, South India (Palni), Ceylon, Java, Oceania

An Indo-Pacific species.

Collection Site: Attukadu (1500m.)

Herbarium No. 13294

Figure: **Plate 14[A]**

Campylopodiella tenella Card. in Bull. Herb. Boiss. Ser., 2, 8 : 90 (1908)

Paroicous. Slender plants on decaying wood. Stems brown, usually unbranched, Covered with erect to spreading leaves, divaricate or all bent to one side. Sterile stems up to 5.5mm. high, fertile plants shorter. Leaves with a broader (± 0.2 mm, broad) concave base suddenly passing into a very long canaliculate (almost tubular) subula, wide base less than 1/5 the total leaf length. Leaf not much changed when dry. Upper leaves longer (up to 2.6mm.). Costa light brown, almost completely fills up the subula, t.s. shows two rows of thin walled, large cells on two sides and several separate substereide bundles in between. Leaf cells thin walled, elongated, rectangular or rhomboidal (up to $90 \times 17.5 \mu$) at leaf base, becoming narrower but not otherwise differentiated towards margin; subula cells shorter, narrow-elongated, $\pm 39 \times 4 \mu$. Seta apical, cygneous, becoming straightened out or flexuose when dry, ± 6 mm. long. Capsule pale brown, elliptical. Peristome teeth dicranate to middle, sometimes not completely divided. Operculum conic-rostrate. Calyptra cucullate with frilled base.

DISTRIBUTION of *Campylopodiella tenella*: East Nepal, Darjeeling

Endemic in this area. But present report from Idukki extends its distribution to south India.

Collection Site: Athirapalli (1200m.)

Herbarium No. 13295

Figure: **Plate 14[B]**

Key to the species of *Campylopus*:

- | | | |
|----|---|-----------------------|
| 1a | Costa homogenous without stereides | 3 |
| 1b | Costa with stereides | 2 |
| 2a | Costa with stereides only on dorsal side | 6 |
| 2b | Costa with stereides on both sides, leaf tip long, hyaline | <i>C. richardii</i> |
| 3a | Upper lamina cells quadrate or rhomboidal | 4 |
| 3b | Upper lamina cells rectangular, leaf short, alar not inflated | <i>C. latinervis</i> |
| 4a | Leaves 5mm or longer | 5 |
| 4b | Leaves 4.5mm or less, lamina cells shorter or rhomboid | <i>C. goughii</i> |
| 5a | Alar not inflated, upper lamina cells rhomboidal | <i>C. subfragilis</i> |
| 5b | Alar inflated, upper lamina cells quadrate | <i>C. schwarzii</i> |
| 6a | Leaves longer, alar much inflated | <i>C. flexuosus</i> |
| 6b | Leaves longer, alar not inflated | <i>C. aureus</i> |

Campylopus aureus Bosch et Lac. in Bryol. Jav., 1 : 80 (1858)

Campylopus merapicola C. Muell. in Gen. Musc. Fr.: 266 (1900) *nom. nud.*

C. balansaeanus Besch. in Ann. Sc. Nat. Bot. ser. 5, 18 : 199 (1873)

C. balansae Besch. ex Kindb. in Enum. Bryin. Exot. 49 (1888) *nom. illeg. incl. sp. prior*

Dioicous. Plants glossy golden brown, darker below, in cushion-like tufts, dichotomously branched, 1 to 6cm. high. Stiff leaves erect to erectopate, scarcely changed when dry, lanceolate, 3 to 7mm. long, slowly narrowing from the concave, rectangular, wider (± 0.62 mm. broad) base to a long subula the upper part of which is formed of the vein only, leaf margin flat. Costa strong, covering about 2/3 of leaf base, excurrent above the leaf lamina (lamina reaches about 1/2 the total length) into a stiff arista ending in a hyaline, denticulate tip; t.s. of costa shows substereide patches on the dorsal side and a rough dorsal surface. Alar prominent, transparent on the outside and red-brown near costa, not much bulging, ± 0.18 mm. high with cells up to $54 \times 27 \mu$. Lamina base cells rectangular, up to $6.16 \times 11.2 \mu$, becoming narrower (half as narrow) near the margin. These lower cells are sharply demarcated by an oblique line from the upper cells which are rhomboid and incrassate ($\pm 40 \times 11.2 \mu$). Perichaetial leaves longer, high-sheathing, erect. Seta flexuose cygneous (sometimes only partially straightened when dry), 7mm. to 1cm. long. Capsule drooping, egg-shaped, narrow-mouthed, ± 1.44 mm. long and 0.75mm. in diameter. Operculum conic-rostrate. Calyptra bell-shaped with frilled base covering most of the capsule. Spores papillose, $\pm 15 \mu$ in diameter.

DISTRIBUTION of *Campylopus aureus*: Nicobar Island, South India (Palni), Ceylon, Java, Celebes, New Guinea, New Caledonia, Taiwan, Japan

An Indo-Pacific species.

Collection Site: Munnar (1600m.)

Herbarium No. 13296

Figure: **Plate 15[A]**

Campylopus flexuosus (Hedw.) Brid. in Mant. Musc., 4: 71 (1819)

Dicranum flexuosum Hedw. in Sp. Musc.: 145 (1801)

Bryum flexuosum (Hedw.) L. ex With. in Syst. Arr. Brit. Pl. ed. 4, 3 : 817 (1801)

- B. immersurn* Dicks. in Pl. Crypt. Britt. fasc. 4: 15 (1801) *fid.* Brid.
Weisia immersa (Dicks.) Brid. in Sp. Musc., 1 : 124 (1806)
Dicramum palustre La Pyl. in Brid. in Bryol. Univ.. 1 : 814 (1827) *hom. illeg.*
Thysanomitrium flexuosurn (Hedw.) Arnott in Mem. Soc. Linn. Paris, 5 : 262 (1827)
Campylopus arduennae Lib. in Pl. Crypt. Arduenn. n. 106 (1831)
C. talhulensis Sull. et Lesq. in Musci Bor. Am.: 17 (1865)
C. paradoxus Wils. in Hardy in Berwickshire Nat. Hist. Cl., 1868: 48 (1868)
Dicramum subleucogaster C. Muell, in Bull. Torr. Bot. Cl., 5 : 49 (1874)
Campylopus subleucogaster (C. Muell.) Jaeg. in Ber. S. Gall. Naturw. Ges., 1877 -
 78: 381 (1880)
C. subcinereus Stirt. in Ann. Scot. Nat. Hist.. 8 : 105 (1899)
C. roellii Ren. et Card. in Bull. Soc. R. Bot. Belg.. 38 : 9 (1900)
C. melaphamus Stirt. in Ann. Scot. Nat. Hist., 12 : 110 (1903)
C. rubiginosus Stirt. in Ann. Scot. Nat. Hist., 15 : 1 (1906)
C. crenulatus Stirt. in Trans. Bot. Soc. Edin., 26 : 244 (1914)

Dioicous. Somewhat shiny, green to olive-green plants in dense tufts. Plants of variable size and vigour, 1-10cm. high, tomentose, dichotomously branched. Leaves erect to erectopate, flexuose when dry, ± 6 mm. long, lanceolate-subulate from a wider base (up to 0.75mm. broad) slowly narrowing down into a canaliculate subula with incurved margins. Leaf tip margin serrate, tip not hyaline. Costa occupying about 1/2 the leaf base, occupying most but not all of the subula, with substereide bundles on the dorsal side but the dorsal surface smooth. Alar brown, highly bulging, rather large ($\pm 0.32 \times 0.28$ mm.), formed of large inflated cells upto $60 \times 30 \mu$. Lamina cells at base long rectangular, $\pm 27 \times 11.5 \mu$ near costa, becoming about half as narrow near margin; upper lamina cells shorter rectangular, $\pm 19 \times 7.6 \mu$ near costa, shorter towards margin, almost rhomboidal and incrassate at margin.

DISTRIBUTION of *Campylopus flexuosus*: East Nepal, Europe (Great Britain, Sweden, Alps), Siberia, China, Algeria, Abyssinia, Madagascar, Australia, New Zealand, Oceania, North, Central and South America.

A cosmopolitan species.

Collection Site: Munnar (1600m.)

Herbarium No. 13297

Figure: **Plate 15[B]**

Campylopus goughii (Mitt.) Jaeg. in Ber. S. Gall. Naturw. Ges., 1870-71: 424 (1872)

Dicranum goughii Mitt. in Musc. Ind. Or.: 17 (1859)

Campylopus compactus Wils. in Kew J. Bot. 9 :297 (1857) *nom. nud.*

Campylopus nilghiriensis (Mitt.) Jaeg. in Ber. S. Gall. Naturw. Ges., 1870-71 : 426 (1872)

Dioicous. Caespitose, comose plants sometimes showing branching. Stems light brown, up to 2cm. long. Leaves up to 3.5mm. long, erect to erectopatent, flexuose when dry, short lanceolate extending into a canaliculate subula; margin inflexed in the upper two-thirds with a scarcely serrulate tip. Leaf base ± 0.4 mm. broad, tapering towards the alar region. Alar not bulging out, alar cells not inflated, hyaline and distinct from general leaf colour. Yellow-brown costa occupying about 1/2 of leaf breadth at base. Basal lamina cells light yellow, rectangular (up to $42 \times 22 \mu$), becoming narrower towards the margin. Higher up, lamina cells become smaller ($\pm 14 \times 6 \mu$) rhomboid, moderately incrassate and tinted light brown like the costa. Brown seta ± 4 mm. long, cygneous when moist and straight or somewhat flexuose when dry. Capsule red-brown, ovate, ± 1.6 mm. long and 0.6 mm. in diameter, lightly plicate when dry. Operculum rostrate, short. Peristome red-brown, dicranate. Calyptra edge smooth to crenate.

DISTRIBUTION of *Campylopus goughii*: East Nepal, Sikkim, Darjeeling, Bhutan, Khasia Hills, Western Himalaya, South India (Palni), Ceylon.

An Indoceylonese species.

Collection Site: Athirapalli (1200m)

Herbarium No. 13298

Figure: **Plate 16[A]**

Campylopus latinervis (Mitt.) Jaeg. in Ber. S. Gall. Naturw. Ges., 1870—71:426 (1872)

Dicranum latinervis Mitt. in Musc. Ind. Or.: 17 (1859)

Caespitose. Brown stems up to 2cm. long often proliferating by branches through tips. Leaves erectopatent, not much changed (only appressed to stem) when dry, up to 4.4mm. long at the stem tip, lanceolate extending into a long tubular (by the rolling of the margin) subula, margin inflexed except at base, leaf tip slightly denticulate, ± 0.55 mm. broad at base. Alar cells larger, hyaline, but not much inflated not forming

auricles. Yellow-brown costa about 3/5 of leaf width at base, then covering almost the whole subula. T.s. of costa shows large, irregular, thin walled cells (without any stereids) forming it. Lamina cells rectangular, $\pm 33.5 \times 14 \mu$ at base near costa, narrower towards margin, $\pm 14 \times 4.2 \mu$ at middle of leaf. Perichaetial leaves erect, rather long (up to 6.2mm.). Seta red-brown, cygneous when moist, erect or bent when dry, ± 1.2 cm. long. Capsule ovate-cylindrical, ± 1.8 mm. long and 0.6mm. in diameter, Operculum subulate rostrate, ± 0.9 mm. long. Calyptra base fimbriate, greenish yellow, ± 2.3 mm. high. Spores brown, $\pm 28 \mu$ in diameter.

DISTRIBUTION of *Campylopus latinervis*: East Nepal, Sikkim, Darjeeling, South India (Nilgiri), Ceylon.

An Indoceylonese species.

Collection Site: Munnar (1600m.)

Herbarium No. 13299

Figure: **Plate 16[B]**

Campylopus richardii Brid. in Mant. Musc. : 73 (1819)

Thysansmitrion richardii (Brid.) Schwaegr. in Sp. Musc. Suppl. 2(1): 61(1823)

Trichostomum exasperatum Nees et Blum. in Nov. Act. Ac. Leop. Car., 11 : 134 (1823)

Thysanomitron umbellatum W. Arn. in Disp.: 34 (1826)

Trichostomum umbellatum (W. Arn.) Schwaegr. in Frey. Voy. Bot.: 224 (1826)

Campylopus exasperatus (Nees et Blum) Brid. in Bryol. Univ., 1 : 473 (1826)

Grimmia richardii (Brid.) Spreng. in Syst. Veg., 4 : 154 (1827)

Dicranum exasperatum (Nees et Blum.) Griff, in Cal. J. Nat. Hist.. 2 : 501 (1842)

Trichostomum blumei Doz. and Molk. in Ann. Sci. Nat. Bot. Ser. 3, 2 : 316 (1844)

Dicranum riichardii (Brid.) C. Muell. in Syn., 1: 413 (1848)

D. dozyanum C. Muell. in Syn., 1 : 385 (1848)

D. laevigatum C. Muell. in Syn., 2 : 601 (1851)

Campylopus blumei (Doz. & Molk.) Bosch. & Lac. in Bryol. Jav. 1 : 68 (1858)

Dicranum nigrescens Mitt. in Musc. Ind. Or. : 19 (1859)

D. didrichsenii C. Muell. in Bot. Zeit., 20 : 329 (1862)

Thysansmitrion mulleri Hamp. in Ann. Sc. Nat. Bot. Ser. 5, 3 : 363 (1865)

- Campylopus nigrescens* (Mitt.) Dub. in Mem. Soc. Phys. Hist. Nat. Geneva. 19 : 292 (1867)
- Dicranum subexasperatum* C. Muell. in Linnaea, 37 : 169 (1872)
- Campylopus laevigatus* (C. Muell.) Schimp. in Besch. in Mem. Soc. Sc. Nat. Cherbourg, 6 : 167 (1872)
- C. dozyanus* (C. Muell.) Jaeg. in Ber. S. Gall. Naturw. Ges., 1870—71: 418 (1872)
- C. nigrescens* (Mitt.) Jaeg. in *ibid.* : 417 (1872)
- C. didrichsenii* (C. Muell.) Jaeg. in *ibid.*: 424 (1872)
- C. mulleri* (Hamp.) Jaeg. in *ibid.*: 442 (1872)
- C. subexasperatus* (C. Muell.) Jaeg. in Ber. S. Gall. Naturw. Ges., 1877—78: 384 (1880)
- C. umbellatus* (W. Arn.) Par. in Index Bryol.: 264 (1894)
- Dicranum pertiste* C. Muell. in Flora, 82 : 444 (1896)
- Campylopus pertristis* (C. Muell.) Par. in Ind. Bryol. Suppl. 95 (1900)
- C. powellii* Par. in *ibid.* 95 (1900) *nom. nud.*
- C. sandwicensis* Par, in *ibid.* 97 (1900)
- Pilopogon umbellatus* (W. Arn.) Broth. in Nat. Pflanz., 1: 336 (1902)
- Pilopogon exasperatus* (Nees et Blum) Broth. *ibid* same page
- Pilopogon nigrescens* (Mitt.) Broth. *ibid* same page
- Pilopogon richardii* (Brid.) Broth. *ibid.* same page
- Pilopogon subexasperatus* (C. Muell.) Broth. *ibid* same page
- Pilopogon blumei* (Doz. & Molk.) Broth. *ibid* same page
- Thysanomitrium blumei* (Doz. & Molk.) Broth, in Nat. Pflanz. 2nd ed., 10 : 189 (1924)
- Thysanomitrium nigrescens* (Mitt.) Broth. *ibid* same page
- Thysanomitrium subexasperatum* (C. Muell.) Broth. *ibid* same page
- Thysanomitrium exasperatum* (Nees et Blum) Hornsch. in Broth. *ibid* same page

Dioicous. Densely caespitose, dark-green tufts of comose plants branching through proliferations from tips. Brown single stems (not counting proliferations) up to 25cm. long although plants may look much longer because of proliferations from comal tufts; reddish tomentose below. Leaves crowded, up to 5mm. long in comal tufts; erectopatent, not changing much when dry, lanceolate, extending into a canaliculate tip which is usually hyaline; margins often inflexed above, not noticeably serrulate. Leaf base about

0.9mm. wide, widest at alar region, with developing rhizoids. Alar cells inflated, irregular, red-brown, bulging to form auricles. Brown costa occupying about 1/3 of leaf breadth at base, with stereides on both sides of the deuter row, wavy (not lamellose in this specimen) on back in cross-section. Basal lamella cells yellow-brown, thin walled, irregularly rectangular, up to $30.5 \times 12 \mu$; become more and more incrassate above, the lumen being reduced to rhomboidal-oval slits ($30 \times 5 \mu$) at middle height of leaf. Several sporophytes on comal tufts looking like umbels. Seta red-brown, cygneous, ± 8 mm. long. Capsule red-brown, ovoid, ± 1.6 mm. long and 0.5mm. in diameter, sometimes rough at base, may or may not be furrowed when dry. Peristome teeth red-brown, $\pm 430 \mu$ long, dicranate to or below middle, often with unequal limbs, with slightly oblique vertical stripes below, papillose and paler above. Operculum conic-rostrate, mm. long. Calyptra ± 1 mm. high, frilled at base. Spores light brown, pellucid, 11.2 to 12.6μ in diameter.

DISTRIBUTION of *Campylopus richardii*: East Nepal, Darjeeling, Sikkim, Khasia Hills, Widespread over the Himalayan ranges (East and West), spreading to South India (Eastern and Western Ghats, Nilgiri, Palni, etc.) over Chhotanagpur; Ceylon, Burma, Vietnam, Malay, Sumatra, Java to Celebes, Borneo, New Guinea, Philippines, Taiwan, China, Japan, Hawaii, Tahiti, Sandwich Is., Central and South America.

Widespread in Indo-Pacific region and South America.

Collection Site: Munnar (1600m.)

Herbarium No. 13300

Figure: **Plate 17[A]**

Campylopus schwarzii Schimp. in Musci. Eur. Nov. Bryol. Eur. Supplm. fasc. 1-2, 1 : 1 (1864)

C. auriculatus Wils. in MacKinlay in Proc. Nat. Hist. Soc. Galsgow, 1 : 91 (1869)

C. symplectus Stirt. in Scott. Natural., 11: 234 (1886)

C. purpurascens Stirt. in Ann. Scott. Nat. Hist., 10 : 109 (1901) *hom. illeg.*

Dioicous. Large, silky yellowish to bright green plants in dense tufts with simple or dichotomously branched, erect or flexuose shoots usually about 2cm. high (known to be up to 8cm.). Leaves erectopatient to erect, not much changed (only more erect) when dry, 4 to 7mm. long, gradually narrowed from a wider (± 0.5 mm. broad) base into a long

tubular subula with incurved margins, tip not hyaline. Costa broad, covering up to 3/4 of leaf base; in t.s. 3 to 4 layers thick, without stereides, dorsal layer rough or grooved; covering practically the whole of the apical subula, very lightly toothed or smooth even in the extreme apex. Alar prominent, bulging (auriculate) with large thinwalled, inflated cells, about 0.11mm. high, brownish-red in colour. Lamina cells not incrassate, large rectangular ($\pm 30 \times 8 \mu$) near costa, becoming very narrow in 5-7 marginal rows and short rectangular ($\pm 20 \times 6 \mu$) with slightly thicker walls above.

DISTRIBUTION of *Campylopus schwarzii*: East Nepal (3,100- 4,100 m.), Darjeeling (2,000- 3,500 m.), Europe, Japan.

A Northern Old World species.

Collection Site: Attukadu (1500m.)

Herbarium No. 13301

Figure: **Plate 17[B]**

Campylopus subfragilis Ren. & Card. in Bull. Soc. R. Belg., 34: 59 (1896)

Radiculose, comose plants showing branching by proliferations from tips. Brown stem up to 1.8cm. long. Leaves up to 7mm. long, erectopatent, flexuose in the top part, more so when dry, lanceolate, extending into a long canaliculate subula, margin inflexed except at base, tip serrulate. Leaf base ± 0.6 mm. broad, narrower at alar region. Alar not bulging out, formed of a few cells which are not much inflated, orange in colour and distinct from the brown costa. Costa light brown, broad but not broader than 2/3 of leaf breadth, smooth on back without stereides. Basal lamina cells pale, irregularly rectangular (up to $60 \times 15 \mu$). Upper lamina cells smaller (up to $16 \times 8 \mu$), rhomboid, distinctly incrassate and light brown like the costa.

DISTRIBUTION of *Campylopus subfragilis*: Darjeeling (2,000m.), East Nepal (2,200-3,000m.), South India.

Endemic in India.

Collection Site: Matupatti (1700m.)

Herbarium No. 13302

Figure: **Plate 18[A]**

Dicranodontium denudatum (Brid.) Britt. in Williams in N. Am. Fl., 15 : 151 (1913)
Dicranum drnudatum Brid. in Sp. Musc., 1 : 184 (1806)
Didymodon longirostris Web. et Mohr in Bot. Taschenb.: 155 (1807)
Cynodontium longirostre (Web. et Mohr) Schwaegr. in Sp. Musc. Suppl., 1 : 111 (1811)
Didymodon denudatus (Brid.) Opiz in Boehm. Phan. Krypt. Gew: 121 (1823)
Campylopus longirostris (Web. et Mohr) Sendtn. in Flora. 31 : 215 (1848)
Trichostomum longirostre (Web. et Mohr.) Hartm. in Handb. Skand. Fl. ed. 5: 385 (1849)
Campylopus alpinus Schimp. in Musc. Eur. Nov. Bryol. Eur. Suppl. Campyl. 1-2: 5 (1864) as ssp.
C. flexuosus (Hedw.) Brid. var. *pachyneuron* Mol. in Ber. Naturh. Ver. Augsburg. 18 : 139 (1865) as ssp.
C. intermedius Wils. in Hunt. in Mem. Lit. Phil. Soc. Manchester ser. 3. 3 : 234 (1867) *nom. nud.*
C. pachyneuros (Mol.) Walth. et Mol. in Laubm. Oberfrank.: 106 (1868) as ssp.
Dicranodontium uncinatum C. Muell. in Jaeg. in Ber. S. Gall. Naturw. Ges., 1877 - 78 : 381 (1880)
Campylopus demudatus (Brid.) Kindb. in Bih. K. Svensk. Vet. Ak. Handl., 7 : 87 (1883)
Dicranum notabile Stirt. in Scott. Natural., 8 : 257 (1886)
Dicranodonthon millsphaugii Britt. in Millsp. in Bull. West Virginia Agric. Exp. Sta., 24 : 488 (1892)
D. virginicum Britt. in Millsp. in *ibid.*: 488 (1892)
Dicranum longirostre (Web. et Mohr) Kindb. in Eur. N. Am. Bryin., 2 : 190 (1897)
D. pachyneuron (Mol.) Kindb. in *ibid.*: 190 (1897)
Dicranodontium alpinum (Schimp.) Loesk. et Podp. in Zpravy Komm. Prir. Pozk. Moravy Odd Bot., 2 : 54 (1906)

Dichotomously branched plants in silky pale green (golden greenish brown when dry) low tufts with somewhat flexuose, radiculose stems 2 to 3cm. tall (longer plants also reported) with sparsely leaved base. Leaves deciduous, falcate or flexuose spreading (strongly flexuose when dry), very small below, larger leaves tufted above, 5 to 8mm. long, slowly narrowing from a sheathing, concave, wider (up to 0.5mm. wide) base to a long, narrow, tubular subula with incurved margins; margin entire. Costa covering 1/4 to 1/3 of costa, excurrent in a finely denticulate, flagellate apex of variable length. Alar prominent, inflated, ±0.12mm. high and 0.18mm. broad, transparent with large cells. Lamina cells moderately thickwalled, rectangular at base, up to 57×11µ

becoming narrower near margin; irregular (rectangular, oval, etc.) and smaller (13.5 to 27 μ long and \pm 8 μ wide) above.

DISTRIBUTION of *Dicranodontium demudatum*: East Nepal (3,500-3,650m.), Sikkim (2,000-4,000m.), Darjeeling, Europe (including Great Britain), Caucasus, Siberia, China, Japan, North, Central and South America.

A widely distributed species.

Collection Site: Athirapalli (1200m.)

Herbarium No. 13303

Figure: **Plate 18[B]**

Rhabdoweisia crenulata (Mitt.) James. in Rev. Bryol., 17 : 6 (1890)

Didymodon crenulatus Mitt, in Musc. Ind. Or.: 23 (1859)

Rhabdoweisia denticulata Wils. et Mitt. in Kew J. Bot.. 9 : 293 (1857) *nom. nud. hom. illeg.*

Weisia longifolia D.C. in Brid. in Bryol. Univ., 1 : 804 (1827) *nom. nud.*

W. denticulata Brid. *nom. illeg.* var. *longifolia* Brid. in Bryol. Univ., 1 : 804 (1827)

Rhabdoweisia denticulata B.S.G. var. *longifolia* (Brid.) Limpr. in Laubm. Deutschl., 1: 277 (1886)

Oncophorus crenulatus (Mitt.) Braithw. in Br. Moss Fl., 1 : 300 (1887)

Rhabdoweisia sikkimensis C. Muell. in Par. in Index Bryol. ed. 2, 4 : 142 (1905) *nom. nud.*

Leptodontium rossii Stirt. in Trans. Proc. Bot. Soc. Edin., 26 : 425 (1915)

Rhabdoweisia laeidens Broth. in Symb. Syn., 4 : 21(1929)

Monoicous, small, green plants growing in cracks of siliceous rocks, about 1 cm. high. Red-brown stem without central strand, usually unbranched but may branch occasionally. Leaves laxly patent, curly when dry, lingulate, up to 3.5mm. long and less than 0.4mm. wide at base. Lower leaves are shorter and wider, lingulate, \pm 1.7mm. long and 0.5mm. wide at base. Leaf apex acute to obtuse; margin closely crenulate-denticulate in the upper half. Light brown costa, \pm 70 μ wide (about 1/6 of leaf base breadth), vanishing below apex. Lamina cells rectangular, large (up to 77 \times 21 μ) and more or less hyaline at base, specially near the costa where they are the largest; subquadrate, smaller (\pm 16 \times 12 μ) and subobscure above. Seta light brown, straight, spirally twisted when dry, \pm 5mm. long. Capsule erect, yellow- brown, oval, with 8 prominent ribs when dry, \pm 0.9mm. long and 0.5mm. in diameter. Operculum conic-

rostrate, may or may not be bent to one side. Peristome teeth yellow-brown, oblique and cross-stripped, erect when dry, broader at base, $\pm 266\mu$ long. Spores brown, 18.5 to 21μ in diameter.

DISTRIBUTION of *Rhabdoweisia crenulata*: Darjeeling, Sikkim, Europe; China, Formosa; North and South Africa; North, Central and South America.

A widely distributed species.

Collection Site: Kannimalai (1600m.)

Herbarium No. 13306

Figure: **Plate 19[A]**

Dicranoweisia alpina (Mitt.) Par. in Index Bryol.: 339 (1895)

Holomitrium alpinum Mitt. in Musc. ind. Or.: 25 (1859)

Yellow-green plants usually simple, may be bifurcate, with dark brown stem ± 1.1 cm. long, covered with patent to falcate leaves which may be secund which show only a little tendency to curling but are closely appressed to stem when dry. Leaves up to 4.3mm. long, oblong to ovate in the base which is about 1/3 of the leaf and ± 0.72 mm. wide, tapering into a long canaliculate subula above. Margin unbroken, incurved. Costa prominent, brown $\pm 146\mu$ wide at base but covering most of the subula above. Basal lamina cells yellow, elongated rectangular, up to $64 \times 11\mu$ near base, becoming narrower at leaf base margin and smaller at the same time incrassate above, $\pm 11.2 \times 7\mu$ at top of basal lamina and still smaller ($\pm 8.5 \times 5.6\mu$) in subula. Prominent alar of rectangular cells (up to $28 \times 20\mu$) which are wider though not inflated and not forming auricle, deep brown in colour. Perichaetial leaves slightly longer, erect. Seta erect, flexuose when dry, ± 11.5 mm. long, red-brown. Capsule ovate-cylindrical, reddish brown, ± 2.34 mm. long and 0.54mm. in diameter. Operculum conic subulate. Spores brown, large (some spores within capsule seemed to be 36μ in diameter).

DISTRIBUTION of *Dicranoweisia alpina*: Sikkim

Endemic in this area. But present report from Idukki extends its distribution to south India.

Collection Site: Matupatti (1700m.)

Herbarium No. 13307

Figure: **Plate 19[B]**

4. LEUCOBRYACEAE

Key to the species of *Leucobryum*:

- | | | |
|----|--|-------------------------|
| 1a | Silky plants with slender, flexuous leaves | 2 |
| 1b | Coarse plants with short leaves, leaf lamina cells not pitted, elongated only in border rows | <i>L. nilghiriense</i> |
| 2a | Large plants with leaves upto 10mm long. Leaf lamina base cells pitted. Leaf base leucocysts 3 or 4 layer deep | <i>L. bowringii</i> |
| 2b | Smaller plants with leaves less than 5mm long. Leaf formed of 2 layers of leucocysts throughout | <i>L. juniperoideum</i> |

Leucobryum bowringii Mitt. in Musc. Ind. Or.: 26 (1859)

Leucobryum angustifolium Wils. in Kew. J. Bot., 9 : 293 (1857) *nom .nud.*

L.yamatense Besch. in J. de Bot., 12 : 288 (1898)

L. sericeum Broth. ex Geh. in Biblioth Bot., 44 : 26 (1898) as var.

L. brotheri Card. in Bull. Soc. R. Bot. Belg., 41 : 36 (1905) as var.

Epiphytic, silky plants forming dense tufts with branched stems ± 1.5 cm. long and densely covered with narrow, elongated leaves. Leaves up to 1cm. long, patent to flexuose, gradually narrowed to a long, narrow, tubular, acute tip from a wider concave base. Costa wide, smooth at back, showing one layer of 4-angled chlorocysts between 2 layers of leucocysts in the upper part; leucocysts become multi-layered (2 layers on dorsal side and 1 or 2 layers on the ventral) near the base. Leucocyst cells measure up to $70 \times 28 \mu$. Lamina cells narrow, elongated, somewhat incrassate with pitted walls, up to 12 rows at the basal region, gradually narrowing and ultimately vanishing upwards. Perichaetial leaves smaller (± 3 mm. long) with ovate base. Reddish, slender seta ± 1.6 cm. long, lateral by further growth of branches. Capsule inclined, strumose, asymmetrical, ± 1.2 mm. long, lightly plicate.

DISTRIBUTION of *Leucobryurn bowringii*: Khasia Hills, N.E.F.A., South India (Palni), Ceylon, Malay, Vietnam, Borneo, New Guinea, Philippines, Formosa, China, Japan.

A South East Asiatic species.

Collection Site: Matupatti (1700m.)

Herbarium No. 13308

Figure: **Plate 20[A]**

Leucobryum juniperoideum (Brid.) C. Muell. in *Linnaea*, 18 : 689 (1845)

Dicranum juniperoideum Brid. in *Bryol. Univ.*, 1 : 409 (1826)

Silky epiphytic plants with small branched stems about 7mm. long and 6mm. wide with leaves. Leaves up to 4.5mm. long, patent to spreading flexuose, not much changed when dry; gradually narrowed to a narrow, tubular, acute tip from a wider (± 0.48 mm. wide) concave base. Costa wide, smooth at back, formed uniformly from base to apex of one layer of chlorocysts sandwiched between two layers of leucocysts. Leucocyst cells irregularly rectangular, $\pm 46 \times 17 \mu$ at base, $\pm 30 \times 15 \mu$ above and still shorter at the acute tip. Lamina cells hyaline, about 5 rows similar in size to the leucocyst cells and then bordered at margin by another two rows of very narrow cells. Hyaline lamina narrower above but persists to tip.

DISTRIBUTION of *Leucobryum juniperoideum*: Khasia Hills, West and Central Europe, Canary Islands, Reunion, Madagascar, Turkey, Caucasus, China, Japan, Brazil.

A widely distributed species.

Collection Site: Munnar (1600m.)

Herbarium No. 13309

Figure: **Plate 20[B]**

Leucobryum nilghiriense C. Muell. in *Bot. Zeit.*, 32 : 556 (1854) name corrected from *neilgherrense* (*ortho. err.*) by Mitt. in *Musci. Ind. Or.*: 26 (1859)

Leucobryum holleanum Doz. & Molk. in *Bryol. Jav.*, 1: 17 (1855)

L. vulgare Wils. in *Kew J. Bot.*, 9 : 293 (1857) *nom. nud.*

L. triviale C. Muell. in *Linnaea*, 36 : 30 (1869)

L. muelleri Levier in *Par. in Index Bryol. Suppl.* 228 (1900) *nom. nud.*

L. sikkimense Card. in *Ren. & Card. in Bull. Soc. R. Bot, Belg.*, 41 : 29 (1905) *nom. nud. in synonym.*

L. ferriei Card, in *ibid.*: 28 : (1905)

Dull whitish green plants on tree trunks forming dense tufts with branched or single stems, up to 2.5cm. long, densely covered with usually erect, sometimes erect-spreading, more or less rigid leaves up to 6mm. long. Leaves gradually narrowing

from a comparatively broad (± 1 mm. wide), ovate, concave base to a rigid, canaliculate, minutely apiculate apex. Costa wide, smooth on back, with one layer of 4-angled chlorocysts between 2 layers of leucocysts, the latter becoming multi-layered (usually 3 layers on the dorsal and 2 on the ventral side-excepting the median region where the layers do not increase) at the base. Leucocysts $\pm 42 \times 28 \mu$ at base. Lamina cells hyaline, 9 to 12 rows at base, gradually decreasing in width towards top; inner cells rectangular but 2 or 3 marginal layers at base formed of narrow, elongated cells; not incrassate or pitted.

DISTRIBUTION of *Leucobryum nilghiriense*: East Nepal (1,850 m.), Darjeeling, Sikkim, Bhutan, Khasia Hills, Manipur, South India (Nilgiri, Palni), Ceylon, Burma, Thailand, Vietnam, Sumatra, Java, Borneo, Celebes, Philippines, China, Korea, Japan, Fiji.

An Indopacific species.

Collection Site: Matupatti (1700m.)

Herbarium No. 13310

Figure: **Plate 21[A]**

Order: Fissidentales

5. FISSIDENTACEAE

Key to the species of *Fissidens*:

- | | | |
|----|--|----------------------|
| 1a | Comparatively smaller plants | 2 |
| 1b | Medium to large plants | 3 |
| 2a | Leaf cells papillose or mamilllose, leaf margins denticulate, seta bent down | <i>F. pulchellus</i> |
| 2b | Leaf cells smooth, base of dorsal lamina ending on excurrent or percurrent nerve | <i>F. pellucidus</i> |
| 3a | Plants comparatively less sturdy, sporophyte on basal lateral shoot | <i>F. taxifolius</i> |
| 3b | Plants large, undifferentiated, one-layered leaf margin | <i>F. areolatus</i> |

Fissidens areolatus Griff. in Cal. J. Nat. Hist., 2 : 506 (1842)

F. polypodioides Hedw. var. *areolatus* (Griff.) Wils. in Kew J. Bot., 9 : 294 (1857)

F. yakushimensis Toyama in Act. Phytotax. Geobot., 4 : 216 (1935) *fid.* Noguchi

Yellowish green sturdy plants forming turf in very shaded places (often cavings) on moist soil. Plants up to 5cm. long and 9mm. broad with leaves, often flexuose. Up to 26 pairs of leaves (about 0.5 leaves per mm. of stem on the average). Leaf curled but not much crumpled when dry; oblong-lingulate, with more or less rounded apex, up to 5mm. long and 1.1mm. broad. Dorsal lamina base rounded, sometimes auriculate. Sheathing lamina usually slightly unequal; sometimes there is a constriction on the leaf where the sheathing lamina terminate. Leaf may be slightly broader at basal region. Leaf cells not incrassate, almost smooth; rounded hexagonal, 10 to 19 μ diagonally, more elongated at the base of the sheathing lamina (up to 48 μ long); margin only faintly toothed near apex and not otherwise differentiated. Perichaetial leaf narrower and with much elongated basal cells. Nerve only slightly darker than the leaf, percurrent, suddenly narrows down near apex. Stem red-orange at base, lighter orange upwards. Deep orange seta, terminal (sometimes two from the apex) as well as lateral on axillary shoots, 8 to 9mm. long bearing light orange, cylindrical capsule \pm 2mm. long and 1.2mm. in diameter; operculum conic-rostrate, \pm 1.5mm. long. Peristome teeth orange, bifid, showing annular thickening and fine vertical striations, \pm 0.47mm. high. Archegonia deep orange, \pm 0.8mm. long. Spores light brown, transparent, 5.5 to 12.5 μ in diameter.

DISTRIBUTION of *Fissidens areolatus*: East Nepal (2,300 - 3,000 m.), Darjeeling, Sikkim, Khasia Hills, N.E.F.A., Burma, Thailand, Vietnam, Malay, Sumatra, North Borneo, Philippines, Taiwan, China, Japan (widespread).

A Southeast Asiatic species.

Collection Site: Devikulam (1700m.)

Herbarium No.13311

Figure: **Plate-21[B]**

Fissidens pellucidus Hornsch. in Linnaea., 15:146. (1841)

Fissidens mittenii Par. in Index Bryol.: 477 (1896)

F. crassinervis Thwait. & Mitt. (*non.* Lac.) in J. Linn. Soc. Bot., 13 : 323 (1873) *hom. Illeg.*

F. immutatus Dix. in J. Ind. Bot., 2 : 179 (1921) *nom. delendum fid.* Dix.

Small, terrestrial, yellow green (with tinge of reddish brown) plants up to 5mm. high and 1.4mm. wide with leaves. Stem usually simple with 6 to 7 pairs of erectopate leaves (about 4 leaves per mm. of stem). Upper mature leaves oblong-lanceolate, acute-acuminate, crumpled but not much changed when dry, ± 0.9 mm. long and 0.24mm. wide (widest at middle of leaf) with sheathing lamina 0.48mm. long. B/L = $\pm 26.6/100$, S/L = $\pm 53.3/100$. Leaf margin edge smooth or lightly crenulate with cell wall outlines. Sheathing laminae unequal (open), usually with one blade ending a little above costa with an acute tip. Dorsal lamina gradually narrowing at base and ending at leaf insertion. Apical lamina symmetrical with acute tip. Costa prominent. percurrent or short excurrent. Lamina cell surface flat or slightly convex; cells irregularly quadrate hexagonal, about 10μ wide in most of the leaf but larger (about 15μ wide) on sheathing laminae base and in cells near costa, the lower cells are also longer. There is no limbidium but there are several rows of rather elongated cells at sheathing lamina extreme base margin. Perichaetial leaves longer (± 1.2 mm. long) usually with sheathing lamina having abruptly narrowed tip. Seta apical, straight or geniculate, with ovate-cylindric vaginula, 2 to 3mm. long. Capsule wide mouthed cylindrical, about 0.4mm. long and 0.16mm. in diameter at middle, with a conic-rostrate operculum ± 0.36 mm. high and 0.24mm. in diameter at base. Exothecial cells quadrate, collenchymatous, with stomata at base. Peristome normal. Spores smooth, small. 8 to 12μ in diameter.

DISTRIBUTION of *Fissidens pellucidus*: East Nepal (600 to 2,000 m.), South India (Bombay), Ceylon, Burma, Thailand, South Vietnam, Singapore, Sumatra, Java, Philippines, Taiwan, Ryukus.

A South & East Asiatic species.

Collection Site: Munnar (1600m.)

Herbarium No. 13312

Figure: **Plate 22[A]**

Fissidens pulchellus Mitt. in Musc. Ind. Or.: 140 (1859)

Slender, terrestrial or epiphytic plants with orange stems about 1cm. long by proliferation with about 28 pairs of leaves (about 27 leaves per mm. of stem). Leaves oblong-lanceolate, apiculate, distinctly denticulate with sharp cells on the border; up to 1.2mm. long and 0.28mm. wide. Sheathing lamina unequal, joining below margin ('open'). Dorsal lamina base rounded, may be slightly decurrent. Apical part usually symmetrical. Costa usually excurrent in short apiculus, $\pm 28\mu$ wide at base, may be percurrent and sometimes may even vanish below apex. Lamina cells irregularly quadrate-hexagonal, 8 to 10.5μ wide with one or two conical papillae on each cell. At extreme leaf base cells become slightly elongated and there is a row of rather large (up to 20μ long), clear, rectangular cells forming a border to the nerve base on the dorsal side. Margin cells distinctly denticulate. Brown seta on short axillary shoots (or apices of older stems), ± 1.4 mm. long, bent on itself rendering the capsule pendulous or at least nodding. Capsule brown, $\pm 0.63 \times 0.3$ mm. in diameter. Exothecial cells elongated rectangular, very unequal. Peristome orange, 0.245mm. high, split into unequal pairs: in each series of 2 pairs, the inner segments are narrower (sometimes even shorter) than the two outer; the segments are papillose showing traces of annular as well as spiral thickening. Operculum brown, conic-rostrate, $\pm 6.25\mu$ high. Spores 11 to 12μ in diameter, covered with minute papillae.

DISTRIBUTION of *Fissidens pulchellus*: East Nepal, Darjeeling.

Endemic in this area. But present report from Idukki extends its distribution to south India.

Collection Site: Athirapalli (1200m)

Herbarium No. 13313

Figure: **Plate 22[B]**

Fissidens taxifolius Hedw. in Sp. Musc.: 155 (1801)

Dicranum taxifolium (Hedw.) Web. et Mohr. in Ind. Mus. P1. Crypt.: 2 (1803)

Schistophyllum taxifolium (Hedw.) Lindb. in Musci Scand.: 13 (1879)

Fissidens pallidulus C. Muell. in Gen. Musc. Fr.: 65 (1900) *nom. nud.*

F. nipponensis Sak. in Bot. Mag. Tokyo, 47: 743 (1933) *fid.* Noguch

F. okinawaensis Bartr. in Bryologist, 50 : 160 (1947) *fid.* Iwatsuki

F. pallidulus Hamp. ex Gangulee in Bull. Bot. Soc. Beng., 11 : 82 (1957) *nom. illeg. incl. sp. prior*

Usually found only in mountain ranges with winter frost. Yellow-green to dark green, semisturdy plants resembling *F. sylvaticus* which latter is found in the lower heights. Stems known to be up to 2cm. long with 20 to 30 pairs of leaves but up to 8.2mm. long and 3.5mm. wide with 16 pairs of leaves (about 2 leaves per mm. of stem) in mature fertile shoots from North America. Sterile shoots from Tonglo [which may be called forma *pallidulus* (Gangulee) Norkett] are longer (up to 2cm.) and leaves laxer (as low as 1.1 leaf per mm. of stem). Leaves not much crumpled but curled circinate at the top of the shoot when dry; oblong-lingulate, broadly acuminate, up to 2.5mm. long and 0.53mm. broad. B/L = $\pm 20.8/100$. S/L = $\pm 69.4/100$. Dorsal lamina base usually meeting stem at point of leaf attachment but undulating at base-sometimes decurrent, usually not narrowing much before reaching base. Sheathing lamina usually unequal ('open'). Apical part usually symmetrical. Costa of deep colour, $\pm 60\mu$ wide at base, short excurrent, the tip ending in a short apiculus. Margin layer of cells slightly irregular (more regular in Swedish specimen) but usually differentiated and serrulate up to leaf base. Even if the margin be not much differentiated it shows a yellowish gleam, specially near leaf apex. On sheathing lamina base the marginal cells are smaller. Leaf cells irregularly quadrate-hexagonal, tumescent, on upper leaf $\pm 8\mu$ wide, up to 11μ at leaf base. larger near costa (up to 14μ wide) and on sheathing lamina. Sporophyte and archegonia on short lateral branch growing from the base of the stem. Perichaetial leaves narrower, longer (up to 35mm. long) and more sheathing. Seta orange, ± 1.2 cm. long. Capsule brown, horizontal, urn ± 1.75 mm. long and 0.77mm. in diameter with a wider ± 0.81 mm. diameter mouth showing a ring of red brown, dicranate peristome teeth.

DISTRIBUTION of *Fissidens taxifolius*: East Nepal (600 to 3,000 m.), Darjeeling (2,800 m.), Khasia Hills, Western Himalaya (West Nepal, Ranikhet, Nainital, Simla, Kashmir), Europe, Caucasus, Canary Is., Madeira, Azores, North Africa, Central Asia, Persia, Korea, Sakhalin, Japan (widespread), Ryukus; North, Central and South America.

Almost cosmopolitan.

Collection Site: Munnar

Herbarium No. 13314

Figure: **Plate 23[A]**

Order: Pottiales

Key to the families of Pottiales:

- 1a Basal cells hyaline, smooth, elongate, quite distinct from the upper green isodiametric cells; bordered by green cells similar to upper ones Calymperaceae
- 1b Basal cells at times hyaline, elongated and smooth, almost invariably without a border of green isodiametric cells; calyptra relatively smaller Pottiaceae

6. CALYMPERACEAE

Key to the species of *Calymperes*:

- 1a Top of cancellinae lower towards margin, tenioli do not enter lamina *C. tenerum*
- 1b Top cancellinae strictly rounded, plants smaller, tenioli present in lamina, lamina cells smooth *C. sikkimense*

Calymperes sikkimense Broth. ex Gangulee in Nova Hedwigia, 12 : 421-422 (1966)

Calymperes sikkimense Broth. in Bruehl : Rec. Bot. Surv. Ind., 13(1) : 125 (1931) *nom. nud.*

Minute erect, green plants with stems up to 2.5mm. high and erectopate leaves. Normal leaves spatulate, up to 2mm. long and 0.5mm. wide at the upper half, narrower in the rectangular base; leaf margin entire, apex rounded, sheathing part about 1/4 of whole leaf. Upper leaves gemmiferous, up to 2.7mm. long, canaliculate, ± 0.36 mm. wide at base, tip widened like a spoon and bearing a cluster of spindle-shaped gemmae. Costa percurrent, deeper in colour, $\pm 0.62\mu$ wide at base, rough on back at tip in gemmiferous leaves. Cancellinae about 0.5mm. high, formed of about 14 rows of large thinwalled, somewhat elongated rectangular (upto $63 \times 15\mu$) cells becoming shorter at its rounded top. Margin of 4 to 5 rows of narrow, elongated cells at base the outermost row of which is short celled and has a smoothly denticulate appearance at the top of the cancellinae. Tenioli of 1 row of cells extend to near the top of the leaf, become 2-rowed at the top of the cancellinae and then get mixed up with the inner rows of the leaf base margin. Upper chlorophyllose cells of lamina irregularly quadrate. 7 to 10μ wide, not papillose though tumescent. Gemmae spindle-shaped, brown ± 0.6 mm. long and 0.05mm. wide at middle, formed of one row of cells.

DISTRIBUTION of *Calymperes sikkimense*: Darjeeling.

Endemic in this area. But present report from Idukki extends its distribution to south India.

Collection Site: Charpa (1200m)

Herbarium No. 13315

Figure: **Plate 23[B]**

Calymperes tenerum C. Muell. in Linnaea, 37 : 174 (1871)

C. dozyanum Besch. (*non* Mitt.) in Ann. Sci. Nat. Bot. ser. 8, 1 : 264, 283 (1895)

Plants forming tufts of green epiphytic plants with stiff leaves which soften on getting wet. Plants usually short with rosette-like spreading of leaves on top; stem simple, may be up to 6.5mm. long with erectopotent leaves ± 2.5 mm. long and 0.5mm. broad which are curled and incurved when dry. Normal leaves unguulate, base not broader than lamina, apex obtuse. Upper gemmae leaves longer and narrower at top, ± 3 mm. long and 0.7mm. broad at base (sometimes even broader). Chlorophyllose lamina cells hexagonal to quadrate, swollen, with one or several coarse papillae, $\pm 5.5\mu$ wide and 5.5 to 7 μ . long. Leaf margin smooth at tip, may be slightly denticulate at base. Cancellinae within leaf base, 0.75mm. high, of about 10 rows of pellucid, elongated, rectangular cells on both sides of costa; cells very large ($\pm 130 \times 37\mu$.) near costa gradually becoming narrower towards margin and bordered by about 6 rows of elongated, very narrow cells at the margin; 2 submarginal rows of these cells extend to a little above the cancellinae but still within the leaf base as very short tenioli. Costa prominent, percurrent in normal leaves but excurrent into a club-like structure (which may branch by splitting in some case) in gemmiferous leaves bearing radiating brood bodies in star-like clusters. Gemmae $134 \times 36\mu$, green, germinating from tip forming protonemal threads. Not known in fruiting condition.

DISTRIBUTION of *Calymperes tenerum*: Lower Bengal, South India (Tirunalveli), N. & S. Vietnam, Malay, Sumatra, Java, Molucca, New Guinea, Philippines, New Caledonia, Hawaii, Caroline Is., Gilbert & Marshall Is., Tonga, Samoa, Tahiti.

An Indo-Pacific species.

Collection Site: Athirapalli (1200m)

Herbarium No. 13316

Figure: **Plate 24[A]**

7. POTTIACEAE

Family: Pottiaceae

Key to the genera of Pottiaceae:

- | | | |
|----|---|--------------------|
| 1a | Leaf base mostly differentiated, leaves mostly narrow-lanceolate; margin upwards involute | 2 |
| 1b | Leaf base rarely differentiated, lamina built of moderately thickened cells with papillae on the faces of cells | 3 |
| 2a | Lamina bistratose | <i>Timmiella</i> |
| 2b | Lamina uni-stratose, serrate leaf margin in the lower half | <i>Oxystegus</i> |
| 3a | Peristome absent; leaves ligulate; perichaetial bracts slightly or not sheathing | <i>Hyophila</i> |
| 3b | Peristome present; leaf cells mostly transparent or translucent; peristome teeth divided or contorted | <i>Hydrogonium</i> |

Timmiella anomala (B.S.G.) Limpr., *ibid.*, 592, 173 (Barbula, 1842).

Tufts lax, yellowish green, on drying the nerve white-glossy. Stem comal. Leaves, (dry) spirally twisted, falcato-secund with strongly inflexed or feebly undulated margin, (moist) erecto-patent to rosette-forming, lanceolate-linear to nearly lingulate, shortly cuspidate or obtuse, upper half somewhat narrowed, mostly toothed near the apex; nerve very broad, flat in the lower part of the leaf, upwards uniformly attenuated, subcurrent or percurrent in T.s. with a median row of guide cells and two strong stereidal bands; lamina, with the exception of the base and one series of marginal cells, bistratose and very obscure, surface and back of the nerve mamilllose; cells on the adaxial surface larger and very strongly mamilllose, those on the other surface smaller and smooth; basal cells hyaline, without a border, remainder green, small, rounded-quadrangle. Seta long, tortuous, on drying sometimes curved below. Capsule erect or inclined, straight or somewhat arcuate, cylindrical. Peristome inserted on the mouth; basal membrane very low; crura 32, very long, filiform, densely papillose, often twisted to the right. Operculum conic-rostrate. Spores small, smooth. Plants robust; annulus revoluble; peristome well-developed; teeth spirally twisted.

DISTRIBUTION of *Timmiella anomala*: Mussoorie, Palni hills, Europe, N. America, Mexico.

Collection Site: Attukadu (1500m)

Herbarium No.13317

Figure: **Plate 24[B]**

Key to the species of *Oxystegus*:

- 1a Leaves shorter, basal hyaline cells cover smaller space and sharply differentiated from upper papillose cells *O. stenophyllous*
1b Leaves longer, basal hyaline cells cover a bigger space and gradually pass over to the upper cells *O. tenuirostris*

Oxystegus stenophyllus (Mitt.) Gangulee in Nova Hedwigia, 12 : 429 (1966)

Tortula stenophylla Mitt. in Musc. Ind. Or.: 28 (1859)

Barbula stenophylla (Mitt.) Jaeg. in Ber. S. Gall. Naturw. Ges.. 1971-72 :415 (1873)

Trichostomum stenophyllum (Mitt.) Broth. in Nat. Pfl., 1: 394 (1902)

Caespitose, green plants up to 1.5cm. long partly prostrate and partly erect, flexuose; laxly covered with erect-spreading leaves which are lightly curled and flexuose when dry. Leaves up to 3.25mm. long, spreading from a short, erect, concave, ovate, sheathing base (± 0.49 mm. wide) narrowing to a ligulate-lanceolate lamina: margin flat and smooth except at tip where it is distantly and mildly serrate; tip acute, ending in a short apiculus. Leaf base cells rectangular with slightly rounded ends, smooth, hyaline. up to $50 \times 12 \mu$ near costa becoming narrower towards margin with the margin somewhat distinct; base cells rather well demarcated from the shorter papillate cells above. Upper leaf cells short rectangular to rounded quadrate, usually $17 \times 11 \mu$, scarcely incrassate, multipapillose and obscure with a somewhat crenulate margin of one row of flattened cells. Perichaetial leaves erect but not otherwise differentiated. Seta pale brown, apical. erect, ± 1.3 cm. long. Capsule erect or slightly nodding, brown, ± 2.275 mm. long, cylindrical with wider base (± 0.455 mm. in diameter), symmetrical. Operculum conic-rostrate, ± 0.95 mm. high, beak slightly bent to one side. Peristome teeth red-brown, irregularly split, papillose, fragile, $\pm 175 \mu$ high. Spores light pellucid brown, finely papillose, 11.2 to 14μ in diameter.

DISTRIBUTION of *Oxystegus stenophyllus*: Darjeeling, Sikkim, Western Himalaya, South India (Nilgiri, Palni).

Endemic in India.

Collection Site: Rajamalai (1600m.)

Herbarium No. 13319

Figure: **Plate 25[A]**

Oxystegus tenuirostris (Hook. & Taylor) A.J.E. Sm. in USDA database.
Oxystegus cylindricus (Brid.) Hilp. in Beih. Bot. Centralbl., 50 : (2) 620 (1933)
Weisia cylindrica Bruch ex Brid. in Bryol. Univ., 1: 806 (1827)
Weisia tenuirostris Hook. & Tayl. in Musc. Brit. ed. 2: 83. Suppl. 3 (1827)
Didymodon tenuirostris (Hook. & Tayl.) Wils. in Hook. J. Bot. 3: 378 (1841)
Didymodon longifolia Griff. in Cal. J. Nat. Hist., 2 :490 (1842)
Didymodon longifolius Griff. in Cal. J. Nat. Hist., 2 :510 (1842)
Didymodon cylindricus (Brid.) B.S.G. in Bryol. Eur., 2 : 139 (1846)
Didymodon calyptratus Tayl. in Lond. J. Bot., 7 :188 (1848)
Trichostomum cylindricum (Brid.) C. Muell. in Syn., 1 :586 (1849)
Tortula cylindrica (Brid.) Mitt. in Musc. Ind. Or.: 28 (1859)
Tortula longifolia (Griff.) Mitt. in Musc. Ind. Or.: 28 (1859)
Trichostomum tenuirostre (Hook. & Tayl.) Lindb. in Oefv. K. Vet. Ak. Foerh. 21: 225 (1864)
Mollia tenuirostris (Hook. & Tayl.) Lindb. in Musci Scand., 21(1879)
Barbula leptotortuosa C. Muell. in N. Giorn. Bot. Ital. n.s.. 5 :179 (1898)
Barbula leptotortella C. Muell. in Hedwigia, 38 :110 (1899)
Trichostomum leptotortuosum (C. Muell.) Broth. in Nat. Pfl., 1(3): 394 (1902)
Tortella cylindrica (Brid.) Loesk. in Stud. Morph. Syst. Laubm.: 97(1910)
Trichostomum longifolium (Griff.) Broth. in Nat. Pfl., 1(3) : 394 (1902)
Oxystegus longifolius (Griff.) Hilp. in Beih. Bot. Centralbl., 50(2): 667 (1933)
Oxystegus leptotortella (C. Muell.) Hilp. in *ibid* same page.
Oxystegus leptotortuosum (C. Muell.) Hilp. in *ibid* same page.

Yellowish green plants in loose tufts turning brownish below. Stems dark, slender, flexuose, up to 3cm. long. Leaves fragile in older parts, comparatively lax, patent to spreading, flexuose, curled when dry, lanceolate-ligulate, longer in the upper regions, up to 4.2mm. long and 0.65mm. broad at the concave, lightly sheathing base; margin flat, a little wavy, smooth below, somewhat crenulate with papillae above; tip acute with a short apiculus. Costa light brown, prominent, percurrent or excurrent in the apiculus. Leaf base cells wide rectangular, hyaline, thin walled, up to 73×12μ near costa, shorter towards margin and gradually passing into shorter chlorophyllose cells above. Upper lamina cells rounded-quadrate, ±12.6×

10 μ somewhat incrassate, multipapillate. Somewhat obscure. Perichaetial leaves not differentiated. Seta apical, erect, yellow-green, slender, ± 1.5 cm. long. Capsule brown, cylindrical, straight or slightly curved, varying in size, up to 3.25mm. long and 0.65mm. in diameter. Operculum conic-rostellate with a long, conical beak, ± 1 mm. long, urn mouth wide. Peristome teeth deep brown, up to 308 μ high and 11.2 μ broad, articulated, highly papillose, usually not split but sometimes incompletely so, fragile. Spores pellucid light brown, 10.5 to 11.2 μ in diameter.

DISTRIBUTION of *Oxystegus tenuirostris*: East Nepal, Darjeeling, Sikkim, Khasia Hills, Griffith, McClelland, Naga Hills, Western Himalaya, Kashmir, South India, Ceylon, Burma, Europe, Central Asia, China, Japan. all Africa, North-Central-South America.

Almost cosmopolitan.

Collection Site: Adimalli (1300m.)

Herbarium No. 13318

Figure: **Plate 25[B]**

Key to the species of *Hyophila*:

1a	Upper leaf margins serrulate	<i>H. involuta</i>
1b	Upper leaf margins smooth or crenulate	2
2a	Hyaline leaf base very short, spores smaller	3
2b	Hyaline leaf base long, gemmae not present, spores larger	<i>H. perannulata</i>
3a	Costa percurrent or ending below tip. Gemmae present	<i>H. rosea</i>
3b	Costa short, excurrent. Gemmae not observed	<i>H. nymiana</i>

Hyophila involuta (Hook.) Jaeg. in Ber. S. Gall. Naturw. Ges. 1871-72: 356 (1873)

Gymnostomum involutum Hook. in Musc. Exot., 2 : 154 (1819)

Gymnostomum tortula Schwaegr. in Sp. Musc. Suppl. 2 : 78 175 (1826)

G. cylindricum Hook. in Icon. Pl. Rar., 1: 17 (1836)

Barbula spathulata Doz. & Molk. in Ann. Sci. Nat. Bot. ser. 3, 2 : 300 (1844)

Hyophila hookeri Hemp. in Bot. Zeit., 4 : 267 (1846) *nom. illeg.*

H. harveyana Hamp. in *ibid* same page *nom. illeg.*

H. torula (Schwaegr.) Hamp. in *ibid* same page.

Pottia involuta (Hook.) C. Muell. in Syn., 1 : 560 (1849)

P. cylindrica (Hook.) C. Muell. in Syn., 1 : 562 (1849)

Desmatodon involutus (Hook.) Mitt. in Musci Ind. Or.: 39 (1959)

- Pottia zollingeri* C. Muell. in Bot. Zeit., 14 : 419 (1856)
- P. circinnata* C. Muell. in Linn., 36 : 38 (1869)
- P. riparia* Aust. in Musci Appal., n. 112 (1870)
- Trichostomum bescherelli* Schimp. in Besch. in Mem. Soc. Sc. Nat. Cherbourg. 16 : 477 (1872)
- Hyophila cylindrica* (Hook.) Jaeg. in Ber. S. Gall. Naturw. Ges., 1871-72 : 356 (1873)
- H. circinnata* (C. Muell.) Jaeg. in Ber. S. Gall. Naturw. Ges. 1870-72: 357 (1873)
- H. bescherelli* (Schimp.) C. Muell. in Flora. 58 : 538 (1875)
- Trichostomum warnstorffii* Limpr. in Laubm. Deutschl., 1 : 587 (1888) *nom. illeg.*
- Leptodontium riparium* (Aust.) E. G. Britt. in Bull. Torr. Bot. Club, 19 : 275 (1892)
- L. canadense* Kindb. in Macoun. in Cat. Canad. Pl., 6 : 45 (1892)
- Hyophila micholitzii* Broth. in Oefv. Finsk. Vet. Soc. Foerh., 35 : 39 (1893)
- Didymodon riparias* (Aust.) Kindb. in Eur. N. Am. Bryin., 2 : 280 (1897)
- Hyophila stenocarpa* Ren. et Card. in Bull. Soc. R. Bot. Belg., 38 (1) : 10 (1900)
- H. moutieri* Par. et Broth. in Rev. Bryol., 28 : 38 (1901)
- H. comutata* Broth. in Nat. Pfl., 1(3) : 403 (1902)
- H. riparia* (Aust.) Fleisch. in Britt. in Bryologist, 7: 69 (1904)
- H. warnstorffii* (Limpr.) Fleisch. in Musci Fl. Buitenz., 1 : 330 (1904)
- H. dozy-molkenboeri* Fleisch. in *ibid* p. 328
- H. tsunodae* Broth. ex Yas. in Bot. Mag. Tokyo, 29 : 151 (1915)
- H. attenuata* Broth. in Symb. Sin, 4 : 37 (1929)
- H. subcylindrica* Broth. in Bruehl. in Rec. Bot. Surv. Ind., 13(1): 126 (1931) *nom. nud.*
- H. sinensi* Dix. in Yang: Sc. Rep. Nat. Tsing Hua Univ. B. Biol., 2 : 117 (1936) *nom. nud.*

Dioicous. Both antheridial and archegonial shoots apical. Dense tufts of dark green plants on bricks, mortar, rocks and rarely on soil. Erect, simple or branched shoots from a long, horizontal, radiculose part below, up to about 1cm. high (may be 2cm. or more counting the radiculose, reddish stem below) with the top leaves spreading in rosettes. Each shoot shows red rhizoids on stem and is uniformly covered with erect-spreading leaves which are curled circinately with the margins inrolled when dry. Leaves up to 3.3mm. long and 1 mm. wide, oblong-lingulate, carinate; the lower oblong part pale, sheathing and erect; apex broadly pointed; margin rolled when dry,

flat and wavy when moist, denticulate at apex (very sharply in some specimens), unbroken below. Costa red-brown, plano-concave, prominent, wide near base ($\pm 150\mu$ wide) narrowing above, percurrent. Upper lamina cells chlorophyllose, mamilllose, lightly obscure, rounded-quadrate 6 to 8 μ in diameter with a few larger cells at the marginal teeth. Leaf base cell rectangular, wide lighted, smooth, $50 \times 22\mu$, becoming smaller above. Perichaetial leaves not much differentiated, only shorter. Seta apical, erect, red-brown below, paler above, ± 1.5 cm. long. Capsule cylindrical (often wider at base), brown, erect or lightly curved in some specimens, urn up to 3.15mm. long and 0.56mm. in diameter. Annulus of one or two rows of very thickwalled, lenticular cells. Peristome absent. Operculum conical, rostrate, ± 0.85 mm. high. Calyptra cucullate. Spores dirty brown pellucid, round, 8.4 to 11 μ in diameter.

DISTRIBUTION of *Hyophila involuta*: East Nepal (1,600- 3,200 m.), Darjeeling, Sikkim (1,700 m.), Lower Bengal (alluvial), Lower Bengal (lateritic), North Bihar, Chhotanagpur, Orissa, Adjacent Madhya Pradesh, Arunachal (NEFA), Khasia Hills, Upper Assam, Western Himalaya, Upper Gangetic Plains, Madhya Pradesh, South India (Gujrat, W.Ghats, Nilgiri. Palni, Mysore), Ceylon, Burma, North & South Vietnam, East China, Manchuria, Korea, Japan, Taiwan, Philippines, Sumatra, Java, Celebes, Borneo, New Guinea, Oceania, North-Central-South America, Europe.

Almost a cosmopolitan species, found everywhere in Southeast Asia.

Collection Site: Kothamangalam (1300m)

Herbarium No. 13321

Figure: **Plate 26[A]**

Hyophila nymaniana (Fleisch.) Menzel in Willdenowia., 22:198 (1992)

Hyophila comosa Dix. et Varde in Arch. Bot., 1 :166 (1927)

Usually unbranched plants about 0.8mm. high and 0.5mm. wide with leaves. Leaves in interrupted rosettes, erectopatient to erect-spreading, inrolled and curled when dry, spathulate from a narrower base, carinate, ± 3.2 mm. long, 0.8mm. wide at top middle and 0.48mm. wide at base, base short with a very short transparent part; apex broadly acuminate; margin unbroken (except crenulation by cells at tip), flat, somewhat undulating. Costa strong, $\pm 120\mu$ wide at base, *short excurrent* in a mucro.

Upper lamina cells chlorophyllose, multipapillate, rounded-hexagonal, moderately incrassate, $\pm 7.5\mu$ wide. Cells at extreme base hyaline, rectangular, up to $38 \times 1.5\mu$, becoming narrower towards margin, and shorter rectangular towards top. Perichaetial leaves not differentiated. Seta apical, erect, $\pm 9\text{mm}$. long. Capsule erect, cylindrical, 1.88mm . long and 0.44mm . in diameter with a conical operculum $\pm 0.7\text{mm}$. high. Peristome absent.

DISTRIBUTION of *Hyophila nymaniana*: Orissa, South India (Palni, Travancore).

Endemic in this area. But present report from Idukki extends its distribution to Kerala.

Collection Site: Thattekad (1200m)

Herbarium No. 13320

Figure: **Plate 26[B]**

Hyophila perannulata Ren. et Card. in Bull. Soc. R. Bot. Belg., 34(2): 60 (1896)

Hyophila decolyii Broth. in Par. in Index Bryol. Suppl. 190 (1900)

Dioicous, caespitose, green, usually simple plants up to 8 mm. long showing proliferation from tips so that leaves are in interrupted clusters presenting annulate appearance. Leaves erectopatent to spreading, curled and involute when dry, broadly lingulate, up to 3.1mm . long and 0.525mm . wide in the rectangular, hyaline, sheathing base (about 1/3 of the leaf in length, $\pm 0.665\text{mm}$. wide in the upper lamina; apex broadly acuminate in a mucro; margin unbroken and usually flat when moist, not denticulate. Costa light brown, $\pm 110\mu$ wide at base, excurrent in the mucro. Upper lamina cells chlorophyllose, irregularly rounded-hexagonal, multipapillate, obscure, 8 to 9μ wide (shorter, $\pm 7\mu$ wide near tip); upper margin shows a row of transverse, mildly crenulate cells. Leaf base formed of lax, thin walled, smooth, pellucid cells, up to $80 \times 11\mu$ near costa base, becoming shorter and narrower towards margin. Seta erect, apical, yellowish, $\pm 1.2\text{cm}$. long. Capsule brown, erect, cylindrical, may be slightly curved, $\pm 2.45\text{mm}$. long and 0.4mm . in diameter with a prominent, deep coloured annulus (cells $\pm 25\mu$ high) and no peristome. Spores light brown, finely papillose, 19.5 to 23μ in diameter.

DISTRIBUTION of *Hyophila perannulata*: Darjeeling, Khasia Hills

Endemic in this area. But present report from Idukki extends its distribution to south India.

Collection Site: Munnar (1600m.)

Herbarium No. 13322

Figure: **Plate 27[A]**

Hyophila rosea Williams in Bull. N.Y. Bot. Gard., 8 :341 (1914)

Dioicous, laxly caespitose, green, usually simple, sometimes branched plants up to 1.5cm. long and 0.5cm. wide with leaves. Leaves in interrupted rosette tufts, erectopatient to erect-spreading, lightly crispate and inrolled when dry, spatulate from a narrower base, up to 3mm. long and 0.68mm. wide in the upper part, carinate; sheathing, erect base short; apex broadly acuminate; margin often slightly involute towards base, not denticulate (except for the papillae). Costa brown, rough with papillae, 75 to 100 μ wide near base, percurrent or ends in a short apiculus. Upper lamina cells chlorophyllose, highly multipapillose on both sides, obscure, 7 to 8.5 μ wide, hexagonal to rounded. Short base with a small area covered by smooth, pellucid, rectangular cells, up to 42 \times 17 μ becoming smaller towards top and margin. Perichaetial leaves not differentiated, Seta apical, erect, light brown to yellow green, \pm 1.15cm. long. Capsule erect, brown, cylindrical but wider at base, \pm 2.35mm. long and 0.42mm. in basal diameter with a conical, beaked operculum \pm 0.7mm. high and sometimes slightly bent to one side. Peristome absent. Spores 11.2 to 16.8 μ in diameter, light brown, pellucid. Multicellular, deep brown, axillary on top leaves, round to oval brood bodies are present.

DISTRIBUTION of *Hyophila rosea*: Orissa, Western Himalaya (Garhwal, Kumaon), South India (Gujrat), Philippines.

An Indo-Pacific species.

Collection Site: Munnar (1600m.)

Herbarium No. 13323

Figure: **Plate 27[B]**

Hydrogonium pseudo-ehrenbergii (Fleisch.) Chen in Hedwigia, 80: 242 (1941)

Barbula pseudo-ehrenbergii Fleisch. in Musci Fl. Buitenz., 1: 356 (1904)

Barbula cataractarum Fleisch. in Musci. Fl. Buitenz., I: 360 (1904)

B.tjibodensis Fleisch. in *ibid.*, p. 358

B.dialytrichoides Ther. in Broth. in Nat. Pfl. ed. 2, 10: 280 (1924)

Hydrogonium cataractarum (Fleisch.) Hilp. in Beih. Bot. Centralbl., 50(2); 630 (1933)

Barbula fulviseta Fleisch. in Chen in Hedwigia, 80: 242 (1941) *nom. nud. in synon.*

Thick tufts of brownish to reddish plants covered with earth below, up to 4cm. high, branched or simple, uniformly covered with erectopotent to erect-spreading leaves which are crumpled and curled at the tips when dry. Leaves carinate, lanceolate from a broader base, ± 2.4 mm, long and 0.68mm. wide at the broader base; leaf tip acute (may be broader), leaf margin unbroken, usually flat, may be slightly incurved at base. Costa strong, percurrent at tip. Upper lamina cells small, incrassate, irregularly quadrate, about 8μ wide, unipapillate but not obscure; lower lamina cells are longer (up to $11 \times 8 \mu$) and with more than one papilla. Cells at leaf base are hyaline, rectangular, up to $41 \times 11.5\mu$ so that the leaf base looks transparent to a height of 0.6mm. Seta apical, ± 1 cm. long. Capsule, apical, cylindrical, ± 1.6 mm. long and 0.6mm. in diameter. Operculum small, conical. Peristome fragile, formed of spirally twisted (completes more than one turn) filamentous teeth.

DISTRIBUTION of *Hydrogonium pseudo-ehrenbergii*: East Nepal (1600-2100m.), Kashmir, South India, Burma, Java, Philippines, China, Japan, Central Africa.

An Afro-Asiatic species.

Collection Site: Kallar (1200m.)

Herbarium No. 13324

Figure: **Plate 28[A]**

Order: Funariales

8. FUNARIACEAE

Key to the genera of Funariaceae:

- 1a Calyptra campanulate, lobed, lamina cells rectangular to rhombic, peristome absent *Physcomitrium*
- 1b Calyptra becoming obliquely placed and generally not lobed, lamina cells rectangular 2
- 2a Peristome generally double *Funaria*
- 2b Peristome single or more *Entosthodon*

Key to the species of *Physcomitrium*:

- 1a Capsule mouth wide, longer turbinate, leaves broader, lanceolate or spatulate *P. eurystomum*
- 1b Capsule mouth narrower than urn, leaves on fruiting shoot, narrower ovate-lanceolate *P. japonicum*

Physcomitrium eurystomum Sendtn. in Denkschr. Bayer Bot. Ges. Regensb., 3 : 142 (1841)

Physcomitrium acuminatum B.S.G. in Bryol. Eur., 3: 247 (1841) *fid.* Loesk.

P. acuminatum var. *denticulatum* Rabenh. in Deutschl. Krypt. Fl., 2 : 87 (1848)

P. sphaericum (Ludw.) Fuernr. var. *cuspidatum* Doz. & Molk. in Prodr. Fl. Batav., 2:70 (1851)

P. sphaericum var. *hueberniana* Rabenh. in Krypt. Fl. Sachsen, 1 : 368 (1863)

P. sphaericum var. *eurystomum* (Sendtn.) Husn. in Fl. Mouss. N. Ouest. ed. 2 : 10 (1882)

P. sphaericum var. *major* Boul. in Muscin. France: 303 (1884)

Gymnostomum eurystomum (Sendtn.) Lindb. et Arn. in K. Svensk. Vet. Ak. Handl., 23 : 58 (1890)

Physcomitrium spurio-acuminatum Dix. in Rev. Bryol. Lichenol., 7: 107 (1934) *fid.* Ochi

P. higoense Sak. in J. Jap. Bot., 28: 56 (1953) *fid.* Ochi.

Scattered to gregarious, small to medium, green plants, 3 to 8mm. high with leaves. Stem short and slender, 2 to 5mm. high, simple or branched at base. Leaves clustered above, erectopatent to erectospreading, shrunk when dry, soft, ovate-lanceolate to oblong-lanceolate, acuminate with acute apex, $\pm 3.45 \times 1$ mm.; margin flat, dentate in the upper part. Costa strong, $\pm 75 \mu$ wide at base, percurrent in the sharp apex or short excurrent. Lamina cells thin-walled, short rectangular, up to $45 \times 23 \mu$ at apex, $60 \times 17 \mu$

at middle, large rectangular (up to $120 \times 32 \mu$) at base; bordered by one row (becomes double-layered at places) of narrow elongated cells (up to $150 \times 12 \mu$) which cause the serration above and which row is tinted at middle of leaf; cells narrower near border at middle and at base. Seta slender, 4-10mm. long. Capsule short pyriform, with a distinct short apophysis, ± 1.8 mm. high and 0.9mm. in diameter. Operculum as wide as capsule top, ± 0.8 mm. in diameter, conical convex, shortly rostrate, with radiating rows of rectangular cells up to 30μ long. Spores rounded, deep brown, spinose-papillose, 25 to 28μ in diameter.

DISTRIBUTION of *Physcomitrium eurystomum*: Lower Bengal, Kumaon, North Vietnam (Tonkin), Taiwan, China, Japan, Great Britain, France, Central & South Africa. An Old World species.

Collection Site: Munnar (1600m.)

Herbarium No. 13325

Figure: **Plate 28[B]**

Physcomitrium japonicum (Hedw.) Mitt. in Trans. Linn. Soc. Bot. Lond. ser. 2, 3 : 164 (1891)

Gymnostomum japonicum Hedw. in Sp. Musc.: 34 (1801)

Physcomitrium subacuminatum Broth. in Hedwigia, 38 : 217 (1899)

P. macrophyllum Card. in Beih. Bot. Centralbl., 17 : 15 (1904) *fid.* Ochi

P. subeurystomum Card. in *ibid.*, 19 : 106 (1905) *fid.* Ochi

P. limbatulum Broth. et Par. in Rev. Bryol., 38 : 53 (1911) *fid.* Ochi

P. longifolium Sak. in Bot. Mag. Tokyo, 46 : 738 (1932) *fid.* Ochi

P. nipponense Sak. in Bot. Mag. Tokyo, 52 : 1938 *fid.* Ochi

P. toyamae Sak. in J. Jap. Bot., 28 : 57 (1963) *fid.* Ochi

P. angustifolium Broth. in sched. *nom. nud. in synonym.* in Ochi (1968)

P. formasicum Broth. in sched. *nom. nud. in synonym.* in Ochi (1968)

Gregarious, terrestrial, green plants usually about 5mm. high. Stems usually simple. Leaves clustered on top, erectopate (shrunk and appressed to stem when dry), spatulate-lanceolate to oblong-lanceolate, $\pm 2.1 \times 1$ mm., acuminate; margin flat, mildly denticulate on top to almost entire. Costa distinct, percurrent or short

excurrent. Lamina cells thin-walled, long rectangular at base (up to $100 \times 38 \mu$), becoming shorter upwards, rhomboid-quadrate ($\pm 45 \times 22 \mu$) at apex, narrower towards margins. Border irregular, usually with a row of narrower cells at top which may be 2- or even 3- rowed below. Seta apical, erect, ± 5 mm. in this specimen but reported to be much longer in other specimens. Capsule short pyriform, ± 2 mm. high and 2mm. in diameter with a narrower mouth. Exothecial cells hexagonal with several layers of flattened rectangular cells near rim. Operculum low conical, apiculate. Spores brown, round, papillose, 19 to 22μ in diameter.

DISTRIBUTION of *Physcomitrium japonicum*: Darjeeling, U.P. (Gorakhpur), China (Yunnan & North), Taiwan, Korea, Japan

An Indo-Sino-Japanese species.

Collection Site: Kannimalai (1600m)

Herbarium No. 13326

Figure: **Plate 29[A]**

Key to the species of *Entosthodon*:

- | | | |
|----|--|---------------------|
| 1a | Small plants with small capsule and longer, narrow, extended leaf tips | <i>E. nutans</i> |
| 1b | Medium sized plants with broader leaves | 2 |
| 2a | Apophysis elongated, about as long as capsule | <i>E. wallichii</i> |
| 2b | Apophysis short | <i>E. wichurae</i> |

Entosthodon nutans Mitt. in Musc. Ind. Or.: 55 (1859)

Physcomitrium nutans Wils. in Kew J. Bot., 9 : 329 (1857) *nom. nud.*

Funaria nutans (Mitt.) Broth. in Nat. Pfl., 1(3) : 522 (1903)

Small, gregarious, green plants forming dense patches, usually on the edges of clay pans. Stem short, ± 2 mm. high, usually unbranched. Leaves few, forming rosette on top of stem, erectopatent when moist, shrunk and reflexed when dry, narrow and long ligulate-lanceolate, $\pm 4 \times 0.39$ mm., apex drawn into a long narrow, capillary point ± 0.46 mm. long; leaf margin entire, not bordered. Costa, thin but clear, passing into the capillary tip. Leaf cells rhomboid or narrow, pointed rectangular ($\pm 70 \times 10 \mu$) at apex, longer and wider rectangular ($\pm 110 \times 20 \mu$) at base; all cells thin-walled. Seta short, thin, erect or wavy, reddish, glossy, ± 5 mm. high. Capsule small, turbinate,

±1mm. high and 1mm. in diameter, wide-mouthed with a small neck. Peristome absent. Exothecial cells wide rectangular to hexagonal with about 3 layers of transverse rectangular cells with thicker walls at rim. Operculum convex, without any apiculus. Spores round, opaque, fine papillose, ±22μ in diameter.

DISTRIBUTION of *Entosthodon nutans*: Chhotanagpur, Gangetic West Bengal, Lahore (West Pakistan), Punjab (Ferozepur), UP., Rajasthan (Jaipur), Western Ghats (Khandala), North Africa (Sudan).

An Indo-African species.

Collection Site: Munnar (1600m.)

Herbarium No. 13327

Figure: **Plate 29[B]**

Entosthodon wallichii Mitt. in Musc. Ind. Or.: 55 (1859)

Funaria wallichii (Mitt.) Broth. in Nat. Pfl., 1(3) : 525 (1903)

Weisia templetonii Griff. In Cal. J. Nat. Hist., 2 : 488 (1842) Lin. Illeg.

Laxly gregarious to tufted green plants ±6mm. high, usually unbranched. Few small lax leaves on lower stem, larger leaves forming a rosette at top, erect-spreading, crumpled and clinging to stem when dry. Leaves obovate-lanceolate to oblong-lanceolate, up to 1.5×0.5mm., apex prolonged into an arista, margin usually dentate in the upper part. Costa ending a little below apex. Leaf cells thin-walled, large rectangular (±100×20μ) at base, narrower and hexagonal to rhomboidal at apex (±76×10μ); arista ±0.18mm. long; leaf marginal cells narrower (with pointed ends causing very mild dentation at apex) forming a somewhat distinct border. Seta apical, erect, ±14mm. long, may be somewhat flexuose, reddish brown. Capsule erect or slightly inclined, symmetrical, elongated pyriform with a tapering apophysis as long as the capsule, ±3mm. high (including the apophysis) and 1mm. in diameter at the urn, urn mouth narrower than capsule; exothecial cells vertical rectangular with 5 or 6 rows of horizontally rectangular, tinted cells at rim. Peristome missing although presence of a very rudimentary one reported in literature. Operculum conical convex with a very rudimentary apiculus.

DISTRIBUTION of *Entosthodon wallichi*: East Nepal, Darjeeling, Meghalaya, Western India (Tehri, UP).

An Indo-Nepalese species.

Collection Site: Eravikulam (1800m)

Herbarium No. 13328

Figure: **Plate 30[A]**

Entosthodon wichurae Fleisch. in Musci Fl. Buitenz., 2: 481 (1904)

Funaria wichurae (Fleisch.) Broth. in Nat. Pfl., 1(3) : 1204 (1909)

F. lutschiana Broth. in Oefv, Finsk. Vet. Soc. Foerh., 62A : 15 (1921) *fid.* Ochi

Physcomitrium kiushiuense Sak. in Bot. Mag. Tokyo, 46 : 738 (1932) *fid.* Ochi

Yellow-green plants in loose tufts, unbranched or branched from base. Short stem (up to 6.5mm.) with small lax leaves below and a rosette of large leaves on top. Leaves erect-spreading (crumpled and erect when dry), lanceolate from a narrower base, acute pointed at top sharply ending in a vertical cell. Costa ending below apex $\pm 30\mu$ wide at base. Leaf margin slightly dentate in the marginal row in the upper half. Leaf cells thin-walled, large rectangular (up to $135 \times 20\mu$) near vein, shorter near margin, $75 \times 17\mu$ at middle leaf with 1 or 2 rows of narrower and sometimes longer (up to $90 \times 13\mu$) border cells. Apical leaf cells shorter rectangular, up to $60 \times 22\mu$ with one row (at places 2-rowed) of narrow elongated cells (up to 150μ long) with projected tips (causing denticulation) forming a clear border. Seta apical, erect, (may be somewhat flexuose), very long (1.4cm. long, may be longer). Capsule erect (may be slightly inclined), pyriform with an apophysis which is clear but shorter than in *wallichii* and *buseanus*, ± 2 mm. high (including the apophysis) and 1mm. in diameter, urn mouth narrower than capsule. No peristome observed though Fleisher reports some rudiments. Operculum nearly convex without apiculus. Spores large, reddish brown, round, rough, warty, 28.4 to 30μ in diameter.

DISTRIBUTION OF *Entosthodon wichurae*: Meghalaya, Western Himalaya (Ranikhet), Burma, Ceylon, Java.

A Southeast Asiatic species.

Collection Site: Munnar (1600m.)

Herbarium No. 13329

Figure: **Plate 30[B]**

Key to the species of *Funaria*:

- 1a Capsule striated and furrowed; annulus revoluble, peristome complete *F. hygrometrica*
1b Capsule neither striate nor furrowed; annulus absent, nerve excurrent *F. wijkii*

Funaria hygrometrica Hedw. in Sp. Musc.: 172 (1801)

Mnium hygrometricum (Hedw.) With. in Syst. Arr. Br. P1. ed. 4, 3 : 787 (1801)

Funaria angustifolia Brid. in Sp. Musc., 3 : 71 (1817)

F. androgyna Brid. in Bryol. Univ., 2 : 58 (1827)

F. ramificans Brid. in *ibid.*; 738 (1827)

F. campylopus Brid. in *ibid.*: 739 (1827)

F. gracilescens Schimp. ex C. Muell. in Bot. Zeit., 16 : 154 (1858)

F. marginata Kindb. in Bih. K. Svensk. Vet. Ak. Handl., 7 : 79 (1883)

F. megapoda C. Muell. in Bull. Herb. Boiss., 5 : 175 (1897)

F. globicarpa C. Muell. in Nuov. Giorn. Bot. Ital. n. ser., 5 : 161 (1898)

F. lonchopelma C. Muell. in Hedwigia, 38 : 61 (1899) var. *calvescens* (Schwaegr.)

Mont. in Ann. Sc. Nat. Bot. ser. 2, 12: 54 (1839)

Funaria calvescens Schwaegr. in Sp. Musc. Suppl. 1(2) : 77(1816)

Funaria leptopoda Griff. in Cal. J. Nat. Hist., 2 : 512 (1842)

F. nepalensis C. Muell. in Bot. Zeit., 13 : 748 (1855)

F. connivens C. Muell. in *ibid.*: 747 (1855)

A variable species of loosely to closely tufted, green to yellow-green plants, simple or branched from base, usually about 1cm. high. Lower leaves small, showing poor development of costa, sparsely placed. Upper leaves large, forming a rosette on top, concave, oblong-obovate to oblong-lanceolate, erect-spreading (much shrunk when dry), 2.5 to 4mm. long and 0.9 to 1.4mm. broad, margin entire, apex acute to acuminate. Costa strong, percurrent or short excurrent in the upper leaves. Lamina cells thin-walled, subhexagonal, more elongated ($\pm 108 \times 27 \mu$) at base, smaller at apex ($\pm 40 \times 20 \mu$); marginal row narrow ($\pm 10 \mu$ wide), almost smooth but may cause very fine indentation at tip. Seta apical, erect, strongly arcuate. Capsule horizontal to pendulous, arcuate-pyriform, asymmetrical with the narrower mouth oblique, ± 4 mm. long with the apophysis and up to 2mm. in diameter, yellow (becomes brown with age) with a deep red mouth, sulcate

when dry. Peristome teeth typical epicranoid; outer teeth brown, spirally arranged, $\pm 580\mu$ high and 90μ wide at base; inner ones hyaline, almost of same height; apices of teeth united to a small central disc. Spores rather small. Autoicous.

DISTRIBUTION of *Funaria hgrometrica*: All over the Himalayas (from Nepal to Arunachal, Manipur & Naga Hills) and Khasia Hills, Chhotanagpur, Orissa, Western Himalaya (Kashmir to Nepal with foothills), Pakistan (N.W.F.P.), Afghanistan, South India (W. Ghats, Nilgiri, Palni), Ceylon, Burma, Thailand, Tibet, China, Taiwan, Korea, Japan, Siberia, Europe, N. & S. America, Africa, Australia, Newzealand, Oceania.

A cosmopolitan species.

Collection Site: Matupatti (1700m)

Herbarium No. 13330

Figure: **Plate 31[A]**

Funaria wijkii R. S. Chopra in Taxonomy of Indian mosses: 185, (1975)

F. pilifera Broth. in Annls bryol.1:34, (1928)

F. pilifera (Mitt.) Broth. in Nat. Pfl. I(3) : 523, (1903).

Autoicous; the discoid male inflorescence terminal on the main stem with female inflorescence innovating from the lower half. Low growing, gregarious to tufted earth mosses. Leaves more or less erect to convolute, forming a bud-like structure of various shapes, mostly somewhat acuminate; nerve ending below the apex to shortly excurrent; cells elongate-rectangular to rhomboid towards the margin sometimes elongate and forming a narrow border. Seta short or elongate; capsule symmetrical to obliquely pyriform, gibbose, then erect to pendulous. Peristome deeply inserted, double, single or absent; teeth of outer peristome lanceolate-subulate, reddish to brown-red, mostly oblique, twisted towards right; inner peristome as long as outer or shorter, yellow, with basal membrane and more or less lanceolate or rudimentary processes, laxly papillose. Operculum flat or convex, rarely obtuse-conical, mostly without a mamilla, with cells arranged in straight lines or showing a right-hand spiral twist. Calyptra persistent, inflated-cucullate, long beaked, smooth with entire margin. Spores moderately large. Capsule neither striate, nor furrowed; annulus absent. Capsule inclined, asymmetrical. Nerve excurrent extending into a long, entire hair.

DISTRIBUTION of *Funaria wijkii*: Kashmir.

Collection Site: Attukadu (1500m)

Herbarium No. 13331

Figure: **Plate 31[B]**

Order: Eubryales

Key to the families of Eubryales:

- | | | |
|----|--|---------------|
| 1a | Leaf cells almost invariably smooth, isodiametric, more or less rhomboidal or linear vermicular. Capsule, (dry) smooth | 2 |
| 1b | Leaf cells in majority, rectangular; mamilllose, or ends of cells projected as mammillae, rarely smooth or papillose. Capsule, (dry) usually furrowed and if not, then spherical. Nerve with guide cells | Bartramiaceae |
| 2a | Upper cells of the leaves prosenchymatous, rhombic or linear and vermiform; basal cells quadrate to rectangular | Bryaceae |
| 2b | Generally all cells in the leaf alike, usually parenchymatous, rounded, often in oblique rows from the nerve outwards | Mniaceae |

9. BRYACEAE

Key to the genera of Bryaceae:

- | | | |
|----|--|-----------------------|
| 1a | Sporogonia generally lateral | 2 |
| 1b | Sporogonia generally terminal in the main stem | 3 |
| 2a | Innovations catenulate; leaves ovate, setaceous | <i>Haplodontium</i> |
| 2b | Innovation usually absent; leaves lanceolate, not setaceous | <i>Mielichhoferia</i> |
| 3a | Teeth when moist get inwards; basal membrane high | 4 |
| 3b | Teeth when moist erect; basal membrane absent or low | <i>Orthodontium</i> |
| 4a | Plants julaceous, filliform; cells in the upper half of the leaf thickened and distinctly different from thin-walled cells in the lower half | <i>Anomobryum</i> |
| 4b | Plants lacking this combination of characters | 5 |
| 5a | Leaf cells usually elongated, 4:1 or longer; leaves multifarious, all alike | 6 |
| 5b | Leaf cells usually broader, less than 4:1 | 8 |
| 6a | Leaves narrow, linear lanceolate; nerve broad; cilia appendaged | <i>Leptobryum</i> |
| 6b | Leaves broader; nerve narrow; cilia non-appendaged, often rudimentary or nodose | 7 |
| 7a | Annulus mostly absent; cilia nodose | <i>Mniobryum</i> |
| 7b | Annulus mostly present; cilia not nodose often rudimentary or lacking | <i>Pohlia</i> |
| 8a | Stem with stoloniform shoots, plants large; sporogonia several in each perichaetium | <i>Rhodobryum</i> |

8b	Stem mostly without stolons; one or two sporogonia in each perichaetium	9
9a	Capsule asymmetrical; outer peristome shorter than the inner	<i>Plagiobryum</i>
9b	Capsule symmetrical; both peristomes of the same length or the inner shorter	10
10a	Processes and cilia usually normal and well-developed	11
10b	Processes mostly rudimentary; cilia rudimentary to absent	<i>Brachymenium</i>
11a	Leaves not so strongly concave	<i>Ptychostomum</i>
11b	Leaves strongly keeled and concave	<i>Bryum</i>

Orthodontium infractum Schwaegr. in Hedw. Sp. Muse. Suppl. 2(11): 123, (1827)

O. infractum Doz. & Molk. Anns Sci. nat. Bot. Ser. 3, 2 : 313 (1844)

O. brevicollum (Fleisch.) Broth. Nat. Pfl. Ed. 2, X : 350 (1924a), *nom. nud. fid.*
Meijer, Acta bot. neerl. 1: 48 (1952)

O. emodi Hamp. & C. Muell. in Jaeg. Bericht. That. St. Gall. Naturw. Ges. (1873-74) :
108, 1875 *nom. nud.*

O. novae-guineae Dix. J. Bot., Lond. 80 : 7, (1942a)

Paroicous or autoicous, in the latter case antheridia on small gemmiform branches. Plants small and delicate, yellowish green, hardly exceeding 0.5cm. in height, erect, simple or slightly branched, radiculose only at the base. Leaves long in relation to the size of the plant, erect, flexuose, linear-setaceous to narrowly ovate or oblong-lanceolate : nerve percurrent or nearly so to somewhat excurrent : cells linear-rhomboidal, basal rectangular. Seta slender, erect, up to 8mm. long. Capsule suberect. clavate or subcylindrical to ovate-pyriform; neck longer or shorter, (dry) smooth or slightly sulcate. Annulus lacking. Peristome inserted below the mouth ; exostome of 16 rather slender and fragile teeth, smooth or slightly papillose: endostome without or with a low basal membrane of 16 slender processes : cilia absent. Operculum prominent, shortly rostrate. Spores small or medium-sized, rounded.

DISTRIBUTION of *Orthodontium infractum*: Himalayas, Sikkim; Ceylon, Indonesia, Borneo.

Collection Site: Matupatti (1700m)

Herbarium No. 13334

Figure: **Plate 32[A]**

Mielichhoferia himalayana Mitt. J. Linn. Soc., Bot. Suppl. 1: 65, 1859

M. robusta Broth., mss.

Female inflorescence without innovations, slender, gemmiform, with or without filiform paraphyses; male inflorescence gemmiform, thick, many-leaved, bracts small and delicate; antheridia in pairs in the axils of the bracts ; paraphyses absent or sparse. Stem with leaves of more or less equal size and usually numerous branches. Leaves erecto-patent to imbricate, ovate-lanceolate to linear-lanceolate, mostly denticulate near the apex, margin plane or somewhat reflexed; nerve percurrent or ending below the apex, rarely excurrent; cells narrow, elongate-rhombic to linear, towards the base somewhat large and thin-walled, subrectangular to quadrate, walls sometimes thick. Seta exerted beyond the branches, thin, short to very long, sometimes arcuate in the upper part. Capsule erect to slightly inclined, symmetrical, with a short or a long neck, pyriform, narrow-mouthed or asymmetrical, cylindrical to clavate, more or less curved, and wide-mouthed. Annulus broad, revolute. Outer peristome absent; inner peristome inserted near the mouth, with a low basal membrane and 16 linear processes which are rarely perforated, but show a weak longitudinal line of division and several fairly prominent transverse bars. Opercutum small, mostly shortly conical. Calyptra small and ephemeral. Spores of medium size. Capsule terminal.

DISTRIBUTION of *Mielichhoferia himalayana*: Kashmir, Kullu, Rohtang pass, Lahul, Kumaon.

Collection Site: Munnar (1600m.)

Herbarium No. 13332

Figure: **Plate 32[B]**

Haplodontium fabroniodes Card. in Grand. Hist. Madag. 39 : 274, 1915.

Dioicous, inflorescence lateral, short, gemmiform, with filiform paraphyses. Slender plants in usually dense, low to about 1 cm., yellowish or reddish, somewhat glossy, soft tufts. Stem brittle, mostly radiculose to brown felted, closely leafy with catenulate, upwards compressed innovations. Leaves erect, (dry) imbricate. (moist) concave, ovate to obovate or oblong-lanceolate. upper margin entire or faintly

toothed: nerve strong, ending a little below the apex or percurrent. rarely excurrent; cells large, thin-walled, rhomboid, near the base rectangular. Seta elongate, upwards arcuate. Capsule mostly cernuous, symmetrical, usually narrow-mouthed : stomata phaneroporous. Annulus broad, revoluble. Inner peristome absent ; teeth 16, lanceolate of uniform width, free or fused in pairs, outer layer generally, narrower than the inner, mostly papillose, lamellose. Operculum thin, arched-conical, with a wort. Spores medium-sized.

DISTRIBUTION of *Haplodontium fabroniodes*: Varinag, Banihal, Skardu, Kashmir, Zaskar, Madurai (Kodaikanal); Madagascar.

Collection Site: Munnar (1600m.)

Herbarium No.13333

Figure: **Plate 33[A]**

Leptobryum pyriforme (Hedw.) Wils. in Bryol. Brit.: 219 (1855)

Webera pyriformis Hedw. in Sp. Musc.: 169 (1801)

Mnium pyriforme (Hedw.) Funck in Crypt. Gew. Fichtelgeb., 3 : n. 61 (1802)

Leptobryum dioicum Debat in Ann. Soc. Bot. Lyon, 3 : 114 (1876)

L. minus Philib. in Husn. in Musci Gall., 16 : n. 768 (1887)

L. hariottii R. Br. in Trans. New Z. Inst., 31 : 144 (1899)

Plants silky yellow-green to green in loose tufts up to 3cm. high, much shorter in sterile plants. Lower leaves small; upper long, comose, sickle-like curved and divergent or erectopate (somewhat flexuose when dry), linear from a lanceolate base, setaceous in a subulate point, ± 5.3 mm. long and 0.44mm. wide at base; margin flat, denticulate only at tip. Costa broad at base (about $\frac{1}{3}$) and filling most of subula at tip. Leaf cells linear and pointed at apices in most of the leaf (30 to $35 \times \pm 6.5 \mu$) but the basal cells are irregularly quadrate-rectangular ($\pm 28.4 \times 14.2 \mu$) shows a row of narrow rectangular cells ($\pm 28.4 \times 5 \mu$) on the border.

DISTRIBUTION of *Leptobryum pyriforme*: Upper Assam, Kashmir, Western Himalaya, China, Taiwan, Korea, Japan, Central & North Asia, Caucasus, East Indies,

Alps, Spitzbergen, Great Britain, North Africa, Madagascar, South Africa, North America, Central & South America, Tasmania, Newzealand, Oceania.

A cosmopolitan species.

Collection Site: Wariyum (1300m)

Herbarium No. 13335

Figure: **Plate 33[B]**

Mniobryum ludwigii (Schwaegr.) Loesk. in Stud. Morph. Syst. Laubm.: 124 (1910)

Bryum ludwigii Spreng. ex Schwaegr. in Sp. Musc. Suppl., 1(2) : 95 (1816)

Webera ludwigii (Schwaegr.) Fuernr. in Flora, 12 : 35 (1829)

Pohlia ludwigii (Schwaegr.) Broth. in Act. Soc. Sc. Fenn., 19(12) : 27 (1892)

Robust, densely or loosely tufted, long, decumbent or erect, simple or branched base, green plants with reddish stems, ± 2.5 cm. tall. Leaves erect to erectopate, somewhat flexuose (shrunk, more flexuose and somewhat imbricate when dry), ovate-lanceolate, $\pm 1.63 \times 0.52$ mm. (larger in Kashmir plants; margin flat, denticulate at the acute apex; costa red or reddish in mature leaves, ending just below apex. Leaf cells on top irregularly narrow rhomboid-hexagonal, $\pm 66 \times 8.5 \mu$ border cells are lightly tinted and the marginal row becomes very narrow at the middle of the leaf; leaf base cells rectangular ($\pm 50 \times 10 \mu$) near periphery becoming narrower towards border.

DISTRIBUTION of *Mniobryum ludwigii*: Meghalaya, Kashmir, Europe (including Great Britain); North America.

A Northern Hemisphere species.

Collection Site: Attukadu (1500m)

Herbarium No. 13336

Figure: **Plate 34[A]**

Key to the species *Pohlia*:

- | | |
|--|----------------------|
| 1a Gemmae globose, seta often flexuose | <i>P. flexuosa</i> |
| 1b Gemmae vermicular | 2 |
| 2a Leaf cells thick walled, monoecious. Capsule horizontal | <i>P. himalayana</i> |
| 2b Leaf cells thin walled, apophysis shorter, leaf lanceolate, costa excurrent | <i>P. gedeana</i> |

- Pohlia flexuosa* Hook. in Icon. Pl. Rar., 1 : 19 (1836)
Bryum brachydontium Hamp. in C. Muell. in Syn., 1 : 327 (1848)
Webera flexuosa (Hook.) Mitt. in Musci Ind. Or.: 66 (1859)
W. delicatula Mitt. in ibid.: 66 (1859)
Brachymenium leucostomum Bosch et Lac. in Bryol. Jav., 1 : 142 (1860)
Webera hampeana Bosch et Lac. in ibid., 1 : 137 (1860) *nom. illeg.*
Bryum scabridens Mitt. in J. Proc. Linn. Soc., 8: 151 (1864)
Webera scabridens (Mitt.) Jaeg. in Ber. S. Gall. Naturw. Ges., 1873-74: 130 (1875)
Brachymenium papillosum Jaeg. in ibid.: 122 (1875)
B. scabridens (Mitt.) Broth. in Hedwigia, 38 : 218 (1899)
Pohlia brachydontia (Hamp.) Broth. in Monsunia, 1 : 45 (1899)
P. delicatula (Mitt.) Broth. in Nat. Pfl., 1(3) : 552 (1903)
P. scabridens (Mitt.) Broth. in ibid., 1(3) : 552 (1903)
P. hampeana Broth. in ibid.: 547 (1903)
P. papillosa (Jaeg.) Broth. in ibid.: 552 (1903)
P. leucostoma (Bosch et Lac.) Fleisch. in Musci Fl. Buitenz., 2 : 514 (1904)
Webera gracillima Card. in Bull. Soc. Bot. Geneve ser. 2, 1: 125 (1909)
Pohlia subflexuosa Broth. in Sitz. Ak. Wiss. Wien. Math. Nat. Kl. Abt. 1, 131 : 213 (1923)
Webera leucostomoides Broth. in Bishop Mus. Bull. 40 : 14 (1927)
Pohlia gracillima (Card.) Ihs. in Cat. Moss Jap.: 91 (1929)
Webera gracilescens Bartr. in Bishop Mus. Bull., 101 : 109 (1933)
W. speciosa Sak. in Bot. Mag. Tokyo, 53 : 288 (1939)
W. curiosa Dix. et Sak. in Bot. Mag. Tokyo, 54 : 6 (1940)
Pohlia gracilescens (Bartr.) Bartr. in Bishop Mus. Occ. Pap. 20: 299 (1952)
P. leucostomoides (Broth.) Bartr. in ibid.: 299 (1952)

Plants in lax tufts or gregarious, erect, sometimes mixed with other mosses, yellowish green to brownish, without lustre. Stem generally erect, ± 1 cm. long, with brown radicles below, simple or with subfloral innovations. Leaves dense (loosely arranged on lower parts of stem where they are also smaller), erectopate (more spreading and curved when dry), lanceolate, up to 2.7mm. long and 0.6mm. broad; margin flat but reflexed at base, entire below, slightly dentate at apex; apex acuminate. Costa fairly strong, reddish, percurrent. Leaf cells in apical and median portions linear-rhomboid

with fairly thick walls, $\pm 57 \times 7 \mu$, narrower, and slightly flexuose towards margins; basal cells rectangular, $\pm 45 \times 11 \mu$; alar cells irregularly quadrate, $\pm 40 \times 30 \mu$, also thick-walled. Perichaetial cells linear lanceolate and larger, $\pm 3.3 \text{mm.}$ long and 0.5mm. broad, sometimes with apex twisted. Seta erect, up to 2.8cm. long, arcuate at top, flexuose when dry. Capsule pendulous or nodding, elongated oval pyriform, $\pm 3 \text{mm.}$ long and 1.5mm. in diameter with very short apophysis and narrow mouth. Operculum small, pointed conical. Exothecial cells irregular in shape, with thin walls and slightly wavy outline, 4-5 rows of iso-diametric smaller cells at capsule mouth are darker pigmented. Outer peristome teeth with hyaline, papillose tips. Inner teeth hyaline, papillose, basal membrane low, cilia rudimentary or lacking. Spores brown, round, lightly papillose, 7.5 to 11.5μ in diameter. Spherical, multicellular gemmae present on rhizoids, $\pm 60 \mu$ in diameter.

DISTRIBUTION of *Pohlia flexuosa*: East Nepal, Sikkim, Darjeeling, Arunachal, Khasia Hills, Calcutta, Orissa, W. Himalaya, W. Ghats, Ceylon, Sumatra, Java, Celebes, Philippines, Taiwan, China (Yunnan), Korea, Japan, Riukiu, Hawaii, Central America, North & South America.

A widely distributed species.

Collection Site: Munnar (1600m.)

Herbarium No. 13337

Figure: **Plate 34[B]**

Pohlia geddeana (Bosch et Lac.) Gangulee *comb. nov.*

Bryum geddeanum Bosch et Lac. in Bryol. Jav., 1 : 147 (1860)

Pohlia geddeana (Bosch et Lac.) Ochi in Herb.

Plants in loose or dense tufts, usually about 5mm. high (may be up to 1cm.). Lower leaves small and distantly placed. Upper leaves erectopatent (appressed to stem when dry), narrowly ovate lanceolate, acuminate, $\pm 2.3 \text{mm.}$ long and 0.45mm. broad; margin entire below, denticulate at tip. Costa strong, excurrent in an awn-like, stiff tip. Leaf cells elongated rhomboid at tip ($\pm 83 \times 10 \mu$), up to $130 \times 10 \mu$ at middle leaf, bordered by a row of slightly narrower, yellowish cells. Basal leaf cells irregularly hexagonal-rectangular, up to $72 \times 21 \mu$ near vein and narrower (up to $72 \times 10 \mu$) near borders. Seta apical, somewhat sinuose and bent at tip, $\pm 1.3 \text{cm.}$ (may be upto 3cm.)

long. Capsule horizontal, cylindrical-clavate, ± 2.8 mm. long (including the apophysis which is about half the length and smoothly merges with the capsule) and 0.7mm. in diameter at the capsule. Operculum conical convex, ± 0.3 mm. high. Peristome inserted on mouth, $\pm 350\mu$ high. Inner peristome as high as the outer.

DISTRIBUTION of *Pohlia gedeanana*: Bhutan (3200-3400 m.), Thailand, Java, Borneo. A Malayasian species.

Collection Site: Eravikulam (1800m)

Herbarium No. 13338

Figure: **Plate 35[A]**

Pohlia himalayana (Mitt.) Broth. in Nat. Pfl., 1 (3) : 548 (1903)

Webera himalayana Mitt. in Musci Ind. Or. : 66 (1859)

Bryum himalayanicum (Mitt.) C. Muell. in Gen. Musc. Fr. : 218 (1900)

Plants variable in size, slender, loosely tufted, usually about 1.2cm. high. Stems with a few innovations from base and from below the flowers. Leaves comparatively lax on stem, erectopate (closely appressed to stem and crispate when dry); lower leaves small, ovate-lanceolate, increasing in size upwards; upper ones longer, narrower lanceolate, topmost ones in comal tuft, ± 2 mm. long and 0.5mm. wide at base, decurrent at base, apex acute; margin entire at base, mildly indented at tip, reflexed through the entire length. Costa strong, shortly excurrent. Leaf cells narrowly rectangular ($\pm 22 \times 7\mu$) at base becoming more elongated upwards, narrowly hexagonal to rhomboidal ($\pm 38 \times 7\mu$) at tip becoming narrower at margin. Seta apical, erect (curved at tip), reddish, 1.2 to 1.8cm. long. Capsule variable, reddish brown, oblong club-shaped, usually horizontal, ± 5 mm. long and 2mm. in diameter a short but distinct, tapering apophysis, contracted below wide mouth.

DISTRIBUTION of *Pohlia himalayana*: Sikkim.

Endemic in this area. But present report from Idukki extends its distribution to south India.

Collection Site: Devikulam (1700m)

Herbarium No. 13339

Figure: **Plate-35[B]**

Key to the species of *Brachymenium*:

1a	Leaves clearly bordered	2
1b	Leaves not bordered	6
2a	Leaves large (more than 2.5mm long)	3
2b	Leaves small (2mm or less)	<i>B. bryoides</i>
3a	Capsule long, leaves with dentate margin at apex	4
3b	Capsule less than 3.5mm	<i>B. ptychothecium</i>
4a	Capsule more the 5mm long	5
4b	Capsule less than 4.5mm long	<i>B. capitulatum</i>
5a	Capsule with long, narrow apophysis. Leaves shorter	<i>B. leptophyllum</i>
5b	Capsule with shorter, tapering apophysis. Leaves longer	<i>B. nepalense</i>
6a	Leaves less than 1.5mm long. Capsule short, pyriform	<i>B. sikkimense</i>
6b	Capsule elongated, very narrow at apex; apophysis tapering	<i>B. acuminatum</i>

Brachymenium acuminatum Harv. in Hook. in Icon. Pl. Rar, 1: 19 (1836)

Brachymenium cuspidatum Griff. in Cal. J. Nat. Hist., 3 : 58 (1943)

Bryum pungens Tayl. in Lond. J. Bot., 5 : 52 (1846) *fid.* Ochi

B. multicaule Tayl. in *ibid.*: 53 (1846) *fid.* Ochi

B. harveyanum C. Muell. in Syn., 1 : 313 (1848)

B. flaccidisetum C. Muell. in Bot. Zeit., 11: 23 (1853)

Brachymenium mielichhoferioides C. Muell. in Nuov. Giorn. Bot. Ital., 4 : 16 (1872)
fid. Ochi

B. flaccidisetum (C. Muell.) Jaeg. in Ber. S. Gall. Naturw. Ges., 1873-74 : 111 (1875)
fid. Ochi

Plants small, terrestrial, pale yellow-green, growing in dense mats. Stem erect, up to 5mm. high, branched by several subfloral innovations up to 1cm. long, matted together by red tomenta below. Leaves crowded, imbricate, erect with spreading points, slightly contorted when dry, oblong-lanceolate, ± 1 mm. long and 0.41mm. wide, concave, acuminate; margin entire, usually flat. Costa strong, excurrent in an arista ± 0.12 mm. long. Leaf cells thin-walled, rhomboid (up to $100 \times 10 \mu$) at top, gradually rectangular to irregularly rounded (19 to 95μ long and 11 to 19μ broad) at base; cells narrower at margin but there is no distinct border. Seta apical, erect or flexuose but curved at tip, ± 2.7 cm. long. Capsule slightly inclined, clavate with a narrower top, light brown, narrow-mouthed, with short neck, ± 3 mm. long and 1mm. in diameter. Operculum short, conical, with blunt apex. Inner peristome basal. membrane about half the height of outer teeth and with very rudimentary segments.

DISTRIBUTION of *Brachymenium acuminatum*: East Nepal (2200- 3000m.), K. & J. Hills, South India (Mahabaleshwar, Nilgiri), Thailand, Penang, Java, Philippines, Ethiopia, Australia, South America

A widespread species.

Collection Site: Munnar (1600m.)

Herbarium No. 13340

Figure: **Plate 36[A]**

Brachymenium bryoides Hook. ex Schwaegr. in Sp. Musc. Suppl. 2(1): 134 (1824)

Brachymenium herpocaulon Brid. in Bryol. Univ., 1 : 603 (1826) *nom. inval.*

B. weisia Harv. in Hook. in Icon. Pl. Rar., 1 : 19 (1836)

Bryum weisia (Harv.) C. Muell. in Syn., 1 : 325 (1848)

Plants green, gregarious, diffused or compact. Stem short (usually less than 5mm.), erect or partly prostrate, branched by several subfloral innovations, matted together by reddish tomenta below. Leaves erect to erectopatent, dense (not much changed when dry), small, ovate-lanceolate, ± 1 mm. long and 0.2mm. broad, acuminate; margin flat and entire throughout the leaf. Costa strong, excurrent in an arista ± 0.2 mm. long. Leaf cells thin-walled, elongated hexagonal to rhomboid ($\pm 40\mu$ long and 7μ wide) at tip becoming subquadrate to rectangular ($\pm 38 \times 7\mu$) at base; there is a border of at least one row of narrower cells at the margin. Branch and perichaetial leaves similar. Seta apical, red, somewhat flexuose, ± 1.2 cm. long. Capsule erect or inclined, brown, ± 2 mm. long and 1mm. in diameter, narrow mouthed, apophysis very short and scarcely differentiated. Operculum short, dark red, conical with obtuse tip. Annulus broad, prominent. Exothecial cells thick-walled, rounded, hexagonal to quadrate, shorter near rim. Peristome closely inserted to urn mouth; outer peristome teeth linear-lanceolate, $\pm 220\mu$ high and 20μ wide at base, papillose at the paler tips; inner transparent, much shorter with very low basal membrane and short segments. Spores rounded, papillose.

DISTRIBUTION of *Brachymenium bryoides*: East Nepal, Darjeeling, Khasia Hills, Western Himalaya (Simla, Almora), South India (Nilgiri)

Endemic to India.

Collection Site: Munnar (1600m.)

Herbarium No. 13341

Figure: **Plate 36[B]**

Brachymenium capitulatum (Mitt.) Paris in J. of Bot., 28: 68-70 (2006)

Brachymenium ochianum Gangulee nom. nov.

B. contortum Hamp. ex Ochi in J. Jap. Bot., 43 : 109 (1968) horn. illeg. (previous species-*B. contortum* Griff.)

B. contortum Hamp. in sched.

Plants medium sized, densely tufted, greenish yellow above and brownish below. Stem erect densely clothed with leaves, tomentose below, red, about a cm. high, with 2 or more subfloral innovations. Lower leaves smaller. Upper leaves tufted, erectopate, contorted and appressed to stem when dry, oblong spatulate, 2.5 to 4mm. long and ± 1 mm. broad, acuminate; margin entire and revolute from base to $2/3$ of the leaf, dentate and flat above. Costa strong, excurrent in a ± 0.37 mm. arista, reddish at base, yellowish green above. Leaf cells thin-walled, rhomboid and up to $50 \times 16.5 \mu$ at apex, $\pm 66 \times 18.5 \mu$ at middle of leaf; rectangular to subrectangular (up to $66 \times 2.65 \mu$) at base; there are 2 to 3 rows of narrow elongated cells ($\pm 96 \times 10 \mu$ at apex, $\pm 160 \times 10 \mu$ at midleaf) forming a clear border which is reduced to 1 or 2 rows of shorter rectangular cells ($\pm 33 \times 15 \mu$) at base. Perichaetial leaves narrower and shorter, ± 2.5 mm. long and 0.5mm. broad. Seta apical, erect, red, 2 to 2.5cm. long. Capsule erect, ovate-cylindrical, 4 to 5mm. long including a tapering apophysis about a quarter of this length and ± 1.2 mm. in diameter at the urn. Capsule mouth narrow. Operculum conical. Exothecial cells irregularly rectangular with wavy walls, $\pm 140 \times 22 \mu$, about 3 rows of small, quadrate cells forming the urn rim. Peristome teeth inserted below mouth; outer teeth $\pm 300 \mu$ high and 60μ wide at base, hyaline papillose at apex; inner peristome imperfect, represented only by a basal membrane $\pm 120 \mu$ high. Spores lightly papillose, 19 to 22μ .

DISTRIBUTION of *Brachymenium capitulatum*: East Nepal (1800-2600m.), Darjeeling, Sikkim (about 2600 m.), Bhutan (1950- 2750 m.), Taiwan.

An Indopacific species.

Collection Site: Adimalli (1300m.)

Herbarium No. 13344

Figure: **Plate 37[A]**

Brachymenium leptophyllum (Bruch. & Schimp. ex Müll.Hal.) Bruch & Schimp. ex Müll.Hal. in Nov. Hedw., 78 : 447-452 (2004)

Brachymenium longicolle Ther. in Bull. Soc. Bot. Geneve, 26 : 85 (1936)

Tufted plants more than 3cm. high with 2 or more subfloral innovations. Leaves smaller and distantly placed below, large and comatose above, erect below, erect to erectopate above, contorted when dry, oblong-spathulate, up to 3mm. long and 1.14mm. broad, acuminate; margin entire and revolute from base to 2/3 of leaf, flat and denticulate at tip. Costa strong, excurrent in an arista up to 0.4mm. long, reddish at base. Leaf cells thin-walled, rhomboid, $\pm 33 \times 13 \mu$ at tip, $\pm 50 \times 11.5 \mu$ at middle of leaf, sub-rectangular ($\pm 40 \times 18 \mu$, shorter and narrower at margin) at base; 2 to 3 rows of narrow elongated cells ($\pm 66 \times 7 \mu$ at middle of leaf) form a clear border from tip to a little above base. Seta apical, erect or slightly curved, up to 3.2cm. long. Capsule almost erect, narrow, long, up to 6.5mm. long (including the narrower tapering apophysis which is about $\frac{1}{3}$ of the length) and ± 1.48 mm. in diameter at the elongated, ovate capsule. Peristome about 300μ high. Spores dirty yellow, pellucid, 25 to 30μ in diameter.

DISTRIBUTION of *Brachymenium leptophyllum*: East Nepal (1100-3800 m.), Sikkim, Thailand, Central Africa, Mauritius Is.

An Afro-Asiatic species.

Collection Site: Matupatti (1700m)

Herbarium No. 13342

Figure: **Plate37[B]**

Brachymenium nepalense Hook. in Schwaegr. in Sp. Musc. Suppl. 2(1): 131 (1824)

Bryum erectum Brid. in Bryol. Univ., 1 : 602 (1826) *nom. inval. in synon.*

B. hookeri Spreng. in Syst. Veg., 4(1) : 212 (1827)

Brachymenium contortum Griff. in Cal. J. Nat. Hist., 3 : 56 (1843)

Bryum brevicaulis Hamp. ex C. Muell. in Syn., 1 : 323 (1848)

Bryum clavariaeforme C. Muell. in Bot. Zeit., 11: 24 (1853)

Brachymenium brevicaulis (C. Muell.) Mitt. et Wils. in Kew J. Bot., 9 : 330 (1857)

B. hookeri (Spreng.) Bosch et Lac. in Bryol. Jav., 1 : 138 (1860)

Bryum orthopelma C. Muell. in Linnaea, 38 : 550 (1874)

Brachymenium clavariaeforme (C. Muell.) Jaeg. in Ber. S. Gall. Naturw. Ges. 1873
74: 119 (1875)

Brachymenium orthopelma (C. Muell.) Jaeg. in Ber. S. Gall. Naturw. Ges. 1877-78:
439 (1880)

B. clavulum Mitt. in Trans. Linn. Soc. Bot. ser. 2, 3 : 165 (1891) as var. *fid.* Ochi

B. isochyroneuron Card. in Rev. Bryol., 28 : 114 (1901)

Brachymenium parvulum Broth. in Symb. Sin., 4 : 54 (1929) as var. *fid.* Ochi

B. sapoznikovi Podp. in Publ. Fac. Sc. Univ. Masaryk Brno, 116 : 12 (1929) *fid.* Ochi

B. nordenskiöldii Besch. f. *kiiense* Horik. et Ochi in Ochi in J. Jap. Bot., 28 : 338
(1953) *fid.* Ochi

Plants robust, gregarious to densely tufted, slightly glossy, yellowish green to green above, about 2cm. high. Stem erect, with several subfloral innovations, red, matted together with reddish tomenta below. Lower leaves small, distantly placed, abruptly larger and tufted at comal region, erectopatent, closely imbricate and twisted around stem when dry, oblong-ungulate to oblong-spathulate, about 4.5mm. long and 1mm. wide, acuminate; margin entire and revolute except at tip where it is dentate and flat. Costa strong, red, excurrent in a smooth or denticulate, ± 0.4 mm. long arista. Leaf cells more or less thick-walled, rhomboidal to hexagonal ($\pm 38 \times 13 \mu$) at apex becoming rectangular ($\pm 65 \times 13 \mu$) at base, extreme base cells are red; there is a distinct border with 2 to 4 marginal rows of narrower, yellowish cells. Branch leaves similar. Perichaetial leaves shorter and narrower. Seta apical, red, flexuose or erect, ± 3.4 cm. long. Capsule generally erect, narrowly pyriform to subclavate, light brown at maturity, 5mm. long with the short tapering apophysis 2mm. in diameter, urn mouth narrow. Operculum small, dark red, glossy, conical. Annulus broad, prominent, fragile. Exothecial cells thick-walled, irregular in shape, becoming smaller towards urn mouth, the last few rows at rim isometric, dark pigmented but not flattened. Peristome deep inserted, outer teeth lanceolate, $\pm 1.429 \mu$ high and 65μ wide at base, yellow at base, pale papillose above; inner peristome imperfect with or without rudimentary segments, basal membrane less than half the height of outer peristome. Spores fine papillose, yellowish, rounded, 7.8 to 10μ in diameter. Autoicous, plants abundantly fruiting, antheridia in terminal bud, not numerous, $\pm 400 \mu$ long and 85μ in diameter, paraphyses long.

DISTRIBUTION of *Brachymenium nepalense*: East Nepal (1900 m.), Sikkim, Darjeeling (1950 m. to 2800 m.), K. & J. Hills, Naga Hills (2100 m.), Western Himalaya (Simla, Kumaon, Garhwal), Mahabaleshwar, Nilgiri, Ceylon, Burma, Thailand, N. & S. Vietnam, Sumatra, Java, Borneo, Celebes, New Guinea, Philippines, Taiwan, China (Yunnan, Setschwan), Japan, Vladivostok, Central Africa, Mauritius Is.

An Afro-Asiatic species.

Collection Site: Munnar (1600m.)

Herbarium No. 13343

Figure: **Plate 38[A]**

Brachymenium ptychothecium (Besch.) Ochi in Adv. Front. Pl. Sc., 4: 108 (1963)

Bryum ptychothecium Besch. in Ann. Sc. Nat. Bot. ser. 7, 15 : 66 (1892)

Plants terrestrial, fairly robust, gregarious to densely tufted, glossy, green, reddish at base. Shoot erect, small, with several subfloral innovations, red stems matted together with reddish tomentum below. A few small and distantly placed lower leaves and then abruptly larger leaves tufted above. Upper leaves erectopatent to erect-spreading (closely imbricate and curled when dry), broadly oblong-spathulate, bordered, aristate-apiculate, 2.8 to 3.1mm. long and 0.8 to 1.5mm. broad at middle, leaf base generally red; margin entire below, dentate above, usually revolute from base to middle of leaf. Costa strong, red below, yellow above, excurrent in a denticulate arista about 0.2mm. long. Leaf cells thick-walled; apical cells rhomboid to hexagonal, 38 to 53 μ long and $\pm 15\mu$ wide; basal cells subrectangular, $\pm 40 \times 19\mu$; marginal cells narrow, elongated, yellowish, forming a border of 2 to 3 rows. Branch leaves similar. Perichaetial leaves shorter and narrower. Seta apical, erect, pale greenish, ± 3.3 cm. long. Capsule erect, cylindrical, ± 3 mm. long and 1mm. in diameter. Peristome as in other species of *Brachymenium*.

DISTRIBUTION of *Brachymenium ptychothecium*: Darjeeling (2400-4000m.), Sikkim (2200 m.), China (Yunnan).

An Indo-Chinese species.

Collection Site: Poyankutti (1200m.)

Herbarium No. 13345

Figure: **Plate 38[B]**

Brachymenium sikkimense Ren. et Card. in Bull. Soc. R. Bot. Belg., 38(1): 12 (1900)

Plants small, gregarious to densely tufted, rupestrine. Stem erect, short (± 3 mm.), red, branched by several subfloral innovations, matted together by rhizoids at base. Leaves compact along the stem, erect, more appressed to stem when dry, small, ovate to ovate-lanceolate, ± 0.8 mm. long and 0.4mm. broad, acuminate; margin recurved from base to half the leaf, entire. Costa strong, excurrent in an arista ± 0.15 mm. long. Numerous broadly clavate gemmae ($\pm 190 \times 120 \mu$) are found in the leaf axils. Leaf cells thin-walled rhomboidal to hexagonal ($\pm 30 \times 7 \mu$) at apex, becoming rectangular ($\pm 38 \times 11 \mu$) at base; one row of narrower cells on the margin form a border. Branch leaves similar. Perichaetial leaves larger, ± 1 mm. long. Seta slender, erect, reddish, ± 1.1 cm. long. Capsule more or less erect, pyriform, ± 2 mm. long and 1.5mm. in diameter, narrow-mouthed, with a very short neck, slightly plicate when moist. Exothecial cells rectangular with a few rows of smaller, transversely elongate cells on the rim. Annulus clear. Peristome deep inserted; outer teeth yellow-brown, narrow lanceolate, $\pm 250 \mu$ long 38μ wide at base, tips hyaline papillose; inner segments hyaline papillose, much shorter than outer teeth. Spores fine papillose, 7 to 11μ in diameter. Dioicous. Cauline archegonia with paraphyses also present.

DISTRIBUTION of *Brachymenium sikkimense*: Darjeeling.

Endemic in this area. But present report from Idukki extends its distribution to south India.

Collection Site: Munnar (1600m.)

Herbarium No. 13346

Figure: **Plate 39[A]**

Plagiobryum zierii (Hedw.) Lindb. in Oefv. K. Vet. Ak. Foerh., 19: 606 (1863)

Bryum zierii Dicks. ex Hedw. in Sp. Musc.: 182 (1801)

Zieria julacea Schimp. in Coroll. 69 (1856)

Plants soft, small, in close tufts, silvery green to whitish above, pale pink below. Stem erect, red, about 4mm. high, with several subfloral innovations., Leaves densely imbricate, erect with points recurved, not much changed when dry, thin, ovate,

acuminate, ± 1 mm. long and 0.4mm. wide; margin flat, usually entire. Costa red, usually vanishing below tip, rarely percurrent. Leaf cells lax, thin-walled, devoid of chlorophyll in mature leaves, slightly reddish at base; rhomboid to hexagonal at tip and middle leaf up to $110 \times 30 \mu$ sub-rectangular ($\pm 68 \mu$ long) at base. Perichaetial larger, oblong-lanceolate, ± 1.6 mm. long and 0.5mm. wide. Seta apical, red, short, ± 7 mm. long, curved or arcuate at top. Capsule inclined to pendulous, clavate, up to 7mm. long including a long apophysis always longer than the urn, gibbous and asymmetrical above with a smaller, oblique mouth. Operculum conical, apiculate. Outer peristome a little shorter than the segments of the inner peristome, cilia rudimentary. Dioicous. Male plants similar, intermingled in the tuft. Antheridia in terminal buds which become lateral by innovations.

DISTRIBUTION of *Plagiobryum zierii*: Sikkim (3900m.), Europe incl. Great Britain, Central Asia, Caucasus, China, Korea, Japan, Siberia, North Africa, North America.

A North Hemisphere species.

Collection Site: Attukadu (1500m)

Herbarium No.13347

Figure: **Plate 39[B]**

Key to the species of *Anomobryum*:

- | | | |
|----|---|---------------------------|
| 1a | Perichaetium with ovate lanceolate, acute bracts and sub-floral innovations | <i>A. brachymenioides</i> |
| 1b | Perichaetia and innovations not so | 2 |
| 2a | Apical cells rhombic, nerve ending two or three cells below the apex | <i>A. pellucium</i> |
| 2b | Apical cells narrow, linear sometimes remiform | 3 |
| 3a | Nerve ending below the apex, leaves cymbiform | <i>A. cymbifolium</i> |
| 3b | Leaves acuminate, plicate | <i>A. latifolium</i> |

Anomobryum brachymenioides Dix. & P. Vard. *Annls Cryptog. exot.* 3: 177, 1930.

Dioicous. Leafy shoots julaceous to filiform. Leaves closely set, concave, (moist and dry) imbricate-appressed, ovate to oval-oblong, sometimes nearly orbicular, obtuse or acute, flat and entire (sometimes indistinctly toothed near the apex); nerve ending well below the apex to excurrent; cells of the upper half of the leaf firm-walled, thickened in the apical part, narrowly rhombic to linear, sometimes sinuous, in the lower half wide,

rhomboidal six-sided, thinwalled. Leaves not bordered. Perichaetium with ovate-lanceolate, acute bracts and subfloral innovations making it look like a *Brachymenium*.

DISTRIBUTION of *Anomobryum brachymenioides*: Panchgani, Western Ghats.

Collection Site: Munnar (1600m.)

Herbarium No. 13348

Figure: **Plate 40[A]**

Anomobryum cymbifolium (Lindb.) Broth. Rec. bot. Surv. India 1(12) : 320, 1898a (*Bryum*, 1870).

A. filiforme (Griff.) Jaeg., *l.c.* (*Brachymenium*, 1843) *hom. illeg. fid.* Par. Index Bryol. 41, 1894.

Dioicous. Leafy shoots julaceous to filiform. Leaves closely set, concave, (moist and dry) imbricate-appressed, ovate to oval-oblong, sometimes nearly orbicular, obtuse or acute, flat and entire (sometimes indistinctly toothed near the apex); nerve ending well below the apex to excurrent; cells of the upper half of the leaf firm-walled, thickened in the apical part, narrowly rhombic to linear, sometimes sinuous, in the lower half wide, rhomboidal six-sided, thinwalled. Leaves, (moist) more or less imbricate, all alike. Leaves not bordered. Apical cells narrow, linear, sometimes vermiform. Leafy shoot more or less filiform ; leaves closely imbricated ; gammae absent. Nerve ending well below the apex. Leaves cymbiform.

DISTRIBUTION of *Anomobryum cymbifolium*: Garhwal, Mussoorie, Kumaon (Nainital, Ranikhet), Khasi hills, Western Ghats, Palni hills, S. India (Perumalmalai), Bhutan.

Collection Site: Athirapalli (1200m)

Herbarium No. 13349

Figure: **Plate 40[B]**

Anomobryum latifolium Card. & P. Vard. in P. Vard. Revue bryol. 50(2) : 19, 5, 1923.

Dioicous. Leafy shoots julaceous to filiform. Leaves closely set, concave, (moist and dry) imbricate-appressed, ovate to oval-oblong, sometimes nearly orbicular, obtuse or acute, flat and entire (sometimes indistinctly toothed near the apex); nerve ending

well below the apex to excurrent; cells of the upper half of the leaf firm-walled, thickened in the apical part, narrowly rhombic to linear, sometimes sinuous, in the lower half wide, rhomboidal six-sided, thinwalled. Leaves, (moist) more or less imbricate, all alike. Leaves not bordered. Apical cells narrow, linear, sometimes vermiform. Leafy shoot more or less filiform ; leaves closely imbricated ; gammae absent. Nerve ending well below the apex. Leaves acuminate, plicate.

DISTRIBUTION of *Anomobryum latifolium*: Palni hills (Silver Cascad, Tiger Shola).

Collection Site: Munnar (1600m.)

Herbarium No. 13350

Figure: **Plate 41[A]**

Anomobryum pellucidum Dix. & Badhw. Rec. bot. Surv. India 12(2) : 173, 1938.

Dioicous. Leafy shoots julaceous to filiform. Leaves closely set, concave, (moist and dry) imbricate-appressed, ovate to oval-oblong, sometimes nearly orbicular, obtuse or acute, flat and entire (sometimes indistinctly toothed near the apex); nerve ending well below the apex to excurrent; cells of the upper half of the leaf firm-walled, thickened in the apical part, narrowly rhombic to linear, sometimes sinuous, in the lower half wide, rhomboidal six-sided, thinwalled. Leaves (moist) more or less imbricate, all alike. Leaves not bordered. Apical cells rhombic, 2-5 times as long as wide. Nerve ending two or three cells below the apex.

DISTRIBUTION of *Anomobryum pellucidum*: Western Himalayas, Kashmir.

Collection Site: Attukadu (1500m)

Herbarium No. 13351

Figure: **Plate 41[B]**

Key to the species of *Bryum*:

- | | | |
|----|---|----------------------|
| 1a | Inner peristome incomplete, costa reaching tip | 2 |
| 1b | Inner peristome complete | 3 |
| 2a | Costa excurrent. Autoicous | <i>B. uliginosum</i> |
| 2b | Costa percurrent. Dioicous | <i>B. cellulare</i> |
| 3a | Plant glossy, silver green. Leaf hyaline on top | 4 |
| 3b | Plants green to brown or red | 5 |

4a	Costa excurrent, lamina cells narrow rhombic	<i>B. argenteum lanatum</i>
4b	Costa pectinate, lamina cells wide rhombic	<i>B. argenteum griffithii</i>
5a	Leaf with distinct border	7
5b	Leaf without border	6
6a	Costa pectinate	<i>B. bicolor</i>
6b	Costa excurrent	<i>B. coronatum</i>
7a	Leaf margin clearly serrate	<i>B. billardieri</i>
7b	Leaf margin entire	8
8a	Plants small	<i>B. atrovirens</i>
8b	Plants large to medium	<i>B. capillare</i>

Bryum argenteum Hedw. In Sp. Musc. : 181 (1801) VAR. *griffithii* (C. Muell.)
Gangulee *stat. nov.*

Struckia griffithii C. Muell. in Arch. Ver. Freund. Naturg. Mecklenburg, 47: 130 (1893)

Bryum griffithii (C. Muell.) Fleisch. in Hedwigia, 63 : 210 (1922)

The sterile plants show shoots up to 7mm. long which may branch from base. Leaves are as in var. *lanatum* but all of them show long, spreading acumens simulating *Struckia* but there is a clear median costa which may end much below tip or may extend to the acumen as a thin, very transparent line. Only the lower one-third of the leaf (leaf up to 1.64mm. long, 0.75mm. wide, ovate-apiculate) is green, the upper two-thirds being very, transparent. The upper leaf cells are narrower than in *lanatum* and longer ($\pm 132 \times 11 \mu$), the lower rhomboid ($\pm 56 \times 13 \mu$) and the basal rectangular cells ($\pm 56 \times 17.5 \mu$) are also larger. These sterile plants show gemmae at the apices which also resemble those in *lanatum*.

DISTRIBUTION of *Bryum argenteum* var. *griffithii*: Assam.

Collection Site: Munnar (1600m.)

Herbarium No. 13352

Figure: **Plate 42[A]**

Bryum argenteum Hedw. in Sp. Musc.: 181 (1801) VAR. *lanatum* (P. Beauv.)

Hamp. in Linnaea, 13: 44 (1839) et B.S.G. in Bryol. Eur., 4: 148 (1839)

Mnium lanatum P. Beauv. in Prodr.: 75 (1805)

Bryum lanatum (P. Beauv.) Brid. in Sp. Musc., 3: 20 (1817)

B. argenteum var. *costa-ricense* Ren. et Card. in Bull. Soc. R. Bot. Belg., 31 (1): 167 (1893)

B. argenteum var. *percurrens* Podp. in Beih. Bot. Centralbl., 15: 492 (1903)

Plants small, densely tufted, terrestrial (or on rocks). Stems erect, very short, with julaceous subfloral branches which may be up to 2cm. in height, glossy, silvery white in colour. Leaves uniformly and densely arranged along the stem, erectopate, broadly ovate, concave, acuminate, varying in size from 0.5 to 1.2mm. in length and ± 0.5 mm. broad, margin flat (may be recurved at top), entire. Costa percurrent or ending in a hyaline arista in top leaves (up to 0.22mm. long). Leaf cells clearly differentiated into hyaline cells in the upper $\frac{1}{3}$ of the leaf and chlorophyllose cells below; upper hyaline cells narrowly rhomboidal with colourless, firm walls, $\pm 60 \times 15 \mu$; lower cells green, rectangular, sometimes with thickened walls, often with reddish tinge, $\pm 45 \times 11.5 \mu$. Perichaetial leaves similar, may be a little triangular, often with hyaline arista. Seta apical, red, erect but arcuate at tip, up to 2cm. long. Capsule red, pendulous, with a short, contracted neck, ovate to cylindrical, ± 2 mm. long and 1mm. in diameter. Operculum convex, apiculate. Annulus 3-rowed. Outer peristome teeth dark yellow, lanceolate, $\pm 390 \mu$ high and 95μ wide at base, tips hyaline, fine papillose; inner peristome well developed, hyaline, basal membrane about $\frac{1}{3}$, segments and cilia as high as the outer teeth. Spores 7 to 11μ in diameter. Multicellular, bud-like gemmae found in sterile shoots. Dioicous. Antheridia numerous in clusters with long paraphyses.

DISTRIBUTION of *Bryum argenteum* var. *lanatum*: Widespread on all the cooler hills. East Nepal, Sikkim (4000 m.), Darjeeling, Arunachal, Khasia Hills, Orissa Hills, Western Himalaya, Kashmir, South India (W. Ghat, Nilgiri, Palni), Ceylon, Vietnam, Europe (incl. Great Britain), Siberia, Korea, China, Japan, Philippines, Java, all over Africa; North, Central & South America; Hawaii, Australia, Newzealand.

A cosmopolitan variety.

Collection Site: Munnar (1600m.)

Herbarium No. 13353

Figure: **Plate 42[B]**

- Bryum atrovirens* Brid. in Musc. Rec., 2 (3): 48 (1803)
Bryum erythrocarpum Schwaegr. in Sp. Musc. Suppl. 1(2) : 100 (1816)
B. sanguineum Brid. in Sp. Musc., 3 : 28 (1817)
B. morisii Bruch in C. Muell. in Syn., 1 : 297 (1848) *nom. nud.* in *synon.*
B. rubens Mitt. in Kew J. Bot., 8 : 232 (1856)
B. laxo-gemmaceum C. Muell. in Hedwigia, 38 : 75 (1899)
B. macleanum C. Muell. in *ibid.*: 74 (1899)
B. laxo-gemmatum C. Muell. ex Broth. in Nat. Pfl., 1(3) : 589 (1904)
B. zuluense Broth. et Bryhn. in Forb. Vid. Selsk. Christianea, 1911(4) : 14 (1911)
B. murale Hunt. ssp. *rubens* (Mitt.) Amann. in Fl. Mouss. Suiss., 2 : 238 (1919)
B. hegelmaieri Corr. et Loesk. in Podp. in Preslia, 2 84 (1923) *nom. nud.* in *synon.*
B. appendiculatum Hag. in Podp. in Consp.: 354 (1954) *nom. nud.* in *synon.*

Plants lax, light green with red tinge at base, growing on sandy soil. Stem short (± 0.3 mm.) which may have longer, slender, subfloral innovations. Leaves erect to erectopate, erect when dry, ovate to elliptical, acuminate, ± 2.1 mm. long and 0.4mm. wide; margin revolute in the lower two-thirds, entire below, mildly denticulate at apex. Costa red, excurrent in a short, denticulate arista ± 0.11 mm. long. Leaf cells thin-walled; narrow rhombic or hexagonal, $\pm 90 \times 15 \mu$ at top; wider subrectangular, $\pm 100 \times 30 \mu$ at base; marginal rows narrower but variable so that it cannot be stressed as a specific character, in some forms there is a regular tinted border 2 to 3 cells wide. Perichaetial leaves small and narrow and more clearly bordered. Numerous gemmae are characteristic. These are clustered at the base on the stem on very short rhizoids and also found inside upper leaves. These are bright crimson (darker on basic soil), sphaerical, large (± 0.5 mm. in diameter) and multicellular. Seta apical, red, erect but bent at top. Capsule horizontal to pendulous, clavate, red, ± 4 mm. long and 2mm. in diameter with a tapering neck. Operculum large on the wide mouth, conical, acuminate. Exothecial cells sub-rectangular with 3 or 4 rows of smaller, more thick-walled cells at rim. Outer peristome teeth $\pm 380 \mu$ high and 64μ wide at base with hyaline, papillose teeth; inner peristome hyaline. basal membrane low, segments as high as outer teeth, 2 regular appendiculate cilia. Spores $\pm 7 \mu$ in diameter.

DISTRIBUTION of *Bryum atrovirens*: Sikkim, Darjeeling, Assam, Himalaya (Mussoori), Taiwan, Japan, Siberia, Caucasus, Central Europe, Great Britain, North & South America, North & South Africa, Oceania.

A widespread species.

Collection Site: Thekadi (1300m.)

Herbarium No. 13354

Figure: **Plate 43[A]**

Bryum bicolor Dicks. in Pl. Crypt. Brit. F 4: 16 (1801)

Bryum atropurpureum B.S.G. in Bryol. Eur., 4 : 143 (1839)

B. pachytheca C. Muell. in Syn., 1 : 307 (1848) *fid.* Ochi

B. hemisphaericarpum C. Muell. in Syn., 2 : 576 (1851) *fid.* Ochi

B. subaenum C. Muell. & Hamp. in Linnaea, 26 : 494 (1855)

B. junghuhnianum Hamp. ex Doz. & Molk. in Bryol. Jav., 1 : 146 (1856) *fid.* Ochi

B. gambierense C. Muell. in Linnaea, 37 : 148 (1872)

B. ovicarpum Broth. in Oefv. Finsk. Vet. Ak. Foerh., 42 : 101 (1899) *fid.* Ochi

B. balanoides Tayl. ex Broth. in Nat. Pfl., 1 (3) : 588 (1904) *fid.* Ochi

B. elegantulum Stirt. in Scott. Bot. Rev., 1 : 92 (1912) *hom. illeg.*

Plants densely tufted, about 1cm. high, deep green, growing on soil, stone or walls. The small plants usually have several subfloral, erect, julaceous innovations. Leaves imbricate, very closely set along stem, soft, very small and elliptical at base of stem, upper larger, soft, oblong-lanceolate, short acuminate, ± 1 mm. long and 0.3mm. broad, erect even when dry; margin flat and almost entire. Costa percurrent. Leaf cells narrow elongated, prosenchymatous, may be vermicular, $\pm 68 \times 7 \mu$ at top and $\pm 45 \times 7 \mu$ at base where they are thick-walled, 2 or 3 layers at base, margin rectangular but there is no marginal border on the leaf. Upper leaves of some shoots bear axillary gemmae (generally one per leaf) which are reddish, spherical with pointed top, multicellular, $\pm 209 \times 90 \mu$. Perichaetial leaves shorter, elongated triangular. Seta apical on the short stems, erect but bent at top, reddish, 1.5 to 2.2cm. long, vaginula ovoid. Capsule pendulous, translucent green when young, reddish brown at maturity, hemisphaerical to ovoid (shrivelled

rectangular when dry), $\pm 2.5 \times 2$ mm. with the orange-red convex operculum covering a very narrow mouth. Peristome deep-inserted, outer teeth lanceolate, $\pm 525 \mu$ high and 70μ broad at base, with sharp, hyaline, papillose tips; endostome free from exostome, transparent yellow, fine papillose, as outer teeth, basal membrane very high, segments short, cilia present. Spores fine papillose, 8 to 11.4μ in diameter.

DISTRIBUTION of *Bryum bicolor*: East Nepal, Sikkim (2700 m.), Darjeeling, Western Himalaya (Kumaon, Nainital), Asia Minor, North Asia, China, Taiwan, Japan, Caucasus, Europe incl. G.E., North & Central America, North & South Africa, Australia, Newzealand, Oceania.

A cosmopolitan species.

Collection Site: Munnar (1600m.)

Herbarium No. 13355

Figure: **Plate 43[B]**

Bryum billardieri Schwaegr. in Sp. Musc. Suppl., 1 (2) : 115 (1816)

Mnium erythrocaulon Schwaegr. in Sp. Musc. Suppl. 1(2) : 127 (1816)

M. truncorum Brid. in Sp. Musc. 3 : 50 (1817)

Byum truncorum (Brid.) Brid. in Mant. Musc. : 119 (1819)

B. erythrocaulon (Schwaegr.) Brid. ibid : 119 (1819)

B. andicola Hook. in Kunth. in Syn. Pl. Aequin., 1 : 58 (1822)

Mnium ramosum Hook. in Icon. Pl. Rar., 1 : 20 (1836)

Br;urn neelgheriense Mont. in C. Muell. in Syn., 1 : 255 (1841)

B. leptothecium Tayl. in Phytologist, 1 : 1094 (1844)

B. decaisnei Doz. et Molk. in Musci. Fr. Ined. Archip. Indici : 19 (1845)

B. zollingeri Dub. in Moritzi in Syst. Verzeichn. Zoll. Pfl. : 133 (1846)

B. rosulatum C. Muell. in Bot. Zeit., 14 : 416 (1856)

B. ramosum (Hook.) Mitt. in Musci Ind. Or.: 75 (1859)

B. rufescens Hook. f. et Wils. in Fl. Tasman., 2 : 192 (1859) *hom. illeg.*

Rhodobryum subtomentosum Hamp. in Linnaea, 36 : 516 (1870)

R. stenothecium Hamp. in Vid. Med. Naturh. For. Kjobenh. ser. 3, 6 : 147 (1875)

R. crispatum Hamp. in *Linnaea*, 40 : 310 (1876)
R. breviramulosum Hamp. in *ibid.*: 311 (1876)
R. subfasciculatum Hamp. in *ibid.*: 312 (1876)
Bryum syntrichioides C. Muell. in *Geh. Rev. Bryol.*, 5 : 70 (1878) *nom. nud.*
B. stenothecium (Hamp.) Hamp. in *Vid. Med. Naturh. For. Kjobenh. ser. 4*, 1 : 103 (1879)
B. nanorrhodon C. Muell. ex Besch. in *Ann. Sc. Nat. Bot. ser. 6*, 10 : 237 (1880)
B. breviramulosum (Hamp.) Mitt. in *Trans. Proc. Soc. Victoria*, 19 : 73 (1882)
B. subfasciculatum (Hamp.) Mitt. in *ibid.* : 73 (1882)
B. subtomentosum (Hamp.) Mitt. in *Trans. Proc. R. Soc. Victoria*, 19 : 73 (1882)
B. streptorhodon C. Muell. in *Bull. Herb. Boiss.*, 5 : 179 (1897)
B. cygnopelma C. Muell. in *ibid.*: 550 (1897)
B. globicoma C. Muell. in *Nuov. Giorn. Bot. Ital. n. ser. 4* : 246 (1897)
B. microrhodon C. Muell. in *Hedwigia*, 37 : 108 (1898)
B. pohliaeopsis C. Muell. in *ibid.*: 107 (1898)
B. abruptinervium C. Muell. in *ibid.*: 102 (1898)
B. angeiothecium C. Muell. in *ibid.*: 108 (1898)
B. brunneidens C. Muell. in *ibid.*: 105 (1898)
B. dobsonianum C. Muell. in *ibid.*: 108 (1898)
B. flavifolium C. Muell. in *ibid.*: 105 (1898)
B. dilatmarginatum C. Muell. in *ibid.*: 102 (1898)
B. subolivaceum C. Muell. in *ibid.*: 103 (1898)
B. leucothecium C. Muell. in *ibid.*: 106 (1898)
B. viridulum C. Muell. in *ibid.*: 104 (1898) *hom. illeg.*
B. gracilithecium R. Br. ter. in *Trans. NewZeal. Inst.*, 31: 453 (1899)
B. gracilicarpum R. Br. ter. in *ibid.*: 462 (1899)
B. wichurae Broth. in *Hedwigia*, 38 : 219 (1899)
B. crenatidens C. Muell. in *Gen. Musc. Fr.*: 238 (1900) *nom. nud.*
B. schlumbergeri Hamp. in C. Muell. in *ibid.*: 236 (1900) *fid. Ochi.*
Rhodobryum pohliaeopsis (C. Muell.) Par. in *Ind. Bryol. Suppl.*: 300 (1900)
R. wichurae (Broth.) Par. in *ibid.*: 301 (1900)
Bryum zickendrathii Card. in *Rev. Bryol*, 28 : 114 (1901)
B. subpusillum Broth. et Par. in *Oefv. Finsk. Vet Soc. Foerh.*, 53(11) : 21 (1911)

B. sigmatellum Ther. in Rev. Bryol., 48 : 24 (1921)

B. greenwoodii Dix. in Proc. Linn. Soc. N. S. Wales, 55 : 280 (1930)

Robust plants in dense tufts, yellow-green to green above, brownish below, growing on humus, tree trunk, stones, creeks above water level etc., tomentose below. Stem erect, branched by two or more subfloral innovations, 2cm. or more high. Lower leaves small, distant; upper leaves large, clustered in prominent comal tufts, ovate-oblong-spathulate, concave, apex acute-acuminate, up to 4mm. long and 2mm. wide at middle, base slightly tapering, erect-spreading, erect and crumpled when dry; margin entire except at upper one-third of leaf where it is dentate-serrulate, recurved only except at the tip. Costa strong, reddish brown, excurrent in an arista up to 0.5mm. long. Leaf cells thin-walled; rhomboid (up to $50 \times 6 \mu$) above, slightly shorter rhomboid below, rectangular ($51 \times 25 \mu$) at base, the middle cell walls are sometimes strongly pitted; 3 to 5 rows of thick-walled, narrow prosenchymatous (up to $66 \times 10 \mu$) cells form a prominent border in the upper leaf. Seta apical, reddish brown, erect but hooked at tip. Capsule pendulous, reddish brown. Capsule 4 to 6mm. long including a tapering neck about one-third of this length, 1.2 to 2mm. in diameter at the cylindrical to ovate-cylindrical capsule. Operculum conical. Peristome deep inserted; outer teeth up to 500μ high, hyaline papillose at tip; inner segments of equal height, split or perforate, hyaline papillose, basal membrane low; paired cilia of almost the same height between segments, strongly or scarcely appendiculate. Spores rounded, fine papillose, 14 to 16.5μ in diameter. Dioicous.

DISTRIBUTION of *Bryum billardieri*: East Nepal, Sikkim (1700 m.), Bhutan (2600-3400 m.), W. Himalaya (Murri, Simla, Mussoorie, Kumaon), South India (Nilgiri, Palni), Ceylon, Burma, Thailand, N. Vietnam, Java, Philippines, Taiwan, Hongkong, China, Japan, Korea, Riukiu, Australia, Newzeland, New Caledonia, Fiji, Hawaii, North, Central & South America, Europe, whole of Africa.

A cosmopolitan species.

Collection Site: Thekadi (1300m)

Herbarium No. 13356

Figure: **Plate 44[A]**

Bryum capillare L. ex Hedw. in Sp. Musc.; 182 (1801)
Bryum squalidum Brid. in Musc. Rec., 2(3) : 52 (1803)
B. ferchellii Funck ex Brid. in Bryol. Univ., 1 : 847 (1827) as var.
B. elegans Nees in Brid. in ibid.: 849 (1827) as var.
B. torquescens De Not. in Syll. n. 163 (1838) as var.
B. domingense C. Muell. in Linnaea, 17 : 594 (1843) *hom. illeg.*
B. philippianum C. Muell. in Linnaea, 18 : 701 (1845) *fid.* Ochi
B. creberrimum Tayl. in Lond. J. Bot., 5 : 54 (1846) *fid.* Ochi
B. capillare var. *capense* C. Muell. in Syn., 1 : 281 (1848)
B. pyrothecium C. Muell. & Hamp. in Linnaea, 26 : 495 (1855)
B. cuspidatum Wils. in Kew J. Bot., 9 : 364 (1857) *hom. illeg.*
B. thomsonii Mitt. in Musci Ind. or: 75 (1859) *syn. nov.*
B. oreganum Sull. in U.S. Expl. Exp. Wilkes Musci : 10 (1859)
B. baueri Hamp. in Linnaea, 30 : 457 (1860)
B. teneriffae Hamp. in C. Muell. in Bot. Zeit., 20 : 12 (1862) *fid.* Ochi
B. triste De Not. in Cronac. Briol. Ital., 1 : 26 (1866)
B. chilense Reichd. in Reis. Oest. Freg. Novara Bot., 1 : 75 (1870) *fid.* Ochi
Rhodobryum albo-limbatum Hamp. & C. Muell. in Linnaea, 36 : 517 (1870) *fid.* Ochi
Bryum pohliaeforme Schimp. in Besch. in Mem. Soc. Sc. Nat. Cherbourg, 16 : 198
(1872) *hom. illeg.*
B. botterii Mohr. ex C. Muell. in Linnaea, 38 : 622 (1874)
B. albo-limbatum (Hamp. & C. Muell.) Jaeg. in Ber. S. Gall. Naturw. Ges., 1973-74:
191 (1875)
B. rufonitens Hamp. in Vid. Medd. Naturh. For. Kjobenh. ser. 3, 9-10 : 261 (1878) *fid.* Ochi
B. nanocoma C. Muell. in Linnaea, 43 : 365 (1882)
B. sawyeri Ren. & Card. in Rev. Bryol., 15 : 71 (1888)
B. pusillum Broth. in Oefv. Finsk. Vet. Soc. Foerh., 33 : 99 (1890) *hom. illeg., fid.* Ochi
B. whiteleggei Broth. in Proc. Linn. Soc. N. S. Wales, 7 : 277 (1892) *nom. nud., fid.* Ochi
B. capillare ssp. *heteroneuron* C. Muell. & Kindb. in Macoun : Cat. Canad. Pl., 6 :
130 (1892)
B. immarginatum Broth. in Oefv. Finsk. Vet. Soc. Foerh., 35 : 50 (1893) *fid.* Ochi

B. heteroneuron (C. Muell. & Kindb.) Ren. & Card. in Rev. Bryol., 20 : 3 (1893)
horn. illeg.
B. floridanum Ren. & Card. in *ibid.*: 4 (1893)
B. sanguilentum Ren. & Card. in *ibid.*: 31 (1893)
B. syntrichiaefolium C. Muell. in Broth. in Bot. Jahrb., 20 : 88 (1894) *nom. nud.*
B. speirophyllum Kindb. in Bull. Soc. Bot. Ital. 1895: 17 (1895)
B. squarrosum Kindb. in Roell in Hedwigia, 35 : 66 (1896) *hom. illeg.*
B. bernouillii C. Muell. in Herb. Boiss., 5 : 183 (1897)
B. vulcanicola C. Muell. in *ibid.*: 184 (1897)
B. donianum var. *floridanum* (Ren. & Card.) Kindb. in Eur. N. Am. Bryin., 2 : 359 (1897)
B. gemmascens Kindb. in *ibid.*: 360 (1897)
B. streptophyllum Kindb. in *ibid.*: 359 (1897)
B. tomentosum Kindb. in *ibid.*: 361 (1897) *hom. illeg.*
B. trichophorum Kindb. in *ibid.*: 359 (1897)
B. plebejum C. Muell. in Hedwigia, 37 : 94 (1898) *fid. Ochi*
B. synoicum C. Muell. in *ibid.*: 96 (1898) *fid. Ochi*
B. erythropyxis C. Muell. in *ibid.*: 101 (1898) *fid. Ochi*
B. nagasakense Broth. in Hedwigia, 38 : 219 (1899) as var.
B. lonchopyxis Broth. in *ibid.*: 72 (1899)
B. microsporum Broth. in Oefv. Finsk. Vet. Foerh., 42 : 100 (1899) *hom. illeg.*
B. flaccidifolium C. Muell. in Gen. Musc. Fr.: 238 (1900) *nom. nud., fid. Ochi*
B. obconicum var. *aristatum* Roth in Eur. Laubm., 2 : 152 (1904)
B. pycnoloma C. Muell. in Par. in Ind. Bryol. ed. 2, 1 : 250 (1904) *nom. nud.*
B. tomentosulum Par. in *ibid.*: 264 (1904)
B. subrepandocarpum Card. & Ther. in Bot. Gaz., 37 : 374 (1904)
B. baileyi Holz. in Bryologist, 8 : 54 (1905) *hom. illeg.*
B. fosteri Holz. in *ibid.*: 80 (1905)
B. moravicum Podp. in Vestn. Klub. Prirod. Prost., 8 : 41 (1906)
B. courtoisii Broth. & Par. in Rev. Bryol., 35 : 41 (1908) as var.
B. tosamum Card. in Bull. Soc. Bot. Geneve ser. 2, 1 : 128 (1909) as var.
B. rubrolimbatum Broth. in Philipp. J. Sci., 5C : 147 (1910) as var.
B. validicostatum Card. & Dix. in J. Bot., 49 : 4 (1911) *fid. Ochi*

B. leptothecioides Besch. et Watts in Proc. Linn. Soc. N.S. Wales, 40: 374 (1915) *fid.* Ochi
B. yuennanese Broth. in Sitz. Ak. Wiss. Wien. Math. Nat. Kl., 133 : 570 (1924)
B. rhomboidale Ther. in Rev. Bryol. n. ser., 3 : 37 (1930) *fid.* Ochi
B. vino-viride Bartr. in Bis. Mus. Bull., 101 : 116 (1933) *fid.* Ochi
B. spininervium Dix. in Not. R. Bot. Gard. Edin., 19 : 291 (1938) *fid.* Ochi
B. capense (C. Muell.) Podp. in Act. Ac. Sc. Nat. Morav., 22 : 439 (1950)
B. littorale Hamp. in Podp. *nom. nud. in synonym.* in *ibid.*: 389 (1950)
B. capillare var. *spininervium* (Dix.) Podp. in *ibid.*: 461 (1950) *fid.* Ochi
B. donianum var. *squarrosus* Podp. in *ibid.*, 23 : 26 (1951)

Plants usually densely tufted growing on rocks or damp soil, soft, deep green above, reddish below, usually branched or with many subfloral innovations. Leaves laxly set below, dense in the upper regions, comal tufts prominent in some forms or the leaves uniformly spread on others, erectopatent to erect-spreading, spirally twisted round stem with flexuose tips when dry; ovate acuminate, concave, up to 3mm. long and 1mm. wide; margin entire (may be finely denticulate at tip), variously recurved. Costa stout below, tapering upwards, excurrent in a sharp, often spinulose arista up to 0.5mm. long. Leaf cells thin-walled; rhomboid-hexagonal ($\pm 45 \times 15 \mu$) at top, rectangular ($\pm 75 \times 25 \mu$) at base with some very deeply coloured cells at leaf attachment; 1 to 3 rows of cells at margin are narrow, elongated, prosenchymatous and sometimes tinted (up to $115 \times 10 \mu$), passing into short rectangular (20 to $40 \times 20 \mu$) cells at base form a distinct but not thickened border. Perichaetial leaves usually shorter and narrower. Seta apical, erect but arcuate at tip, up to 2.8cm. long, red. Capsule horizontal, clavate-pyriform to ovate cylindrical, with a tapering apophysis and a wide mouth, up to 4mm. long and 1mm. in diameter but often variable, brown with a red mouth. Peristome deep inserted, normal; outer teeth reddish at base, $\pm 380 \mu$ high and 83μ wide at base, paler at tips; endostome free from outer, hyaline with segments as high as outer teeth and regular appendiculate cilia. Spore variable in size, 8 to 20μ in diameter. Usually dioicous but may be synoicous or autoicous.

DISTRIBUTION of *Bryum capillare*: Eastern Nepal (2000m.), Darjeeling (Phalut 3500 m.), Sikkim (1700 m.), Bhutan (4100-5000m.), Western Himalaya, Kashmir, South India (Nilgiri), Thailand, North Vietnam, China with Western Tibet, Taiwan,

Korea, Japan, Siberia, Central Asia, Caucasus, Europe (incl. G.B.), North & Central Africa, whole of North & South America, Australia, Newzealand, Hawaii).

A cosmopolitan species.

Collection Site: Attukadu (1500m.)

Herbarium No. 13357

Figure: **Plate44[B]**

- Bryum cellulare* Hook. in Schwaegr. in Sp. Musc. Suppl. 3 (1): 214a (1827)
Pohlia turbinata Schwaegr. in Sp. Musc. Suppl. 2(2) : 150 (1827)
Brachymenium splachnoides Harv. in Hook. in Icon. P1. Rar., 1 : f 19 (1836)
Bryum splachnoides (Harv.) C. Muell. in Syn., 1 : 291 (1848)
B. compressidens C. Muell. in Syn., 1 : 290 (1848)
Plagiobryum wildii Broth. in Oefv. Vet. Soc. Foerh., 33 : 101 (1891)
Brachymenium japonense Besch. in Ann. Sc. Nat. Bot. Ser. 7, 17 : 340 (1893)
Bryum japonicum C. Muell. in Gen. Musc. Fr.: 204 (1900)
B. wildii (Broth.) C. Muell. in Gen. Musc. Fr.: 204 (1900) *fid.* Ochi
Webera thermalis Besch. in Oefv. K. Vet. Ak. Foerh., 57 : 291 (1900)
Epipterygium thermale (Besch.) Broth. in Nat. Pfl., 1(3) : 555 (1903) *fid.* Ochi
Bryum japonense (Besch.)Broth. in Nat. Pfl., 1 (3): 576 (1903)
B. calabricum Warnst. et Fleisch. in Roth in Eur. Laubm., 2 : 68 (1904)
B. nagasakense Broth. var. *laxifolium* Card. in Bull. Soc. Bot. Geneve ser. 2, 1 : 128 (1909) as var. *fid.* Ochi
B. diversifolium Broth. in Philipp. J. Sci. C, 5 : 147 (1910)
B. perdelicatulum Broth. in Hariot in Bull. Mus. Hist. Nat. Paris, 19 : 115 (1913) *nom. nud.*
B. formosanum Broth. in Oefv. Finsk. Vet. Soc. Foerh. 62A(9) : 17 (1921) *fid.* Ochi
B. argyrobryoides Broth. et Par. in ibid. p. 18 as var. *fid.* Ochi
B. cochleatum Broth. in ibid p. 18 as var. *fid.* Ochi
Brachymenium cumingii Ther. in Bull. Soc. Bot. Geneve, 26 : 85 (1936)
Bryum epipterygoides Ochi in J. Jap. Bot., 29 : 212 (1954) as var. *fid.* Ochi

Plants small, reddish green, densely tufted. Stem erect, about 3mm. long, branched by 2 to 3 subfloral innovations, densely and uniformly foliose, tomentose below. Leaf erectopate, not much changed when dry, ovate-lanceolate, ± 1.8 mm. long and 0.5mm. wide at middle, concave with an acute apex; margin flat, entire, with a very narrow border. Younger leaves smaller. Costa reddish, percurrent or ending a little below apex. Leaf cells lax, thin-walled, sub-rectangular at base ($\pm 95 \times 19 \mu$), becoming rhomboid to hexagonal at apex ($\pm 83 \times 15 \mu$); marginal row of very long linear cells. Seta apical, erect (flexuose when dry), brownish, ± 1.8 cm. long. Capsule nodding to horizontal, clavate-cylindrical, brownish, ± 4 mm. long and 1.5mm. in diameter at top with a short tapering neck and a broad mouth. Operculum conical. Inner peristome of narrow segments from a very low basal membrane and without any cilia. Dioicous. Male plants small, with very loosely arranged leaves, antheridia $\pm 380 \mu$ long with long paraphyses.

DISTRIBUTION of *Bryum cellulare*: East Nepal, Arunachal, Western Himalaya (NWFP, Garhwal, Ranikhet), Burma, Sumatra, Java, Bali, Philippines, Taiwan, Eastern China, Japan. Europe (Eastern Mediterranean), North & Central Africa, Australia.

A widespread species.

Collection Site: Munnar (1600m.)

Herbarium No. 13358

Figure: **Plate 45[A]**

Bryum coronatum Schwaegr. in Suppl. 1 (2): 103 (1816)

Bryum angustifolium Brid. in Sp. Musc., 3 : 31 (1817)

B. caespiticium var. *angustifolium* (Brid.) Hamp. in Linnaea, 13 : 44 (1839)

B. doliolum Dub. in Moritzi in Syst. Verz. Zoll. Pfl. : 133 (1846)

B. brevicaule Hamp. in Linnaea, 36 : 518 (1870) *hom. Illeg., fid. Ochi*

B. subatropurpureum C. Muell. in Linnaea, 37 : 147 (1871)

B. macropelma C. Muell. in Linnaea, 37 : 149 (1872) *hom. illeg., fid. Ochi*

B. rufinerve C. Muell. in Linnaea, 38 : 549 (1874)

B. barbulateum C. Muell. in Linnaea, 39 : 389 (1875)

- B. convolutaceum* C. Muell. in *ibid.* : 388 (1875)
B. gracilifolium C. Muell. in *ibid.* : 390 (1875)
B. hogbergii C. Muell. in *ibid.* : 391 (1875)
B. schweinfurthii C. Muell. in *ibid.* : 386 (1875)
B. mariei Besch. in *Ann. Sc. Nat. Bot. ser. 6, 10* : 235 (1880)
B. zygodontoides C. Muell. in *Bot. Jahrb., 5* : 83 (1883)
B. afro-litorale C. Muell. in *ibid.* : 88 (1883)
B. erythrostegium C. Muell. in *Flora, 69* : 279 (1886)
B. rhyparicaulon C. Muell. in *ibid.* : 507 (1886)
B. balanocarpum Besch. in *Bull. Soc. Bot. France, 41; 82* (1894)
B. curtum Par, in *Ind. Bryol.*: 176 (1894) *fid.* Ochi

Plants densely tufted, slender, growing on damp calcareous soil or walls, bright to dull green, tomentose at base. Stem often branched from base, up to 2cm. high, with central strand. Lower leaves smaller. Upper leaves, ovate- to oblong-lanceolate, erect to erectopate, lightly contorted when dry, acuminate, ± 4 mm. long and 1mm. wide. Margin entire, flat. Costa strong, reddish at base, excurrent in a mildly denticulate arista ± 0.5 mm. long. Upper leaf cells thin- to thick-walled, narrow rhomboid to hexagonal, $\pm 57 \times 8 \mu$; basal cells shorter rectangular, thin-walled, $\pm 39 \times 19 \mu$ without any marginal border though 1 or 2 marginal rows at base are narrower. Perichaetial leaves shorter, triangular. Seta apical, erect, but arcuate at tip, red to Purple, up to 3cm. long, vaginula ovoid. Capsule pendulous, thick, shaped like cup in another cup, ± 2.5 mm. long and 1mm. in diameter with the thick, spongy apophysis shorter than capsule and provided with stomata and a wide capsule mouth. Operculum big, conical. Annulus 3-rowed. Peristome reddish $\pm 500 \mu$ high; outer teeth broad lanceolate with sharp, hyaline, papillose tips; endostome transparent yellow, finely papillose, as high as exostome, with 2 to 3 appendiculate cilia. Spores 7.6 to 11.4 μ in diameter. Dioicous. Male plants slender, long, antheridial bud becomes pseudolateral by innovations; antheridia large, numerous, with many long filamentous paraphyses.

DISTRIBUTION of *Bryum coronatum*: East Nepal, Sikkim (1500 m.), Darjeeling, Calcutta, Howrah, Hoogli, Burdwan, Midnapore, Orissa (Cuttack, Puri, Koraput), Andaman Is., Throughout India, Cocos Is., Thailand, Taiwan, Japan, Java, Philippines.

Cosmopolitan in tropical, subtropical and warm temperate regions of the World.

Collection Site: Munnar (1600m.)

Herbarium No. 13359

Figure: **Plate 45[B]**

Bryum uliginosum (Brid.). B.S.G. in Bryol. Eur., 4: 88 (1839)

Cladodium uliginosum Brid. in Bryol. Univ., 1: 841 (1827)

Cynodontium cernuum Hedw. in Sp. Musc. : 58 (1801)

Cynodontium cernuum (Hedw.) Brid. in Sp. Musc., 1 : 156 (1806) *fid.* Lindb.

Bryum turbinatum var. *pallens* Drumm. in Musci Bor. Am. n. 267 (1828)

B. cernuum (Hedw.) B.S.G. in Bryol. Eur., 4 : 84 (1839) *hom. illeg.*

B. viridans Wils. in Mitt. in Musc. Ind. Or.: 71 (1859) *nom. nud. in synonym.*

B. elbingense Warnst. in Schrift. in Naturf. Ges. Danzig Ser. 2, 9 : 170 (1896)
nom.nud. in synonym.

B. conditum Williams in Bull. N.Y. Bot. Gard., 2 : 125 (1901)

B. camptocarpum Card. et Ther. in Bot. Gaz., 37 : 374 (1904)

B. inclinatum var. *stolleianum* Podp. in Riehm. in Sitzungsab. Naturw. Ges. Isis
Dresden 1926: 24 (1927) *nom. nud. in synonym.*

Plants in loose tufts, olive-green to brownish, densely interwoven below with tomenta, growing in bogs or damp, sandy places. Stem deep purple, erect, ± 4 mm. long, often with subfloral innovations. Leaves soft, clustered in comal tufts, erectopate when moist, erect and appressed when dry, lower leaves smaller; upper ovate to oblong-lanceolate with a narrower base and acuminate above, ± 4 mm. long and 0.6mm. wide at middle; margin flat (may be recurved at middle), entire except mild denticulation at tip, distinctly bordered. Costa brown, excurrent in an arista ± 0.2 mm. long. Leaf cells large, thin-walled, rectangular to rhomboid at base ($\pm 57 \times 8 \mu$), becoming longer and rhomboid-hexagonal ($\pm 69 \times 8 \mu$) at top, with a distinct border of 2 to 3 rows of narrower cells. Seta apical, slender, erect but arcuate at tip, ± 2.6 cm. long. Capsule horizontal to pendulous, brown, oval-pyriform with an incurved, gibbous, tapering apophysis and a smaller, slightly oblique mouth, ± 4 mm. long and 2mm. in diameter at middle of capsule. Operculum small, conical. Exothecial cells

thick-walled, rounded-hexagonal with a row of flattened cells at rim. Peristome deep-inserted; outer teeth linear-lanceolate, pale yellowish brown, $\pm 550\mu$ long and 65μ wide at base; inner peristome hyaline with segments slightly shorter than outer teeth and cilia very short and rudimentary. Spores rounded, 20 to 30μ in diameter. Autoicous. Male flower gemmiform, reddish; antheridia reddish, $\pm 530\mu$ long and 100μ in diameter at middle; paraphyses long, slender, $\pm 610\mu$ long.

DISTRIBUTION of *Bryum uliginosum*: Sikkim, Northwest Himalaya, Kashmir, Korea, Manchuria, Europe including Great Britain, North & South America.

A widely distributed species.

Collection Site: Eravikulam (1800m.)

Herbarium No. 13362

Figure: **Plate 46[A]**

Ptychostomum pseudotriquetrum (Hedw.) J.R.Spence & H.P.Ramsay in Spence: 23 (2005)

Bryum pseudotriquetrum (Hedw.) Schwaegr. in Sp. Musc. Suppl., 1 (2):110 (1816)

Mnium pseudotriquetrum Hedw. in Sp. Musc.: 190 (1801)

Bryum cubitale Dicks. ex With. in Syst. Arr. Brit. Pl. ed. 4, 3 : 823 (1801)

B. ventricosum Relh. in Fl. Cantrabr. ed. 2: 427 (1802)

Mnium bimum Schreb. in Bot. Zeit. Regensburg 1 : 79 (1802) as var.

Bryum bimum (Schreb.) Turn. in Musc. Hib.: 127 (1804) as var.

B. straminifolium Tayl. ex Schwaegr. in Sp. Pl. ed. 4, 5(2) : 54 (1832)

B. subobliquum Lindgr. in Bot. Not. 1842 : 18 (1842)

B. tasmanicum Hamp. in Linnaea, 25 : 714 (1853) *fid.* Ochi

B. rubiginosum Hook. f. et Wils. in Fl. Tasman., 2 : 90 (1859) *fid.* Ochi

B. ellipticum Lac. in Ned. Kruidk. Arch., 5 : 294 (1861) *hom. illeg.*

B. physcomitrioides C. Muell. in Jaeg. in Ber. S. Gall. Naturw. Ges. 1877-78: 446 (1880) *nom. nud.*, *fid.* Ochi

B. turgens Hag. in K. Norsk. Vid. Selsk. Skrift. 1897 (2): 20 (1897) as ssp.

B. maudii R. Br. ter. in Trans. NewZ. Inst., 31: 460 (1899) *fid.* Ochi

B. austropolare Card. in Rev. Bryol., 27 : 45 (1900) *fid.* Ochi

Webera gerlachei Card. in *ibid.*: 44 (1900) *fid.* Ochi
Bryum amoenum var. *cavifolium* Podp. in *Beih. Bot. Centralbl.*, 15 : 483 (1903)
B. quarnboense Bomanss. in *Rev. Bryol.*, 30 : 99 (1903)
B. gracilens Card. in *Bull. Soc. Bot. Geneva, Ser. 2*, 1 : 128 (1909) as var.
B. pollens var. *filamentosum* Mik. in *Bryoth. Balt.*: 105 (1910)
B. intortulum Stirt. in *Trans. Bot. Soc. Edin.*, 26 : 428 (1915) as var.
B. subventricosum Broth. in *Proc. Linn. Soc. N.S. Wales*, 42 : 586 (1916) *fid.* Ochi
B. austro-affine Broth. in *ibid.*: 487 (1916) *fid.* Ochi
B. baurii Amann in *Fl. Mousse Suiss.*, 1 : 128 (1919) as var.
B. yendangaianum Card. in *Card. & Broth. in K. Svensk. Vet. Ak. Handl.*, 63(10) : 43
(1923) *nom. nud. in synon.*
B. suzukii Broth. in *Sas. in Trans. Nat. Hist. Soc. Formosa*, 18 : 90 (1928) *nom. nud.*,
fid. Ochi
B. samuelssonii Ther. in *Rev. Bryol. Lichen.*, 14 : 17 (1944) *fid.* Ochi

Plants tall and robust, glowing in bogs or wet places in mountains, green above, reddish below. Stem erect, about 3.3cm. high, with 2 or 3 subfloral innovations, reddish, tomentose below. Leaves somewhat loose below, in comal tuft above, erectopatent to erect-spreading, shrunk and erect when dry, oblong-lanceolate, ± 5 mm. long and 1.5mm. broad, tapering into an acute apex, base wide and often red; margin revolute, entire except light denticulation at apex. Costa stout, reddish, excurrent in a short, denticulate arista ± 0.075 mm. long. Leaf cells thin-walled hexagonal to rhomboid, $\pm 45 \times 19 \mu$ at apex, longer at middle, rectangular ($\pm 64 \times 19 \mu$) at base; 2 to 3 rows of narrow, long cells at margin form a distinct yellowish border. Seta apical, reddish brown, erect but arcuate at tip, up to 5.4cm. long. Capsule pendulous, ovate-clavate with a distinct tapering apophysis, some with inflated capsule ($\pm 5 \times 2$ mm.) others narrower ($\pm 4 \times 1.5$ mm.). Operculum conical, acuminate. Peristome normal. Dioicous.

DISTRIBUTION of *Ptychostomum pseudotriquetrum*: East Nepal (3800-4300 m.), Sikkim, Bhutan (4000-4800 m.), Western Himalaya, Kashmir, N. Vietnam, Western Tibet, Central Asia, Caucasus, Siberia, Amur, Korea, Japan, Taiwan, Tasmania,

Newzealand, North, Central & South Africa, Europe (incl. G.B.), North, Central & South America, Antractica.

A cosmopolitan species.

Collection Site: Munnar (1600m.)

Herbarium No. 13361

Figure: **Plate 46[B]**

Key to the species of *Rhodobryum*:

1a Rib with stereide cells

R. roseum

1b Ribs without stereide cells

R. laxe-limbatum

Rhodobryum laxe-limbatum (Ochi) Iwats. & Kop. in Acta Bot. Fenn., 96: 14 (1972)

Rhodobryum laxe-limbatum (Ochi) Gangulee in Singh in Cal. Univ. Ph.D. Thesis (1971) *ined.*

Bryum laxe-limbatum Ochi in J. Jap. Bot., 43 : 112 (1968)

B. laxe-limbatum Hamp. in sched.

Plants yellowish green, in loose mats with creeping subterranean stolon. Stem robust, erect, ± 2.5 m. high, covered by distantly placed, minute (± 4 mm. long), appressed, scaly leaves but with a crown of suddenly enlarged, deep green leaves forming a conspicuous rosette. Top leaves spreading (spreading and irregularly shrunk when dry), spatulate from a narrower base, ± 9 mm. long and 0.4mm wide (may be larger); apex acute acuminate; margin revolute in the lower two-thirds, entire below but with uniseriate denticulation at tip; bordered by 2 to 5 rows of yellowish hyaline cells. Costa strong, green, ending below apex. Leaf cells thin-walled; rhomboid to rhomboid-hexagonal ($\pm 95 \times 19 \mu$) at apex, narrower, hyaline and more elongated at border ($\pm 110 \times 11 \mu$) median cells similar but larger ($\pm 30 \mu$ wide) and with porose walls; basal cells rectangular, $\pm 110 \times 45 \mu$. T.S. of costa shows the begleiter cells but stereides are absent.

DISTRIBUTION of *Rhodobryum laxe-limbatum*: East Nepal (2600-3000m.), Darjeeling, Sikkim, Sikkim (2150-2900m.)

Endemic in this area. But present report from Idukki extends its distribution to south India.

Collection Site: Attukadu (1500m.)

Herbarium No. 13363

Figure: **Plate 47[A]**

Rhodobryum roseum (Hedw.) Limpr. in Laubm. Deutsch. Oester. Schweiz, 2 : 444 (1892)

Mnium roseum Hedw. in Sp. Musc.: 194 (1801)

Mnium proliferum Leyss. ex With. in Syst. Arr. Brit. Pl. ed, 4, 3 : 789 (1801)

Bryum roseum (Hedw.) Crom. in Samml. Deutsch. Laubm. : 47 (1803)

Hypnum roseum (Hedw.) Web. et Mohr in Ind. Mus. Pl. Crypt. : 3 (1803)

Bryum ontariense Kindb. in Torr. Bot. Club, 16 : 96 (1889)

B. proliferum (With.) Lindb. & Arn. in K. Svensk. Vet. Ak. Handl., 23 (10) : 39 (1890)

B. leptothrix C. Muell. in Par. in Index Bryol. : 192 (1894) *nom. nud.*

B. leptorhodon C. Muell. in Nuov. Giorn. Bot. Ital n. ser. 3 : 95 (1896)

B. nanorosula C. Muell. in *ibid.*, 4 : 247 (1897)

B. ptychothecioides C. Muell. in *ibid.*: 247 (1897)

B. leucothrix C. Muell. in Hedwigia, 38 : 69 (1899)

B. macrorosula C. Muell. in Broth. in Nat. Pfl. ed. 2, 10 : 404 (1924) *nom. nud. in synonym.*

Plants. gregarious or in lax mats with creeping subterranean stolons growing on humus soil or decaying wood in woods and shady hill sides. Stems robust, erect, about 3cm. tall, lower stem clothed with distantly placed minute, appressed, scale-like leaves, suddenly enlarged to form a conspicuous, beautiful rosette of deep green leaves. Top leaves spreading; very much shrunk, flexuose, spreading or erect when dry; spatulate from a narrower base, apex acute and sometimes twisted, ± 8.3 mm. long and 2.7mm. wide; margin usually narrowly recurved at middle, flat at top, entire below, spinulose-dentate at top, spines in one row. Costa strong at base, gradually narrowing above, usually percurrent in the upper leaves; in cross section the costa shows a Mnoid type begleiter group with a batch of stereides on the dorsal side. Leaf cells very large and lax, thin-walled, regularly elongate-rhomboid, $92 \times 17.6 \mu$ at apex, wider ($\pm 26.4 \mu$) at middle leaf; there is a clear border of about 2 rows of elongated, cartilaginous, narrow, yellowish cells

on the margin with spinous projections in one row (spine cell $\pm 106 \times 17.6 \mu$); cells at extreme base rectangular, $\pm 26.4 \mu$ wide and of varying lengths up to 118μ . Perichaetial leaves narrower. Seta apical, reddish brown, erect but arcuate at tip, $\pm 4 \text{ cm.}$ long, several setae may arise from same tip. Capsule brown, pendulous, oblong-cylindrical (slightly incurved) with a short inconspicuous neck, $\pm 5.2 \text{ mm.}$ long and 2.24 mm. in diameter. Peristome Bryoid, $\pm 600 \mu$ high, endostome with basal membrane about half as high and normal appendiculate cilia. Spores brownish green, large, papillose. Dioicous. Antheridia numerous with filamentous, green paraphyses.

DISTRIBUTION of *Rhodobryum roseum*: East Nepal, Darjeeling (2600 m.), Khasia Hills, Western Himalaya (Punjab, Mussoori, Kumaon, Garhwal, W. Nepal), Ceylon, S. Vietnam, West Tibet, Siberia, Japan, China, Taiwan, Europe (incl. G. B.), Caucasus, central and South Africa, North America, Mexico.

Almost cosmopolitan.

Collection Site: Matupatti (1700m.)

Herbarium No. 13364

Figure: **Plate 47[B]**

10.MNIACEAE

Mnium thomsonii Schimp. in Syn. ed. 2: 485 (1876)

Mnium orthorrhynchum C. Muell. nom. inval. in Syn., 1 : 163 (1848) fid. Kop.

M. lycopodioides Hook. ex Mitt. in Musci Ind. Or.: 142 (1859) nom. illegit., fid. Kop.

Astrophyllum orthorrhynchum Lindb. in Musci Scand.: 14 (1879) fid. Kop.

Mnium decurrens C. Muell. & Kindb. in Macoun: Cat. Canad. P1., 6 : 140 (1892) fid. Kop.

M. rostellulatum C. Muell. in Nuov. Giorn. Bot. n. ser. 3 : 91 (1896) fid. Kop.

M. gracillimum C. Muell. in ibid. n. ser. 5 : 162 (1898) fid. Kop.

M. purpureoneuron C. Muell. in Gen. Musc. Fr.: 135 (1900)

M. secundum C. Muell. ex Kab. in Hedwigia, 76 : 27 (1936) nom. nud. in synonym.

M. lycopodioides ssp. *orthorrhynchum* (Lindb.) Wijk. & Marg. in Taxon, 10 : 25 (1961)

Plants tufted, green, rupestrine or terrestrial. Stem slender, ± 7 mm. or more long more or less erect, branched, rather lax. Leaves laxly arranged, erect-spreading, somewhat contorted and erect when dry. Lower leaves distant, shorter and wider; upper leaves more compact but still lax, elliptical, 3 to 3.5mm. long and 0.7 to 1mm. wide, very narrow at base, sharply acuminate; margin usually recurved, sharply toothed (biseriate) from apex almost to base, with clear border. Costa percurrent or short excurrent, spinulose on top back. Leaf cells more or less thick-walled; rounded-hexagonal, not collenchymatous, $\pm 19\mu$ wide; basal cells laxer, rectangular near costa, $\pm 30 \times 19\mu$, shorter and ovate-hexagonal towards margin; border of 2 or 3 rows of long, narrow cells ($\pm 87 \times 7\mu$), Dioicous. Antheridia club-shaped.

DISTRIBUTION of *Mnium thomsonii*: East Nepal, Darjeeling, Sikkim, Bhutan (2000-2800m.), Arunachal, W. Himalaya (Kajmag, Simla), Burma, W. Tibet, C. Asia, China (Yunnan, Shensi etc.), Sakhalin, Korea, Japan, C. & N. Europe incl., G. Britain, N. America (Brit. Columbia).

A North Hemisphere species.

Collection Site: Matupatti (1700m.)

Herbarium No. 13365

Figure: **Plate 48[A]**

11. BARTRAMIACEAE

Key to the genera of Bartramiaceae:

- | | | |
|----|---|---------------------|
| 1a | Plants without sub-floral innovations; leaf base not sheathing; operculum not rostrate | <i>Anacolia</i> |
| 1b | Plant with sub-floral innovations; leaves not glossy, erectopate, not plicate; basal cells lax | 2 |
| 2a | Capsule symmetrical, erect to inclined, mostly not furrowed; peristome absent or single and teeth rudimentary | <i>Bartramidula</i> |
| 2b | Capsule inclined to horizontal, furrowed; peristome almost always double; neck short | <i>Philonotis</i> |

Anacolia menziesii (Turn.) Par. in Ind. Bryol.: 27 (1894)

Bartramia menziesii Turn. in Ann. Bot., 1: 525 (1805)

Glyphocarpa baueri Hamp. in Linnaea, 30: 457 (1860) as var.

G. elliptica Hamp. in ibid.: 457 (1860)

Glyphocarpus menziesii (Turn.) Jaeg. in Ber. S. Gall. Naturw. Ges., 1873-74: 63 (1875)

G. baueri (Hamp.) Jaeg. in *ibid.*: 64 (1875) as var.

Anacolia leiophylla Kindb. in Flow. in Bull. Torr. Bot. Cl., 79: 176 (1952) *nom. nud.*
in synonym.

Sturdy, rigid plants, in dense tufts, brownish green (darker below). Shoots dichotomously branched, sterile ones up to 4cm. high, covered by red-brown tomenta and radiculose below. Leaves in many rows, stiff, erectopate to erect-spreading, appressed to stem when dry, awl-shaped, gradually narrowing from a non-sheathing, broad, ovate base into a long, spinose tip, ± 5.2 mm. long and 0.6mm. wide at base, base shows longitudinal folding; margin often revolute, finely but sharply serrate in about 2/3 of the leaf length from tip. Costa strong, rough on back, excurrent in a stiff, spinose arista. Leaf cells thick-walled; irregular but more or less rectangular, small, up to 18μ long in the upper lamina where the cells are papillose with the papillae mostly on tips of cells and never on the middle of the lumen; large rectangular near costa but more or less quadrate ($\pm 9\mu$ wide) near margins, smooth. Seta apical but usually becomes lateral because of subfloral innovation, erect (sinuose when dry), ± 7.5 mm. long in this specimen (reported 6 to 14 mm.). Capsule erect, regular, pyriform, brown, ± 2.5 mm. long and 1mm. in diameter, wrinkled with wavy striations when dry. Operculum short, conical. Peristome incomplete, endostome absent, exostome represented by blunt, irregular, short teeth. Dioicous.

DISTRIBUTION of *Anacolia menziesii*: East Nepal (3800-4300m.), Vancouver, Mexico, Eastern Himalaya and North & Central America.

Collection Site: Attukadu (1500m.)

Herbarium No. 13366

Figure: **Plate 48[B]**

Bartramidula roylei (Hook.f.) B.S.G. in Bryol. Eur., 4: 55 (1846)

Glyphocarpa roylei Hook.f. in Hook.: Icon. Pl. Rar., 2: 194C (1837)

Philonotis roylei (Hook.f.) Mitt. in Musci Ind. Or.: 59 (1859)

Glyphocarpus roylei (Hook.f.) Jaeg. in Ber. S. Gall. Naturw. Ges. 1873-74: 60 (1875)

Philonotis mathildae C. Muell. in Gen. Musc. Fr.: 339 (1900) *nom. nud.*

Plants and shoot as in *B. bartramioides*. Leaves erect, lanceolate, acuminate, ± 1.6 mm. long and 0.2mm. broad; margin more or less flat, serrulate in most upper part. Costa excurrent in an aristate point ± 0.18 mm. long. Leaves on branches smaller and narrower. Leaf cells thin-walled, rectangular, papillose; linear, $\pm 41 \times 7 \mu$ at apex; broader. 41 to $49 \mu \times 11$ to 15μ at base. Capsule erect or suberect, subglobose or urn-shaped, ± 3 mm. long and 2mm. in diameter, wrinkled or lightly striate when dry. Operculum conical convex. Peristome absent.

DISTRIBUTION of *Bartramidula roylei*: East Nepal, Bhutan, Chhotanagpur, Western Himalaya (Garhwal, Jaunsar. Mussoorie, Nainital. Simla), South India (Mahabaleswar, Nilgiri), Ceylon, Philippines, Taiwan. China (Yunnan), Japan.

A south & east Asiatic species.

Collection Site: Kannimalai (1600m.)

Herbarium No. 13368

Figure: **Plate 49[A]**

Key to the species of *Philonotis*:

- | | | |
|----|---|-------------------------|
| 1a | Capsule inclined or erect, mostly not furrowed. Peristome failing or single | <i>P. bartramioides</i> |
| 1b | Capsule nodding to horizontal, furrowed. Peristome double. | 2 |
| 2a | Dry leaves mostly appressed to stem | <i>P. turnerriana</i> |
| 2b | Dry leaves not appressed to stem. Plants soft | <i>P. mollis</i> |

Philonotis bartramioides (Griff.) Griffin & Buck in Tixier: 122 (1971)

Bartramidula bartramioides (Griff.) Wijk & Marg. in Taxon, 7: 289 (1958)

Weisia bartramioides Griff. in Cal. J. Nat. Hist., 2: 489 (1842)

Philonotis griffithiana Mitt. in Musci Ind. Or.: 59 (1859)

P. fabroniacea C. Muell. in Kindb. in Enum. Bryin. Exot.: 93 (1889) *nom. nud.*

Bartramia fabroniacea C. Muell. in Gen. Musc. Fr.: 338 (1900) *nom. nud.*

B. kurzeana Hamp. in C. Muell. in ibid.: 338 (1900) *nom. nud.*

Philonotis gammiana Broth. in Ren. & Card. in Bull. Soc. R. Bot. Belg., 41 (1): 61(1905)

Bartramidula griffithiana (Mitt.) Kab. in Hedwigia, 77: 92 (1937) *nom. illeg. incl. sp. prior*

Philonotis kurzeana Kab. in *ibid.*: 93 (1937)

P. sikkimensis Broth. in Kab. in *ibid.*: 94 (1937)

Philonotula fabroniaceae Kab. in *ibid.*: 93 (1937) *nom. nud. in synonym.*

Plants comparatively small and slender, caespitose, green. Stem slender, ± 5 mm. long, with 4 or 5 subfloral innovations of about same length in a ring, thickly covered with leaves, tomentose below. Leaves erect, variable in size, linear lanceolate, acuminate, ± 2.5 mm. long and 0.2mm. broad; margin strongly inrolled throughout, sharply dentate at tip; costa usually ending in a long excurrent tip (± 0.2 mm.). Leaves on branches smaller (± 1 mm. \times 0.15mm.). Leaf cells thin-walled; narrow elongated ($\pm 38 \times 7 \mu$), mamilllose at tip; becoming rectangular ($\pm 26 \times 11 \mu$), mamilllose at base. Seta apical, erect, slender, ± 1.4 cm. long. Capsule erect, ovoid-subglobose, ± 2 mm. high and 1mm. in diameter, wrinkled (but not furrowed) when dry. Peristome single, only with exostome teeth which are lanceolate, $\pm 190 \mu$ high and 30μ wide at base. Exothecial cells thick-walled.

DISTRIBUTION of *Philonotis bartramioides*: Darjeeling, Sikkim, Assam, Khasia Hills, Naga Hills, Chhotanagpur, Orissa, Western Himalaya (Kumaon, Dehradun, Mussoorie), Western Ghats (near Bombay), Burma (Bassein), Java, Philippines, Taiwan, Japan.

A south & east Asiatic species.

Collection Site: Attukadu (1500m.)

Herbarium No. 13367

Figure: **Plate 49[B]**

Philonotis mollis (Doz. & Molk.) Mitt. in *Musci Ind. Or.*: 60 (1859)

Batramia mollis Doz. & Molk. in *Ann. Sc. Nat. Bot. ser. 3, 2*: 300 (1844)

Bartramia sphaerocarpa Mont. in C. Muell. in *Syn.*, 1: 484 (1849) *nom. nud.*

Philonotula slolonacea C. Muell. in Par. in *Ind. Bryol. Suppl.* 268 (1900) *nom. nud.*

Philonotis slolonacea Par. in *ibid.*: 268 (1900) *nom. nud.*

Plants yellowish green, soft, in lax tufts. Shoots slender, weak, ascending, more than 2cm. long, not branched in sterile clumps. Leaves lax on top, more crowded below, spreading in lax regions, erectopatent below, shrunk, and more erect when dry,

lanceolate, gradually narrowed into a long filiform point (± 0.32 mm. long), decurrent below, ± 1.6 to 1.94 mm. long and ± 0.4 mm. broad; margin usually plain but may be slightly reflexed above, serrulate above with paired teeth. Costa long excurrent. Leaf cells narrow elongated $\pm 40 \times 7 \mu$ at top, $\pm 57 \times 13 \mu$ at middle, mamilllose at upper ends; basal cells lax, smooth, rectangular, $\pm 57 \times 18 \mu$. Dioicous.

DISTRIBUTION of *Philonotis mollis*: Sikkim, Bhutan, Andaman Is., South India (Kanara, Coorg), Ceylon, Tonkin, Sumatra, Java, Borneo, Celebes, Philippines, Taiwan, Japan, Madagascar.

Spreading from Madagascar to Japan.

Collection Site: Charpa (1200m.)

Herbarium No. 13369

Figure: **Plate 50[A]**

Philonotis turneriana (Schwaegr.) Mitt. in Musci Ind. Or. : 62 (1859)

Bartramia turneriana Schwaegr. in Sp. Musc. Suppl. 3 (1) : 238 (1828)

Philonotis palustris Mitt. in J. Linn. Soc. Bot., 8: 150 (1864) *fid.* Ochi

P. turneri Schwaegr. ex Kindb. in Enum. Bryin. Exot. : 71 (1888)

Bartramia macroglobus C. Muell. in Flora. 82: 448 (1896)

Philonotis macroglobus (C. Muell.) Par. in Ind. Bryol. Suppl. 267 (1900)

P. ulii Ihs. in Trans. Sapporo Nat. Hist. Soc., 13: 395 (1934) *fid.* Ochi

P. luteo-tapes Sak. in Bot. Mag. Tokyo, 55: 4 (1941) *fid.* Ochi

Plants erect, more or less rigid, yellow-green above, entangled by brownish tomentum below. Shoots more than 2cm. high with a ring of subfloral innovations. Leaves erect (somewhat appressed and shrunk when dry), with stiff aristate points, carinate, triangular-lanceolate, 2 to 3mm. long and 0.6mm. wide margin flat, serrate. Costa long excurrent in an arista ± 0.5 mm. long. Leaf cells narrow rectangular, mamilllose at one or both ends, $\pm 38 \times 7 \mu$ at top and 38 to 79×10 to 26μ at base. Seta slender, apical, sinuose erect, light brown, ± 2.8 cm. long. Capsule usually nodding to horizontal rarely erect, subglobose, ± 3.5 mm. long and 3mm. in diameter, furrowed when dry, light brown. Exostome teeth lanceolate, $\pm 350 \mu$ high, endostome segments $\pm 280 \mu$ high, papillose. Spores brownish green, fine papillose, rounded, 25 to 30μ in diameter.

DISTRIBUTION of *Philonotis turneriana*: East Nepal (1300-3100 m.), Darjeeling, Sikkim, Bhutan, Khasia Hills, Western Himalaya (Simla, Mussoorie, Garhwal, Kumaon, Jaunsar .NWFP, Kashmir), Ceylon, Burma, Java, Philippines, Hongkong, China (Yunnan, Szetschwan, Kiangsu), Japan, Taiwan, Hawaii, Sandwich Is.

An Indo-Pacific species.

Collection Site: Attukadu (1500m.)

Herbarium No.13371

Figure: **Plate 50[B]**

Order: Isobryales

Key to the families of Isobryales:

- | | | |
|----|--|-----------------|
| 1a | Sporangia mostly terminal; leaf cells usually rounded and often papillose | Orthotrichaceae |
| 1b | Sporangia mostly lateral | 2 |
| 2a | Alar cells distinctly defined, basal cells pitted, thin-walled; nerve single | Cryphaeaceae |
| 2b | Alae cells absent; leaves not plicate; basal cells not pitted | 3 |
| 3a | Leaf cells rhomboid to linear, papillose | Trachypodaceae |
| 3b | Leaf cells prosenchymatous, smooth | 4 |
| 4a | Secondary stem tough and rigid | Pterobryaceae |
| 4b | Secondary stem not rigid but flexible | Meteoriaceae |

12. ORTHOTRICHACEAE

Key to the genera of Orthotrichaceae:

- | | | |
|----|--|---------------------|
| 1a | Leaves cochleariform, bordered, median and upper cells rectangular or linear, cells along nerve rectangular, marginal few rows shorter to quadrate | <i>Orthotrichum</i> |
| 1b | Leaves not cochleariform, not bordered, basal part of leaf plicate, basal cells thick-walled, leaves all alike. Capsule exerted | <i>Macromitrium</i> |

Orthotrichum speciosum Nees in Sturm in Deutschl. Fl., 2(3): 5 (1819)

Orthotrichum elegans Schwaegr. in Richardson in Bot. App. Frankl. Narr. J.: 756 (1823) as ssp.

O. bruchii Hueb. in B.S.G. in Bryol. Eur., 3:62 (1837) nom. nud. in synonym.

O. killiasii C.Muel. in Jahresber. Naturf. Ges. Graub., 3: 166 (1858) as var.

O. sclerodon Schimp. in Wood in Phytologist, 5: 1860 nom. nud.

O. macroblephare Schimp. in Mus. Eur. Nov. Bryol. Eur. Suppl. F. 1-2: 7 (1864) as var.
O. raii Aust. In Bull. Torr. Bot. Cl., 6: 342 (1879)
O. erythrostomum Groenv. in Nya Bidr. Kaenned.: 12 (1887) as var.
O. psilothecium C. Muell. et Kindb. in Macoun: Cat. Canad. P1., 6:91(1892) as var.

Reddish yellow-green plants in loose or dense tufts. Shoots simple or branched, erect, only about 1.5cm in this specimen but reported up to 4cm. Leaves dense, sometimes in intermittent tufts erectopatent to erect-spreading, oblong or ovate-lanceolate, ± 3.5 mm. long and 0.75mm. wide, imbricate and appressed to stem when dry; apex acute, acuminate; margine entire (except papillate), recurved throughout. Costa usually reaching tip. Leaf cells incrassate; ovate to elliptical, $\pm 11\mu$ long, multipapillate at tip to midleaf; more elongated (lumen $20 \times 8\mu$) and less papillose at base. cells at base near costa rectangular (tips may be pointed), smooth, almost thin-walled (still coloured), up to $38 \times 11\mu$. Specimen from this area sterile. Seta known to be short (2mm. or less) where found.

DISTRIBUTION of *Orthotrichum speciosum*: Sikkim (5000 m.), Kashmir, West Tibet, Europe including G.B., Siberia, Amur, Caucasus, Algeria, Canada, West & East U.S.A., North Andes.

A widespread species.

Collection Site: Matupatti (1700m.)

Herbarium No. 13372

Figure: **Plate 51[A]**

Macromitrium sulcatum (Hook.) Brid. in Bryol. Univ., 1: 319 (1826)

Schlotheimia sulcata Hook. in Musci Exot., 2: 156 (1819)

Macromitrium neelgheriense C. Muell. in Syn., 1: 737 (1849) as var.

M. neilgherrense C. Muell. in Bot. Zeit., 11: 61(1833) as var.

M. corrugatum Wils. in Kew J. Bot., 9: 328 (1857) *nom. nud.*

M. tersum Wils. in *ibid.*, *nom. nud.* as var.

M. nilghiriense C. Muell. ex Mitt. in Musci Ind. Or.: 52 (1859)

M. ceylanicum Mitt. in Musci. Ind. Or.: 52 (1859) as var.

M. ramentosum Thwait. et Mitt. in J. Linn. Soc. Bot., 13: 301 (1873) as ssp.

Tufted plants on tree trunks with ramifying main stem 2cm. or more long giving rise to erect secondary branches 1 to 2cm. high. Leaves dense, erect to erectopate, usually carinate, more appressed and hook-like curled when dry, lanceolate, ± 2.1 mm. long and 0.64mm. wide; apex acute apiculate; margin entire, flat. Costa ending just behind tip. Leaf apical cells with highly thickened walls, irregularly rounded ($\pm 6\mu$ wide) or ovate ($\pm 9\mu$ long) lumens. At midleaf all cells are thick-walled but juxtacostal cells show elongated, linear lumens ($\pm 19 \times 4\mu$) with no clear papillae but outer cells show rounded lumens ($\pm 6\mu$ wide) with one large papilla each. Basal cells with less thick walls are rectangular ($\pm 23 \times 8\mu$) and show one large tubercular papilla each. There is one border row of smooth rectangular, thin-walled cells (largest at alar $\pm 23 \times 13\mu$) running to a height of 5 or 6 cells gradually narrowing upwards. Seta apical, erect (spirally twisted when dry), ± 6.5 mm. long. Capsule erect, oval with narrowed mouth, clearly sulcate, ± 2.3 mm. long and 0.88mm. in diameter at base. Operculum conic, long rostrate, ± 1.28 mm. high. Calyptra mitriform, pilose. Peristome of exostome only, 200μ high. Spores round, papillose, 15.5 to 21μ in diameter with some spores much smaller.

DISTRIBUTION of *Macromitrium sulcatum*: East Nepal, Khasia Hills, Arunachal, Naga Hills, Western Ghats (Bombay), Nilgiri, Coorg, Madras, Ceylon, Burma, Thailand, Malaya, Malacca, Borneo, Philippines.

An Indomalaysian species.

Collection Site: Matupatti (1700m.)

Herbarium No. 13373

Figure: **Plate 51[B]**

13. CRYPHEACEAE

Schoenobryum concavifolium (Griff.) Gangulee *stat. nov.*

Orthotrichum concavifolium Griff. in Cal. J. Nat. Hist., 2: 400 (1842)

Sehocnobryum julaceum Doz. & Molk. in Musci Fr. Ined. Archip. Indici, 6 : 184 (1848)-Java gen. lectotype specimen only, *non Grimmia julacea* Hornsch.

Acrocryphaea javanica B.S.G. in Bryol. Eur., 5: 32 (1830) *nom. nud.*

Cryphaea concavifolia (Griff.) Mitt. in Musci Ind. Or.: 125 (1859)

Acrocryphaea concavifolia (Griff.) Bosch & Lac. in Bryol. Jav., 2: 106 (1864)

Primary stem creeping, stiff, wiry, rhizomatous, giving rise to erect, rigid, yellowish green, julaceous shoots about 3cm. high, branched above middle; loosely tufted. Leaves on secondary or tertiary shoots dense, erectopate to spreading (erect and appressed to stem when dry), concave, broadly ovate, $\pm 1.28\text{mm.}$ long and 0.8mm. wide; apex acute, shortly acuminate; margin flat and entire except feeble indentations at tip. Costa ending about $\frac{1}{3}$ leaf length below tip. Leaf cells ovate to elliptical, $\pm 11.5\mu \times 7.7\mu$. At base, juxtacostal cells are narrow elongated ($\pm 19.3 \times 8\mu$), then shorter ($\pm 15 \times 8\mu$) and in oblique rows towards margin, finally near margin they are oval as on top, at margin these short cells are placed crosswise. Sporophytes terminal on branches. Perichaetial leaves differentiated, narrower, longer ($\pm 1.47\text{mm.}$) and with longer acumens. Seta almost absent keeping capsule hidden. Peristome single, of 16 papillose, lanceolate teeth. Operculum short conical. Calyptra short, campanulate, only covering operculum. Spores large ($\pm 25\mu$).

DISTRIBUTION of *Schoenobryum concavifolium*: East Nepal (Dhankuta 6000 ft.), Khasia Hills, Manipur, Bangladesh, Coorg, Ceylon, Burma, Thailand, Vietnam, Java, Celebes, New Guinea, Philippines.

An indomalesian species.

Collection Site: Matupatti (1700m.)

Herbarium No. 13374

Figure: **Plate 52[A]**

14. TRACHYPODACEAE

Trachypodopsis serrulata (P. Beauv.) Fleisch. in Hedwigia, 45: 65 (1906)

Pilotrichum serrulatum P. Beaus^r. in Prodr.: 83 (1805)

Neckera serrulata (P. Beauv.) Brid. in Sp. Musc., 2 : 29 (1812)

Hypnum ericetorum Brid. in Sp. Muse., 2 : 97 (1812)

Meteorium serrulatum (P. Beauv.) Mitt. in J. Linn. Soc. Bot., 7 : 156 (1863)

Neckera nodicaulis C. Muell. in Linnaea, 40 : 269 (1876)

Papillaria serrulata (P. Beauv.) Jaeg. in Ber. S. Gall. Naturw. Ges. 1875-76 : 274 (1877)

Papillaria nodicaulis (C. Muell.) Jaeg. in *ibid.* (1877)

Trachypus serrulatus (P. Beauv.) Besch. in Ann. Sc. Nat. Bot. ser. 6, 10 : 269 (1880)
T. nodicaulis (C. Muell.) Besch. in *ibid.*: 270 (1880)
T. rutenbergii C. Muell. in C. Muel. & Geh. in Abh. Naturw. Ver. Bremen, 7 : 209 (1881)
Neckera macleai Rehm. ex Kindb. in Enum. Bryin. Exot. : 101 (1891) *nom. nud.*
Papillaria rutenbergii (C. Muell.) Par. in Index Bryol. : 908 (1897)
P. pintasiana C. Muell. in Par. in Index Bryol. ed. 2, 3 : 359 (1905) *nom. nud.*
Trachypodopsis nodicaulis (C. Muell.) Fleisch. in Hedwigia, 45: 67 (1906)
T. pintasiana Fleisch, in *ibid.* : 67 (1906)
T. rutenbergii (C. Muell.) Fleisch. in *ibid.* : 68 (1906)
Trachypus quintasiamus C. Muell. in Broth, in Nat. Pfl., 1 (3): 832 (1906) *nom. nud.*
in synonym.
Hypnum crispatum Hook. in Trans. Linn. Soc. Lond., 9: 321 (1808)
Neckera crispatula (Hook.) Hook. in Musci Exot., 2 : 302 (1816)
Cyrtopus crispatus (Hook.) Brid. in Bryol. Univ., 2 237 (1827)
Trachypus crispatus (Hook.) Mitt. in Musci. Ind. Or.: 129 (1859)
Papillaria crispatula (Hook.), Jaeg. in Ber. S. Gall. Naturw. Ges., 1875-76 : 274 (1877)
Trachypus feae C. Muell. in Nuov. Gioro. Bot. Ital., 23: 601 (1891) *nom. nud.*
T. subcrispatus C. Muell. in Par. in Index Bryol.: 1304 (1898)
T. himantophyllus C. Muell. ex. Ren. & Card. in Bull. Soc. R. Bot. Belg., 38 (1) : 22 (1900)
Trachypodopsis crispatula (Hook.) Fleisch. in Hedwigia, 45: 65 (1906)
T. himantophylla (Ren. & Card.) Fleisch. in *ibid.* : 67 (1956)
T. macrodontis Fleisch. in *ibid.*: 67 (1906) *nom. invalid*
T. subcrispatula Fleisch. in *ibid.*: 66 (1906)
T. sumatrana Fleisch. in *ibid.* : 67 (1906) *nom. nud.*
T. feae Fleisch. in *ibid.*: 67 (1906) *nom. nud.*
T. macrodon Fleisch. in Musci Fl. Buitenz., 3 : 733 (1906)
Papillaria feae C. Muell. ex Fleisch. in *ibid.* : 761 (1908)
Prionodon otiophyllus Card. in Rev. Bryol., 37 : 7 (1910)
Trachypodopsis otiophyllus (Card.) Card. to Rev. Bryol., 38 : 39 (1911)

T. densifolia Broth. to .*Symb. Sin.*, 4 : 77 (1929)

T. plicata Dix. in *Ann. Bryol.*, 9 : 65 (1937)

T. angustiretis Dix. in *Ann. Bryol.*, 12 : 53 (1939)

T. subulata Chen in *Fedd. Rep. Sp. Nov. Regn. Veg.*, 58 : 29 (1955)

Robust to semirobust plants with reddish tinge, in dense mats. Secondary stems ascending or hanging, up to 10cm. or even more long, laxly pinnately branched. Leaves not so dense, erect-spreading (slightly curved, flexuose and strongly appressed to stem when dry), plicate, lanceolate, acuminate; margin serrulate, flat; ± 3 mm. long and 0.52mm. wide at base; base showing faintly developed auricles. Costa ending below apex. Leaf cells thick-walled, rhomboid to elliptical to linear, $\pm 38 \times 8 \mu$ and smooth at apex; lower down about two rows of similar cells form a border; inside cells are rhomboid with a single papilla at lumen centre, $\pm 19 \mu$ long and 8μ wide; at base juxtacostal cells are broader rectangular ($\pm 19.5 \times 7 \mu$) with porose walls, outer cells are narrower ($\pm 19.5 \times 4 \mu$). A group of quadrate-rhomboid ($\pm 11.5 \times 7 \mu$) cells with highly thickened walls are present in the alar region. Sporophyte on short lateral shoots on branches. Periehaetial leaves shorter. Seta about 4 mm. long, rough. Capsule erect, oval, ± 1.92 mm. high and 1.3mm. in diameter with a short apophysis. Operculum conic-rostrate, ± 0.83 mm. high, beak usually bent to one side. Peristome double and regular.

DISTRIBUTION of *Trachypodopsis serrulata*: East Nepal (1500-3800m.), Darjeeling, Sikkim, Darjeeling, Bhutan, Arunachal, Naga Hills, Khasia Hills, Manipur, Andaman Is., Western Himalaya (Kumaon, Simla etc.), Palni, Ceylon, Burma, Thailand, Cambodia, Laos, Sumatra, Java, Borneo, Celebes, Lombok, Philippines, Taiwan, Yunan, Kansu, Mauritius, Madagascar, Comoro Is., Central Africa, South Africa, Mexico, Guatemala.

A widespread species.

Collection Site: Matupatti (1700m.)

Herbarium No. 13375

Figure: **Plate 52[B]**

15. PTEROBRYACEAE

Key to the genera of Pterobryaceae:

- 1a Main stem filiform, sparsely radiculose, without leaves or with distinct scale leaves. Secondary stems without paraphyllia. Dorsal layers of peristome teeth often irregularly thickened and smooth; inner peristome very transitory, fused with the outer mostly without processes, also apparently absent. Alar cells distinctly defined, basal cells of leaf not pitted *Symphysodontella*
- 1b Main stem rhizomatous, densely brown felted. Dorsal layer of the peristome teeth normally developed, rarely smooth; inner peristome free, with basal membrane and processes. Nerve very short or absent. Secondary stem mostly simple, rarely rebranched with distinct branchlets, without paraphyllia. Capsule completely immersed, completely mitriform. *Garovaglia*

Garovaglia plicata (Brid.) Bosch & Lac. in Bryol. Jav., 2 : 79 (1863)

Esenbeckia plicata Brid. in Bryol. Univ., 2 : 754 (1827)

Cryphaea plicata Nees in Brid. in *ibid.* : 754 (1827) *nom. nud. in synon.*

Neckera plicata (Brid.) Schwaegr. in Sp. Musc. Suppl. 3 (2): 268 (1829)

Endotrichum densum Doz. & Molk. in Ann. Sc. Nat. Bot. ser. 3, 2 : 303 (1844)

Pilotrichum plicatum (Brid.) C. Muell. in Syn., 2 : 158 (1850)

Meteorium plicatum (Brid.) Mitt. in Musci Ind. Or. : 84 ((1859)

Endotrichum plicatum (Brid.) Jaeg. in Ber. S. Gall. Naturw. Ges., 1875-76 : 231 (1877)

Primary stem thick rhizomatous. Secondary stems thick, erect or bent, closely placed usually unbranched, sometimes with a short branch, golden green on top, brownish below, about 5cm. high and 8mm. wide. Leaves dense, ± 4.5 mm. long and 2.25mm. wide, erect-spreading (a little appressed when dry), ovate-lanceolate, sharply and suddenly acuminate, plicate; margin more or less dentate at apex. Leaf cells incrassate with porose walls (showing middle lamellae at base), $\pm 54 \times 1.6 \mu$ at tip, up to $84 \times 11.6 \mu$ in lower half of leaf with some wider, shorter, yellow-brown cells at leaf insertion region. Sporophytes many on very short lateral shoots (about 4mm. long). Seta very short keeping the capsule immersed. Capsule oblong-cylindrical, ± 2 mm. long and

1.2mm. in diameter. Operculum conic-apiculate. Peristome double with endostome lobes filamentous. Calyptra small, mitriform.

DISTRIBUTION of *Garovaglia plicata*:

Sikkim (3300 m.), Malaya, Sumatra, Java, North Borneo, Philippines, Taiwan

An Indomalesian species.

Collection Site: Matupatti (1700m.)

Herbarium No. 13376

Figure: **Plate 53[A]**

Symphysodontella borii Dix. in J. Bombay Nat. Hist. Soc., 39: 781 (1937)

Plants light green above, brownish below, of medium size. Secondary branches slender, pinnately branched, about 2cm. long, some branches rather narrowed at apex (subflagellate). Leaves dense, imbricate, erect to erectopatent, concave, plicate, to 2mm. long and 0.73mm. wide, acute and apiculate at tip, margin very faintly denticulate at tip. Leaf cells lightly incrassate, elongate linear, $\pm 50 \times 7 \mu$ up to base. Cells at stem attachment coloured; alar cells differentiated, deep brown, rectangular, $\pm 46 \times 23 \mu$ and smaller, gradually becoming longer above, up to $77 \times 8 \mu$. Sporophyte on short lateral shoots. Perichaetial leaves narrower. Seta curved, usually curved, ± 1.8 cm. long. Capsule erect, oval, narrowed at mouth, ± 1 mm. long and 0.7mm. in diameter. Peristome and calyptra not seen but endostome undeveloped and calyptra smooth, cucullate.

DISTRIBUTION of *Symphysodontella borii*: Arunachal.

Endemic in this area. But present report from Idukki extends its distribution to south India.

Collection Site: Eravikulam (1800m)

Herbarium No. 13377

Figure: **Plate 53[B]**

16. METEORACEAE

Key to the genera of Meteoraceae:

- | | | |
|----|--|-------------------------|
| 1a | Leaves either distichous or the branches complanate; cells narrow, linear rhomboid, papillae many per cells. Seta smooth | <i>Barbella</i> |
| 1b | Leaves neither distichous nor the branches complanate; leaves not cochleariform | 2 |
| 2a | Cells invariably smooth, nerve double, shorter or absent. Leaf base auricled, cells thick-walled | <i>Meteoriella</i> |
| 2b | Cells papillose, nerve long always ending higher than midleaf; cells rhomboid or elliptic | <i>Cryptopapillaria</i> |

Cryptopapillaria fuscescens (Hook.) Menzel in Willdenowia, 22:171-196 (1992)

Papillaria fuscescens (Hook.) Jaeg. in Ber. S. Gall. Naturw. Ges., 1875-76: 270 (1877)

Neckera fuscescens Hook. in Musci Exot., 2: 157 (1819)

Daltonia fuscescens (Hook.) Arnott in Mem. Soc. Linn. Paris, 5 : 296 (1827)

Pilotrichum fuscescens (Hook.) Brid, in Bryol. Univ., 2 : 264 (1827)

**Neckera chrysoclada* C. Muell. in Syn., 2 : 139 (1850)

Trachypus fuscescens (Hook.) Mitt, in Musci Ind. Or. : 128 (1859)

Meteorium fuscescens (Hook.) Bosch & Lac. in Bryol. Jav., 2 : 93 (1864)

Papillaria chrysoclada (C. Muell.) Jaeg. in Ber. S. Gall. Naturw. Ges., 1875-76 : 270 (1877)

**P. fuscescens* var. *crassiramea* Ren. & Card. in Bull. Soc. R. Bot. Belg., 38 (1) : 19 (1900)

**Meteorium chrysocladum* (C. Muell.) Broth. in Nat. Pfl. 1 (3): 818 (1906)

**Papillaria feae* C. Muell. ex Fleisch. in Musci Fl. Buitenz., 3 : 761 (1908)

**P. fuscescens* var. *gracilis* Fleisch. in *ibid.* : 761 (1908)

**P. bamforthiae* Broth. ex Dix. in J. Bot., 50 : 148 (1912)

**P. tumida* Card. in Vard. in Rev. Bryol., 50 : 73 (1923) *nom. nud. in. synonym.* = var. *crassiramea*

* = forms of the type species

Branches comparatively slender, pendulous. 12cm. or more long, pinnately branched, yellow green on top, brownish or blackish below. Leaves dense, more or less erect, imbricate (more appressed when dry), oblong-lanceolate, ±1.8mm. long and 0.7mm.

wide, base plicate auriculate; apex acuminate, twisted; margin finely denticulate - crenulate at apex and base. Costa single, ending at midleaf. Leaf cells linear-crenulate to linear-rhomboid, serially multipapillate except at basal juxta-costal cells and at auricle, thick-walled, $\pm 27 \times 3 \mu$ at apex, shorter in auricle with a group of rectangular cells (up to $46 \times 10 \mu$) at leaf attachment. Sporophyte on short lateral shoots. Perichaetial leaves very long, completely enclosing the capsule. Seta extremely short. Capsule cylindrical, ± 3 mm. long and ± 0.64 mm. in diameter. Operculum conic-rostrate, curved to one side, ± 0.64 mm. high. Peristome double, exostome teeth lanceolate; endostome segments filamentous from a low basal membrane, shorter than exostome. Calyptra cap-like, small, pilose.

DISTRIBUTION OF *Cryptopapillaria fuscescens*: East Nepal (1100-3000m.), Sikkim (1900-4000m.), Darjeeling (1600-3500m.), Bhutan (2300-3700 m.), Arunachal, K. & J. Hills, Naga Hills, Manipur, Nilgiri, Palni, Ceylon, Burma, Thailand, Laos, Tonkin, Yunan, Sumatra, Java, Borneo, Celebes, Philippines.

A Southeast Asiatic species.

Collection Site: Devikulam (1700m.)

Herbarium No. 13378

Figure: **Plate-54[A]**

Meteoriella soluta (Mitt.) Okam. in J. Coll. Sc. Imp. Univ. Tokyo, 36(7): 18 (1915)

Meteoriella soluta Mitt. in Musci. Ind. Or.: 88 (1859)

Meteoriella soluta var. *kudoii*. Okam. in *ibid.* : 18 (1915)

M. kudoii (Okam.) Okam. in *ibid.*, 38 (4): 36 (1916)

M. dendroidea Sak. in Bot. Mag. Tokyo, 47 : 336 (1933)

Jaegerinopsis integrifolia Dix. in J. Bomb. Nat. Hist. Soc., 39 : 781 (1937)

Secondary branches long, pendulous, 10cm. or more long, pinnately branched, yellow-green on tops, brownish below, complanate on tops. Leaves dense, squarrose, ovate, auriculate, top rounded, suddenly narrowed down into a long subula, ± 2.9 mm. long and 1.4mm. wide at base in stem leaves and ± 3.46 mm. long and 1.28mm. wide at base in branch leaves; margin incurved in shoulders and sometimes also at auricles, crenulate. Costa double, usually one long and one short, the longer one not

covering more than half the leaf. Leaf cells elongate linear, smooth, with highly porose incrassate walls $\pm 38.5 \times 5 \mu$ at subula, $\pm 38.5 \times 7 \mu$ in lamina. There is a group of deep brown, quadrate-rectangular cells in the centre of each auricle. Lateral sporophyte with short (± 4 mm.) seta and double peristome but with endostome reduced.

DISTRIBUTION of *Meteoriella soluta*: Sikkim, Darjeeling, Arunachal, North Vietnam, South & East China, Taiwan, South Japan.

An east Asiatic species.

Collection Site: Athirapalli (1200m.)

Herbarium No. 13379

Figure: **Plate 54[B]**

Barbella chrysonema (Muell.Hall.) Nog. in J. Eco. & Taxo. Bot., 28 : 338-346 (1976)

Floribundaria chrysonema (C. Muell.) Broth. in Nat.Pfl., 1 (3) : 822 (1906)

Papillaria chrysonema C. Muell. In Ren. & Card. In Bull. Soc. R. Bot. Belg., 34 (2) : 69 (1896)

Papillaria chrysonema C. Muell. ex Par. in Ind. Bryol. ed. 2, 3: 352 (1905) *nom. inval. err. pro. Chrysonema*

P. chrysonema var. *brachyclada* Ren. & Card. in Bull. Soc. R. Bot. Belg., 41 (1) : 73 (1905)

Slender, filmy, delicate plants, yellow-green, about 5cm. long, pinnately branched with branches in different planes. Leaves with beautiful feather-like arrangement, lanceolate, widely spreading, ± 1.6 mm. long and only 0.28mm. wide at the wider base, apex apiculate in a more or less long acumen, sometimes twisted; base variable from cordate to narrower; margin flat, denticulate-serrate almost to base. Costa single, about two-thirds of the leaf. Leaf cells elongated, linear to rhomboid, more or less incrassate, $\pm 40 \times 4 \mu$ at tip, $\pm 55 \times 4 \mu$ in lower half, with a few small, scattered papillae except at the extreme tip and the extreme base.

DISTRIBUTION of *Barbella chrysonema*: Darjeeling, Bhutan

Endemic in this area. But present report from Idukki extends its distribution to south India.

Collection Site: Eravikulam (1800m.)

Herbarium No. 13380

Figure: **Plate 55[A]**

Order: Hypnobryales

Key to the families of Hypnobryales:

- | | | |
|----|--|------------------|
| 1a | Leaves not complanate, single nerve; cells usually isodiametric, small and papillose or elongate, prosenchymatous and smooth; alar cells slightly differentiated | 2 |
| 1b | Leaves often complanate, single nerved or nerveless; cells more or less linear, smooth; alar cells frequently strongly differentiated | 6 |
| 2a | Alar cells distinct | 3 |
| 2b | Alar cells absent | 4 |
| 3a | Central strand poorly differentiated or absent | Amblystegiaceae |
| 3b | Central strand well-developed | Brachytheciaceae |
| 4a | Paraphyllia generally present; nerve single, usually ending below the apex | 5 |
| 4b | Paraphyllia absent; nerve short or absent, never reaching near the apex; leaves flat | Fabroniaceae |
| 5a | Branching slight; stem and branch leaf alike. Capsule mostly erect | Leskeaceae |
| 5b | Branching extensive, often regularly pinnate; stem and branch leaves distinct. Capsule mostly inclined | Thuidiaceae |
| 6a | Alar cells sharply defined, often large and inflated | 7 |
| 6b | Alar cells few and inconspicuous | 8 |
| 7a | Alar cells numerous, quadrate or transversely elongated, never coloured. Capsule cylindrical, erect | Entodontaceae |
| 7b | Alar cells few, large, often oblong, only in one row or with others of smaller size above these, coloured and often vesicular | Sematophyllaceae |
| 8a | Leaf cells large, wide and thin-walled | Hypnaceae |
| 8b | Leaf cells firm walled, narrow; leaves decurrent, complanate; cells oval to rhomboid or rhomboid linear | Plagiotheciaceae |

17. FABRONIACEAE

Fabronia pusilla Raddi in Atti. Acc. Sc. Siena, 9: 231 (1808)

F. schimperiana De Not. in Cronac. Briol. Ital., 2: 41(1867) as var.

F. schimperi Vent, in Rev. Bryol., 10: 55 (1883) *ortho. err.*

F. octoblepharis ssp. *pusilla* (Raddi) Kindb. in Eur. N. Am. Bryin., 1: 13 (1897)

F. ciliaris ssp. *pusilla* (Raddi) Grout in Moss Fl. N. Am., 3: 228 (1934)

Minute, yellow-green, glossy plants forming dense mats. Main stem creeping, giving rise to short (up to 6mm.), erect or ascending branches which further branch irregularly. Leaves dense, not complanate, almost erect, not much changing when dry, ovate-lanceolate, tip suddenly narrowed into a long, narrow, spreading, pilose flagellum (± 0.4 mm. long), leaf ± 0.5 mm. long (excluding flagellum) and 0.15 mm. wide at middle; margin flat, serrated by long 1-2 celled cilia. Costa single, about half the length of leaf, rather faint. Leaf cells rhomboid, $\pm 40 \times 7 \mu$ at apex, wider and somewhat rectangular at base; several rows of quadrate ($\pm 8 \mu$ wide) cells at base angle. Perichaetial buds lateral. Inner perichaetial buds oblong-lanceolate. Seta ± 4 mm. long, erect or geniculate. Capsule erect, small, ovate-cylindrical, rough on surface, ± 0.58 mm. long and 0.45mm. in diameter. Endostome missing. Exostome broad lanceolate, $\pm 145 \mu$ long and 54μ wide in the basal part. Spores 14.5 to 16μ in diameter, faintly papillose.

DISTRIBUTION of *Fabronia pusilla*: Bhutan, Afghanistan, Central Asia, Caucasus, Israel, Europe (Switzerland, Italy and Mediterranean), Algeria, Tunisia, South Africa, N. America (California, Br. Columbia, Colorado, New Mexico, Mexico).

A widespread species.

Collection Site: Idukki (1500m.)

Herbarium No. 13381

Figure: **Plate 55[B]**

18. LESKEACEAE

Key to the genera of Leskeaceae:

- 1a Outer peristome much smaller than inner *Regmatodon*
1b Both peristome usually of equal length, paraphyllia numerous *Lescuraea*

Regmatodon declinatus (Hook.) Brid. in Bryol. Univ., 2: 204 (1827)

Pterogoniurn declinatum Hook. in Trans. Linn. Soc. Lond., 9: 309 (1808)

Plants in loose tufts, light green to dark green. Main stem creeping giving rise to erect branches which, usually, again branch pinnately and are not more than 1.5cm. tall, julaceous. Leaves dense, imbricate, erectopate (erect and appressed to stem when dry), concave, ovate-apiculate, apiculus short, ± 1.53 mm. long and 0.64mm. wide, margin entire. Costa single, covering more than half the leaf length. Leaf cells irregularly elliptical-rectangular-hexagonal, incrassate, $\pm 19 \times 7 \mu$ at tip, becoming rectangular on the borders; at base cells are more incrassate and elongated (up to $31 \times 6 \mu$ lumen at the juxtacostal region), becoming shorter towards margin ($\pm 19 \times 6 \mu$) with the border rows of shorter, more rectangular cells ($\pm 10 \times 6 \mu$), a few cells at extreme base (near stem attachment) wider. Seta from lateral perichaetial buds erect, rough (specially at tip), ± 1 cm. high. Capsule erect, ovate-cylindrical, ± 2.24 mm. long and 0.96mm. in diameter. Peristome double, inserted deep below urn mouth level. Exostome teeth dark brown, with thick transverse lamellae, $\pm 300 \mu$ long of which half is below urn mouth level. Endostome with very low basal membrane, segments pale, lanceolate, split along median fissure, $\pm 550 \mu$ long. Spores brown, rounded, coarse papillose, 25 to 27μ in diameter.

DISTRIBUTION of *Regmatodon declinatus*: East Nepal (1700 & 2100 m.), Khasia Hills, Burma, Taiwan, S. W. China

An India-Burma-China-Taiwan species.

Collection Site: Eravikulam (1800m.)

Herbarium No. 13382

Figure: **Plate 56[A]**

Lescuraea incurvata (Hedw.) Lawt. in Bull. Torr. Bot. Club, 84: 290 (1957)
Leskea incurvata Hedw. in Sp. Musc.: 216 (1801)
Hpmum atrovirens Dicks. ex Brid. in Musc. Rec., 2 (2): 153 (1801)
H.filamentosum Dicks. ex With. in Syst. Arr. Brit. Pl. ed. 4, 3: 845 (1801)
Leskea atrovirens (Brid.) Hartm. in Handb. Skand. Fl. ed. 2: 339 (1832)
Pseudoleskea atrovirens (Brid.) B.S.G. in Bryol. Eur., 5: 148 (1852)
Lesquereuxia filamentosa (With.) Lindb. in Musci Scand.: 36 (1879)
Leskea filamentosa (With.) Kindb. in Bih. K. Svensk. Vet. Ak. Handl., 7 (9): 12 (1883)
Lescuraea atrovirens (Brid.) Kindb. in Rev. Bryol., 12: 29 (1885)
Pseudoleskea filamentosa (With.) C. Jens. in Medd. Groenland, 3: 341 (1887)
Lescuraea filamentosa (With.) Broth, in Act. Soc. Sc. Fenn., 19 (12): 119 (1892)
Lesquereuxia atrovirens (Brid.) Braithw. in Brit. Moss. Fl., 3: 121 (1900)
Pseudoleskea incurvata (Hedw.) Loesk. in Hedwigia, 50: 313 (1911)
P. vagans C. Muell. *ined. nom. nud. in synonym.* in Chopra: Tax. Ind. Moss (1975)
P. denticuspis Dix. *ined. nom. nud. in synonym.* in Chopra *ibid.*
P. fuscifolia C. Muell. *ined. nom. nud. in synonym.* in *ibid.*
P. pterogonoides Broth. *ined. nom. nud. in synonym.* in *ibid.*

Plants of moderate size in dense interwoven mats, yellow-green at tops, green to brownish below. Main stem creeping, branches erect to prostrate, pinnate. Leaves dense, erectopatent (appressed when dry), concave, plicate, ovate-lanceolate-apiculate. Stem leaf larger, up to 2mm. long and 1mm. wide. Branch leaves ± 0.9 mm. long and 0.34mm. wide, may be secund; margin revolute in the middle of the leaf, smooth. Costa single, strong, ending well below apex in stem leaves but very near apex in branch leaves. Leaf cells irregularly hexagonal-rhomboid, $\pm 15 \times 7 \mu$ at apex; basal juxtacostal cells as on top, becoming wider ($\pm 16 \times 9 \mu$) towards margin but 3 or 4 marginal rows are quadrate to rectangular. Perichaetial leaves longer (up to 3mm.), clasping. Seta erect, long (± 2.3 cm.), smooth. Capsule inclined to horizontal, curved at gibbous apophysis, constricted below mouth when dry, ovate-oblong, ± 2.25 mm. long and 0.9mm. in diameter. Peristome double, $\pm 400 \mu$ high. Exostome teeth lanceolate, united at base below urn level. Endostome with high basal membrane, segments

keeled, perforated along keel, of same height as exostome. Cilia rudimentary. Spores small ($\pm 12\mu$ in diameter), fine papillose.

DISTRIBUTION of *Lescurea incurvata*: East Nepal (3500-4100 m.), Murree, Jammu & Kashmir, Afghanistan, North & Central Asia, Japan, Europe (incl. Great Britain & Caucasus), North Africa, Greenland, North America.

A widespread species.

Collection Site: Munnar (1600m.)

Herbarium No. 13383

Figure: **Plate 56[B]**

19. THUIDIACEAE

Key to the genera of Thuidiaceae:

- | | | |
|----|--|----------------------|
| 1a | Leaves not plicate, nerve strong, elongated, ending below the apex | 2 |
| 1b | Leaves plicate; leaf cells parenchymatous to rounded; in branched leaves nerve prominent at the back | <i>Pelekium</i> |
| 2a | Nerve markedly tortuous | <i>Herpetineuron</i> |
| 2b | Nerve either not or faintly tortuous, leaves not in five rows; mid-basal leaf cells not pitted | 3 |
| 3a | Alar cells absent. Plant autoicous | <i>Claopodium</i> |
| 3b | Alar cells present. Plant dioicous | <i>Haplocladium</i> |

Herpetineuron toccoae (Sull. & Lesq.) Card. in Beih. Bot. Centralbl., 19 (2): 128 (1905)

Anomodon toccoae Sull. & Lesq. in Musci Bor. Am.: 52 (1856)

Anomodon devolutus Mitt, in Musci Ind. Or.: 127 (1859)

A. wichurae Broth. in Hedwigia, 39: 247 (1899)

A. fuscinervis C. Muell. in Salm. in J. Bot., 39: 363 (1901) *nom. nud. in synonym.*

Herpetineuron wichurae (Broth.) Card. in *ibid.* (1905)

H. attenuatum Okam. in J. Coll. Sc. Imp. Univ. Tokyo, 38 (4): 54 (1916)

Yellow-green to dark green plants in dense, non-glossy, mostly epiphytic tufts. Main stem creeping, with long rhizoids and distant scaly leaves, 5cm. or more long, with central strand. Secondary branches erect, simple or sparsely branched, with characteristic circinate tips (mostly whitish in colour) when dry, about 2cm. high. Lower leaves smaller, lax. Upper leaves dense, in 5 rows, erectopatent to erect-

spreading (sometimes secund); conduplicate, hook-like curved and somewhat imbricate when dry; ovate-lanceolate, carinate-concave and often plicate at base, up to 2.25mm. long and 0.7mm wide at base; apex acute; margin flat, smooth below and serrulate above. Costa strong, characteristically flexuose at top, ending at apex almost reaching tip. Leaf cells small, thick-walled, smooth, rounded-quadrangle-rhomboid, $\pm 9 \times 5 \mu$, arranged ray-like in lamina, flattened at base; at extreme base there are some large, hyaline cells becoming up to $23 \times 11 \mu$ at leaf attachment. Sporophytes in small perichaetial buds lateral near the top of the branches. Perichaetial leaves few, upper ones narrower lanceolate with a very narrowed tip. Seta almost erect, ± 1.2 cm. long (may be up to 2cm.). Capsule erect, cylindrical to oblong-elliptic, ± 2.4 mm. long and 0.45mm. in diameter. Operculum conic, acute. Calyptra cucullate. Peristome double; endostome teeth narrow-lanceolate, papillose; endostome with a low (about $\frac{1}{4}$) basal membrane, segments yellowish, filamentous, reaching only half the exostome height, papillose; cilia absent. Spores small.

DISTRIBUTION of *Herpetineuron toccocae*: East Nepal (1220-1720m.), Sikkim, Darjeeling, Assam, Manipur, Khasia Hills, Bihar, Orissa, Mussoorie, Kasauli, Jaunsar, Almora, Garhwal, W. Ghats, Central India, Palni, Ceylon, Tonkin, Sumatra, Java, Celebes, Philippines, Hong Kong, Taiwan, East China, Manchuria, Ussuri, Korea, Japan, Riukiu Is., Australia, New Zealand, New Caledonia, North Carolina, Georgia (Type locality: Toccoa Falls), Florida, Louisiana, Arizona, S. California, Mexico, Guatemala, Fr. Guinea, Central & South Africa.

A widely distributed species.

Collection Site: Attukadu (1500m.)

Herbarium No. 13384

Figure: **Plate 57[A]**

Claopodium pellucinerve (Mitt.) Best in Bryologist, 3: 19 (1900)

Leskea pellucinervis Mitt, in Musci Ind. Or.: 130 (1859)

Anomodon subpilifer Lindb. & Arn. in K. Svensk. Vet. Ak. Handl., 23 (10): 111 (1890)

Thuidium papillicaule Broth. in Hedwigia, 38: 245 (1899)

Th. pugionifolium Broth. & Par. in Rev. Bryol., 31: 59 (1904)

- Claopodium papillicaule* (Broth.) Broth. in Nat. Pfl., 1: 1009 (1908)
C. pugionifolium (Broth. & Par.) Broth. in *ibid.*: 1009 (1908)
C. subpiliferum (Lindb. & Arn.) Broth. in *ibid.*: 1009 (1908)
C. piliferum Broth, in Sitz. Ak. Wiss. Wien. Math. Nat. Kl. Abt. 1, 133: 578 (1924)
fid. Nog.
C. tenuissimum Dix. in Rev. Bryol. n.ser. 1: 187 (1928) *fid.* Nog.
C. longipilum Dix. in Ann. Bryol., 3: 65 (1930) *fid.* Nog.
Thuidium integrifolium Broth. in Herb. CAL *ined.*

Moderate sized, yellow-green plants forming mats. Main stem creeping. Secondary shoots pinnately branched. Stems and branches densely papillose with minute papillae. Leaves dense on all sides, erectopatent, often falcate, erect and contorted when dry, ovate-lanceolate narrowed into a long, narrow tip, larger on stem, up to 1mm. long and 0.5mm. wide on branches; margin flat, finely dentate at extreme apex, smooth below. Costa strong, ending below acumen covering at least 2/3 of leaf length. Extreme tip cells linear, elongated, $\pm 40\mu$ long; apical cells rhomboid, $\pm 12 \times 6\mu$; lower leaf cells irregularly ovate-rectangular, $\pm 12 \times 9\mu$, with many minute papillae on both sides; at extreme base cells are pellucid (still with a few papillae), $\pm 11.5\mu$ wide, up to 30μ long near costa, gradually shorter and almost quadrate at margin. Sporophytes on short, lateral shoots. Perichaetial leaves, erect, smaller than branch leaves. Seta erect (may be flexuose), up to 2.3cm. long. Capsule nodding, oblong-cylindric, $\pm 2.56\text{mm.}$ long and 0.9mm. in diameter. Peristome $\pm 300\mu$ high; exostome teeth lanceolate, bordered below, united at extreme base; endostome segments pale, keeled, basal membrane high, cilia 2 to 3, nodose. Spores small, fine papillose.

DISTRIBUTION of *Claopodium pellucinerve*: Bhutan, Upper Assam, Kashmir, Jammu, Himachal, Simla, Mussoorie, Garhwal, N.W.F.P., Palni, Sumatra, Siberia, China (Setschwan, Shenshi, Manchuria), Korea, Japan, Alaska (Yukon), New Mexico, Tennessee, Mexico.

A widespread species.

Collection Site: Munnar (1600m.)

Herbarium No. 13385

Figure: **Plate 57[B]**

Haplocladium schimperi Ther. in Ann. Crypt. Exot., 3: 75 (1930)

Hypnum jacquemontii Cambess. in Jacquemont: Voyage Ind. Bot. 1828-32, 4: 51 (1844) *nom.nud.* (the name has been later validly applied to an Abyssinian species)

Haplocladium himalayanum Bartr. in Bull. Torr. Bot. C., 82: 27 (1955) *fid.* Vohra

Yellow-green to brownish, slender plants in tufts. Main stem creeping, branching more or less pinnately. Paraphyllia on main stems numerous, lanceolate. Leaves cordate-lanceolate, larger (± 1 mm. long and 0.5mm. broad) on main stem, smaller (± 0.65 mm. long and 0.32mm. wide) and more crowded on branches, erectopate (appressed to stem when dry) and spreading on all sides; apex acute pointed; margin flat, very faintly denticulate. Costa strong, ending a few cells below tip. Leaf cells incrassate, irregularly rounded to hexagonal, $\pm 8\mu$ long and 6μ wide, each with one (Sometimes 2) small papilla; there is a row of pellucid, rhomboidal ($\pm 15 \times 6\mu$), faintly dentate cells forming a border; at extreme base also there are some rectangular ($\pm 15 \times 7\mu$), pellucid cells on both sides of costa. Perichaetial buds mostly on main stem. Perichaetial leaves longer, narrower and erect. Seta erect, ± 1.5 cm. high, often arcuate at tip. Capsule oblong-ovate, nodding to horizontal, ± 1.28 mm. long and 0.64mm. in diameter. Peristome normal, hypnoid.

DISTRIBUTION of *Haplocladium schimperi*: Darjeeling, Mussoorie, Dharamsala

A Himalayan species.

Collection Site: Matupatti (1700m.)

Herbarium No. 13386

Figure: **Plate 58[A]**

Pelekium investe (Mitt.) Touw. in J. Hattori Bot. Lab., 90: 167-209 (2001b)

Thuidium tamariscellum (C. Muell.) Bosch & Lac. in Bryol. Jav., 2:20 (1865)

Hypnum tamariscellum C. Muell. in Bot. Zeit., 12: 573 (1854)

Leskea tamariscella Mitt. in Musci Ind. Or.; 134 (1859)

Autoicous. Slender to more robust, filmy, yellow-green plants forming mats. Main stem without central strand, creeping, may be ascending, giving rise to irregular or very regular, bipinnate branches. Paraphyllia numerous, simple filamentous, truncate

pluripapillate at tip. Stem leaves distant, larger, cordate base, suddenly narrowing acumen, up to 0.5mm. long. Branch leaves dense, erectopate (tips more spread out when dry), ovate-lanceolate, ± 0.25 mm. long and 0.12mm. wide, apex acute, margin crenulate. Costa single, ending just below tip. Leaf cells, rounded rhomboid, $\pm 7\mu$ wide, with a single large papilla on both sides of lumen (more papillae also reported). Sporophyte on main shoot. Perichaetial leaves long (± 1.25 mm.), oblong-lanceolate with excurrent costa forming an arista. Seta erect, ± 1.5 cm. long, smooth, arcuate at apex. Capsule inclined to horizontal, ovate-cylindrical, ± 1.2 mm. long. Operculum conic-rostrate. Peristome as in other species, ± 0.35 mm. high, exostome and endostome of same height, basal membrane high, cilia in pairs. Spores small, fine papillose.

DISTRIBUTION of *Pelekium investe*: East Nepal (350-2000m.), Sikkim (1500-2000m. including Gangtok), Bhutan (1500-1600m.), Tehri-Garhwal (Gamble), Nilgiri, Coorg, Palni, Burma, Thailand, Tonkin, Yunnan, Hunan, Taiwan, Riukiu, Sumatra, Java, Philippines

A South & East Asiatic species.

Collection Site: Matupatti (1700m.)

Herbarium No. 13387

Figure: **Plate 58[B]**

20. AMBLYSTEGIACEAE

Calliergon cordifolium (Hedw.) Kindb. in Canad. Rec. Sc., 6 (2) : 72 (1894)

Hypnum cordifolium Hedw. in Sp. Musc.: 254 (1801)

Hypnum cuspidatum Hedw. var. *β bicolor* Turn. in Musc. Hib.: 177 (1804)

H. phyllorhizans P. Beauv. in Prodr.: 67 (1805)

H. fontanum Schleich. in Brid.: Bryol. Univ., 2 : 566 (1827) *nom. nud. in synon.*

Stereodon cordifolius (Hedw.) Brid. in Bryol. Univ., 2: 824 (1827)

Amblystegium cordifolium (Hedw.) De Not. in Cronac. Briol. Ital., 2 : 23 (1867)

Acrocladium cordifolium (Hedw.) Richs. & Wall. in Trans. Brit. Bryol. Soc., 1 (4): xxv (1950)

Autoicous. Slender to robust, shiny yellow-green (brown below) plants in dense tufts. Main stem long (known to be up to 20cm.), procumbent (may be erect) with stiff irregularly pinnate, erect branches which are not usually further branched. Leaves soft, erectopatent, dense imbricate or somewhat loose, soft (erect and shrunk when dry), ovate-cordate with obtuse but ultimately pointed apex and decurrent base, ± 2 mm. long and 1mm. wide, sometimes apex may be cucullate, margin smooth, not plicate, concave. Costa strong, covering more than $2/3$ of leaf length (may almost reach apex). Leaf cells pellucid, $\pm 50 \times 8 \mu$, at extreme base wider and shorter, in the alar region $\pm 46 \times 23 \mu$, more or less inflated, still pellucid. Seta long (5 to 8cm.), smooth. Capsule horizontal, often arcuate, oblong cylindrical. Peristome normal hypnoid, cilia usually 3, shorter.

DISTRIBUTION of *Calliergon cordifolium*: East Nepal (4470m.), Europe (incl. G.B.), Siberia, Amur, Kamchatka, Sakhalin, Japan, Greenland, Labrador, Alaska, Canada, N.E. U.S.A., New Zealand.

A widely distributed species.

Collection Site: Munnar (1600m.)

Herbarium No. 13388

Figure: **Plate 59[A]**

21. BRACHYTHECIACEAE

Key to the species of *Brachythecium*:

- | | | |
|----|--|----------------------|
| 1a | Seta smooth, capsule inclined, leaf margin dentate | <i>B. kamounense</i> |
| 1b | Seta rough, costa of branch leaves almost reaching tip or percurrent | <i>B. populeum</i> |

Brachythecium kamounense (Harv.) Jaeg. in Ber. S. Gall. Naturw. Ges., 1876-77: 342 (1878)

Hypnum kamounense Harv. in Hook. in Ic. Pl. Rar., 1: 24-10 (1836)

Dioicous. Robust, yellow-green (golden brown below), somewhat glossy plants in dense mats. Main stem creeping. Secondary branches pinnate, erect to ascending. Leaves terete, dense, imbricate, erectopatent (appressed when dry), concave, plicate, ovate-lanceolate, up to 2.88mm. long and 1.15mm. wide, base shortly decurrent, apex

acuminate (sometimes twisted), margin denticulate on top to almost halfway down. Costa single, covering at least half of leaf length. Leaf cells elongate linear-rhomboid, $\pm 69 \times 8 \mu$ at top, near base gradually shorter and wider; the extreme base is formed of lax rectangular cells which are more conspicuous at alar ($\pm 20 \mu$ wide and 46μ long to quadrate). Sporophytes on main stem. Perichaetial leaves erect with narrow, long and reflexed acumen. Seta erect, ± 1 cm. long, smooth. Capsule inclined to horizontal, arcuate, ovate-oblong, $\pm 2 \times 1$ mm. Operculum conical, short. Peristome normal hypnoid. Cilia 2. Spores 14 to 16μ in diameter, fine papillose.

DISTRIBUTION of *Brachythecium kamounense*: East Nepal, Kashmir, Lahul, Chamba, Garhwal, Kumaon

A Himalayan species.

Collection Site: Devikulam (1700m.)

Herbarium No. 13389

Figure: **Plate-59[B]**

Brachythecium populeum (Hedw.) B.S.G. in Bryol. Eur., 6 : 7 (1853)

Hypnum populeum Hedw. in Sp. Musc.: 270 (1801)

Hypnum viride Lam. ex Boucher in Extr. Fl. Abbeville: 85 (1803)

H. implexum Sw. ex Turn. in Musc. Hib.: 173 (1804)

H. erythropodium Brid. in Sp. Musc., 2: 181 (1812) *nom. nud. in synonym.*

H. polysetum Bland. in Brid. in *ibid.* *nom. nud. in synonym.*

H. saxicola Voit in Sturm.: Deutschl. Fl., 2 : 12 (1812)

H. laurai Funck in Brid. in Bryol. Univ., 2 : 595 (1827)

H. concinnum Hartm. in Handb. Skand. Fl. ed. 5 : 328 (1849) *hom. illeg.*

H. glabratum Broth. in Act. Bot. Sc. Fenn., 24 : 36 (1899)

Brachythecium glabratum (Broth.) Par, in Index Bryol. Suppl. 44 (1900) *fid.* Vohra

Cirriphyllum populeum (Hedw.) Loesk & Fleisch. in Allg. Bot. Zeitschr., 13 : 22 (1907)

Bright pale to yellowish green, slender to somewhat stouter plants in dense tufts. Main stem creeping, giving rise pinnately to numerous short as well as long (again branching pinnately), erect branches, brown below. Leaves terete, dense, erectopate (appressed to stem when dry), ovate-lanceolate, concave, often plicate (not in stem

leaves), ± 1.47 mm. long and 0.58mm. wide, apex acute acuminate; margin denticulate at apex, irregularly recurved in stem leaf otherwise flat. Costa strong, almost reaching apex in branch leaves but short in stem leaves. Leaf cells elongate linear ($\pm 77 \times 8 \mu$) at apex, shorter ($\pm 70 \times 8 \mu$) narrow rhomboid in mid-lamina, basal cells lax, wide ($\pm 38.5 \times 19 \mu$) in base, somewhat inflated in alar. Sporophytes on main or principal stems Perichaetial bracts erectopate to squarrose. Seta erect flexuose, 1.2cm. or more long, rough above, smooth below. Capsule inclined to horizontal, stout ovate ($\pm 1.28 \times 0.9$ mm. to a little longer), arcuate (more apparent when longer). Operculum conical, short beaked. Peristome perfect hypnoid, cilia nodose, in groups of two; exostome, endostome and cilia of same height (± 0.47 mm. high).

DISTRIBUTION of *Brachythecium populeum*: East Nepal (2600-3200 m.), Bhutan (2300m.), Kashmir, Mussoorie, Caucasus, Europe (incl. G.B.), Siberia, Korea, Japan, North & Central Africa, Canada, Miquelon, New Brunswick, Nova Scotia, North Carolina, Minnesota.

A widespread North Hemisphere species.

Collection Site: Attukadu (1500m.)

Herbarium No. 13390

Figure: **Plate 60[A]**

22. ENTODONTACEAE

Key to the genera of Entodontaceae:

- | | | |
|----|--|-----------------------|
| 1a | Leaves not cochleariform, if so upper margin flat; leaf base not auriculate, nerve very short and double or absent; alar cells present, ascending along the margin, branches neither julaceous nor catenulate or filliform | <i>Entodon</i> |
| 1b | Leaves not cochleariform, if so upper margin flat; leaf base not auriculate, nerve very short and double or absent; alar cells present, branches either julaceous, catenulate or filliform | 2 |
| 2a | Leaf cells smooth; alar cells forming a large, conspicuous group extending obliquely about half way up the margins | <i>Erythrodonium</i> |
| 2b | Leaf cells usually papillose, cells rhombic; when papillose, papillae on the lumina | <i>Pterigynandrum</i> |

Pterigynandrum decolor (Mitt.) Broth. in Nat. Pfl., 1 (3): 892 (1907)

Stereodon deco/or Mitt. in Musci Ind. Or.: 92 (1859)

Pylaisia brevifolia Wils, in Mitt.: *id. nom. nud. in synon.*

Pterigynandrum brandisii C. Muell. in Fleisch.: Hedwigia. 59: 218 (1917) *nom. nud.*

Leptopterygynandrum decolor (Mitt.) Fleisch. in Musci Fl. Buitenz., 4: 1496 (1923)

Branches long, filamentous, forming caespitose bundles. Leaves dense, erectopate (appressed to stem when dry), concave, rounded ovate with a narrow extended apiculus, $\pm 0.83 \times 0.5$ mm., margin smooth. Costa double, faint, short (about $\frac{1}{3}$ leaf length). Leaf cells smooth, rhomboid ($\pm 27 \times 8 \mu$) above, irregularly elongate rectangular at midbase, a few rows at base angle are short, transversely elongated. Specimen sterile but Mitten has described a normal peristome in which low basal membrane is noted. Differs from *filiforme* in the leaf tip, absence of papillae in the leaf cells and in the presence of a low basal membrane.

DISTRIBUTION of *Pterigynandrum decolor*: Sikkim (3000 to 3600m.).

Endemic in the Eastern Himalaya. But present report from Idukki extends its distribution to south India.

Collection Site: Attukadu (1500m.)

Herbarium No. 13391

Figure: **Plate 60[B]**

Entodon laetus (Griff.) Jaeg. in Ber. S. Gall. Naturw. Ges. 1876-77: 295 (1878)

Neckera laeta Griff, in Cal. J.Nat. Hist., 3: 67 (1843)

Stereodon laetus (Griff.) Mitt. in Musci Ind. Or.: 107 (1859)

Neckera nitida Wils. in Mitt, *in ibid.* (1859) *nom. nud. in synon.*

Monoicous. Medium sized glossy, yellow-green plants forming tufts. Main stem creeping, giving rise to erect, somewhat dendroid, pinnately branched shoots. Leaves complanate (though in several rows), laxly imbricate, erectopate (appressed to stem when dry), concave, ovate-elliptical, tip acute, base narrow, ± 1.6 mm. long and 0.5 to 0.65 mm. broad, margin finely crenulate at top and incurved at places (because of concavity). Costa two, double, short. Leaf cells elongate-elliptical, $\pm 57 \times 6 \mu$ at top (slightly

wider at margin and a few short cells at extreme tip), $\pm 8\mu$ lower down; base angle cells lax, rectangular ($\pm 34 \times 19\mu$) to quadrate. Sporophytes on main branches. Perichaetial leaves erect, narrow. Seta erect (or a little flexuose), reddish, smooth, ± 1.4 cm. long. Capsule erect, ovate-cylindrical, $\pm 2.8 \times 0.7$ mm. Operculum conic-rostrate, ± 0.77 mm. long. Peristome normal, double; exostome teeth reddish, lanceolate, smooth at tip; endostome segments pale, shorter, irregularly split along median line.

DISTRIBUTION of *Entodon laetus*: East Nepal (1900 to 2800m.), Darjeeling (2150 to 2300m.), Bhutan (2300-2400 m.), Upper Assam, Khasia Hills.

Endemic in this region. But present report from Idukki extends its distribution to south India.

Collection Site: Athirapalli (1200m)

Herbarium No. 13392

Figure: **Plate 61[A]**

Erythrodonium julaceum (Schwaegr.) Par. in Index. Bryol.: 436 (1896)

Nckera julacea Hook. ex Schwaegr. in Sp. Musc. Suppl. 3 (1): 245 (1828)

Leptohymenium julaceum (Schwaegr.) Hamp. in Linnaea, 20: 83 (1847)

Pterogonium squarrosulum Griff. in Cal. J. Nat. Hist., 3: 63 (1843)

P. squarrosulum Mont. in Lond. J. Bot., 4: 9 (1845)

P. julaceum (Schwaegr.) Hook. in C. Muell., Syn., 2: 101 (1850)

Neckera squarrolosa C. Muell. in Syn., 2: 101 (1850)

Pterogonium squarrolosum Mont. in Syll.: 21(1856) *ortho. err.*

Stereodon juliformis Mitt. in Musci Ind. Or.: 92 (1859)

Platygyrium julaceum (Schwaegr.) Bosch & Lac. in Bryol. Jay., 2: 107, 217 (1864)

P. squarrosulum (Mont.) Jaeg. in Ber. S. Gall. Naturw. Ges. 1876-77: 277 (1878)

Entodon julaceus (Schwaegr.) C. Muell. in Linnaea, 42: 435 (1879)

Erythrodonium juliforme (Mitt.) Par. in Index Bryol.: 436 (1896)

E. squarrolosum (Mont.) Par. in Index Bryol.: 437 (1896)

Robust, rigid, glossy, golden green to brown plants in dense tufts. Mostly epiphytic. Main stem creeping, 8cm. or more long, with narrow central strand. Branches numerous, short, julaceous, erect. Leaves dense, terete, imbricate, erectopatent

(appressed to stem with outspread tips when dry), concave, ovate, ± 1.6 mm. long and 0.8mm. wide, with suddenly narrowed, short tips; margin smooth (there may be faint denticulation at tip), flat. Ecostate. Leaf cells smooth, narrow elliptical to linear, $\pm 57 \times 7 \mu$ at tip and $\pm 70 \times 9 \mu$ at base; at basal angle on both sides there are large triangular patches of transverse ovate-rectangular cells reaching to considerable height on two margins, $\pm 23 \times 15 \mu$, somewhat larger near centre at base and smaller, almost elliptical ($\pm 19 \times 8 \mu$) at tip. Sporophytes on main stem or principal branches. Perichaetium small, of erect, narrower leaves. Seta erect (may be a little sinuose), spirally twisted when dry, ± 1.7 cm. high. Capsule erect, ovate-cylindrical, $\pm 2.75 \times 1$ mm. operculum conical, short rostrate. Calyptra cucullate, covering less than half the capsule. Peristome double, inserted deep below rim; exostome teeth red, 16, broadly lanceolate with horizontal stripes below and vertical stripes above; endostome ill developed, formed of 16 short, very fragile segments which are almost adhering to the inner side of the exostome teeth. Spores coarse papillose, large (20 to 30μ in diameter).

DISTRIBUTION of *Erythrodonium julaceum*: East Nepal (980 to 3000 m.), Sikkim (1700 to 2000 m.), Darjeeling, Bhutan (2300 to 2450 m.), Assam, Khasia Hills, Orissa, Mussoorie, Kumaon, Nilgiri, Coorg, Palni, Ceylon, Burma (Moulmein), Thailand, Laos, Tonkin, Sumatra, Java, Celebes, Philippines, Yunnan, Central & South Africa, Solomon Islands.

A widespread tropical-subtropical Old World species.

Collection Site: Attukadu (1500m.)

Herbarium No. 13393

Figure: **Plate 61[B]**

23. PLAGIOTHECIACEAE

Plagiothecium cavifolium (Brid.) Iwats. in J. Hattori Bot. Lab., 33: 360 (1970)

Hypnum cavifolium Brid. in Bryol. Univ., 2: 556 (1827)

Leskea flaccida Brid. in Bryol. Univ., 2: 302 (1827) *fid.* Iwats.

Plagiothecium roeseanum B.S.G. in Bryol. Eur., 5: 193, 504 (1851) *fid.* Iwats.

P. denticulatum var. *myurum* B.S.G. in Bryol. Eur. 5: 191 (1851)

Hypnum sullivantiae Sull. & Lesq. in Musci Bor. Am.: 78 (1856)

Plagiothecium sylvaticum var. *roesei* Lindb. in Bot. Not. 1865: 143 (1865)

P. sullivantiae (Sull. & Lesq.) B.S.G. ex. Jaeg. in Ber. S. Gall. Naturw. Ges. 1876-77: 450 (1878)

P. sylvaticum var. *pseudo-roeseanum* Card. in Bull. Soc. Bot. Geneve, 4: 385 (1912) *fid.* Iwats.

P. sakurarii Reim. in Bot. Jahrb., 64: 554 (1931) *fid.* Iwats.

P. takahashii Sak. in Bot. Mag. Tok., 1: 795 (1937) *fid.* Iwats.

Small to medium-sized, yellow-green, glossy plants in dense tufts. Main stem spreading, irregularly branching. Branches ascending, crowded, somewhat julaceous, terete (may be complanate at the tips of branches), central strand present. Leaves imbricate or somewhat lax, erectopate (appressed to stem when dry), mostly symmetrical, concave, ovate-lanceolate, $\pm 1.4 \times 0.58$ mm., apex acute acuminate, base decurrent, margin almost entire. Costa two, short. Leaf cells narrow, linear, $\pm 77 \times 8 \mu$ at tip, $90 \times 8 \mu$ (with irregular wall thickenings) lower down; alar region differentiated by rectangular and irregularly quadrate ($\pm 28 \times 19 \mu$) cells. Dioicous. Sporophytes on main branches. Perichaetial leaves erect with narrow tops. Seta erect, ± 1.5 cm. long, reddish to yellowish. Capsule erect or inclined (arcuate if inclined), ovate-cylindrical, ± 2.5 mm. long. Operculum conical. Peristome normal with 1 to 3 cilia.

DISTRIBUTION of *Plagiothecium cavifolium*: East Nepal (3400- 3530 m.), Bhutan (3200-3450 m.), Korea, Japan, Eastern Siberia, Caucasus, Europe (including Sardinia and G.B.), North America

A North Hemisphere species.

Collection Site: Matupatti (1700m.)

Herbarium No. 13394

Figure: **Plate 62[A]**

24. SEMATOPHYLLACEAE

Key to the genera of Sematophyllaceae:

- 1a Alar cells oval, reddish; operculum; filliform, gemmae often present 2
- 1b Alar cells large, inflated, oval to oblong, yellow; operculum long beaked; gemmae usually absent 3
- 2a Gemmae present, foliar and gemmiparous branches separate; *Clastrobryopsis* gemmae smooth

2b	Gemmae absent; more or less rigid plants; branches not attenuated; alar cells inflated, mostly coloured	<i>Hageniella</i>
3a	Leaves usually cochleariform; leaf cells at least in upper part rhombic; seta smooth	4
3b	Leaves not cochleariform	5
4a	Cells above the insertion line short, golden yellow, pitted; alar cells about five	<i>Chionostomum</i>
4b	Cells above the insertion line elongated, yellow, not pitted; alar cells several	<i>Meiothecium</i>
5a	Leaf cells papillose; leaf apex always acute, nerve never present, leaf cells usually unipapillose; seta rough in the upper part	<i>Trichosteleum</i>
5b	Leaf cells smooth, nerve absent	6
6a	Leaves not homomallous fulcate	<i>Sematophyllum</i>
6b	Leaves homomallous fulcate	7
7a	Cells rhombic to linear; operculum shortly or moderately long rostrate; alar cells of two types, lower large and inflated; upper smaller, parenchymatous	<i>Brotherella</i>
7b	Cells narrowly linear; operculum long and oblique; alar cells of two types, lower large and inflated; upper smaller, parenchymatous	<i>Pylaisiadelpha</i>

Hageniella assamica Dix. in J. Bomb. Nat. Hist. Soc., 39: 790 (1937)

Plants yellow-green, slightly glossy, densely caespitose. Main stem creeping, branches short, erect but curved. Leaves dense, erectopate (appressed, more cuspidate and imbricate when dry), concave, ovate with a narrow, acuminate, subpilose tip, narrowed at base, $\pm 0.62 \times 0.23$ mm., margin faintly denticulate at tip. Ecostate. Leaf cells linear, $\pm 40 \times 5 \mu$ with cell tip forming a prominent papilla in the upper half of leaf; at base middle such cells are smooth and seem to radiate towards margins; alar cells differentiated, hyaline, incrassate, lowest row large, rectangular ($\pm 35 \times 17.5 \mu$), smaller and irregularly shaped above. Sporophytes on main stem. Perichaetial leaves erect but with spreading tips. Seta long, thin, smooth, sinuose erect, ± 1.6 cm. long. Capsule inclined to horizontal, ovate, $\pm 1.4 \times 0.6$ mm. Operculum short-rostrate. Peristome normal, double; exostome teeth $\pm 270 \times 75 \mu$ at base, bordered, horizontally striped below; endostome basal membrane high, segments hyaline, as long as exostome, not split. Spores $\pm 22 \mu$ in diameter.

DISTRIBUTION of *Hageniella assamica*: Naga Hills.

Endemic in this locality. But present report from Idukki extends its distribution to south India.

Collection Site: Eravikulam (1800m.)

Herbarium No. 13395

Figure: **Plate 62[B]**

Clastobryopsis planula (Mitt.) Fleisch. in Musci Fl. Buitenz., 4: 1180 (1923)

Stereodon planulus Mitt. in Musci md. Or.: 111(1859)

Symphyodon planulus (Mitt.) Jaeg. in Ber. S. Gall. Naturw. Ges. 1876—77: 296 (1878)

Clastobryum planulum (Mitt.) Broth. in Nat. Pfl., 1 (3): 874 (1907)

C. robustum Broth. in Philipp. J. Sci., 5: 1955 (1910) *fid.* Tixier

Aptychella planula (Mitt.) Fleisch. in Musci Fl. Buitenz., 4: 1671 (1923)

A. robusta (Broth.) Fleisch. in *id.*, 4: 1671 (1923)

Clastobryopsis robusta (Broth.) Fleisch. in *id.*, 4: 1181 (1923)

C. heteroclada Fleisch. in *id.*, 4: 1181 (1923)

Aptychella heteroclada (Fleisch.) Fleisch. in *id.*, 4: 1671 (1923)

Clustobryum glomerato-propaguliferum Toyama in Act. Phytotax. Geob., 4: 214 (1935)

C. heterocladum (Fleisch.) Dix. in J. Bot., 79: 74 (1941)

Yellow-green, glossy, moderate-sized, creeping plants forming light tufts. Branches erect, pinnately branched, narrowing at the tops, sometimes with bundles of filamentous gem.mae at the axils of upper leaves. Leaves lax, erectopatient (shrunk and curled when dry), ovate-lanceolate, ± 1.47 mm. long and 0.42mm. wide, narrowing and decurrent at base, acute at tip, margin faintly crenulate at tip. Ecostate (two very short veins sometimes reported). Leaf cells narrow, rhomboid, $\pm 35 \times 5 \mu$ at top, longer ($\pm 45 \times 5 \mu$) lower down; alar cells inflated rectangular (up to $35 \times 18 \mu$) and slightly tinted, gradually becoming narrower upwards. Sporophytes on principal stems. Perichaetial leaves erect, narrower. Seta slender, erect to sinuose, ± 2 cm. long. Capsule inclined to horizontal, subspherical (Tixier reports cylindrical for *robusta* which is quite different from *planula* and renders the synonymy subject to doubt), $\pm 1 \times 0.77$ mm. Operculum conic, short rostrate, ± 0.38 mm. high. Peristome double; exostome teeth lanceolate, papillose, with a median row of perforations; endostome segments filamentous, papillose, without any median line.

DISTRIBUTION of *Clastobryopsis planula*: East Nepal (2000 to 3300 m.), Sikkim (2200 m.), Darjeeling, Bhutan (2600 to 3400 m.), Khasia Hills, Naga Hills, Java, Philippines (*robusta*), Japan, Hawaii

An east Asiatic-Oceanic species.

Collection Site: Athirapalli (1200m.)

Herbarium No. 13396

Figure: **Plate 63[A]**

Chionostomum rostratum (Griff.) C. Muell. in *Linnaea*, 36: 21(1869)

Neckera rostrata Griff, in *Cal. J. Nat. Hist.*, 3: 70 (1843)

Stereodon rostratus (Griff) Mitt, in *Musci Ind. Or.*: 102 (1859)

Chionostomum latifolium Thér. & Henry in *Dix.: J. Siam Nat. Hist. Suppl.* 10 (1): 20 (1935) *fid.* Tix.

Autoicous. Robust, yellow-green to golden (brown below), glossy plants forming dense tufts. Main stem creeping with irregularly pinnate branches which are tumid and blunt. Leaves erectopate (appressed when dry), concave, oblong-lanceolate, acuminate, $\pm 2 \times 0.5$ mm., margin reflexed at middle, smooth. Ecostate. Leaf cells elongate, $\pm 50 \times 6 \mu$ at top (shorter in extreme apex), $\pm 62 \times 5 \mu$ below. Alar differentiated, rectangular, largest $\pm 57 \times 34 \mu$, tinted. Sporophyte on main stem. Perichaetial leaves narrow, erect. Seta erect, slender, reddish, smooth, ± 1.2 cm. in this specimen. Capsule inclined, cylindrical, $\pm 2.2 \times 0.7$ mm. Operculum conical, long rostrate, ± 1.4 mm. Peristome normal, double; exostome teeth up to 400μ high; endostome with high basal membrane, segments filamentous, shorter. Calyptra cucullate. Corticolous.

DISTRIBUTION of *Chionostomum rostratum*: Darjeeling, Khasia Hills, Coorg, Ceylon, Thailand, N. & S. Vietnam, Philippines, Taiwan

A southeast Asiatic species.

Collection Site: Athirapalli (1200m.)

Herbarium No. 13397

Figure: **Plate 63[B]**

Meiothecium jagorii (C. Muell.) Broth. in Nat. Pfl., 1(3): 1103 (1908)

Neckera jagorii C. Muell. in Bot. Zeit., 22: 373 (1864)

Sauloma jagorii (C. Muell.) Lac. in Bryol. Jav., 2: 209 (1864)

Pterogonium jagorii (C. Muell.) C. Muell. in Linnaea, 36: 8 (1869)

Pterogoniella jagorii (C. Muell.) Jaeg. in Ber. S. Gall. Naturw. Ges., 1875—76: 207 (1877)

Monoicous. Robust, glossy, yeollow-green to brownish green plants forming low (usually corticolous) mats. Main stem creeping, branching in an irregular pinnate manner. Leaves dense, all bent to on side (erect on the flat stem), somewhat appressed to stem when dry, ovate acute, plicate, $\pm 2.4 \times 0.62$ mm., margin faintly dentate in the acute tip, involute on two sides of the leaf. Ecostate (Fleischer states that faint, short double costa is sometimes apparent). Leaf cells irregularly rhomboid ($\pm 23 \times 8 \mu$) at tip, on leaf margin the cell tips extend as papillae giving a dentate appearance; more elongated and narrow ($\pm 50 \times 6 \mu$) at midleaf. A row of large, inflated and tinted cells ($\pm 50 \times 19 \mu$ and largest in the alars) forming a row across the leaf attachment region; on top of this the cells are smaller and irregularly rhomboid ($\pm 35 \times 9 \mu$) arranged in diagonal rows to the leaf margin; the axial row cells are a little narrower with highly porose walls. Perichaetial leaves narrow, erect. Seta (bent at top), ± 7 mm. long. Capsule inclined to horizontal, ovate-cylindrical, $\pm 1.2 \times 0.6$ mm. Peristome of exostome teeth only, $\pm 200 \mu$ high $\times 58 \mu$ wide at base, distantly placed.

DISTRIBUTION of *Meiothecium jagorii*: Andaman Is., South India, Ceylon, Burma, Singapore, Java, Moluccas, Borneo, Celebes, Philippines, Oceania

An Indomallesian species.

Collection Site: Athirapalli (1200m.)

Herbarium No. 13398

Figure: **Plate 64[A]**

Key to the species of *Sematophyllum*:

- | | | |
|----|--------------------------|-----------------------|
| 1a | Leaves larger, broader | <i>S. caespitosum</i> |
| 1b | Leaves smaller, narrower | <i>S. humile</i> |

Sematophyllum caespitosum (Hedw.) Mitt. In J. Linn. Soc. Bot., 12: 479 (1869)

Leskea caespitosa Hedw. in Sp. Musc.: 233, 49 (1801)

Leskea subpinnata Brid. in Sp. Musc., 2: 54 (1812)

Hypnum loxense Hook, in Kunth: Syn. Pl. Aequin., 1: 62 (1822)

H. subsecundum Arnott in Mem. Soc. Linn. Paris, 1: 350 (1823)

H. densifolium Spreng. in Brid.: Bryol. Univ., 2: 591 (1827) *nom. mid. in synonym.*

H. pallidisetum Brid. in *ibid.*: 591 (1827)

H. inconspicuum Hornsch. in Fl. Bras., 1 (2): 86 (1840)

H. lithophilum Hornsch. in *ibid.*: 84 (1840)

Hookeria leduceana Mont. in Ann. Sc. Nat. Bot., ser. 2, 16: 275 (1841)

Hypnum obliquifolium C. Muell. in Bot. Zeit., 2: 741 (1844)

Leskea circinalis Hamp. in Icon. Musc.: 5 (1844)

L. kegeliana C. Much. in Linnaea. 21: 19 (1848)

Hypnum galipense C. Much, in Bot. Zeit., 6: 780 (1848)

H. tovariense C. Muell. in *ibid.*: 780 (1848)

Leskea duisaboana Mont. in Ann. Sc. Nat. Bot. ser. 3, 4: 97 (1845)

Hypnum hampeanum C. Much, in Syn., 2: 326 (1851)

H. sphaerotheca C. Muell. in *ibid.*: 333 (1851)

Stereodon tristiculus Mitt, in Musci Ind. Or.: 102 (1859)

Hypnum admixtum Sull. in Proc. Ac. Arts. Sc., 5: 289 (1861)

H. dissolutum Sull. in *ibid.*: 289 (1861)

Sauloma baliensis Bosch & Lac. in Bryol. Jav., 2: 110, 220 (1864)

Hypnum cucullatifolium Hamp. in Ann. Sc. Nat. Bot. ser. 5, 5: 328 (1866)

H. agnatum Hamp. in *ibid.*: 327 (1866)

Sematophyllum galipense (C. Muell.) Mitt. in J. Linn. Soc. Bot., 12: 480 (1869)

S. lamprophyllum Mitt. in *ibid.*: 496 (1869)

S. leptothecium Mitt. in *ibid.*: 482 (1869)

S. subnervatum Mitt. in *ibid.*: 483 (1869)

Hypnum baliense (Bosch & Lac.) Lac. in Bryol. Jav., 2: 228 (1870)

Rhyncho-Hypnum substrumiferum Hamp. in Vid. Medd. Naturh. For. Kjobenh. ser. 3, 2: 294 (1870)
Rhynchostegium hampei Besch. in Mem. Soc. Bot. Cherbourg, 16: 249 (1872)
Hypnum contractum Lac. in Natuurk. Verh. K. Ak. Wet. Amsterd., 13: 12 (1872)
H. catillum C. Much, in Linnaea, 39: 467 (1875)
H. subsphaericarpum Hamp. in Vid. Medd. Naturh. For Kjobenh. ser. 3, 6: 173 (1875)
Rhaphidostegium caespitosum (Hedw.) Besch. in Ann. Sc. Nat. Bot. ser. 6, 3: 247 (1876)
Hypnum lecoultriae Dub. in Flora, 60: 91(1877)
H. robillardii Dub. in *ibid.*: 91(1877)
Rhaphidostegium fallax Besch. in Mem. Soc. Sc. Nat. Cherbourg, 21: 270 (1877)
R. tristiculum (Mitt.) Jaeg. in Ber. S. Gall. Naturw. Ges., 1876—77: 392 (1878)
Hypnum aureolum Hamp. in Vid. Medd. Naturh. For Kjobehn. ser. 3, 9—10: 272 (1878)
H. pulvinale Hamp. in *ibid.*: 271 (1878)
H. leucostomum Hamp. in *ibid.*, ser. 4, 1: 153 (1879)
H. mundemonense Hamp. in *ibid.*: 155 (1879)
Ectropothecium baliense (Bosch & Lac.) Jaeg. in Ber. S. Gall. Naturw. Ges., 1877—78: 268 (1880)
E. contractum (Lac.) Jaeg. in *ibid.*: 268 (1880)
Rhaphidostegium replicatum Besch. in Ann. Sc. Nat. Bot. ser. 6, 10: 299 (1880)
Leucomium robillardii (Dub.) Jaeg. in *ibid.*: 276 (1880)
Hypnum afro-demissum C. Muell. ex Geh. in Abh. Naturw. Ver. Bremen, 7: 212 (1881)
Rhaphidostegium barnesii Ren. & Card, in Bull. Soc. R. Bot. Belg. 29 (1): 182 (1890)
R. ovate Broth, in *Oefv. Finsk. Vet. Soc. Foerh.*, 33: 107 (1890)
R. fusco-viride Besch. in *J. de Bot.*, 5: 347 (1891)
R. globosum Besch, in *ibid.*: 347 (1891)
R. peralare Broth, in *Bot. Jahrb.*, 20: 206 (1894)
Aptychus concinnus C. Muehl. in *Malpighia*, 10: 516 (1896)
A. grammicarpus C. Much, in *ibid.*: 5: 7 (1896)
A. longicollis Hamp. ex C. Muell. in *Bull. Herb. Boiss.*, 5: 213 (1897)
A. semitorlulus C. Muell, in *ibid.*: 213 (1897)
Rhaphidostegium chrysotis Broth, in *Bot. Jahrb.*, 24: 274 (1897)
R. dicnemonella Broth, in *ibid.*: 273 (1897)

R. fluminale Broth, in *ibid.*: 274 (1897)
R. sauloma Broth, in *ibid.*: 273 (1897)
R. subcurvulum Broth, in *ibid.*: 273 (1897)
R. glutinosum Broth. in *ibid.*: 275 (1897)
R. concinnurn (C. Muell.) Par. in Index Bryol.: 1090 (1898)
R. grammicarpurn (C. Muell.) Par, in *ibid.*: 1095 (1898)
R. perlaxum Par. in *ibid.*: 1102 (1898) *nom. nud.*
Pterogoniella stuhlmanii Broth.in Par.: Index Bryol.: 1048 (1898)
Rhaphidostegium caespitans Schimp. ex Par, in *ibid.*, Suppl. 295 (1900)
R. stuhlmanii (Broth.) Broth, in Nat. Pfl., 1 (3): 1113 (1903)
Sematophyllum tristiculum (Mitt.) Fleisch. in Musci Fl. Buitenz., 4: 1262 (1923)

Monoicous. Medium to sturdy, bright to brownish green, glossy, tufted plants. Main stem creeping, fairly long, branching irregularly. Leaves on branches erectopate, sometimes homomalous, appressed to stem when dry, broad ovate-lanceolate, $\pm 1.7 \times 0.57$ mm. broad, apex usually narrow acute but leaf tip sometimes narrower with a narrower acumen, margin more or less dentate at apex, concave. Ecostate. Leaf cells narrow rhomboid, $\pm 50 \times 8 \mu$ at apex, narrower and longer ($\pm 85 \times 8 \mu$) below, cells (specially those on midleaf) show papillose development of tips. Alar differentiated at angle by a row of about 4 tinted, inflated, oblong ($\pm 65 \times 34 \mu$) cells at base and another row of shorter ($\pm 42 \times 34 \mu$) cells on top of them; cells at midbase are highly porose and tinted in the lowest row joining the alars. Sporophytes on main stem. Seta slender, erect flexuose, up to 2 cm. long. Capsule more or less inclined, ovate- cylindrical, ± 1.66 mm. long and 0.8 mm. in diameter. Operculum long rostrate, almost as long as capsule. Peristome normal, double.

DISTRIBUTION of *Sematophyllum caespitosum*: Darjeeling, Upper Assam, Khasia Hills, Palni, Ceylon, Annam, Malay, Sumatra, Java, Bali, Philippines, Japan, Oceania, Australia, Central & South Africa, Madagascar, all over America.

A cosmopolitan species.

Collection Site: Munnar (1600m.)

Herbarium No. 13399

Figure: **Plate 64[B]**

Sematophyllum humile (Mitt.) Broth. in Nat. Pfl. ed. 2, 11: 431 (1925)

Stereodon humilis Mitt, in Musci Ind. Or.: 102 (1859)

Hypnum humile Harv. in Hook.: Icon. Pl. Rar., 1: 23 (1836) *horn. illeg.*

Rhaphidostegium humus (Mitt.) Jaeg. in Ber. S. Gall. Naturw. Ges., 1876-77: 397 (1878)

Yellow-green, glossy, medium-sized plants in tufts. Main stem creeping. Branches usually pinnate, erect, short, parallel, but may be fasciculated. Leaves dense, imbricate, almost erect (appressed when dry), highly concave, ovate-lanceolate, $\pm 1.28 \times 0.32$ mm., apex narrow acute, margin smooth. Ecostate. Leaf cells narrow rhomboid, $\pm 46 \times 8 \mu$ at apex, $\pm 65 \times 8 \mu$ at lower leaf, lower cells showing papillose development of cell tips. Alar differentiated by about three large ($\pm 63 \times 34 \mu$), ovate-oblong, inflated cells at extreme angle and a few small irregular cells on top of them. Sporophytes on main stem. Seta slender, erect, ± 1.2 cm. long, almost smooth. Capsule horizontal, oblong-ovate, $\pm 1.6 \times 0.65$ mm. Peristome disintegrated.

DISTRIBUTION of *Sematophyllum humile*: East Nepal.

Endemic in this area. But present report from Idukki extends its distribution to south India.

Collection Site: Munnar (1600m.)

Herbarium No. 13400

Figure: **Plate 65[A]**

Pylaisiadelphina drepanioides Card. & Dix. in Rev. Bryol., 39: 58 (1912)

Chionostomum flavicolor C. Muell. in Par.: Index Bryol. Suppl. 101 (1900) *nom. nud.*

Slender to moderate-sized, brownish green, glossy, epiphytic plants in low tufts. Main stem creeping, giving rise to pinnate, erect, short branches. Leaves dense, imbricate, patent to spreading (not much changed but with more prominent, spinose leaf tips when dry), concave, oblong-lanceolate, apex gradually tapering into a long, narrow subula, 1.34×0.224 mm., margin dentate at tip. Ecostate. Leaf cells narrow, linear, $\pm 77 \times 6 \mu$. Alar differentiated by irregular rectangular, hyaline cells, $\pm 37 \times 19 \mu$ at extreme angle, gradually smaller above, a row of small, rectangular cells ascend a little along margin. Sporophytes on main stem. Perichaetial leaves narrow, erect. Seta

slender, erect, ± 1.2 cm. long. Capsule mostly erect, cylindrical, $\pm 1.92 \times 0.57$ mm. Operculum conical, long rostrate, ± 1.15 mm. long. Peristome normal, double; exostome teeth $\pm 375 \mu$ high, with fine horizontal stripes below and coarse papillae above; endostome segments of same height, keeled and split along median line, basal membrane about quarter of total height.

DISTRIBUTION of *Pylaisiadelpho drepanioides*: Sikkim, Western Himalaya (Duthie from Jaunsar, etc.)

Endemic in the Himalayas. But present report from Idukki extends its distribution to south India.

Collection Site: Eravikulam (1800m.)

Herbarium No. 13401

Figure: **Plate 65[B]**

Brotherella dixonii Herz. in Ann. Bryol., 12:95, 14(1939)

Autoicous. Slender, yellow-green, corticolous plants in lax tufts. Main stem creeping, giving rise to short, erect branches pinnately. Leaves not very dense, patent to squarrose (appressed to stem with outspread tips when dry), small, concave, ovate-lanceolate, $\pm 0.7 \times 0.2$ mm., apex narrow acuminate, margin dentate to a little above base, base subcordate. Ecostate. Leaf cells narrow rhomboid, $\pm 26 \times 5 \mu$ at tip, longer ($\pm 20 \times 5 \mu$) at mid-lamina, most lamina cells showing papillose development of cell tip; alar differentiated by a few larger, subquadrate cells of which the extreme cell is found to be tinted and $\pm 26 \times 11.5 \mu$. Sporophytes on main stem. Perichaetial leaves longer, narrower, erect with outspread tips. Seta slender, wavy erect, $\pm 1.15 \times 0.7$ mm. Peristome normal, double, with 2-3 cilia.

DISTRIBUTION of *Brotherella dixonii*: Sikkim.

Endemic in this locality. But present report from Idukki extends its distribution to south India.

Collection Site: Eravikulam (1800m.)

Herbarium No. 13402

Figure: **Plate 66[A]**

Trichosteleum glauco-virens (Mitt.) Broth. in Nat. Pfl., 1 (3): 1119 (1908)

Stereodon glauco-virens Mitt. in Musci Ind. Or.: 103 (1859)

Chionostomum glauco-virens (Mitt.) Jaeg. in Ber. S. Gall. Naturw. Ges., 1876-77: 272 (1878)

Rhaphidostichum glauco-virens (Mitt.) Broth, in Nat. Pfl. ed. 2, 11: 435 (1925)

Monoicous. Slender, light green, caespitose plants. Leaves fairly dense, erectopate (appressed to stem with outturned tips when dry), concave, elliptic-lanceolate, apex narrowly acute, $\pm 1.7 \times 0.48$ mm., margin mildly dentate down to midleaf. Ecostate (Mitten notes short binerve which is not found in the Type specimen). Leaf cells elongate narrow rhomboid, $\pm 31 \times 7 \mu$ at apex, $\pm 58 \times 7 \mu$ at midleaf, a few cells at midleaf slightly papillose on back. Alar distinguished by a row of inflated oblong cells of which the largest at extreme angle is $\pm 84 \times 34.5 \mu$; the whole row of alar and leaf attachment cells is tinted. Perichaetial leaves narrow, erect. A seta ± 1 cm. long is present. Capsule not seen but reported horizontal, oval.

DISTRIBUTION of *Trichosteleum glauco-virens*: Upper Assam.

Endemic in this locality. But present report from Idukki extends its distribution to south India.

Collection Site: Matupatti (1700m.)

Herbarium No. 13403

Figure: **Plate 66[B]**

25. HYPNACEAE

Key to the genera of Hypnaceae:

- | | |
|---|------------------|
| 1a Leaves distinctly differentiated into stem and branch leaves, leaf with distinct alar cells; leaf base markedly decurrent | <i>Ctenidium</i> |
| 1b Leaves slightly or not at all differentiated; alar cells present, not chlorophyllous; all cells in a leaf narrow linear; ca[sule oblong to cylindrical, usually curved | <i>Hypnum</i> |

Key to the species of *Hypnum*:

- | | |
|--|-------------------------|
| 1a Leaf tips hooked, alars scarcely differentiated | <i>H. aduncooides</i> |
| 1b Leaves tip fulcate | <i>H. setschwanicum</i> |

Hypnum aduncoides (Brid.) C. Muell., Syn., 2: 295 (1851)

H. cupressiforme Hedw. Var. *aduncoides* Brid. in Sp. Musc., 2: 219 (1812)

H. zickendrahtii (-*thii*) Ren. & Card. in Bull. Soc. R. Bot. Belg., 41 (1): 116 (1905)
fid. Card.

Stereodon zickendrahtii (Ren. & Card.) Broth. in Nat. Pfl., 1 (3): 1071 (1908)

Robust, straw-green, silky plants forming dense tufts. Main stem long (12cm. or even more), creeping, branching regular pinnate. Leaves erectopate (only shrunk when dry), strongly falcate to hooked, concave, oblong-lanceolate, hooked tip very narrow, $\pm 2.24 \times 0.77$ mm. on main stem and $\pm 1.3 \times 0.48$ mm. on branches. Costa short, double. Alar somewhat differentiated on stem leaves but on branch leaves there is a row of large cells all along extreme leaf base with a few irregular rows on top of these but alars cannot be specially distinguished. Branch leaf cells linear, $\pm 38 \times 5 \mu$ at tip, $\pm 65 \times 5 \mu$ at lower leaf; basal row of large $\pm 65 \times 20 \mu$ cells with irregular $\pm 46 \times 6 \mu$ cells on top. Sporophytes on main stem. Seta slender, erect, ± 2.4 cm. long. Capsule horizontal, ovate-cylindrical, cernuate, $\pm 2.3 \times 1.1$ mm.

DISTRIBUTION of *Hypnum aduncoides*: Darjeeling, Assam, Burma, China (Yunnan), Madagascar, South Africa

An Afro-Asian species.

Collection Site: Munnar (1600m.)

Herbarium No. 13404

Figure: **Plate 67[A]**

Hypnum setschwanicum (Broth.) Ando. in J. Sc. Hiroshima Univ. Ser. B(2), 16(1): 24 (1976)

Stereodon setschwanicus Broth. in Handel-Mazzetti: Symb. Sin., 4: 123 (1929)

Stereodontopsis setschwanica (Broth.) Ando in Hikobia, 5: 184 (1969)

Dioicous. Moderately robust, golden (may be yellow-brown), glossy plants in dense tufts. Main stem prostrate to ascending, branching irregular, branches narrower at apex. Leaves erectopate, falcate but not circinate or hooked, oblong-lanceolate, concave on top, apex gradually very narrow acuminate, $\pm 1.4 \times 0.38$ mm; margin finely crenulate to smooth at apex, often revolute to a length from top. Costa short, double.

Leaf cells linear to narrow elongated rhomboid, $\pm 40 \times 6 \mu$ at top, $\pm 58 \times 7 \mu$ at midleaf; alar well differentiated, bulging with inflated, $\pm 26 \times 20 \mu$ cells below, shorter upwards.

DISTRIBUTION of *Hypnum setschwanicum*: East Nepal (2850-4000m.), Bhutan, China (Yunnan, Setschwan), Eastern Himalaya - Yunnan.

Collection Site: Munnar (1600m.)

Herbarium No. 13405

Figure: **Plate 67[B]**

Ctenidium lychnites (Mitt.) Broth. in Nat. Pfl., 1 (3): 1048 (1909)

Stereodon lychnites Mitt. in Musci Ind. Or.: 114 (1859)

Hyocomium lychnites (Mitt.) Mitt. in Trans. Linn. Soc. Bot. Lond. ser. 2, 3: 177 (1899)

Hypnum lychnites (Mitt.) C. Muell. in Linnaea, 36: 8 (1869)

Dioicous. Semi-robust, yellowish to golden green, silky plants in dense tufts. Main stem creeping, branching more or less regular pinnate. Stem leaves larger ($\pm 1.25 \times 0.48$ mm.), narrowed into a slender, curved acumen from a wide, cordate and somewhat auriculate base, margin strongly denticulate almost to base. Branch leaves somewhat lax, spreading (shrunk and partly appressed when dry), much narrower than stem leaves ($\pm 1 \times 0.26$ mm.), apiculus almost erect, margin dentate about halfway down. Ecostate (Mitten noted short binerves). Leaf cells linear, $\pm 38 \times 5 \mu$. at apex, $\pm 57 \times 7 \mu$ in lower leaf. Alar distinct by some hyaline quadrate-rectangular cells the most prominent of which are quadrate ($\pm 11 \mu$ wide). Sporophytes on main stem. Perichaetial leaves narrow with outspread tips. Seta slender, erect, 1.5 to 1.75cm. long. Capsule horizontal (sometimes inclined), cernuate ovate-cylindrical, $\pm 1.28 \times 0.64$ mm. Operculum conic, short rostrate, ± 0.65 mm. long. Peristome normal.

DISTRIBUTION of *Ctenidium lychnites*: Naga Hills, Khasia Hills, Palni, Nilgiri, Ceylon, Philippines

An India-Philippines species.

Collection Site: Eravikulam (1800m.)

Herbarium No. 13407

Figure: **Plate 68[A]**

PLATE 1

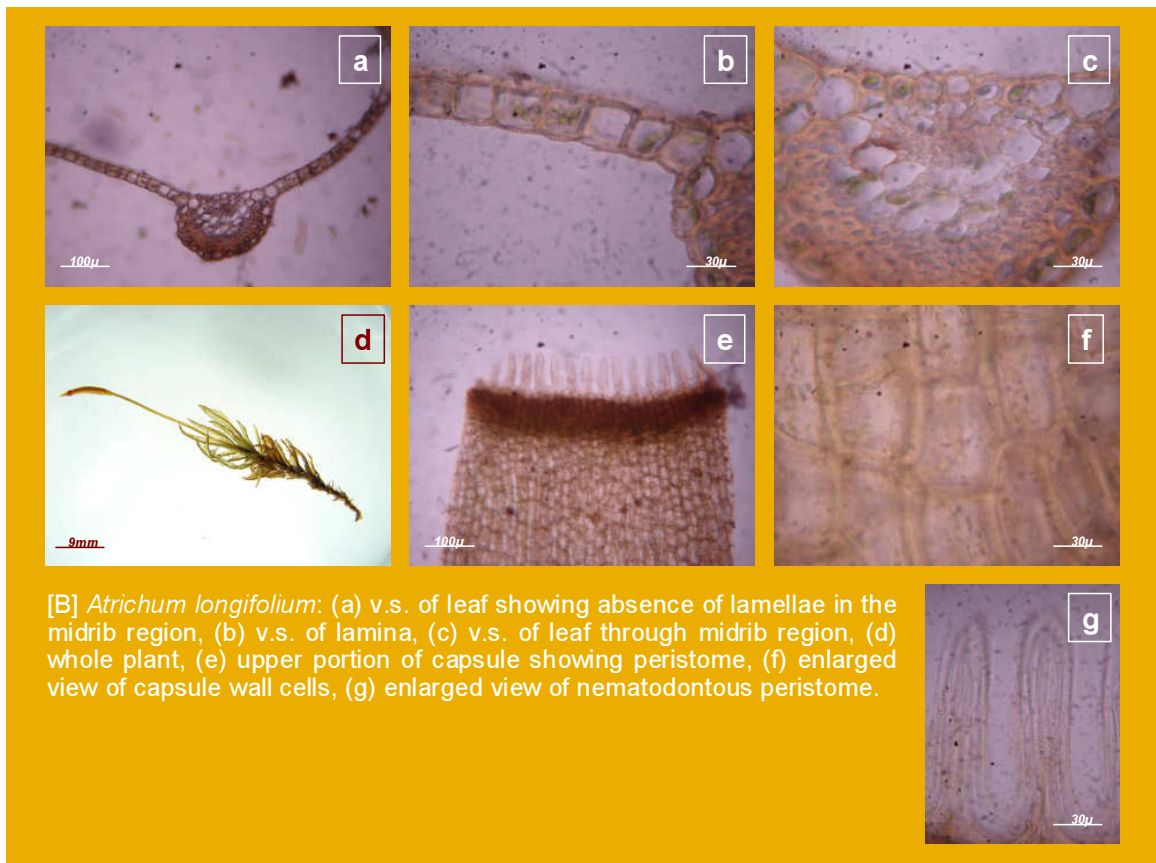
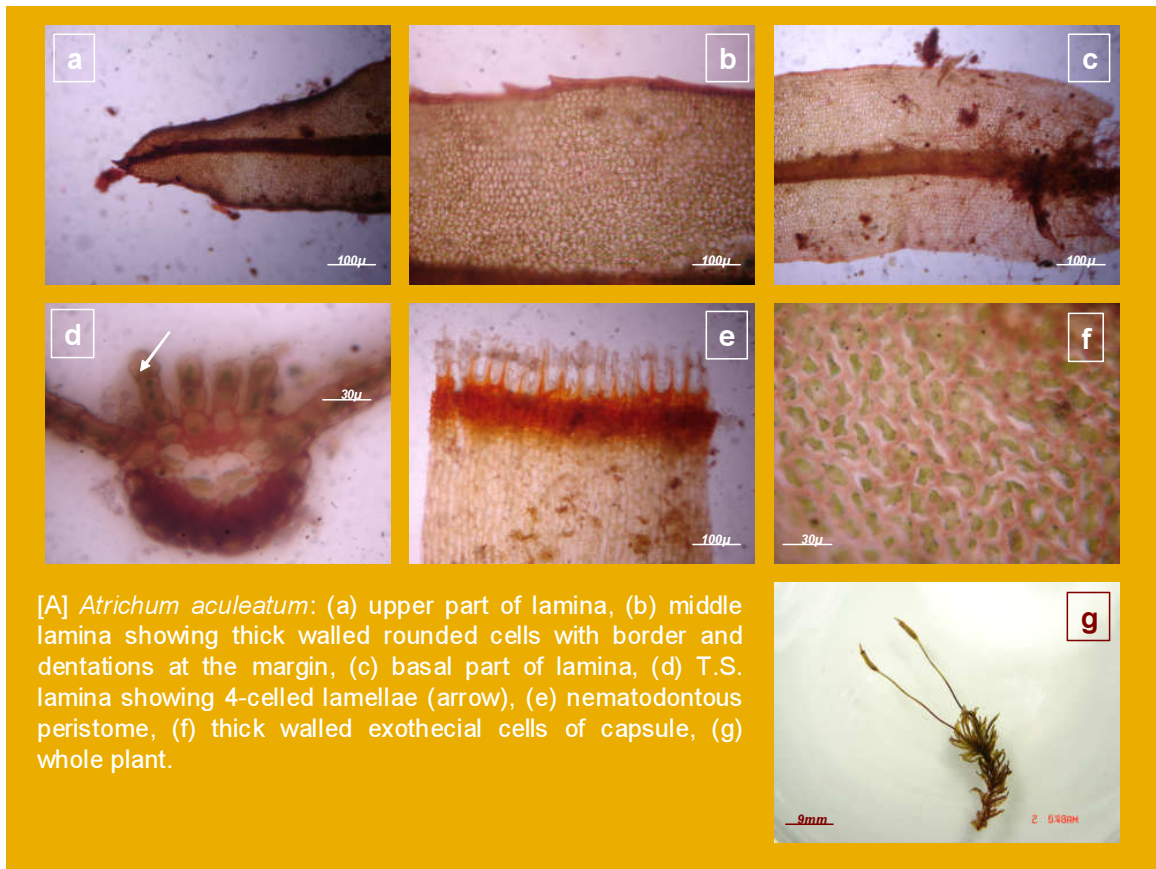


PLATE 2

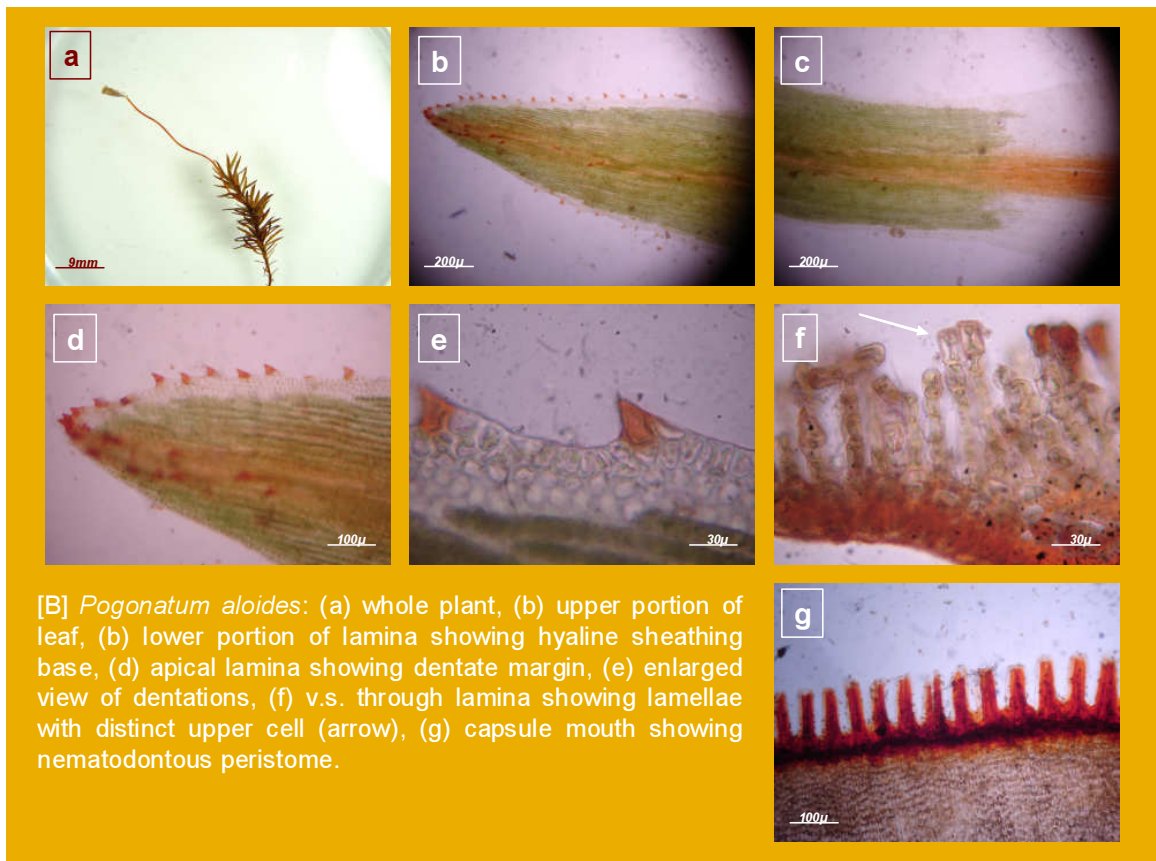
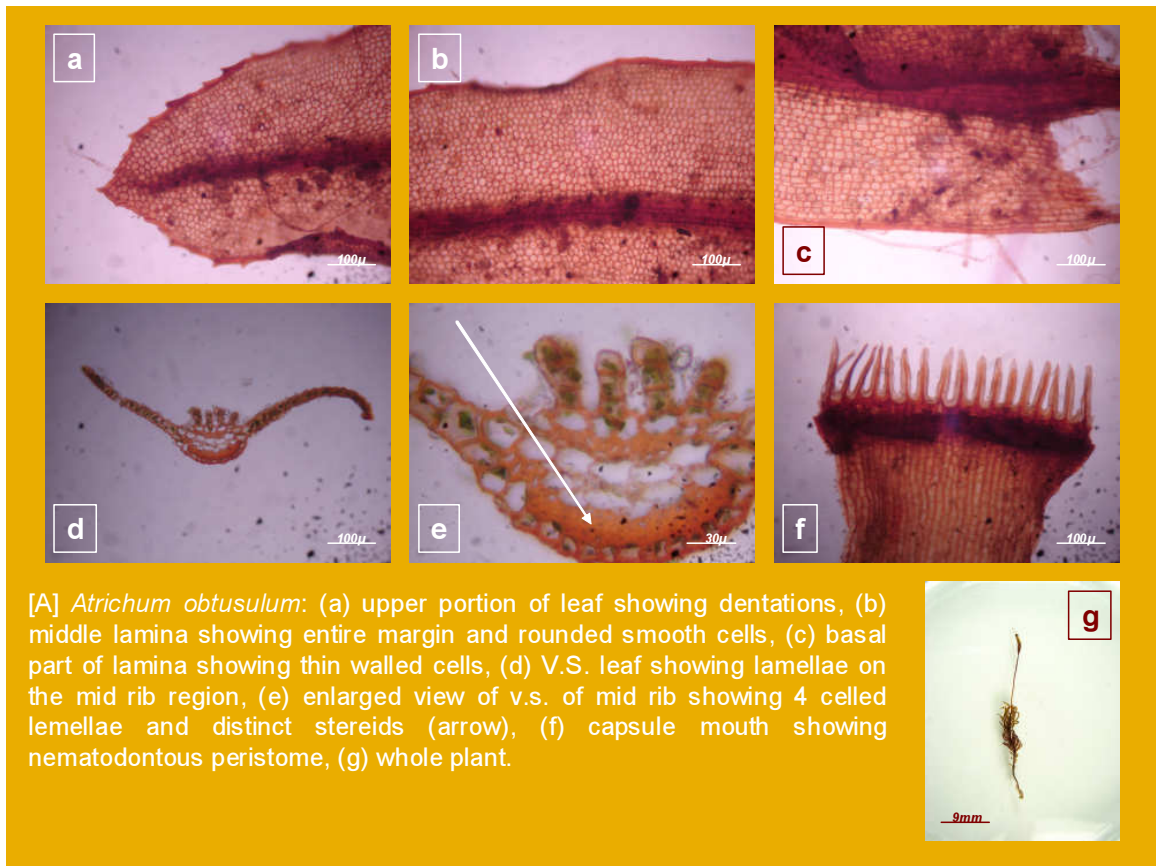


PLATE 3

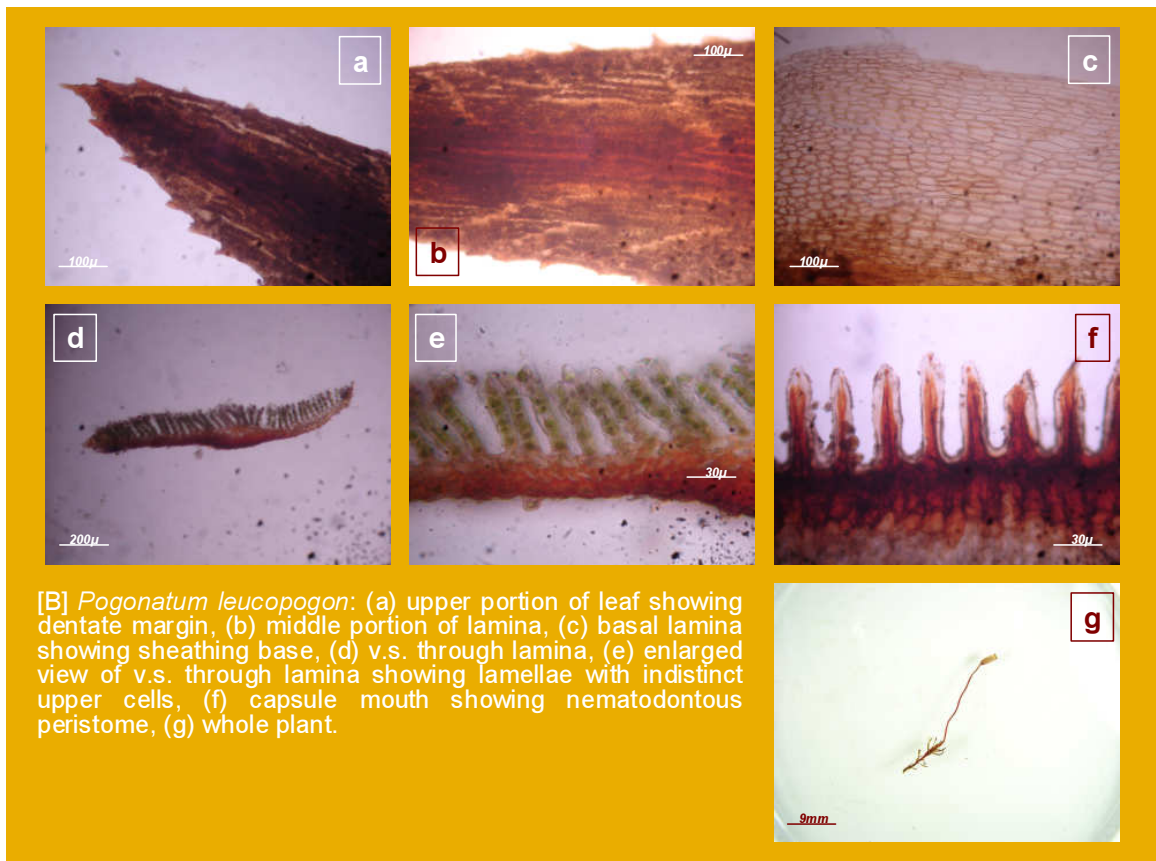
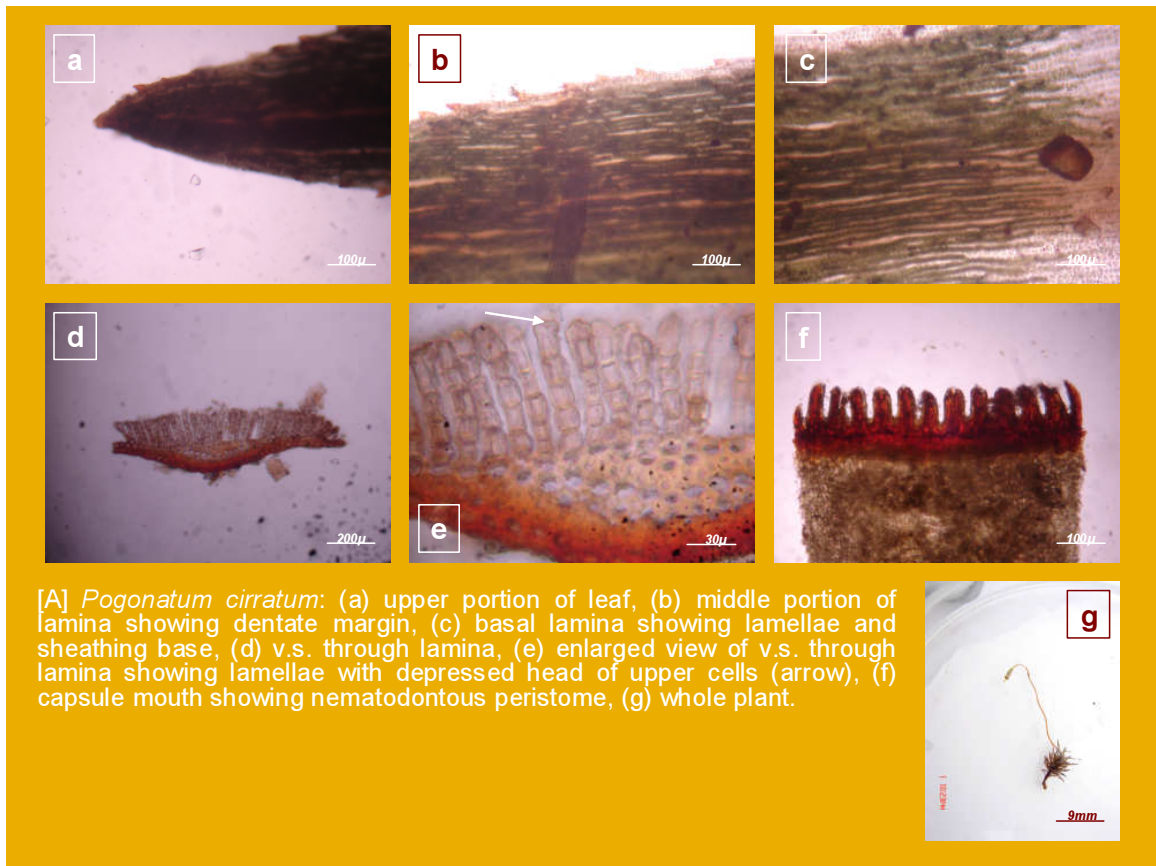
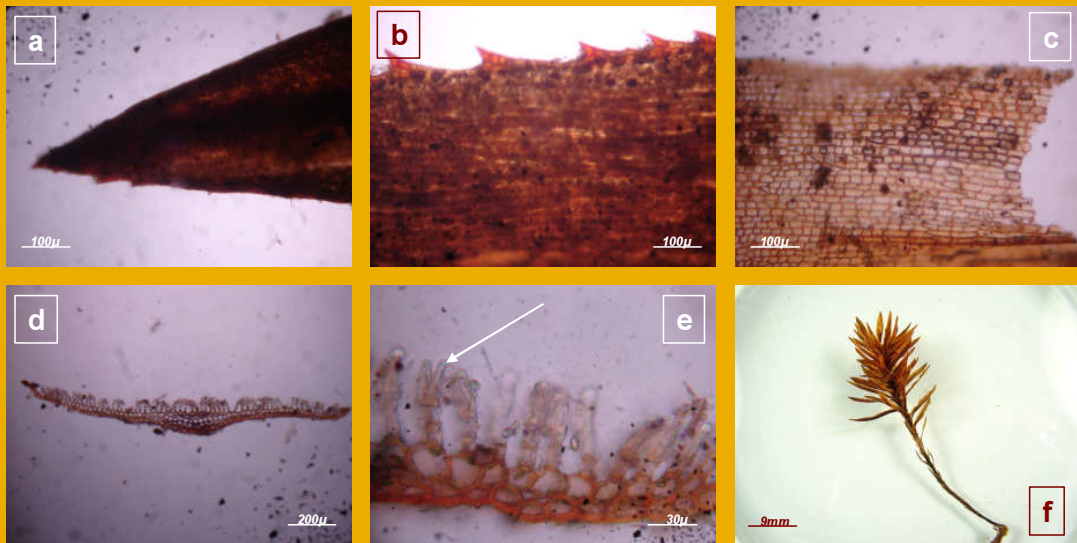
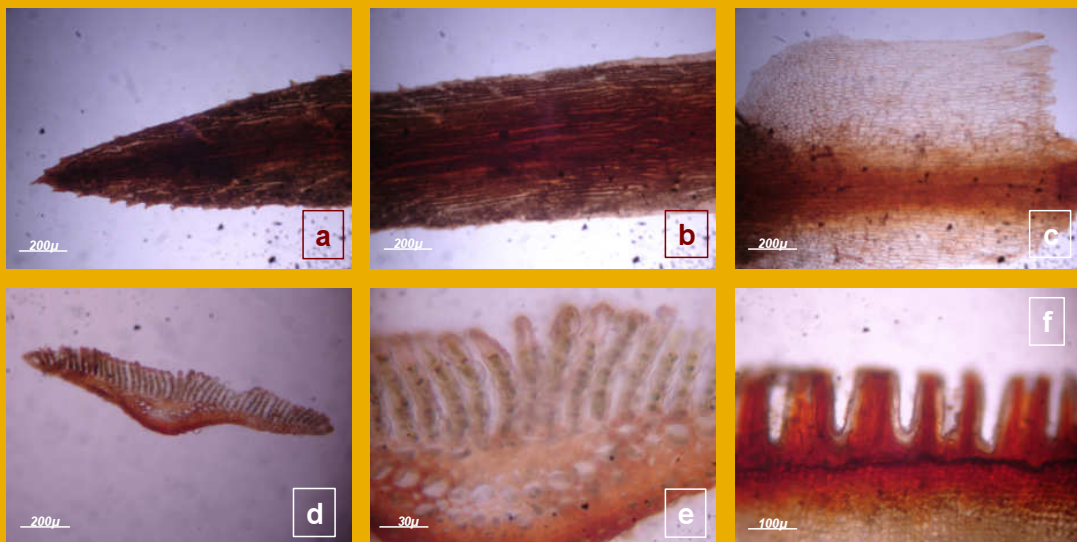


PLATE 4



[A] *Pogonatum microstomum*: (a) upper portion of leaf, (b) middle portion of lamina showing dentate margin, (c) basal lamina showing lamellae and sheathing base, (d) v.s. through lamina, (e) enlarged view of v.s. through lamina showing lamellae with divided upper cells (arrow), (f) whole plant.



[B] *Pogonatum perichaetiale*: (a) upper portion of leaf showing dentate margin, (b) middle portion of lamina, (c) basal lamina showing sheathing base, (d) v.s. through lamina, (e) enlarged view of v.s. through lamina showing lamellae with indistinct upper cells, (f) capsule mouth showing nematodontous peristome, (g) whole plant.

PLATE 5

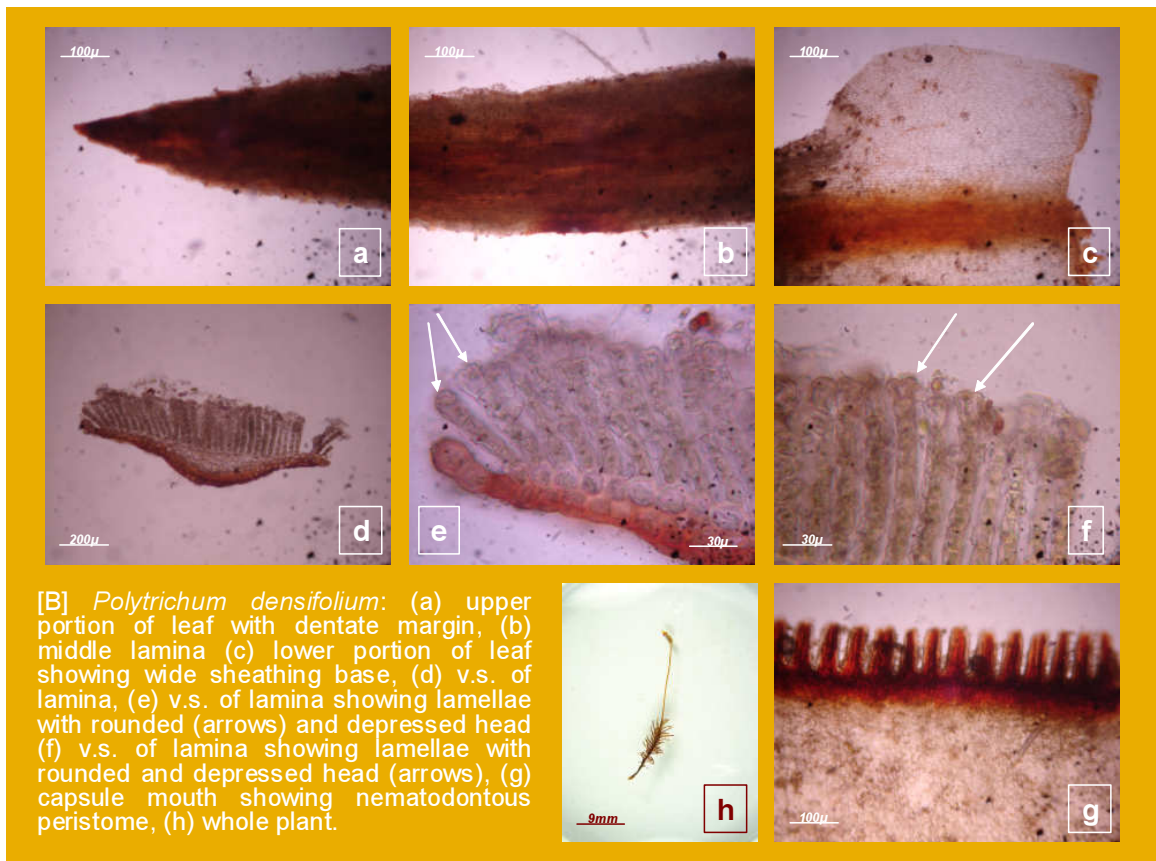
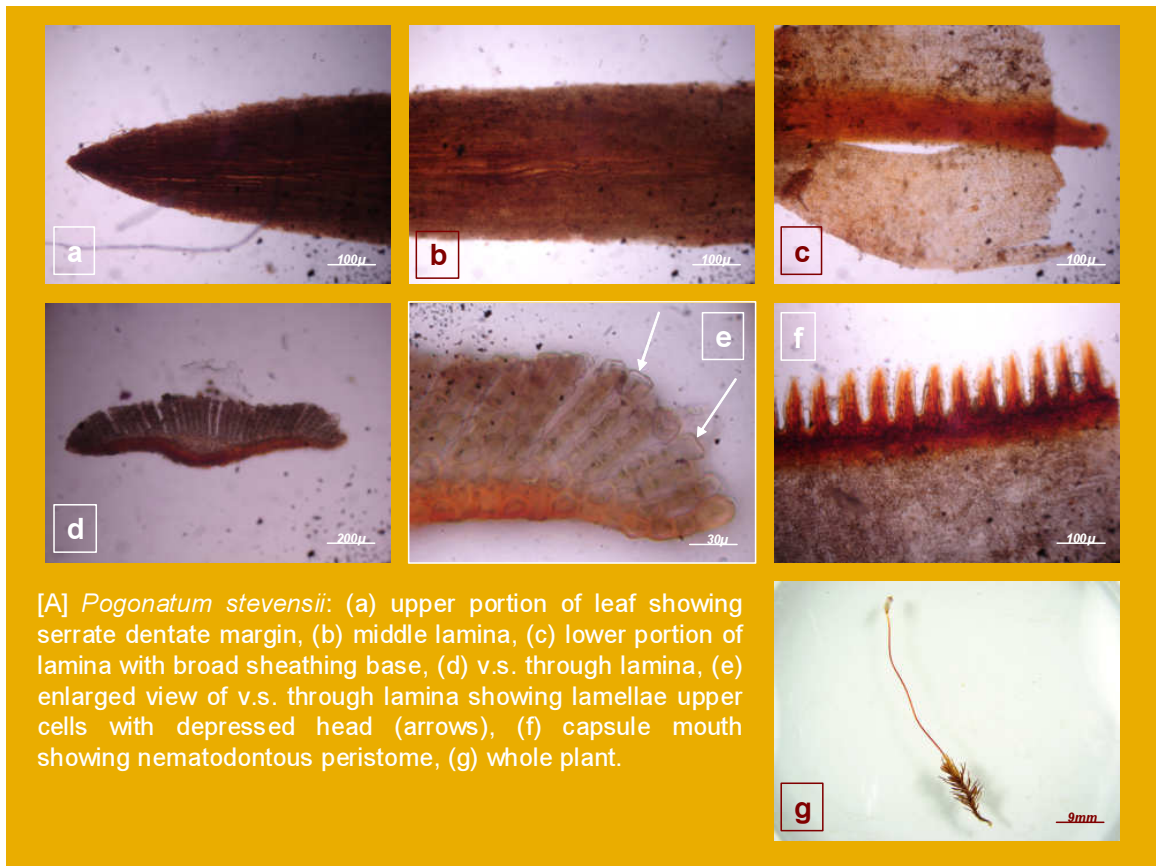


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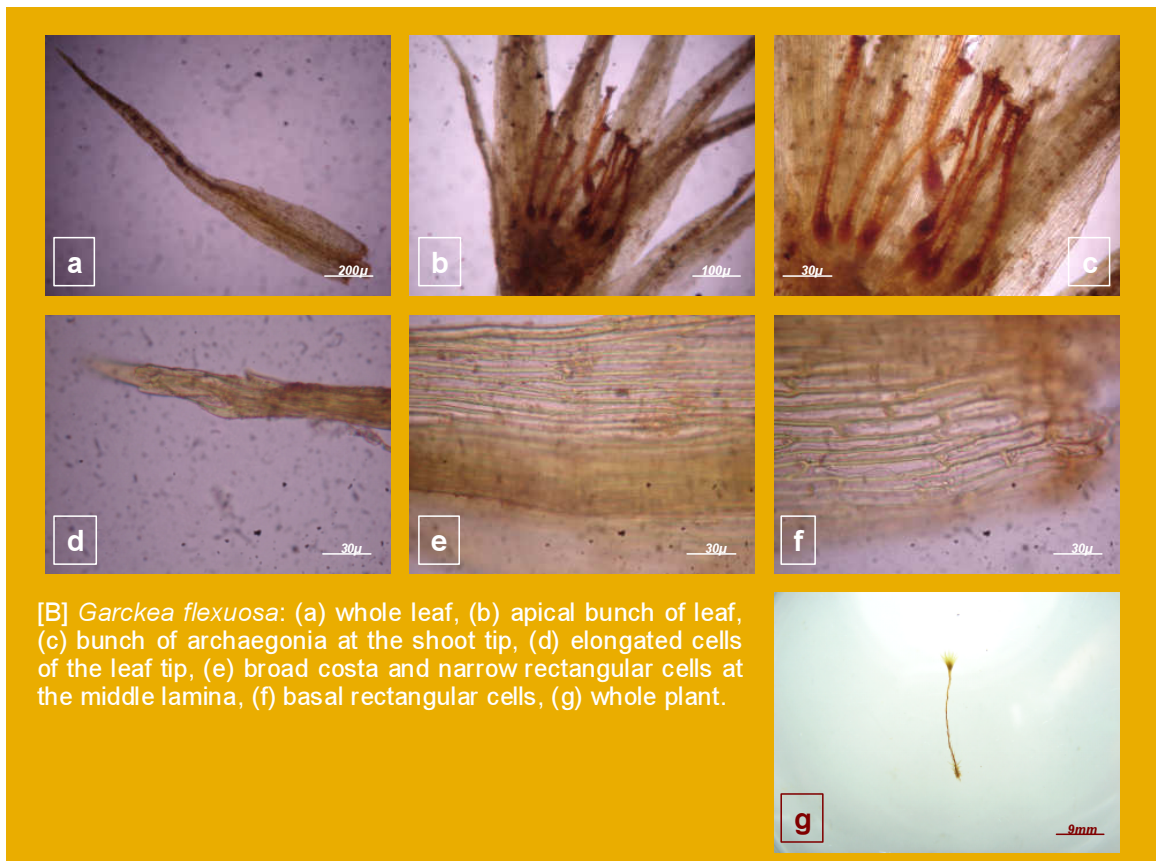
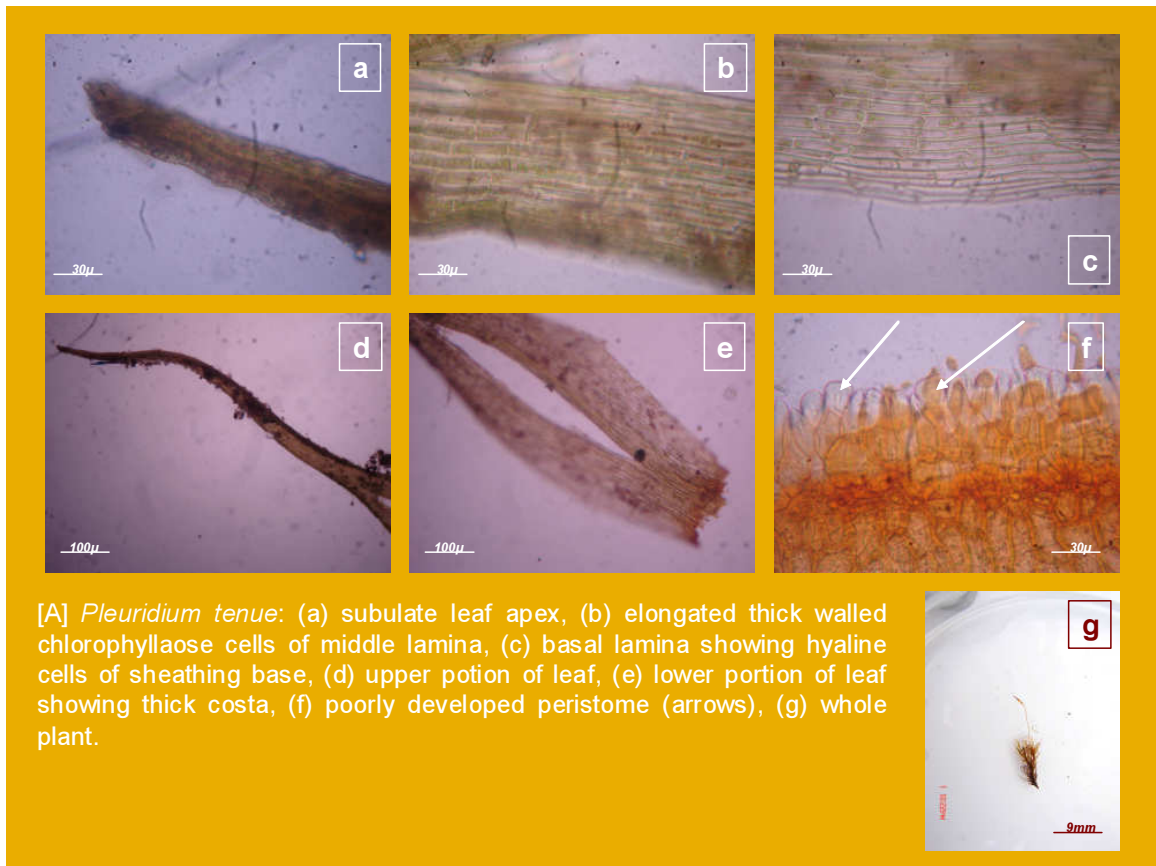


PLATE 7

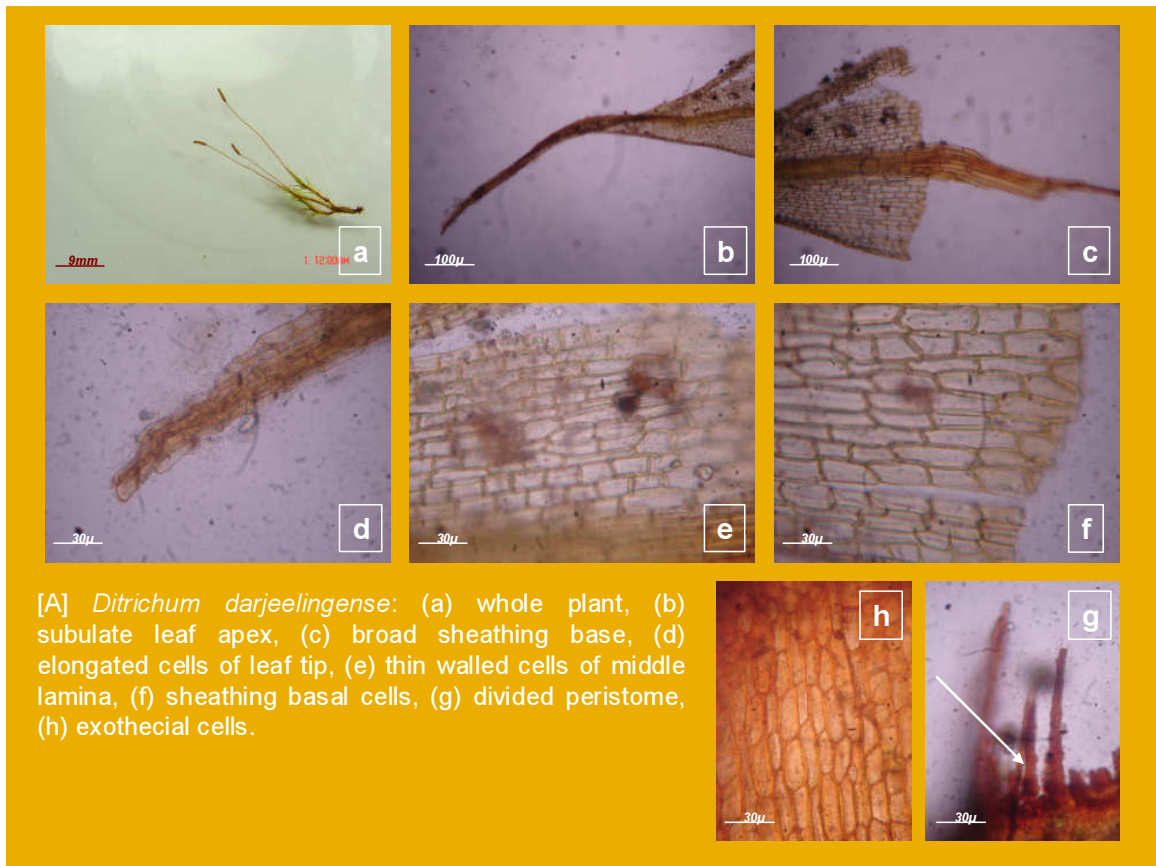


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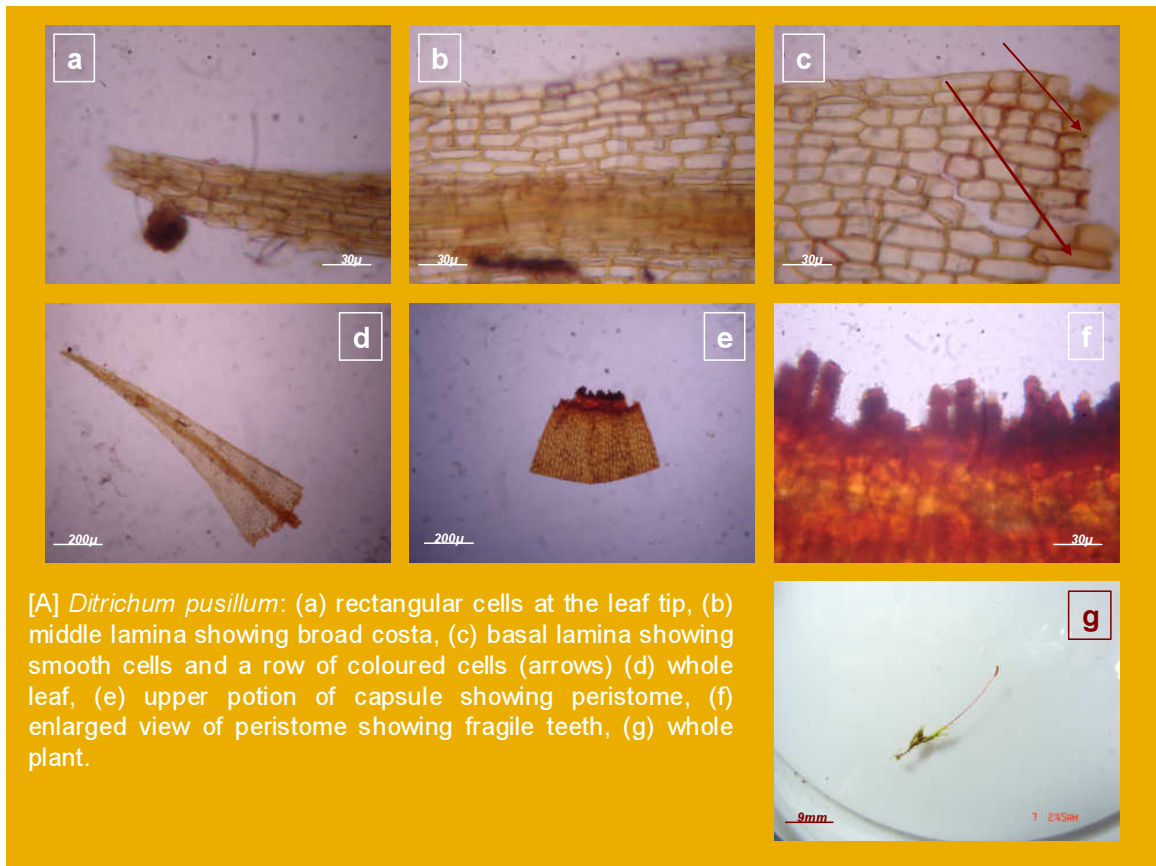


PLATE 9

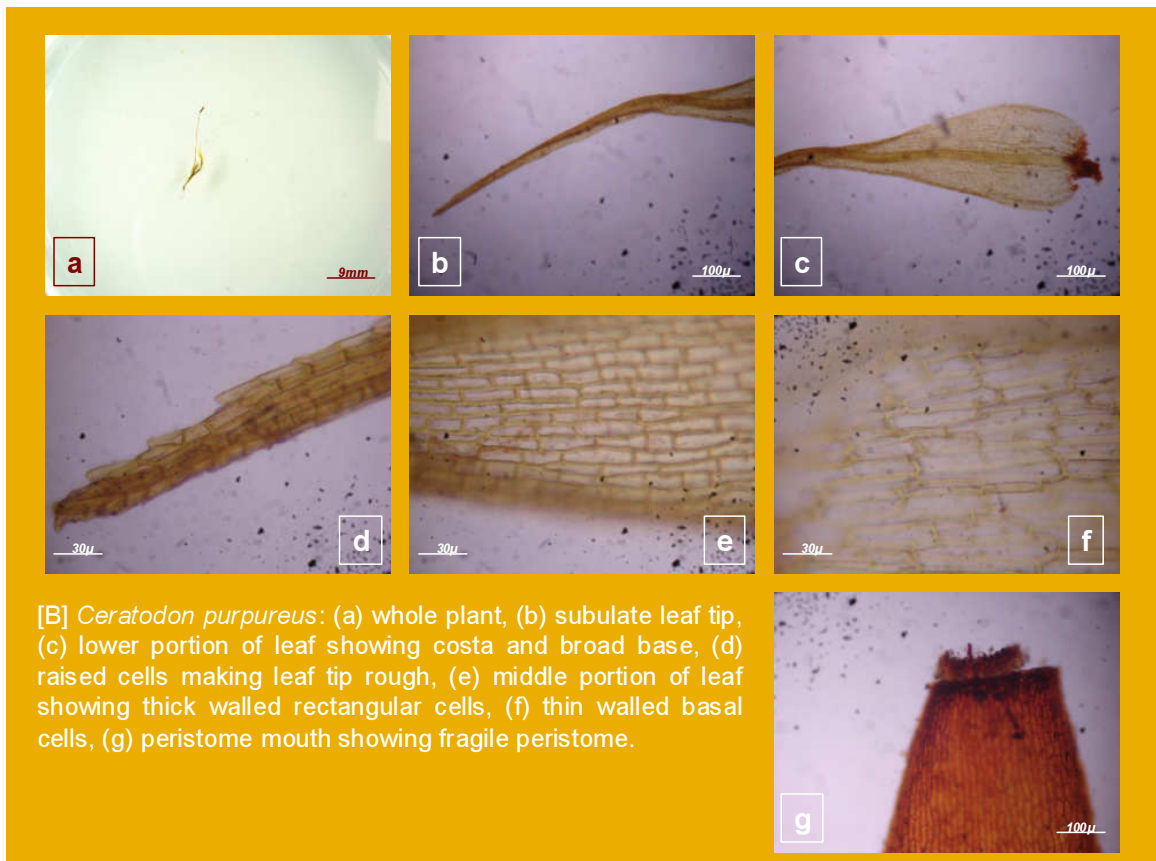
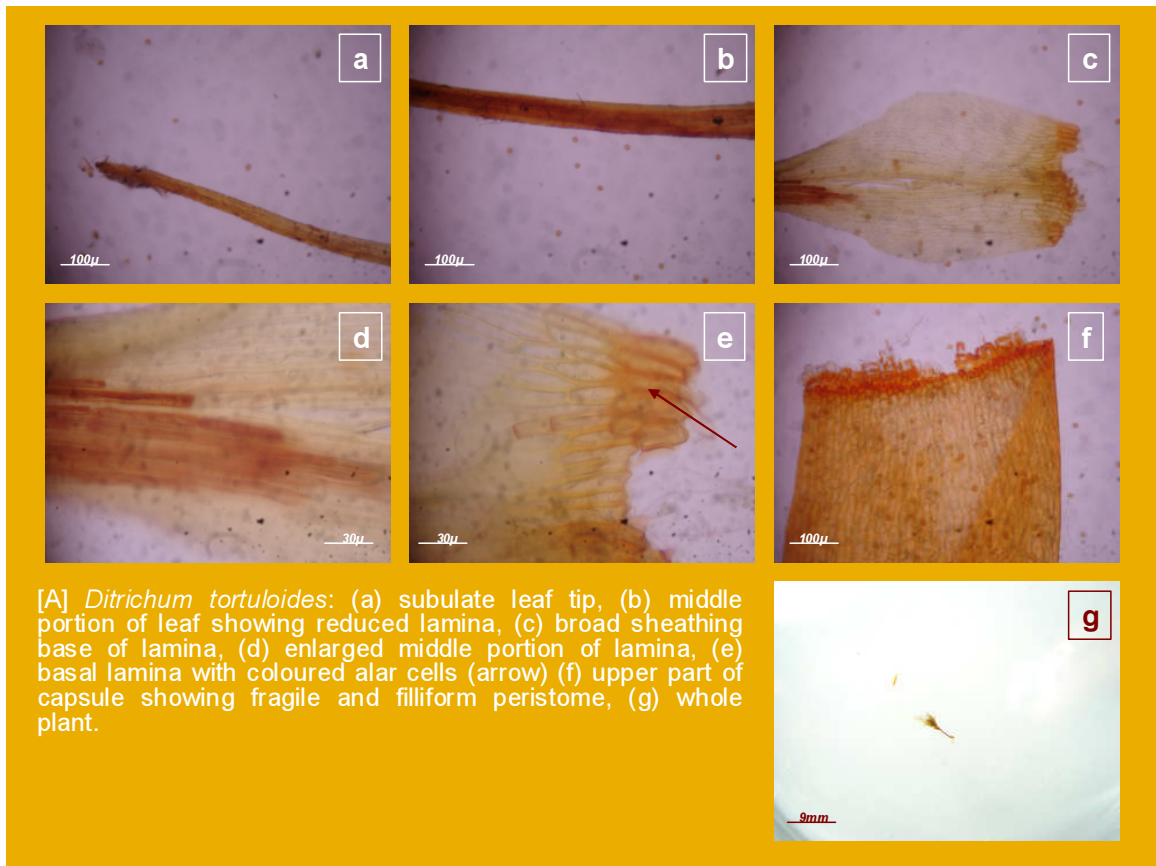


PLATE 10

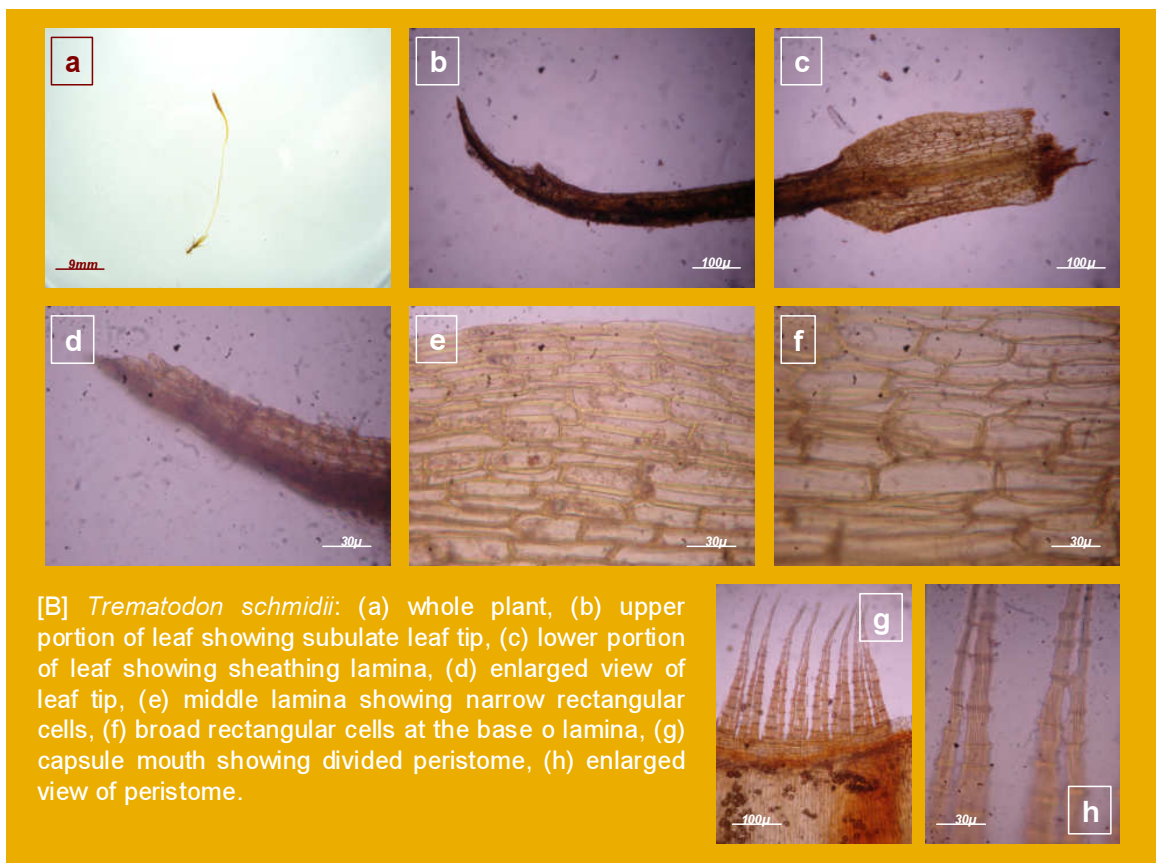
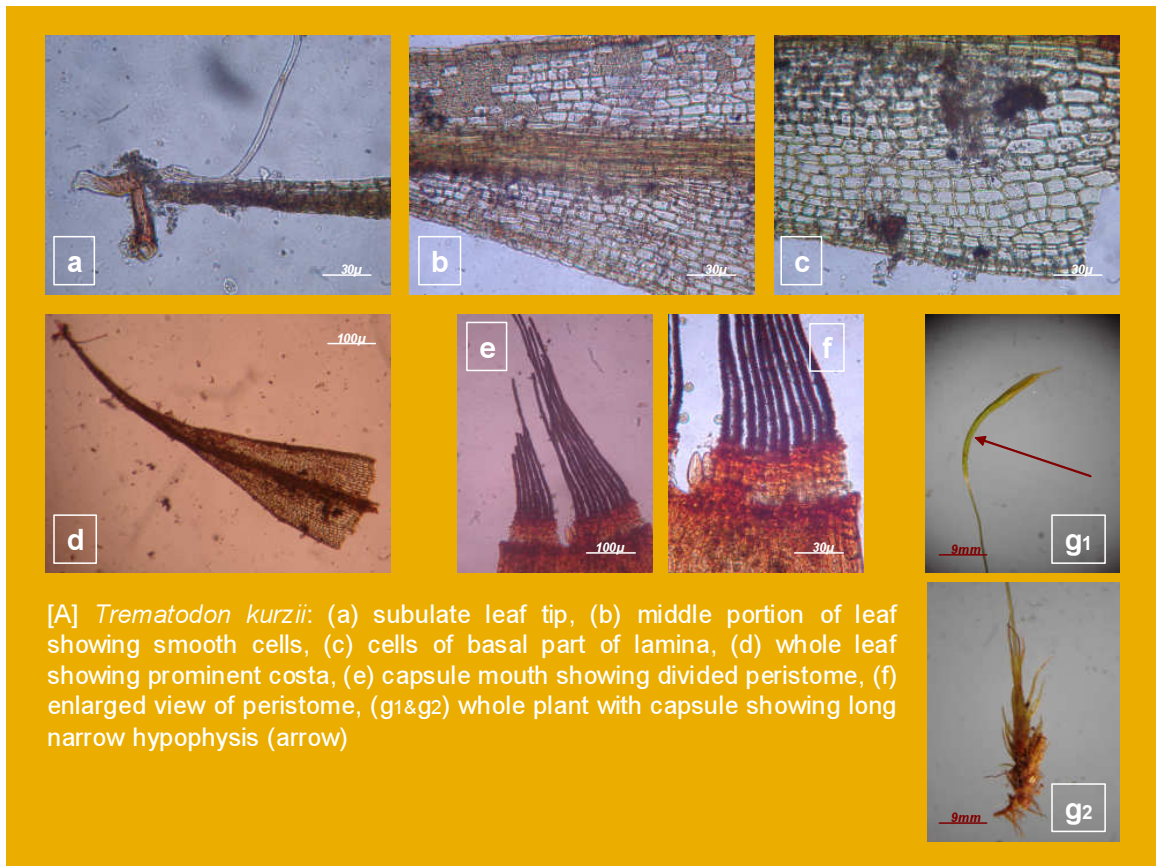


PLATE 11

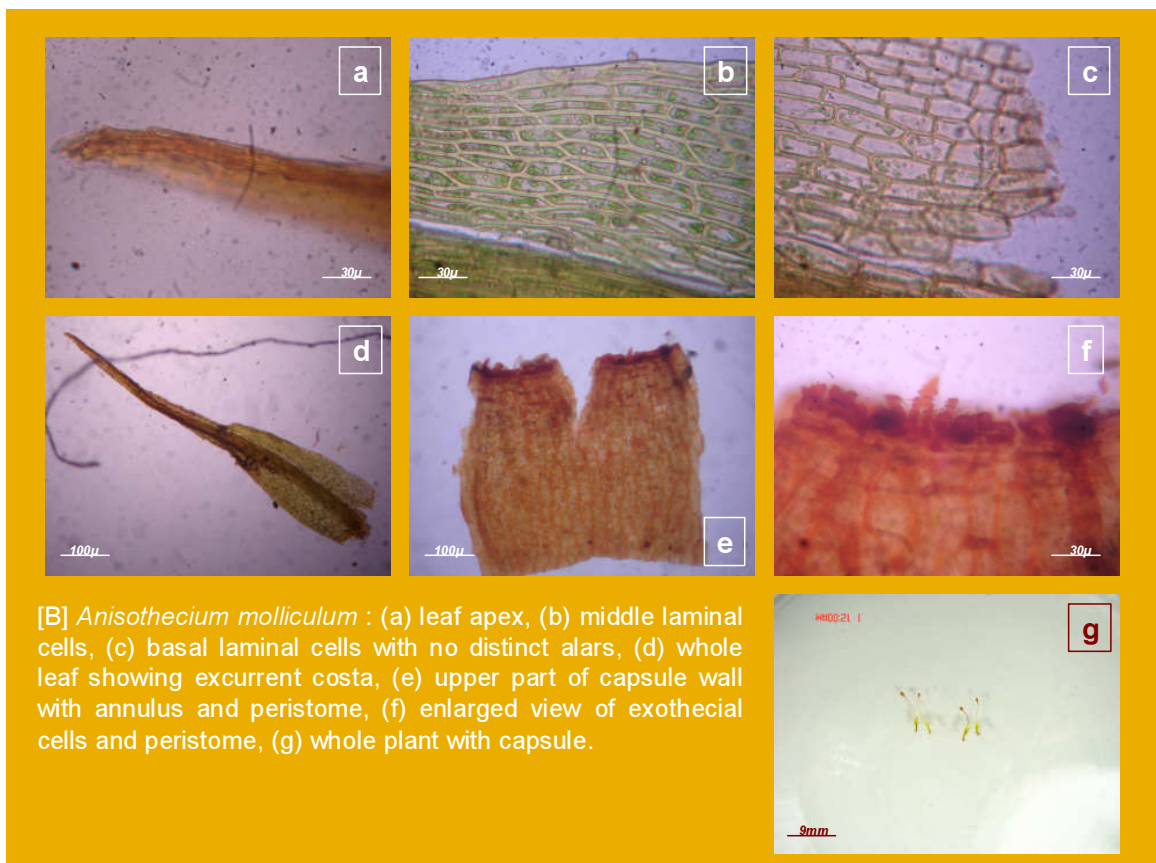
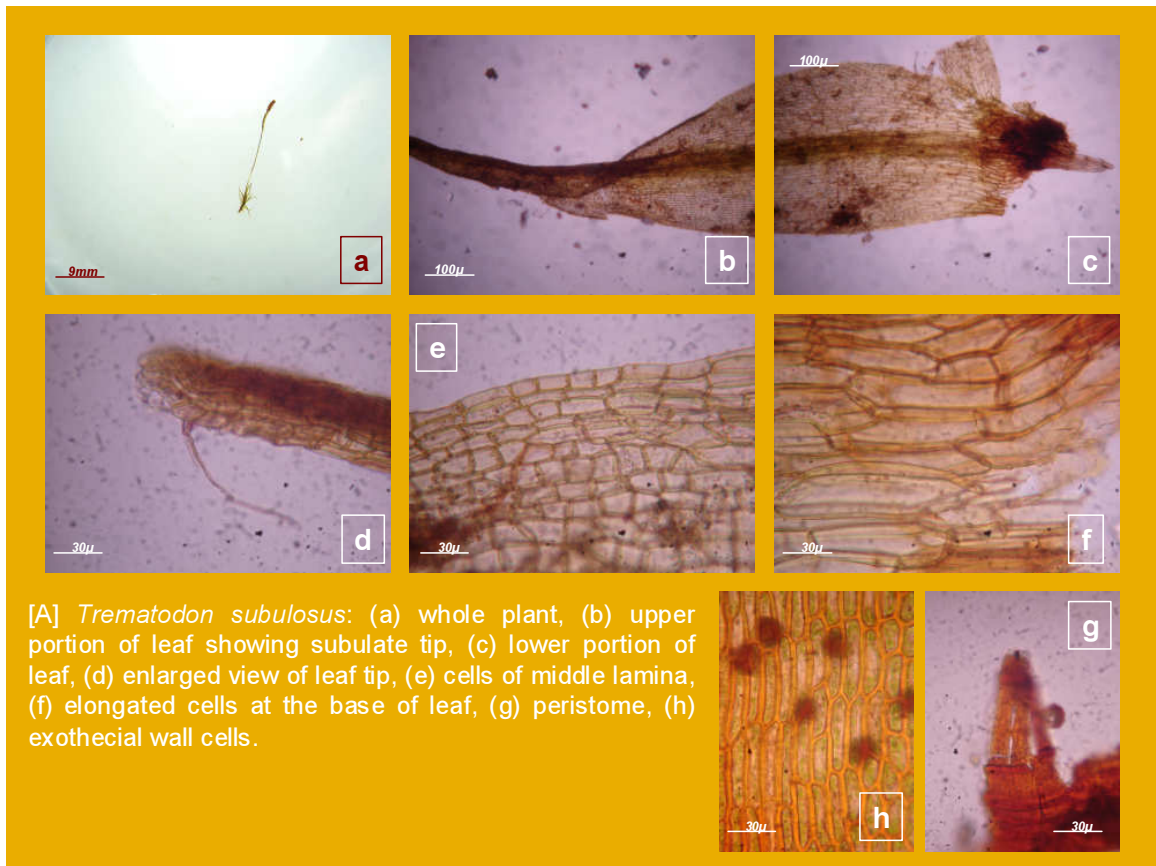


PLATE 12

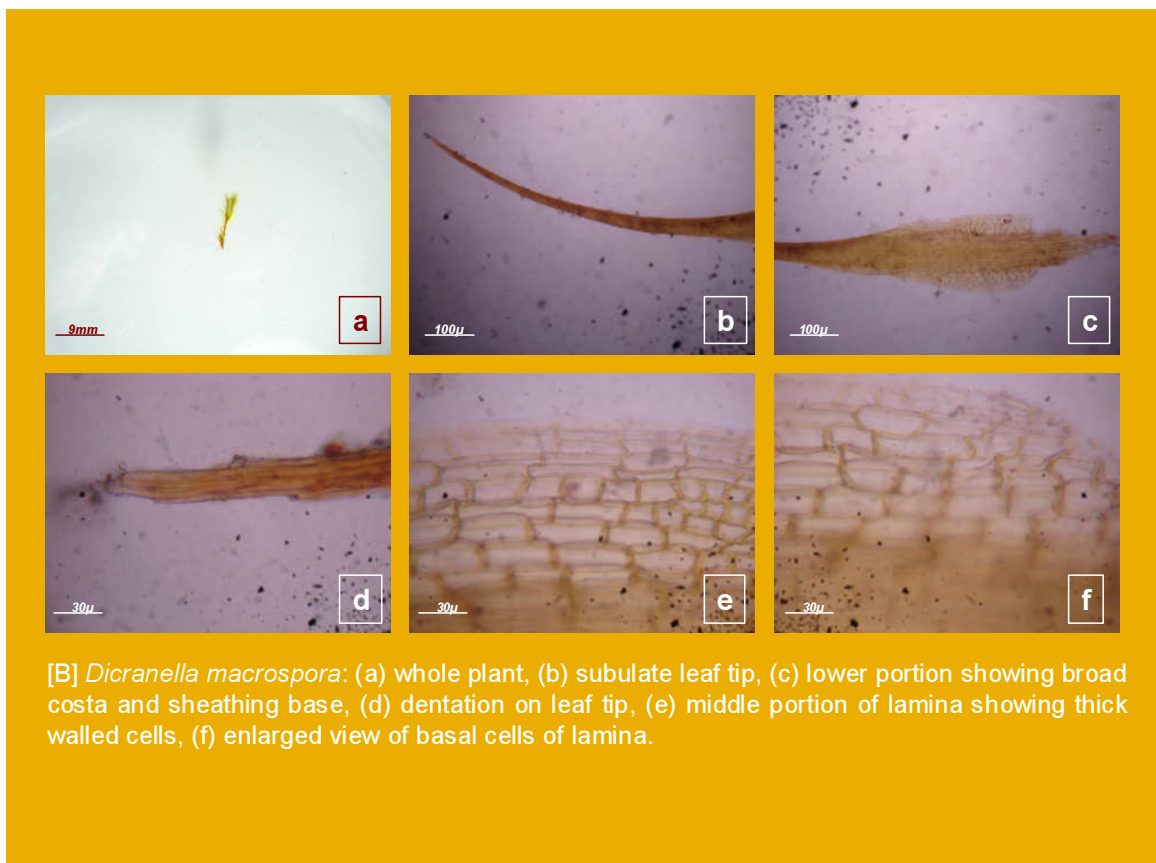
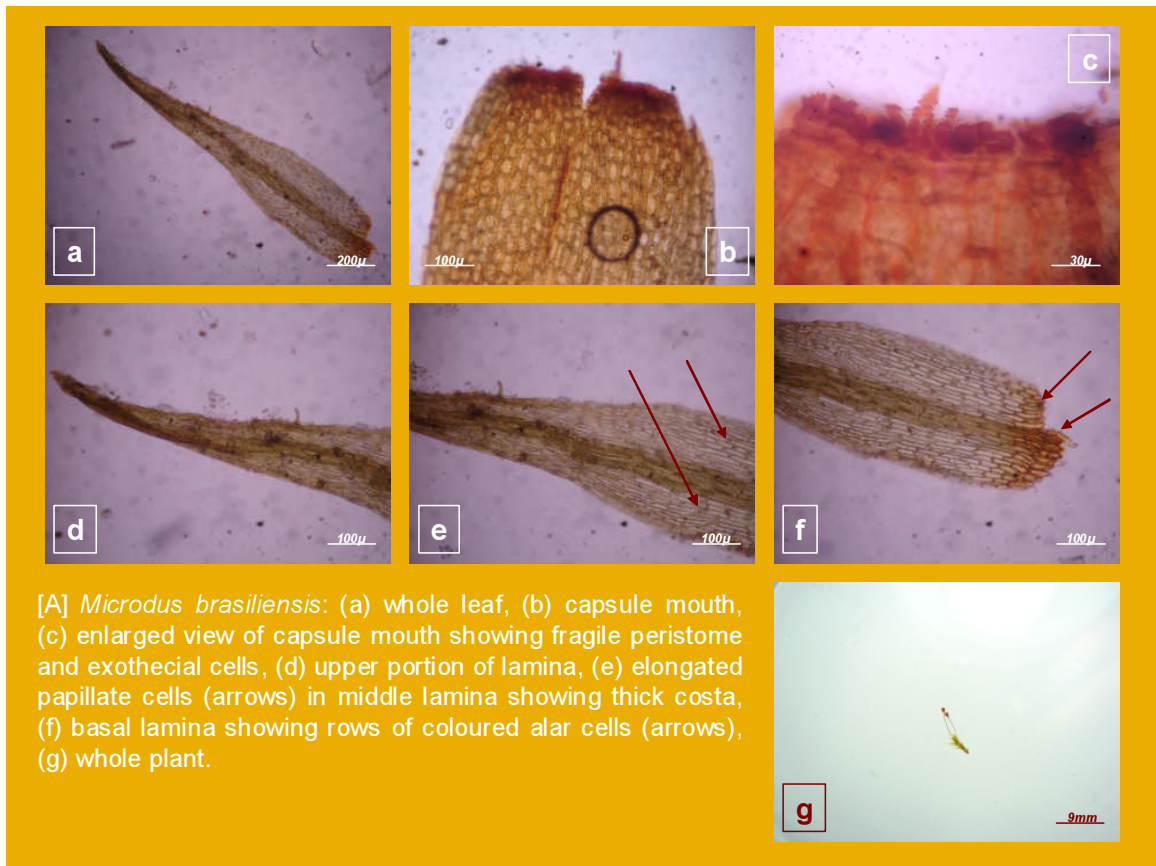


PLATE 13

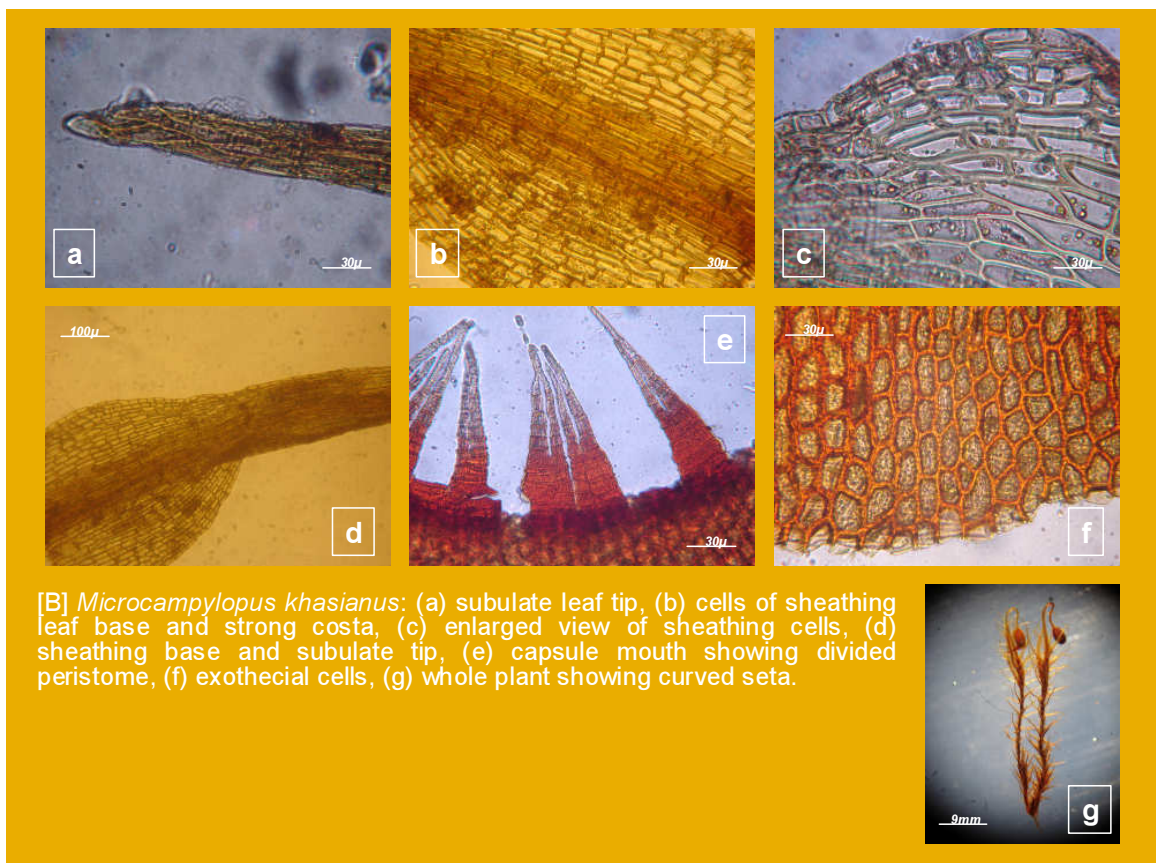
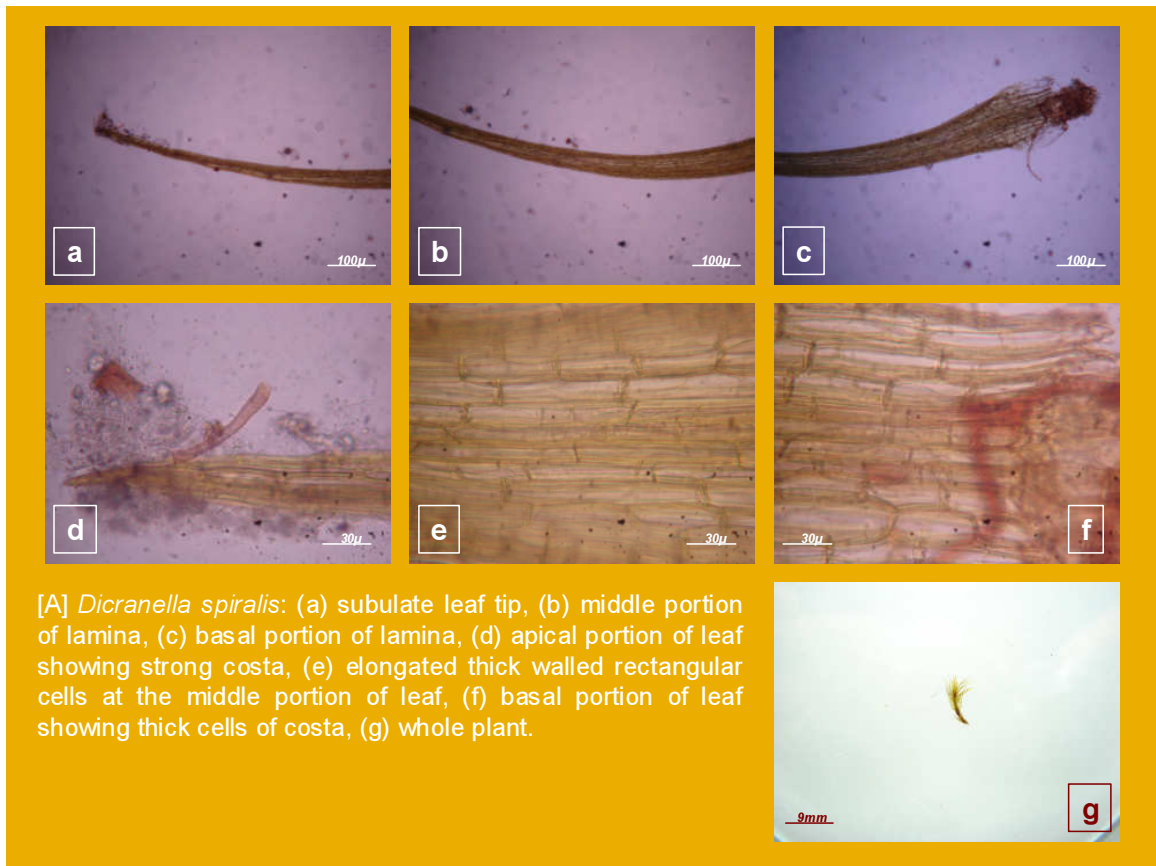


PLATE 14

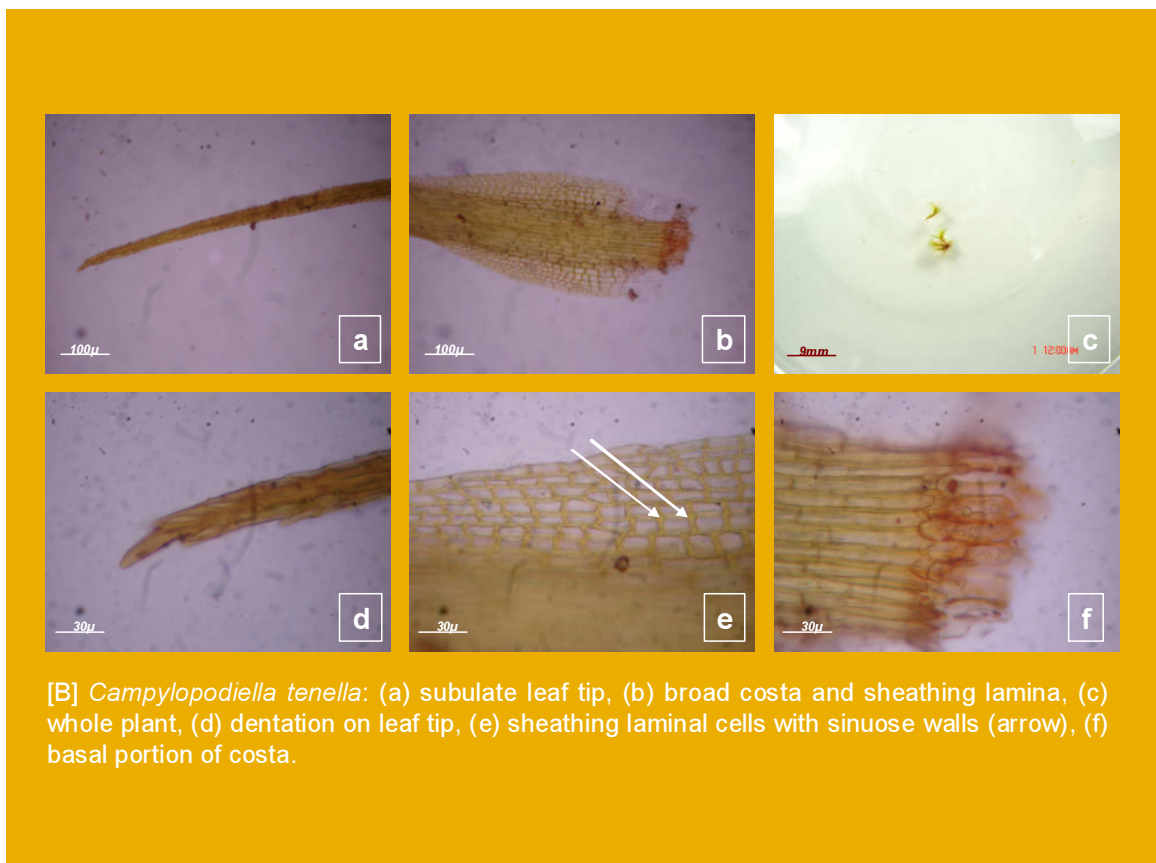
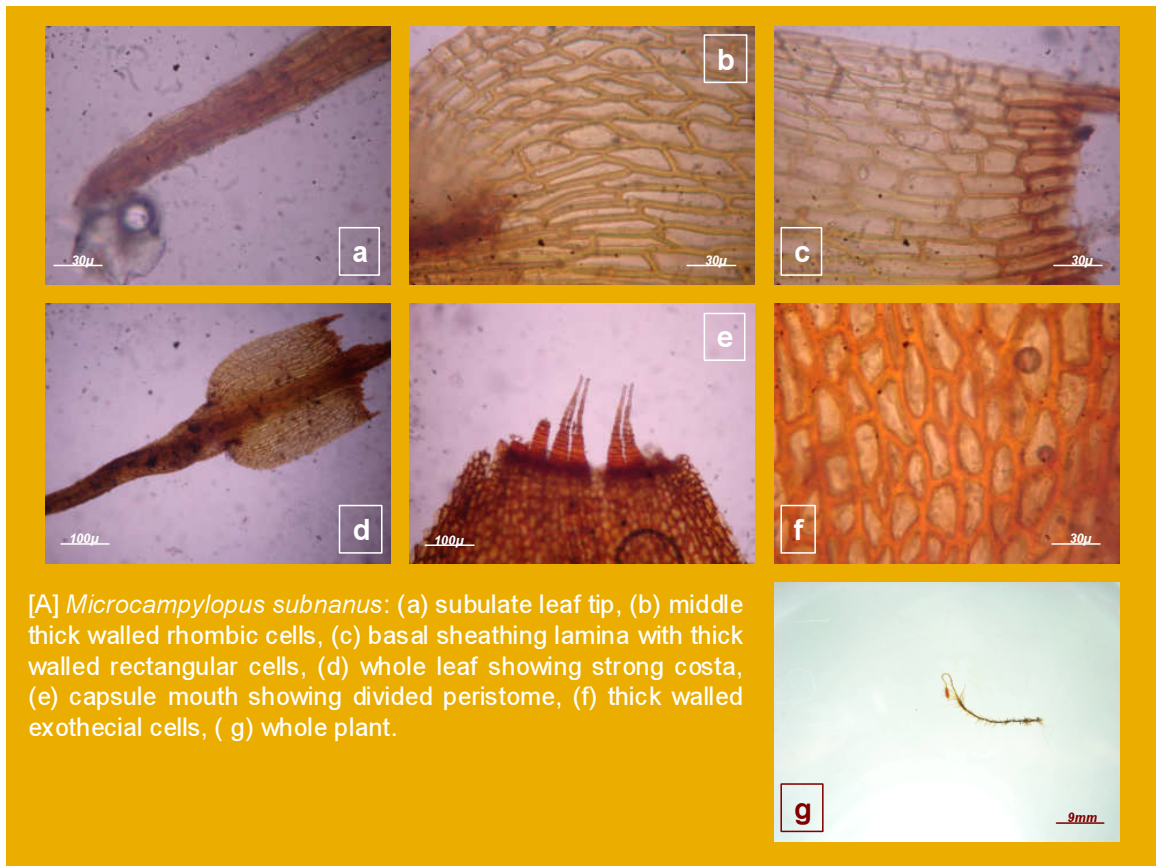


PLATE 15

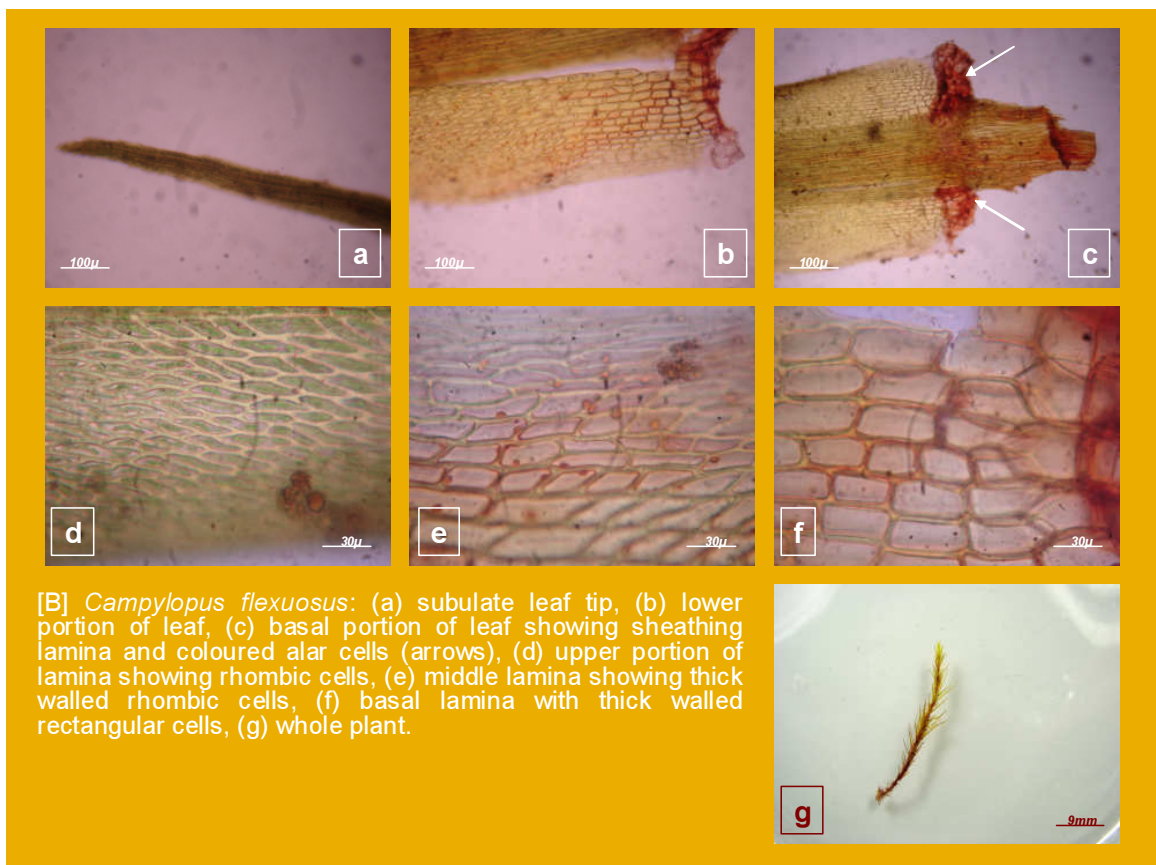
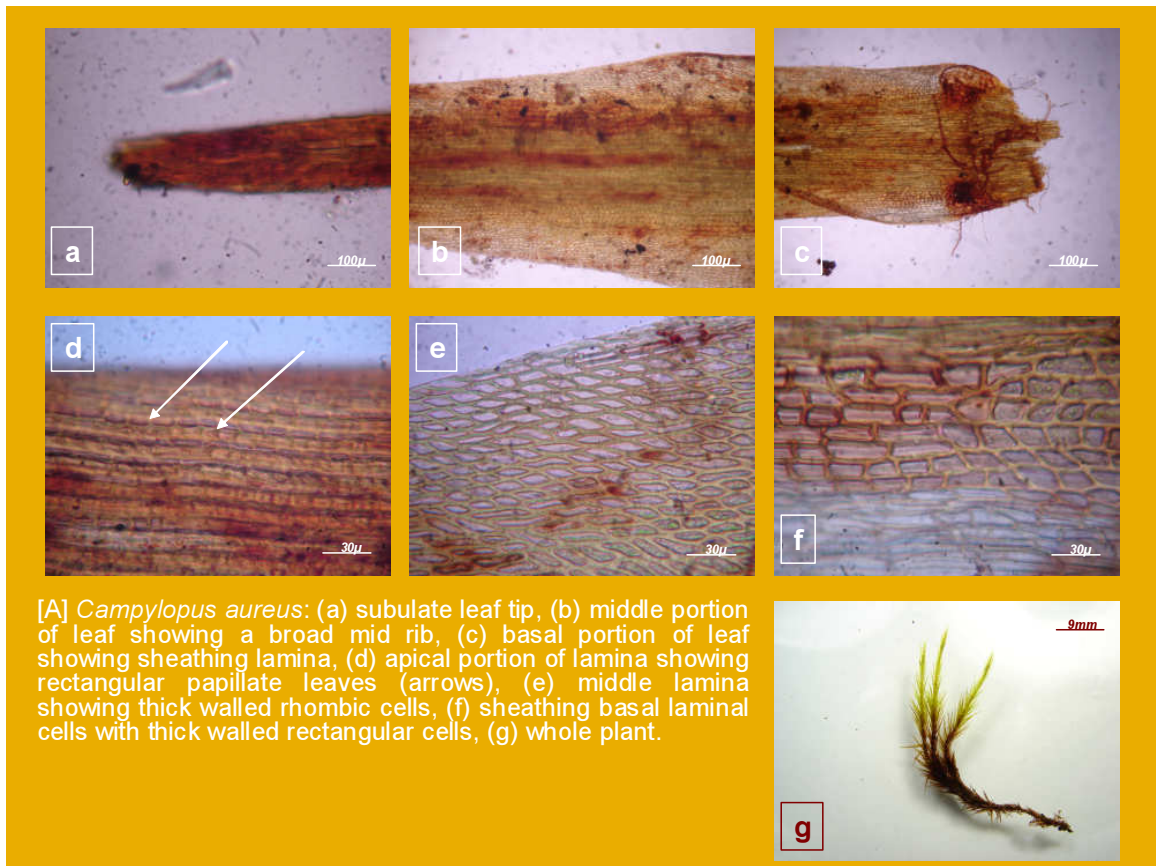
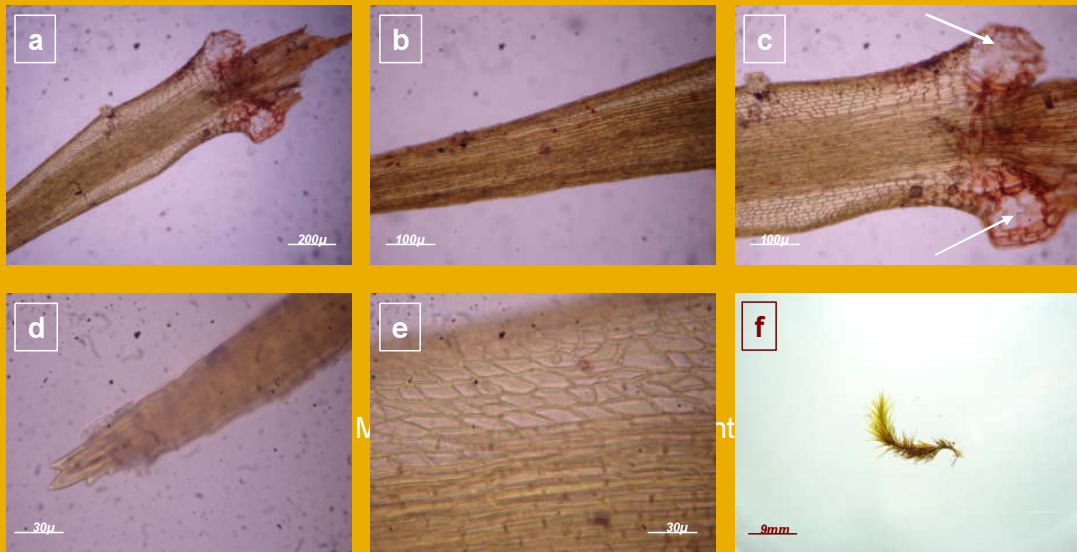
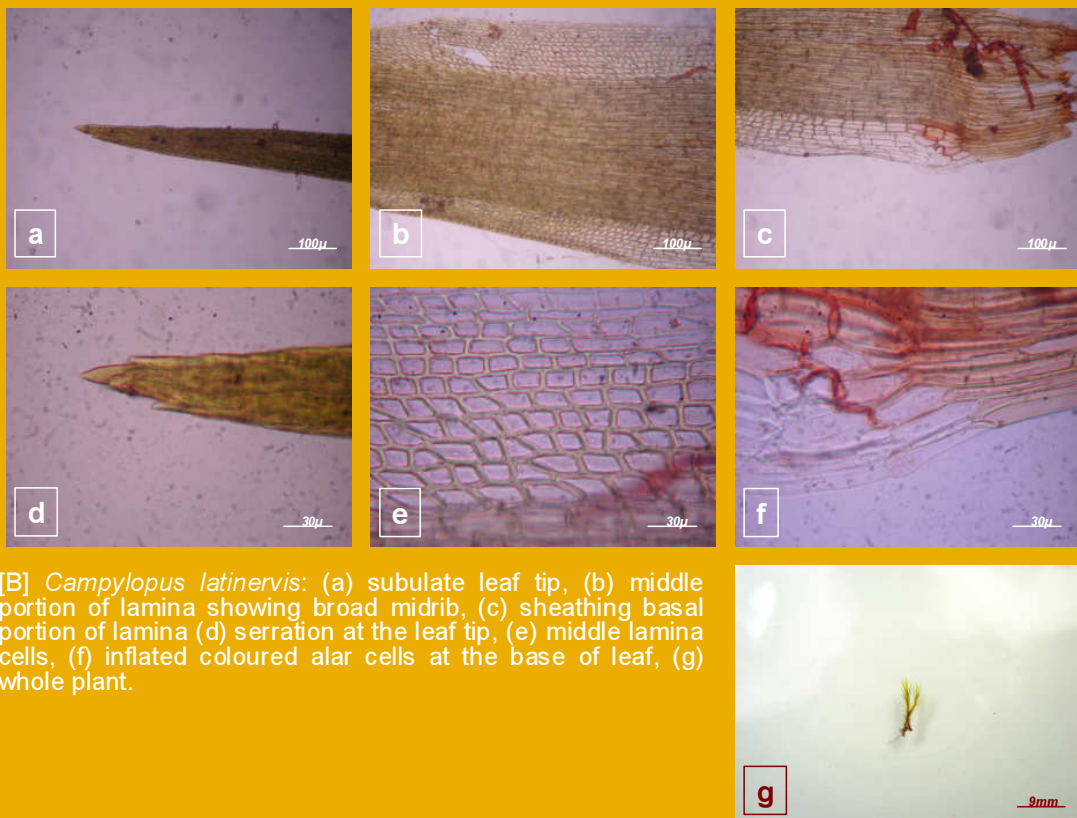


PLATE 16



[A] *Campylopus goughii*: (a) lower portion of leaf showing broad costa and extended base, (b) middle portion of leaf, (c) basal portion of leaf showing extended base of alar cells (arrows), (d) subulate leaf tip, (e) middle portion showing rhombic cells and broad mid rib, (f) whole plant.



[B] *Campylopus latinervis*: (a) subulate leaf tip, (b) middle portion of lamina showing broad midrib, (c) sheathing basal portion of lamina (d) serration at the leaf tip, (e) middle lamina cells, (f) inflated coloured alar cells at the base of leaf, (g) whole plant.

PLATE 17

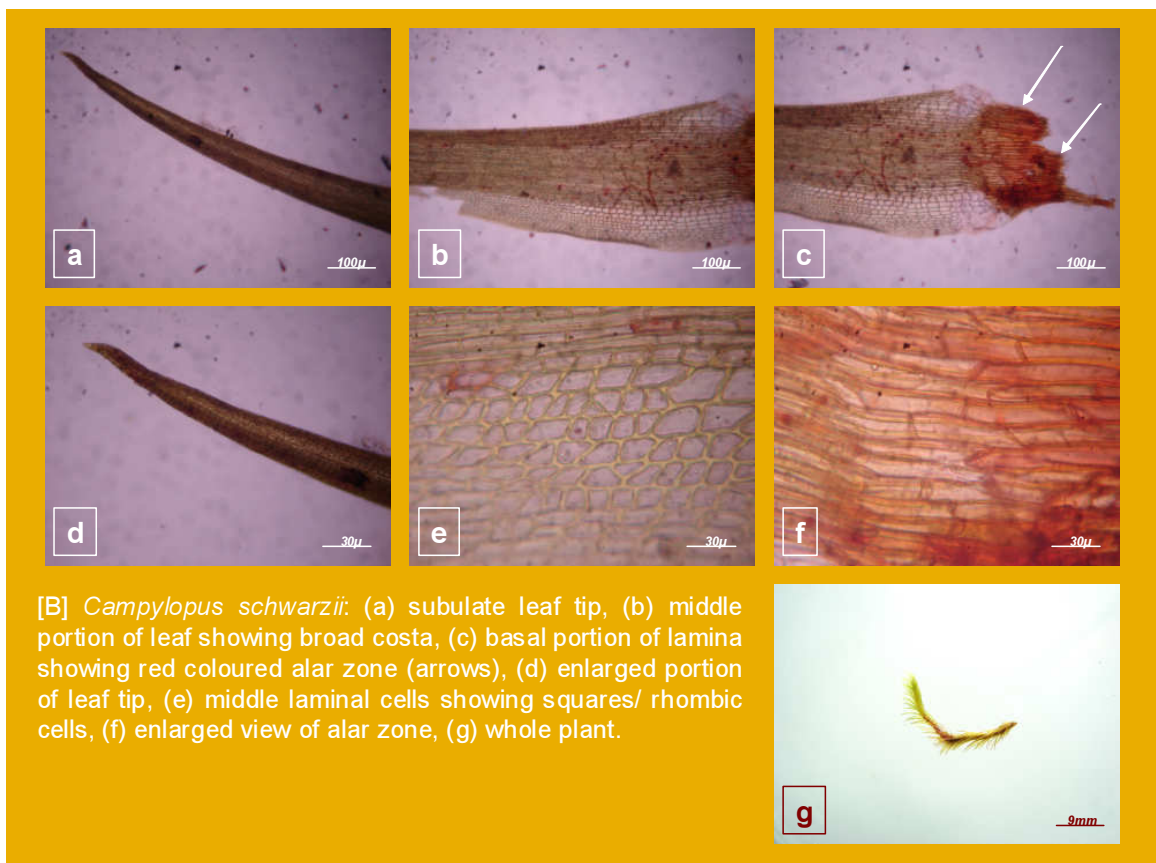
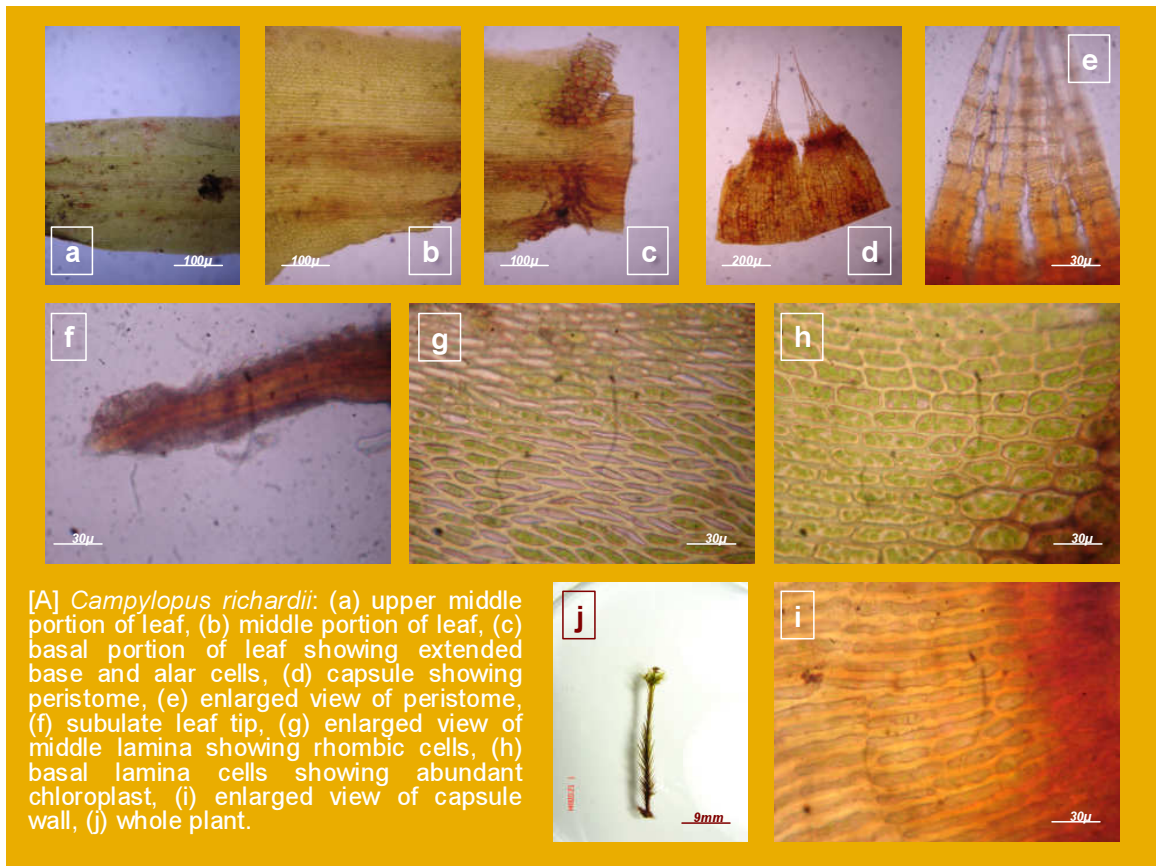


PLATE 18

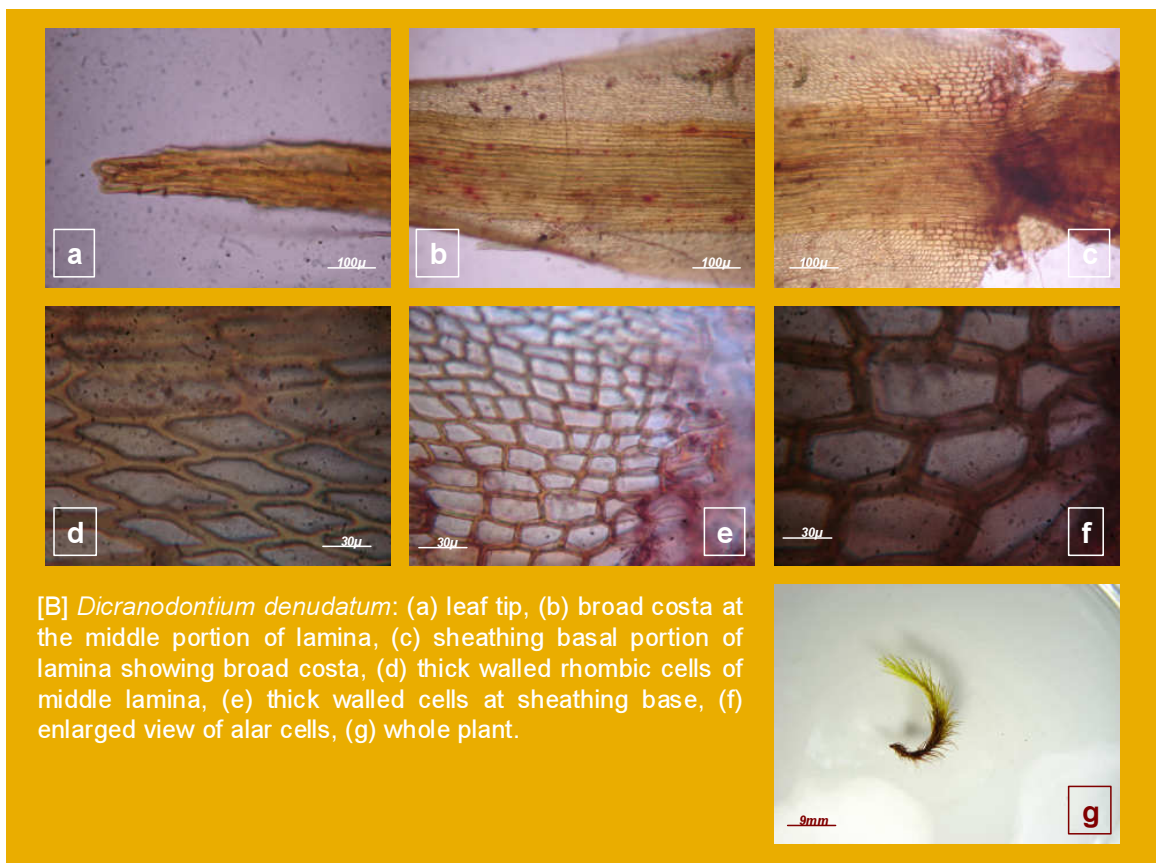
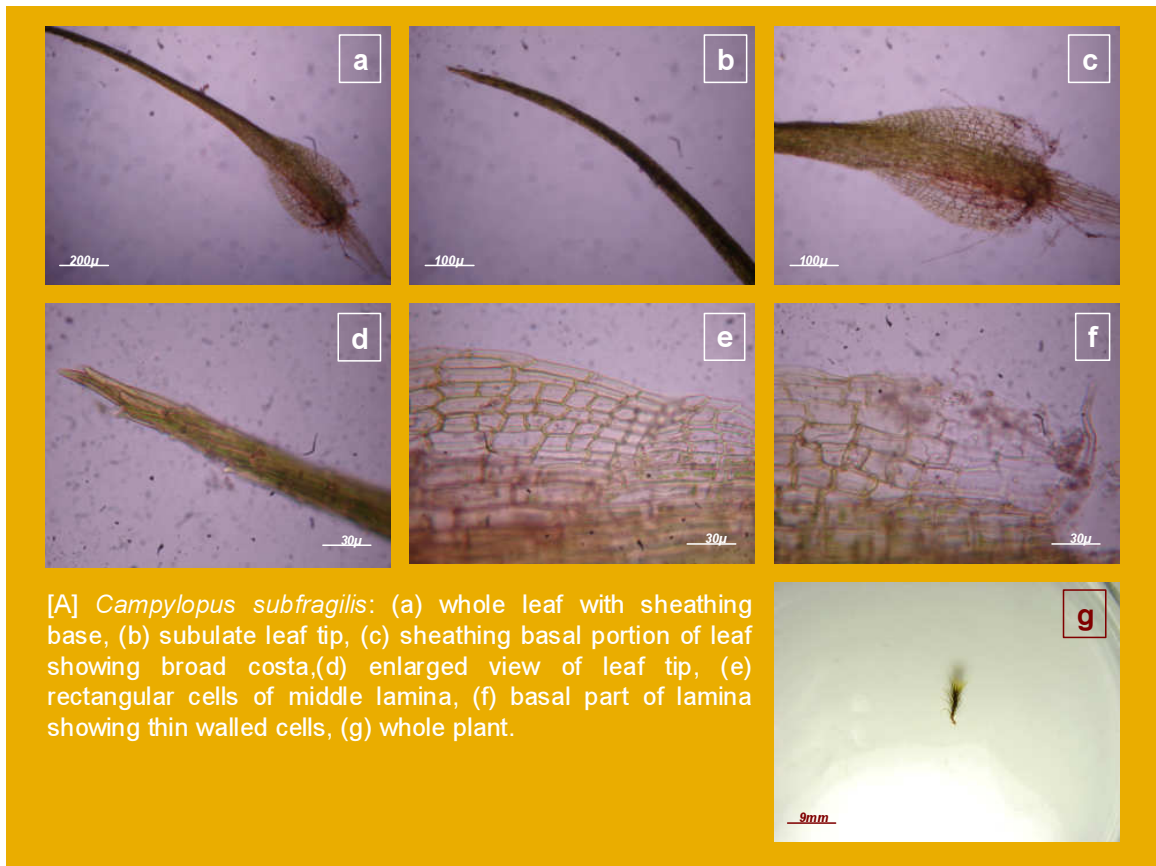


PLATE 19

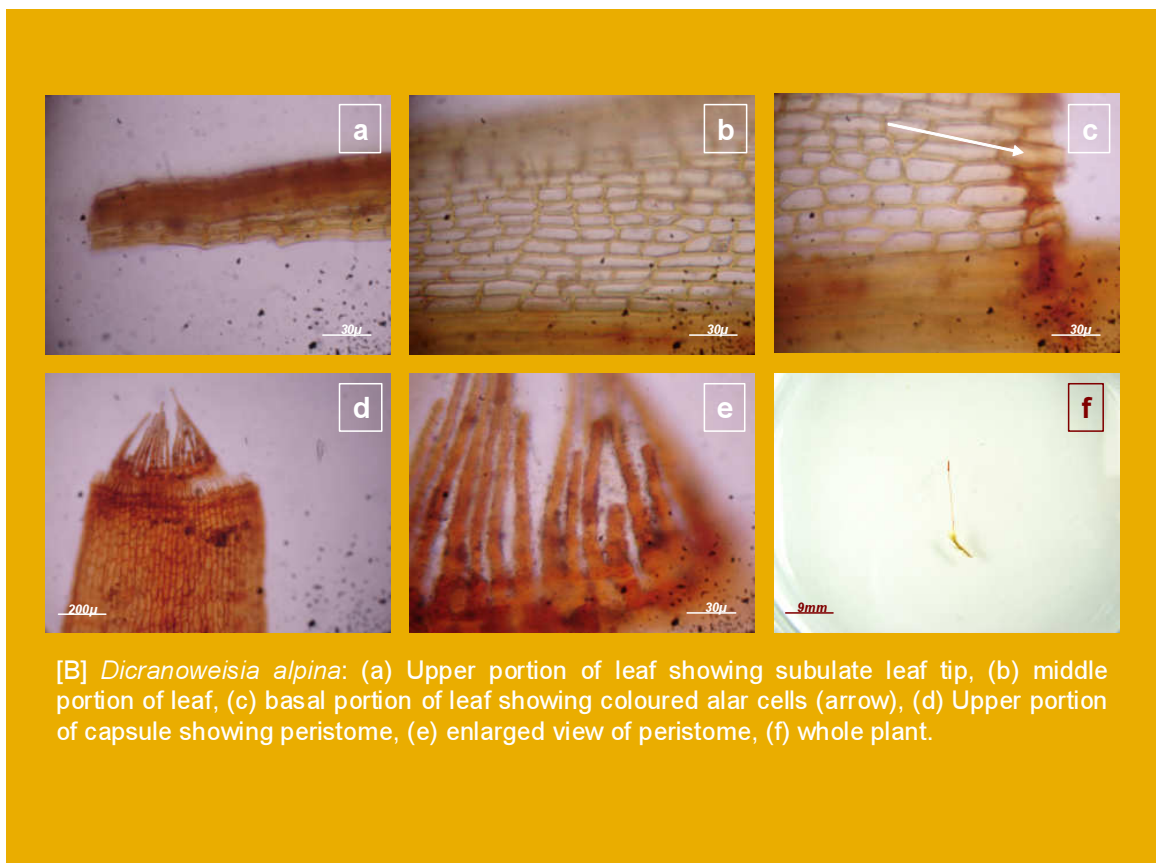
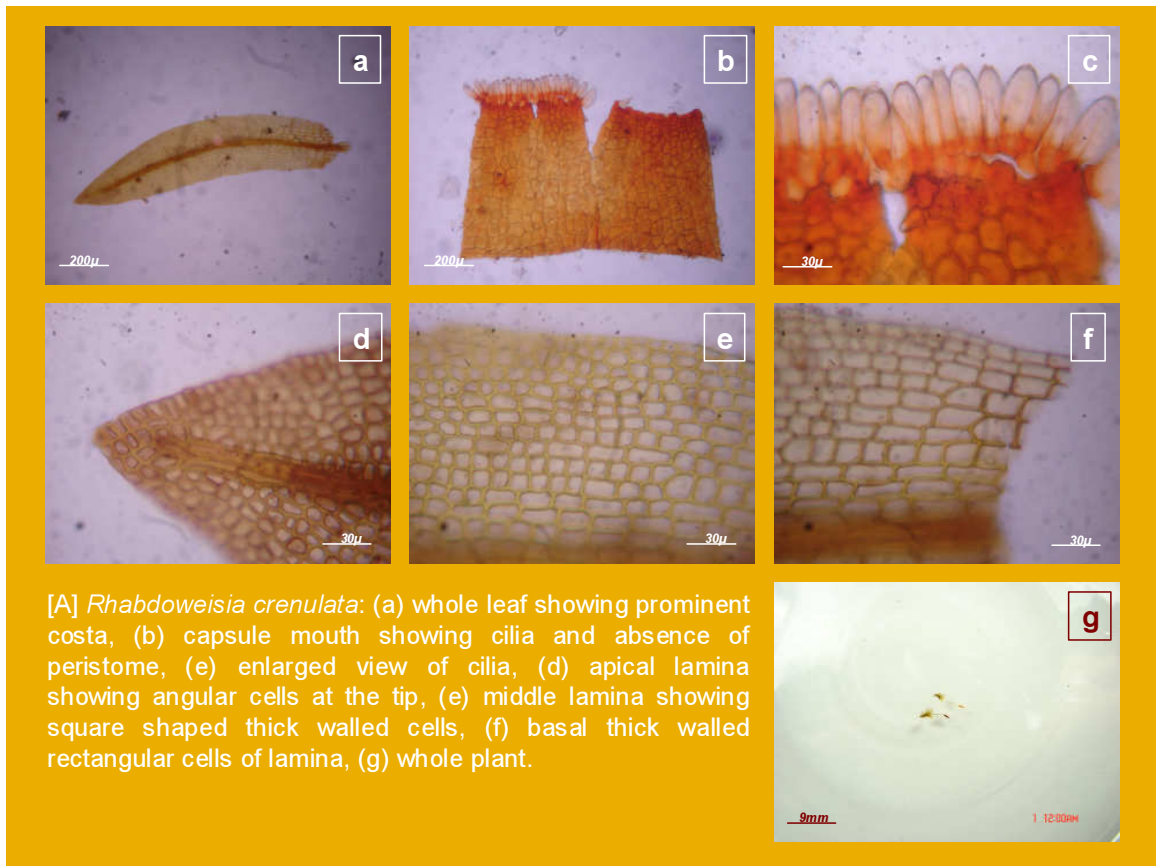
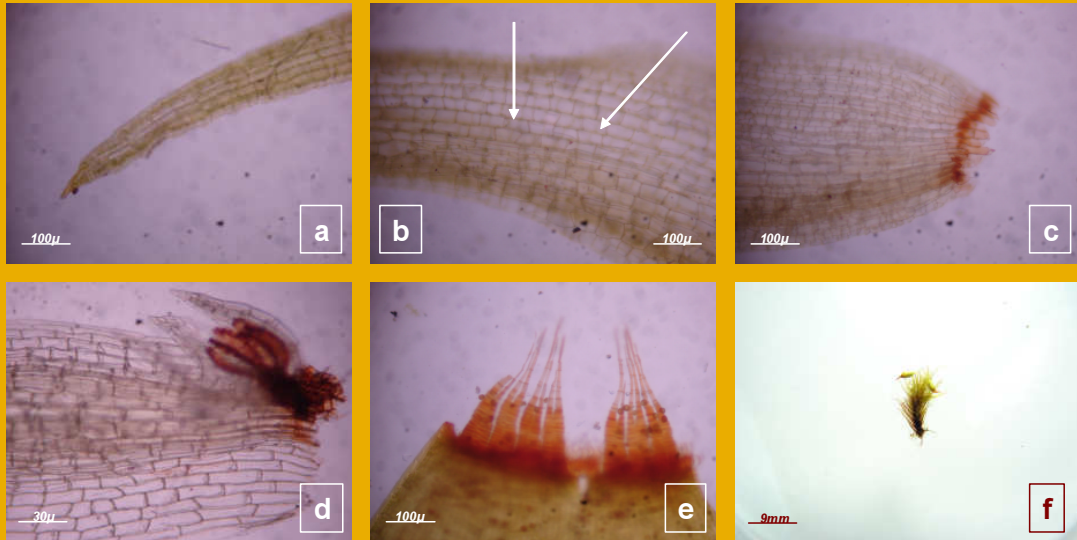
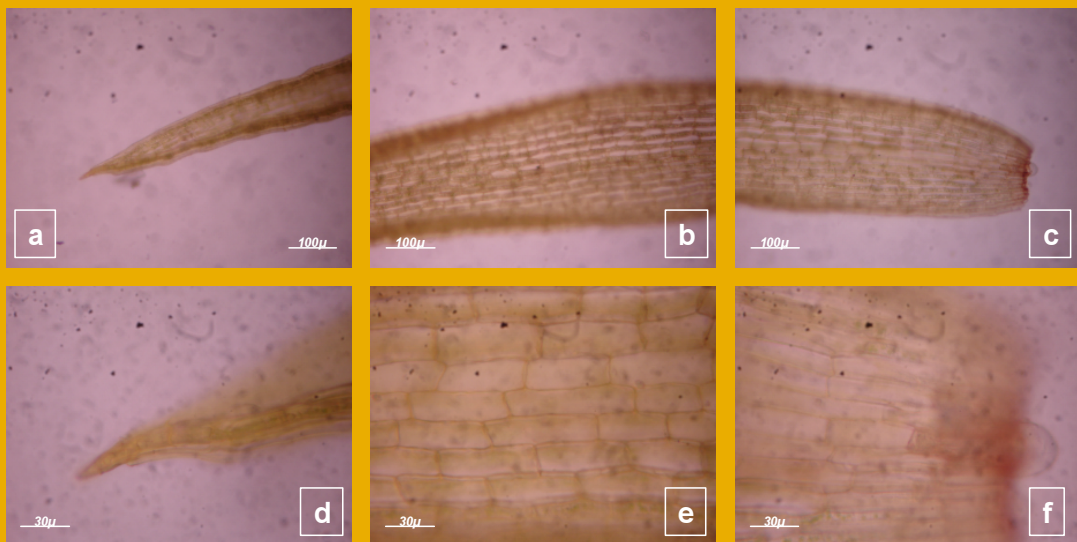


PLATE 20



[A] *Leucobryum bowringii*: (a) leaf tip showing rectangular cells, (b) middle lamina showing chlorophyllose and hyaline cells (arrows), (c) basal lamina showing a row of coloured alar cells, (d) a bunch of antheridia at the base of leaf, (e) capsule mouth showing divided peristome, (f) whole plant.



[B] *Leucobryum juniperoideum*: (a) upper portion of leaf, (b) middle portion of lamina showing rectangular cells, (c) basal lamina, (d) apical lamina with elongated cells, (e) middle lamina with hyaline rectangular cells, (f) basal lamina showing hyaline rectangular cells, (g) a bunch of leaves at the apex of whole plant, (h) whole plant.



PLATE 21

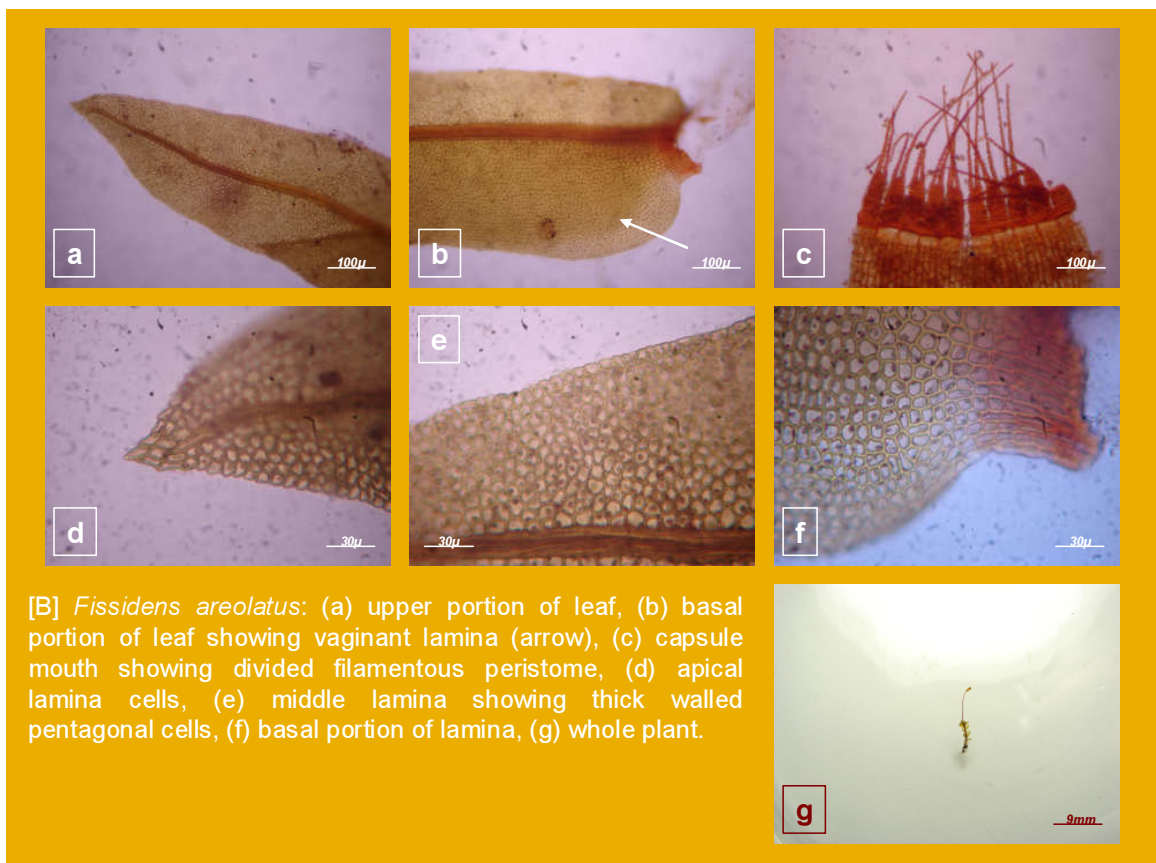
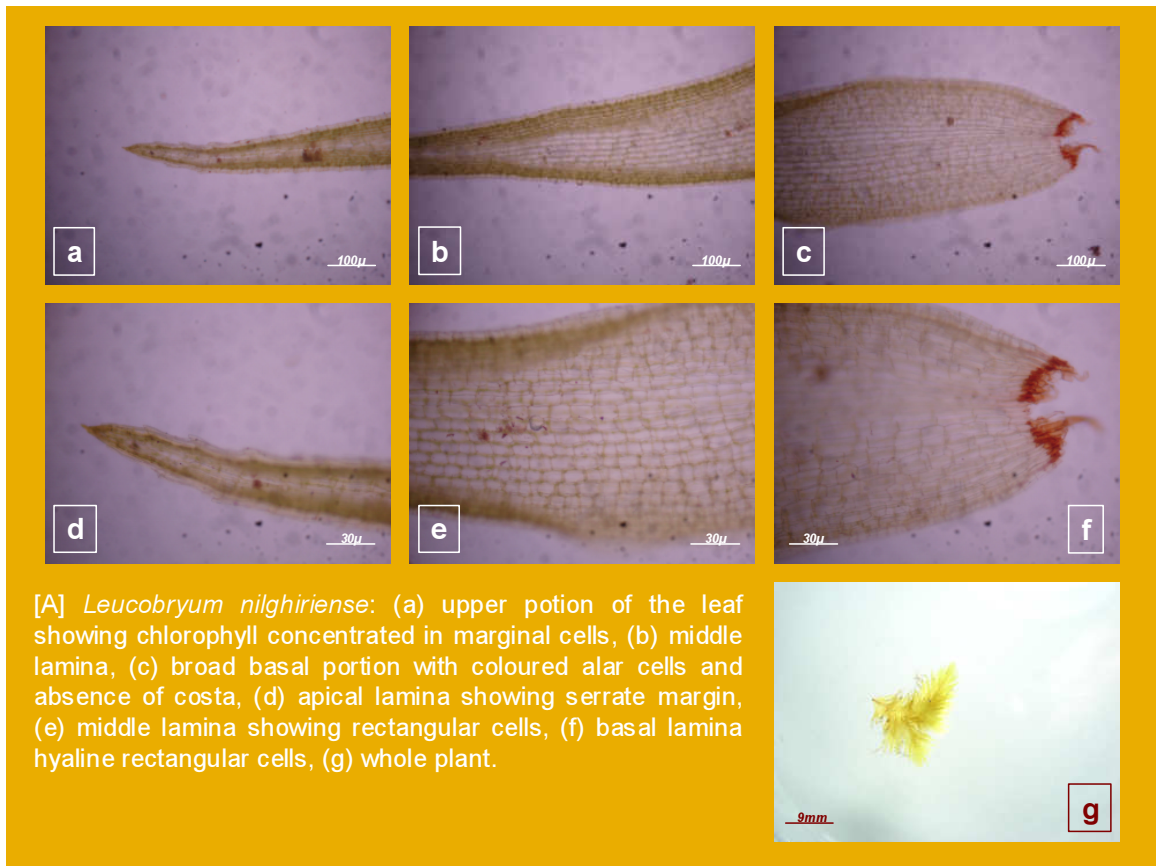
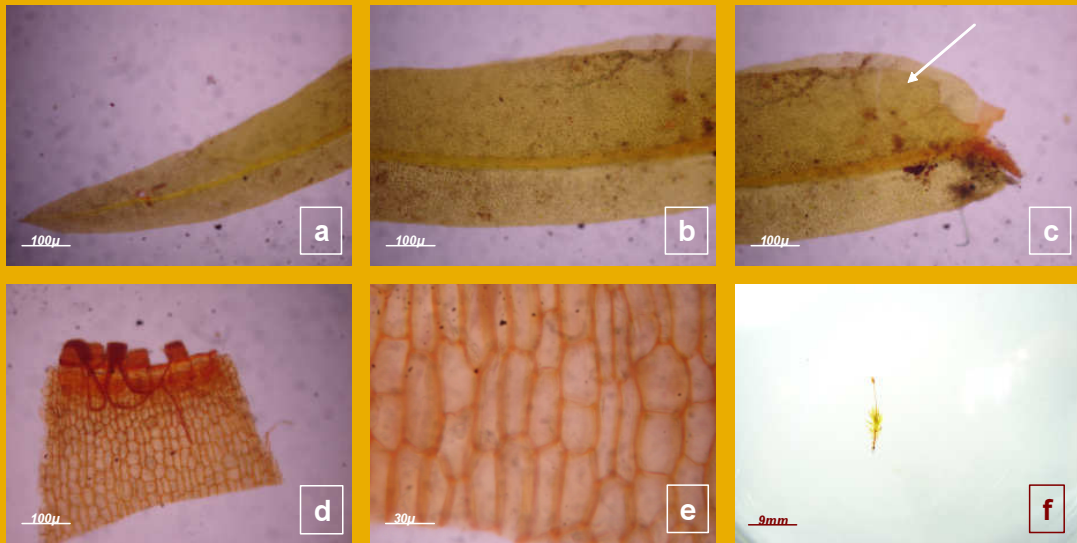
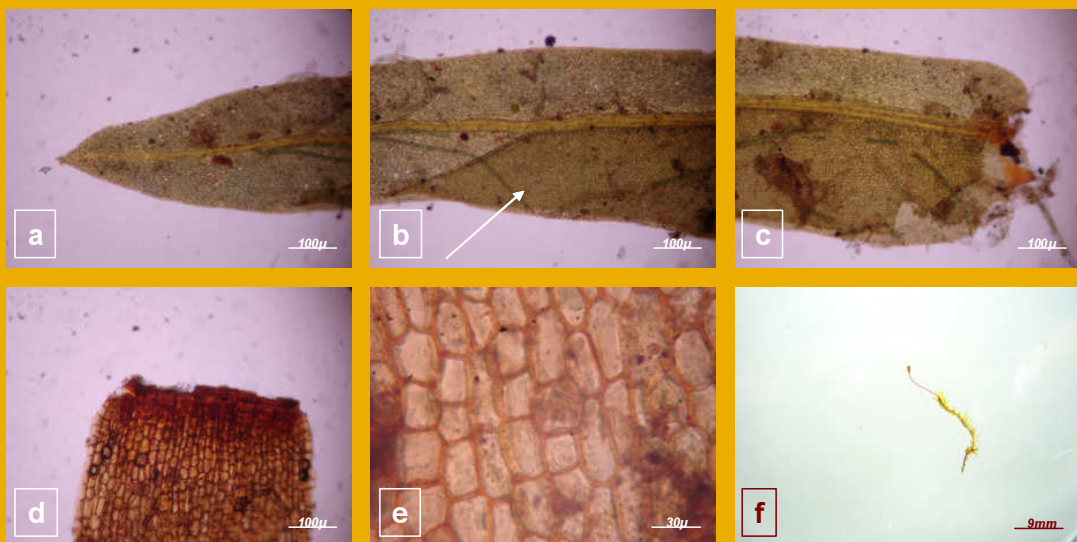


PLATE 22



[A] *Fissidens pellucidus*: (a) upper portion of lamina, (b) middle lamina, (c) basal portion showing vaginant lamina (arrow), (d) capsule mouth showing filamentous peristome, (e) exothecial thick walled cells, (f) whole plant.



[B] *Fissidens pulchellus*: (a) upper portion of leaf, (b) middle portion of leaf showing vaginant lamina (arrow), (c) basal lamina, (d) capsule mouth, (e) exothecial thick walled cells, (f) whole plant.

PLATE 23

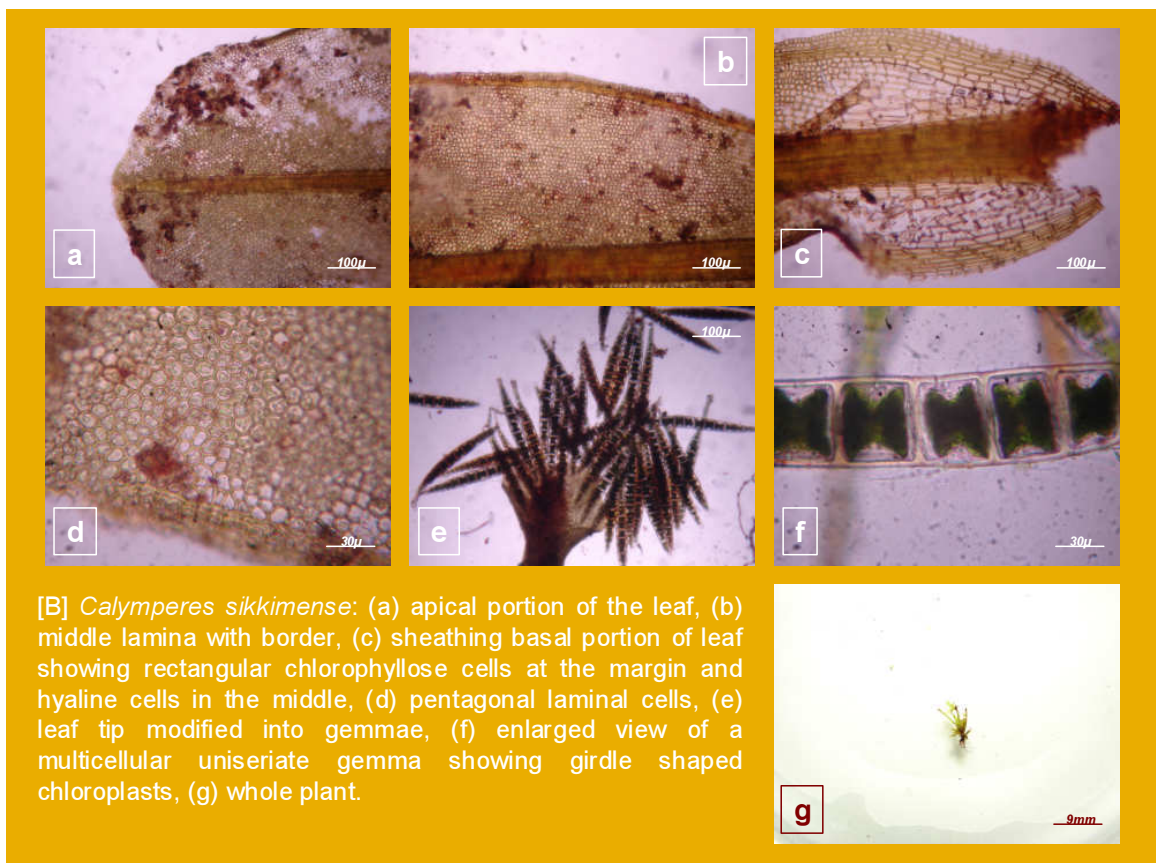
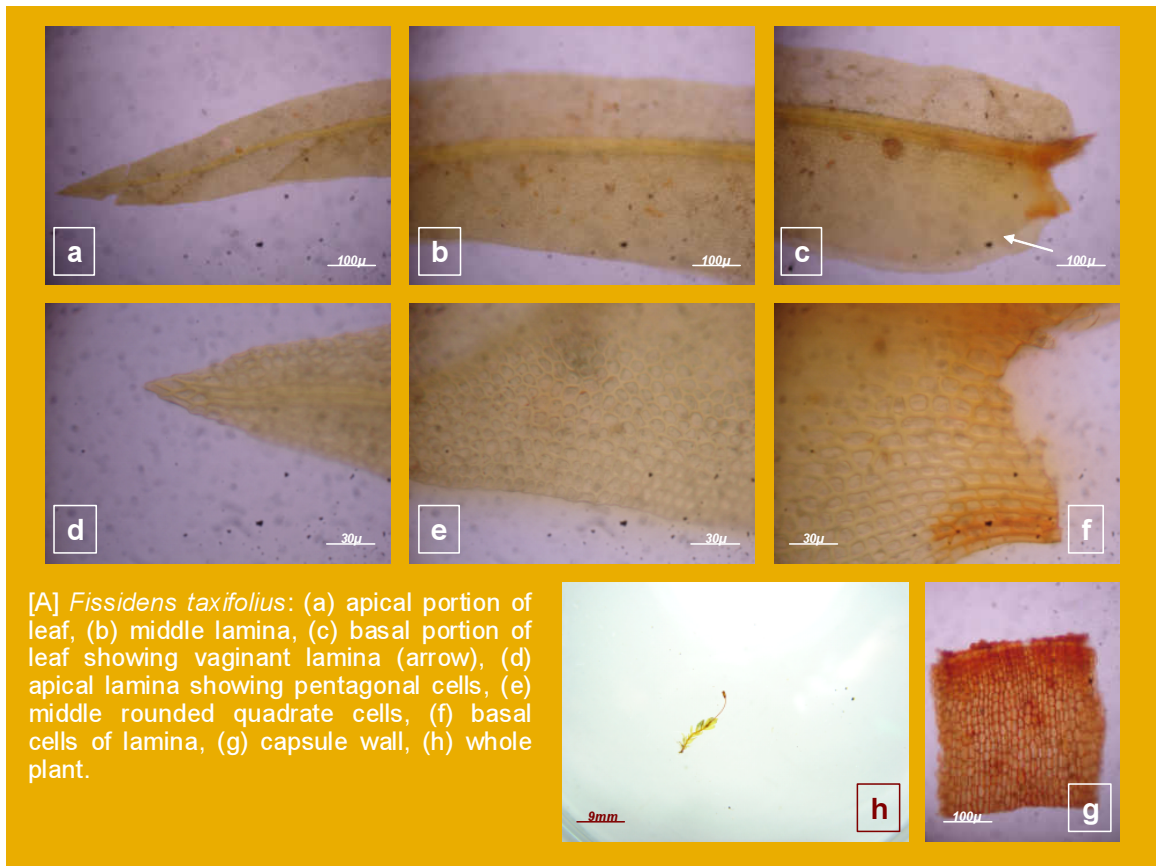


PLATE 24

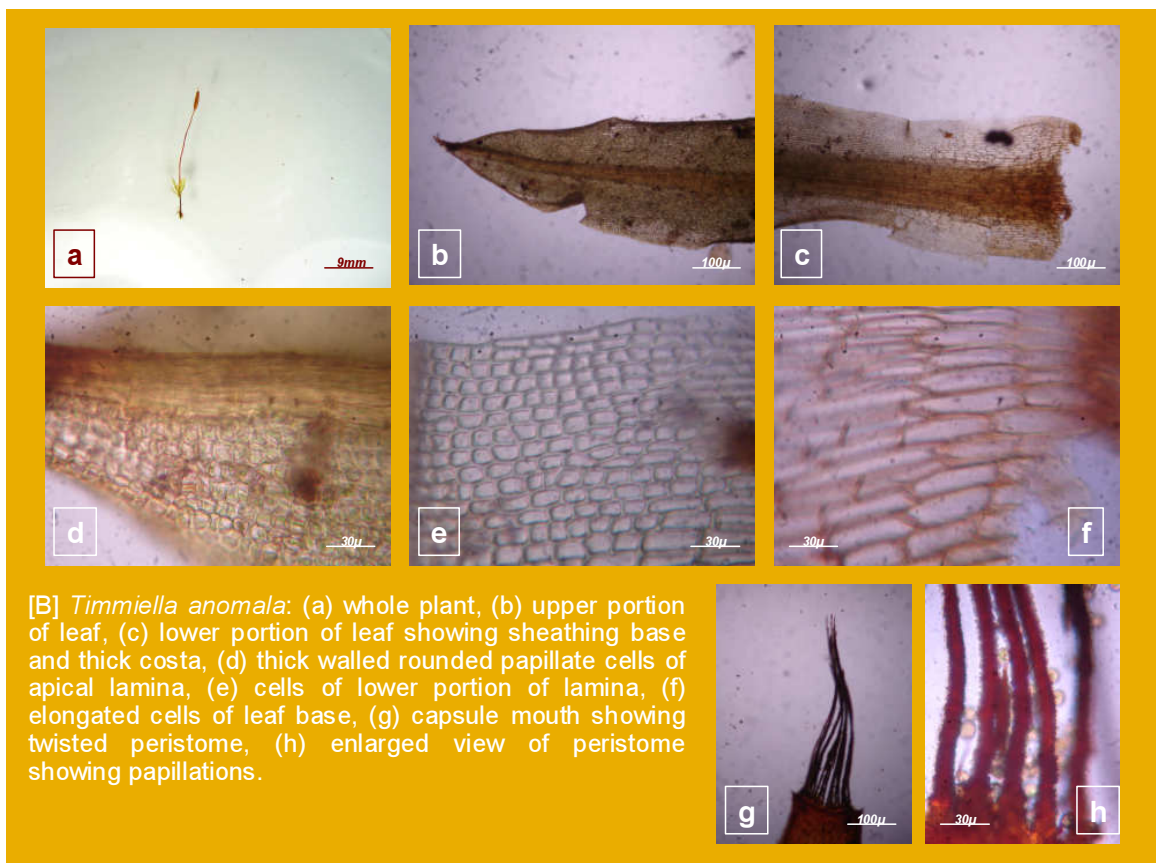


PLATE 25

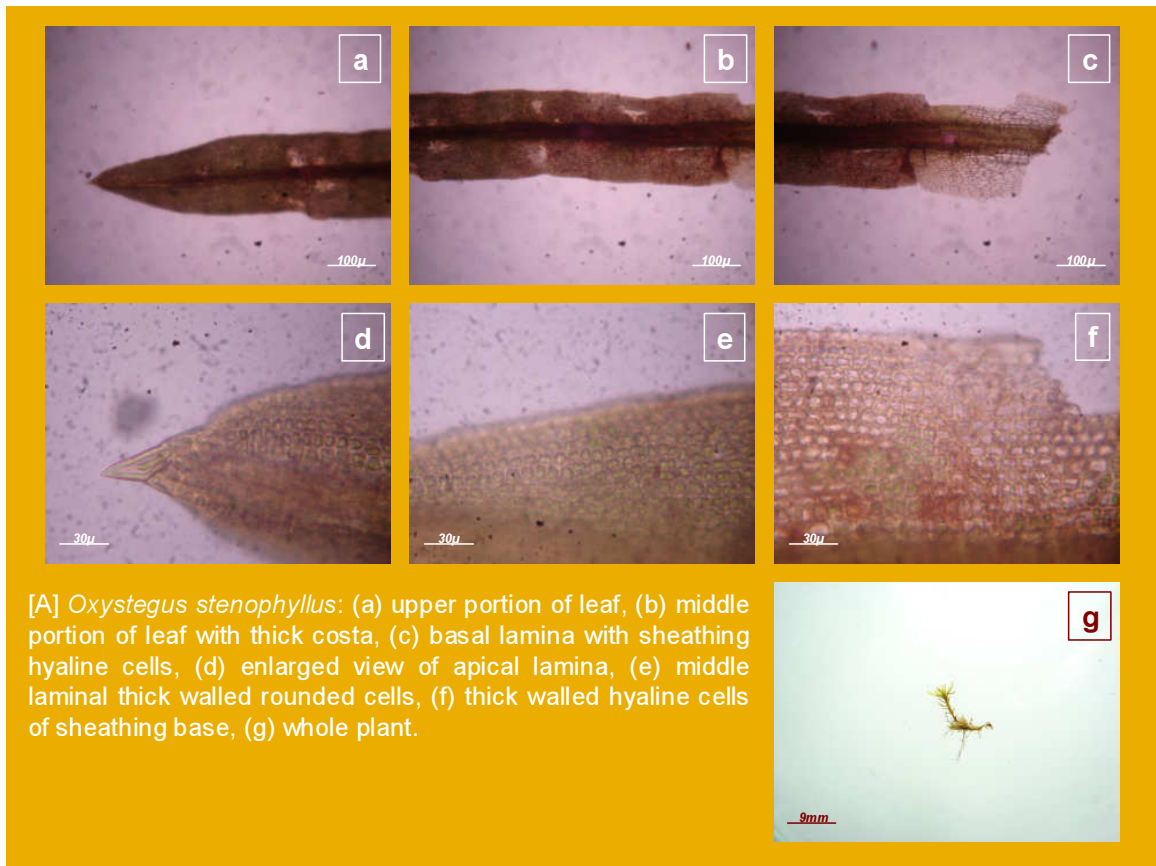
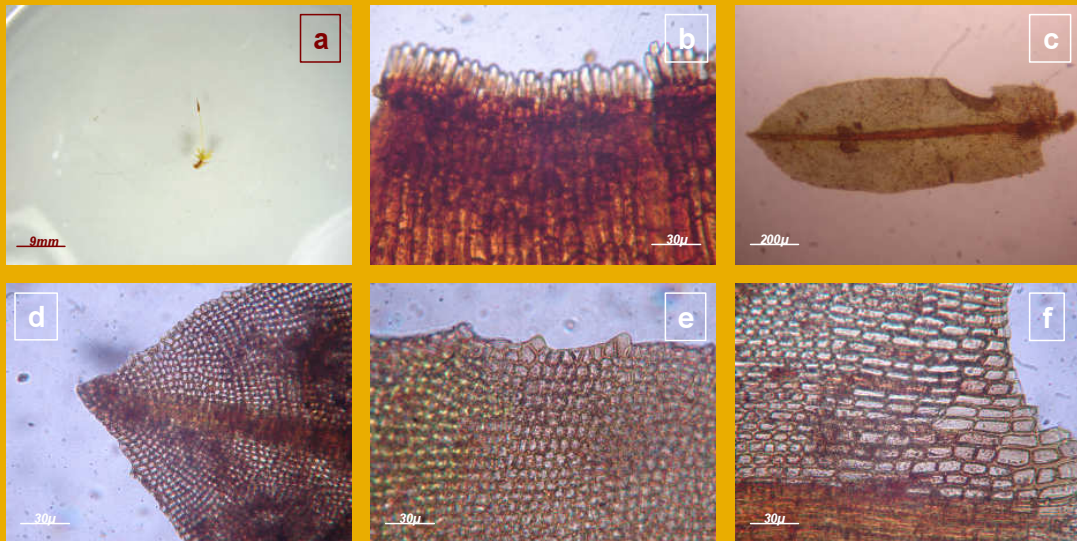
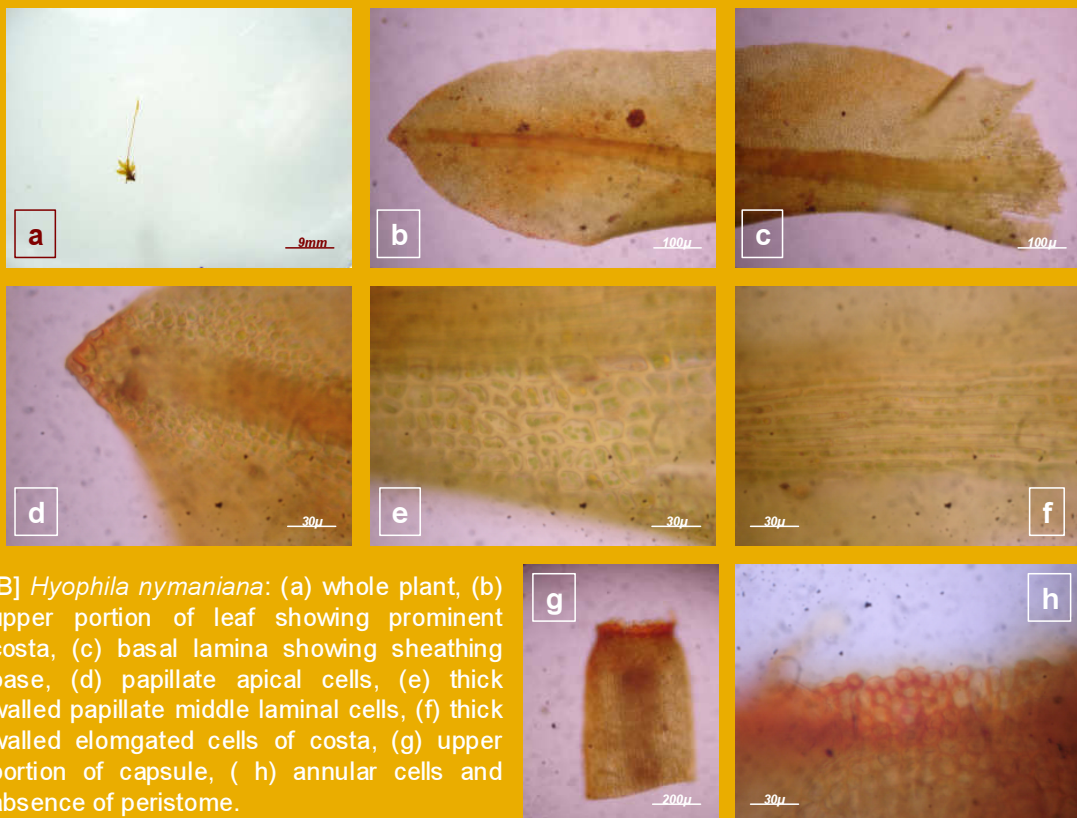


PLATE 26



[A] *Hyophila involuta*: (a) whole plant, (b) capsule mouth showing cilia and lacking peristome, (c) whole leaf showing prominent costa, (d) apical portion of leaf showing thick walled small rounded cells, (e) middle laminal cells showing dentations on margin, (f) basal rectangular thick walled cells of lamina.



[B] *Hyophila nymaniana*: (a) whole plant, (b) upper portion of leaf showing prominent costa, (c) basal lamina showing sheathing base, (d) papillate apical cells, (e) thick walled papillate middle laminal cells, (f) thick walled elongated cells of costa, (g) upper portion of capsule, (h) annular cells and absence of peristome.

PLATE 27

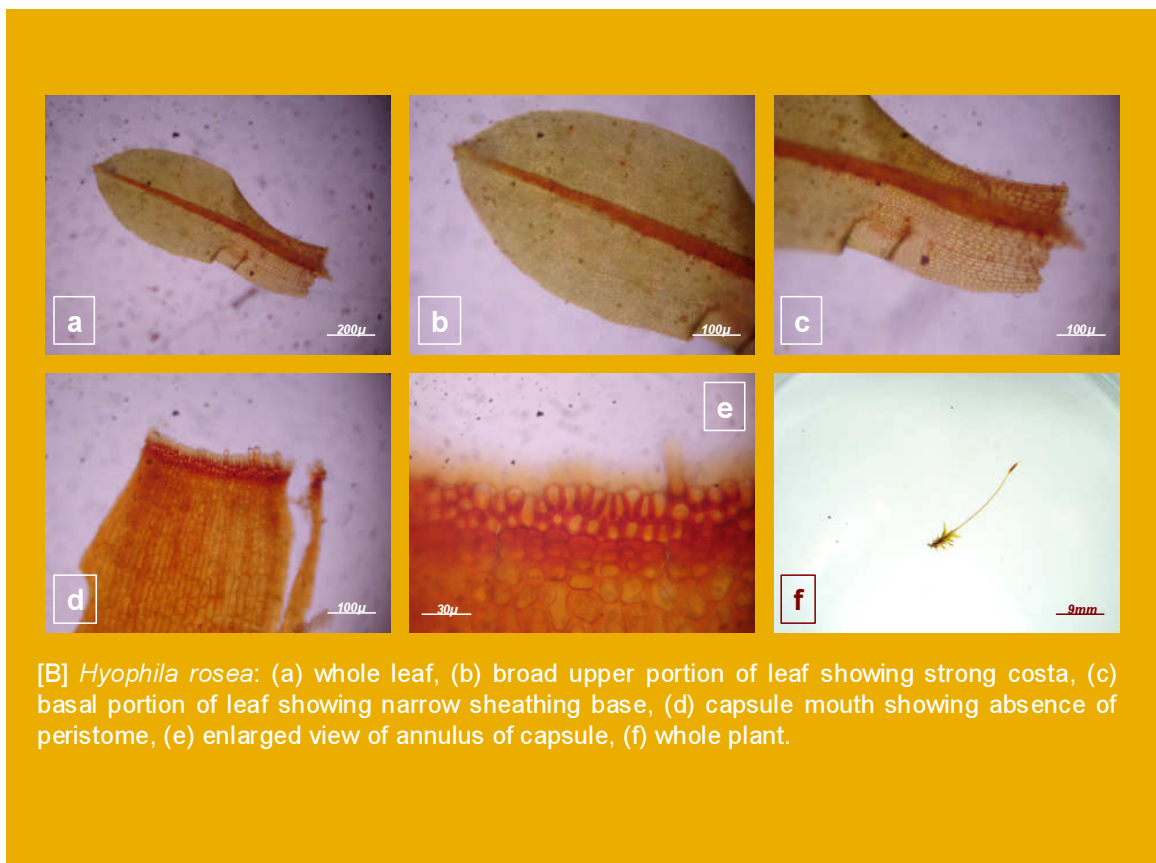


PLATE 28

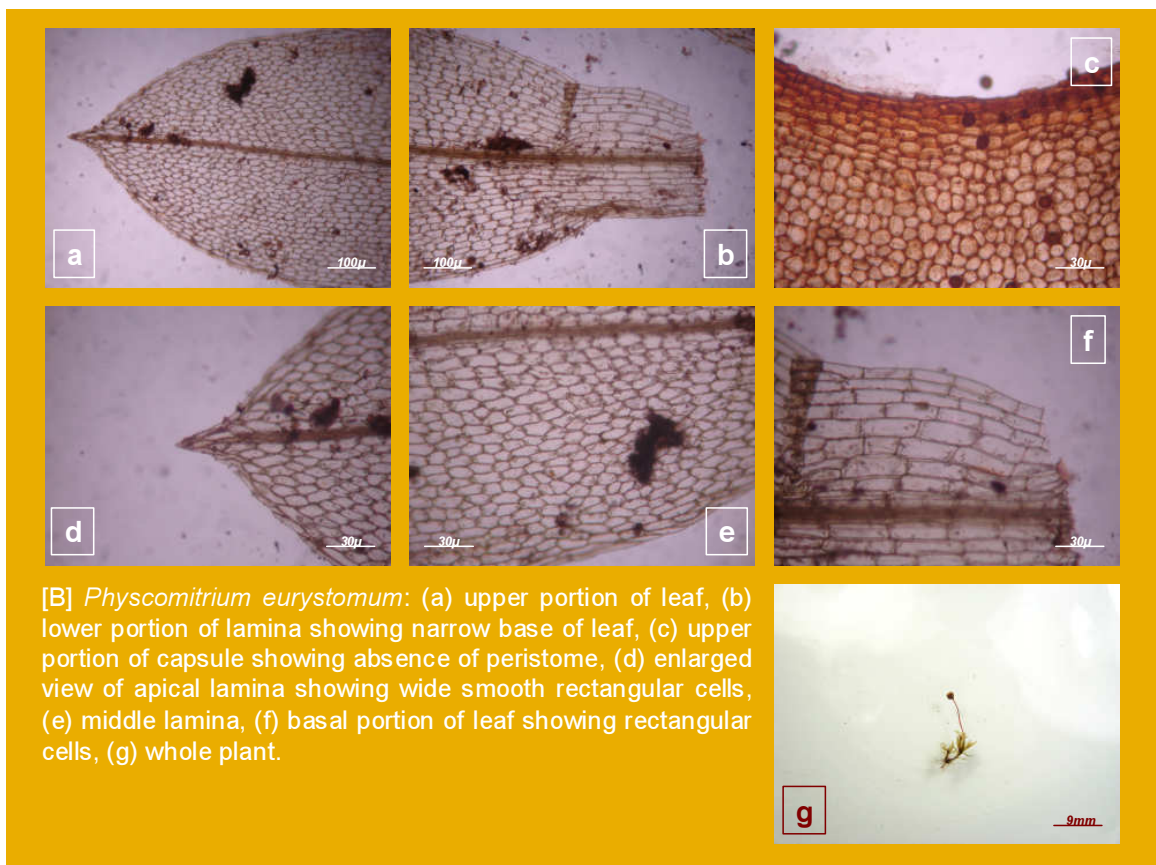


PLATE 29

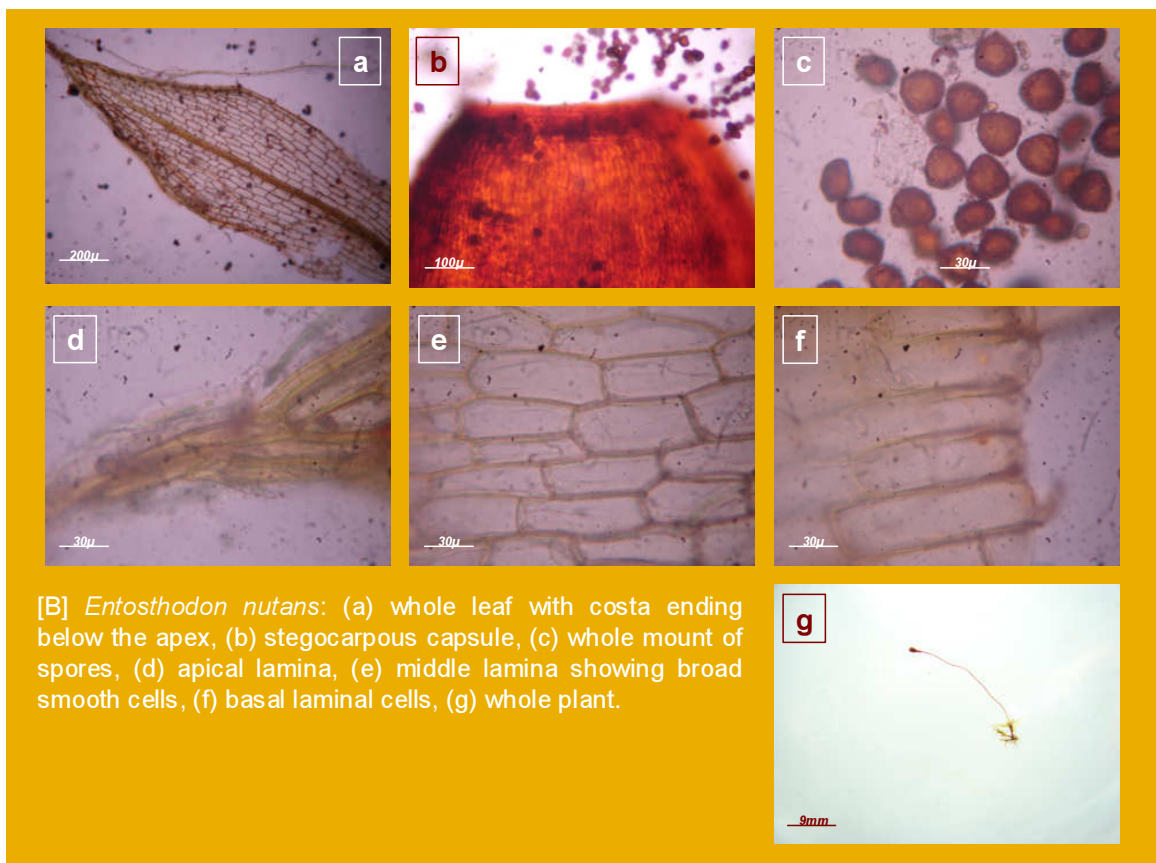
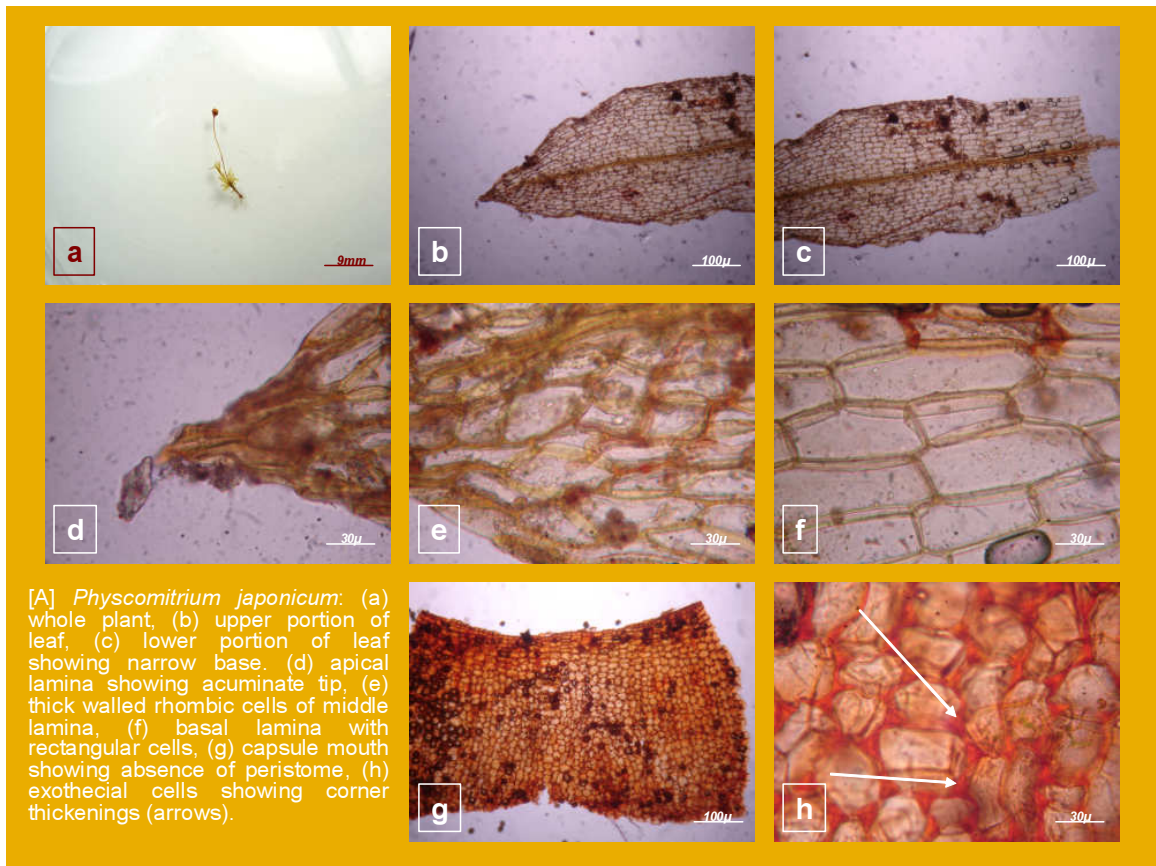


PLATE 30

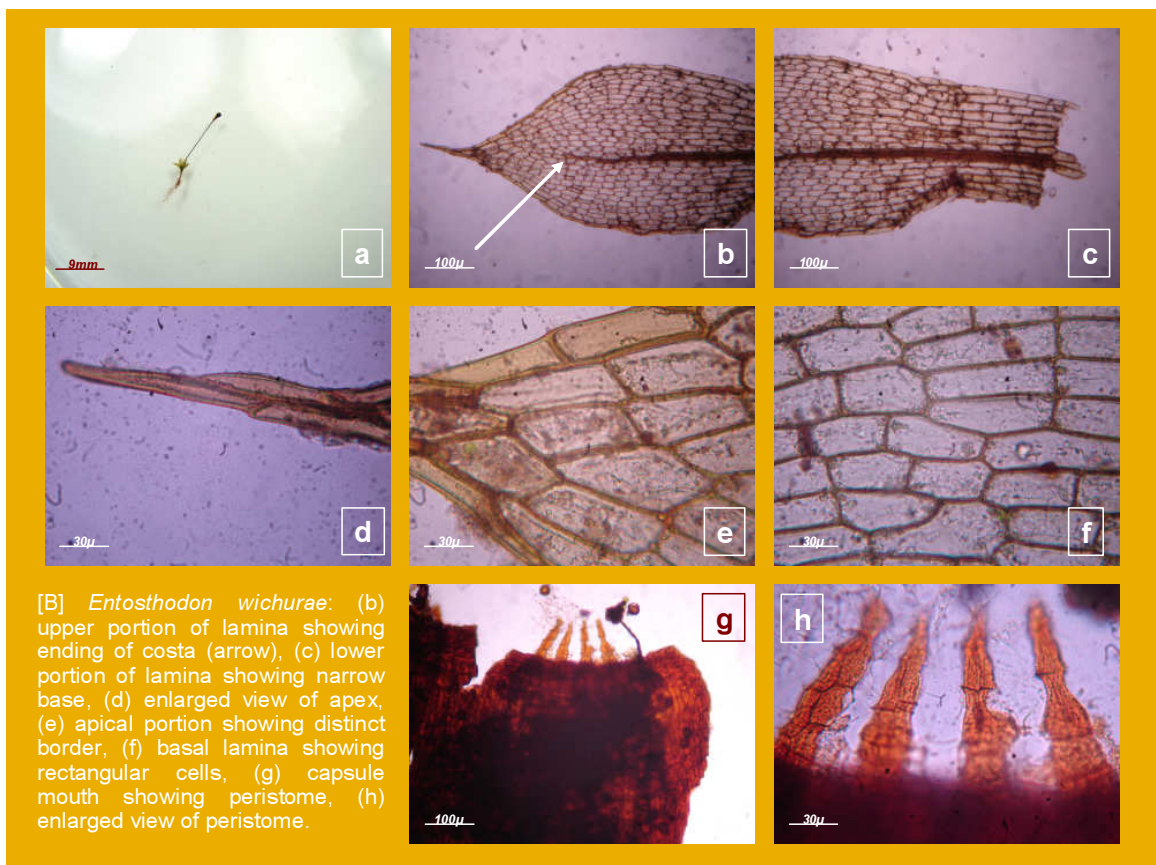
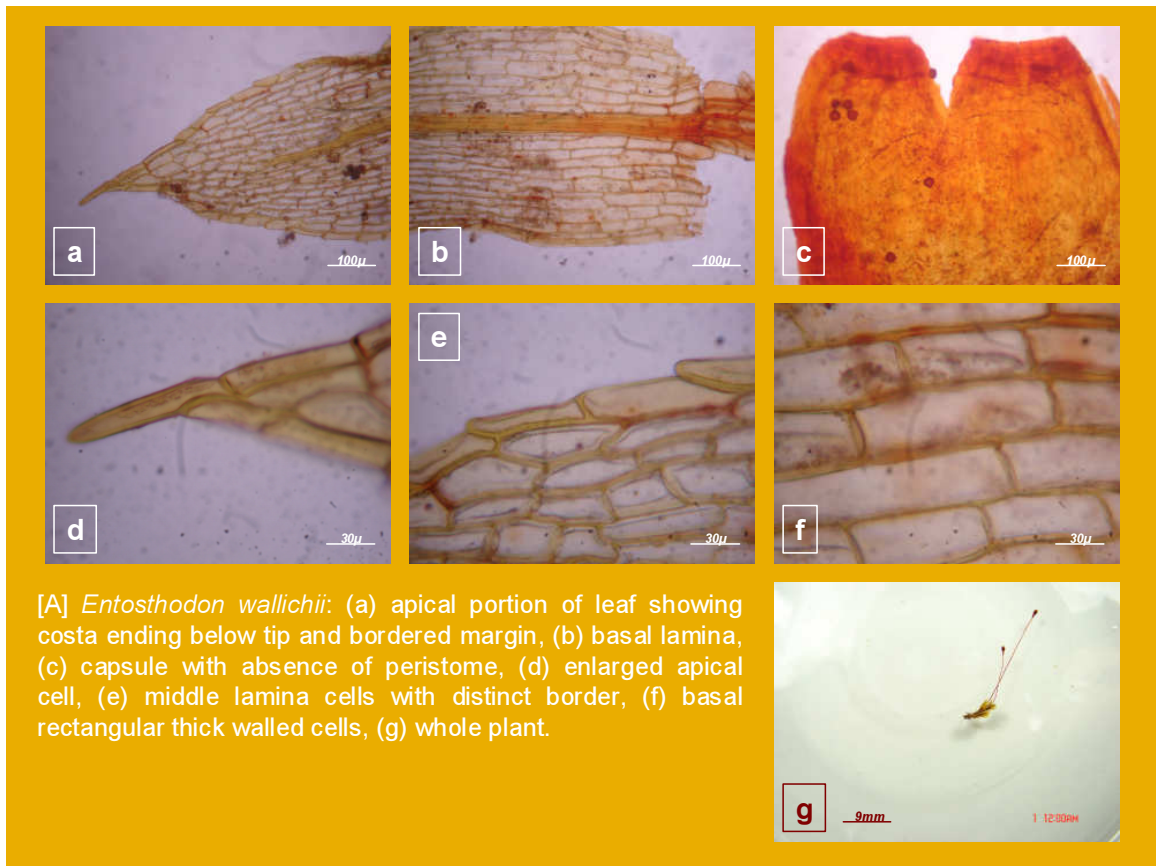


PLATE 31

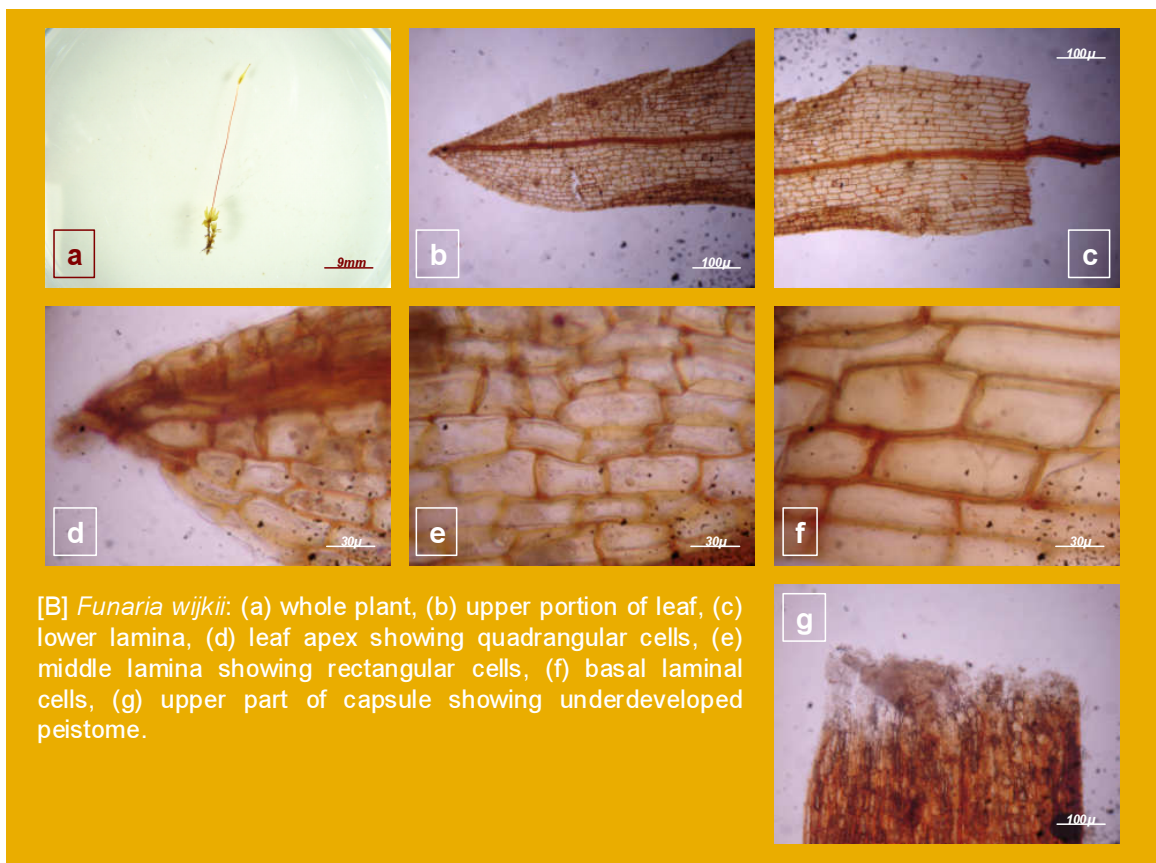
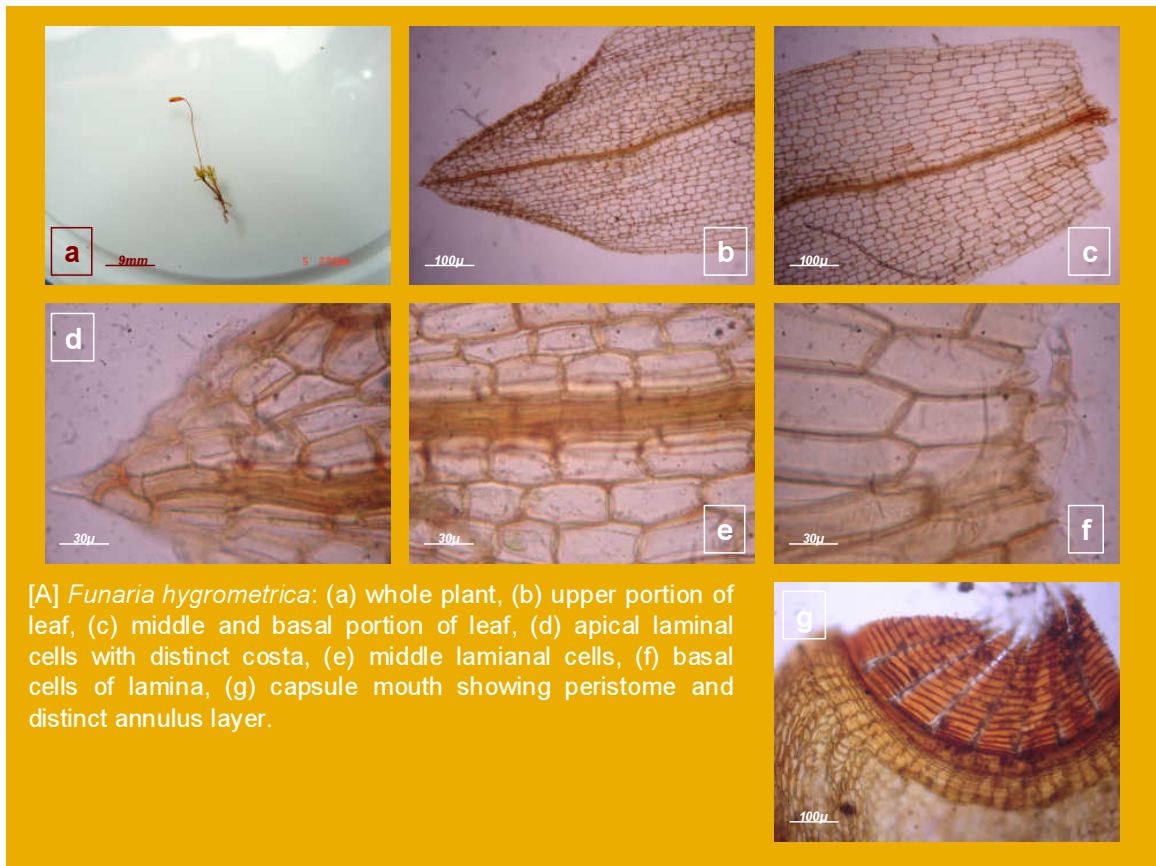
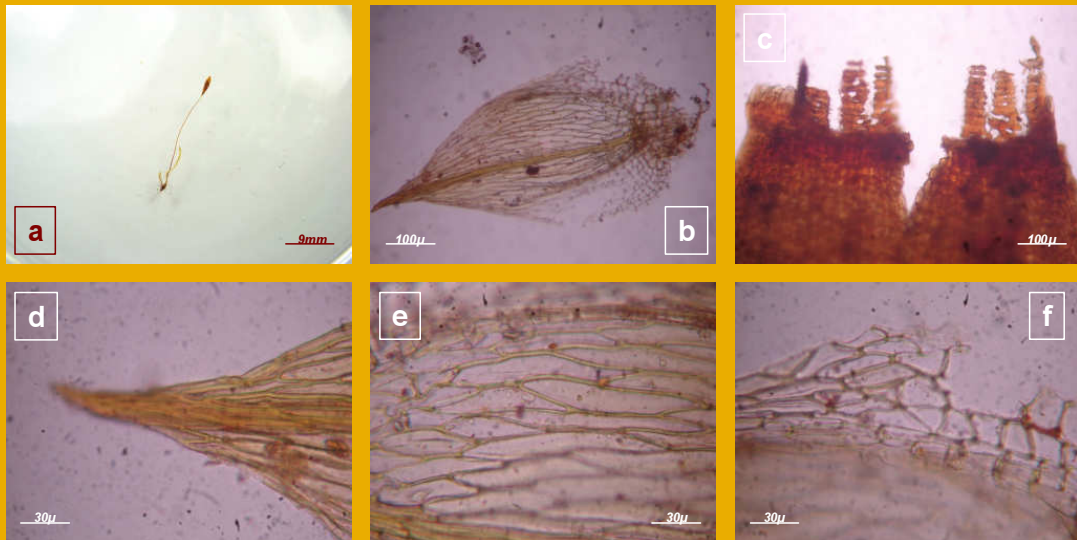
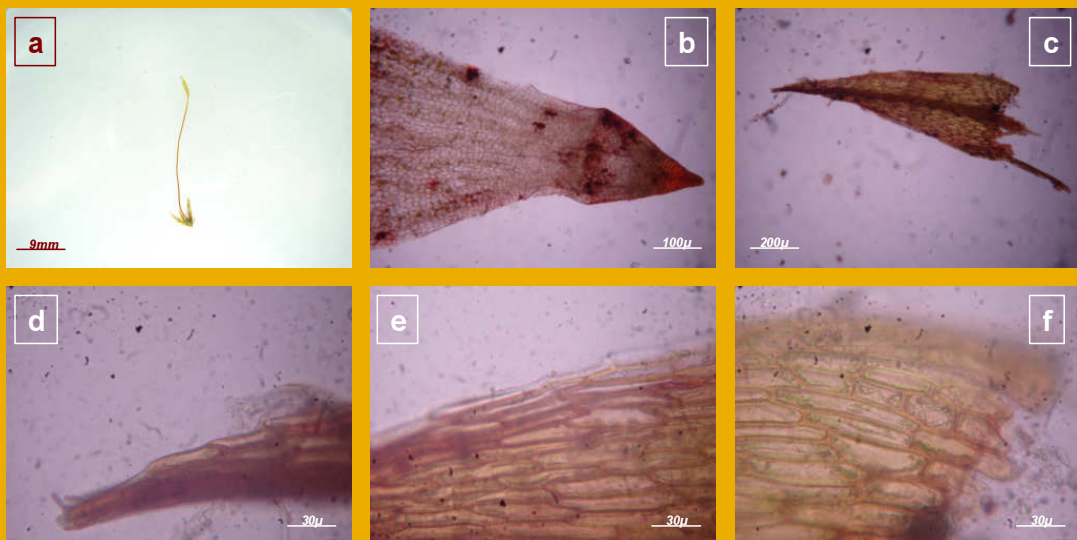


PLATE 32



[A] *Orthodontium infractum*: (a) whole plant, (b) whole leaf showing prominent costa and fragile base, (c) capsule mouth showing peristome, (d) apical portion of leaf, (e) middle lamina showing narrow rhombic cells, (f) basal fragile cells of lamina.



[B] *Mileichhoferia himalayana*: (a) whole plant, (b) capsule mouth showing reduced peristome, (c) whole leaf with prominent excurrent costa, (d) apical lamina showing acuminate tip, (e) narrow rhombic cells of the middle lamina, (f) rectangular alar cells at the base of leaf.

PLATE 33

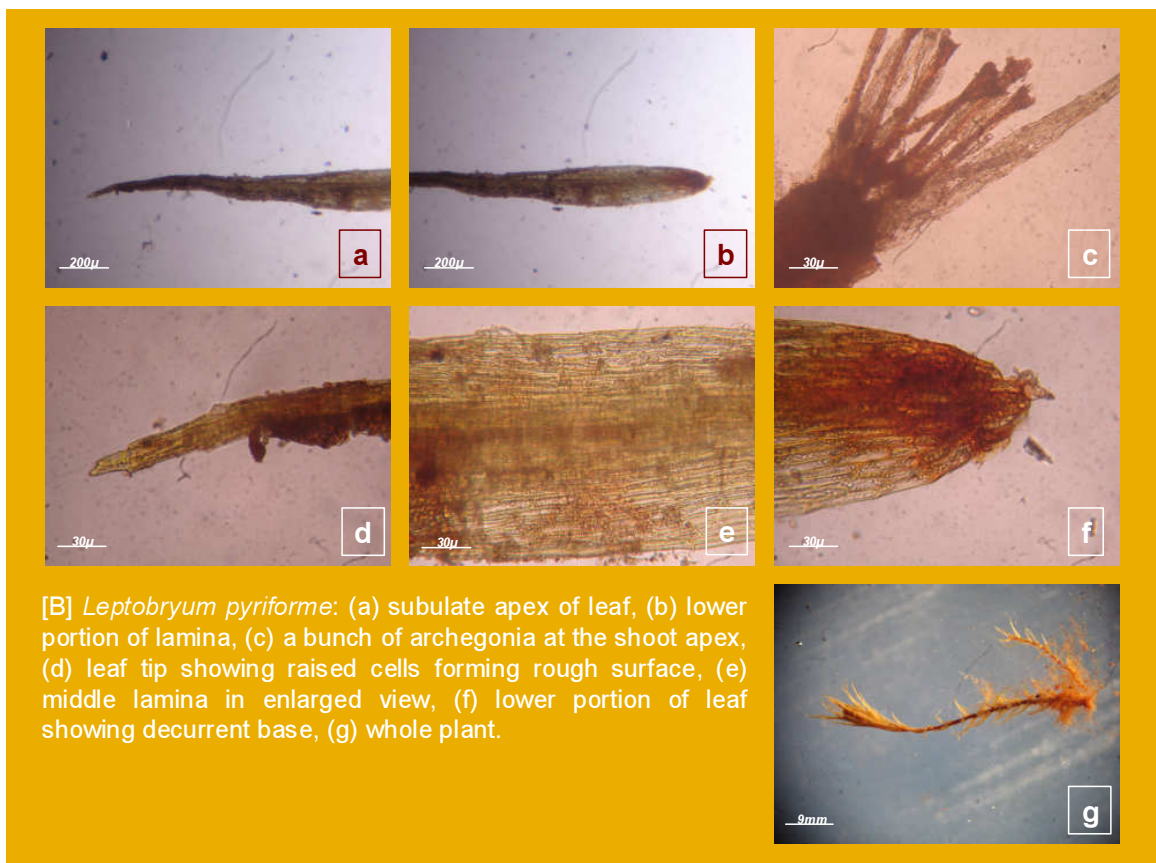
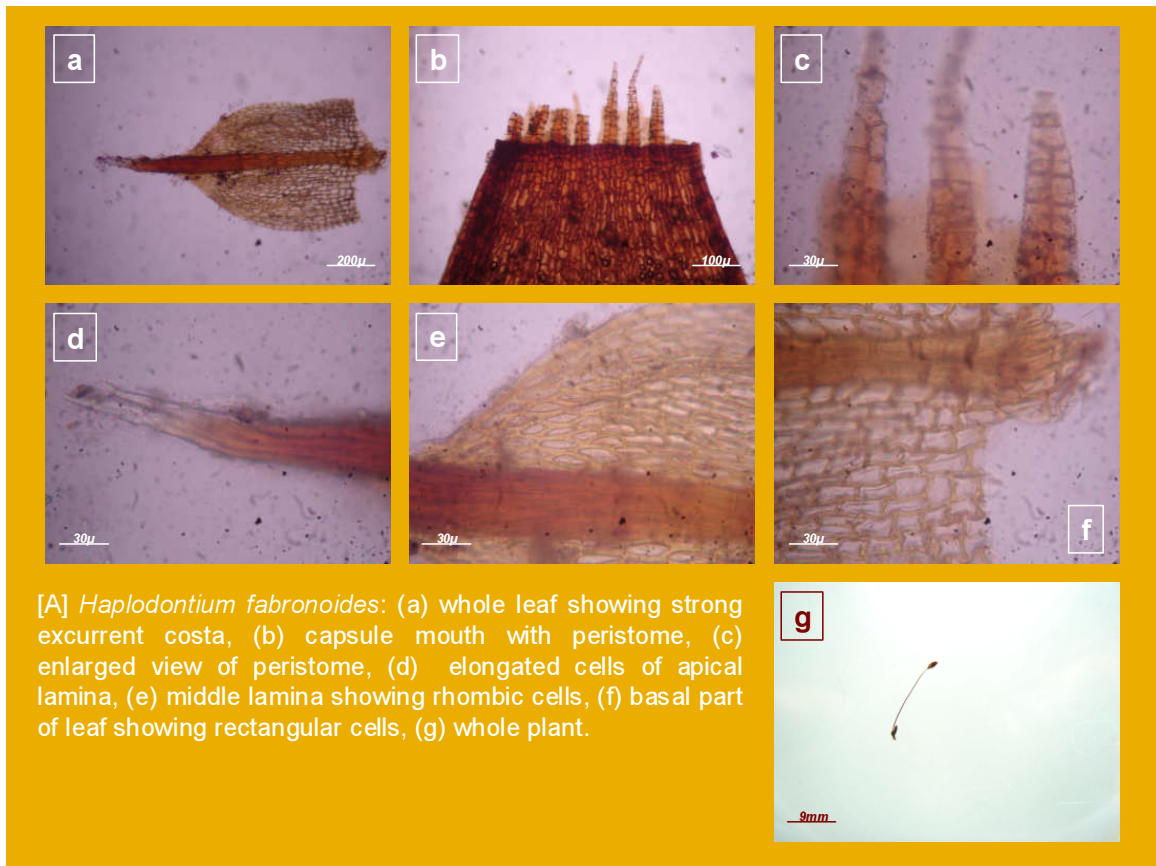


PLATE 34

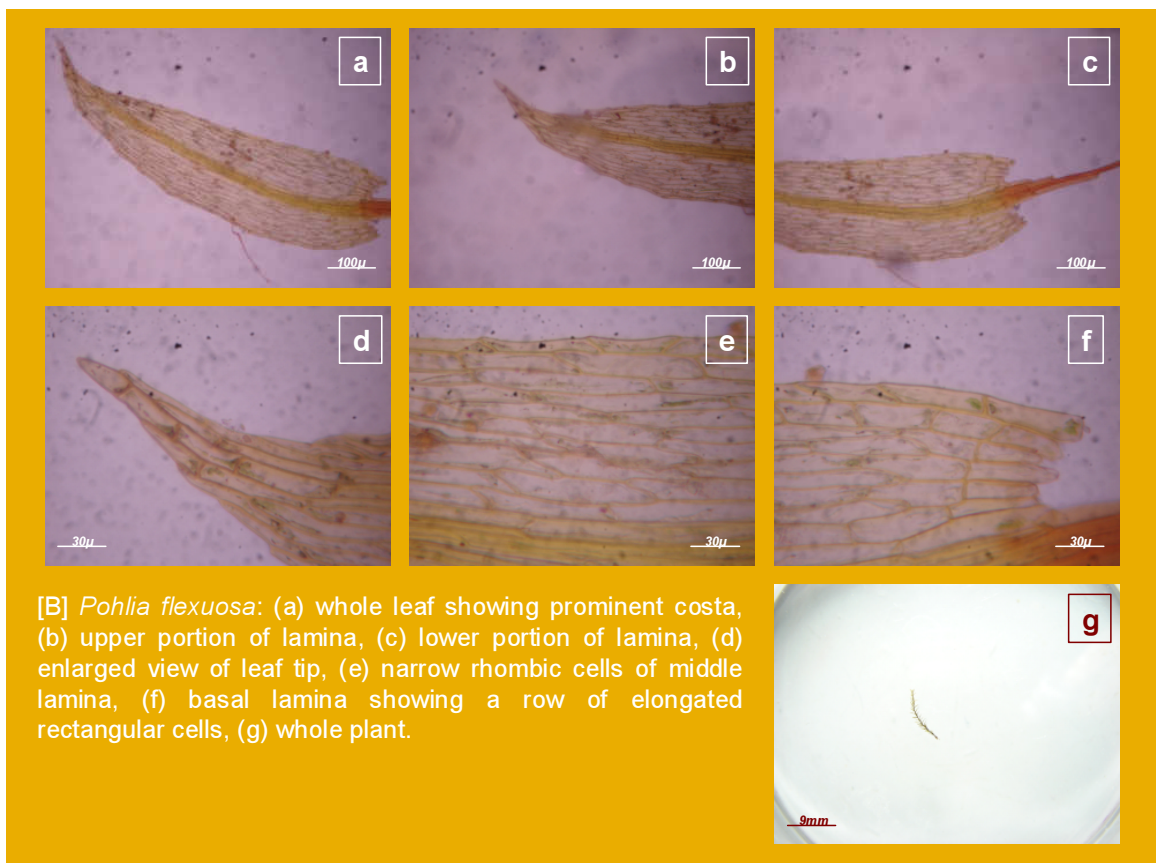
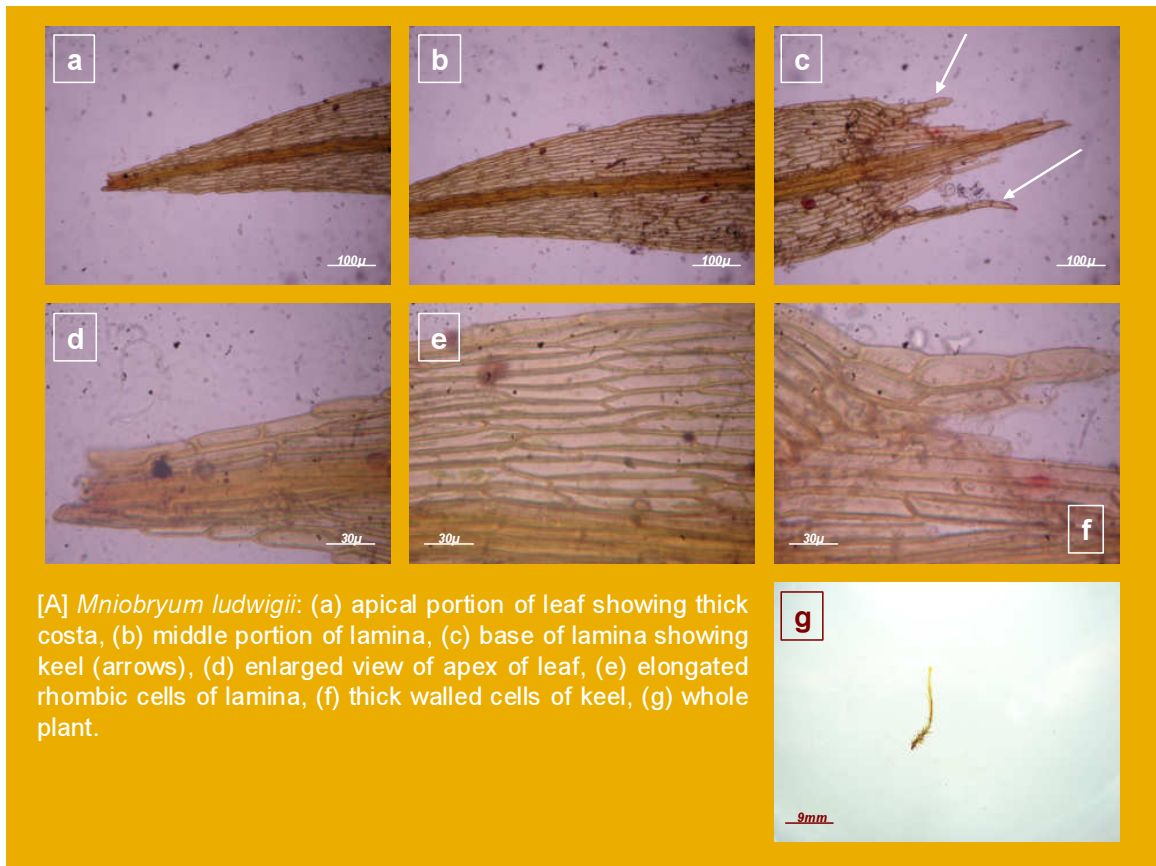


PLATE 35

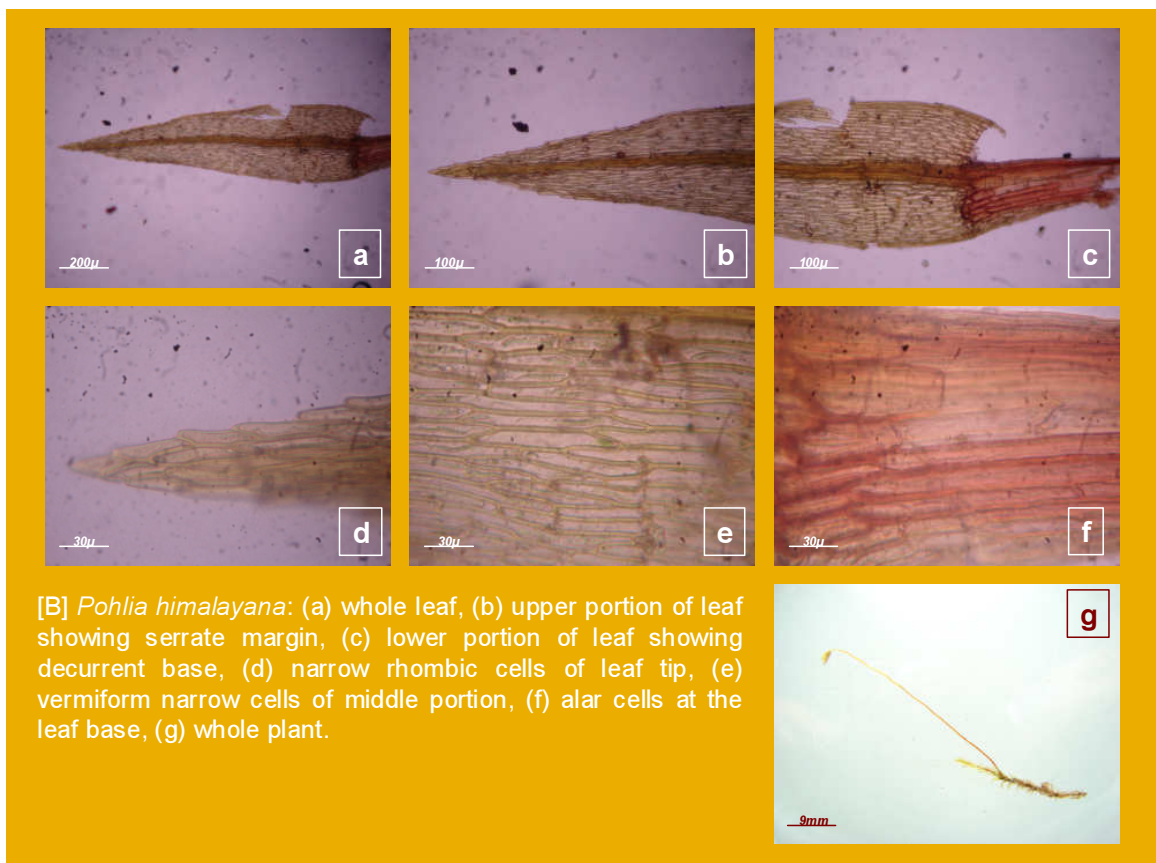
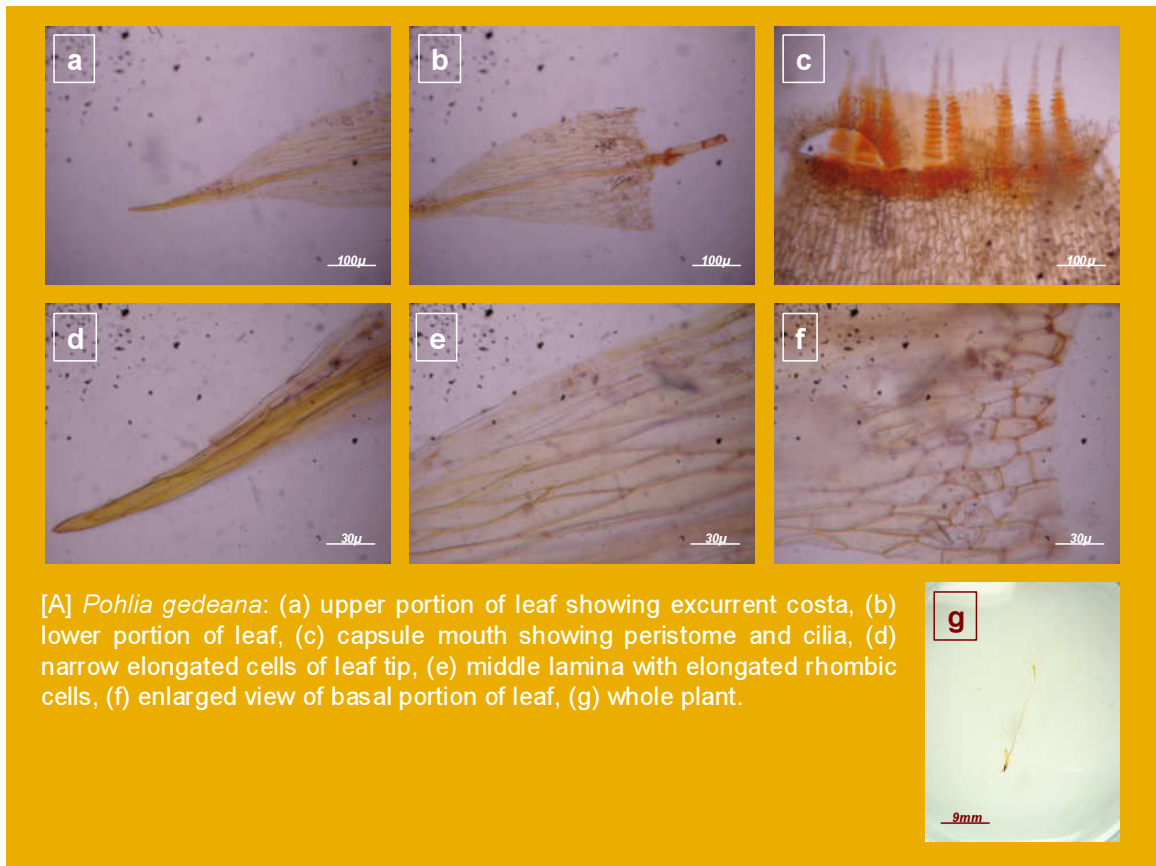


PLATE 36

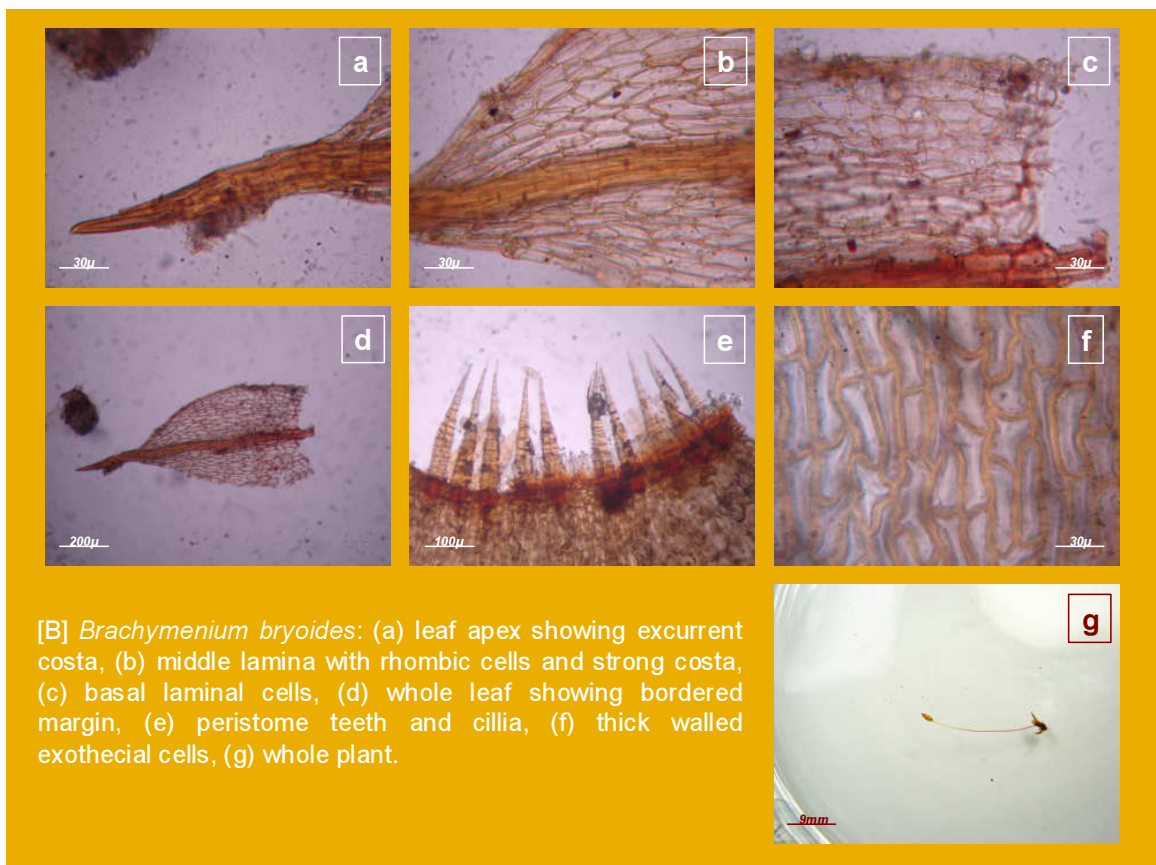
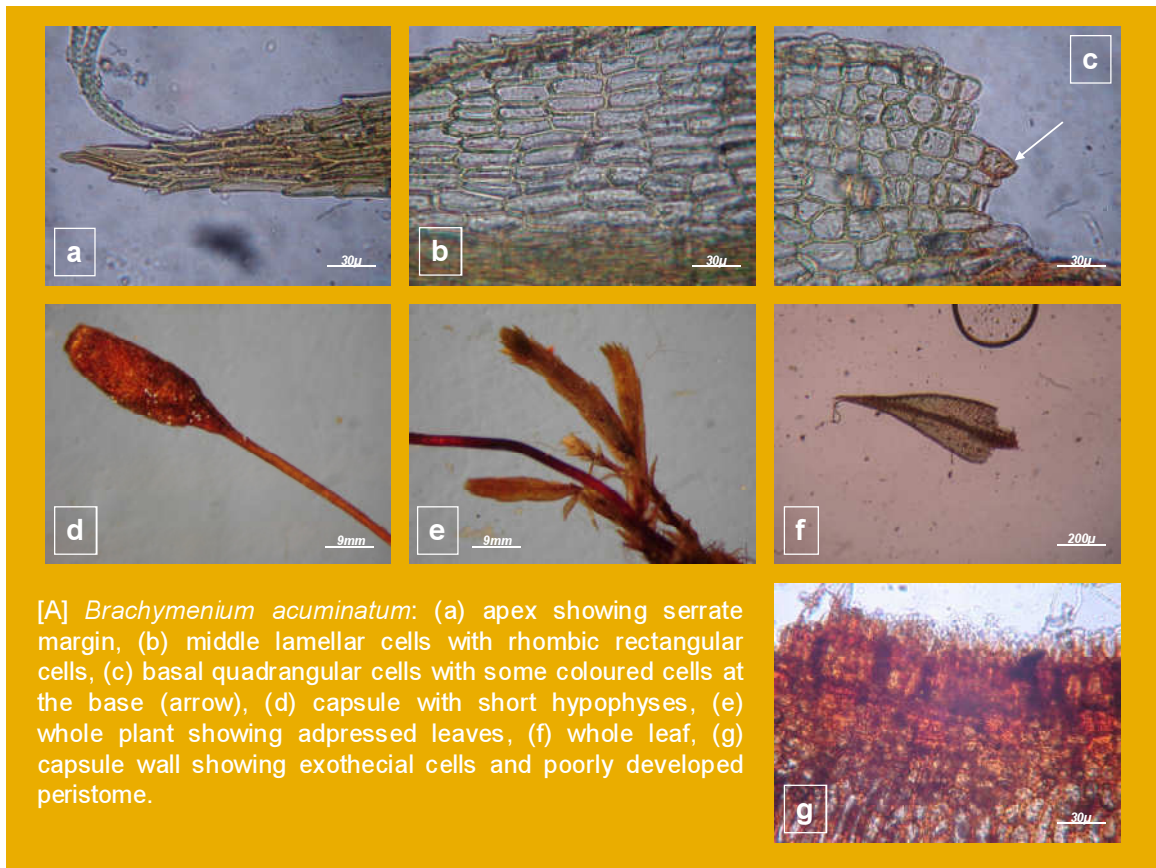
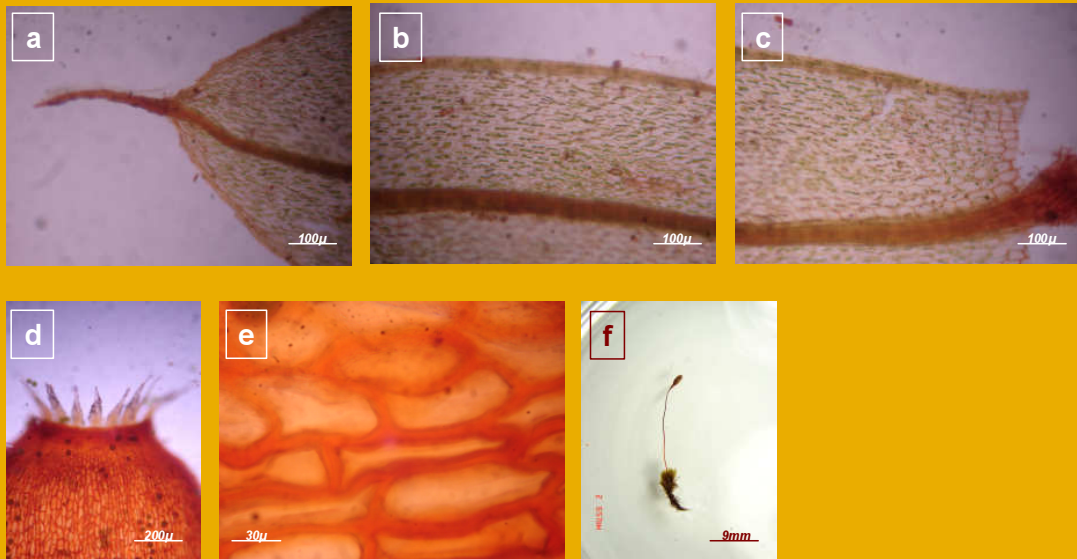
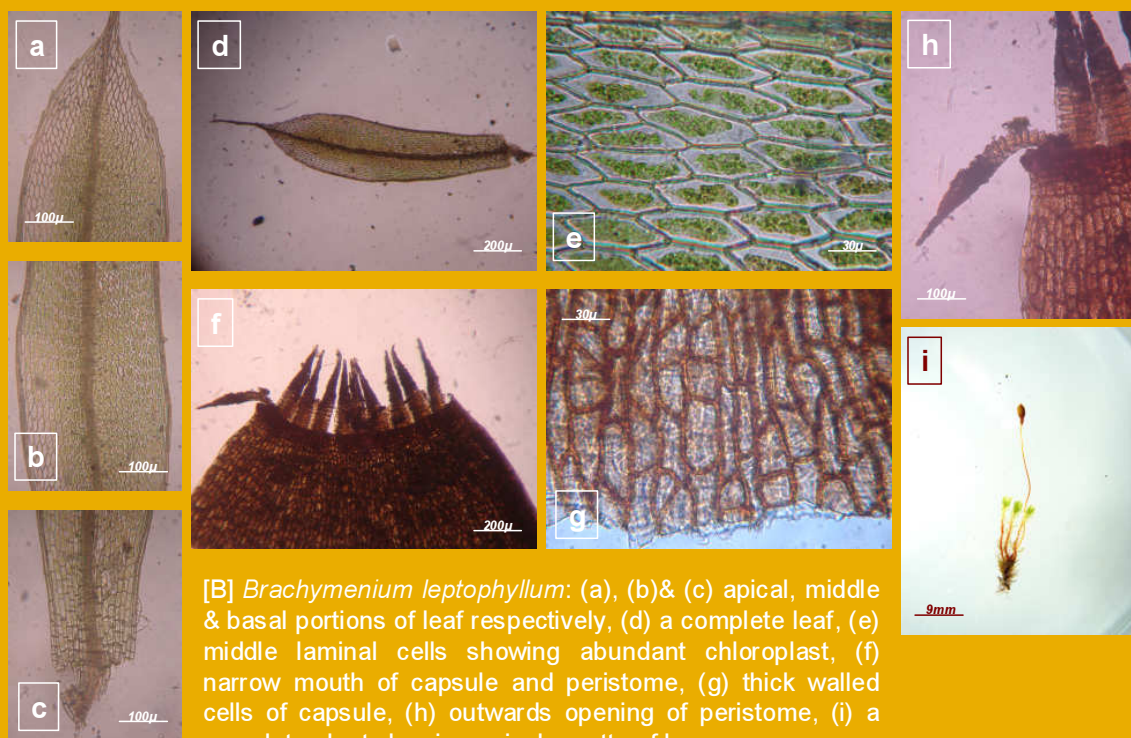


PLATE 37



[A] *Brachymenium capitulatum*: (a) Apical portion of leaf showing excurrent costa, (b) middle portion of leaf showing bordered margin, narrow rhombic cells and strong costa, (c) basal portion of leaf, (d) narrow mouth of capsule with outward opening of peristome, (e) thickened exothecial cells, (F) whole plant,



[B] *Brachymenium leptophyllum*: (a), (b) & (c) apical, middle & basal portions of leaf respectively, (d) a complete leaf, (e) middle laminal cells showing abundant chloroplast, (f) narrow mouth of capsule and peristome, (g) thick walled cells of capsule, (h) outwards opening of peristome, (i) a complete plant showing apical rosette of leaves.

PLATE 38

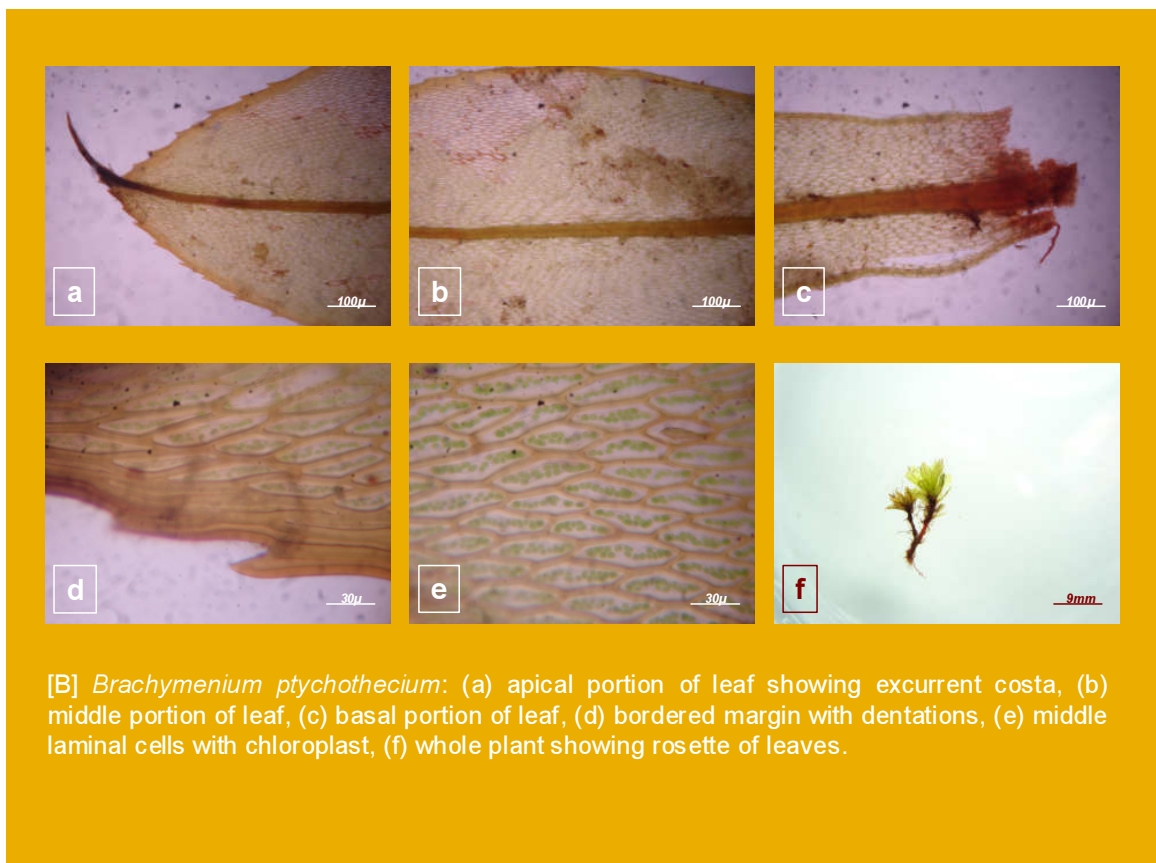
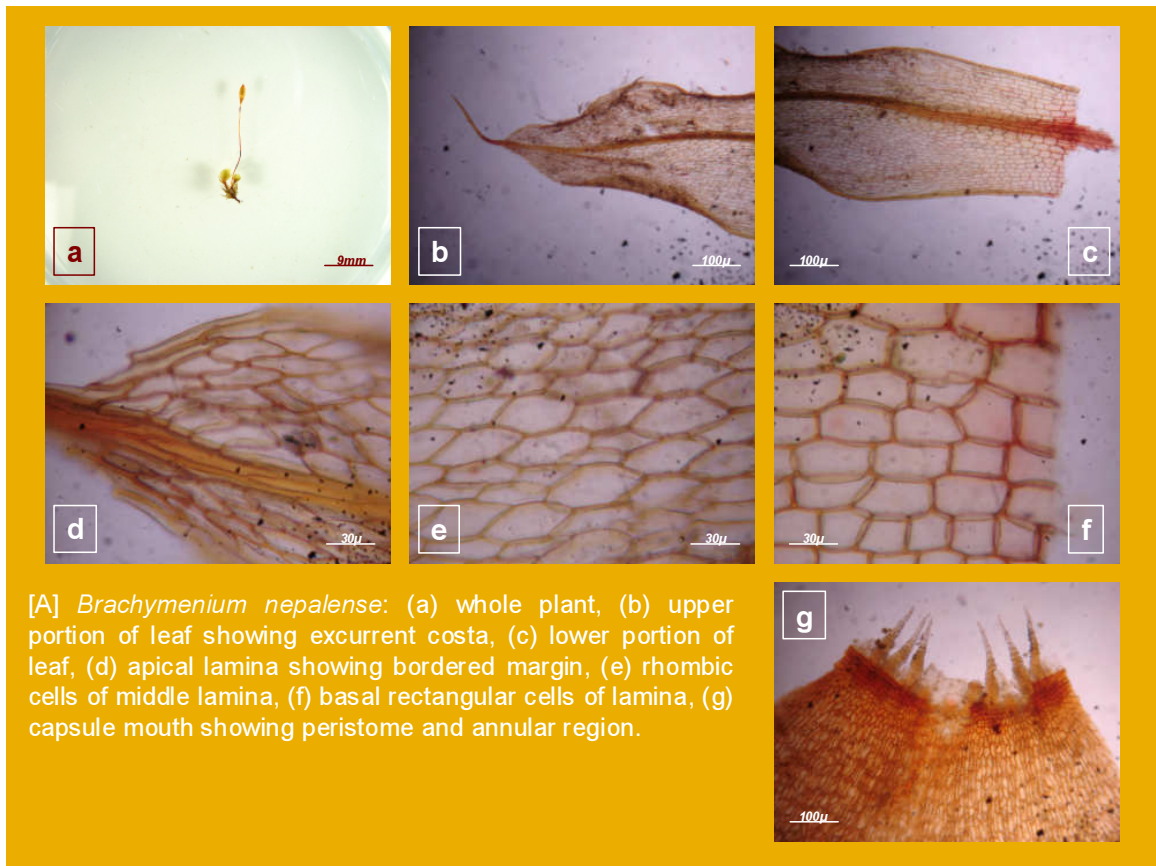


PLATE 39

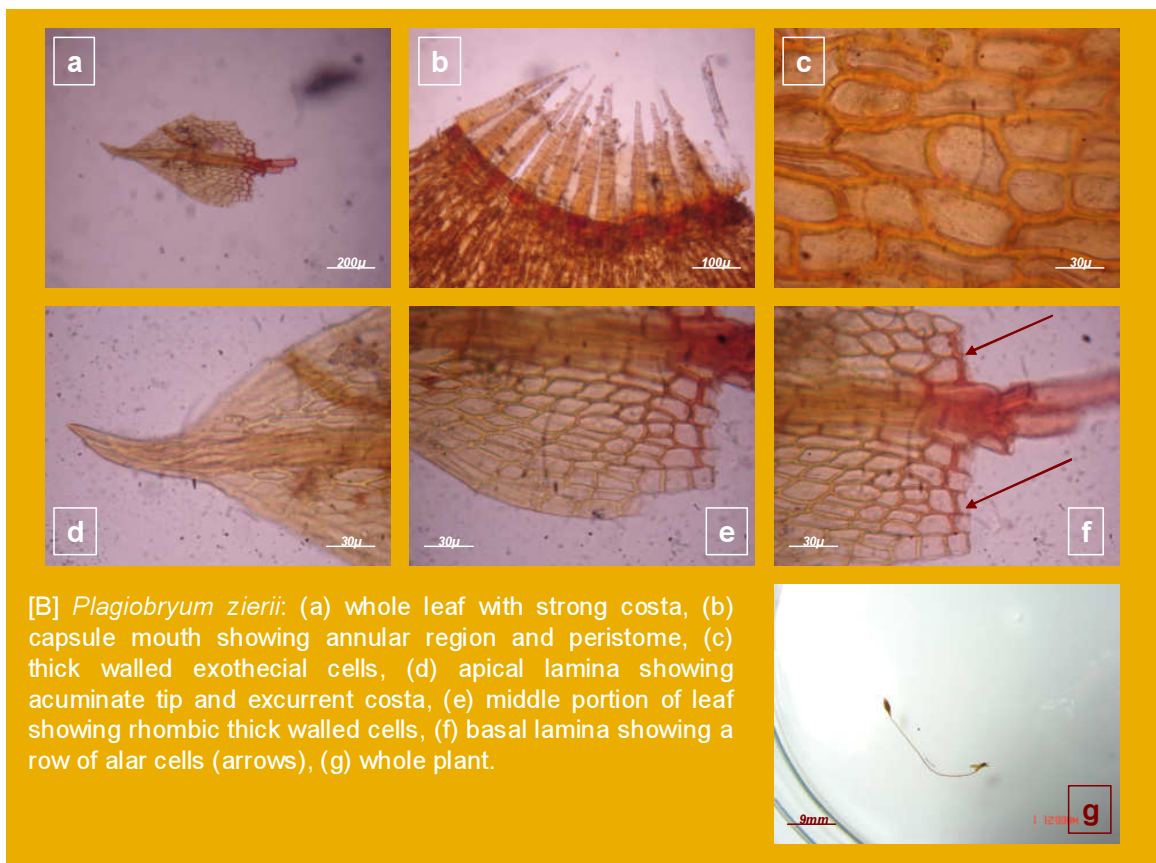
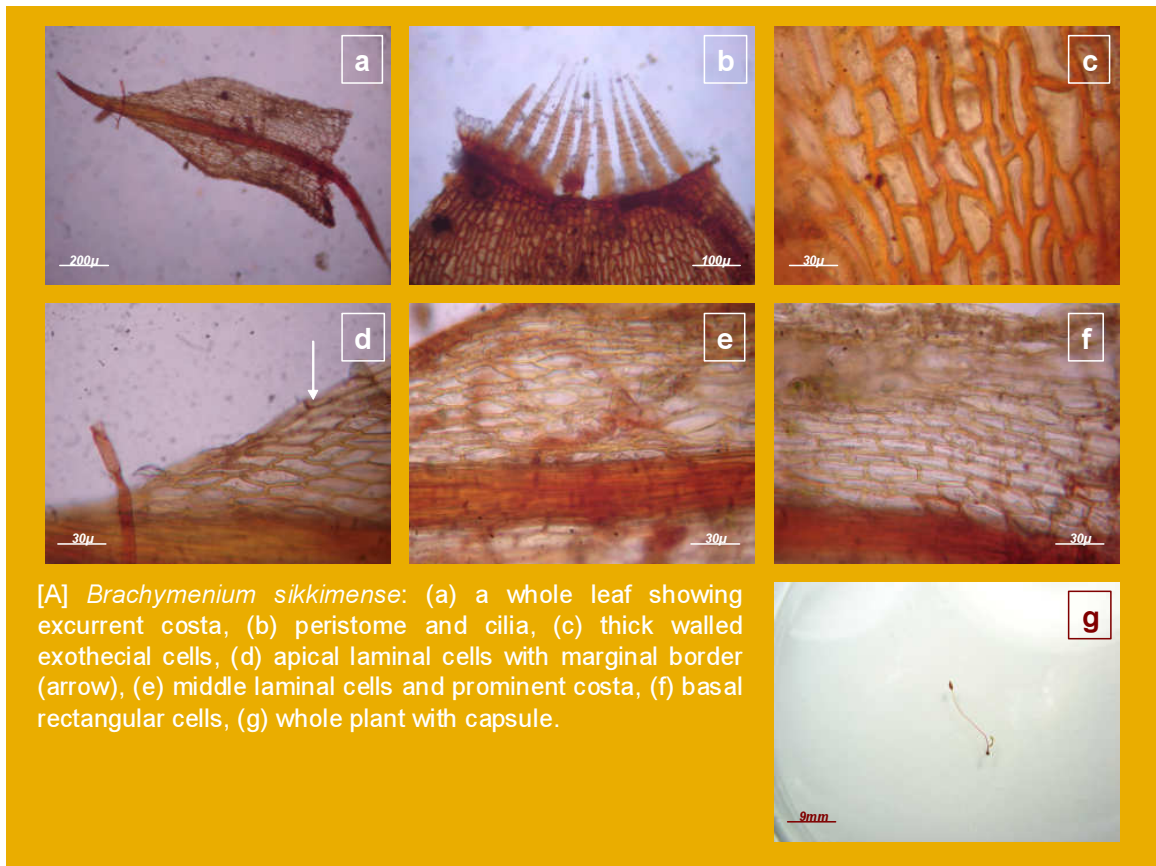
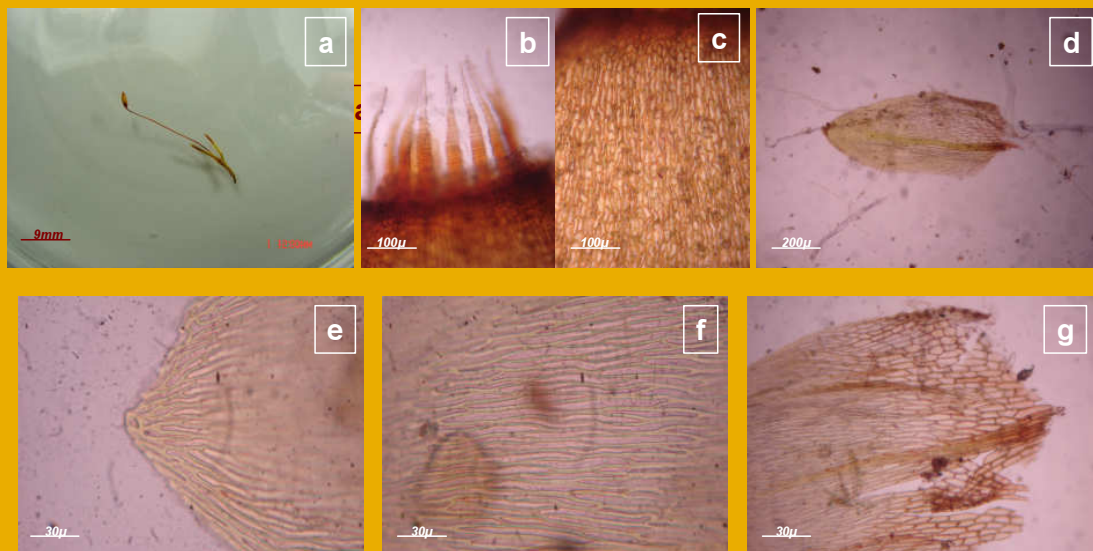


PLATE 40

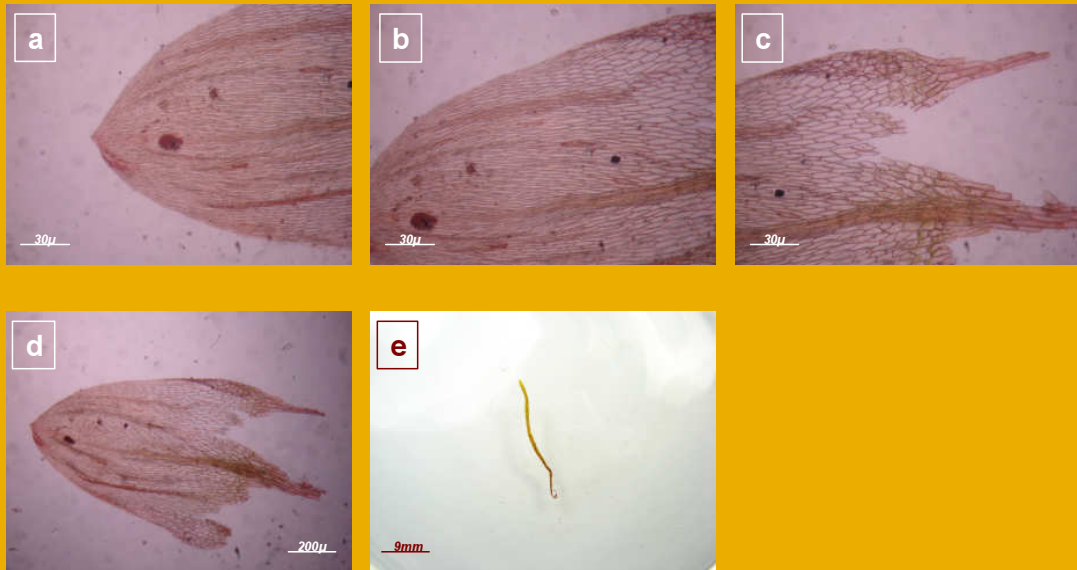


[A] *Anomobryum brachymenioides*: (a) whole plant showing julaceous habit, (b) Whole leaf showing plications and incomplete costa, (c) basal part of leaf, (d) leaf apex showing vermiform cells, (e) narrow rhombic cells in the middle lamina, (f) basal rectangular cells of leaf.

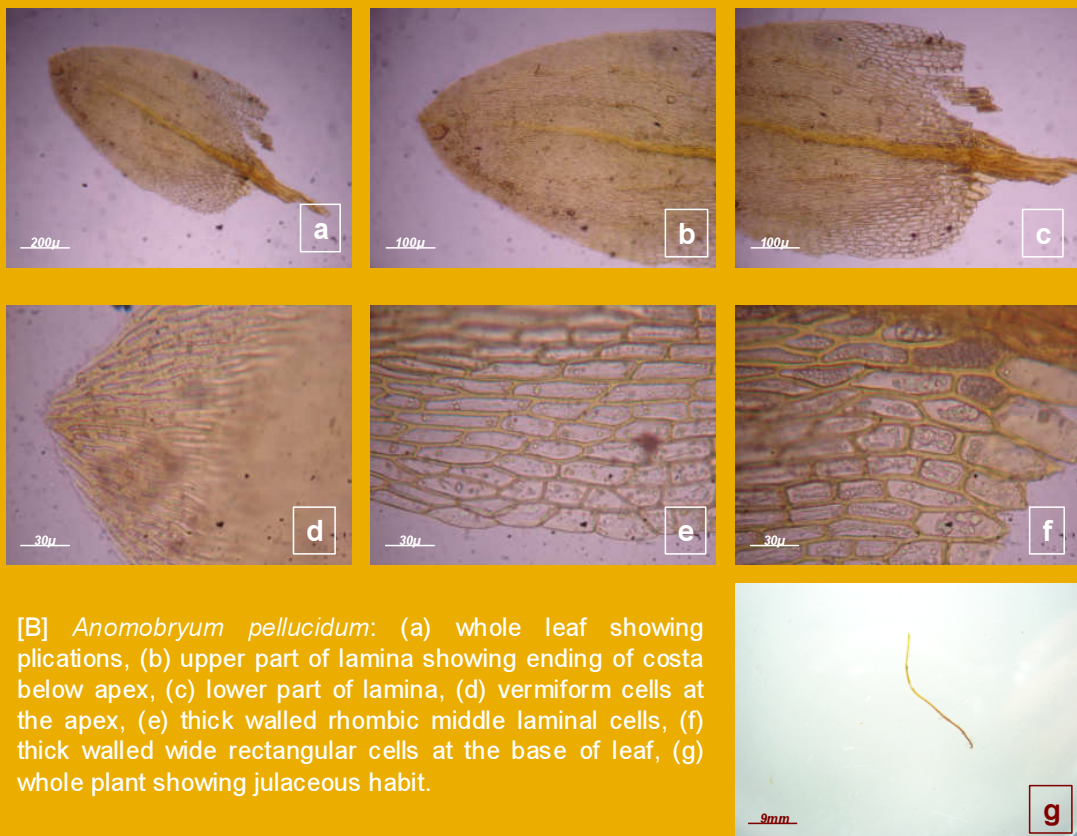


[B] *Anomobryum cymbifolium*: (a) whole plant showing julaceous habit, (b) enlarged portion of peristome, (c) capsule wall showing small thick walled exothecial cells, (d) whole leaf showing short costa, (e) narrow elongated cells of leaf apex, (f) narrow elongated cells of middle lamina, (g) narrow rectangular cells at the basal part of leaf.

PLATE 41



[A] *Anomobryum latifolium*: (a) apical portion of leaf with rounded tip, (b) middle portion of leaf showing end of costa below the apex, (c) basal portion of leaf showing thin walled fragile cells, (d) whole leaf showing plications, (e) whole plant showing julaceous habit.



[B] *Anomobryum pellucidum*: (a) whole leaf showing plications, (b) upper part of lamina showing ending of costa below apex, (c) lower part of lamina, (d) vermiform cells at the apex, (e) thick walled rhombic middle laminal cells, (f) thick walled wide rectangular cells at the base of leaf, (g) whole plant showing julaceous habit.

PLATE 42

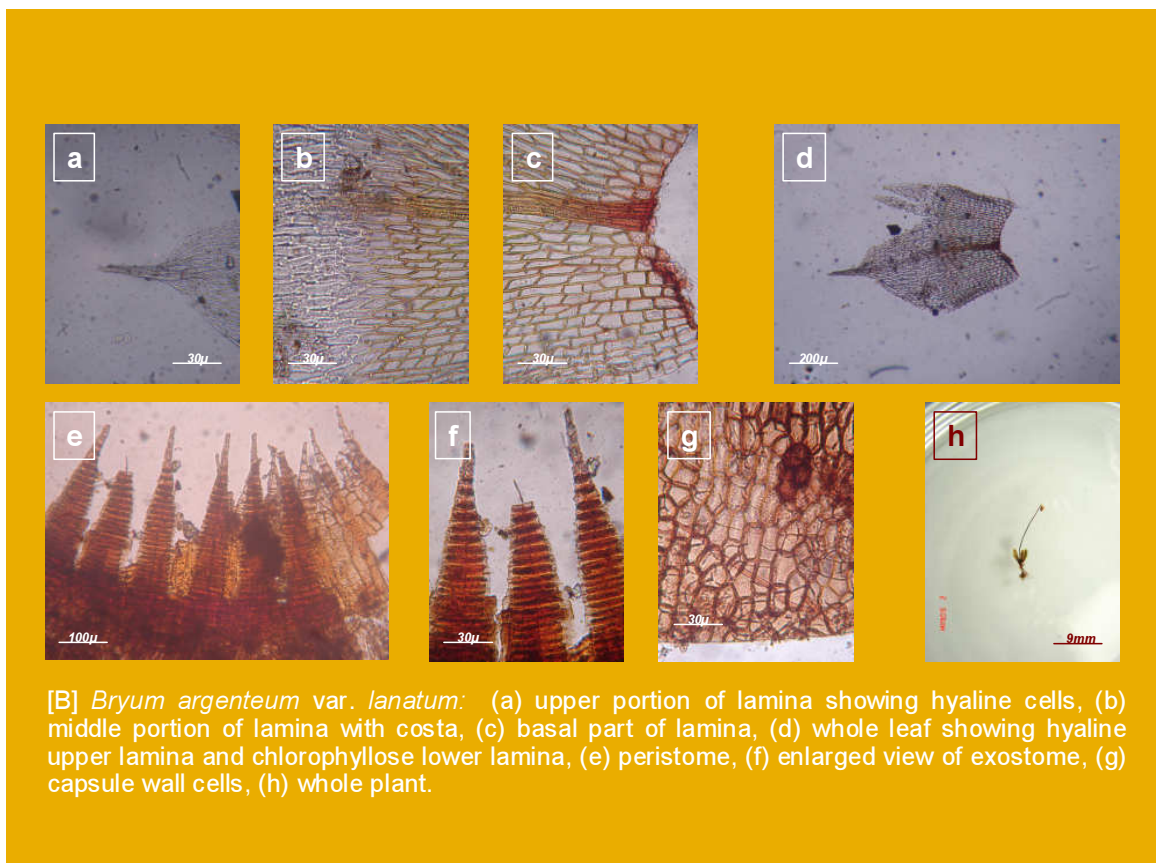
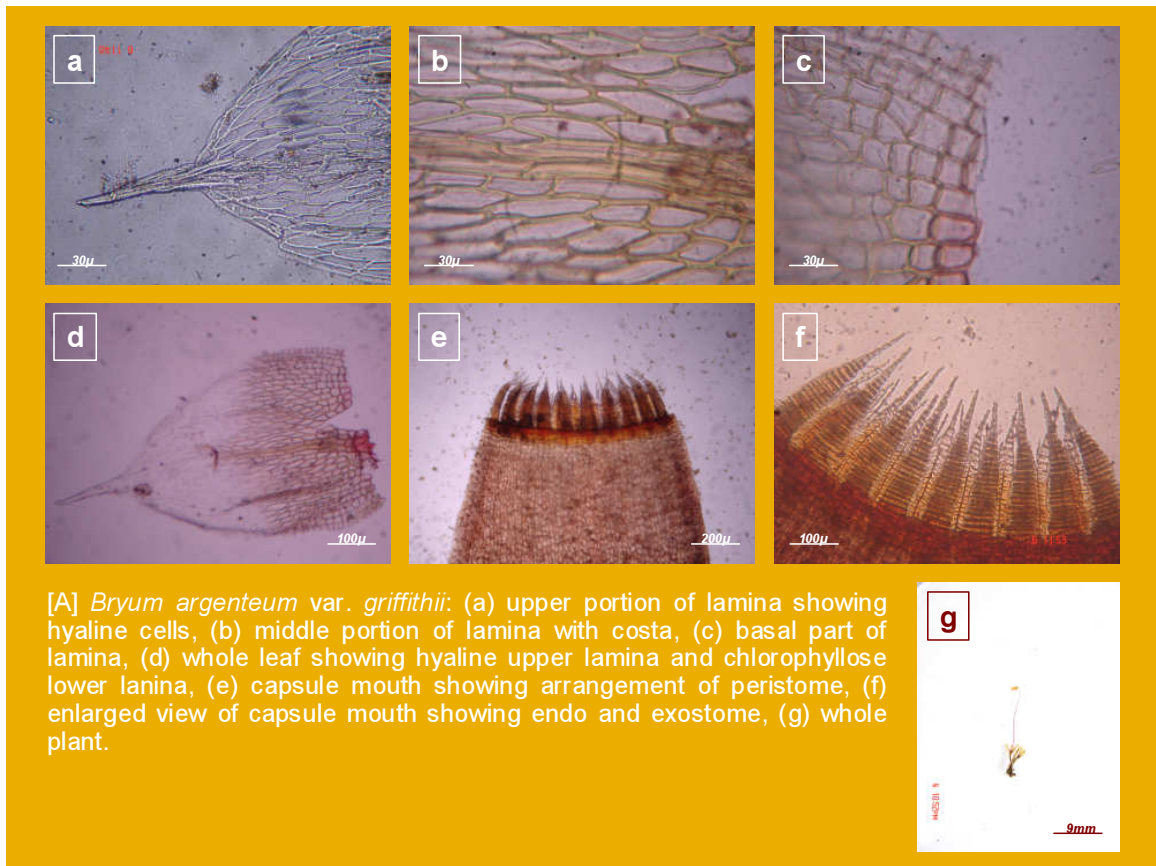
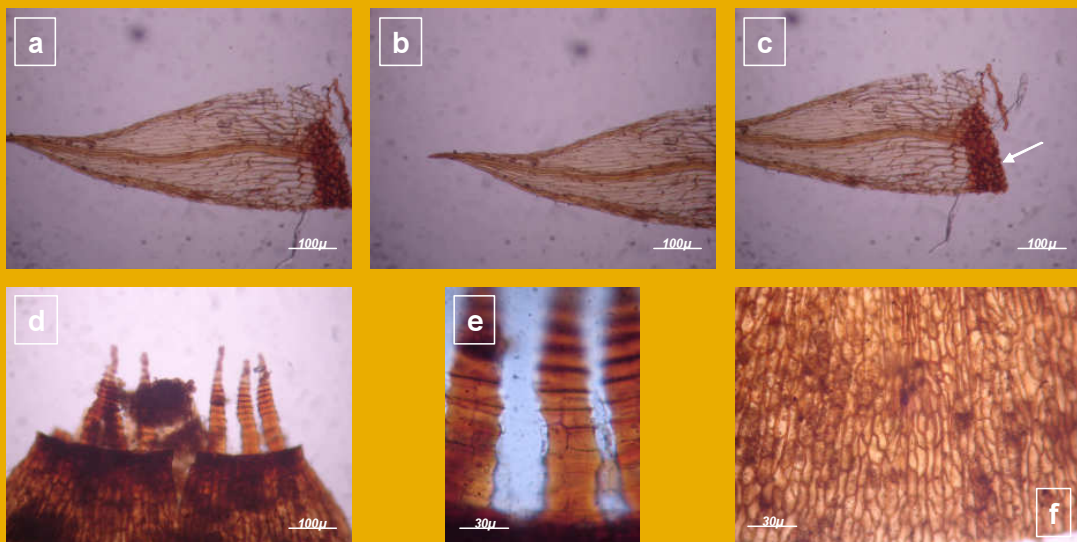


PLATE 43



[A] *Bryum atrovirens*: (a) upper portion of lamina, (b) middle portion of lamina showing distinct marginal border, (c) coloured alar cells at the base, (d) whole leaf, (e) capsule mouth showing folded peristome, (f) whole plant.



[B] *Bryum bicolor*: (a) whole leaf, (b) upper portion of lamina, (c) lower portion of lamina with distinct alar zone (arrow), (d) capsule mouth showing peristome, (e) enlarged view of peristome showing thick anticlinal wall, (f) capsule wall, (g) whole plant.

PLATE 44

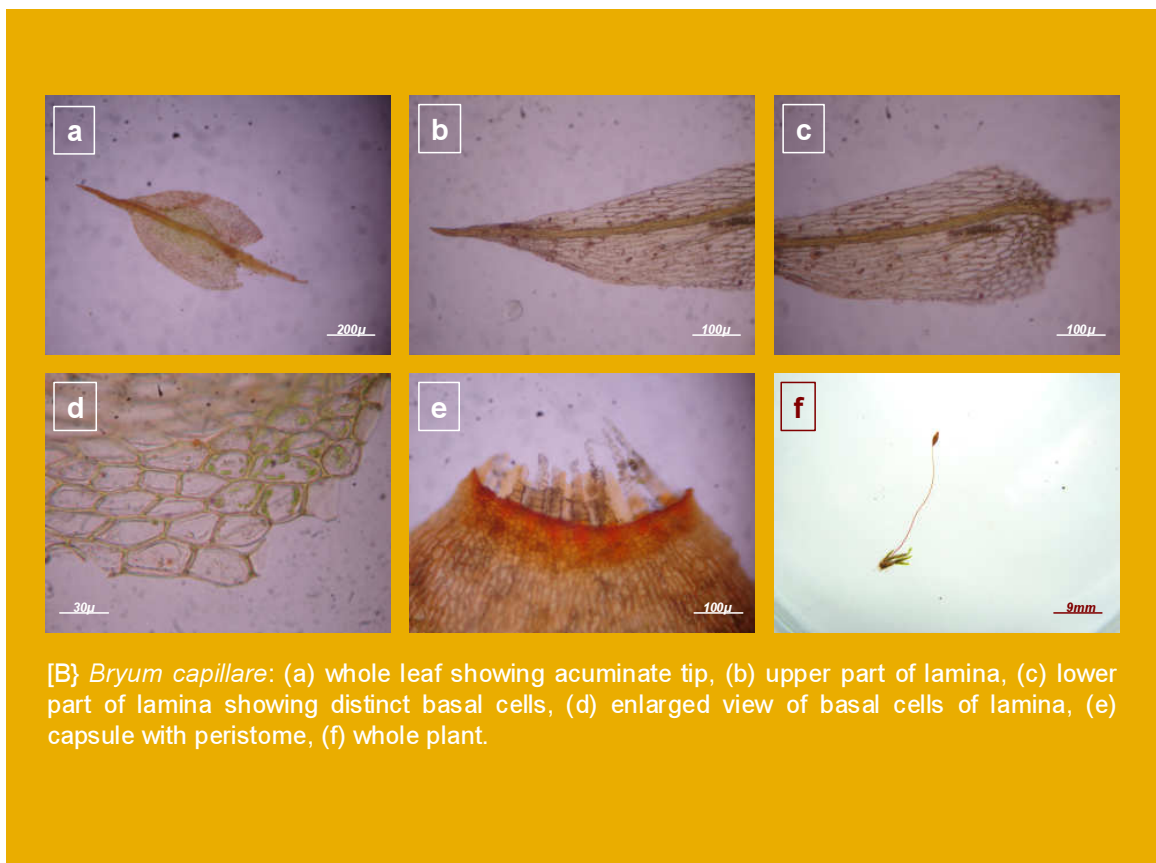
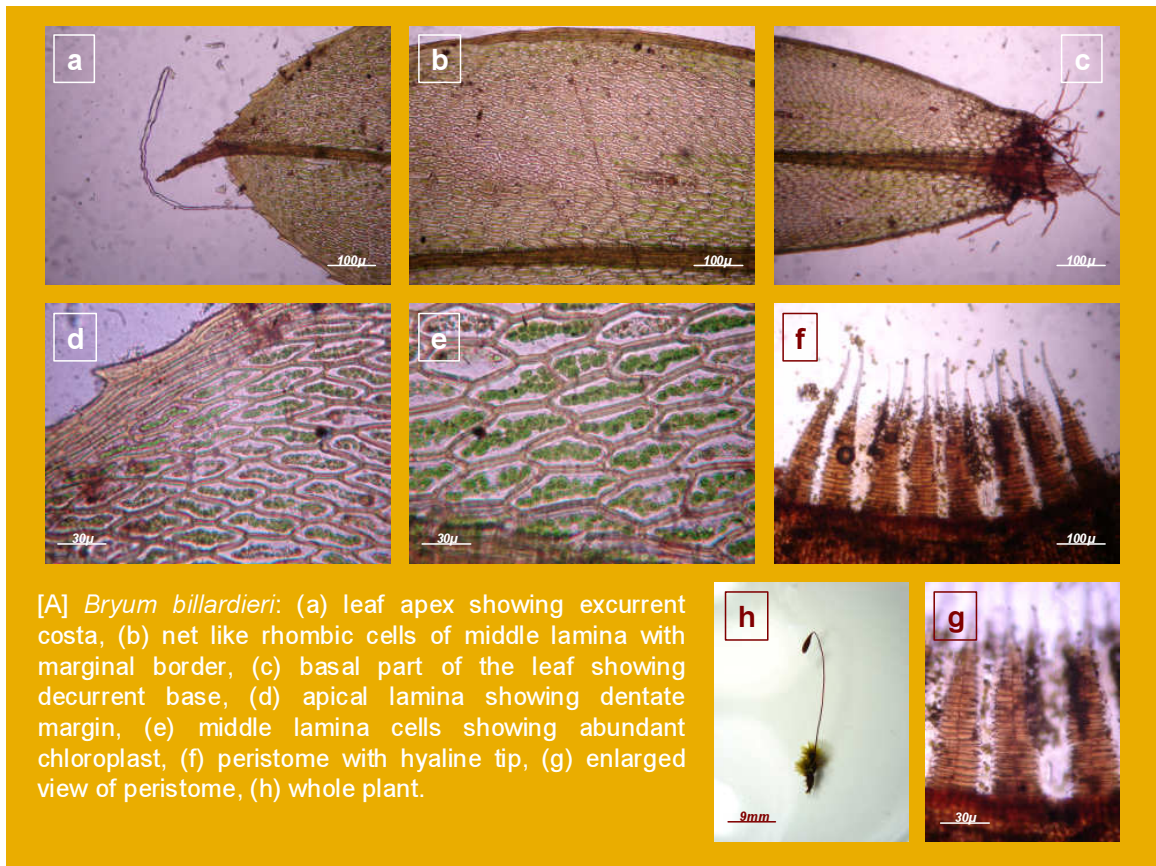


PLATE 45

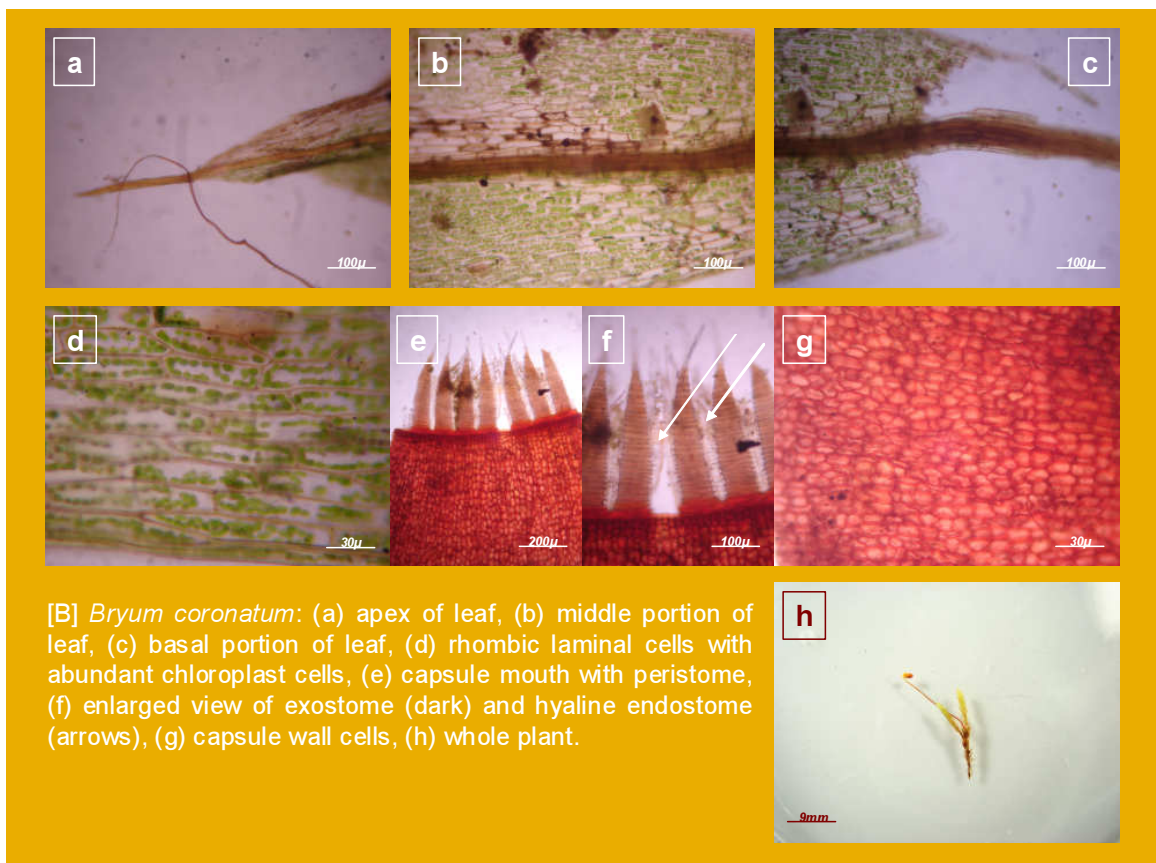
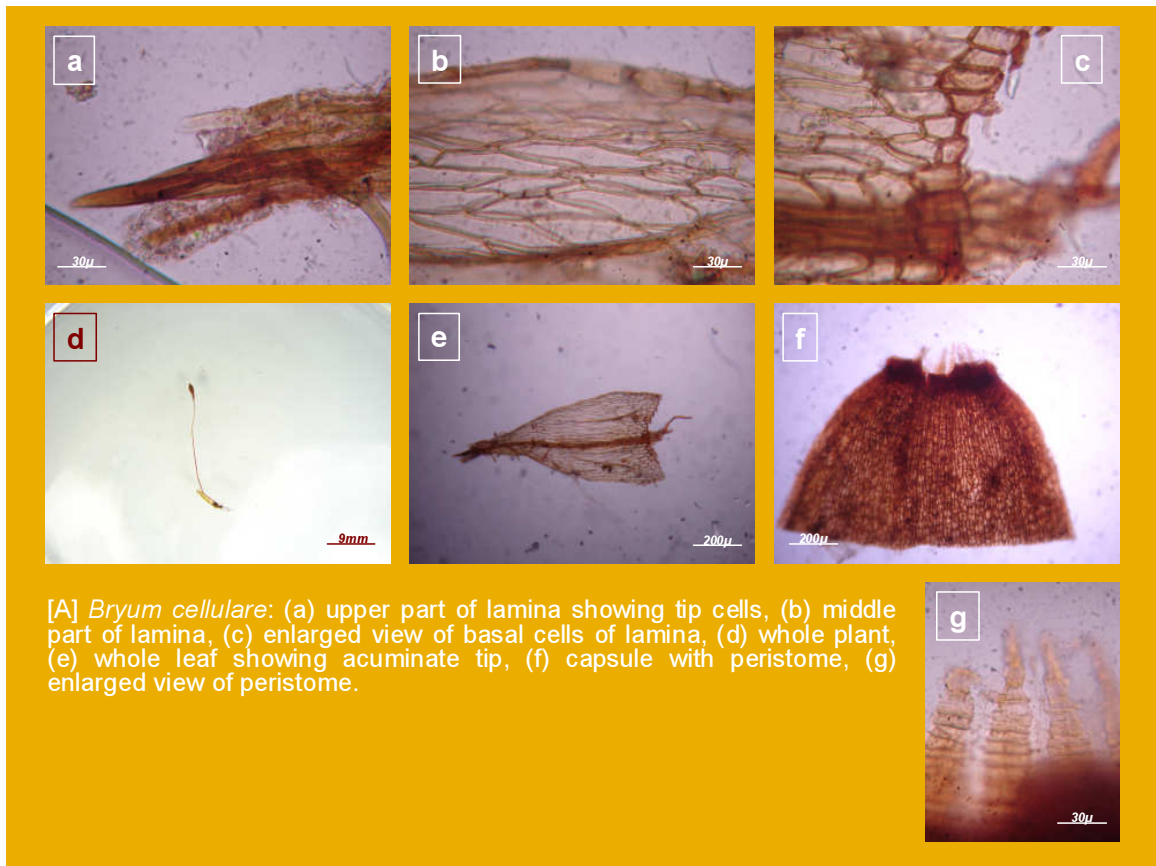


PLATE 46

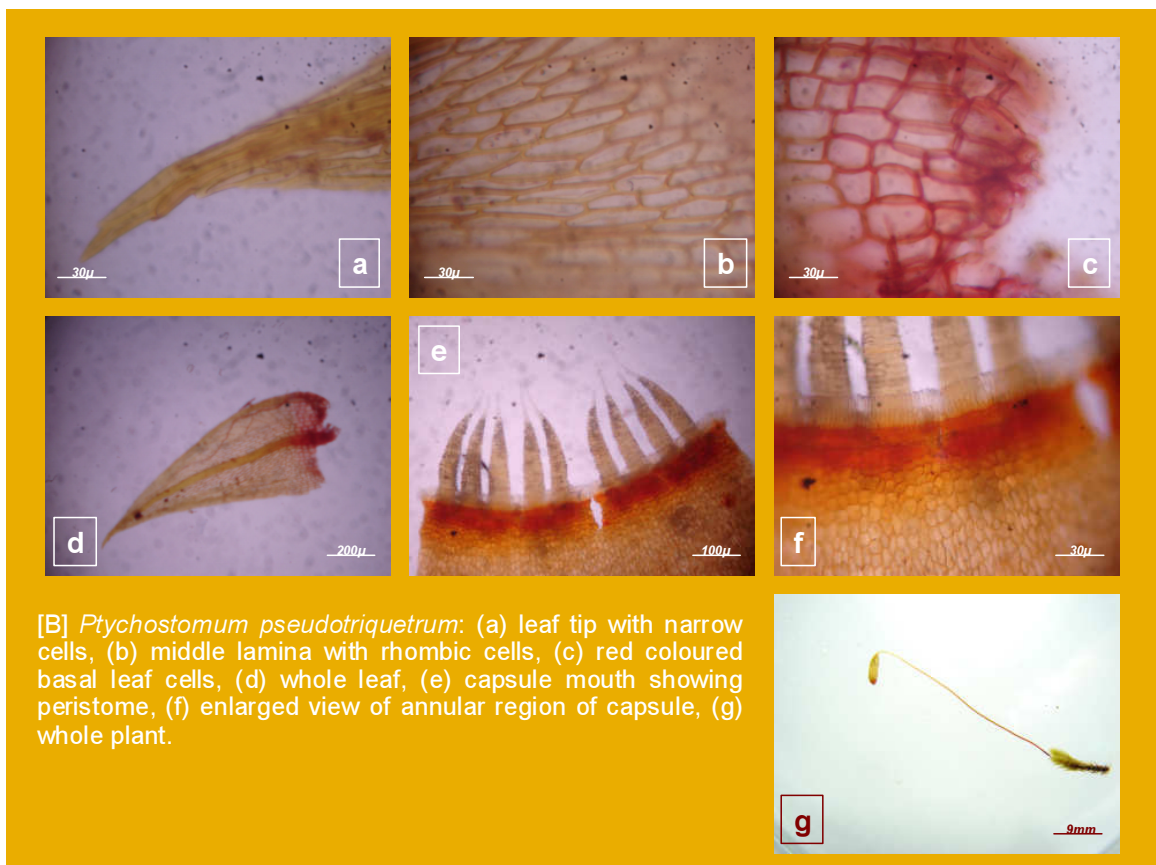
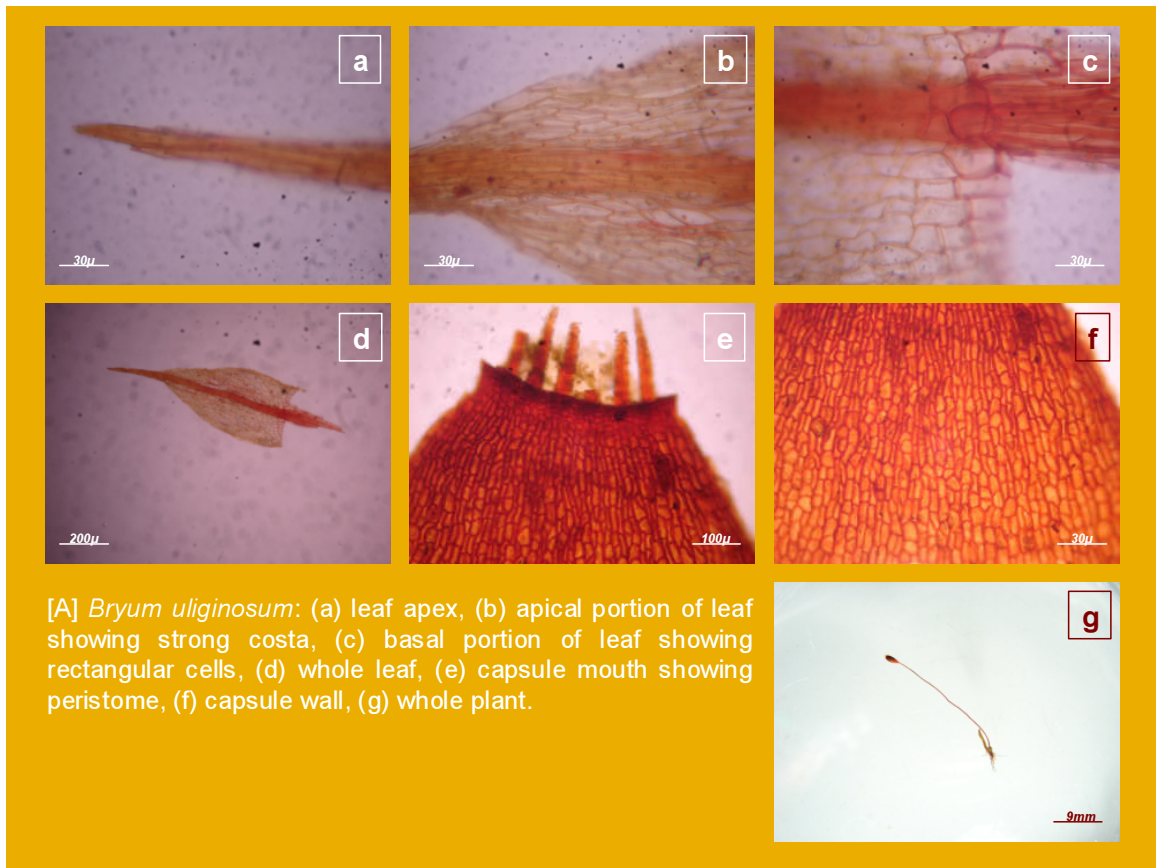


PLATE 47

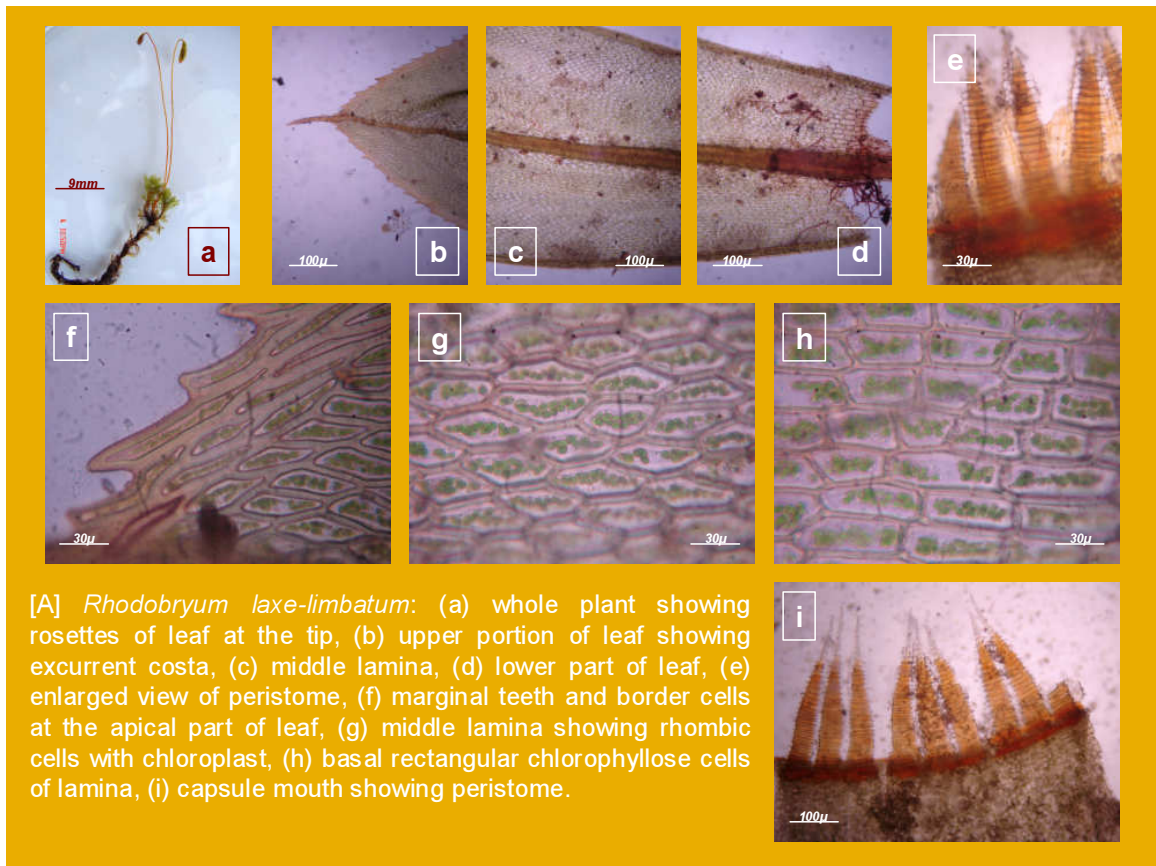


PLATE 48

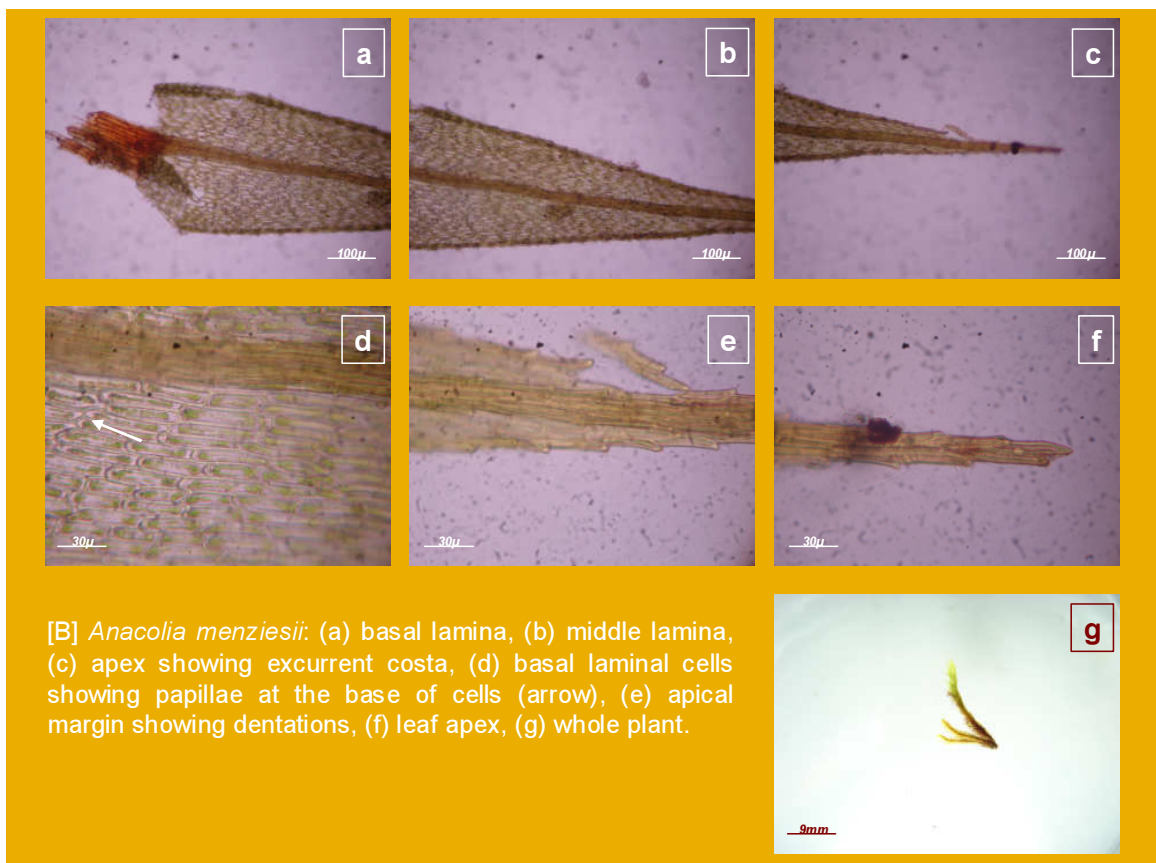
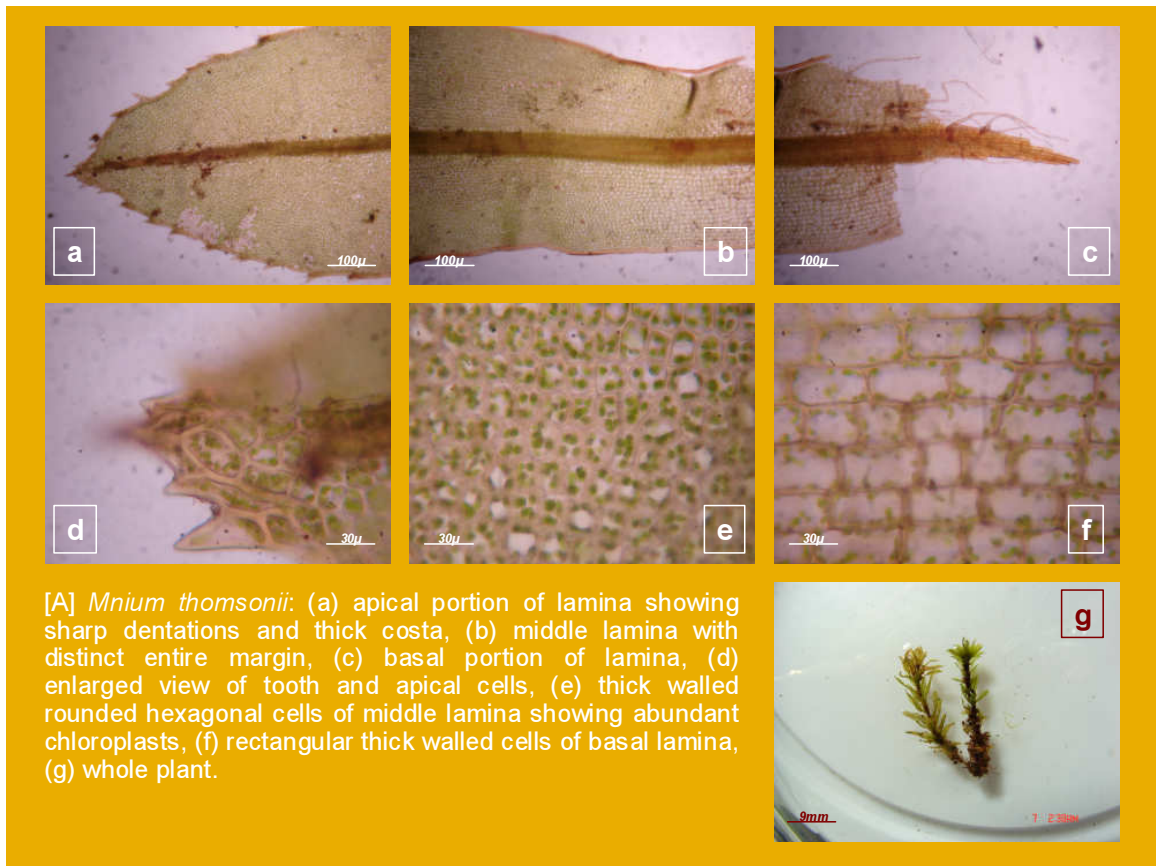


PLATE 49

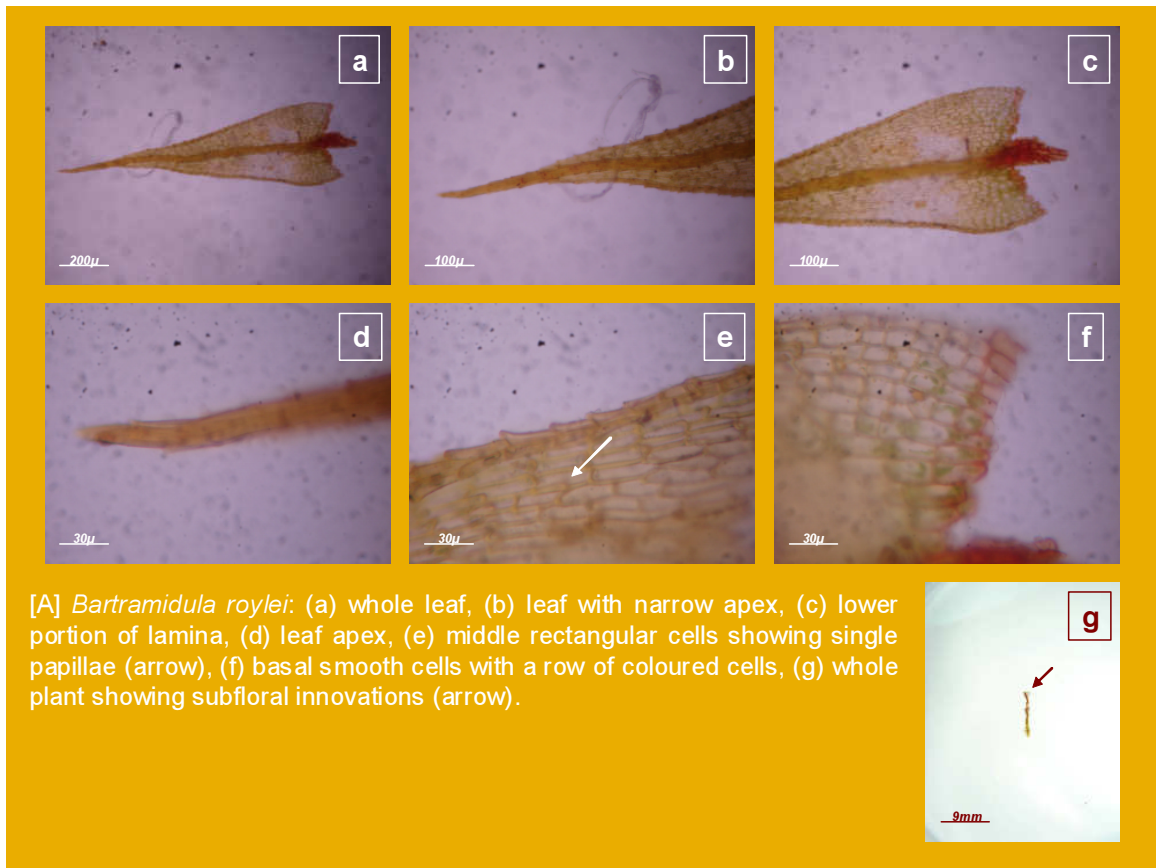
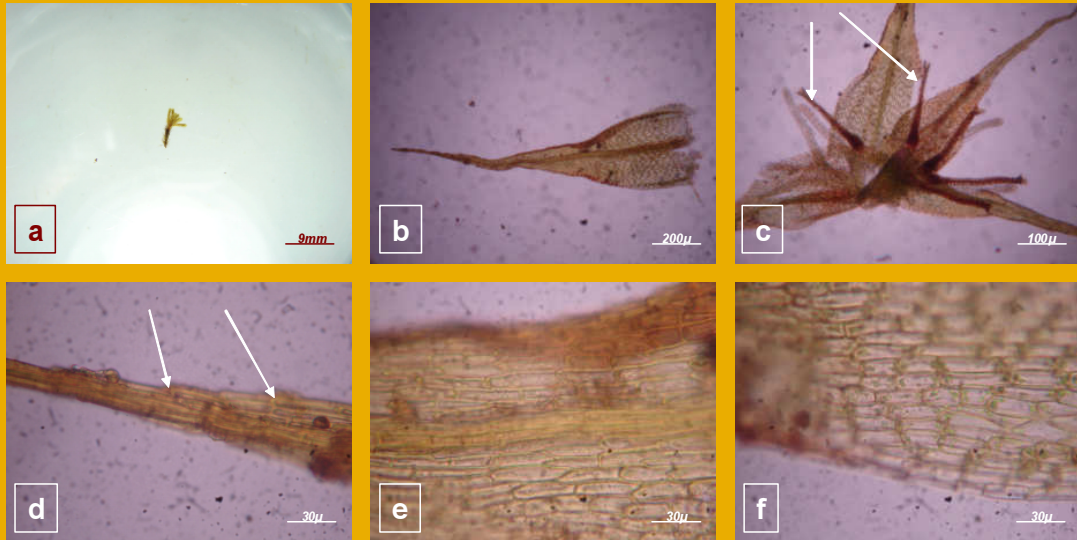


PLATE 50



[A] *Philonotis mollis*: (a) whole plant showing subfloral innovations, (b) whole leaf (c) archegonia arising out of a bunch of leaves (arrow), (d) enlarged view of leaf tip showing papillations (arrow), (e) enlarged view of middle lamina showing (f) basal lamina showing rectangular papillate cells.



[B] *Philonotis turneriana*: (a) whole plant showing subfloral innovations and capsule, (b) whole leaf showing prominent costa, (c) capsule mouth showing annulus and peristome, (d) leaf apical cells, (e) middle lamina showing rectangular papillate cells (arrows), (f) smooth basal cells at the base of leaf.

PLATE 51

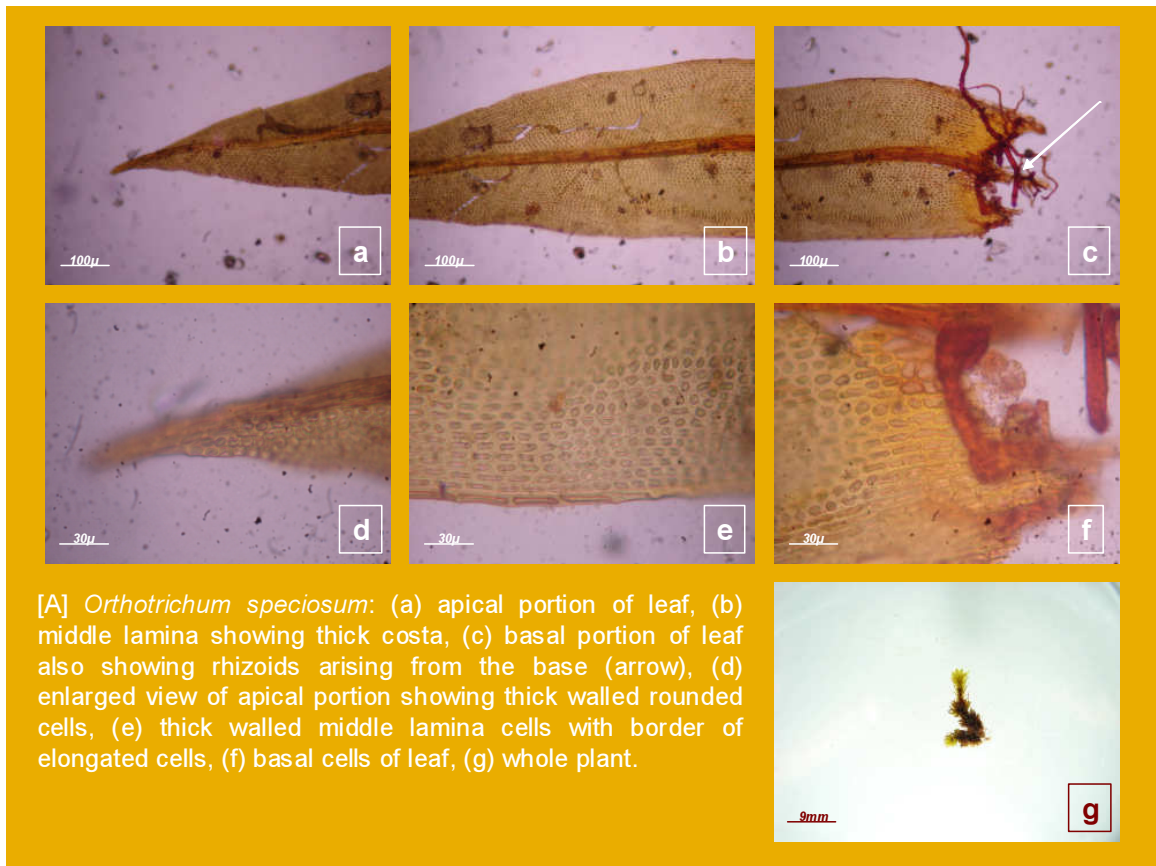
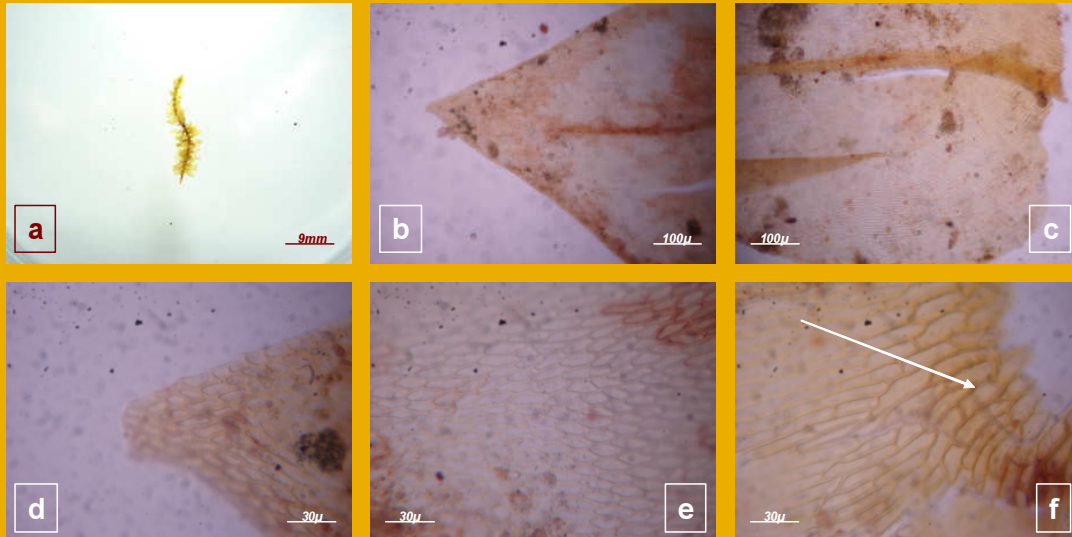
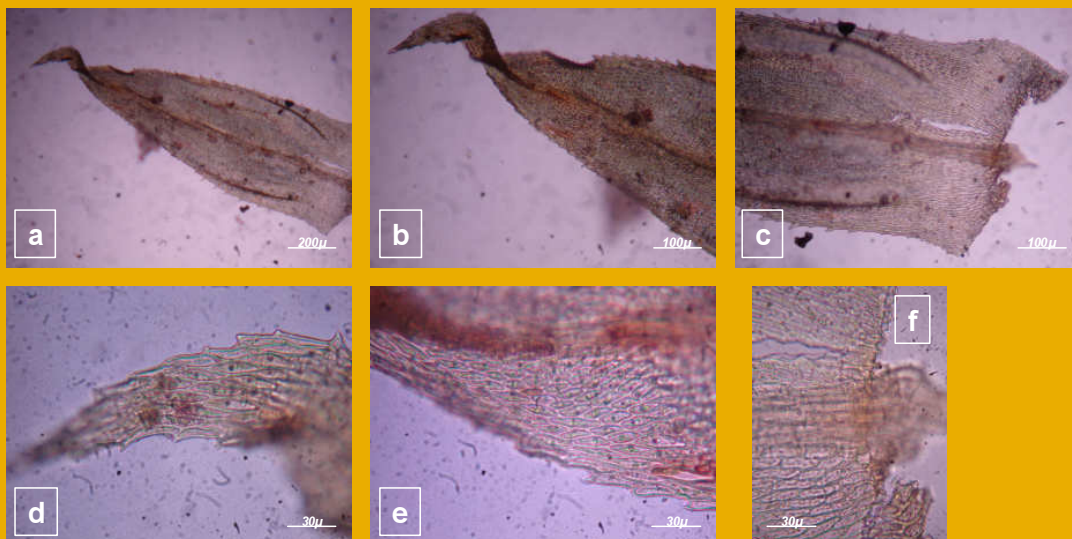


PLATE 52



[A] *Schoenobryum concavifolium*: (a) whole plant, (b) upper portion of leaf ending of costa below tip, (c) lower portion of lamina, (d) thick walled rhombic cells at the tip of lamina, (e) middle lamina cells, (f) basal part of lamina showing rectangular coloured alar cells (arrow).



[B] *Trachypodopsis serrulata*: (a) whole leaf, (b) upper portion of leaf showing twisted tip, (c) lower portion of leaf showing broad base, (d) papillate cells at leaf apex, (e) middle lamina showing papillations and dentate margin, (f) basal part of lamina, (g) whole plant.



PLATE 53

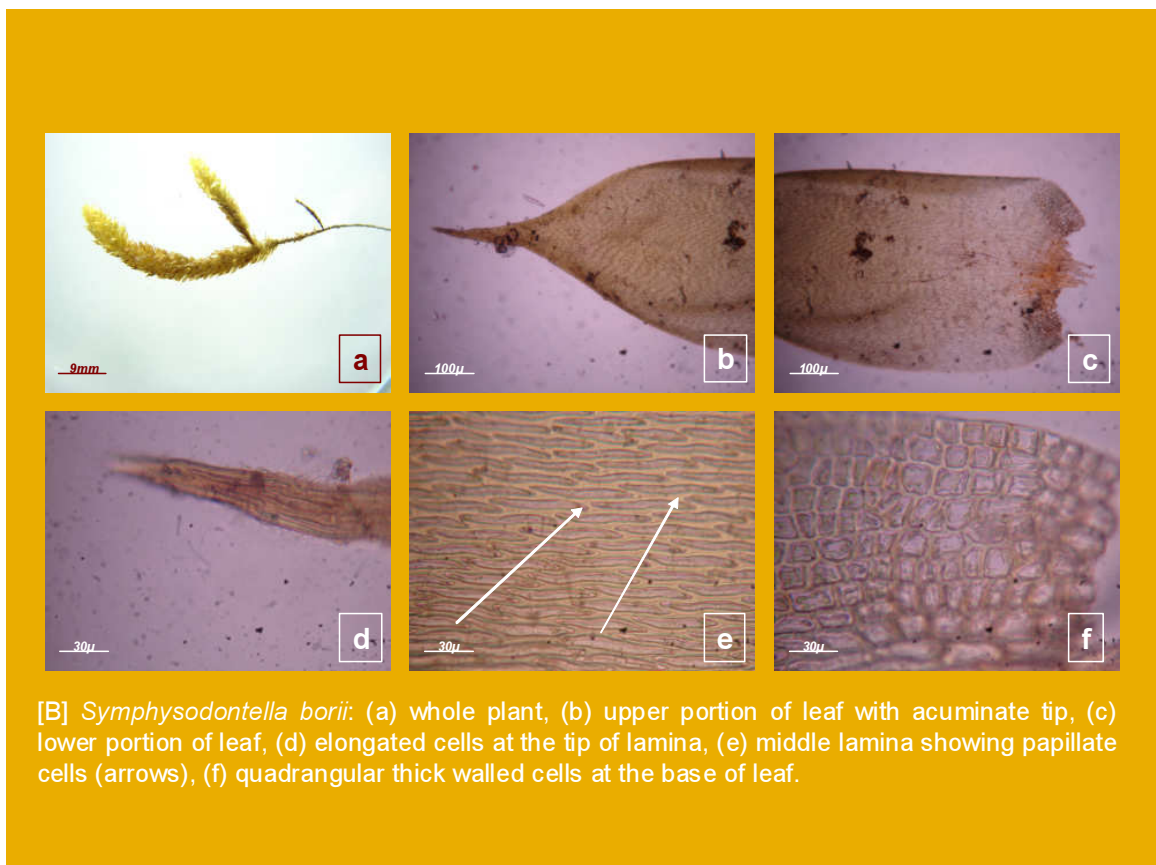
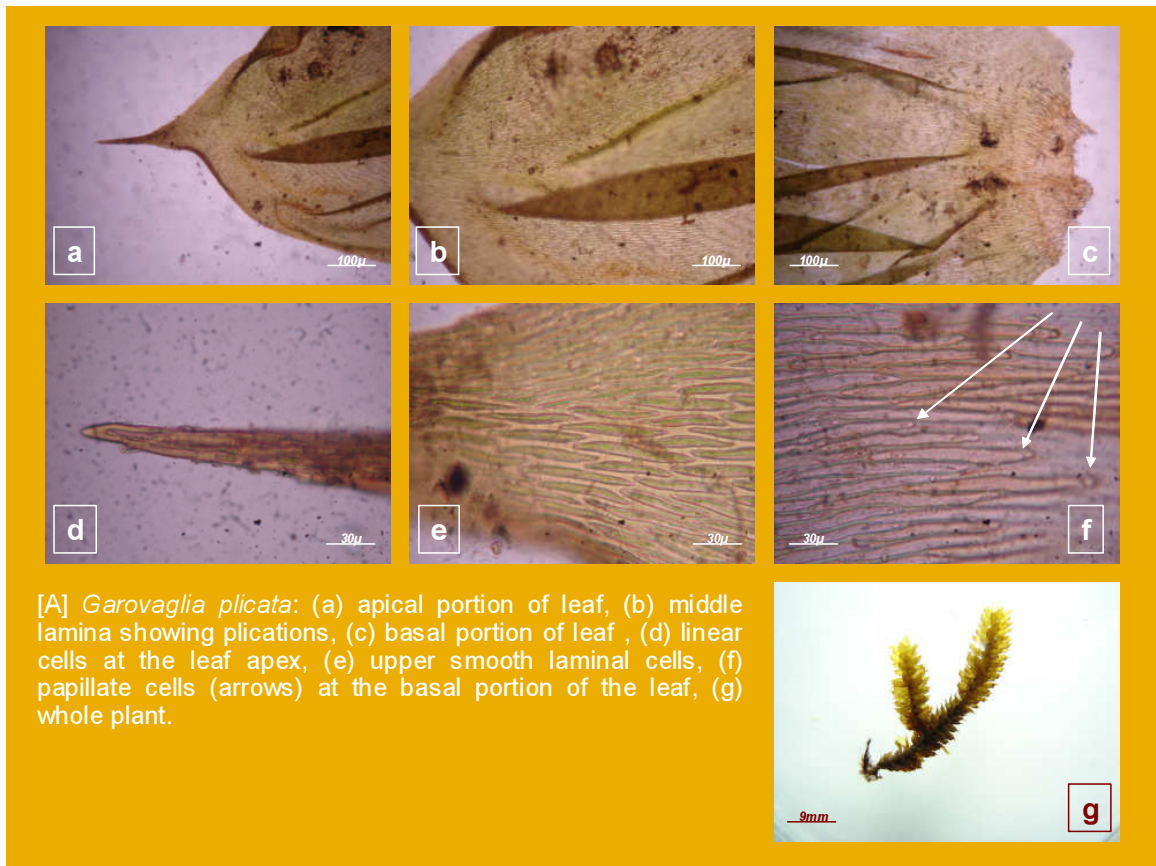
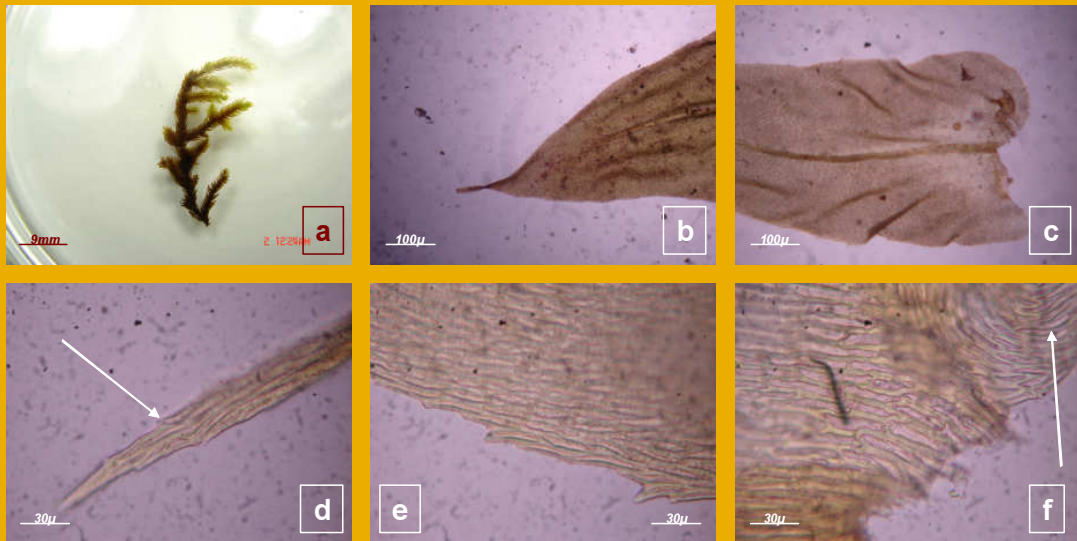
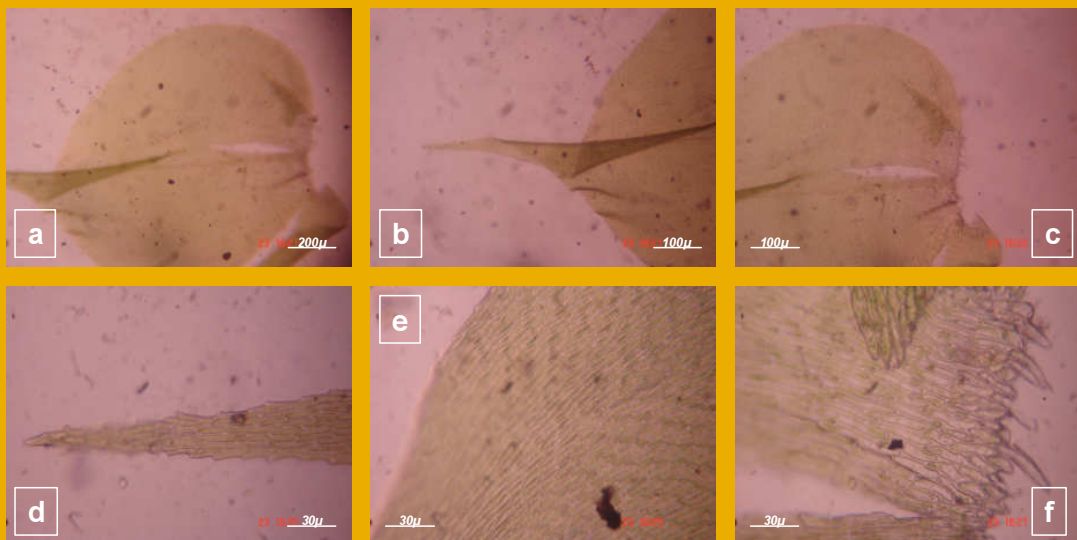


PLATE 54



[A] *Cryptopapillaria fuscescens*: (a) a portion of plant, (b) upper portion of leaf showing plications and absence of costa, (c) lower portion of leaf with auriculate base showing costa and plications, (d) leaf tip cells showing papillations (arrow), (e) portion of middle lamina showing linear papillate cells with dentations on margin, (f) thick walled basal cells and vermiform cells at the auriculate base (arrow).



[B] *Meteorrella soluta*: (a) whole leaf with plications and cordate base, (b) pointed upper portion of leaf, (c) basal portion of leaf showing absence of costa, (d) apical lamina showing serrations, (e) middle lamina showing linear cells, (f) basal elongated laminal cells with thick walls, (g) whole plant.



PLATE 55

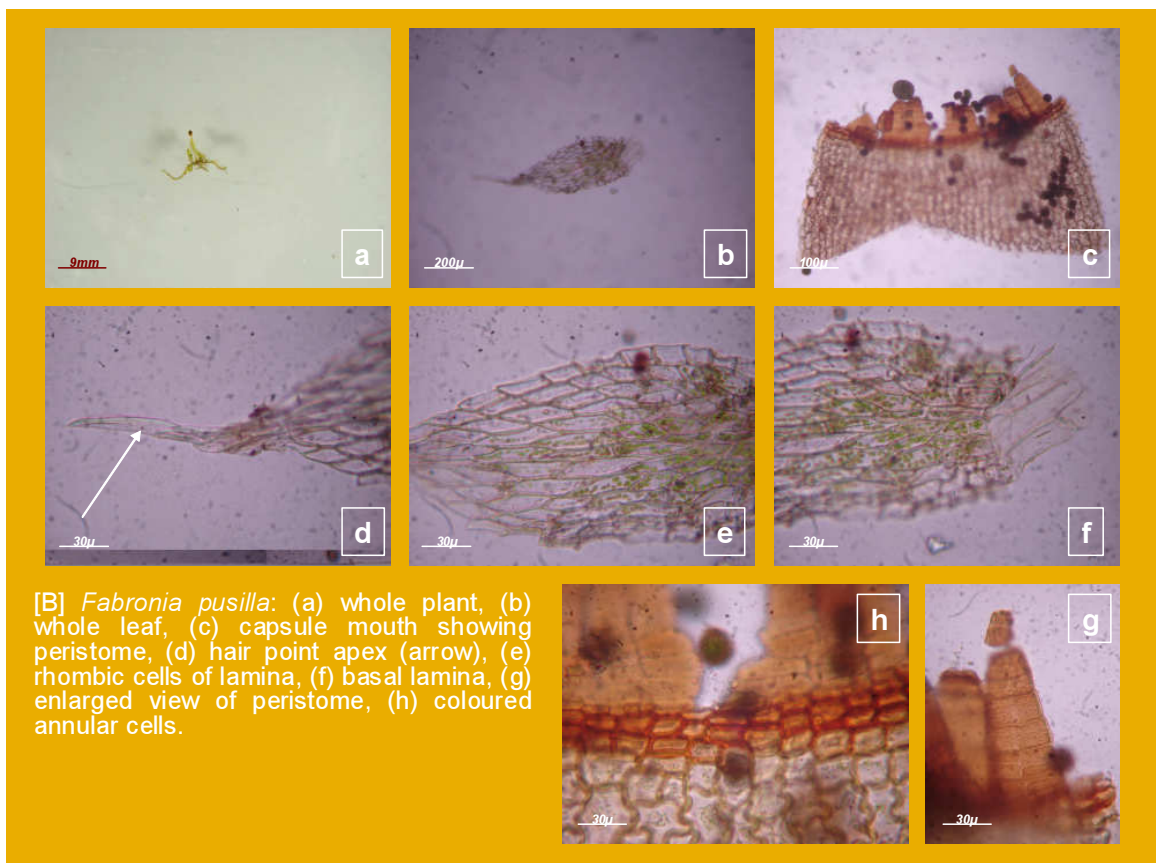
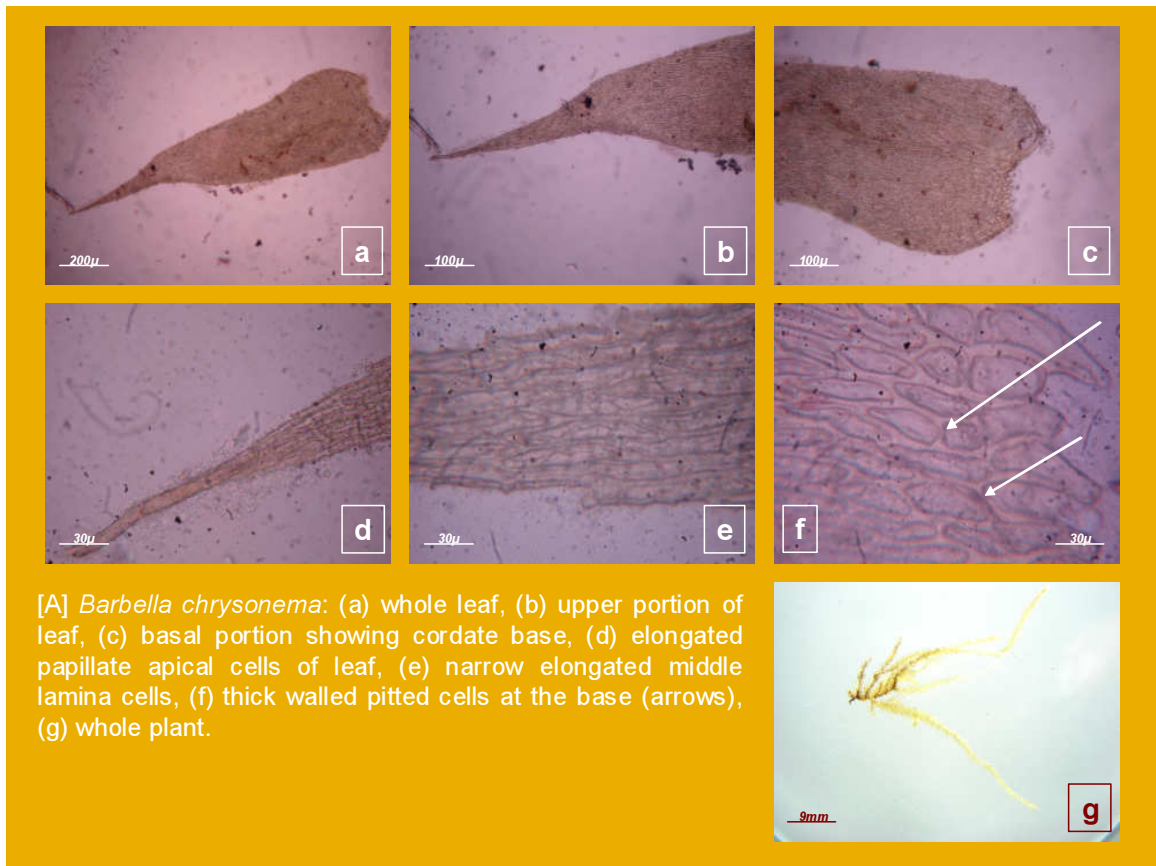


PLATE 56

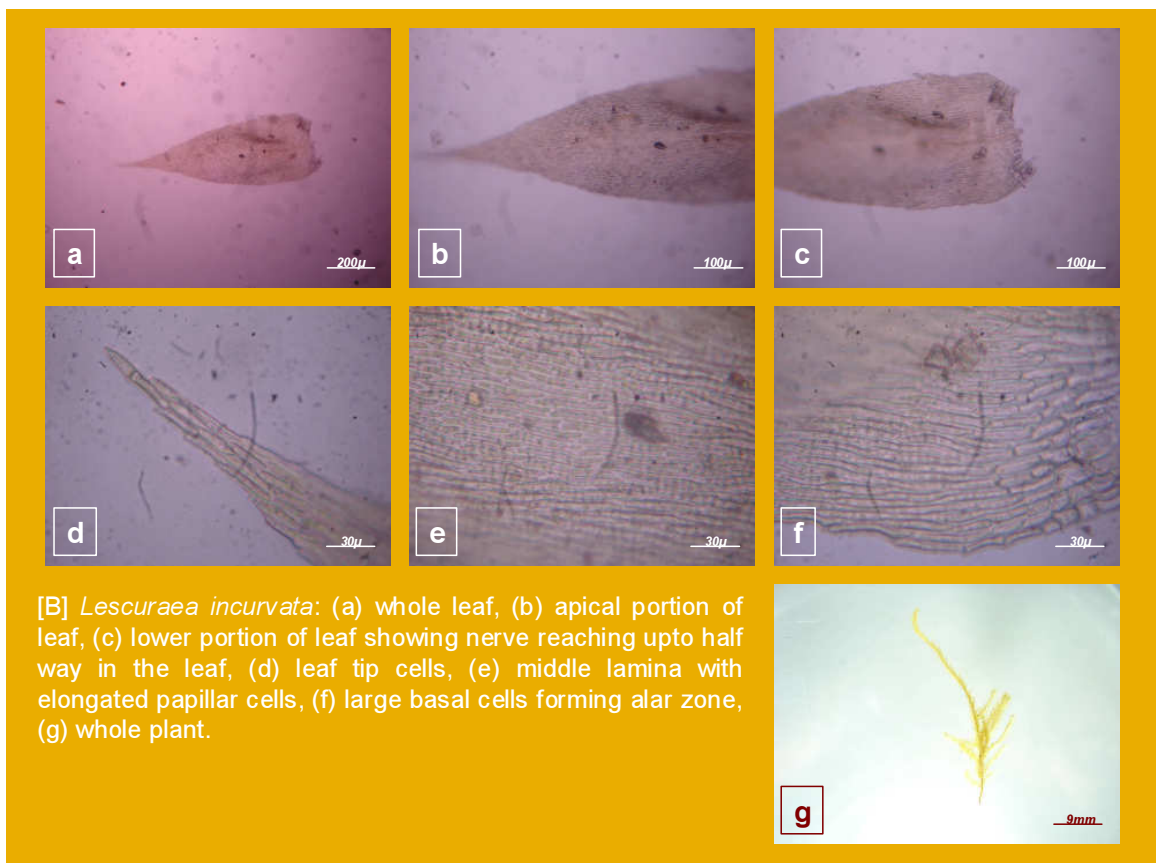
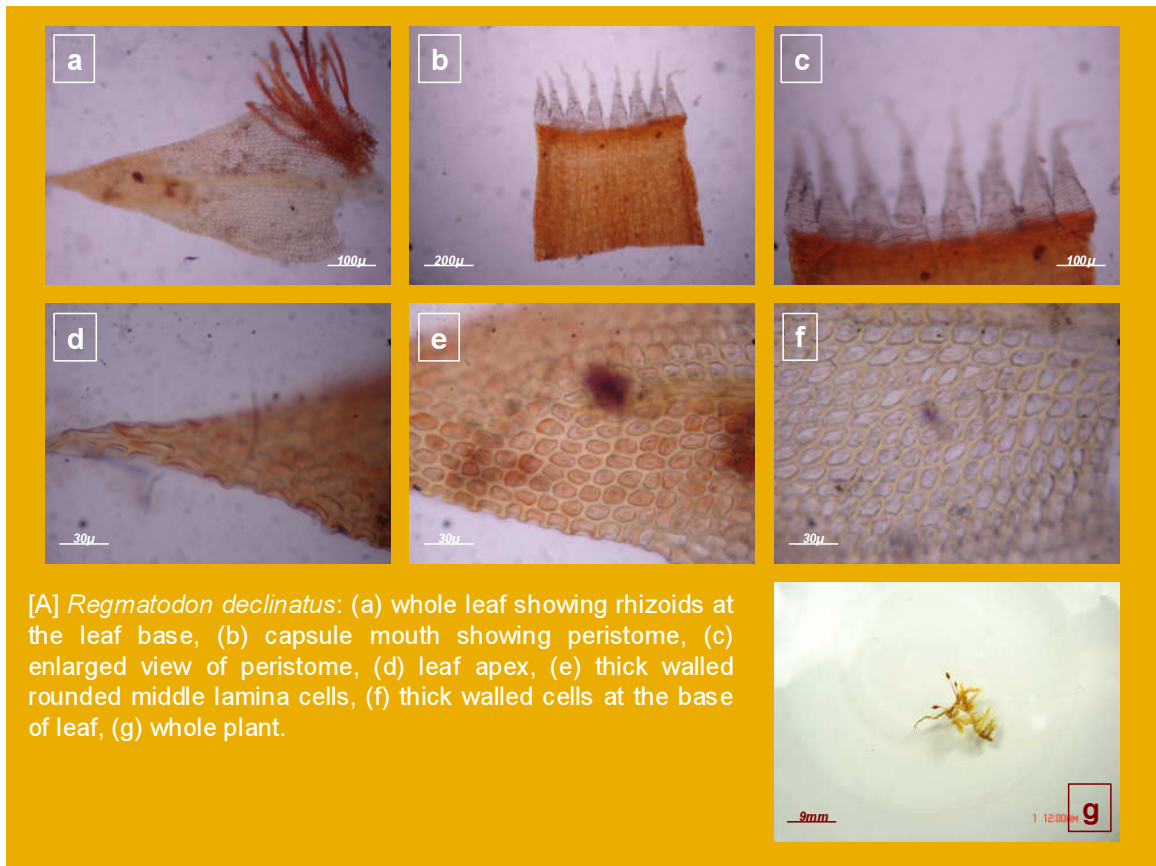
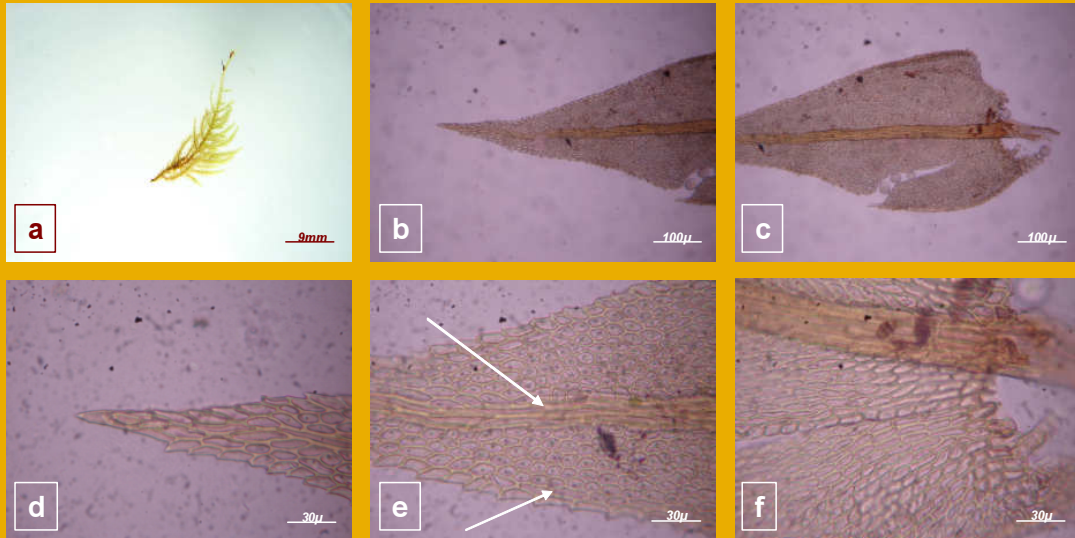
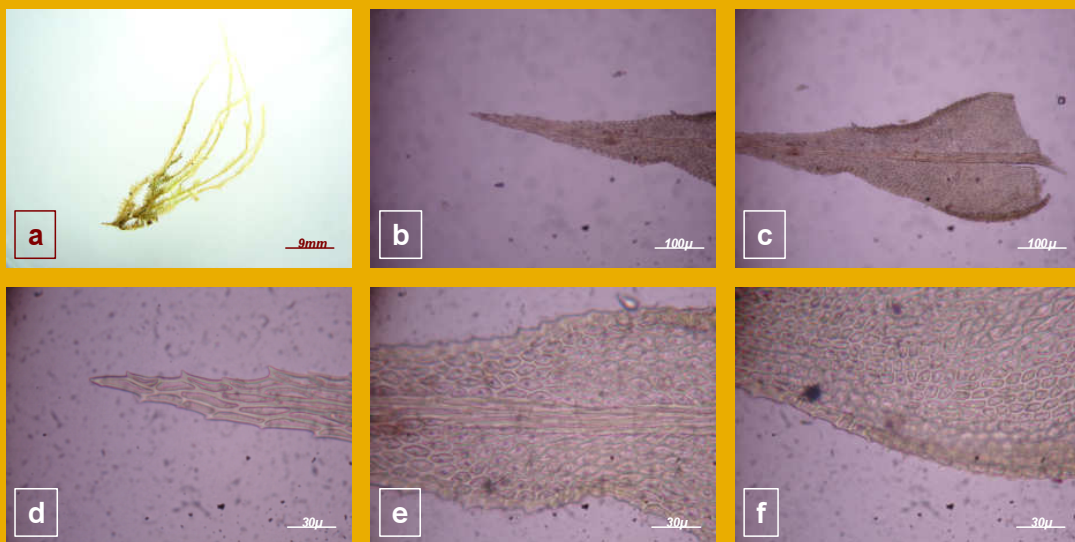


PLATE 57

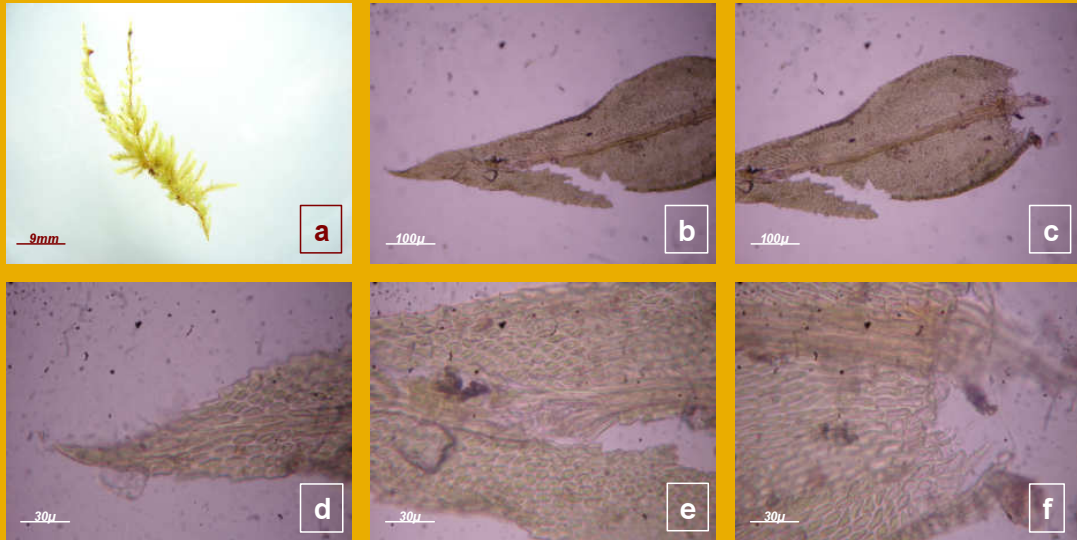


[A] *Herpetineuron toccoae*: (a) whole plant, (b) upper portion of leaf, (c) middle and lower portion of lamina, (d) apical lamina showing serrate margin, (e) middle lamina with tortuous costa and round quadrangular papillate cells, (f) basal lamina with smooth rectangular cells.

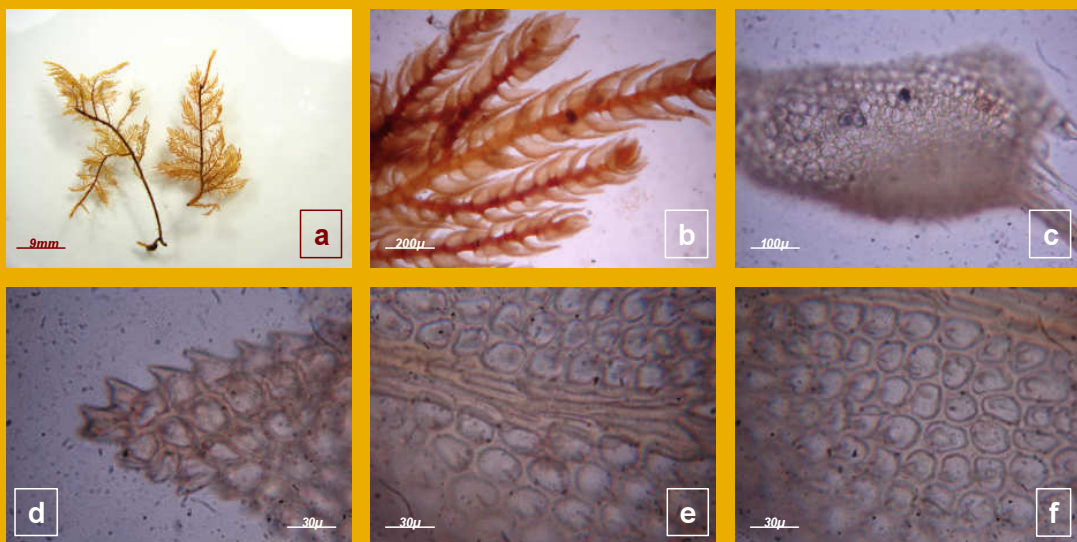


[B] *Claopodium pellucinerve*: (a) whole plant, (b) apical portion of leaf, (c) middle portion of leaf showing broad base, (d) enlarged view of apical portion with serrate margin, (e) middle lamina showing distinct border with serrations, (f) basal quadrate cells.

PLATE 58



[A] *Haplocladium schimperi*: (a) whole plant, (b) upper portion of costate lamina, (c) basal part of leaf, (d) apical lamina with serrate margin, (e) basal lamina with distinct margin, (f) basal portion of lamina.



[B] *Pelekium investe*: (a) whole plant, (b) arrangement of leaves on the branches, (c) whole leaf, (d) apical portion of leaf showing thick walled cells and dentations, (e) middle lamina showing costa and thick walled rounded cells, (f) cells of leaf base.

PLATE 59

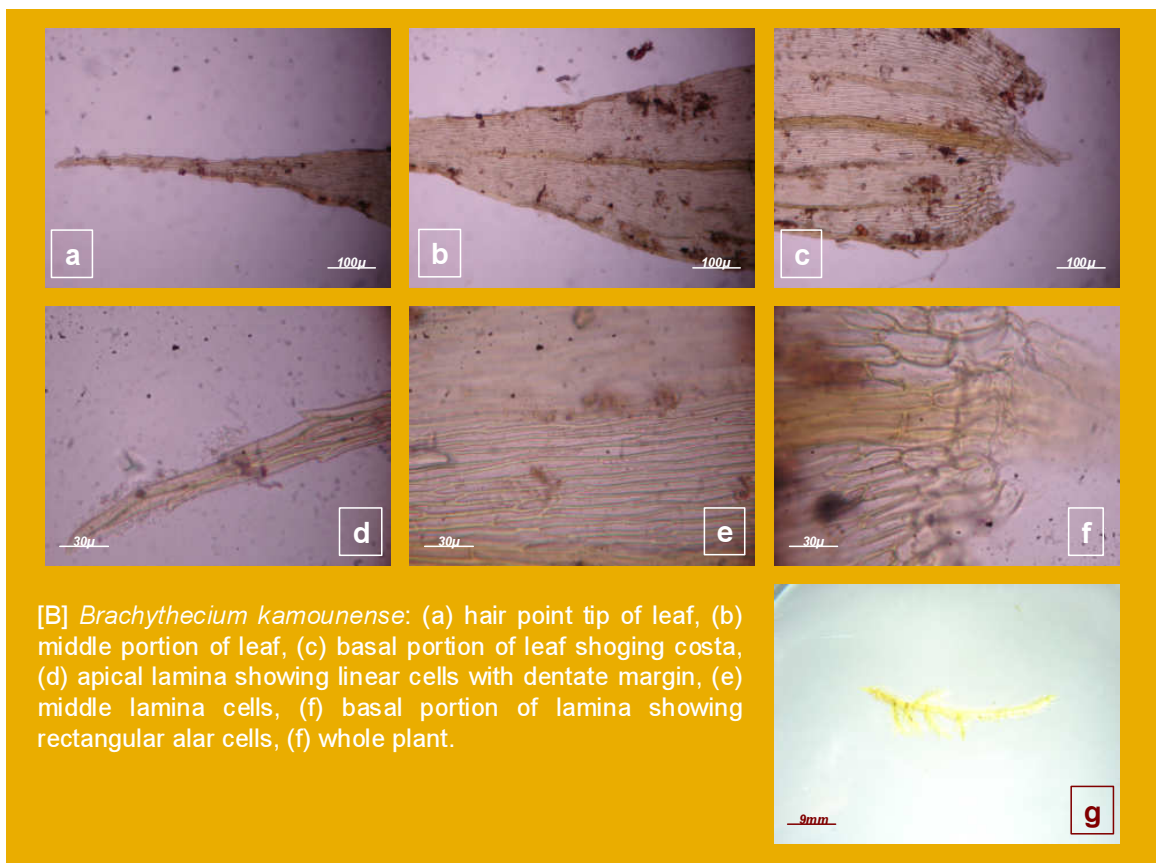
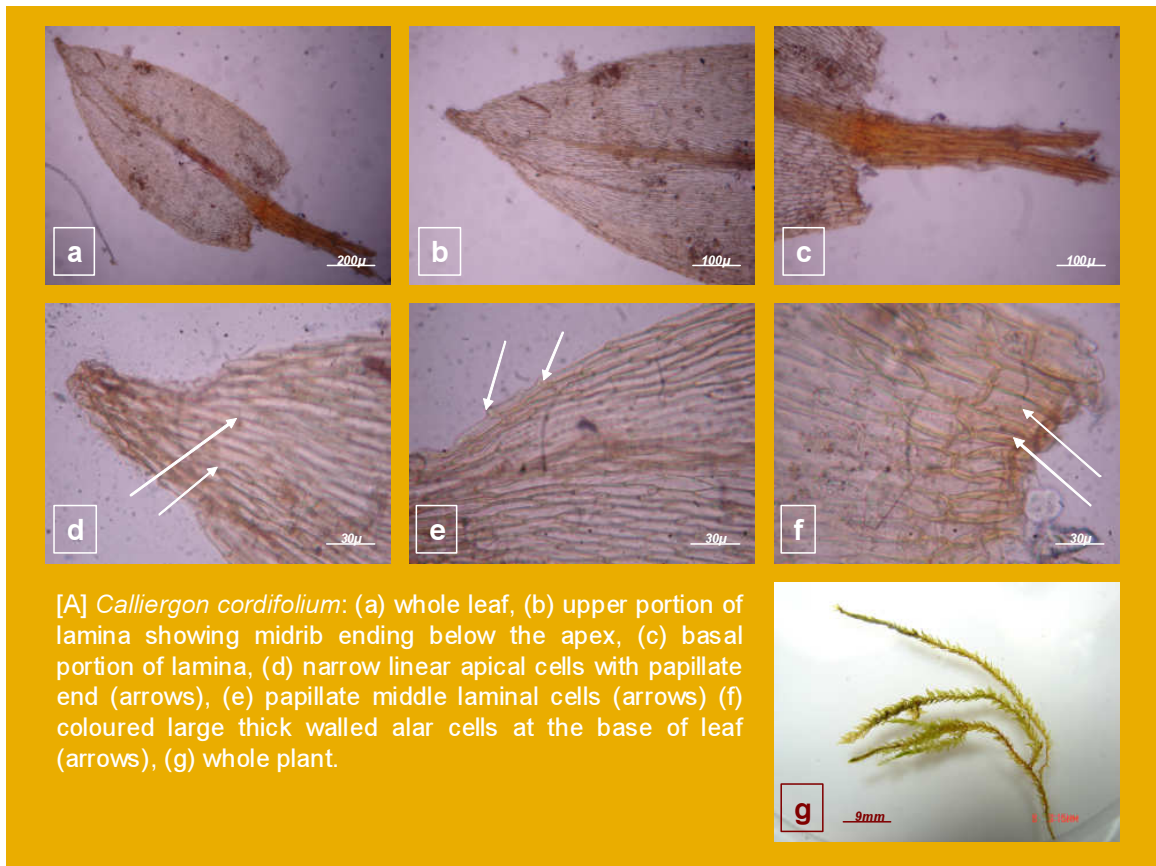


PLATE 60

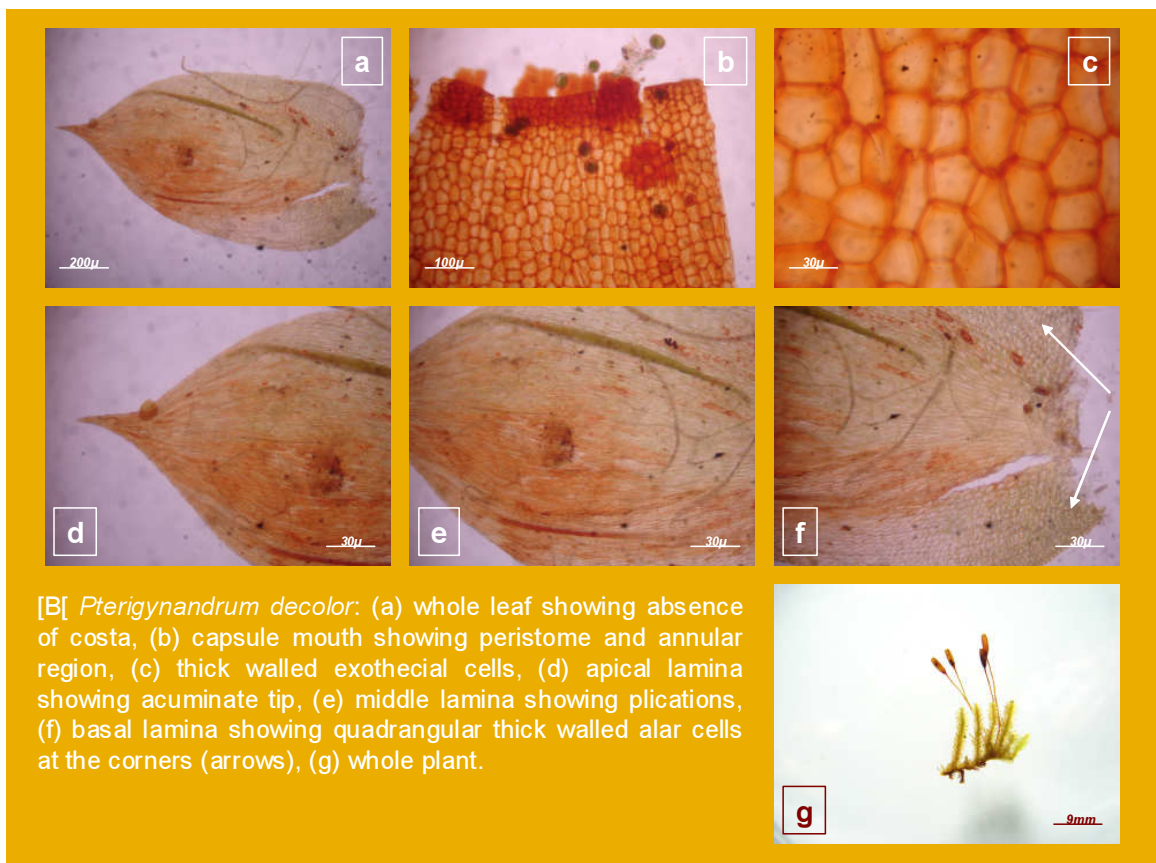
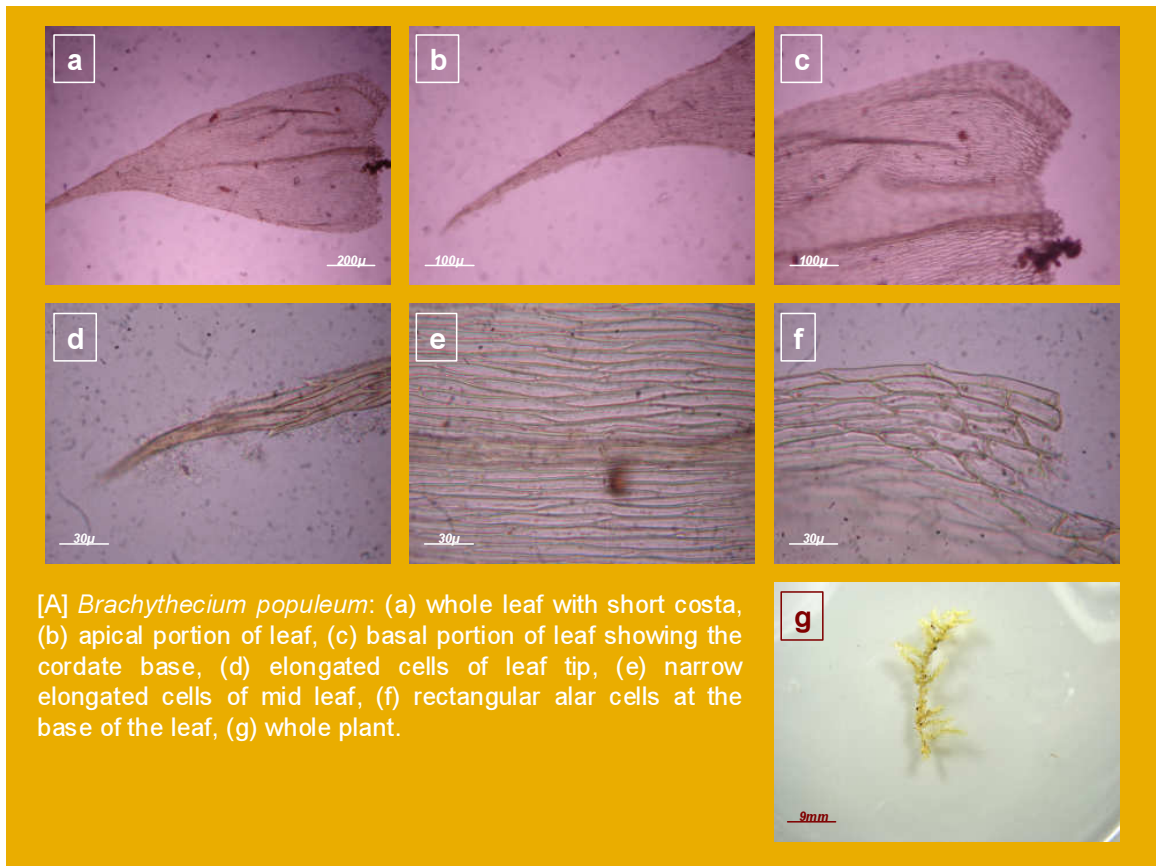


PLATE 61

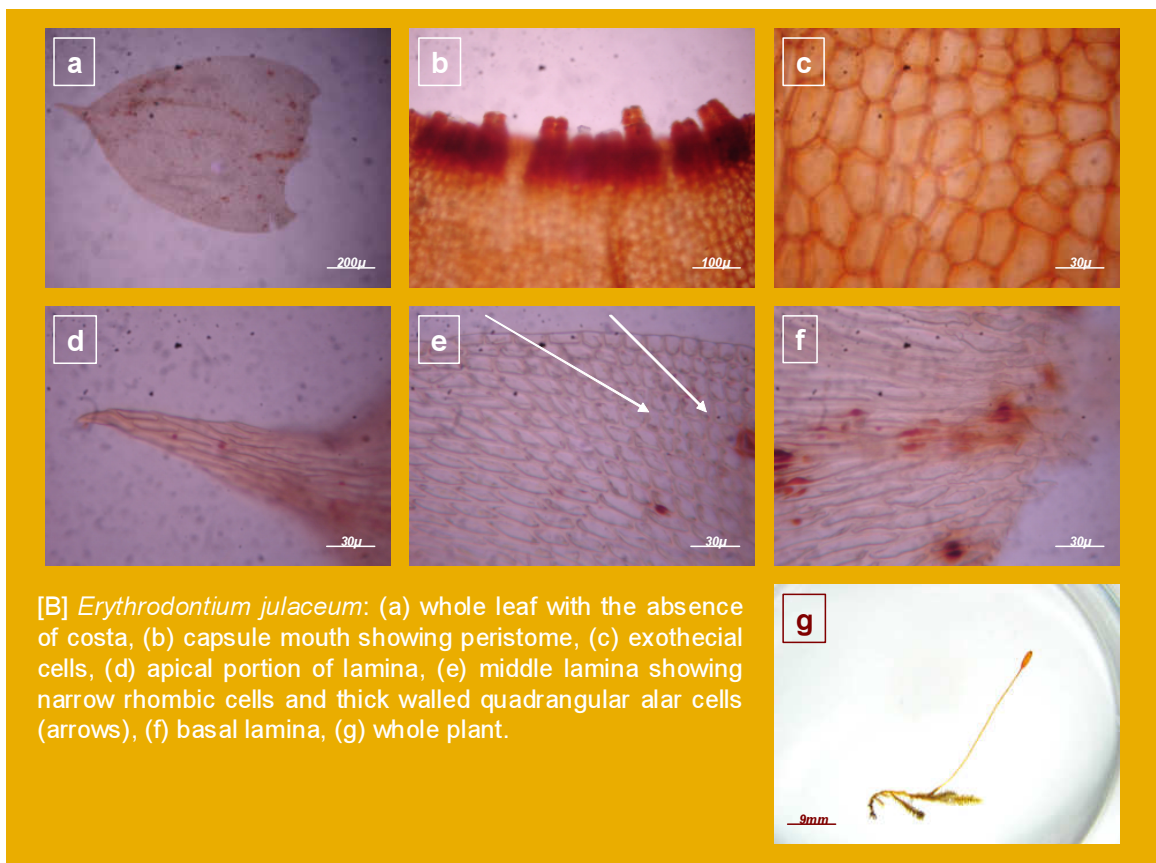
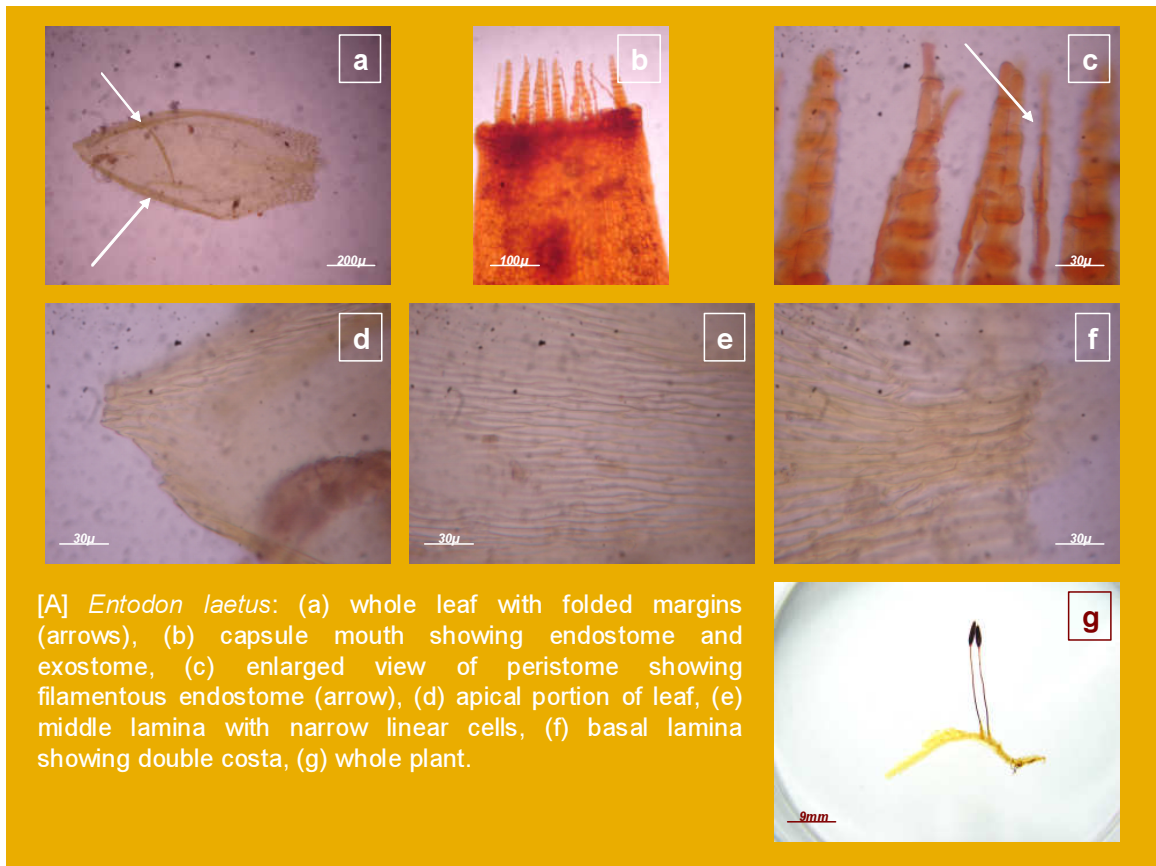


PLATE 62

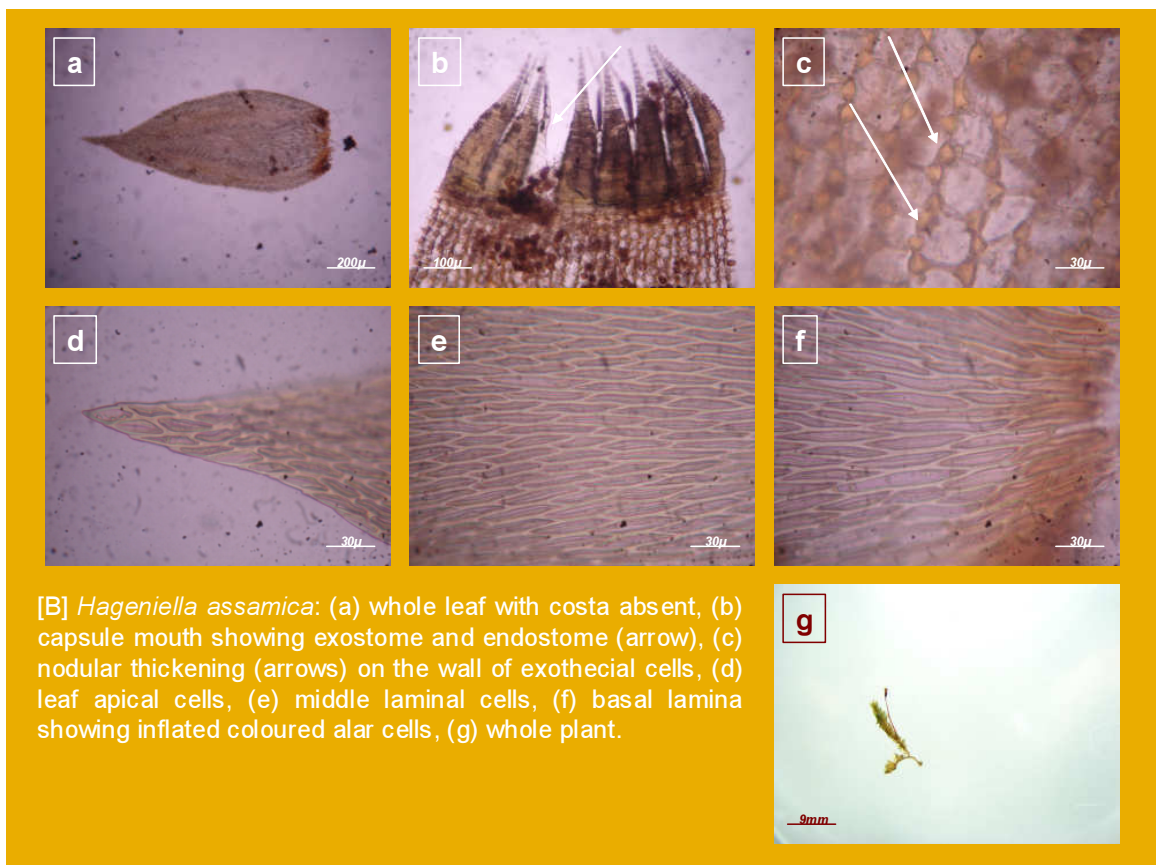
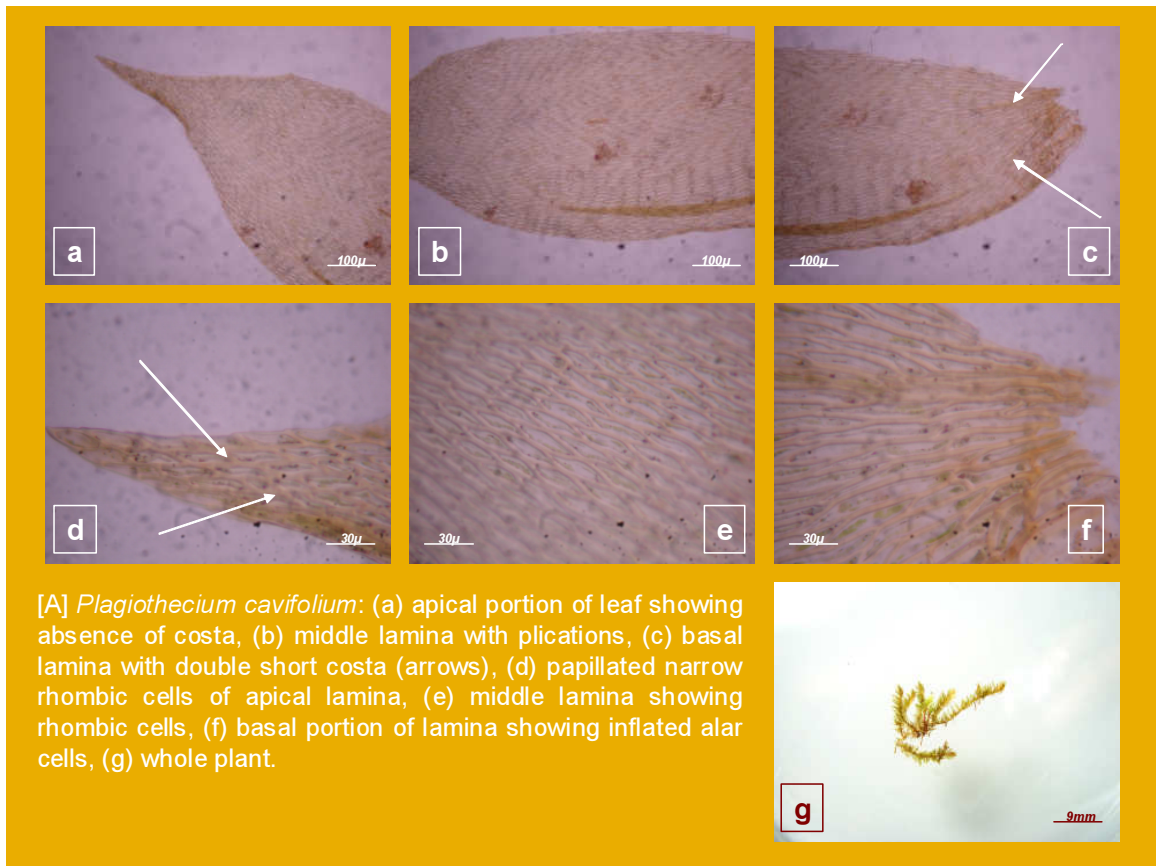


PLATE 63

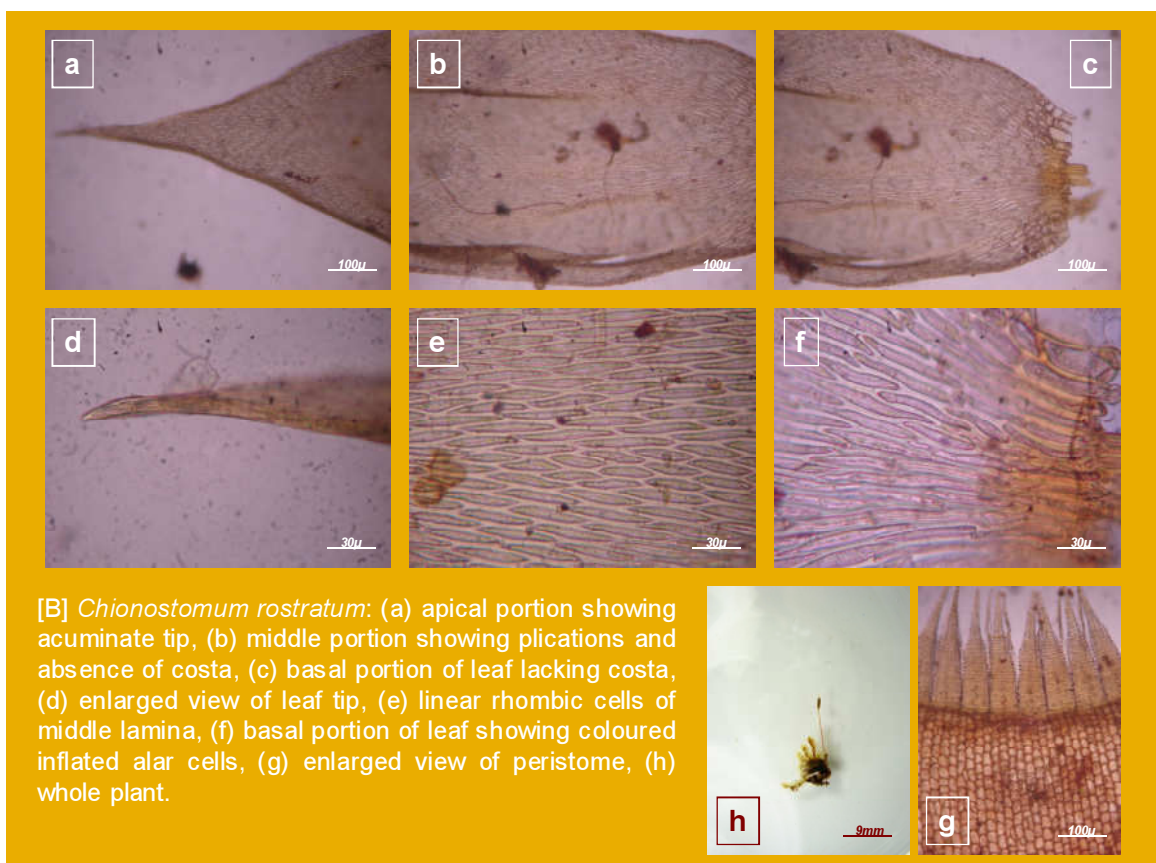
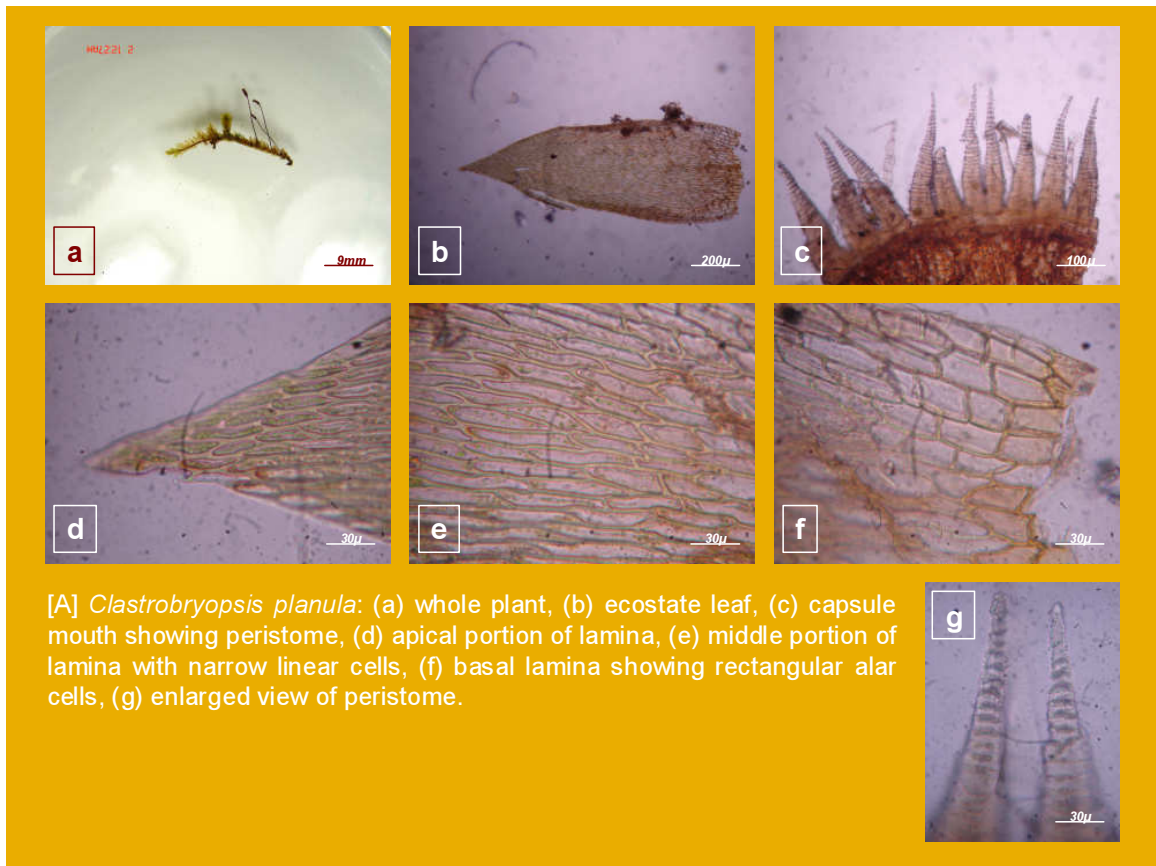


PLATE 64

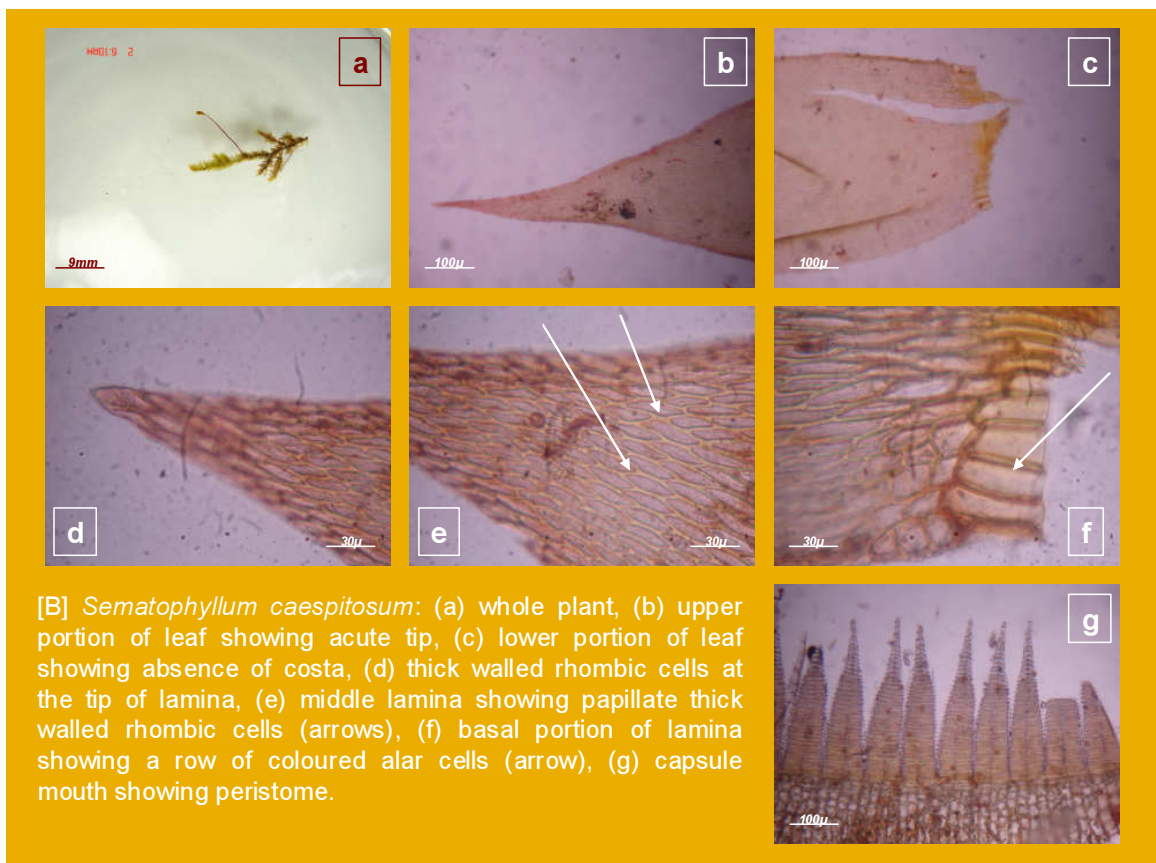
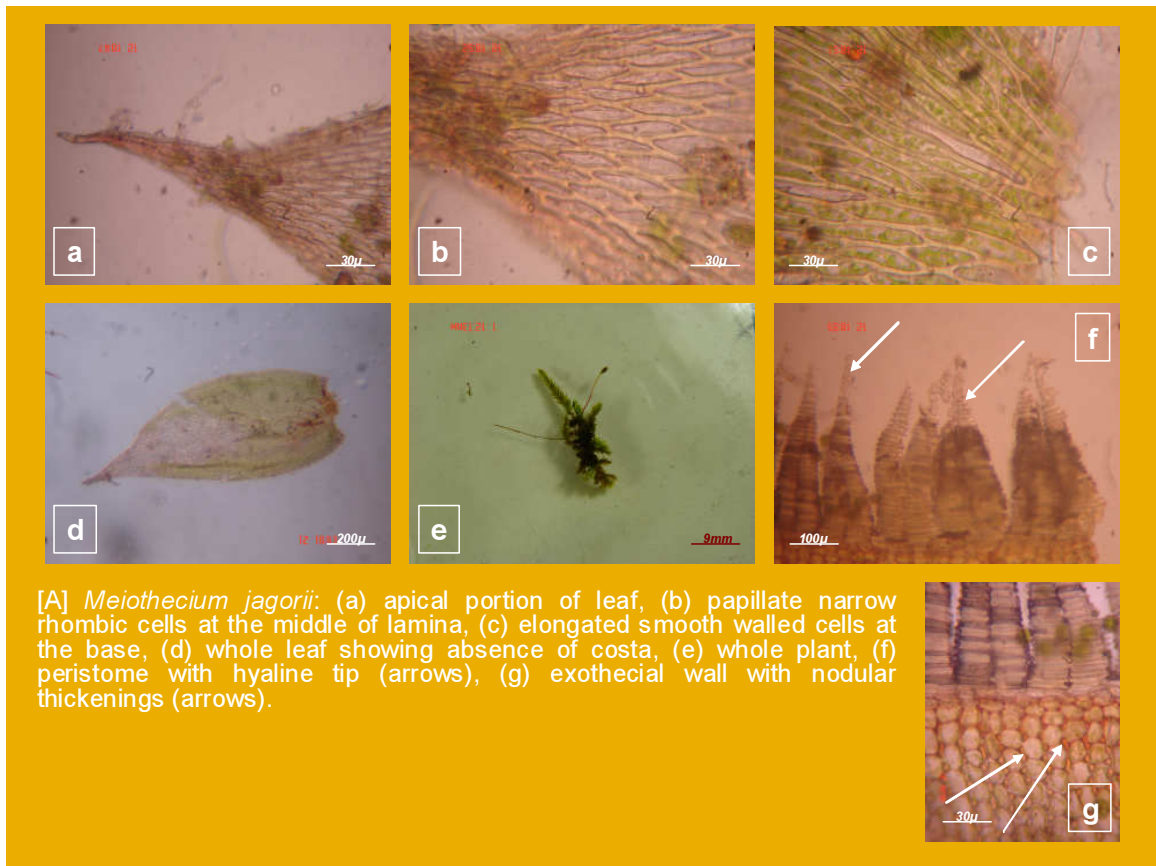
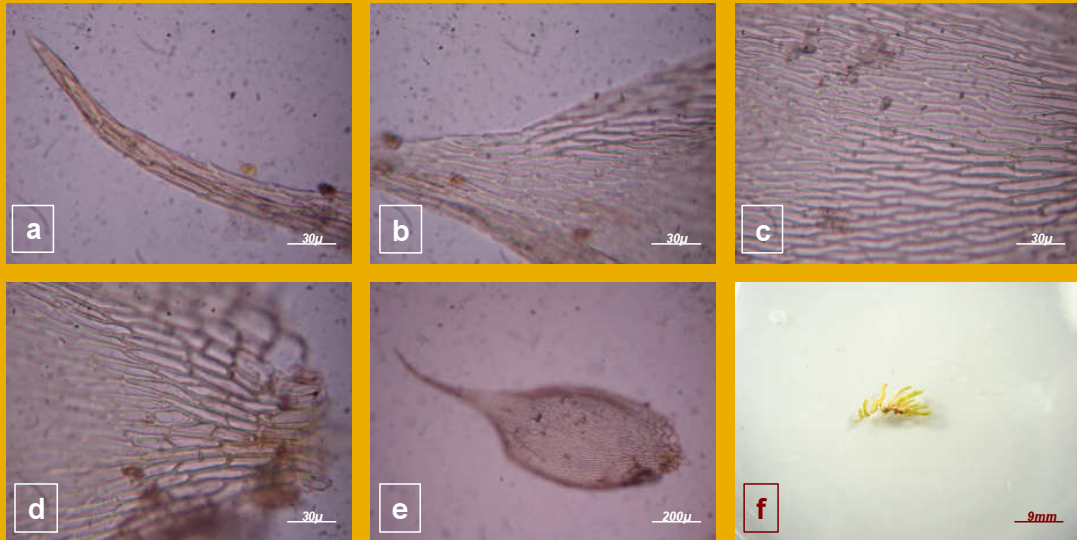


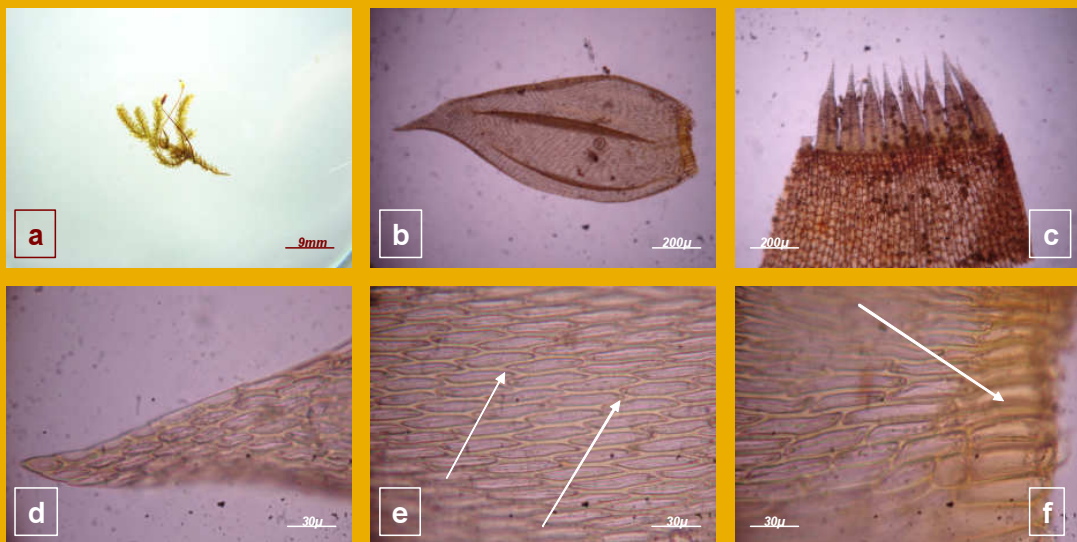
PLATE 65



PLATE 66



[A] *Brotherella dixonii*: (a) elongated leaf tip cells, (b) upper part of lamina, (c) papillate cells at the lower part of lamina, (d) quadrangular alar cells at the basal margins, (e) whole leaf showing absence of costa, (f) whole plant.



[B] *Trichosteleum glauco-virens*: (a) whole plant, (b) whole leaf showing plications and absence of costa, (c) capsule mouth showing exostome and endostome, (d) enlarged view of leaf tip, (e) middle lamina showing thick walled narrow cells with papillations (arrows), (f) a row of inflated coloured alar cells at the base of leaf (arrow), (g) enlarged view of exostome and endostome.

PLATE 67

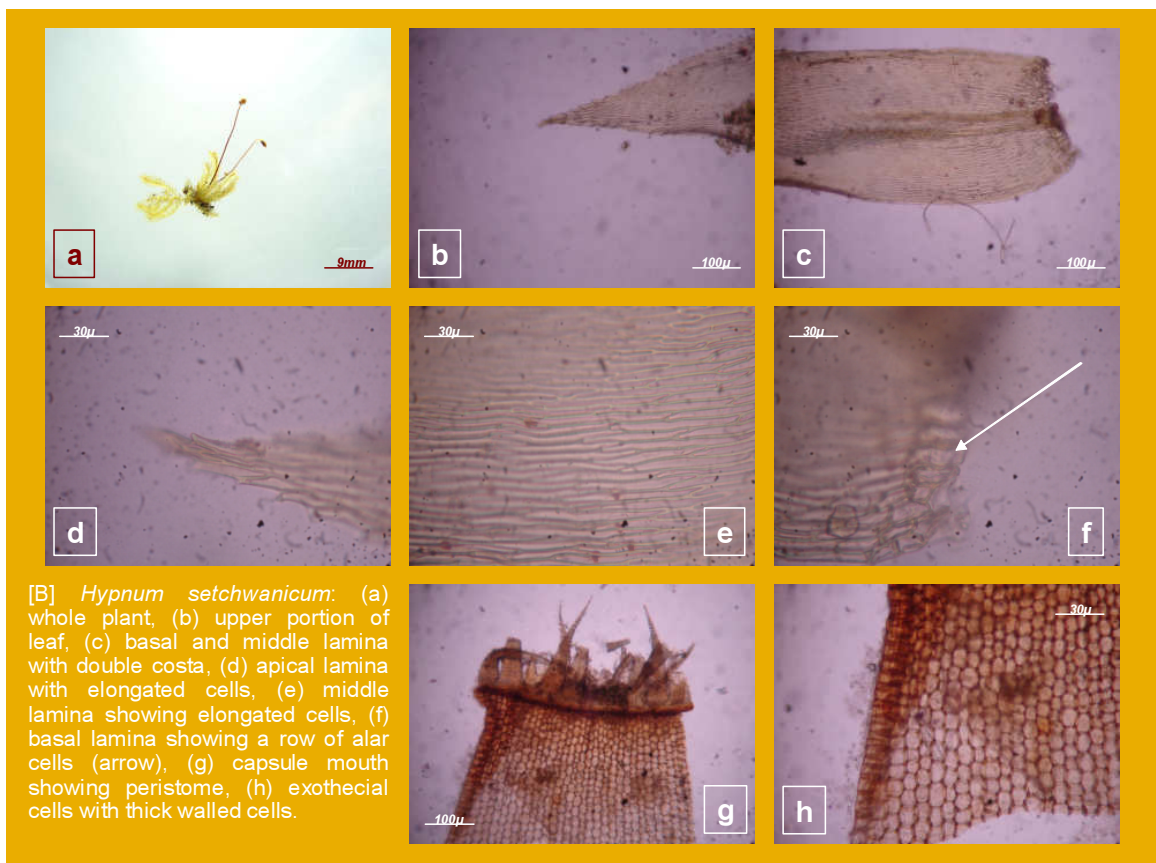
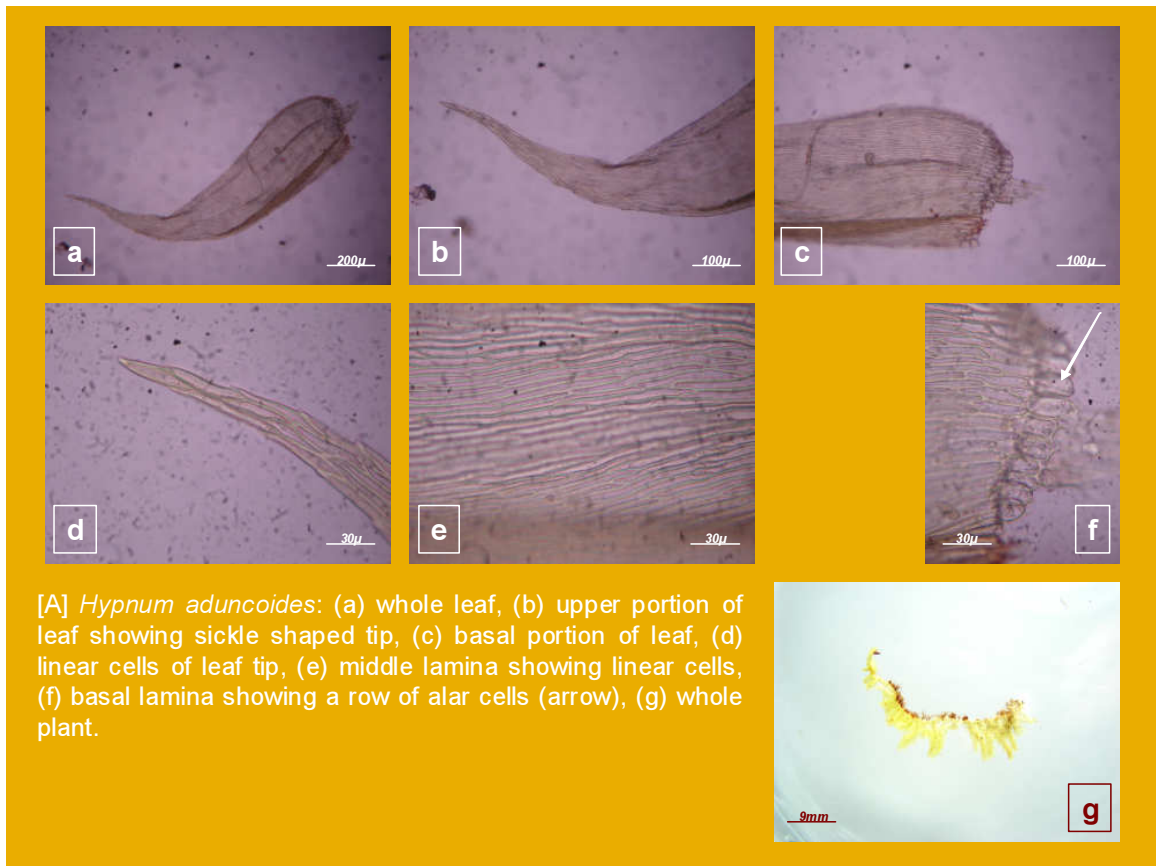
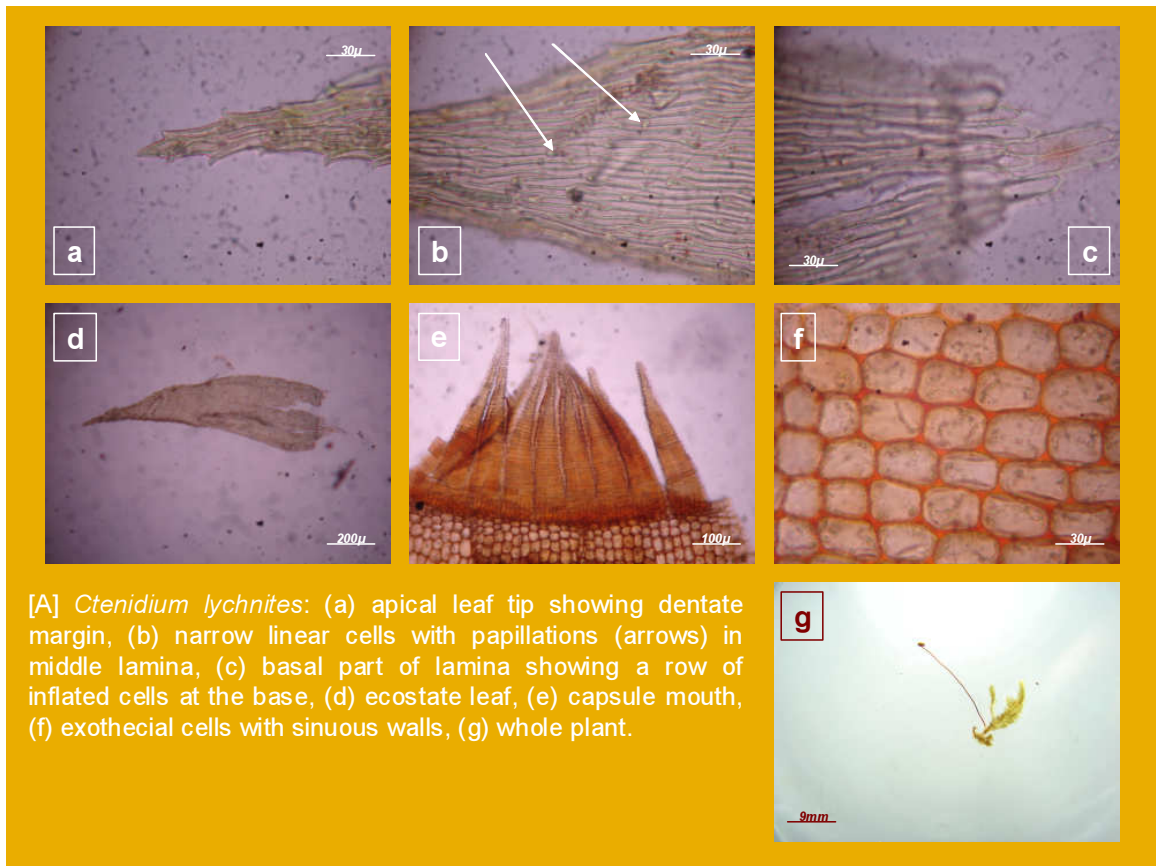


PLATE 68



Chapter 6
Results and Discussion

Bryophyte Systematics and Ecology

Mosses have always been linked to the terrestrial environment and have been achieved their greatest diversity in cool, moist, oceanic climates found at higher latitudes and altitudes. Several species have potential to adapt the changing climates of this area. The considerable extant diversity of these groups reflect the genetic plasticity of the ancestral populations and their great success in occupying the many new and edaphically and hospitable niches created by the rise of the angiosperms. The morphological divergence between taxa is decisive in determining the taxonomic divergence. For classification of mosses, especially for separating orders, families & genera, sporophytic characters including peristome morphology are the most important. The structure of the peristome teeth is also useful to distinguish species in almost all groups of mosses. The adaptive value of taxonomic characters has not received much attention recently, however, there exist evolutionary trends in mosses which are correlated with their substrates and habitats.

Barkman (1970) has stressed that although the habitats in which taxon grows may be equivalent physiologically, because changes in one factors are balanced by reverse changes in other factors. It is also of considerable biosystemetic importance to determine the widely distributed species of bryophytes throughout the world. Bryophyte taxonomists face problems from both intra and inter continental isolation of taxa with increasing frequency as we begin to access bryophytes critically on a world wide scale. Information on the ecology of plants is basic to systematics in providing an understanding of:

1. distribution of taxa
2. variation within taxa
3. adaptations of plants

Differences in habitat ecology of mosses are commonly used as an aid in their identification, at any taxonomic level, used in conjunction with the morphological characters. Many tropical genera are entirely epiphytic. Thus habitat differences between closely related species are valuable non-morphological characters useful for taxonomic purpose. Ecological studies have demonstrated that the character state of many morphological features is correlated with environmental factors. Ecology contributes to taxonomic interpretation of the evolutionary process by seeking environmental explanations for discontinuities in the structure, function and distribution of plants (Kruckeberg, 1969). Studies on rates of water uptake and loss, evaluation of atmospheric humidity and water holding capacities, growth forms, temperature changes, photosynthetic rates & influence of phyto-hormones provide useful evidence for taxonomic studies. It is also concluded that the real differences between species are in the field, where whole populations and their reaction to environmental factors can be clearly observed.

The growth of tourism and other recreational activities as well as the agricultural and industrial development of the area are destroying the habitat of mosses and the population size of mosses is decreasing. Efforts should be made to the conservation of bryophytes and their habitats.

The need for more monographic work, frequently stressed in the past, is still felt today. Much can be learned from these studies about the delimitation and distribution of species. Today, most bryologists are well aware that widespread genera may include species whose areas of distribution cover more than one continent. Some genera have a different but overlapping geographical distribution which can be used in conjunction with morphology to suggest evolutionary relationships. Ideas about evolution can be then correlated with evidence of geological history.

Phytogeography and Systematics

It has been found that some species are rather narrowly localized by environmental circumstances and special habitat preferences e.g. a specific type of rock, the ecological conditions of certain types of forest or a specific climatic zone,

specific bark etc. Bryophytes are intrinsically interesting group and have an important contribution to make to solving problems of evolution and phytogeography. They show evolutionary potential comparable to that of angiosperms. In so far, as bryology is concerned, the present state of knowledge of most of the world's flora is very much in first, exploratory phase. Bryogeography has been closely co-ordinated with the taxonomy of bryophytes since Schimper's (1860) and Brothier's (1884) works on the zonal distribution of bryophytes.

Peristome Characters and Systematics

In musci, the higher taxonomic ranks such as classes and orders have for a long time been largely defined by peristome characters, in recent times, there have been very few studies on peristome structure as a taxonomic character. An easily observable arrangement of the cells that form the peristome has been noted as characteristic of the Haplolepididae. The possible occurrence of the pattern in two diplolepidous orders might suggest a link between the two groups but this seem unlikely. Thus, it is assumed that "haplolepidous" describes a peristome with a single rank of teeth around the capsule mouth and that "diplolepidous" indicates a peristome with two such ranks. Crosby and Magill (1977) mentioned no category above the level of family and gave an undivided list of 87 currently accepted families from the Sphagnaceae to the Polytrichaceae. Most haplolepidous mosses are indeed grouped together, but some odd placements appear among the diplolepidous families.

Present study deals with a comprehensive and illustrated account of 135 taxa belonging to 75 genera and 25 families from Idukki district, specially the hilly areas of Munnar and its surrounding, representing several interesting taxa from just 13.07% of the total geographical area of the state of Kerala.

Within the study area, Eubryales with 38 species belonging to 16 genera and 3 families is found to be the largest order followed by Dicranales with 31 species belonging to 15 genera and 3 families. The order Hypnobryales is found to be represented by 26 species belonging to 23 genera and 9 families showing highest

diversity of mosses. 10 species belonging to 5 genera and 2 families belong to order Pottiales whereas the order Polytrichales is represented by 10 species belonging to 3 genera and one family only. Isobryales is represented by 9 species belonging to 9 genera and 5 families. Funariales is represented by 7 species belonging to 3 genera and one family only. Fissidentales is represented by 4 species only of the genus *Fissidens* (Table 6.1).

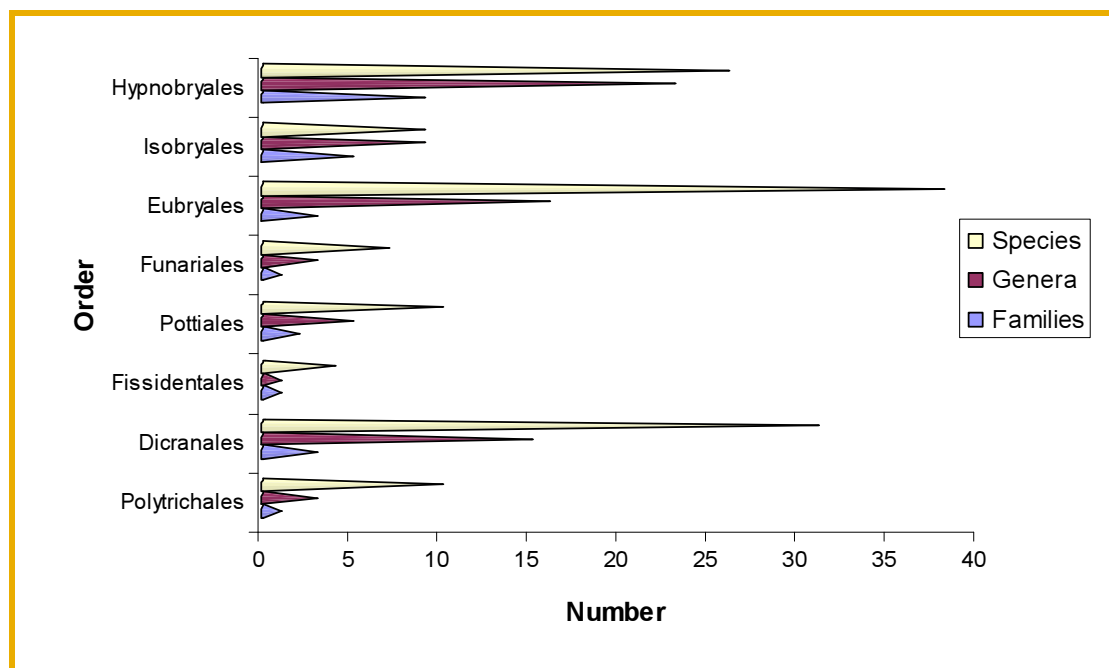


Figure 6.1: Order wise Distribution of Taxa in the Study Area

The family Bryaceae with 32 species and 12 genera is the largest family followed by Dicranaceae (20 species and 10 genera), Polytrichaceae (10 species and 3 genera), Sematophyllaceae (9 species and 8 genera), Ditrichaceae and Pottiaceae (8 species and 4 genera each), Funariaceae (7 species and 3 genera), Bartramiaceae (5 species and 3 genera), Thuidiaceae (4 species and 4 genera), Fissidentaceae (4 species and 1 genus), Meteoriaceae and Entodontaceae (3 species and 3 genera each), Hypnaceae (3 species and 2 genera), Leucobryaceae (3 species and 1 genus). The families Orthotrichaceae, Pterobryaceae and Leskeaceae are represented by 2 species and 2 genera each whereas Brachytheciaceae and Calymperaceae are represented by 2 species and 1 genus each. The families Mniaceae, Cryphaeaceae, Trachypodaceae,

Fabroniaceae, Amblystegiaceae and Plagiotheciaceae are represented by single species in each (Table 6.2).

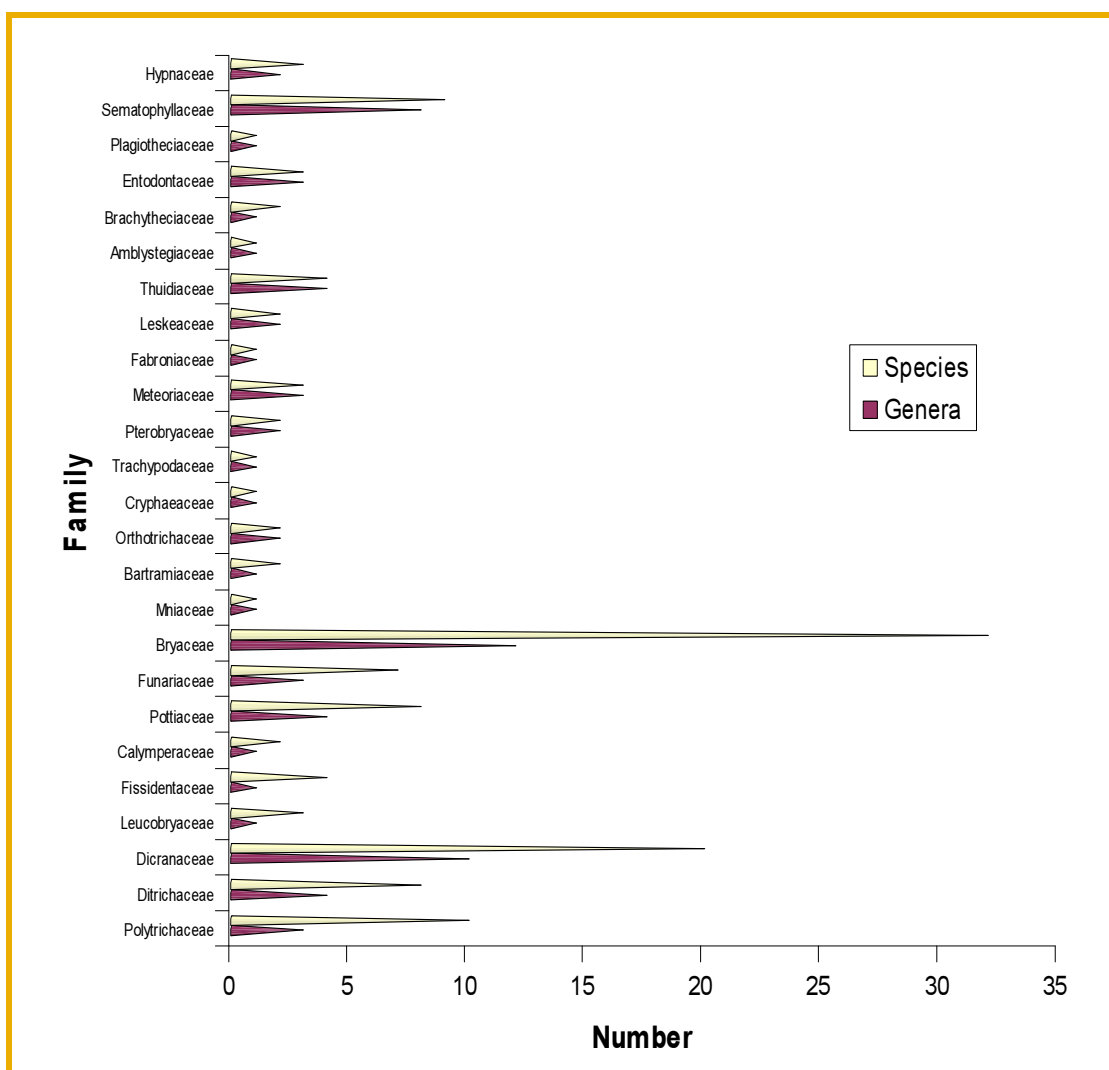


Figure 6.2: Family wise Distribution of Taxa in the Study Area

At the generic level, genus *Bryum* Hedw. with 9 species was found to have highest number of species followed by *Campylopus* Brid. and *Brachymenium* Schwaegr. (with 7 species of each), *Pogonatum* P. Beauv. (with 6 species), *Ditrichum* Hamp. (with 5 species), *Fissidens* Mitt., *Hyophila* Brid., *Anomobryum* Schimp. (with 4 species each), *Atrichum* P.Beauve., *Trematodon* Michx., *Leucobryum* Hamp., *Entosthodon* Wils., *Pohlia* Hedw., *Philonotis* Brid., (with 3 species each). Ten genera viz., *Dicranella* (C.Muell.) Schimp., *Microcampylopus* (C.Muell.) Fleisch., *Calymperes* Sw., *Oxystegus* (Limpr.)Hilp., *Physcomitrium* (Brid.)Fuenr., *Funaria*

Hedw., *Rhodobryum* (Schimp.)Hamp., *Brachythecium* B.S.G., *Sematophyllum* Mitt., *Hypnum* Broth. are represented by two species only, while 51 genera viz., *Polytrichum* Hedw., *Pleuridium* Brid., *Garckea* C.Muell., *Ceratodon* Brid., *Anisothecium* Mitt., *Microdus* Schimp., *Campylopodiella* Card., *Dicranodontium* B.S.G., *Rhabdoweisia* B.S.G., *Dicranoweisia* Mild., *Timmiella* (De Not.) Limpr., *Hydrogonium* (C.Muell.) Jaeg., *Mielichhoferia* Nees & Hornsch., *Orthodontium* Schwaegr., *Haplodontium* Hamp., *Leptobryum* (B.S.G.) Wils., *Mniobryum* Limpr., *Plagiobryum* B.S.G., *Ptychostomum* Hornschuch, *Mnium* Hedw., *Anacolia* Schimp., *Bartramidula* B.S.G., *Orthotrichum* Hedw., *Macromitrium* Brid., *Schoenobryum* Doz. & Molk., *Trachypodopsis* Fleisch., *Garovaglia* Endl., *Symphysodontella* Fleisch., *Cryptopapillaria* Menzel, *Meteoriella* Okam., *Barbella* Fleisch., *Fabronia* Raddi, *Regmatodon* Brid., *Lescuraea* B.S.G., *Herpetineuron* (C.Muell.) Card., *Claopodium* (Lesq. & Jam.) Ren. & Card., *Haplocladium* (C. Muell.) C. Muell., *Pelekium* Mitt., *Calliergon* (Sull.) Kindb., *Pterigynandrum* Hedw., *Entodon* C. Muell., *Erythrodonium* Hamp., *Plagiothecium* B.S.G., *Hageniella* Broth., *Clastobryopsis* Fleisch., *Chionostomum* C. Muell., *Meiothecium* Mitt., *Pylaisiadelpha* Card., *Brotherella* Loesk. Ex Fleisch., *Trichosteleum* Mitt., *Ctenidium* (Schimp.) Mitt. are represented by one species each.

Altitude wise Distribution of the Taxa

The most favourable altitudinal range for the growth of mosses is approximately 1600m where a total of 45 taxa have been reported belonging to 14 families and 27 genera, followed by 1700m where a total of 26 taxa have been reported belonging to 16 families and 24 genera. A total of 22 taxa belonging to 10 families and 18 genera have been reported at an altitudinal range of approximately 1200m whereas at approximately 1500m a total of 20 taxa have been reported belonging to 10 families and 19 genera. Less number of taxa were encountered at an altitudinal range of approximately 1800m with a total of 12 taxa belonging to 8 families and 11 genera, and least number of taxa were collected from the altitudinal range of approximately 1300m with a total of 10 taxa belonging to 4 families and 9 genera (Table 6.3).

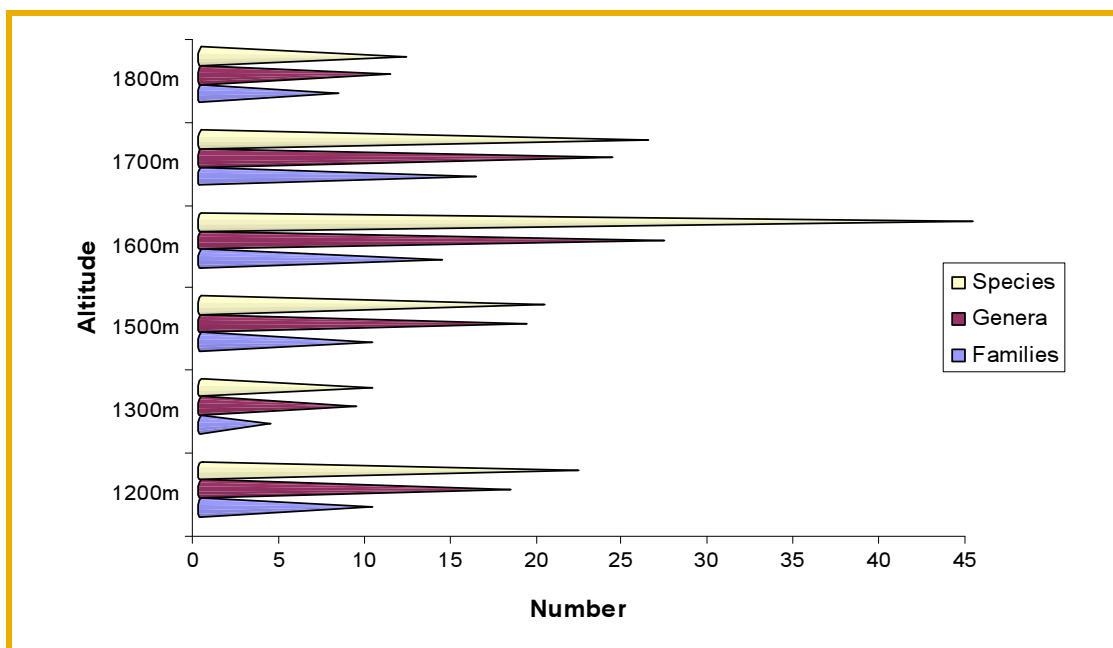


Figure 6.3: Altitude wise Distribution of Taxa in the Study Area

Habitat wise Distribution of the Taxa

In the tropical rain forest, the moss flora on the forest floor is less because of the high competition and frequent rains. However, the epiphytic mosses are abundant in this biome. Present study area consists of mostly open land, still 27 species have been recorded as epiphytic species. Out of 135 taxa reported from the study area 100 taxa are acrocarpous whereas 35 are pleurocarpous. Frequency of pleurocarpous mosses is found to be more in the study site.

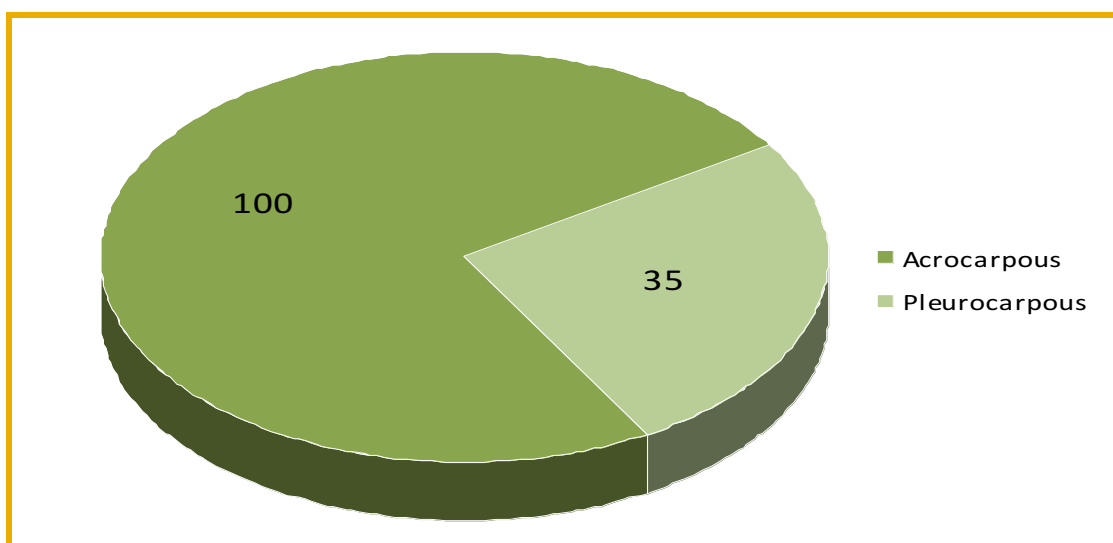


Figure 6.4: Distribution of Acrocarpous and Pleurocarpous Mosses in the Study Area

Of the total 135 taxa of mosses reported from the study area, 70 taxa are lithophytic belonging to 44 genera and 17 families. 41 taxa belonging to 26 genera and 14 families were reported from rocks whereas 29 taxa are exclusively reported from wet rocks belonging to 10 families and 21 genera. On shaded or moist rocks 5 taxa belonging to 5 families were reported and from exposed rocks 6 taxa belonging to 3 genera and 2 families were reported. 34 taxa are terrestrial belonging to 9 families and 18 genera, of which 5 taxa are reported from loose soils belonging to 3 families and 3 genera, 4 taxa are reported from sandy soils belonging to two families. In total 8 taxa have been reported from moist/shaded soils belonging to 5 families. *Pogonatum stevensii* Ren. et Card. and *Polytrichum densifolium* Wils. ex Mitt. have been reported from stable soils and disturbed soils respectively whereas *Ptychostomum pseudotriquetrum* (Hedw.) J.R.Spence & H.P.Ramsay has been reported from exposed soils.

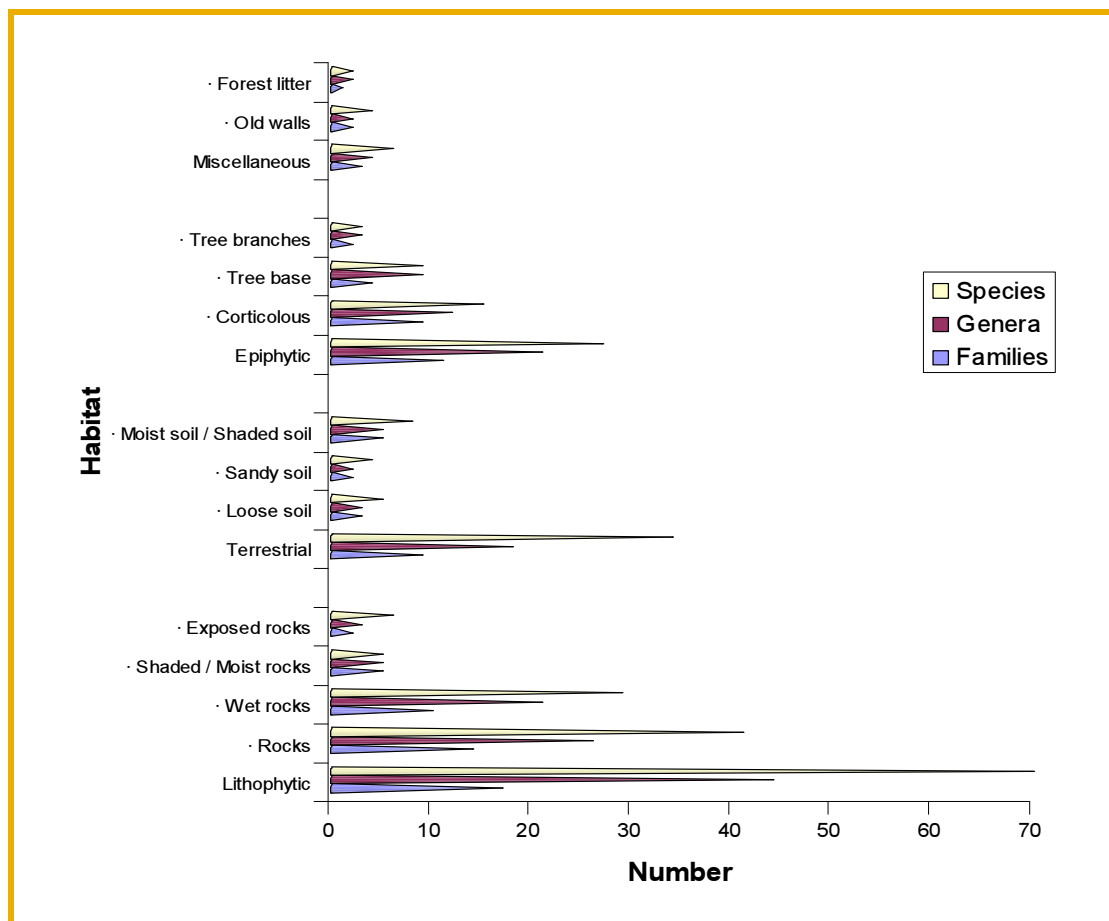


Figure 6.5: Habitat wise Distribution of Taxa in the Study Area

A total of 27 taxa belonging to 16 families and 24 genera have been reported from epiphytic habitat out of which 16 taxa belonging to 10 families and 13 genera are corticolous, 8 taxa belonging to 4 families have been reported from tree base and 3 taxa belonging to 2 families have been recorded from tree branches. 4 taxa belonging to 2 genera and families have been recorded from construction sites (such as old walls) whereas 2 taxa belonging to 2 genera and a single family have been reported from litters also (Table 6.4).

Status of Taxa in the Study Area

Out of the total 135 taxa reported from the study area 13 taxa belonging to 9 genera and 8 families are abundant as they were found everywhere at open as well as forested sites, 28 taxa belonging to 20 genera and 13 species are frequent as they were reported from many forested sites, 38 taxa belonging to 27 genera and 14 families are moderately present or infrequent as they were reported from 5 to 10 sites only in moist habitat. 34 taxa belonging to 21 genera and 10 families are sparse as they were reported from 3 to 4 sites only whereas 22 species belonging to 22 genera and 11 families have been found to be rare as these are represented by just single collection only (Table 6.5).

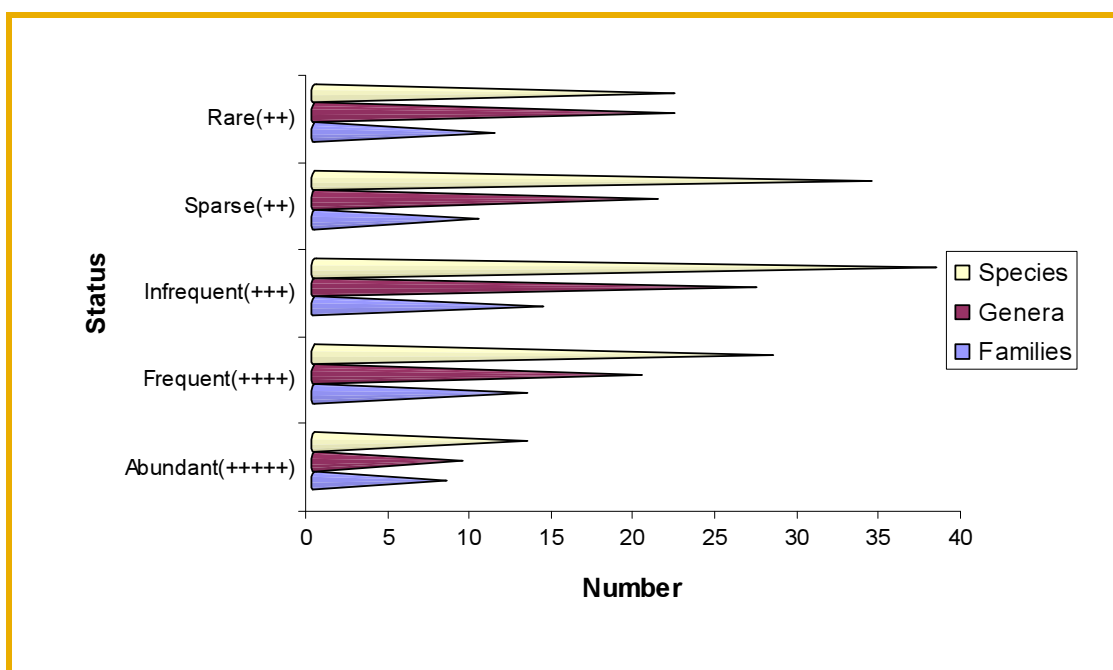


Figure 6.6: Status of Taxa in the Study Area

Endemic Species

Out of the 135 taxa reported from the study area, 24 taxa viz. *Atrichum longifolium* Card. & Dix. ex Gangulee, *Pogonatum leucopogon* Ren. et Card., *Pogonatum stevensii* Ren. et Card., *Ditrichum darjeelingense* Ren. & Card., *Trematodon subulosus* Griff., *Dicranella macrospora* Gangulee, *Campylopus subfragilis* Ren. & Card., *Dicranoweisia alpina* (Mitt.) Par., *Fissidens pulchellus* Mitt., *Calymperes sikkimense* Broth. ex Gangulee, *Oxystegus stenophyllus* (Mitt.) Gangulee, *Hyophila nymaniana* (Fleisch.) Menzel, *Hyophila perannulata* Ren. et Card., *Pohlia himalayana* (Mitt.) Broth., *Brachymenium sikkimense* Ren. et Card., *Rhodobryum laxelimbatum* (Ochi) Iwats. & Kop., *Symphysodontella borii* Dix., *Barbella chrysonema* (Muell.Hall.) Nog., *Pterigynandrum decolor* (Mitt.) Broth., *Hageniella assamica* Dix., *Sematophyllum humile* (Mitt.) Broth., *Pylaisiadelphina drepanioides* Card. & Dix., *Brotherella dixonii* Herz. and *Trichosteleum glauco-virens* (Mitt.) Broth. are endemic to India.

The Taxa Reported for the First Time from the Study Area

Before taking up the present study, a total of 465 bryophyte taxa comprising 148 taxa of liverworts, 10 taxa of hornworts and 307 taxa of mosses were reported from Kerala (Manju *et al.*, 2008). The present study has added 83 taxa of mosses comprising 51 new genera belonging to 18 families to the hitherto known bryoflora of the study area which is only 13.07% of the total geographical area of the state of Kerala (Table 6.6).

Table 6.1: Order wise Distribution of Taxa

S.No.	Order	Families	Genera	Species
1.	Polytrichales	1	3	10
2.	Dicranales	3	15	31
3.	Fissidentales	1	1	4
4.	Pottiales	2	5	10
5.	Funariales	1	3	7
6.	Eubryales	3	16	38
7.	Isobryales	5	9	9
8.	Hypnobryales	9	23	26

Table 6.2: Family wise Distribution of Taxa

S.No.	Family	Genera	Species
1.	Polytrichaceae	3	10
2.	Ditrichaceae	4	8
3.	Dicranaceae	10	20
4.	Leucobryaceae	1	3
5.	Fissidentaceae	1	4
6.	Calymperaceae	1	2
7.	Pottiaceae	4	8
8.	Funariaceae	3	7
9.	Bryaceae	12	32
10.	Mniaceae	1	1
11.	Bartramiaceae	1	2
12.	Orthotrichaceae	2	2
13.	Cryphaeaceae	1	1
14.	Trachypodaceae	1	1
15.	Pterobryaceae	2	2
16.	Meteoriaceae	3	3
17.	Fabroniaceae	1	1
18.	Leskeaceae	2	2
19.	Thuidiaceae	4	4
20.	Amblystegiaceae	1	1
21.	Brachytheciaceae	1	2
22.	Entodontaceae	3	3
23.	Plagiotheciaceae	1	1
24.	Sematophyllaceae	8	9
25.	Hypnaceae	2	3

Table 6.3: Altitude wise Distribution of Taxa

S.No.	Altitude	Families	Genera	Species
1.	1200m	10	18	22
2.	1300m	4	9	10
3.	1500m	10	19	20
4.	1600m	14	27	45
5.	1700m	16	24	26
6.	1800m	8	11	12

Table 6.4: Habitat wise Distribution of Taxa

S.No.	Habitat	Families	Genera	Species
1.	Lithophytic	17	44	70
	• Rocks	14	26	41
	• Wet rocks	10	21	29
	• Shaded / Moist rocks	5	5	5
	• Exposed rocks	2	3	6
2.	Terrestrial	9	18	34
	• Loose soil	3	3	5
	• Sandy soil	2	2	4
	• Moist soil / Shaded soil	5	5	8
3.	Epiphytic	11	21	27
	• Corticolous	9	12	15
	• Tree base	4	9	9
	• Tree branches	2	3	3
4.	Miscellaneous	3	4	6
	• Old walls	2	2	4
	• Forest litter	1	2	2

Table 6.5: Status of Taxa in the Study Area

S.No.	Occurrence	Families	Genera	Species
1.	Abundant(++++)	8	9	13
2.	Frequent(++++)	13	20	28
3.	Infrequent(+++)	14	27	38
4.	Sparse(++)	10	21	34
5.	Rare(+)	11	22	22

Table 6.6: Total Number of Taxa reported for the first time from the State of Kerala

S.No.	Family	Genus	Species	Locality	Altitude	Habitat	Occurrence	Herbarium No.
1.	POLYTRICHACEAE	<i>Atrichum</i>	<i>Atrichum aculeatum</i> Card. & P. Vard.	Devikulam	1700m	Loose soil	++	13267
2.			<i>Atrichum obtusulum</i> (C. Muell.) Jaeg.	Kannimalai(Munnar)	1600m	Loose soil	+++++	13269
3.		<i>Pogonatum</i>	<i>Pogonatum cirratum</i> (Sw.) Brid.	Matupatti	1700m	Soil	+	13272
4.			<i>Pogonatum perichaetiale</i> (Mont.) Jaeg.	Eravikulam	1800m	Wet rocks	++	13275
5.			<i>Pogonatum stevensii</i> Ren. et Card.	Attukadu	1500m	Soil	++	13276
6.		<i>Polytrichum</i>	<i>Polytrichum densifolium</i> Wils. ex Mitt.	Munnar	1600m	Soil	++++	13277
7.	DITRICHACEAE	<i>Pleuridium</i>	<i>Pleuridium tenue</i> Mitt.	Adimali	1300m	Wet rocks	+	13278
8.		<i>Ditrichum</i>	<i>Ditrichum heteromallum</i> (Hedw.) Britt.	Thattekad	1200m	Wet rocks	++++	13281
9.			<i>Ditrichum pusillum</i> (Hedw.) Hamp.	Munnar	1600m	Rocks	++++	13282
10.			<i>Ditrichum tortuloides</i> Grout	Thattekad	1200m	Rocks	++	13284
11.		<i>Ceratodon</i>	<i>Ceratodon purpureus</i> (Hedw.) Brid.	Kothamangalam	1300m	Soil, rocks & roofs	+++++	13285
12.	DICRANACEAE	<i>Trematodon</i>	<i>Trematodon kurzii</i> Hamp. Ex Gangulee	Athirapalli	1200m	Sandy soil	++	13286
13.			<i>Trematodon schmidii</i> C. Muell.	Adimali	1300m	Sandy soil	++	13287
14.			<i>Trematodon subulosus</i> Griff.	Kallar	1200m	Soil	++	13288
15.		<i>Anisothecium</i>	<i>Anisothecium molliculum</i> (Mitt.) Broth.	Attukadu	1500m	Rocks	+++	13289
16.		<i>Microdus</i>	<i>Microdus brasiliensis</i> (Dub.) Ther.	Matupatti	1700m	Wet rocks	+	13290
17.		<i>Dicranella</i>	<i>Dicranella macrospora</i> Gangulee	Munnar	1600m	Soil	+++	13291
18.			<i>Dicranella spiralis</i> (Mitt.) Jaeg.	Munnar	1600m	Moist soil	++++	13292
19.		<i>Microcampylopus</i>	<i>Microcampylopus subnanus</i> (C. Muell.) Fleisch.	Attukadu	1500m	Rocks	++	13294
20.		<i>Campylopodia</i>	<i>Campylopodia tenella</i> Card.	Athirapalli	1200m	Rocks	+	13295
21.		<i>Campylopus</i>	<i>Campylopus aureus</i> Bosch et Lac.	Munnar	1600m	Rocks	++++	13296
22.			<i>Campylopus goughii</i> (Mitt.) Jaeg.	Athirapalli	1200m	Rocks	++	13298
23.			<i>Campylopus latinervis</i> (Mitt.) Jaeg.	Munnar	1600m	Rocks	+	13299
24.			<i>Campylopus schwarzii</i> Schimp.	Attukadu	1500m	Rocks	++	13301
25.		<i>Dicranodontium</i>	<i>Dicranodontium demudatum</i> (Brid.) Britt.	Athirapalli	1200m	Rocks	++	13303
26.		<i>Rhabdoweisia</i>	<i>Rhabdoweisia crenulata</i> (Mitt.) James.	Kannimalai	1600m	Wet rocks	+	13306
27.		<i>Dicranoweisia</i>	<i>Dicranoweisia alpina</i> (Mitt.) Par.	Matupatti	1700m	Wet rocks	+	13307

S.No.	Family	Genus	Species	Locality	Altitude	Habitat	Occurrence	Herbarium No.
28.	FISSIDENTACEAE	<i>Fissidens</i>	<i>Fissidens areolatus</i> Griff.	Devikulam	1700m	Soil	+++	13311
29.			<i>Fissidens taxifolius</i> Hedw.	Munnar	1600m	Soil	++++	13314
30.	CALYMPERACEAE	<i>Calymperes</i>	<i>Calymperes sikkimense</i> Broth. ex Gangulee	Charpa	1200m	Wet rocks	++	13315
31.	POTTIACEAE	<i>Oxystegus</i>	<i>Oxystegus stenophyllus</i> (Mitt.) Gangulee	Rajamalai	1600m	Soil	+++	13319
32.		<i>Hyophila</i>	<i>Hyophila perannulata</i> Ren. et Card.	Munnar	1600m	Rocks	++++	13322
33.			<i>Hyophila rosea</i> Williams	Munnar	1600m	Rocks	+++	13323
34.		<i>Hydrogonium</i>	<i>Hydrogonium pseudo-ehrenbergii</i> (Fleisch.) Chen	Kallar	1200m	Wet rocks	++++	13324
35.	FUNARIACEAE	<i>Physcomitrium</i>	<i>Physcomitrium japonicum</i> (Hedw.) Mitt.	Kannimalai	1600m	Soil	++++	13326
36.		<i>Entosthodon</i>	<i>Entosthodon nutans</i> Mitt.	Munnar	1600m	Rocks	+++	13327
37.			<i>Entosthodon wallichii</i> Mitt.	Eravikulam	1800m	Rocks	++	13328
38.		<i>Funaria</i>	<i>Funaria wijkii</i> R. S. Chopra	Attukadu	1500m	Rocks	+	13331
39.	BRYACEAE	<i>Mielichhoferia</i>	<i>Mielichhoferia himalayana</i> Mitt.	Munnar	1600m	Soil	++	13332
40.		<i>Orthodontium</i>	<i>Orthodontium infractum</i> Schwaegr.	Munnar	1600m	Tree base	++	13333
41.		<i>Haplodontium</i>	<i>Haplodontium infractum</i>	Matupatti	1700m	Soil	+	13334
42.		<i>Leptobryum</i>	<i>Leptobryum pyriforme</i> (Hedw.) Wils.	Wariyum	1300m	Rocks	+	13335
43.		<i>Mniobryum</i>	<i>Mniobryum ludwigii</i> (Schwaegr.) Loesk.	Attukadu	1500m	Soil	+	13336
44.		<i>Pohlia</i>	<i>Pohlia himalayana</i> (Mitt.) Broth.	Devikulam	1700m	Tree base	+++	13339
45.		<i>Brachymerium</i>	<i>Brachymerium acuminatum</i> Harv.	Munnar	1600m	Wet rocks	+++	13340
46.			<i>Brachymerium pychothecium</i> (Besch.) Ochi	Poyankutti	1200m	Soil	+++	13345
47.			<i>Brachymerium sikkimense</i> Ren. Et Card.	Munnar	1600m	Tree bark	+++++	13346
48.		<i>Plagiobryum</i>	<i>Plagiobryum zierii</i> (Hedw.) Lindb.	Attukadu	1500m	Wet rocks	+	13347
49.		<i>Anomobryum</i>	<i>Anomobryum brachymerioides</i> Dix. & P. Vard.	Munnar	1600m	Wet rocks	++	13348
50.			<i>Anomobryum cymbifolium</i> (Lindb.) Broth.	Athirapalli	1200m	Wet rocks	++	13349
51.			<i>Anomobryum latifolium</i> Card. & P. Vard.	Munnar	1600m	Wet rocks	++	13350
52.			<i>Anomobryum pellucidum</i> Dix. & Badhw.	Attukadu	1500m	Wet rocks	++	13351
53.		<i>Bryum</i>	<i>Bryum atrovirens</i> Brid.	Thekadi	1300m	Soil	+++	13354
54.			<i>Bryum bicolor</i> Dicks.	Munnar	1600m	Soil	++++	13355
55.			<i>Bryum capillare</i> L. ex Hedw.	Attukadu	1500m	Wet rocks	+++++	13357

S.No.	Family	Genus	Species	Locality	Altitude	Habitat	Occurrence	Herbarium No.
56.		<i>Rhodobryum</i>	<i>Rhodobryum laxe-limbatum</i> (Ochi) Iwats. & Kop.	Attukadu	1500m	Rocks	+++	13363
57.	MNIACEAE	<i>Mnium</i>	<i>Mnium thomsonii</i> Schimp.	Matupatti	1700m	Wet rocks	+	13365
58.	BARTRAMIACEAE	<i>Anacolia</i>	<i>Anacolia menziesii</i> (Turn.) Par.	Attukadu	1500m	Rocks	+	13366
59.		<i>Bartramidula</i>	<i>Bartramidula roylei</i> (Hook.f.) B.S.G.	Kannimalai	1600m	Wet rocks	+++	13368
60.	ORTHOTRICHACEAE	<i>Orthotrichum</i>	<i>Orthotrichum speciosum</i> Nees	Matupatti	1700m	Tree branches	+++	13372
61.	PTEROBRYACEAE	<i>Symphysodontella</i>	<i>Symphysodontella borii</i> Dix.	Eravikulam	1800m	Tree bark	+	13377
62.	METEORACEAE	<i>Meteoriella</i>	<i>Meteoriella soluta</i> (Mitt.) Okam.	Athirapalli	1200m	Tree branches	++	13379
63.	FABRONIACEAE	<i>Fabronia</i>	<i>Fabronia pusilla</i> Raddi	Idukki	1500m	Rocks	+++	13381
64.	LESKEACEAE	<i>Regmatodon</i>	<i>Regmatodon declinatus</i> (Hook.) Brid.	Eravikulam	1800m	Rocks	+++	13382
65.		<i>Lescurea</i>	<i>Lescurea incurvata</i> (Hedw.) Lawt.	Munnar	1600m	Tree bark	+++	13383
66.	THUIDIACEAE	<i>Herpetineuron</i>	<i>Herpetineuron toccoe</i> (Sull. & Lesq.) Card.	Attukadu	1500m	Rocks	+++	13384
67.		<i>Claopodium</i>	<i>Claopodium pellucinerve</i> (Mitt.) Best	Munnar	1600m	Rocks	+++	13385
68.		<i>Haplocladium</i>	<i>Haplocladium schimperi</i> Ther.	Matupatti	1700m	Litter	+++	13386
69.	AMBLYSTEGIACEAE	<i>Calliergon</i>	<i>Calliergon cordifolium</i> (Hedw.) Kindb.	Munnar	1600m	Wet rocks	++	13388
70.	BRACHYTHECIACEAE	<i>Brachythecium</i>	<i>Brachythecium kamounense</i> (Harv.) Jaeg.	Devikulam	1700m	Rocks	+++++	13389
71.			<i>Brachythecium populeum</i> (Hedw.) B.S.G.	Attukadu	1500m	Soil	+++++	13390
72.	ENTODONTACEAE	<i>Pterigynandrum</i>	<i>Pterigynandrum decolor</i> (Mitt.) Broth.	Attukadu	1500m	Tree base	++	13391
73.		<i>Entodon</i>	<i>Entodon laetus</i> (Griff.) Jaeg.	Athirapalli	1200m	Tree bark	++++	13392
74.	PLAGIOTHECIACEAE	<i>Plagiothecium</i>	<i>Plagiothecium cavifolium</i> (Brid.) Iwats.	Matupatti	1700m	Tree base	+	13394
75.	SEMATOPHYLLACEAE	<i>Hageniella</i>	<i>Hageniella assamica</i> Dix.	Eravikulam	1800m	Wet rocks	++	13395
76.		<i>Meiothecium</i>	<i>Meiothecium jagorii</i> (C. Muell.) Broth.	Athirapalli	1200m	Rocks	++++	13398
77.		<i>Sematophyllum</i>	<i>Sematophyllum caespitosum</i> (Hedw.) Mitt.	Athirapalli	1200m	Tree bark	++++	13399
78.			<i>Sematophyllum humile</i> (Mitt.) Broth.	Munnar	1600m	Tree bark	++	13400
79.		<i>Pylaisiadelpha</i>	<i>Pylaisiadelpha drepanioides</i> Card. & Dix.	Eravikulam	1800m	Wet rocks	++	13401
80.		<i>Brotherella</i>	<i>Brotherella dixonii</i> Herz.	Eravikulam	1800m	Wet rocks	+	13402
81.		<i>Trichosteleum</i>	<i>Trichosteleum glauco-virens</i> (Mitt.) Broth.	Matupatti	1700m	Rocks	+++	13403
82.	HYPNACEAE	<i>Hypnum</i>	<i>Hypnum aduncoides</i> (Brid.) C. Muell.	Munnar	1600m	Soil	+++	13404
83.			<i>Hypnum setschwanicum</i> (Broth.) Ando.	Munnar	1600m	Soil	+++	13405

Table 6.7: Altitude wise Distribution of Taxa in the Study Area

S.No.	Family	Genus	Species	Locality	Altitude	Herbarium No.		
1.	POLYTRICHACEAE	<i>Atrichum</i>	<i>Atrichum aculeatum</i> Card. & P. Vard.	Devikulam	1700m	13267		
2.			<i>Atrichum longifolium</i> Card. & Dix.	Attukadu	1500m	13268		
3.			<i>Atrichum obtusulum</i> (C. Muell.) Jaeg.	Kannimalai(Munnar)	1600m	13269		
4.		<i>Pogonatum</i>	<i>Pogonatum aloides</i> (Hedw.) P. Beauv.	Munnar	1600m	13271		
5.			<i>Pogonatum cirratum</i> (Sw.) Brid.	Matupatti	1700m	13272		
6.			<i>Pogonatum leucopogon</i> Ren. et Card.	Devikulam	1700m	13273		
7.			<i>Pogonatum microstomum</i> (Schwaegr.) Brid.	Eravikulam	1800m	13274		
8.			<i>Pogonatum perichaetiale</i> (Mont.) Jaeg.	Eravikulam	1800m	13275		
9.			<i>Pogonatum stevensii</i> Ren. et Card.	Attukadu	1500m	13276		
10.			<i>Polytrichum</i>	<i>Polytrichum densifolium</i> Wils. ex Mitt.	Munnar	1600m	13277	
11.	DITRICHACEAE	<i>Pleuridium</i>	<i>Pleuridium tenue</i> Mitt.	Adimali	1300m	13278		
12.			<i>Garckea</i>	<i>Garckea flexuosa</i> (Griff.) Margad. & Nork.	Adimali	1300m	13279	
13.		<i>Ditrichum</i>	<i>Ditrichum darjeelingense</i> Ren. & Card.	Poyankutti	1200m	13280		
14.			<i>Ditrichum heteromallum</i> (Hedw.) Britt.	Thattekad	1200m	13281		
15.			<i>Ditrichum pusillum</i> (Hedw.) Hamp.	Munnar	1600m	13282		
16.			<i>Ditrichum tortipes</i> (Mitt.) Kuntze	Munnar	1600m	13283		
17.			<i>Ditrichum tortuloides</i> Grout	Thattekad	1200m	13284		
18.			<i>Ceratodon</i>	<i>Ceratodon purpureus</i> (Hedw.) Brid.	Kothamangalam	1300m	13285	
19.			DICRANACEAE	<i>Trematodon</i>	<i>Trematodon kurzii</i> Hamp. ex Gangulee	Athirapalli	1200m	13286
20.					<i>Trematodon schmidii</i> C. Muell.	Adimali	1300m	13287
21.		<i>Trematodon subulosus</i> Griff.			Kallar	1200m	13288	
22.		<i>Anisothecium</i>		<i>Anisothecium molliculum</i> (Mitt.) Broth.	Attukadu	1500m	13289	
23.	<i>Microdus</i>	<i>Microdus brasiliensis</i> (Dub.) Ther.		Matupatti	1700m	13290		
24.	<i>Dicranella</i>	<i>Dicranella macrospora</i> Gangulee		Munnar	1600m	13291		
25.		<i>Dicranella spiralis</i> (Mitt.) Jaeg.		Munnar	1600m	13292		
26.		<i>Microcampylopus</i>		<i>Microcampylopus khasianus</i> (Griff.) Giese & Frahm.	Rajamalai	1600m	13293	
27.		<i>Microcampylopus subnamus</i> (C. Muell.) Fleisch.		Attukadu	1500m	13294		
28.		<i>Campylopodia</i>		<i>Campylopodia tenella</i> Card.	Athirapalli	1200m	13295	
29.		<i>Campylopus</i>	<i>Campylopus aureus</i> Bosch et Lac.	Munnar	1600m	13296		
30.			<i>Campylopus flexuosus</i> (Hedw.) Brid.	Munnar	1600m	13297		
31.	<i>Campylopus goughii</i> (Mitt.) Jaeg.		Athirapalli	1200m	13298			
32.	<i>Campylopus latinervis</i> (Mitt.) Jaeg.		Munnar	1600m	13299			

S.No.	Family	Genus	Species	Locality	Altitude	Herbarium No.
33.			<i>Campylopus richardii</i> Brid.	Munnar	1600m	13300
34.			<i>Campylopus schwarzii</i> Schimp.	Attukadu	1500m	13301
35.			<i>Campylopus subfragilis</i> Ren. & Card.	Matupatti	1700m	13302
36.		Dicranodontium	<i>Dicranodontium denudatum</i> (Brid.) Britt.	Athirapalli	1200m	13303
37.		Rhabdoweisia	<i>Rhabdoweisia crenulata</i> (Mitt.) James.	Kannimalai	1600m	13306
38.		Dicranoweisia	<i>Dicranoweisia alpina</i> (Mitt.) Par.	Matupatti	1700m	13307
39.	LEUCOBRYACEAE	Leucobryum	<i>Leucobryum bowringii</i> Mitt.	Matupatti	1700m	13308
40.			<i>Leucobryum juniperoides</i> (Brid.) C. Muell.	Munnar	1600m	13309
41.			<i>Leucobryum milghiriense</i> C. Muell.	Matupatti	1700m	13310
42.	FISSIDENTACEAE	Fissidens	<i>Fissidens areolatus</i> Griff.	Devikulam	1700m	13311
43.			<i>Fissidens pellucidus</i> Hornsch.	Munnar	1600m	13312
44.			<i>Fissidens pulchellus</i> Mitt.	Athirapalli	1200m	13313
45.			<i>Fissidens taxifolius</i> Hedw.	Munnar	1600m	13314
46.	CALYMPERACEAE	Calymperes	<i>Calymperes sikkimense</i> Broth. ex Gangulee	Charpa	1200m	13315
47.			<i>Calymperes tenerum</i> C. Muell.	Athirapalli	1200m	13316
48.	POTTIACEAE	Timmiella	<i>Timmiella anomala</i> (B.S.G.) Limpr.	Attukadu	1500m	13317
49.		Oxystegus	<i>Oxystegus stenophyllus</i> (Mitt.) Gangulee	Rajamalai	1600m	13319
50.			<i>Oxystegus tenuirostris</i> (Hook. & Taylor) A.J.E. Sm.	Adimalli	1300m	13318
51.		Hyophila	<i>Hyophila involuta</i> (Hook.) Jaeg.	Kothamangalam	1300m	13321
52.			<i>Hyophila nymmana</i> (Fleisch.) Menzel	Thattekad	1200m	13320
53.			<i>Hyophila peramulata</i> Ren. et Card.	Munnar	1600m	13322
54.			<i>Hyophila rosea</i> Williams	Munnar	1600m	13323
55.		Hydrogonium	<i>Hydrogonium pseudo-ehrenbergii</i> (Fleisch.) Chen	Kallar	1200m	13324
56.	FUNARIACEAE	Physcomitrium	<i>Physcomitrium eurystomum</i> Sendtn.	Munnar	1600m	13325
57.			<i>Physcomitrium japonicum</i> (Hedw.) Mitt.	Kannimalai	1600m	13326
58.		Entosthodon	<i>Entosthodon nutans</i> Mitt.	Munnar	1600m	13327
59.			<i>Entosthodon wallichii</i> Mitt.	Eravikulam	1800m	13328
60.			<i>Entosthodon wichurae</i> Fleisch.	Munnar	1600m	13329
61.		Funaria	<i>Funaria hygrometrica</i> Hedw.	Matupatti	1700m	13330
62.			<i>Funaria wijkii</i> R. S. Chopra	Attukadu	1500m	13331
63.	BRYACEAE	Mielichhoferia	<i>Mielichhoferia himalayana</i> Mitt.	Munnar	1600m	13332
64.		Orthodontium	<i>Orthodontium infractum</i> Schwaegr.	Munnar	1600m	13333
65.		Haplodontium	<i>Haplodontium infractum</i>	Matupatti	1700m	13334
66.		Leptobryum	<i>Leptobryum pyriforme</i> (Hedw.) Wils.	Wariyum	1300m	13335

S.No.	Family	Genus	Species	Locality	Altitude	Herbarium No.
67.		<i>Mniobryum</i>	<i>Mniobryum ludwigii</i> (Schwaegr.) Loesk.	Attukadu	1500m	13336
68.		<i>Pohlia</i>	<i>Pohlia flexuosa</i> Hook.	Munnar	1600m	13337
69.			<i>Pohlia gedeanana</i> (Bosch et Lac.) Gangulee	Eravikulam	1800m	13338
70.			<i>Pohlia himalayana</i> (Mitt.) Broth.	Devikulam	1700m	13339
71.		<i>Brachymenium</i>	<i>Brachymenium acuminatum</i> Harv.	Munnar	1600m	13340
72.			<i>Brachymenium bryoides</i> Hook. Ex Schwaegr.	Munnar	1600m	13341
73.			<i>Brachymenium capitulatum</i> (Mitt.) Paris	Adimalli	1300m	13344
74.			<i>Brachymenium leptophyllum</i> Bruch & Schimp. ex Müll.Hal.	Matupatti	1700m	13342
75.			<i>Brachymenium nepalense</i> Hook.	Munnar	1600m	13343
76.			<i>Brachymenium pychothecium</i> (Besch.) Ochi	Poyankutti	1200m	13345
77.			<i>Brachymenium sikkimense</i> Ren. Et Card.	Munnar	1600m	13346
78.		<i>Plagiobryum</i>	<i>Plagiobryum zierii</i> (Hedw.) Lindb.	Attukadu	1500m	13347
79.		<i>Anomobryum</i>	<i>Anomobryum brachymenioides</i> Dix. & P. Vard.	Munnar	1600m	13348
80.			<i>Anomobryum cymbifolium</i> (Lindb.) Broth.	Athirapalli	1200m	13349
81.			<i>Anomobryum latifolium</i> Card. & P. Vard.	Munnar	1600m	13350
82.			<i>Anomobryum pellucidum</i> Dix. & Badhw.	Attukadu	1500m	13351
83.		<i>Bryum</i>	<i>Bryum argenteum</i> Hedw. VAR. <i>griffithii</i> (C. Muell.) Gangulee	Munnar	1600m	13352
84.			<i>Bryum argenteum</i> Hedw. VAR. <i>lanatum</i> (P. Beauv.) Hamp.	Munnar	1600m	13353
85.			<i>Bryum atrovirens</i> Brid.	Thekadi	1300m	13354
86.			<i>Bryum bicolor</i> Dicks.	Munnar	1600m	13355
87.			<i>Bryum billardieri</i> Schwaegr.	Thekadi	1300m	13356
88.			<i>Bryum capillare</i> L. ex Hedw.	Attukadu	1500m	13357
89.			<i>Bryum cellulare</i> Hook.	Munnar	1600m	13358
90.			<i>Bryum coronatum</i> Schwaegr.	Munnar	1600m	13359
91.			<i>Bryum uliginosum</i> (Brid.), B.S.G.	Eravikulam	1800m	13362
92.		<i>Ptychostomum</i>	<i>Ptychostomum pseudotriquetrum</i> (Hedw.) J.R.Spence & H.P.Ramsay	Munnar	1600m	13361
93.		<i>Rhodobryum</i>	<i>Rhodobryum laxe-limbatum</i> (Ochi) Iwats. & Kop.	Attukadu	1500m	13363
94.			<i>Rhodobryum roseum</i> (Hedw.) Limpr.	Matupatti	1700m	13364
95.	MNIACEAE	<i>Mnium</i>	<i>Mnium thomsonii</i> Schimp.	Matupatti	1700m	13365
96.	BARTRAMIACEAE	<i>Anacolia</i>	<i>Anacolia menziesii</i> (Turn.) Par.	Attukadu	1500m	13366
97.		<i>Bartramidula</i>	<i>Bartramidula roylei</i> (Hook.f.) B.S.G.	Kannimalai	1600m	13368
98.		<i>Philonotis</i>	<i>Philonotis bartramioides</i> (Griff.) Griffin & Buck	Attukadu	1500m	13367
99.			<i>Philonotis mollis</i> (Doz. & Molk.) Mitt.	Charpa	1200m	13369
100.			<i>Philonotis turneriana</i> (Schwaegr.) Mitt.	Attukadu	1500m	13371

S.No.	Family	Genus	Species	Locality	Altitude	Herbarium No.
101.	ORTHOTRICHACEAE	<i>Orthotrichum</i>	<i>Orthotrichum speciosum</i> Nees	Matupatti	1700m	13372
102.		<i>Macromitrium</i>	<i>Macromitrium sulcatum</i> (Hook.) Brid.	Matupatti	1700m	13373
103.	CRYPHAEACEAE	<i>Schoenobryum</i>	<i>Schoenobryum concavifolium</i> (Griff.) Gangulee	Matupatti	1700m	13374
104.	TRACHYPODACEAE	<i>Trachypodopsis</i>	<i>Trachypodopsis serrulata</i> (P. Beauv.) Fleisch.	Matupatti	1700m	13375
105.	PTEROBRYACEAE	<i>Garovaglia</i>	<i>Garovaglia plicata</i> (Brid.) Bosch & Lac.	Matupatti	1700m	13376
106.		<i>Symphysodontella</i>	<i>Symphysodontella borii</i> Dix.	Eravikulam	1800m	13377
107.	METEORACEAE	<i>Cryptopapillaria</i>	<i>Cryptopapillaria fuscescens</i> (Hook.) Menzel	Devikulam	1700m	13378
108.		<i>Meteoriella</i>	<i>Meteoriella soluta</i> (Mitt.) Okam.	Athirapalli	1200m	13379
109.		<i>Barbella</i>	<i>Barbella chrysonema</i> (Muell.Hall.) Nog.	Eravikulam	1800m	13380
110.	FABRONIACEAE	<i>Fabronia</i>	<i>Fabronia pusilla</i> Raddi	Idukki	1500m	13381
111.	LESKEACEAE	<i>Regmatodon</i>	<i>Regmatodon declinatus</i> (Hook.) Brid.	Eravikulam	1800m	13382
112.		<i>Lescuraea</i>	<i>Lescuraea incurvata</i> (Hedw.) Lawt.	Munnar	1600m	13383
113.	THUIDIACEAE	<i>Herpetineuron</i>	<i>Herpetineuron toccocae</i> (Sull. & Lesq.) Card.	Attukadu	1500m	13384
114.		<i>Claopodium</i>	<i>Claopodium pellucinerve</i> (Mitt.) Best	Munnar	1600m	13385
115.		<i>Haplocladium</i>	<i>Haplocladium schimperi</i> Ther.	Matupatti	1700m	13386
116.		<i>Pelekium</i>	<i>Pelekium investe</i> (Mitt.) Touw.	Matupatti	1700m	13387
117.	AMBLYSTEGIACEAE	<i>Calliergon</i>	<i>Calliergon cordifolium</i> (Hedw.) Kindb.	Munnar	1600m	13388
118.	BRACHYTHECIACEAE	<i>Brachythecium</i>	<i>Brachythecium kamounense</i> (Harv.) Jaeg.	Devikulam	1700m	13389
119.			<i>Brachythecium populeum</i> (Hedw.) B.S.G.	Attukadu	1500m	13390
120.	ENTODONTACEAE	<i>Pterigynandrum</i>	<i>Pterigynandrum decolor</i> (Mitt.) Broth.	Attukadu	1500m	13391
121.		<i>Entodon</i>	<i>Entodon laetus</i> (Griff.) Jaeg.	Athirapalli	1200m	13392
122.		<i>Erythrodontium</i>	<i>Erythrodontium julaceum</i> (Schwaegr.) Par.	Attukadu	1500m	13393
123.	PLAGIOTHECIACEAE	<i>Plagiothecium</i>	<i>Plagiothecium cavifolium</i> (Brid.) Iwats.	Matupatti	1700m	13394
124.	SEMATOPHYLLACEAE	<i>Hageniella</i>	<i>Hageniella assamica</i> Dix.	Eravikulam	1800m	13395
125.		<i>Clastobryopsis</i>	<i>Clastobryopsis plamula</i> (Mitt.) Fleisch.	Athirapalli	1200m	13396
126.		<i>Chionostomum</i>	<i>Chionostomum rostratum</i> (Griff.) C. Muell.	Athirapalli	1200m	13397
127.		<i>Meiothecium</i>	<i>Meiothecium jagorii</i> (C. Muell.) Broth.	Athirapalli	1200m	13398
128.		<i>Sematophyllum</i>	<i>Sematophyllum caespitosum</i> (Hedw.) Mitt.	Athirapalli	1200m	13399
129.			<i>Sematophyllum humile</i> (Mitt.) Broth.	Munnar	1600m	13400
130.		<i>Pylaisiadelpha</i>	<i>Pylaisiadelpha drepanioides</i> Card. & Dix.	Eravikulam	1800m	13401
131.		<i>Brotherella</i>	<i>Brotherella dixonii</i> Herz.	Eravikulam	1800m	13402
132.		<i>Trichosteleum</i>	<i>Trichosteleum glauco-virens</i> (Mitt.) Broth.	Matupatti	1700m	13403
133.	HYPNACEAE	<i>Hypnum</i>	<i>Hypnum aduncooides</i> (Brid.) C. Muell.	Munnar	1600m	13404
134.			<i>Hypnum setschwanicum</i> (Broth.) Ando.	Munnar	1600m	13405
135.		<i>Ctenidium</i>	<i>Ctenidium lychnites</i> (Mitt.) Broth.	Eravikulam	1800m	13407

Table 6.8: Habitat wise Distribution of Taxa in the Study Area

S.No.	Family	Genus	Species	Locality	Habitat	Herbarium No.	
1.	POLYTRICHACEAE	<i>Atrichum</i>	<i>Atrichum aculeatum</i> Card. & P. Vard.	Devikulam	Loose soil	13267	
2.			<i>Atrichum longifolium</i> Card. & Dix.	Attukadu	Loose soil	13268	
3.			<i>Atrichum obtusulum</i> (C. Muell.) Jaeg.	Kannimalai(Munnar)	Loose soil	13269	
4.		<i>Pogonatum</i>	<i>Pogonatum aloides</i> (Hedw.) P. Beauv.	Munnar	Rocks	13271	
5.			<i>Pogonatum cirratum</i> (Sw.) Brid.	Matupatti	Soil	13272	
6.			<i>Pogonatum leucopogon</i> Ren. et Card.	Devikulam	Soil	13273	
7.			<i>Pogonatum microstomum</i> (Schwaegr.) Brid.	Eravikulam	Rocks	13274	
8.			<i>Pogonatum perichaetiale</i> (Mont.) Jaeg.	Eravikulam	Wet rocks	13275	
9.			<i>Pogonatum stevensii</i> Ren. et Card.	Attukadu	Stable soil	13276	
10.			<i>Polytrichum</i>	<i>Polytrichum densifolium</i> Wils. ex Mitt.	Munnar	Disturbed soil	13277
11.	DITRICHACEAE	<i>Pleuridium</i>	<i>Pleuridium tenue</i> Mitt.	Adimali	Wet rocks	13278	
12.			<i>Garckea</i>	<i>Garckea flexuosa</i> (Griff.) Margad. & Nork.	Adimali	Shaded rocks	13279
13.		<i>Ditrichum</i>	<i>Ditrichum darjeelingense</i> Ren. & Card.	Poyankutti	Wet rocks	13280	
14.			<i>Ditrichum heteromallum</i> (Hedw.) Britt.	Thattakad	Wet rocks	13281	
15.			<i>Ditrichum pusillum</i> (Hedw.) Hamp.	Munnar	Rocks	13282	
16.			<i>Ditrichum tortipes</i> (Mitt.) Kuntze	Munnar	Dry exposed rocks	13283	
17.			<i>Ditrichum tortuloides</i> Grout	Thattakad	Exposed rocks	13284	
18.			<i>Ceratodon</i>	<i>Ceratodon purpureus</i> (Hedw.) Brid.	Kothamangalam	Soil, rocks & roofs	13285
19.		DICRANACEAE	<i>Trematodon</i>	<i>Trematodon kurzii</i> Hamp. ex Gangulee	Athirapalli	Sandy soil	13286
20.				<i>Trematodon schmidii</i> C. Muell.	Adimali	Sandy soil	13287
21.				<i>Trematodon subulosus</i> Griff.	Kallar	Loose soil	13288
22.			<i>Anisothecium</i>	<i>Anisothecium molliculum</i> (Mitt.) Broth.	Attukadu	Rocks	13289
23.	<i>Microdus</i>		<i>Microdus brasiliensis</i> (Dub.) Ther.	Matupatti	Wet rocks	13290	
24.	<i>Dicranella</i>		<i>Dicranella macrospora</i> Gangulee	Munnar	Soil	13291	
25.			<i>Dicranella spiralis</i> (Mitt.) Jaeg.	Munnar	Moist soil	13292	
26.	<i>Microcampylopus</i>		<i>Microcampylopus khasianus</i> (Griff.) Giese & Frahm.	Rajamalai	Rocks	13293	
27.			<i>Microcampylopus subnanus</i> (C. Muell.) Fleisch.	Attukadu	Rocks	13294	
28.	<i>Campylopodia</i>		<i>Campylopodia tenella</i> Card.	Athirapalli	Rocks	13295	
29.	<i>Campylopus</i>		<i>Campylopus aureus</i> Bosch et Lac.	Munnar	Rocks	13296	
30.			<i>Campylopus flexuosus</i> (Hedw.) Brid.	Munnar	Rocks	13297	
31.			<i>Campylopus goughii</i> (Mitt.) Jaeg.	Athirapalli	Rocks	13298	
32.			<i>Campylopus latinervis</i> (Mitt.) Jaeg.	Munnar	Rocks	13299	
33.		<i>Campylopus richardii</i> Brid.	Munnar	Rocks	13300		

S.No.	Family	Genus	Species	Locality	Habitat	Herbarium No.
34.			<i>Campylopus schwarzii</i> Schimp.	Attukadu	Rocks	13301
35.			<i>Campylopus subfragilis</i> Ren. & Card.	Matupatti	Rocks	13302
36.		<i>Dicranodontium</i>	<i>Dicranodontium demudatum</i> (Brid.) Britt.	Athirapalli	Rocks	13303
37.		<i>Rhabdoweisia</i>	<i>Rhabdoweisia crenulata</i> (Mitt.) James.	Kannimalai	Wet rocks	13306
38.		<i>Dicranoweisia</i>	<i>Dicranoweisia alpina</i> (Mitt.) Par.	Matupatti	Wet rocks	13307
39.	LEUCOBRYACEAE	<i>Leucobryum</i>	<i>Leucobryum bowringii</i> Mitt.	Matupatti	Tree bark	13308
40.			<i>Leucobryum juniperoideum</i> (Brid.) C. Muell.	Mummar	Tree bark	13309
41.			<i>Leucobryum nilghiriense</i> C. Muell.	Matupatti	Tree bark	13310
42.	FISSIDENTACEAE	<i>Fissidens</i>	<i>Fissidens areolatus</i> Griff.	Devikulam	Soil	13311
43.			<i>Fissidens pellucidus</i> Hornsch.	Mummar	Rocks	13312
44.			<i>Fissidens pulchellus</i> Mitt.	Athirapalli	Rocks	13313
45.			<i>Fissidens taxifolius</i> Hedw.	Mummar	Shaded soil	13314
46.	CALYMPERACEAE	<i>Calymperes</i>	<i>Calymperes sikkimense</i> Broth. ex Gangulee	Charpa	Wet rocks	13315
47.			<i>Calymperes tenerum</i> C. Muell.	Athirapalli	Wet rocks	13316
48.	POTTIACEAE	<i>Timmiella</i>	<i>Timmiella anomala</i> (B.S.G.) Limpr.	Attukadu	Soil	13317
49.		<i>Oxystegus</i>	<i>Oxystegus stenophyllus</i> (Mitt.) Gangulee	Rajamalai	Sandy soil	13319
50.			<i>Oxystegus tenuirostris</i> (Hook. & Taylor) A.J.E. Sm.	Adimali	Sandy soil	13318
51.		<i>Hyophila</i>	<i>Hyophila involuta</i> (Hook.) Jaeg.	Kothamangalam	Old walls	13321
52.			<i>Hyophila nymaniana</i> (Fleisch.) Menzel	Thattakad	Old walls	13320
53.			<i>Hyophila peranmulata</i> Ren. et Card.	Mummar	Moist rocks	13322
54.			<i>Hyophila rosea</i> Williams	Mummar	Rocks	13323
55.		<i>Hydrogonium</i>	<i>Hydrogonium pseudo-ehrenbergii</i> (Fleisch.) Chen	Kallar	Wet rocks	13324
56.	FUNARIACEAE	<i>Physcomitrium</i>	<i>Physcomitrium eurytomum</i> Sendtn.	Mummar	Moist soil	13325
57.			<i>Physcomitrium japonicum</i> (Hedw.) Mitt.	Kannimalai	Moist soil	13326
58.		<i>Entosthodon</i>	<i>Entosthodon nutans</i> Mitt.	Mummar	Exposed rocks	13327
59.			<i>Entosthodon wallichii</i> Mitt.	Eravikulam	Exposed rocks	13328
60.			<i>Entosthodon wichurae</i> Fleisch.	Mummar	Exposed rocks	13329
61.		<i>Funaria</i>	<i>Funaria hygrometrica</i> Hedw.	Matupatti	Exposed rocks	13330
62.			<i>Funaria wijkii</i> R. S. Chopra	Attukadu	Shaded rocks	13331
63.	BRYACEAE	<i>Mielichhoferia</i>	<i>Mielichhoferia himalayana</i> Mitt.	Mummar	Soil	13332
64.		<i>Orthodontium</i>	<i>Orthodontium infractum</i> Schwaegr.	Mummar	Tree base	13333
65.		<i>Haplodontium</i>	<i>Haplodontium infractum</i>	Matupatti	Soil	13334
66.		<i>Leptobryum</i>	<i>Leptobryum pyriforme</i> (Hedw.) Wils.	Wariyum	Wet rocks	13335
67.		<i>Mniobryum</i>	<i>Mniobryum ludwigii</i> (Schwaegr.) Loesk.	Attukadu	Wet soil	13336
68.		<i>Pohlia</i>	<i>Pohlia flexuosa</i> Hook.	Mummar	Tree bark	13337

S.No.	Family	Genus	Species	Locality	Habitat	Herbarium No.
69.			<i>Pohlia gedeanae</i> (Bosch et Lac.) Gangulee	Eravikulam	Rocks	13338
70.			<i>Pohlia himalayana</i> (Mitt.) Broth.	Devikulam	Tree base	13339
71.		Brachymenium	<i>Brachymenium acuminatum</i> Harv.	Mummar	Wet rocks	13340
72.			<i>Brachymenium bryoides</i> Hook. Ex Schwaegr.	Mummar	Wet rocks	13341
73.			<i>Brachymenium capitulatum</i> (Mitt.) Paris	Adimalli	Soil	13344
74.			<i>Brachymenium leptophyllum</i> Bruch & Schimp. ex Müll.Hal.	Matupatti	Tree base	13342
75.			<i>Brachymenium nepalense</i> Hook.	Mummar	Exposed soil	13343
76.			<i>Brachymenium pychothecium</i> (Besch.) Ochi	Poyankutti	Soil	13345
77.			<i>Brachymenium sikkimense</i> Ren. Et Card.	Mummar	Tree bark	13346
78.		Plagiobryum	<i>Plagiobryum zierii</i> (Hedw.) Lindb.	Attukadu	Wet rocks	13347
79.		Anomobryum	<i>Anomobryum brachyenioides</i> Dix. & P. Vard.	Mummar	Wet rocks	13348
80.			<i>Anomobryum cymbifolium</i> (Lindb.) Broth.	Athirapalli	Wet rocks	13349
81.			<i>Anomobryum latifolium</i> Card. & P. Vard.	Mummar	Wet rocks	13350
82.			<i>Anomobryum pellucidum</i> Dix. & Badhw.	Attukadu	Wet rocks	13351
83.		Bryum	<i>Bryum argenteum</i> Hedw. VAR. <i>griffithii</i> (C. Muell.) Gangulee	Mummar	Exposed old walls	13352
84.			<i>Bryum argenteum</i> Hedw. VAR. <i>lanatum</i> (P. Beauv.) Hamp.	Mummar	Exposed old walls	13353
85.			<i>Bryum atrovirens</i> Brid.	Thekadi	Moist soil	13354
86.			<i>Bryum bicolor</i> Dicks.	Mummar	Moist soil	13355
87.			<i>Bryum billardieri</i> Schwaegr.	Thekadi	Tree bark	13356
88.			<i>Bryum capillare</i> L. ex Hedw.	Attukadu	Wet rocks	13357
89.			<i>Bryum cellulare</i> Hook.	Mummar	Tree base	13358
90.			<i>Bryum coronatum</i> Schwaegr.	Mummar	Loose soil	13359
91.			<i>Bryum uliginosum</i> (Brid.) B.S.G.	Eravikulam	Soil	13362
92.		Ptychostomum	<i>Ptychostomum pseudotriquetrum</i> (Hedw.) J.R.Spence & H.P.Ramsay	Mummar	Exposed soil	13361
93.		Rhodobryum	<i>Rhodobryum laxe-limbatum</i> (Ochi) Iwats. & Kop.	Attukadu	Rocks	13363
94.			<i>Rhodobryum roseum</i> (Hedw.) Limpr.	Matupatti	Wet rocks	13364
95.	MNIACEAE	Mnium	<i>Mnium thomsonii</i> Schimp.	Matupatti	Wet rocks	13365
96.	BARTRAMIACEAE	Anacolia	<i>Anacolia menziesii</i> (Turn.) Par.	Attukadu	Moist rocks	13366
97.		Bartramidula	<i>Bartramidula roylei</i> (Hook.f.) B.S.G.	Kannimalai	Wet rocks	13368
98.		Philonotis	<i>Philonotis bartramoides</i> (Griff.) Griffin & Buck	Attukadu	Wet rocks	13367
99.			<i>Philonotis mollis</i> (Doz. & Molk.) Mitt.	Charpa	Wet rocks	13369
100.			<i>Philonotis turneriana</i> (Schwaegr.) Mitt.	Attukadu	Wet rocks	13371
101.	ORTHOTRICHACEAE	Orthotrichum	<i>Orthotrichum speciosum</i> Nees	Matupatti	Tree branches	13372
102.		Macromitrium	<i>Macromitrium sulcatum</i> (Hook.) Brid.	Matupatti	Tree bark	13373

S.No.	Family	Genus	Species	Locality	Habitat	Herbarium No.
103.	CRYPHAEACEAE	<i>Schoenobryum</i>	<i>Schoenobryum concavifolium</i> (Griff.) Gangulee	Matupatti	Tree bark	13374
104.	TRACHYPODACEAE	<i>Trachypodopsis</i>	<i>Trachypodopsis serrulata</i> (P. Beauv.) Fleisch.	Matupatti	Tree bark	13375
105.	PTEROBRYACEAE	<i>Garovaglia</i>	<i>Garovaglia plicata</i> (Brid.) Bosch & Lac.	Matupatti	Tree bark	13376
106.		<i>Symphysodontella</i>	<i>Symphysodontella borii</i> Dix.	Eravikulam	Tree bark	13377
107.	METEORACEAE	<i>Cryptopapillaria</i>	<i>Cryptopapillaria fuscescens</i> (Hook.) Menzel	Devikulam	Tree bark	13378
108.		<i>Meteoriella</i>	<i>Meteoriella soluta</i> (Mitt.) Okam.	Athirapalli	Tree branches	13379
109.		<i>Barbella</i>	<i>Barbella chrysonema</i> (Muell.Hall.) Nog.	Eravikulam	Tree branches	13380
110.	FABRONIACEAE	<i>Fabronia</i>	<i>Fabronia pusilla</i> Raddi	Idukki	Rocks	13381
111.	LESKEACEAE	<i>Regmatodon</i>	<i>Regmatodon declinatus</i> (Hook.) Brid.	Eravikulam	Rocks	13382
112.		<i>Lescuraea</i>	<i>Lescuraea incurvata</i> (Hedw.) Lawt.	Munnar	Tree bark	13383
113.	THUIDIACEAE	<i>Herpetineuron</i>	<i>Herpetineuron toccocae</i> (Sull. & Lesq.) Card.	Attukadu	Rocks	13384
114.		<i>Claopodium</i>	<i>Claopodium pellucinerve</i> (Mitt.) Best	Munnar	Rocks	13385
115.		<i>Haplocladium</i>	<i>Haplocladium schimperii</i> Ther.	Matupatti	Forest litter	13386
116.		<i>Pelekium</i>	<i>Pelekium investe</i> (Mitt.) Touw.	Matupatti	Forest litter	13387
117.	AMBLYSTEGIACEAE	<i>Calliergon</i>	<i>Calliergon cordifolium</i> (Hedw.) Kindb.	Munnar	Wet rocks	13388
118.	BRACHYTHECIACEAE	<i>Brachythecium</i>	<i>Brachythecium kamounense</i> (Harv.) Jaeg.	Devikulam	Rocks	13389
119.			<i>Brachythecium populeum</i> (Hedw.) B.S.G.	Attukadu	Soil	13390
120.	ENTODONTACEAE	<i>Pterigynandrum</i>	<i>Pterigynandrum decolor</i> (Mitt.) Broth.	Attukadu	Tree base	13391
121.		<i>Entodon</i>	<i>Entodon laetus</i> (Griff.) Jaeg.	Athirapalli	Tree base	13392
122.		<i>Erythrodonium</i>	<i>Erythrodonium julaceum</i> (Schwaegr.) Par.	Attukadu	Tree base	13393
123.	PLAGIOTHECIACEAE	<i>Plagiothecium</i>	<i>Plagiothecium cavifolium</i> (Brid.) Iwats.	Matupatti	Tree base	13394
124.	SEMATOPHYLLACEAE	<i>Hageniella</i>	<i>Hageniella assamica</i> Dix.	Eravikulam	Wet rocks	13395
125.		<i>Clastobryopsis</i>	<i>Clastobryopsis plamula</i> (Mitt.) Fleisch.	Athirapalli	Rocks	13396
126.		<i>Chionostomum</i>	<i>Chionostomum rostratum</i> (Griff.) C. Muell.	Athirapalli	Tree base	13397
127.		<i>Meiothecium</i>	<i>Meiothecium jagorii</i> (C. Muell.) Broth.	Athirapalli	Rocks	13398
128.		<i>Sematophyllum</i>	<i>Sematophyllum caespitosum</i> (Hedw.) Mitt.	Athirapalli	Tree bark	13399
129.			<i>Sematophyllum humile</i> (Mitt.) Broth.	Munnar	Tree bark	13400
130.		<i>Pylaisiadelphina</i>	<i>Pylaisiadelphina drepanioides</i> Card. & Dix.	Eravikulam	Wet rocks	13401
131.		<i>Brotherella</i>	<i>Brotherella dixonii</i> Herz.	Eravikulam	Wet rocks	13402
132.		<i>Trichosteleum</i>	<i>Trichosteleum glauco-virens</i> (Mitt.) Broth.	Matupatti	Rocks	13403
133.	HYPNACEAE	<i>Hypnum</i>	<i>Hypnum aduncoides</i> (Brid.) C. Muell.	Munnar	Shaded soil and rocks	13404
134.			<i>Hypnum setschwanicum</i> (Broth.) Ando.	Munnar	Shaded soil	13405
135.		<i>Ctenidium</i>	<i>Ctenidium hychmites</i> (Mitt.) Broth.	Eravikulam	Shaded rocks	13407

Table 6.9: Status of Taxa in the Study Area

S.No.	Family	Genus	Species	Locality	Occurrence	Herbarium No.					
1.	POLYTRICHACEAE	<i>Atrichum</i>	<i>Atrichum aculeatum</i> Card. & P. Vard.	Devikulam	++	13267					
2.			<i>Atrichum longifolium</i> Card. & Dix.	Attukadu	++	13268					
3.			<i>Atrichum obtusulum</i> (C. Muell.) Jaeg.	Kannimalai(Munnar)	+++++	13269					
4.			<i>Pogonatum</i>	<i>Pogonatum aloides</i> (Hedw.) P. Beauv.	Munnar	+++	13271				
5.				<i>Pogonatum cirratum</i> (Sw.) Brid.	Matupatti	+	13272				
6.				<i>Pogonatum leucopogon</i> Ren. et Card.	Devikulam	++	13273				
7.				<i>Pogonatum microstomum</i> (Schwaegr.) Brid.	Eravikulam	++++	13274				
8.				<i>Pogonatum perichaetiale</i> (Mont.) Jaeg.	Eravikulam	++	13275				
9.				<i>Pogonatum stevensii</i> Ren. et Card.	Attukadu	++	13276				
10.				<i>Polytrichum</i>	<i>Polytrichum densifolium</i> Wils. ex Mitt.	Munnar	++++	13277			
11.	DITRICHACEAE	<i>Pleuroidium</i>			<i>Pleuroidium tenue</i> Mitt.	Adimali	+	13278			
12.					<i>Garckea</i>	<i>Garckea flexuosa</i> (Griff.) Margad. & Nork.	Adimali	+	13279		
13.						<i>Ditrichum</i>	<i>Ditrichum darjeelingense</i> Ren. & Card.	Poyankutti	++	13280	
14.			<i>Ditrichum heteromallum</i> (Hedw.) Britt.				Thattekad	++++	13281		
15.			<i>Ditrichum pusillum</i> (Hedw.) Hamp.				Munnar	++++	13282		
16.			<i>Ditrichum tortipes</i> (Mitt.) Kuntze				Munnar	++++	13283		
17.			<i>Ditrichum tortuloides</i> Grout				Thattekad	++	13284		
18.			<i>Ceratodon</i>				<i>Ceratodon purpureus</i> (Hedw.) Brid.	Kothamangalam	+++++	13285	
19.							DICRANACEAE	<i>Trematodon</i>	<i>Trematodon kurzii</i> Hamp. ex Gangulee	Athirapalli	++
20.				<i>Trematodon schmidii</i> C. Muell.					Adimali	++	13287
21.	<i>Trematodon subulosus</i> Griff.	Kallar		++					13288		
22.	<i>Anisothecium</i>	<i>Anisothecium molliculum</i> (Mitt.) Broth.		Attukadu	+++				13289		
23.		<i>Microdus</i>		<i>Microdus brasiliensis</i> (Dub.) Ther.	Matupatti	+			13290		
24.				<i>Dicranella</i>	<i>Dicranella macrospora</i> Gangulee	Munnar			+++	13291	
25.					<i>Dicranella spiralis</i> (Mitt.) Jaeg.	Munnar			++++	13292	
26.					<i>Microcampylopus</i>	<i>Microcampylopus khasianus</i> (Griff.) Giese & Frahm.			Rajamalai	+++	13293
27.						<i>Microcampylopus subnamus</i> (C. Muell.) Fleisch.			Attukadu	++	13294
28.			<i>Campylopodiella</i>			<i>Campylopodiella tenella</i> Card.			Athirapalli	+	13295
29.						<i>Campylopus</i>	<i>Campylopus aureus</i> Bosch et Lac.	Munnar	++++	13296	
30.							<i>Campylopus flexuosus</i> (Hedw.) Brid.	Munnar	+++++	13297	
31.							<i>Campylopus goughii</i> (Mitt.) Jaeg.	Athirapalli	++	13298	
32.	<i>Campylopus latinervis</i> (Mitt.) Jaeg.						Munnar	+	13299		

S.No.	Family	Genus	Species	Locality	Occurrence	Herbarium No.
33.			<i>Campylopus richardii</i> Brid.	Munnar	++	13300
34.			<i>Campylopus schwarzii</i> Schimp.	Attukadu	++	13301
35.			<i>Campylopus subfragilis</i> Ren. & Card.	Matupatti	++++	13302
36.		<i>Dicranodontium</i>	<i>Dicranodontium demudatum</i> (Brid.) Britt.	Athirapalli	++	13303
37.		<i>Rhabdoweisia</i>	<i>Rhabdoweisia crenulata</i> (Mitt.) James.	Kannimalai	+	13306
38.		<i>Dicranoweisia</i>	<i>Dicranoweisia alpina</i> (Mitt.) Par.	Matupatti	+	13307
39.	LEUCOBRYACEAE	<i>Leucobryum</i>	<i>Leucobryum bowringii</i> Mitt.	Matupatti	++++	13308
40.			<i>Leucobryum juniperoideum</i> (Brid.) C. Muell.	Munnar	++++	13309
41.			<i>Leucobryum nilghiriense</i> C. Muell.	Matupatti	+++++	13310
42.	FISSIDENTACEAE	<i>Fissidens</i>	<i>Fissidens areolatus</i> Griff.	Devikulam	+++	13311
43.			<i>Fissidens pellucidus</i> Hornsch.	Munnar	+++	13312
44.			<i>Fissidens pulchellus</i> Mitt.	Athirapalli	++++	13313
45.			<i>Fissidens taxifolius</i> Hedw.	Munnar	++++	13314
46.	CALYMPERACEAE	<i>Calymperes</i>	<i>Calymperes sikkimense</i> Broth. ex Gangulee	Charpa	++	13315
47.			<i>Calymperes tenerum</i> C. Muell.	Athirapalli	++	13316
48.	POTTIACEAE	<i>Timmiella</i>	<i>Timmiella anomala</i> (B.S.G.) Limpr.	Attukadu	+++	13317
49.		<i>Oxystegus</i>	<i>Oxystegus stenophyllus</i> (Mitt.) Gangulee	Rajamalai	+++	13319
50.			<i>Oxystegus tenuirostris</i> (Hook. & Taylor) A.J.E. Sm.	Adimalli	+++	13318
51.		<i>Hyophila</i>	<i>Hyophila involuta</i> (Hook.) Jaeg.	Kothamangalam	+++++	13321
52.			<i>Hyophila nymiana</i> (Fleisch.) Menzel	Thattekad	+++	13320
53.			<i>Hyophila perannulata</i> Ren. et Card.	Munnar	++++	13322
54.			<i>Hyophila rosea</i> Williams	Munnar	+++	13323
55.		<i>Hydrogonium</i>	<i>Hydrogonium pseudo-ehrenbergii</i> (Fleisch.) Chen	Kallar	++++	13324
56.	FUNARIACEAE	<i>Physcomitrium</i>	<i>Physcomitrium eurystomum</i> Sendtn.	Munnar	++++	13325
57.			<i>Physcomitrium japonicum</i> (Hedw.) Mitt.	Kannimalai	++++	13326
58.		<i>Entosthodon</i>	<i>Entosthodon mutans</i> Mitt.	Munnar	+++	13327
59.			<i>Entosthodon wallichii</i> Mitt.	Eravikulam	++	13328
60.			<i>Entosthodon wichuriae</i> Fleisch.	Munnar	++	13329
61.		<i>Funaria</i>	<i>Funaria hygrometrica</i> Hedw.	Matupatti	+++++	13330
62.			<i>Funaria wijkii</i> R. S. Chopra	Attukadu	+	13331
63.	BRYACEAE	<i>Mielichhoferia</i>	<i>Mielichhoferia himalayana</i> Mitt.	Munnar	++	13332
64.		<i>Orthodontium</i>	<i>Orthodontium infractum</i> Schwaegr.	Munnar	++	13333
65.		<i>Haplodontium</i>	<i>Haplodontium infractum</i>	Matupatti	+	13334
66.		<i>Leptobryum</i>	<i>Leptobryum pyriforme</i> (Hedw.) Wils.	Wariyum	+	13335

S.No.	Family	Genus	Species	Locality	Occurrence	Herbarium No.
67.		<i>Mniobryum</i>	<i>Mniobryum ludwigii</i> (Schwaegr.) Loesk.	Attukadu	+	13336
68.		<i>Pohlia</i>	<i>Pohlia flexuosa</i> Hook.	Munnar	+++	13337
69.			<i>Pohlia gedeanana</i> (Bosch et Lac.) Gangulee	Eravikulam	+++	13338
70.			<i>Pohlia himalayana</i> (Mitt.) Broth.	Devikulam	+++	13339
71.		<i>Brachymerium</i>	<i>Brachymerium acuminatum</i> Harv.	Munnar	+++	13340
72.			<i>Brachymerium bryoides</i> Hook. Ex Schwaegr.	Munnar	+++	13341
73.			<i>Brachymerium capitulatum</i> (Mitt.) Paris	Adimalli	++++	13344
74.			<i>Brachymerium leptophyllum</i> Bruch & Schimp. ex Müll.Hal.	Matupatti	+++	13342
75.			<i>Brachymerium nepalense</i> Hook.	Munnar	++++	13343
76.			<i>Brachymerium pychothecium</i> (Besch.) Ochi	Poyankutti	+++	13345
77.			<i>Brachymerium sikkimense</i> Ren. Et Card.	Munnar	+++++	13346
78.		<i>Plagiobryum</i>	<i>Plagiobryum zierii</i> (Hedw.) Lindb.	Attukadu	+	13347
79.		<i>Anomobryum</i>	<i>Anomobryum brachymerioides</i> Dix. & P. Vard.	Munnar	++	13348
80.			<i>Anomobryum cymbifolium</i> (Lindb.) Broth.	Athirapalli	++	13349
81.			<i>Anomobryum latifolium</i> Card. & P. Vard.	Munnar	++	13350
82.			<i>Anomobryum pellucidum</i> Dix. & Badhw.	Attukadu	++	13351
83.		<i>Bryum</i>	<i>Bryum argenteum</i> Hedw. VAR. <i>griffithii</i> (C. Muell.) Gangulee	Munnar	+++++	13352
84.			<i>Bryum argenteum</i> Hedw. VAR. <i>lanatum</i> (P. Beauv.) Hamp.	Munnar	+++++	13353
85.			<i>Bryum atrovirens</i> Brid.	Thekadi	+++	13354
86.			<i>Bryum bicolor</i> Dicks.	Munnar	++++	13355
87.			<i>Bryum billardieri</i> Schwaegr.	Thekadi	++++	13356
88.			<i>Bryum capillare</i> L. ex Hedw.	Attukadu	+++++	13357
89.			<i>Bryum cellulare</i> Hook.	Munnar	+++++	13358
90.			<i>Bryum coronatum</i> Schwaegr.	Munnar	+++	13359
91.			<i>Bryum uliginosum</i> (Brid.). B.S.G.	Eravikulam	++	13362
92.		<i>Ptychostomum</i>	<i>Ptychostomum pseudotriquetrum</i> (Hedw.) J.R.Spence & H.P.Ramsay	Munnar	++++	13361
93.		<i>Rhodobryum</i>	<i>Rhodobryum laxe-limbatum</i> (Ochi) Iwats. & Kop.	Attukadu	+++	13363
94.			<i>Rhodobryum roseum</i> (Hedw.) Limpr.	Matupatti	++	13364
95.	MNIACEAE	<i>Mnium</i>	<i>Mnium thomsonii</i> Schimp.	Matupatti	+	13365
96.	BARTRAMIACEAE	<i>Anacolia</i>	<i>Anacolia menziesii</i> (Turn.) Par.	Attukadu	+	13366
97.		<i>Bartramidula</i>	<i>Bartramidula roylei</i> (Hook.f.) B.S.G.	Kannimalai	+++	13368
98.		<i>Philonotis</i>	<i>Philonotis bartramioides</i> (Griff.) Griffin & Buck	Attukadu	+++	13367
99.			<i>Philonotis mollis</i> (Doz. & Mol.) Mitt.	Charpa	+++	13369
100.			<i>Philonotis turneriana</i> (Schwaegr.) Mitt.	Attukadu	++++	13371

S.No.	Family	Genus	Species	Locality	Occurrence	Herbarium No.
101.	ORTHOTRICHACEAE	<i>Orthotrichum</i>	<i>Orthotrichum speciosum</i> Nees	Matupatti	+++	13372
102.		<i>Macromitrium</i>	<i>Macromitrium sulcatum</i> (Hook.) Brid.	Matupatti	+++	13373
103.	CRYPHAEACEAE	<i>Schoenobryum</i>	<i>Schoenobryum concavifolium</i> (Griff.) Gangulee	Matupatti	+	13374
104.	TRACHYPODACEAE	<i>Trachypodopsis</i>	<i>Trachypodopsis serrulata</i> (P. Beauv.) Fleisch.	Matupatti	+++	13375
105.	PTEROBRYACEAE	<i>Garovaglia</i>	<i>Garovaglia plicata</i> (Brid.) Bosch & Lac.	Matupatti	+	13376
106.		<i>Symphysodontella</i>	<i>Symphysodontella borii</i> Dix.	Eravikulam	+	13377
107.	METEORACEAE	<i>Cryptopapillaria</i>	<i>Cryptopapillaria fuscescens</i> (Hook.) Menzel	Devikulam	++	13378
108.		<i>Meteoriella</i>	<i>Meteoriella soluta</i> (Mitt.) Okam.	Athirapalli	++	13379
109.		<i>Barbella</i>	<i>Barbella chrysonema</i> (Muell.Hall.) Nog.	Eravikulam	++++	13380
110.	FABRONIACEAE	<i>Fabronia</i>	<i>Fabronia pusilla</i> Raddi	Idukki	+++	13381
111.	LESKEACEAE	<i>Regmatodon</i>	<i>Regmatodon declinatus</i> (Hook.) Brid.	Eravikulam	+++	13382
112.		<i>Lescuraea</i>	<i>Lescuraea incurvata</i> (Hedw.) Lawt.	Munnar	+++	13383
113.	THUIDIACEAE	<i>Herpetineuron</i>	<i>Herpetineuron tocoae</i> (Sull. & Lesq.) Card.	Attukadu	+++	13384
114.		<i>Claopodium</i>	<i>Claopodium pellucinerve</i> (Mitt.) Best	Munnar	+++	13385
115.		<i>Haplocladium</i>	<i>Haplocladium schimperi</i> Ther.	Matupatti	+++	13386
116.		<i>Pelekium</i>	<i>Pelekium investe</i> (Mitt.) Touw.	Matupatti	++++	13387
117.	AMBLYSTEGIACEAE	<i>Calliergon</i>	<i>Calliergon cordifolium</i> (Hedw.) Kindb.	Munnar	++	13388
118.	BRACHYTHECIACEAE	<i>Brachythecium</i>	<i>Brachythecium kamounense</i> (Harv.) Jaeg.	Devikulam	+++++	13389
119.			<i>Brachythecium populeum</i> (Hedw.) B.S.G.	Attukadu	+++++	13390
120.	ENTODONTACEAE	<i>Pterigynandrum</i>	<i>Pterigynandrum decolor</i> (Mitt.) Broth.	Attukadu	++	13391
121.		<i>Entodon</i>	<i>Entodon laetus</i> (Griff.) Jaeg.	Athirapalli	++++	13392
122.		<i>Erythrodontium</i>	<i>Erythrodontium julaceum</i> (Schwaegr.) Par.	Attukadu	++++	13393
123.	PLAGIOTHECIACEAE	<i>Plagiothecium</i>	<i>Plagiothecium cavifolium</i> (Brid.) Iwats.	Matupatti	+	13394
124.	SEMATOPHYLLACEAE	<i>Hageniella</i>	<i>Hageniella assamica</i> Dix.	Eravikulam	++	13395
125.		<i>Clastobryopsis</i>	<i>Clastobryopsis plamula</i> (Mitt.) Fleisch.	Athirapalli	+	13396
126.		<i>Chionostomum</i>	<i>Chionostomum rostratum</i> (Griff.) C. Muell.	Athirapalli	+	13397
127.		<i>Meiothecium</i>	<i>Meiothecium jagorii</i> (C. Muell.) Broth.	Athirapalli	++++	13398
128.		<i>Sematophyllum</i>	<i>Sematophyllum caespitosum</i> (Hedw.) Mitt.	Athirapalli	++++	13399
129.			<i>Sematophyllum humile</i> (Mitt.) Broth.	Munnar	++	13400
130.		<i>Pylaisiadelphina</i>	<i>Pylaisiadelphina drepanioides</i> Card. & Dix.	Eravikulam	++	13401
131.		<i>Brotherella</i>	<i>Brotherella dixonii</i> Herz.	Eravikulam	+	13402
132.		<i>Trichosteleum</i>	<i>Trichosteleum glauco-virens</i> (Mitt.) Broth.	Matupatti	+++	13403
133.	HYPNACEAE	<i>Hypnum</i>	<i>Hypnum aduncoides</i> (Brid.) C. Muell.	Munnar	+++	13404
134.			<i>Hypnum setschwanicum</i> (Broth.) Ando.	Munnar	+++	13405
135.		<i>Ctenidium</i>	<i>Ctenidium lychnites</i> (Mitt.) Broth.	Eravikulam	+++	13407

Table 6.10: The Total Number of Mosses from the Study Area (Idukki District, Kerala) along with their Family, Genus, Locality, Altitude, Habitat Preference, their Status and Herbarium Number

S.No.	Family	Genus	Species	Locality	Altitude	Habitat	Occurrence	Herbarium No.		
1.	POLYTRICHACEAE	<i>Atrichum</i>	<i>Atrichum aculeatum</i> Card. & P. Vard.	Devikulam	1700m	Loose soil	++	13267		
2.			<i>Atrichum longifolium</i> Card. & Dix.	Attukadu	1500m	Loose soil	++	13268		
3.			<i>Atrichum obtusulum</i> (C. Muell.) Jaeg.	Kannimalai(Munnar)	1600m	Loose soil	+++++	13269		
4.		<i>Pogonatum</i>	<i>Pogonatum aloides</i> (Hedw.) P. Beauv.	Munnar	1600m	Rocks	+++	13271		
5.			<i>Pogonatum cirratum</i> (Sw.) Brid.	Matupatti	1700m	Soil	+	13272		
6.			<i>Pogonatum leucopogon</i> Ren. et Card.	Devikulam	1700m	Soil	++	13273		
7.			<i>Pogonatum microstomum</i> (Schwaegr.) Brid.	Eravikulam	1800m	Rocks	++++	13274		
8.			<i>Pogonatum perichaetiale</i> (Mont.) Jaeg.	Eravikulam	1800m	Wet rocks	++	13275		
9.			<i>Pogonatum stevensii</i> Ren. Et Card.	Attukadu	1500m	Stable soil	++	13276		
10.			<i>Polytrichum</i>	<i>Polytrichum densifolium</i> Wils. ex Mitt.	Munnar	1600m	Disturbed soil	++++	13277	
11.	DITRICHACEAE		<i>Pleuridium</i>	<i>Pleuridium temie</i> Mitt.	Adimali	1300m	Wet rocks	+	13278	
12.		<i>Garckea</i>		<i>Garckea flexuosa</i> (Griff.) Margad. & Nork.	Adimali	1300m	Shaded rocks	+	13279	
13.		<i>Ditrichum</i>	<i>Ditrichum darjeelingense</i> Ren. & Card.	Poyankutti	1200m	Wet rocks	++	13280		
14.			<i>Ditrichum heteromallum</i> (Hedw.) Britt.	Thattekad	1200m	Wet rocks	++++	13281		
15.			<i>Ditrichum pusillum</i> (Hedw.) Hamp.	Munnar	1600m	Rocks	++++	13282		
16.			<i>Ditrichum tortipes</i> (Mitt.) Kuntze	Munnar	1600m	Dry exposed rocks	++++	13283		
17.			<i>Ditrichum tortuloides</i> Grout	Thattekad	1200m	Exposed rocks	++	13284		
18.			<i>Ceratodon</i>	<i>Ceratodon purpureus</i> (Hedw.) Brid.	Kothamangalam	1300m	Soil, rocks & roofs	+++++	13285	
19.			DICRANACEAE	<i>Trematodon</i>	<i>Trematodon kurzii</i> Hamp. ex Gangulee	Athirapalli	1200m	Sandy soil	++	13286
20.					<i>Trematodon schmidii</i> C. Muell.	Adimali	1300m	Sandy soil	++	13287
21.	<i>Trematodon subulosus</i> Griff.	Kallar			1200m	Loose soil	++	13288		
22.	<i>Anisothecium</i>	<i>Anisothecium molliculum</i> (Mitt.) Broth.		Attukadu	1500m	Rocks	+++	13289		
23.	<i>Microdus</i>	<i>Microdus brasiliensis</i> (Dub.) Ther.		Matupatti	1700m	Wet rocks	+	13290		
24.	<i>Dicranella</i>	<i>Dicranella macrospora</i> Gangulee		Munnar	1600m	Soil	+++	13291		
25.		<i>Dicranella spiralis</i> (Mitt.) Jaeg.		Munnar	1600m	Moist soil	++++	13292		
26.		<i>Microcampylopus</i>		<i>Microcampylopus khasianus</i> (Griff.) Giese & Frahm.	Rajamalai	1600m	Rocks	+++	13293	
27.		<i>Microcampylopus subnanus</i> (C. Muell.) Fleisch.		Attukadu	1500m	Rocks	++	13294		
28.	<i>Campylopodia</i>	<i>Campylopodia tenella</i> Card.		Athirapalli	1200m	Rocks	+	13295		
29.	<i>Campylopus</i>	<i>Campylopus aureus</i> Bosch et Lac.	Munnar	1600m	Rocks	++++	13296			
30.		<i>Campylopus flexuosus</i> (Hedw.) Brid.	Munnar	1600m	Rocks	+++++	13297			
31.		<i>Campylopus goughii</i> (Mitt.) Jaeg.	Athirapalli	1200m	Rocks	++	13298			

S.No.	Family	Genus	Species	Locality	Altitude	Habitat	Occurrence	Herbarium No.
32.			<i>Campylopus latinervis</i> (Mitt.) Jaeg.	Munnar	1600m	Rocks	+	13299
33.			<i>Campylopus richardii</i> Brid.	Munnar	1600m	Rocks	++	13300
34.			<i>Campylopus schwarzii</i> Schimp.	Attukadu	1500m	Rocks	++	13301
35.			<i>Campylopus subfragilis</i> Ren. & Card.	Matupatti	1700m	Rocks	++++	13302
36.		Dicranodontium	<i>Dicranodontium demudatum</i> (Brid.) Britt.	Athirapalli	1200m	Rocks	++	13303
37.		Rhabdoweisia	<i>Rhabdoweisia cremulata</i> (Mitt.) James.	Kannimalai	1600m	Wet rocks	+	13306
38.		Dicranoweisia	<i>Dicranoweisia alpina</i> (Mitt.) Par.	Matupatti	1700m	Wet rocks	+	13307
39.	LEUCOBRYACEAE	Leucobryum	<i>Leucobryum bowringii</i> Mitt.	Matupatti	1700m	Tree bark	++++	13308
40.			<i>Leucobryum juniperoides</i> (Brid.) C. Muell.	Munnar	1600m	Tree bark	++++	13309
41.			<i>Leucobryum nilghiriense</i> C. Muell.	Matupatti	1700m	Tree bark	+++++	13310
42.	FISSIDENTACEAE	Fissidens	<i>Fissidens areolatus</i> Griff.	Devikulam	1700m	Soil	+++	13311
43.			<i>Fissidens pellucidus</i> Hornsch.	Munnar	1600m	Rocks	+++	13312
44.			<i>Fissidens pulchellus</i> Mitt.	Athirapalli	1200m	Rocks	++++	13313
45.			<i>Fissidens taxifolius</i> Hedw.	Munnar	1600m	Shaded soil	++++	13314
46.	CALYMPERACEAE	Calymperes	<i>Calymperes sikkimensis</i> Broth. ex Gangulee	Charpa	1200m	Wet rocks	++	13315
47.			<i>Calymperes tenerum</i> C. Muell.	Athirapalli	1200m	Wet rocks	++	13316
48.	POTTIACEAE	Timmiella	<i>Timmiella anomala</i> (B.S.G.) Limpr.	Attukadu	1500m	Soil	+++	13317
49.		Oxystegus	<i>Oxystegus stenophyllus</i> (Mitt.) Gangulee	Rajamalai	1600m	Sandy soil	+++	13319
50.			<i>Oxystegus tenuirostris</i> (Hook. & Taylor) A.J.E. Sm.	Adimalli	1300m	Sandy soil	+++	13318
51.		Hyophila	<i>Hyophila involuta</i> (Hook.) Jaeg.	Kothamangalam	1300m	Old walls	+++++	13321
52.			<i>Hyophila nymaniana</i> (Fleisch.) Menzel	Thattekad	1200m	Old walls	+++	13320
53.			<i>Hyophila peranmulata</i> Ren. et Card.	Munnar	1600m	Moist rocks	++++	13322
54.			<i>Hyophila rosea</i> Williams	Munnar	1600m	Rocks	+++	13323
55.		Hydrogonium	<i>Hydrogonium pseudo-ehrenbergii</i> (Fleisch.) Chen	Kallar	1200m	Wet rocks	++++	13324
56.	FUNARIACEAE	Physcomitrium	<i>Physcomitrium euryostomum</i> Sendtn.	Munnar	1600m	Moist soil	++++	13325
57.			<i>Physcomitrium japonicum</i> (Hedw.) Mitt.	Kannimalai	1600m	Moist soil	++++	13326
58.		Entosthodon	<i>Entosthodon nutans</i> Mitt.	Munnar	1600m	Exposed rocks	+++	13327
59.			<i>Entosthodon wallichii</i> Mitt.	Eravikulam	1800m	Exposed rocks	++	13328
60.			<i>Entosthodon wichurae</i> Fleisch.	Munnar	1600m	Exposed rocks	++	13329
61.		Funaria	<i>Funaria hygrometrica</i> Hedw.	Matupatti	1700m	Exposed rocks	+++++	13330
62.			<i>Funaria wijkii</i> R. S. Chopra	Attukadu	1500m	Shaded rocks	+	13331
63.	BRYACEAE	Mielichhoferia	<i>Mielichhoferia himalayana</i> Mitt.	Munnar	1600m	Soil	++	13332
64.		Orthodontium	<i>Orthodontium infractum</i> Schwaegr.	Munnar	1600m	Tree base	++	13333
65.		Haplodontium	<i>Haplodontium infractum</i>	Matupatti	1700m	Soil	+	13334
66.		Leptobryum	<i>Leptobryum pyriforme</i> (Hedw.) Wils.	Wariyum	1300m	Wet rocks	+	13335

S.No.	Family	Genus	Species	Locality	Altitude	Habitat	Occurrence	Herbarium No.
67.		<i>Mniobryum</i>	<i>Mniobryum ludwigii</i> (Schwaegr.) Loesk.	Attukadu	1500m	Wet soil	+	13336
68.		<i>Pohlia</i>	<i>Pohlia flexuosa</i> Hook.	Munnar	1600m	Tree bark	+++	13337
69.			<i>Pohlia gedeanae</i> (Bosch et Lac.) Gangulee	Eravikulam	1800m	Rocks	+++	13338
70.			<i>Pohlia himalayana</i> (Mitt.) Broth.	Devikulam	1700m	Tree base	+++	13339
71.		<i>Brachymenium</i>	<i>Brachymenium acuminatum</i> Harv.	Munnar	1600m	Wet rocks	+++	13340
72.			<i>Brachymenium bryoides</i> Hook. Ex Schwaegr.	Munnar	1600m	Wet rocks	+++	13341
73.			<i>Brachymenium capitulatum</i> (Mitt.) Paris	Adimalli	1300m	Soil	++++	13344
74.			<i>Brachymenium leptophyllum</i> Bruch & Schimp. ex Müll.Hal.	Matupatti	1700m	Tree base	+++	13342
75.			<i>Brachymenium nepalense</i> Hook.	Munnar	1600m	Exposed soil	++++	13343
76.			<i>Brachymenium pychothecium</i> (Besch.) Ochi	Poyankutti	1200m	Soil	+++	13345
77.			<i>Brachymenium sikkimense</i> Ren. Et Card.	Munnar	1600m	Tree bark	+++++	13346
78.		<i>Plagiobryum</i>	<i>Plagiobryum zierii</i> (Hedw.) Lindb.	Attukadu	1500m	Wet rocks	+	13347
79.		<i>Anomobryum</i>	<i>Anomobryum brachyenioides</i> Dix. & P. Vard.	Munnar	1600m	Wet rocks	++	13348
80.			<i>Anomobryum cymbifolium</i> (Lindb.) Broth.	Athirapalli	1200m	Wet rocks	++	13349
81.			<i>Anomobryum latifolium</i> Card. & P. Vard.	Munnar	1600m	Wet rocks	++	13350
82.			<i>Anomobryum pellucidum</i> Dix. & Badhw.	Attukadu	1500m	Wet rocks	++	13351
83.		<i>Bryum</i>	<i>Bryum argenteum</i> Hedw. VAR. <i>griffithii</i> (C. Muell.) Gangulee	Munnar	1600m	Exposed old walls	+++++	13352
84.			<i>Bryum argenteum</i> Hedw. VAR. <i>lanatum</i> (P. Beauv.) Hamp.	Munnar	1600m	Exposed old walls	+++++	13353
85.			<i>Bryum atrovirens</i> Brid.	Thekadi	1300m	Moist soil	+++	13354
86.			<i>Bryum bicolor</i> Dicks.	Munnar	1600m	Moist soil	++++	13355
87.			<i>Bryum billardieri</i> Schwaegr.	Thekadi	1300m	Tree bark	++++	13356
88.			<i>Bryum capillare</i> L. ex Hedw.	Attukadu	1500m	Wet rocks	+++++	13357
89.			<i>Bryum cellulare</i> Hook.	Munnar	1600m	Tree base	+++++	13358
90.			<i>Bryum coronatum</i> Schwaegr.	Munnar	1600m	Loose soil	+++	13359
91.			<i>Bryum uliginosum</i> (Brid.) B.S.G.	Eravikulam	1800m	Soil	++	13362
92.		<i>Ptychostomum</i>	<i>Ptychostomum pseudotriquetrum</i> (Hedw.) J.R.Spence & H.P.Ramsay	Munnar	1600m	Exposed soil	++++	13361
93.		<i>Rhodobryum</i>	<i>Rhodobryum laxe-limbatum</i> (Ochi) Iwats. & Kop.	Attukadu	1500m	Rocks	+++	13363
94.			<i>Rhodobryum roseum</i> (Hedw.) Limpr.	Matupatti	1700m	Wet rocks	++	13364
95.	MNIACEAE	<i>Mnium</i>	<i>Mnium thomsonii</i> Schimp.	Matupatti	1700m	Wet rocks	+	13365
96.	BARTRAMIACEAE	<i>Anacolia</i>	<i>Anacolia menziesii</i> (Turn.) Par.	Attukadu	1500m	Moist rocks	+	13366
97.		<i>Bartramidula</i>	<i>Bartramidula roylei</i> (Hook.f.) B.S.G.	Kannimalai	1600m	Wet rocks	+++	13368
98.		<i>Philonotis</i>	<i>Philonotis bartramoides</i> (Griff.) Griffin & Buck	Attukadu	1500m	Wet rocks	+++	13367
99.			<i>Philonotis mollis</i> (Doz. & Molk.) Mitt.	Charpa	1200m	Wet rocks	+++	13369
100.			<i>Philonotis turneriana</i> (Schwaegr.) Mitt.	Attukadu	1500m	Wet rocks	++++	13371
101.	ORTHOTRICHACEAE	<i>Orthotrichum</i>	<i>Orthotrichum speciosum</i> Nees	Matupatti	1700m	Tree branches	+++	13372

S.No.	Family	Genus	Species	Locality	Altitude	Habitat	Occurrence	Herbarium No.
102.		<i>Macromitrium</i>	<i>Macromitrium sulcatum</i> (Hook.) Brid.	Matupatti	1700m	Tree bark	+++	13373
103.	CRYPHAEACEAE	<i>Schoenobryum</i>	<i>Schoenobryum concavifolium</i> (Griff.) Gangulee	Matupatti	1700m	Tree bark	+	13374
104.	TRACHYPODACEAE	<i>Trachypodopsis</i>	<i>Trachypodopsis serrulata</i> (P. Beauv.) Fleisch.	Matupatti	1700m	Tree bark	+++	13375
105.	PTEROBRYACEAE	<i>Garovaglia</i>	<i>Garovaglia plicata</i> (Brid.) Bosch & Lac.	Matupatti	1700m	Tree bark	+	13376
106.		<i>Symphysodontella</i>	<i>Symphysodontella borii</i> Dix.	Eravikulam	1800m	Tree bark	+	13377
107.	METEORACEAE	<i>Cryptopapillaria</i>	<i>Cryptopapillaria fuscescens</i> (Hook.) Menzel	Devikulam	1700m	Tree bark	++	13378
108.		<i>Meteoriella</i>	<i>Meteoriella soluta</i> (Mitt.) Okam.	Athirapalli	1200m	Tree branches	++	13379
109.		<i>Barbella</i>	<i>Barbella chrysonema</i> (Muell.Hall.) Nog.	Eravikulam	1800m	Tree branches	++++	13380
110.	FABRONIACEAE	<i>Fabronia</i>	<i>Fabronia pusilla</i> Raddi	Idukki	1500m	Rocks	+++	13381
111.	LESKEACEAE	<i>Regmatodon</i>	<i>Regmatodon declinatus</i> (Hook.) Brid.	Eravikulam	1800m	Rocks	+++	13382
112.		<i>Lescurea</i>	<i>Lescurea incurvata</i> (Hedw.) Lawt.	Munnar	1600m	Tree bark	+++	13383
113.	THUIDIACEAE	<i>Herpetineuron</i>	<i>Herpetineuron toccoeae</i> (Sull. & Lesq.) Card.	Attukadu	1500m	Rocks	+++	13384
114.		<i>Claopodium</i>	<i>Claopodium pellucinerve</i> (Mitt.) Best	Munnar	1600m	Rocks	+++	13385
115.		<i>Haplocladium</i>	<i>Haplocladium schimperi</i> Ther.	Matupatti	1700m	Forest litter	+++	13386
116.		<i>Pelekium</i>	<i>Pelekium investe</i> (Mitt.) Touw.	Matupatti	1700m	Forest litter	++++	13387
117.	AMBLYSTEGIACEAE	<i>Calliergon</i>	<i>Calliergon cordifolium</i> (Hedw.) Kindb.	Munnar	1600m	Wet rocks	++	13388
118.	BRACHYTHECIACEAE	<i>Brachythecium</i>	<i>Brachythecium kamounense</i> (Harv.) Jaeg.	Devikulam	1700m	Rocks	+++++	13389
119.			<i>Brachythecium populium</i> (Hedw.) B.S.G.	Attukadu	1500m	Soil	+++++	13390
120.	ENTODONTACEAE	<i>Pterigynandrum</i>	<i>Pterigynandrum decolor</i> (Mitt.) Broth.	Attukadu	1500m	Tree base	++	13391
121.		<i>Entodon</i>	<i>Entodon laetus</i> (Griff.) Jaeg.	Athirapalli	1200m	Tree base	++++	13392
122.		<i>Erythrodontium</i>	<i>Erythrodontium julaceum</i> (Schwaegr.) Par.	Attukadu	1500m	Tree base	++++	13393
123.	PLAGIOTHECIACEAE	<i>Plagiothecium</i>	<i>Plagiothecium cavifolium</i> (Brid.) Iwats.	Matupatti	1700m	Tree base	+	13394
124.	SEMATOPHYLLACEAE	<i>Hageniella</i>	<i>Hageniella assamica</i> Dix.	Eravikulam	1800m	Wet rocks	++	13395
125.		<i>Clastobryopsis</i>	<i>Clastobryopsis plamula</i> (Mitt.) Fleisch.	Athirapalli	1200m	Rocks	+	13396
126.		<i>Chionostomum</i>	<i>Chionostomum rostratum</i> (Griff.) C. Muell.	Athirapalli	1200m	Tree base	+	13397
127.		<i>Meiothecium</i>	<i>Meiothecium jagorii</i> (C. Muell.) Broth.	Athirapalli	1200m	Rocks	++++	13398
128.		<i>Sematophyllum</i>	<i>Sematophyllum caespitosum</i> (Hedw.) Mitt.	Athirapalli	1200m	Tree bark	++++	13399
129.			<i>Sematophyllum humile</i> (Mitt.) Broth.	Munnar	1600m	Tree bark	++	13400
130.		<i>Pylaisiadelpha</i>	<i>Pylaisiadelpha drepanioides</i> Card. & Dix.	Eravikulam	1800m	Wet rocks	++	13401
131.		<i>Brotherella</i>	<i>Brotherella dixonii</i> Herz.	Eravikulam	1800m	Wet rocks	+	13402
132.		<i>Trichosteleum</i>	<i>Trichosteleum glauco-virens</i> (Mitt.) Broth.	Matupatti	1700m	Rocks	+++	13403
133.	HYPNACEAE	<i>Hypnum</i>	<i>Hypnum aduncooides</i> (Brid.) C. Muell.	Munnar	1600m	Shaded soil and rocks	+++	13404
134.			<i>Hypnum setschwanicum</i> (Broth.) Ando.	Munnar	1600m	Shaded soil	+++	13405
135.		<i>Ctenidium</i>	<i>Ctenidium lychmites</i> (Mitt.) Broth.	Eravikulam	1800m	Shaded rocks	+++	13407

Chapter 7
Summary and Conclusions

SUMMARY AND CONCLUSIONS

The thesis embodies the results of morpho-taxonomic studies carried out on the mosses occurring in Idukki district in Kerala, India since April 2005, with the objectives, (a) Survey of mosses of Idukki district through field studies and available literature. (b) Documentation and enriching herbarium of mosses of Idukki district. (c) To provide illustrations of preferably all the mosses of Idukki district for easy identification. (d) Preliminary evaluation of mosses for their habitat preference. (e) To bring out illustrated moss flora of Idukki district. The study is based on more than 500 samples of 135 specimens collected during extensive and intensive field tours undertaken to different eco-regions of Idukki district during 2005-2008 in different seasons. All the specimens have been deposited in the herbarium of Department of Botany, University of Delhi, India.

Mosses have always been linked to the terrestrial environment and have been achieved their greatest diversity in cool, moist, oceanic climates found at higher latitudes and altitudes. Several species have potential to adapt the changing climates of this area. The considerable extant diversity of these groups reflect the genetic plasticity of the ancestral populations and their great success in occupying the many new and edaphically and hospitable niches created by the rise of the angiosperms. Differences in habitat ecology of mosses are commonly used as an aid in their identification, at any taxonomic level, used in conjunction with the morphological characters. It is also concluded that the real differences between species are in the field, where whole populations and their reaction to environmental factors can be clearly observed. The growth of tourism and other recreational activities as well as the agricultural and industrial development of the area are destroying the habitat of mosses and the population size of mosses is decreasing. The preparation of generic floras and keys of south India is needed urgently.

Present study deals with a comprehensive morphological study and illustrated account of 135 species of mosses belonging to 75 genera and 25 families from Idukki district, specially the hilly areas of Munnar and its surrounding, representing several interesting taxa from just 13.07% of the total geographical area of the state of Kerala.

Within the study area, Eubryales with 38 species belonging to 16 genera and 3 families is found to be the largest order followed by Dicranales with 31 species

belonging to 15 genera and 3 families. Fissidentales is represented by 4 species only of the genus *Fissidens*. The family Bryaceae with 32 species and 12 genera is the largest represented family in the study area followed by Dicranaceae (20 species and 10 genera) and Polytrichaceae (10 species and 3 genera). The families Mniaceae, Cryphaeaceae, Trachypodaceae, Fabroniaceae, Amblystegiaceae and Plagiotheciaceae are represented by single species in each.

At the generic level, genus *Bryum* Hedw. with 9 species was found to have highest number of species followed by *Campylopus* Brid. and *Brachymerium* Schwaegr. (with 7 species of each) while 51 genera viz., *Polytrichum* Hedw., *Pleuridium* Brid., *Garckea* C.Muell., *Ceratodon* Brid., *Anisothecium* Mitt., *Microdus* Schimp., *Campylopodiella* Card., *Dicranodontium* B.S.G., *Rhabdoweisia* B.S.G., *Dicranoweisia* Mild., *Timmiella* (De Not.) Limpr., *Hydrogonium* (C.Muell.) Jaeg., *Mielichhoferia* Nees & Hornsch., *Orthodontium* Schwaegr., *Haplodontium* Hamp., *Leptobryum* (B.S.G.) Wils., *Mniobryum* Limpr., *Plagiobryum* B.S.G., *Ptychostomum* Hornschuch, *Mnium* Hedw., *Anacolia* Schimp., *Bartramidula* B.S.G., *Orthotrichum* Hedw., *Macromitrium* Brid., *Schoenobryum* Doz. & Molk., *Trachypodopsis* Fleisch., *Garovaglia* Endl., *Symphysodontella* Fleisch., *Cryptopapillaria* Menzel, *Meteoriella* Okam., *Barbella* Fleisch., *Fabronia* Raddi, *Regmatodon* Brid., *Lescurea* B.S.G., *Herpetineuron* (C.Muell.) Card., *Claopodium* (Lesq. & Jam.) Ren. & Card., *Haplocladium* (C. Muell.) C. Muell., *Pelekium* Mitt., *Calliergon* (Sull.) Kindb., *Pterigynandrum* Hedw., *Entodon* C. Muell., *Erythrodontium* Hamp., *Plagiothecium* B.S.G., *Hageniella* Broth., *Clastobryopsis* Fleisch., *Chionostomum* C. Muell., *Meiothecium* Mitt., *Pylaisiadelpha* Card., *Brotherella* Loesk. Ex Fleisch., *Trichosteleum* Mitt., *Ctenidium* (Schimp.) Mitt. are represented by one species each.

The most favourable altitudinal range for the growth of mosses is approximately 1600m where a total of 45 taxa have been reported belonging to 14 families and 27 genera, followed by 1700m where a total of 26 taxa have been reported belonging to 16 families and 24 genera and least number of taxa were collected from the altitudinal range of approximately 1300m with a total of 10 taxa belonging to 4 families and 9 genera.

Of the total 135 taxa of mosses reported from the study area, 70 taxa are lithophytic belonging to 44 genera and 17 families. 34 taxa are terrestrial belonging to

9 families and 18 genera. A total of 27 taxa belonging to 16 families and 24 genera have been reported from epiphytic habitat. 4 taxa belonging to 2 genera and families have been recorded from construction sites (such as old walls) whereas 2 taxa belonging to 2 genera and a single family have been reported from litters also.

Out of the total 135 taxa reported from the study area 13 taxa belonging to 9 genera and 8 families are found to be widely distributed at open as well as forested sites such as *Atrichum obtusulum*, *Ceratodon purpureus*, *Campylopus flexuosus*, etc. 28 taxa belonging to 20 genera and 13 species are frequent as they were reported from many forested sites, 38 taxa belonging to 27 genera and 14 families are moderately present or infrequent as they were reported from 5 to 10 site only in moist habitat. 34 taxa belonging to 21 genera and 10 families are sparse as they were reported from 3 to 4 sites only whereas 22 genera belonging to 11 families have been found to be rare as these are represented by just single collection only such as *Pogonatum cirratum*, *Pleuridium tenuis*, *Garckea flexuosa*, etc. Out of the 135 taxa reported from the study area, 24 taxa are endemic to India.

Before taking up the present study, a total of 465 bryophyte taxa comprising 148 taxa of liverworts, 10 taxa of hornworts and 307 taxa of mosses were reported from Kerala (Nair *et al.*, 2008). The present study has added 83 taxa of mosses comprising 51 new genera belonging to 18 families to the hitherto known bryoflora of the study area which is only 13.07% of the total geographical area of the state of Kerala.

The following conclusions were drawn from the present study:

- Present study shows that the area is rich in bryophyte species and harbours many of the endemic taxa.
- Developmental activities are threatening the bryophyte species and also the associated organisms.
- Some of the areas should be protected for the habitat for bryophytes and to be declared as moss gardens.
- Epiphytic species play an important role in protecting the host species by providing continuous moisture.

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