ECO-SYSTEMATIC STUDIES ON BRYOPHYTES OF MALABAR WILDLIFE SANCTUARY, KERALA

Thesis submitted to the
University of Calicut in partial fulfillment of the
requirements for the award of the Degree of

Doctor of Philosophy in Botany

by

PRAJITHA B.

U.O. No. Dor/B3/3298/Ph.D- 2012 dtd. 29.10.2012

under

Dr. R. Prakashkumar
(Guide)
&
Dr. Manju C. Nair
(Co guide)

KSCSTE-Malabar Botanical Garden and Institute for Plant Sciences
Kozhikode, Kerala-673 014, INDIA
October 2019

KSCSTE-Malabar Botanical Garden & Institute for Plant Sciences (KSCSTE-MBGIPS) is an institution of the Government of Kerala, administered by the Kerala State Council for Science Technology and Environment (KSCSTE), dedicated to the conservation and research on aquatic plant diversity, lower group plants, endangered plants of the erstwhile Malabar Region, as well as disseminating knowledge on various facets of plant sciences. By virtue of possessing a vast morass land, the Malabar Botanical Garden and Institute for Plant Sciences becomes unique in the nation ideal for ex situ conservation of aquatic/wetland plants and for undertaking research on them. The educational value of the Garden lies with the descriptive labels displayed for the different sections and plants.

POST GRADUATE & RESEARCH DEPARTMENT OF BOTANY
THE ZAMORIN'S GURUVAYURAPPAN COLLEGE
(Established in 1877. Affiliated to University of Calicut. Re-accredited by NAAC with A Grade)
Guruvayurappan College P.O., Kozhikode-673014, Kerala
Web. www.zgcollege.org Phone: 0495-2331516 Email zgckozhikode@gmail.com

Dr. Manju C. Nair, M.Sc., Ph.D., PDF
Assistant Professor of Botany

CERTIFICATE

This is to certify that the thesis entitled entitled **"Eco-Systematic Studies on Bryophytes of Malabar Wildlife Sanctuary, Kerala"** submitted to the University of Calicut by Ms. Prajitha B., Research Scholar, Malabar Botanical Garden & Institute for Plant Science, Kozhikode, in partial fulfillment of the requirements for the award of the degree of Doctor of Philosophy in Botany, has been carried out by her under my Co-Guidance. This work is original and has not been submitted in part or full for the award of any degree or diploma in any University.

Place: ZGC
Date:

(Dr. Manju C. Nair)
Co-guide

DECLARATION

The thesis entitled **"Eco-Systematic Studies on Bryophytes of Malabar Wildlife Sanctuary, Kerala"** being submitted in part fulfilment of requirements for the degree of Doctor of Philosophy in Botany of the University of Calicut embodies the results of a bonafide research work done by me under the guidance of Dr. R. Prakashkumar, Director, JNTBGRI, Palode, Thiruvananthapuram and co-guidance of Dr. Manju C. Nair, Assistant Professor of Botany, The Zamorin's Guruvayurappan College, Kozhikode and that no part of it has previously formed the basis for the award of any degree, diploma, fellowship and title or recognition.

Place: MBGIPS Prajitha B.

Date:

ACKNOWLEDGEMENT

It is indeed a great pleasure to express my gratitude to each and everyone who have directly or indirectly helped me in the successful compilation of my research work.

I wish to express my gratitude from the bottom of my heart to Dr. R. Prakashkumar, Director, KSCSTE-JNTBGRI, Palode, Thiruvanathapuram (Former Director, KSCSTE-MBGIPS, Kozhikode-14), under whose guidance I have completed my research work. I feel myself fortunate to accomplish my research work under his supervision. I express my deep sense of gratitude from the bottom of my heart to Dr. Manju C. Nair, Assistant Professor, Department of Botany, The Zamorins' Guruvayurappan College Calicut under whose co-guidance I have completed my research work. Her support and care always encouraged me to pursue right path in my work. It is my privilege that I have the opportunity to work under her guidance.

I am grateful to Dr. S. Pradeep Kumar, Director in Charge, KSCSTE-MBGIPS for providing me the required facilities and support throughout my research work.

With great pleasure I record my sincere thanks to the Kerala State Council for Science Technology & Environment for the fellowship in the Back to Lab Scheme during the period 2010-2013.

It is indeed a great pleasure to express my gratitude towards Prof. P.V. Madhusoodanan, Emiratus Scientist, KSCSTE-MBGIPS, for his guidance, morale support, encouragements and invaluable help throughout my work.

I am indebted to Dr. R, Ansari, Former Managing Director, MBGIPS for providing valuable suggestions and support. I sincerely acknowledge the help and encouragement of Dr. N.S. Pradeep, Senior Scientist, KSCSTE-MBGIPS and Dr. P.N. Krishnan, Emeritus Scientist, KSCSTE-MBGIPS.

I am extremely thankful to Dr. K.P. Rajesh, Assistant Professor, Department of Botany, The Zamorins' Guruvayurappan College, Calicut for providing valuable suggestions and support. I am grateful to the Principal and other staff members of the Department of Botany, The Zamorins' Guruvayurappan College for providing me the required lab facilities and support.

I am indebted to many scientists for their generous support in helping identification of some difficult taxa, for providing literature, guidance and encouragement, especially to Dr. William R. Buck, New York Botanical Garden; Wen Zhang Ma, Scientist, Chinese Academy of Sciences, Yunnan; Dr L.T. Ellis, Senior Curator, Natural History Museum, London; Dr. Dulip Daniels, Associate Professor; Dr. Kariyappa K.C., Research Scholar, Scott Christian College, Nagercoil, Tamil Nadu; Dr. P. Uniyal, Department of Botany, Delhi University; Dr. A.K. Asthana, Principal Scientist & Group Leader, Bryology Laboratory & Dr. Ajith Pratab Singh, Scientist-C, CSIR-National Botanical Research Institute, Lucknow.

I am extremely thankful to the Doctoral Committee members, Prof. (Dr.) Santhosh Nampy (Former Head) and Dr. Jos T. Puthur, Associate Professor of Botany, University of Calicut; I wish to thank Herbarium Curator and Librarian, University of Calicut for their help in specimen reference and providing literature during the course of the study. I thank Dr. Kishore Kumar, Head of the Department of Botany, Feroke College for providing valuable suggestions and support.

I am thankful to Dr. Udayan P.S. (Assistant Professor, Sree Krishna College, Guruvayur), for his help during the field trips.

I thank Chief Wildlife Warden of Kerala state, Divisional Forest Officer and Range Officer and other staffs of forest Dept. Malabar Wildlife Sanctuary for granting permission and rendering necessary assistance in the field.

My sincere and heartfelt thanks to Dr. K.P. Anoop and Mr. Rajilesh V.K for their timely help and encouragement throughout the period of the study.

I express my heartfelt gratitude to fellow Researchers of MBGIPS; Dr. Anoop. P. Balan, Dr. Neethu R.S., Dr. R.B. Smitha, Dr. Abhilash Joseph, Dr. Sibi M.C, Dr. Arun K. Das, Pavisha, P., Swetha Thilak, Saranya Babu, Jayaprakash, Mithun Venugopal, Athulya Sadhanand and Bipin Joseph for their help and support during the study period; thankful to Research Scholars of Department of Botany, The Zamorin's Guruvayurappan College Mr. Mufeed B. and Chandini V.K. for the help in taking some photographs and their valuable suggestions during the study period.

I extend my sincere thanks to Hareesh K.T (Project Assistant) for his help during field explorations and Liji, M. (Technical Assistant) in preparing herbarium specimens.

I thank field guides Ajesh, P.P., Rahul, R., Shilpa Raj, V., and Aishwarya S. Srinivas for their encouragement and help in various ways during the progress of this work.

I wish to thank all the administrative and non-administrative staffs of KSCSTE-MBGIPS for their valuable help.

I deeply indebted to my parents, husband and brothers for their wholehearted support, encouragement and inspiration which formed the basis for the completion of this research work.

Above all I thank the Almighty for showering the unseen blessings on me with which I am able to complete my work successfully.

Prajitha, B.

CONTENTS

Page No.

1. INTRODUCTION

Bryophytes are the pioneer land plants, which appeared first in plant succession and have been around 400 million years or more, provided the seed bed for the expansion of enormous plant diversity. Like the rest of land plants, bryophytes are embryophytes and they have traditionally been viewed as a distinct lineage from other land plants. Bryophytes are an assemblage of three distinct lineages such as Marchantiophyta (liverworts), Anthocerotophyta (hornworts) and Bryophyta (mosses). More than 20,000 bryophyte species have been identified in the world. Among these, Bryophyta are the most specious group, comprising over 13,000 species (Goffinet *et al*., 2009). Liverworts (Marchantiophyta) and hornworts (Anthocerotophyta) comprising 7486 species under 398 genera (Soderstrome *et al*., 2016).

Bryophytes mostly prefer an area of high humidity and frequent rain fall and have dominating role in ecosystem. Poikilohydry and desiccation tolerance of bryophytes helps to tolerate long term water stress than vascular plants (Turetsky, 2003). They are seen in a variety of microhabitats like soil (terricolous), bark (corticolous), rocks (saxicolous), logs, leaves (epiphyllous), fern' rhizomes, concrete walls, etc. in diverse life forms.

Bryophytes enjoy a cosmopolitan distribution and play an important role in ecosystem dynamics. They are the primary form of carbon storage in many ecosystems and are important in nutrient sequestration, water retention, regulation of soil temperature and p^H (Vitt, 2000). Mosses have been used as experimental models as bio monitors and bio indicators of heavy metal pollution (Markert *et al.*, 1996). They have proved invaluable in investigations on the effect of atmospheric deposition of nitrogen and sulfur-containing compounds on uplands (Bates, 2000). These groups are also important in preventing soil erosion and nutrient leaching (Saxena & Harinder, 2004). In addition to this, they are economically important being the source of medicine, preservatives, energy sources, etc (Thieret, 1956).

They can also be used as potential system in pollution monitoring and other experimental purposes (Stankovic *et al*., 2018).

The ecological role of bryophytes may be the most significant one, as they are integral part of most of the major habitats of the globe, except marine. They inhabit a variety of microhabitats and eventhough small but when gorws as a community influence the microclimate at greater level. Several pleurocarpic mosses acts as space fillers, helps in soil and rock binding, especially the members of Hypnaceae, Thuidiaceae, etc. They form dense mats on substrates and hold falling water, there by reducing the run off water and prevent soil erosion. Webbed and netted protonemata of acrocarpic mosses like *Pogonatum* spp*., Dicranum* spp., etc. over the exposed substrata help to prevent erosion of soil (Saxena & Harinder, 2004). The bryophytes acts as substratum for higher plants to grow and in majority of nurseries they use bryophytes as substratum for the growth of seedlings of rare plants like, *Nepenthes* spp*., Drocera* spp*., Platycerium* spp*,* etc. (Nair *et al*., 2005a). Many invertebrates and small insects depends on bryophytes for their shelter and also for food (William & Alan, 2009).

Bryophytes act as bioindicators of air pollution and water pollution by accumulating metals. Some species have high ability to accumulate or tolerate high level of Zinc, Cadmium and Copper (Bahuguna *et al.*, 2013). They act as ecological indicators of water quality (Simona *et al.*, 2012). Bryophytes are traditionally used for curing many diseases. They have biochemical properties and potential medicinal value (Mishra *et al*, 2014.). Ancient people used bryophytes for their medicine following the believes of 'Doctorine of signature', because the resemblance of shape and structure of these plant parts to human organs. Many useful compounds are isolated from bryophytes such as oligosaccharides, polysaccharides, amino acids, aliphatic compounds, phenylquinones, fatty acids, phenolic and aromatic substance (Glime, 2017). Anticancerous and antimicrobial activities of extracts of Bryophytes were also reported (Kaushik *et al.*, 2000).

Horticulturist use many species of bryophytes to develop green carpet resembling the carpet by grasses. *Leucobryum neilgherrense* Muell. Hal. and

Polytrichum commune Hedw. are important elements in bonsai pots as they keep the soil moisture for several days (Saxena & Harinder, 2004). Nowadays products made of Bryophytes like decorative pots, floral arrangements, garden furnishing, etc. have big market in Kerala also (pers.observation).

Significance of the present study

Though India is blessed with rich bryodiversity, documentation of these floristic resources is incomplete. More bryo- exploration programmes in unexplored areas are essential, without which there are chances for disappearance of species before being documented. Urbanization and anthropogenic activities are the major threats which can lead to habitat destruction and disappearance of species.

Bryophytes are the least documented group, especially in the tropics. Their small size, difficulty in identification, inconspicuous position in the ecosystem may be the causes of ignorance about bryophytes (Glime, 2017). The Indian scenario is not different which still remain bryologically under explored. Studies done earlier are mainly dealt with the northern Indian region. The south Indian region largely remains unexplored. Many naturalists and explorers have collected bryophytes from different localities of Kerala in earlier times. These collections remained unstudied for a long period. Recently Manju *et al*. (2001-2019) made efforts to explore the bryological diversity of the area in detail, in an elaborated manner. Their study reported several new records and new species from Kerala. These studies also estimated that the State is holding rich bryophyte diversity consisting more than 600 species (Manju & Rajesh, 2017). They also pointed out the urgent need to undertake detailed bryological surveys for the systematic documentation of the bryowealth of the area (Nair & Madhusoodanan, 2002; Nair *et al.*, 2002, 2005a).

Since the study area (Malabar Wildlife Sanctuary) being a part of the Western Ghats, one of the biodiversity hot spot in the country, is rich in bryodiversity. Manju *et al*. (2008a) in a preliminary study recorded 52 species of bryophytes including 28 liverworts and 24 mosses from the Sanctuary. It is also an indication of the rich bryo-wealth of the area, which urged to explore in detail as part of the present study.

Objectives

- A comprehensive field study and collection of the bryophyte (mosses, liverworts & hornworts) flora of the study area in different seasons.
- Studies on the ecological aspects.
- Preparation of taxonomic account of the bryophytes giving the up to date nomenclature.
- Description giving anatomical and morphological details of all the species.
- Ex-situ conservation of collected specimens at Malabar Botanical Garden.

2. STUDY AREA: THE MALABAR WILDLIFE SANCTUARY

The Malabar Wildlife Sanctuary is located in Kozhikode district in Kerala state. The description is mainly based on the records of Kerala Forest Department (http://www.forest.kerala.gov.in/). The Sanctuary covers an area of 74.2 sq.km, lies between $35^0$11'-$35^0$40' latitude and $75^0$55'-$76^0$00' longitude and is bordered by Wayanad district in the east, Kannur district in the north and lands of Kozhikode in the south west (Plate 2.1). Topographically, the area comprises rugged, steep hills that rise from 40 to 1506 m. Proximity of the Banasura Mala (2,059 m) and the varying altitudinal ranges have contributed to the rich biodiversity of the forests. Government of Kerala has declared the area as a Wildlife Sanctuary having its head quarters at Peruvannamuzhi, in the year 2009 for ensuring long term conservation of its entire biodiversity. It is the only protected area in Kozhikode district and has tremendous scope in the field of conservation, education, research and creating environmental awareness. Northern part of this area is Chembanoda village, southern part is the occupied lands of Chakittapara village and Plantation Corporation of Kerala. Towards the eastern side it occupies the forests of south Wayanad forest division, Hill Dale reserve forest of Wayanad and the western part is occupied by the Pannikottoor tribal colony.

The sharp topographical gradient of the hills of this area ranging from 40-1506 m is the primary reason for the rich diversity of plants and animals. Steep hills, deep valleys, vast plains, marshy lands, with hillocks and perennial water resources combined with altitudinal variation make it an ideal habitat for its dense vegetation. Pockets of shaded rocky ravines and streams at Sithapara offering an excellent condition for mosses and liverworts.

South west monsoon occurs in between June and September. Heaviest rain fall occurs in July and August (3800 mm-6468 mm), sometimes it became violent and causes considerable damages to the forest. North east monsoon occurs in between October and November. April and May are the hottest months.

Temperature of the study area varies from 16ºc-38ºc. Humidity ranges from 50% to 100%.

Vegetation

The study area represents variety of vegetation such as West-coast Tropical evergreen forest, Southern Hill-top semi evergreen forest, Southern moist deciduous forest and grasslands (www.forest.kerala.gov.in) **(Plate: 2.1- 2.4).**

West-coast Tropical evergreen forest: This type of forest seen in between 250-1200 m altitude with rain fall of 1500-5000 mm. *Actinodaphne hookerii*, *Cinnamomum zeylanicum*, *Euphorbia longana,* etc. are the common trees found in this forest. Beside this ferns, aroids, palms, orchids, bamboo, etc. are also growing here.

West- coast semi evergreen forest: The area is characterized by high rain fall (over 4500 mm), high humidity, wind, etc. Trees reach the height above 10 m, e.g. *Dysoxylum malabaricum*, *Elaeocarpus serratus*, *Holigarna beddomei, Ochlandra travancorica,* etc.

Southern moist deciduous forest: Here rainfall is commonly above 2000 mm. Common tree species growing here are *Tectona grandis, Xylia xylocarpa, Dillenia pentagyna,* etc.

Grasslands: Maximum altitude of grassland areas comes near 1500 m. Commonly small herbs, shrubs, grasses (height up to 1.5 m) are growing here. e.g. *Andropogon lividus, Agrostis peninsularis, Chrysopogon zeylanicus, C. nodulibarbis, Eriocaulon sp., Cyperus sp., Striga asiatica, Centella sp*., etc.

Flora and Fauna

The area is notable for the unique assemblage of flora and fauna, with high levels of endemism. More than 600 species of Angiosperms, 79 Pteridophytes (Niranjana *et al*., 2013) and 52 Bryophytes (Manju *et al.,* 2008a) are known from the Sanctuary. The Sanctuary is also notable for the recently known endemic plants such as *Humboldtia brunonis* var. *rakthapushpa* Udayan *et al.,* (2007), *Thottea*

sasidharaniana Robi (Robi *et al*., 2014), *Diospyros udayanii* Udayan *et al*. (2015), *Alseodaphne semecarpifolia* var. *malabarica* Robi & Udayan (2017), *Artabotrys sahyadricus* Robi *et al*. (Prabhukumar *et al*., 2017), *Litsea indoverticillata* Robi *et al.* (2017), *Sonerila malabarica* Sujanapal *et al.* (2017), and *Impatiens saulierea* (Mani *et al.*, 2018) and animals such as *Philautus ochlandrae* Gururaja *et al*. (2007), *Glyptotermes chiraharitae* Amina & Rajmohana (2016) and *Nyctibatrachus mewasinghi* Krutha *et al*. (2017).

A total of 41 species of mammals are found in the Sanctuary (e.g. Leopard, Lion- tailed Macaque, etc.). More than 180 species of birds are found in the Sanctuary of which 12 are endemic to Western Ghats. Out of 38 species of amphibians, 26 are Western Ghats endemics. Kakkayam stream contains 52 species of fish, of which 21 species are Western Ghats endemics. Out of 148 butterflies found here, eight species are Western Ghats endemics. A total of 51 dragon flies are found here of which 11 are endemic to the Western Ghats (www. forest.kerala.gov.in).

3. REVIEW OF LITERATURE

The pioneer contribution in bryophyte taxonomy was by German botanist Dillenius (1741) in his *Historia Muscorum*. Linnaeus (1753) followed Dillenius (1741) and included some Indian mosses along with angiosperms in his *Species Plantarum*. Hamilton, a British medical officer explored mosses from Nepal, Assam and Burma in 1802. Later the moss flora of Nepal was published by Hooker as *Musci Nepalensis* (1808). Wallich (1828-1832) published a list of 114 mosses collected from Nepal, Burma and India in *Wallich Catalogue.*

Brawn (1866) introduced the term Bryophyta, from the Greek word bryon which means mosses and phyton means plant. Eichler (1883) classified bryophytes into two classes of which Hepaticae includes liverworts and Musci includes mosses. Engler divided each class into three orders, ie. Hepaticae divided into Marchantiales, Jungermanniales and Anthocerotales and Musci divided into Sphagnales, Andreales and Bryales. Howe (1899) gave class status to the order Anthocerotales and renamed it as Anthocerites. Later Smith (1955) and Schuster (1958) renamed Anthocerotes as Anthocerotae.

Stephani (1906-1926) published *Species Hepaticarum*, a monograph on liverworts in the world and included many species from India, Sri Lanka, Myanmar and Nepal. Dixon (1932) reported many moss species from Sumatra along with 20 new species. Dixon (1937) described the mosses collected in Mauritius by Vaughan and reported 35 species along with a new species, *Jaegerina excurrens* Dix. Bartram (1951) added a new genus, *Glossadelphus andersonii* Bartr. from United States.

Bartram (1954) reported 41 moss species from Northeastern Canada. Noguchi (1967) described 13 species of *Macromitrium* from Japan. Kitagawa (1966) revised the family Lophoziaceae of Japan included six species of *Lophozia*. Kitagawa (1969) described many species of Hepaticae from Thailand. Inoue and Schuster (1971) provided a monograph of the New Zealand and Tasmanian Plagiochilaceae. Koponen (1971) provided a monograph of *Plagiomnium* Sect. Rosulata. Koponen (1974) gave an easy identification guide to the Mniaceae in

Canada. Jones (1975) described many species of African Hepaticae. Delgadillo (1975) made revision on three moss genera *viz*., *Aloina*, *Aloinella* and *Crossidium* on a world-wide basis. Inoue (1976) reported 13 species of *Plagiochila* (Dum.) Dum. along with a new species, *P. hoei* Inoue. from Hawaiian Islands

Lewinsky (1977) provided taxonomic revision on the family Orthotrichaceae in Greenland and reported 11 species under three genera such as *Orthotrichum*, *Ulota* and *Amphidium*, of which four species were reported new to Greenland. Koponen (1982) has studied Mniaceae in Australia and the Pacific and reported 72 species under nine genera. Lewinsky (1985) revised the genus *Orthotrichum* Hedw. in Australia and reported nine species and three varieties. Ochyra (1985) reported two species of Orthotrichaceae *viz.*, *Orthotrichum rupestre* Schleisch ex Schwaegr. and *Muelleriella crassifolia* (Hook.f.&Wils) Dus. from Antarctic zone.

Enroth (1989) provided bryophyte flora of Papua New Guinea and reported 19 species under Neckeraceae family, represented by the genera *Neckeropsis* Reichardt with three species, *Himantocladium* (Mitt.) Fleidch with five species, *Homaliodendron* Fleisch with three species, *Pinnatella* Fleisch with five species and *Thamnobryum* Nieuwl with two species and described a new species *Himantocladium submontanum* Enroth. Frahm (1983) studied the taxonomic status of *Neckera besseri* (Lob.) Jur. and *Homalia webbiana* Mont. Fife and Shaw (1990) described a new species *Epipterygium opararense* Fife & Shaw from New Zealand.

Lara *et al.* (1994) reported a new moss species, *Orthotrichum macrocephalum* F. Lara, Garilleti & Mazimpaka from the Mediterranean zone of the Iberian Peninsula. He and Snider (2000) provided taxonomic revision on the genus *Symphyodon* comprised of 15 species. Koponen *et al.* (2000) reported 105 species under 55 genera and 28 families from China, of which *Diplophyllum serrulatum* (Muell. Frib.) Steph, *Lopholejeunea brunnea* Horik., and *Metzgeria albinea* Spruce were new to China. O'Shea and Buck (2001) reported a monotypic genus, *Bryocrumia* Anderson new to Africa.

Enroth & Tan (2007) reported a new moss species, *Stereophyllum linisii* Enroth & B.C. Tan from Philippines. Ramsay (2012) described the genus

Acroporium along with 4 species, *A. lamprophyllum* Mitt. var. *percaudatum* (E.B. Bartram) B.C. Tan, *A. microcladon* (Dozy & Molk.) B.C. Tan var. *rhizogemmae* B.C. Tan *et al*, *A. stramineum* (Reinw. &Hornsch.) M. Fleisch and *A. strepsiphyllum* (Mont.) B.C. Tan from Australia. Makinde *et al.* (2015) made phytochemical screening and studied antimicrobial potential of *Philonotis hastata* (Duby) Wijk & Margad. That study revealed presence of flavanoides, cardiac glycosides, alkaloids and saponins in *P.hastata* and proved their antimicrobial activity against *Staphylococcus aureus*, *Aspergillus flavus* and *Candida albicans*. Tessler (2016) updated checklist of Shawangunk Mountains, New York and reported 125 species ie, 93 mosses and 32 liverworts newly reported from there. The sporophyte of *Bryocrumia vivicolor* was reported by Ma *et al*. (2016). Soderstrom *et al*. (2016) compiled the world checklist of liverworts (Marchantiophyta) and hornworts (Anthocerotophyta) which includes 7486 valid species in 398 genera representing 92 families from the two phyla.

Bryology in India

At earlier times liverworts got more attention than mosses by Indian researchers. Griffith (1849) accompanied Dr. Wallich and made valuable collections from Assam additions to this from Bhutan and Burma. About 50 species were described in his book *Notulae and Plantae Asiaticae*. Mitten made comprehensive studies on Indian liverworts and published *Hepaticae Indiae Orientalis* which listed out 290 species of liverworts including many new species. Mitten (1859) published *Musci Indiae orientalis* based on Indian moss species and reported 800 species under 85 genera and 19 families incuded many novelties. Mitten (1860) made detailed studies on Indian liverworts and published in *Hepaticae Indiae Orientalis* and provided a list of liverworts known till that time and included many novelties.

Kashyap (1912), 'father of Indian bryology' published his first paper 'Morphological and biological notes on new and little known West Himalayan liverworts' and enumerated 28 species of liverworts from West Himalaya, of which three genera and several species were new to science. Stephani (1924) in his '*Species Hepaticarum'* deals with liverwort flora of the whole world. Last two

volume of it revealed about 525 species occurring in India of which more than half are endemic. Dixon (1930) reported 73 species from North Western Himalayas in which 18 species were new to science.

Pande (1936) gave a historical review on studies in Indian liverworts and described liverworts collected by Dr. Wallich and Wight. Chopra (1938) provided notes on South Indian liverworts and listed out 89 liverworts and five hornworts. Bhardwaj (1948) provided details of Indian Hepaticae and described a new species *Aspiromitus mamillispora* Bhardwaj which was collected by Pande (1939) from Ceylon. Pande *et al.* (1957) have studied epiphyllous liverworts of India and Ceylon and provided illustrative account of four epiphyllous liverworts *viz*., *Toeniolejeunea peraffinis* (Schffn.) Zwickel, *T. pseudofloccosa*, *Leptolejeunea schiffneri* St. and *Drepanolejeunea foliicola* Horikawa. Noguchi (1958) reported 24 moss species from south India. Pande (1958) discussed problems concerning Indian Hepaticology and he suggested teaching of liverworts in Indian universities.

Chopra (1960) provided preliminary list of 158 moss species from Himalayas. Amakawa (1964) revised Himalayan Scapania and provided illustrative account of 15 species of Scapania including eight Himalayan endemic species, two new species *viz*., *S. harae, S. pseudoferruginea* and three new additions to Himalayan flora *viz*., *S. nimbosa, S. ligulata* and *S. okamurana*. Campbell (1971) provided notes on the origin and classification of bryophytes with particular reference to liverworts.

Srivastava and Udar (1975) provided monographic studies on Indian Metzgeriaceae. Which includes one species and one variety of *Apometzgeria viz*., *Apometzgeria pubescence* (Schrank) Kuwah and *A. pubescence* var. *kinabaluensis* Kuwah and 11 species of *Metzgeria*. Srivastava and Udar (1976) described three species of liverworts *Aneura pinguis* (L.) Dumort*., Riccardia tenuicostata* Schiffn., *R. levieri* Schiffn. and *R. sikkimensis* (Steph.) Pande *et* Srivast. from Western Himalayas. Udar and Singh (1977) reported *Haplomitrium hookeri* (Sm.) Nees for the first time from Western Himalayas. Bapna (1980) reported *Fissidens* spp. from Rajasthan, *viz*., *F. involutus ssp. curvato-involutus (Dix.) Gangulee, F. diversifolins*

Mitt., F. geminijlorus Doz. et Molk. var. *nagasakins* (Besch.) Iwats. and *F. sylvaticus* Griff.. Of this *F. sylvaticus* Griff was newly reported from Rajasthan and *F, geminijlorus* var. *nagasakins* was new addition for India.

Ochyra (1989) reported a new species and genus ie, *Miehea himalaya* along with detailed description and illustration from Himalayan region. Ellis (1989) revised the Genus Calymperes in Southern India.

Negi and Gadgil (1997) have studied the species diversity and community ecology of mosses of Garhwal Himalaya and reported 177 species distributed in varying altitudes and habitats. Their studies proved that microhabitat and altitude levels are the major ecological factor governing species diversity and composition. Nath *et al.* (2000) have studied the role of bryophytes in soil management and their role in rock building, soil binding, land conservation, mineral indication, slope formation and erosion prevention. Kaushik *et al.* (2000) discussed antibacterial potential of bryophytes and showed *Riccia* inhibited the growth of *E. coli, Sarcina lutea and Bacillus megaterium*. Kumar *et al.* (2000) reported the ethno therapeutics use of thalloid liverwort *Plagiochasma appendiculatum* Lehm et. Lind. by Gaddi tribes of Kangra valley to cure burns, boils and blisters of skin.

Bapna and Kachroo (2000) described 800 species of liverworts from India in his book 'Hepaticology in India, of which 73 species were from Himachal Pradesh. Srivastava and Rawat (2001) reported an endemic and threatened liverwort *Isotachis indica* Mitt. from Khasi hills. Asthana and Srivastava (2003) provided a book, 'Indian Cololejeunea', comprised 30 species of Cololejeunea recognized in India along with many new species and new records. Daniels & Daniel (2003) described three moss species, *Fissidens leptopelma* Dixon, *Leptolejeunea sikkimensis* Udar and U.S Awasthi and *Radula madagascariensis* Gottsche. Nair *et al*. (2004) reported *Bryum tuberosum* Mohammed *et* Damanhuri from Karnataka which was a new addition. Srivastava and Srivastava (2007) added a species *Scapania stephanii* Muell to Indian bryoflora from Western Himalaya.

Das and Singh (2009) described three liverworts *Lophocolea muricata* (Lehm.) Nees, *Cololejeunea jelinekii* Steph. and *C. nilgiriensis* Asthana &

Srivastava. for the first time from Mehao Wildlife Sanctuary. Verma (2009) discussed the status of the genus *Cololejeunea* (Spruce) Schiffn. and described *Cololejeunea nilgiriensis* Asthana & Srivast., *C. latilobula* (Herzog) Tixier, *C. minutissima* (Sm.) Schiffn., *C. appressa* (A. Evans) Benedix and *C. pseudofloccosa* (Horik.) Benedix and added two more species, *C. udarii* Asthana & Srivast. and *C. cardiocarpa* (Mont.) A. Evans. Alam and Srivastava (2009) investigated the diversity of liverworts in Palni Hills and reported the occurrence of 75 species along with ecology and distribution.

Nath and Gupta (2009) have studied the family Bryaceae of Pachmarhi Biosphere Reserve (Madhya Pradesh) and reported nine species for the first time from there ie, *Anomobryum auratum* (Mitt.) A.Jaeger, *Brachymenium acuminatum* Harv., *Brachymenium ptychothecium* (Besch) Ochi, *Bryum argenteum* Hedw., *Bryum caespiticum* L. ex. Hedw., *Bryum capillare* L. ex Hedw., *Bryum coronatum* Schwaegr., *Bryum paradoxum* var. *reflexifolium* (Ochi) Ochi and *Pohlia flexuosa* Hook. Daniels (2010) provided a checklist of bryophytes of Tamil Nadu and 712 species were listedout, of which 211 species of liverworts belonging to 56 genera and 32 families and 493 species of mosses belonging to 189 genera and 44 families.

Singh *et al.* (2010) investigated Hepaticae of Andaman Island and 12 species were reported, of which 11 species belonging to the family Lejeuneaceae and one species under the family Marchantiaceae, three species *viz.*, *Cololejeunea gottschei* (Steph.) Mizut., *Lejeunea anisophylla* Mont. and *Marchantia linearis* Lehm. & Lindenb. were added to Anadaman & Nicobar Island. Kapoor *et al.* (2010) have studied the bryophytes flora of Achanakmar Wildlife Sanctuary in Chhattisgarh and enumerated 34 species belonging to 24 genera and 15 families, of which nine liverwort species under eight genera and five families, two species of hornwort under one genus and one family and 23 species of mosses under 15 genera and nine families. Singh *et al.* (2010) described SEM images of 12 species of Riccia L. from West Bengal.

Daniels *et al.* (2011a) added two species of *Daltonia* new to India *viz*., *D. angustifolia* Dozy& Molk and *D. conorta* Muell. Hal. From Agasthyamala. Daniels

et al. (2011b) reported seven moss species new to Western Ghats from Agasthyamala Biosphere. Which include *Chaetomitrium papillifolium* Bosch &Sande Lac., *Entodon ovicarpus* Dixon, *Entodon scariosus* Renauld& Cardot, *Glossadelphus bilobatus* (Dixon) Broth., *Pseudobarbella ancistrodes* (Renauld& Cardot) M.G.Manuel, *Sematophyllum micans* (Mitt.) Braithw. and *Taxithelium kerianum* (Broth.) Broth. Dandotiya *et al.* (2011) provided a checklist of bryophytes of India and reported 2489 species from India. It included 1786 species of mosses under 355 genera, 675 liverworts under 121 genera and 25 species of hornworts under six genera, of which 340 species were endemic to India.

Sudipa and Singh (2011) described a new species, *Calypogeia udarii* Sudipa das & D.K. Singh from Eastern Himalaya. Srivastava and Rawat (2011) described an endangered liverwort, *Southbya gollanii* Steph. from Himalayas, that was a proposal for Red listing. It was originally described from Mussoorie and since the status of that species remained undefined in the Indian bryoflora. They believed that work could inspire students of bryology towards the preparation of the Red Data Book of Indian Bryophytes.

Singh and Singh (2011) added a species, *Ptilidium pulcherrium* (G. Weber) Vainio to Indian bryoflora. Dey and Singh (2011) described a new species *Lopholejeunea udarii* M. Dey & D.K Singh from Eastern Himalayas. Daniels and Kariyappa (2012a) reported two liverworts new to Peninsular India *viz*., *Mastigophora diclados* (Brid. Ex F. Weber) Nees ex Schiffn and *Plagiochilion oppositum* (Reinw.) S. Hatt from Agasthyamalai Biosphere Reserve. Daniels and Kariyappa (2012b) described a little known moss species, *Lepidopilidium furcatum* (Thwaites & Mitt.) Broth. from Agasthyamala. Daniels *et al.* (2012) have studied Erpodiaceae of India and described taxa *viz*., *Aulacopium glaucum* Wilson, *Aulacopium beccarii* (Muell. Hal. Ex. Venturi) Mitt., *Erpodium glaziovii* Hampe, *Erpodium mangiferae* Muell. Hal and *Solmsiella biseriata* (Austin).

Alam *et al.* (2012) proved antibacterial activity of alcoholic extracts of *Entodon nepalensis* against pathogenic bacteria *Escherichia coli, Salmonella typhimurium* and *Bacillus subtilis*. Mujumdar and Singh (2013) added *Plagiochilion*

braunianum (Nees) S. Hatt. From Arunachal Pradesh. Schwarz (2013) updated that checklist of bryophytes of Karnataka and provided history of bryological explorations of Karnataka. The checklist includes 113 liverworts under 42 genera and 20 families, nine hornworts under four genera and two families and 216 mosses under 97 genera and 35 families. Verma *et al.* (2013) updated catalogue of Hepaticae and Anthocerotae of Nilgiri Hills. Hepaticae included 164 species under 55 genera and 29 families and Anthocerotae included five species under three genera and two families. Sathish *et al.* (2013) studied status of bryophytes in India and listed out 2489 species, of which 1786 species under 355 genera, 675 species of liverworts under 121 genera and 25 species of hornworts under six genera.

Singh and Singh (2014) reported two poorly known liverworts, *Horikawaella subacuta* (Herzog) Hatt & Amakawa from Himalaya and *Pleurozia purpurea* Lindb. from Arunachal Pradesh. Singh and Singh (2014) reported a critically endangered species from Arunachal Pradesh, *Bazzania bhutanica* N. Kitag. & Grolle was previously known only from Bhutan. This species were included in IUCN Red list of threatened species under critically endangered category. Aruna & Krishnappa (2014) studied the distribution of Bryophytes in Malanad Regions of Chick Mangalur district, Karnataka and reported 62 species from that region. Alam *et al.* (2015) enumerated the mosses of Central India comprising 210 species under 94 genera and 30 families.

Manjula & Manju (2016) revealed the distribution pattern of the genus *Fissidens* in the Eastern Ghats of Andhra Pradesh with eight species *viz., F. flaccidus* Mitt., *F. zollingeri* Mont., *F. diversifolius* Mitt., *F. crenulatus* Mitt., *F. crispulus* Brid., *F. taxifolius* Hedw., *F. ceylonensis* Dozy & Molk. and *F. pallidinervis* Mitt. Of which, *F. taxifolius* Hedw. and *F. pallidinervis* Mitt. were new for Eastern Ghats; *F. crispulus* Brid. and *F. ceylonensis* Dozy & Molk. were new for the state of Andhra Pradesh. Deepa *et al.* (2016) reported a rare species of the genus *Clevea viz*., *C. pusilla* (Steph.) Rubasinghe & D.G. Long of the family Cleveaceae from the Western Ghats of Valparai area of Tamil Nadu. Magdum (2017) provided a checklist of mosses of Maharashtra compiling 128 moss species.

Daniels *et al*. (2018) reported 2 species of *Symphysodontella* M. Fleisch. *viz*., *S. cylindracea* (Mont.) M. Fleisch. and *S. involuta* (Thwaites & Mitt.) M. Fleisch. from the Kolli Hills of Eastern Ghats. *S. cylindracea* is a new record to the moss flora of India and *S. involuta* is new to the moss flora of Eastern Ghats.

Manju *et al*. (2019) reported *Oreoweisia brevidens* Herzog an Indian endemic species of the family Dicranaceae as new record to Western Ghats. The species is reported from nandhi hills in Karnataka.

Bryology in Kerala

The earlier works on bryophytes of Kerala were scanty and limited to random collections and remained unstudied for a long period. Some of these were subjected to studies by European bryologists, which resulted in occasional publications, but most of them with the comments 'precise locality not known'. The first ever work on bryophytes on Kerala found in Rheedes' (1693) monumental work 'Hortus Malabaricus'. He described and beautifully illustrated one moss species as 'poovan – peda' (vol.12, p.71). Nicolson *et al.* (1988) identified it as *Bryum bicolor* Dickson. Now it is a synonym of *Bryum dichotomum* Hedw. Udar and Jain (1984) investigated liverworts of Kerala for the first time in Indian bryology and reported 14 species under eight genera.

The first Ph. D thesis on taxonomy of bryophytes from Kerala is 'Bryophyte flora of Idukki district' by Rajeevan (1990). He described 76 moss species and 19 liverwort species. He recommended five new species *viz*., *Diaphanodon ganguleei*, *Fissidens choprai*, *Macromitrium vohrai*, *Pohlia foreaui* and *Pterobryopsis keralensis*, 3 new varieties *Entodon macroporus* var. *indica*, *Philonotis hastata* (Duby) Wijk. & Marg. var. *idukkiensis* and *Calycularia crispula* Mitt. var. *udarii* and one new record *viz*., *Fissidens hollianus* Dozy& Molk. But all these were still remained as unpublished.

Nair and Madhusoodanan (2002) had examined the subject in detail and provided the status of bryological studies from the time of Hortus Malabaricus to year 2000. Intensive bryological explorations were conducted over these years, and

many species were discovered from the area. Manju *et al*. (2001-2019) reported many species along with a complete checklist of the bryophytes of Kerala in 2008.

Srivastava and Sharma (2000) made priliminary studies on the liverwort and hornwort flora of Silent Valley and reported 29 species, in which four species coming under the order Metzgeriales, 17 species under Jungermanniales, five species under Marchantiales and Anthocerotales with three species. Easa (2003) compiled the information on bryophytes of Kerala and reported 232 species including 63 liverworts and 169 mosses.

Madhusoodanan and Nair (2003) reported two new bryophytes records for South India *Ricciocarpus natans* (L.) Corda from Tholpetty range of Wayanad and *Notothylas levieri* Schiffn. ex. Steph. from Dhoni hills of Palakkad district. Nair & Madhusoodanan (2004) provided a preliminary account on the diversity of bryophytes of Kerala with brief history, its importance, implications of conservation were discussed and reported 358 species including 219 mosses, 133 liverworts and six species of hornworts.

Nair *et al*., (2005a) published a book on 'Bryophytes of Wayanad in Western Ghats' and provided illustrative accounts of 171 species and two varieties of bryophytes belonging to 105 genera and 47 families including several new distributional records and two new species *viz*., *Trichostomum wayanadensis* and *Amphidium gangulii.* Nair *et al.* (2005b) described and illustrated seven species of *Plagiochila* from Eravikulam National Park of which *P. arbuscula* (Bridv & Lindenb.) was new to India, *P.chinensis* Steph., *P. devexa* Steph. and *P. fruticosa* Mitt were new for Peninsular India.

Nair *et al.* (2006a) reported *Lejeunea exilis* (Reinw., Blume & Nees) Grolle for the first time from Wayanad and Idukki. Nair *et al.* (2006b) provided a preliminary account on bryophytes of Chinnar Wildlife Sanctuary, 60 taxa were listedout including 40 mosses, 19 liverworts, and one hornwort. Among these *Fissidens asperisetus* Sande. var. *andamanensis* Gangulee from Koyman Shola was new to the main land of India; seven species *viz*., *Asterella nepalensis* Taylor, *Cephalozia pandei* Udar & Kumar, *Fissidens virens* Thwait & Mitt, *Garowaglia*

plicata (Brid.) Bosch. & Sande., *Pterobryopsis crassicaulis* (C. Muell.) M. Fleisch. and *Fabronia minuta* Mitt. were new records to Peninsular India and 18 species *Aneura pelloides* (Hook.) Inoue., *Riccardia tenuicostata* Schiffn., *Metzgeria furcata* (L.) Dumort., *Heteroscyphus argutus* (Nees) Schiffn., *Plagiochila elegans* Mitt., *Porella pionnata* (Dick.) Lindb., *Pogonatum aloides* (Hedw.) P. Beauv., *Trematodon longicollis* Michx., *Campylopodium khasianum* (Griff.) Par., *Campylopodium griffithi* (Mitt.) Broth., *Anomobryum auratum* (Mitt.) A. Jaeger, *Pyrrobryum spiniforme* (Hedw.) Mitt., *Philonotis falcata* (Hook.) Mitt., *Lopidium struthiopteris* (Bridel) M. Fleisch., *Cladopodium nervosum* (Harv.) M. Fleisch., *Eurhynchium riparioides* (Hedw.) Jennings, *Sematophyllum subhumile* (C. Muell) M. Fleish. and *Taxiphyllum taxirameum (*Mitt.) M. Fleisch. were new to Kerala. Nair *et al.* (2007a) described and illustrated 11 species of the genus *Philonotis*, of which *P. seriata* Mitt. from Vellarimala of Kozhikode dist., *P. angusta* Mitt. and *P. turneriana* (Schwaegr.) Mitt. from Chinnar Wildlife Sanctuary were new records for Peninsular India.

Nair *et al.* (2007b) collected the genus Duthiella from Tholpetty range of Wayanad was a newly reported for Peninsular India. Nair *et al.* (2007c) provided an illustrated account on three bryophytes, *Calyptothecium wightii* (Mitt) M. Fleisch from Thirunelli and Chembra hills of Wayanad, *Fabronia schensiana* C. Muell from Chembra and Munnar, *Pelekium gratum* (P. Beauv.) Touw. from Wayanad Wildlife Sanctuary.

Manju *et al.* (2008b) presented a checklist of Bryophytes that have been recorded from Kerala, including some taxa that are reported for the first time from the state. A total of 465 Bryophyte taxa are accepted including 148 taxa of liverworts, 10 taxa of hornworts and 307 taxa of Mosses. Manju *et al.* (2008c) described two new liverworts records for Kerala, *Cololejeunea latilobula* (Herzog) Tixier and *Schiffnerilolejeunea pulopenagensis* (Gott.) Gradst. Manju *et al.* (2008d) made ecological observations on the bryophytes of Eravikulam National Park and listedout a total 126 bryophytes including liverwort, hornwort and mosses. Of which 39% are epiphytes, 27% are terrestrial, 12% are saxicolous, about 10% both as

terrestrial and saxicolous, 6% are epiphytic and saxicolous, 1% is epiphytic and terrestrial and 6% are found in all forms. A narrow endemic species of Nilgiri mountains, *Thysananthus rotundistipulus* Steph., also reported from that study.

Manju *et al.* (2009a) described *Jungermannia obliquifolia* (Schiffn.) Vana, from Aralam Wildlife Sanctuary. Manju *et al.* (2009b) reported 116 species from Aralam Wildlife Sanctuary, including 89 mosses and 27 liverworts. Of which two species *viz*., *Plagiochila singularis* Schiffn. and *Vesicularia dubyana* (Muell. Hal.) Broth. were new addition to India and 21 species were new to Peninsular India. Manju *et al.* (2009c) reported *Lindbergia* Kindb., a new genus from Pakshipadalam as new to Peninsular India. Manju *et al.* (2009d) reported 90 species including 58 mosses and 32 liverworts from Agasthyamalai Biosphere Reserve, of which 16 species were new addition to Peninsular India. Manju & Rajesh (2009a) described *Notoscyphus pandei* Udar & Kumar from Kakkayam and Chandanathode of Wayanad as an endemic liverwort reported for the first time from Kerala. Manju and Rajesh (2009b) have studied Bryophyte diversity in the high altitude grasslands of Eravikulam National Park, Mannavanshola National Park of Idukki distict, Chembra hills of Wayanad, Nelliampathy hills of Palakkad and Agasthyamala of Trivandrum of Western ghats of Kerala compared with low altitude grasslands of Kerala *viz*., Kannur, Kasargode, Kozhikode and Malappuram districts. A total of 57 Bryophytes were observed from the grasslands and noted species diversity is comparatively high in the high altitude grasslands compared to low altitude grasslands, out of 57 species 23 species are exclusively in the high altitude grasslands only.

Ramesh and Manju (2009) provided ethnobryological notes on liverwort *Targionia hypophylla* L. to cure scabies, itches and other skin diseases by Irula tribes and *Frullania ericoides* (Nees) Mont. for head lice and nourishment of hair by Mudugar tribes of Attappadi in Western Ghats. They also discussed medicinal aspects of moss, *Bryum bicolor* Dicks. in Rheedes Hortus Malabaricus. (Manju & Rajesh, 2010) reported the genus *Leptohymenium* Schwegr. New to the moss flora of Peninsular India. Shanthanu (2010) in the doctoral thesis 'Mosses of Idukki in Western Ghats' reported 135 moss species under 75 genera and 25 families.

Manju *et al.* (2011a) reported a new species, *Chiloscyphus chinnarensis* Manju, K.P. Rajesh & Madhus. from Idukki, Chinnar Wildlife Sanctuary. Manju *et al.* (2011b) described a rare liverwort *Exormotheca tuberifera* Kashyap from Neriamangalam hills of Eranakulam dist. as a new record for Kerala. Manju and Rajesh (2011) provided a checklist of the Bryophyte flora of Parambikulam Tiger Reserve included 58 taxa consist of 39 mosses, one hornwort and 18 liverworts. Of which *Grimmia funalis* (Schwagr.) Bruch & Schimp. and *Thuidium subdelicatulum* (Hedw.) Schimp. were reported for the first time from India, *Leucophanes glaucum* (Schwagr.) Mitt. newly reported for the mainland of India, *Asterella leptophylla* (Mont.) Grolle, *Pallavicinia indica* Schiffner, *Fissidens kurzii* Muell. Hal., *Meteoriopsis ancistrodes* (Ren. & Card.) Broth, *Meteorium helminthocladum* (Muell. Hal.) M. Fleisch., *Papillaria leuconeura* (Muell. Hal.) A. Jaeger., *Syntrichia fragilis* (Taylor) Ochyra, *Tortula muralis* Hedw., and *Aerobryidium aureonitens* (Hook. ex Schwagr.) Broth. were newly reported for Peninsular India and four species, *Schiffneriolejeunea polycarpa* (Nees) Gradst., *Hypnum imponens* (Hedw.) Boulay, *Hypnum subimponens* subsp. *ulophyllum* (Muell. Hal.), and *Regmatodon orthostegius* Mont. were newly reported for Kerala.

Manju and Rajesh (2012) described and illustrated a new species *Symphysodontella madhusoodananii* from New Amarambalam, the wet evergreen forest of the Western Ghats of India. Manju *et al.* (2012a) reported a rare moss, *Trichosteleum stigmosum* from Silent Valley was a new addition to the country. Manju *et al.* (2012b) studied Lejeuneaceae of Western Ghats and reported 76 species. Of which *Archilejeunea abbreviata* (Mont.) Vanden Berghen, *Octolejeunea sempetiana* (Gottsche *et* Steph) Grolle and *Tuyamaella angulistipa* (Steph.) Schust & Kachroo were new to India, *Lejeunea cocoes* Mitt. was new to South India and three species, *Archelejeunea minutiloba* Udar & Awasthi, *Cololejeunea appressa* (Evans) Benedix and *Cololejeunea udarii* Asthana & Srivastava were new to Kerala. Manju *et al*. (2012c) reported *Aerobryopsis eravikulamensis* a new species from the Eravikulam National Park in Idukki district.

Manju *et al.* (2014) have studied the bryophytes of Silent Valley National Park and catalogued 148 taxa including 109 mosses, 36 liverworts and three hornworts, of which nine species *viz*., *Chrysocladum flammeum* (Mitt.) M.Fleisch, *Gymnostomum calcareum* Nees & Hornsch., *Notoscyphus paroicus* Schiffn., *Macromitrium turgidum* Dix., *Calyptothecium pinnatum* Nog., *Brotherella amblystegia* (Mitt.) Broth. and *Wijkia deflexifolia* (Ren. & Card.) Crum. were newly reported for Peninsular India and four species *viz*., *Lejeunea cavifolia* (Ehrh.) Lindb., *Radula obscura* Mitt., *Radula meyeri* Steph. and *Barbella turgida* were new to Kerala. Manjula *et al.* (2013a) gave detailed descriptions and photographs of four species representing the genus Bazzania, *viz*. *B. pearsonii* St., *B. praerupta* (Reinw., Bl.et Nees) Trev. and *B. sumbavensis* (Gott.) ex St.) St. Manjula *et al.* (2013b) have studied the family Geocalycaceae and reported 11 species under three genera *viz*. *Chyloscyphus, Heteroscyphus* and *Lophocolea and* reported two species *viz*., *Chiloscyphus muricatus* and *Heteroscyphus bescherellei* were new to the state. Rajesh and Manju (2014) have studied diversity of bryophytes in the lowland and midland of Kozhikode and listed out 57 species.

Manjula *et al.* (2015a) added *Fissidens linearis* var. *obscurirete* to Indian bryoflora from Idukki and Agasthyamala. Manju *et al.* (2015) reported the genus *Calycularia* from Mathiketan Shola National Park for the first time from Kerala. Manjula *et al.* (2015b) rediscovered a little known moss, *Fissidens macrosporus* Dixon from Western Ghats of Wayanad. Deepa *et al*. (2015) reported an endangered liverwort *Exormotheca ceylonensis* Meijer from a highly threatened habitat of Palakkad district of Kerala.

Jyothilakshmi *et al.* (2016) reported 29 species from Vallikattukavu of Kozhikode, including 10 liverworts and 19 mosses. Bruggeman-Nannenga *et al.* (2016) reported an African species *F. enervis* Sim as new distributional record to Asia. It is reported from a highly disturbed habitat in the Nelliampathy hills of Western Ghats in Kerala which is earlier reported from South Africa.

Manju *et al.* (2017) reported a new species *Cololejeunea manilalia*, an epiphyllous leafy liverwort from New Amarambalam Reserve forest. Manju and

Rajesh (2017) published a book, Bryophytes of Kerala- Liverworts vol.1. in which 101 species of liverworts were described with photographs. It serves as a user-friendly identification manual. Manjula *et al.* (2017) described a new species, *Fissidens manilaliana* from Kozhikode district. It also compared with related taxa *viz*., *F. bogoriensis* M. Fleisch and *F. flabellatus* Thwaites & Mitt. They also discussed challenges to conservation of species in human influenced habitat.

Mithun and Manju (2017) documented the diversity of bryophytes in Thamarassery pass and reported 37 species including 28 mosses, seven liverworts and one hornwort. of these two mosses were new to Peninsular India *viz*., *Taxiphyllum giraldii* (C. Muell.) M. Fleisch and *Taxithelium laeviusculum* Dixon. Mufeed and Manju (2017) reported a rare liverwort *Porella perrottetiana* (Mont.) Trevis. from the Anamudi shola National Park as new record for Kerala. Manju *et al*., (2017) reported a tiny moss *Physcomitrium immersum* from the Peechi-Vazhani Wildlife Sanctuary as new record for Western Ghats. Manju *et al*., (2017) reported *Amblystegium serpens* (Hedw.) Schimp. of the family Amblystegiaceae collected from the Anakkampoyil area of Kozhikode district as new record for Peninsular India. Mufeed and Manju (2018) reported a rare taxa *Gottschelia schizopleura* (Spruce) Grolle, of Jungermanniales collelcted from Anamudi shola National Park in the Western Ghats of Kerala. Mufeed *et al*. (2018) reported *Colura calyptrifolia* (Hook.) Dumort. of the family Lejeuneaceae, a rare leafy liverwort from the Anamudi shola National park of Idukki district.

Deepa *et al*. (2019) reported *Wiesnerella denudata* (Mitt.) Steph. of the family Wiesnerellaceae a genus similar to *Dumortiera* collected from the Anamudi shola National park in the Western Ghats of Kerala. A new species, *Riccia sahyadrica* Manju & Cargill is described and illustrated and compared to the only other morphologically similar species, *R. caroliniana* endemic to northern Australia by Cargill *et al.* (2019). Both species possess the unique characteristic of bearing ventral photosynthetic tissue in contrast to the dorsal position typically seen in all other *Riccia* species. Manju *et al*. (2019a) reported a new species of tiny moss *Micromitrium vazhanicum* Manju, Chandini & Rajesh of the family

Micomitriacecae from the Vazhani area of Peechi-Vazhani Wildlife Sanctuary of the Western Ghats of Peninsular India. The species is related to to *M. tenerum* and *M. austinii*, a tiny moss that grows in temporary ponds and moist muddy soil of the Moist Deciduous Forest of the Sanctuary.

Bryophyte studies with reference to the present study area

Very few studies were conducted in the study area with respect to bryophytes. A preliminary account on the bryophytes of Kakkayam forests were given by Manju *et al.* (2008a) consist of 52 species of bryophytes including 28 liverworts and 24 Mosses. This include several new records of phytogeographical significance such as *Chiloscyphus polyanthus* (L.) Corda., *Chilolejeunea subopaca* (Mitt) Mizut., *Lejeunea punctiformis* Taylor, *Lejeunea stevensiana* (Steph.) Mizut., *Lejeunea subacuta* Mitt., *Fissidens jungermannoides* Griff., *Pogonatum decolyi* Gangulee, *Leucoloma taylori* (Shwaegr.) Mitt. and *Wijkia surcularis* (Mitt) H.A. Crum found for the first time from Peninsular India and seven species *viz*., *Calypogeia tosana* (Steph.) Steph., *Cheilolejeunea birmensis* (Steph.) Mizut., *Frullania gaudichaudii* Nees. & Mont., *Pallavicinia ambigua* (Mitt) Steph., *Bryum alpinum* Huds.ex With., *Diphyscium involutum* Mitt., and *Barbella cubensis* (Mitt.) Broth. were new to Kerala.

Manju *et al.* (2012) recorded *Lejeunea cocoes* Mitt. of the family Lejeuneaceae as a new record for Peninsular India collected from the Peruvannamuzhi area of Malabar Wildlife Sanctuary.

Prajitha *et al.* (2017) reported two rare mosses *viz*., *Bryocrumia vivicolor* (Broth. & Dixon) Buck new to Kerala and *Phyllodon subretusus* (Thwaites & Mitt.) Ochyra & R.R. Ireland new to India from Malabar Wildlife Sanctuary.

From this review it is clear that only preliminary attempt has been made to record some species. Hence the present study is relevant as far as the detailed study reveals many more additions including a new species.

4. MATERIALS AND METHODS

Taxonomy

Collection of specimens and field data's: Specimens collected in different seasons during the period 2012 to 2015 from the study area. Field trips were conducted with all necessary items required such as newspaper, field book, specimen bottles, hand lens, sharp edged knife, shovel, forceps, pencil, slip pad, collection bag and GPS. Epiphytic species were scrapped out with the help of knife. Terrestrial species were collected with the help of shovel. High canopy species are collected from fallen leaves and branches. Digital photos of the plants and the vegetation of the area was taken from the field using Canon C1560 camera. Altitude of the areas measured by GPS Garmin Montana 650. Field data's were noted in the field book such as date of collection, altitude, habitat, availability, associated species, etc.

Preservation

The collected specimens were cleaned by removing the soil as far as possible. Herbarium prepared by air drying the collected specimens. Liverworts are stored in 70% alcohol for further studies. Dried specimen stored in brown paper packets of standard size (5''×4''). Each packets contains two or more species, which were separated with the help of Labomed stereo dissection microscope. Specimens were stored in labelled packets and kept in Malabar Botanical Garden and Institute for Plant Sciences' Herbarium (MBGH).

Morphological and Anatomical studies

Fresh materials were subjected to study as far as possible. External morphological features were studied by using Labomed stereo dissection microscope and anatomical features studied by Labomed compound microscope. Digital microscopic photos were taken with the help of Jenoptik ProgRes C5 camera attached compound microscope. Size of leaf, cells, and spores were measured by using micrometry. Specimen identified based on the vegetative as well as

reproductive characters by referring authentic literatures such as Gangulee (1969-1980); Kuwahara (1986); Bapna and Kachroo (2000); Asthana and Srivastava (2003); Nair *et al.* (2005a); Singh and Nath (2007), etc. and published papers fom journals. The doubtful specimens were confirmed by consulting with the experts.

Nomenclature, Citation and Taxonomic Description

Nomenclature of species were updated by using online database Tropicose.org. The citation was followed by taxonomic description, habitat, specimen examined and distribution of each species. Dichotomous keys were provided for each species, genera and families. Occurrence of the number of genera in each family, in India, Kerala and the study area were also provided.

The species are arranged according to the classifications by Crandall-Stotler & Stotler (2000) (Marchantiophyta), Renzaglia & Vaughn (2000) (Hornworts) and Goffinet *et al*., 2009 (Bryophyta). Photoplates were provided for each species.

Ecology

The distribution of each species is studied according to different habitats, altitudinal zone and vegetation types with respect to the study area.

Ex-situ conservation

Specimens were collected along with its' substratum from different microhabitat of the study area and conserved in Malabar Botanical Garden and Institute for Plant Sciences' lower group plants conservatory by providing suitable habitat.

Abbreviations used

CALI	:	Calicut University Herbarium
WLS	:	Wildlife Sanctuary
ENP	:	Eravikulam National Park
KSCSTE	:	Kerala State Council for Science, Technology and Environment.

MBGH	:	Malabar Botanical Garden Herbarium
MBGIPS	:	Malabar Botanical Garden and Institute for Plant Sciences
MCN	:	Manju C. Nair
mm	:	Milli meter
MWLS	:	Malabar Wildlife Sanctuary
NP	:	National Park
µm	:	Micro meter

5. RESULT

SYSTEMATIC TREATMENT

Key to the Phylum

1a. Plants differentiated in to root, stem and leaf like structures; stem with or without central strand; sex organ seen on main stem; sporophyte differentiated into foot, seta and capsule; peristome teeth present…… .....**Bryophyta**

1b. Plants thalloid or foliose; sex organ seen on dorsally on thallus or embedded in thallus tissue; capsule represents the sporophyte; peristome teeth absent… .....(2)

2a. Plants thalloid; thallus without internal tissue differentiation; cells containing pyrenoids… ..... **Anthocerotophyta**

2b. Plants thalloid or foliose; thallus with internal tissue differentiation; cells not containing pyrenoids… ..... **Marchantiophyta**

MARCHANTIOPHYTA Stotler & Crand. Stotl. (Liverworts)

Thallus lobed; internal tissue differentiation present; rhizoids single celled; gametophytes are thalloid and foliose types. Thalloid types are dorsi-ventrally flattened, ribbon like structures; thallus lobed or dichotomously branched. In foliose type leaves are three rowed, two lateral rows of leaves and one ventral row of leaves; ventral leaves differ from that of lateral leaves.

Marchantiales Limpr.,

Krypt., Fl. Schlesien 1:336, 239. 1877.

Key to the Families

1a. Capsule embedded in the thallus; elaters absent…..... **Ricciaceae**

1b. Capsule not embedded in the thallus; elaters present… .....(2)

2a. Thallus with air chambers; gemmae absent..…..**Cyathodiaceae**

2b. Thallus without air chamberes; gemmae present..... **Dumortieraceae**

Cyathodiaceae Stotler & Crand. Stotl.,

Bryoph. Biol. 55, 63. 2000.

Thallus thin or thick and fleshy, yellowish green; rhizoids many, hyaline; scales numerous, two rowed; margin wavy or not; midrib present or absent; air chambers one or more rowed, empty or with assimilatory filaments; dorsal air pores present.

Note: This family is represented by only one genus, *Cyathodium* Kunze.

Cyathodium Kunze.,

Nov. Strip. Pug. 6:17. 1834.

Thallus fan like, yellowish green to fluorescent green, branched dichotomously; rhizoids hyaline, smooth; scales two rowed; lobes broad at top, margin wavy, deeply incised; midrib present or absent; air chambers 1or more rowed; filaments absent; dorsal air pores formed by concentric ring of 7-10 cells.

Cyathodium cavernarum Kunze ex Lehm., Nov. Stirp. Pug. 6: 17. 1834; Srivastava & Dixit, J. Hattori Bot. Lab. 80 :185- 189.1996; Bapna & Kachroo, Hepatic. India 2: 391. 2000; Nair *et al.,* Bryo. Wayanad W. Ghats 36. 2005; Chaudhary *et al*., Bryo. Fl. Gujrat. 25. 2006; Chaudhary *et al*., Bryo. Fl. N. Konkan 81-83. 2008; Manju *et al*., Checklist Bryo. Kerala, Trop. Bryol Res. Rep. 7: 4. 2008; Singh & Nath, Hepat. Khas & Jaint Hills: East. Himal., 341. 2013; Sandhya Rani *et al*., Bryo. Andhra Pradesh 58-59. 2014; Singh *et al.,* Liverw. & Hornw. India : 76. 2016; *C. africanum* Mitt., J. Proc. Linn. Soc. London, 22: 327.1887. *C. mexicanum* Steph., Rev. Bryol. 36: 139. 1909. *C. barodae* Chavan, Bryologist 11: 57. 1937.

Thallus delicate, thin, yellowish green to fluorescent green, branched dichotomously, 5-8 × 2-4 mm; rhizoids hyaline, smooth; scales two rowed; lobes broad at top, margin wavy, 1 × 0.5 mm; midrib absent; air chambers one rowed, two celled; filaments absent; thallus cells hexagonal, chlorophyllous, epidermal pores with 2-4 concentric rings of 5-6 cells; male receptacle lateral or at the terminal point of dichotomy; spores spinate; elaters brownish with 2 or 3 spiral thickening (Plate 5.1).

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary: Kakkayam, Raveendra estate (850 m), 10-05-03, *MCN 120126* (CALI); Peruvannamuzhi: Chenkotakkolli (160-520 m), 16-03-13, *Prajitha 8665*; 11-09-14, *Prajitha 14078* (MBGH).

Habitat: Seen on varying habitat such as on rocks, soil cuttings, concrete walls and on the upper part of the tree trunk in the evergreen, semi evergreen and moist deciduous forests.

Distribution: World: Africa, America, Australia, Brazil, China, India, Java, Mexico, Myanmar, Sri Lanka and UAE.

India: Andra Pradesh (Sandhya Rani *et al*., 2014), Chhattisgarh (Kapoor *et al.*, 2010), Gujarat (Chaudhary *et al*., 2006), Karnataka (Aruna & Krishnappa, 2014), Kerala, Maharashtra (Lavate, 2015), Madhya pradesh (Sharma & Alam, 2011 Meghalaya (Singh & Nath, 2007), Odisha (Mishra *et al*., 2016), Rajasthan (Alam *et al*., 2011), Sikkim (Dandotiya *et al*., 2011), Tamil Nadu (Verma *et al.*, 2013).

Kerala: Kozhikode: Kakkavayal (Manju & Rajesh, 2014); Kakkayam (Manju *et al.*, 2008a); Vallikkatukavu (Manju *et al.*, 2016), Palakkad: Silent Valley (Srivastava & Sharma, 2000), Wayanad (Nair *et al.*, 2005a).

Economic importance: Local inhabitants of Ponmudi hills using it for skin diseases (Murugan *et al.*, 2014).

Ricciaceae Rchb.,

Bot. Damen: 255. 1828.

Thallus monoecious or dioecious, forms rosettes, yellowish green or pinkish green, simple or branched dichotomously; rhizoids absent or smooth walled if present; lobes oblong, obovate at apex; ventral scales absent or inconspicuous; thallus divided in to two layers; upper assimilatory zone containing chlorophyllous assimilatory filaments, where the air chambers elongated; storage zone colourless and 4-6 cells thick; archegonia and antheridia scattered, immersed with in the thallus; foot and seta absent; capsule globose; spores tetrahedral.

Note: This family include two genera such as *Riccia* and *Ricciocarpos.* Of these two genera *viz*., *Riccia* L. and *Ricciocarpos* Corda present in India. The genus, *Riccia* L. is represented in the study area.

Riccia L.,

Sp. Pl.2:1138. 1753.

Thallus monoecious or dioecious, forms complete or incomplete rosettes, yellowish green or pinkish green, branched dichotomously; rhizoids mostly smooth walled; scales absent or inconspicuous ventrally at apex; air chambers elongated; epidermal cells hyaline; assimilatory filaments chlorophyllous; storage zone 4-6 cells thick; archegonia and antheridia scattered; spores tetrahedral.

Riccia huebeneriana Lindenb., Nova Acta Leop. Carol. 18: 504, 1836; Pande & Udar, Proc. Nat. Inst. Sci. India. 24B (2): 85-87. 1958; Srivastava, Bull. Nat. Bot. Gard.104 : 53-55. 1964; Bapna & Kachroo, Hepatic. India 2: 454.. 2000; Singh et al., Taiwania 55 (2): 103. 2010; Singh *et al.,* Liverw. & Hornw. India 248. 2016. *R. klinggraeffii* Gottsche, Bot.Ztg. 17: 88,1859. *Ricciella huebeneriana* Du Motier, Bull. Soc. Roy. Bot. Belgique. 171, 1874. *Riccia huebeneriana* Lindenb. var. *pseudo- frostii* Schffn., Oesterr. Bot. Z. 55: 8. 1905. *R. kashyapii* Kachroo, Sci. & Cult. 20: 98, 1954.

Thallus monoecious, forms rosettes, pinkish green, branched dichotomously; rhizoids pinkish, smooth walled; scales absent or minute if present; air chambers elongated; epidermal cells hyaline; assimilatory filaments chlorophyllous; storage zone 4-6 cells thick; archegonia many, not projected; antheridia 2 rowed; sporogonia scattered and spherical in shape; spores brownish, tetrahedral, 50µm wide (Plate 5.2).

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary: Peruvannamuzhi, Moothaveedu puzha (805 m), 16-03-13, *Prajitha 8678*; Peruvannamuzhi, Chenkotakolli (340 m), 11-09-14, *Prajitha 14068* (MBGH).

Habitat: Seen on moist and exposed soils in the evergreen and semi evergreen forest floor.

Distribution: **World**: Africa, China, Germany, India, Japan, Korea, North America, Philippines Sri Lanka and Russia.

India: Assam (Barbhuiya and Singh, 2012), Karnataka (Schwarz, 2013), Kerala (Manju & Rajesh, 2017), Madhya pradesh (Sharma & Alam, 2011), West Benghal (Singh *et al*., 2010).

Dumortieraceae D.G. Long,

Edinburg J. Bot. 63 (2-3): 260. 2006.

Thallus prostrate greenish or dark green, flat, margin undulate, apex notched, repeat dichotomously branched; midrib present; air chambers absent; dorsal and ventral tissue differentiated or not; gemmae present or absent; sporogonia on receptacle; capsule globose; spores tetrahedral.

Note: This family is represented by only one genus*, Dumortiera* Nees

Dumortiera Nees,

Nova Acta Acad. Nat. Cur, 12: 410. 1824.

Thallus prostrate, large, expanded patches, overlapping, dark green, flat, margin undulate, apex notched, repeat dichotomously branched; midrib present; air chambers absent; dorsal and ventral tissue not differentiated; gemma seen on dorsal side of the thallus at apex; male receptacle disciform, terminal, stalked with bristle like hairs; female receptacle stalked at maturity; capsule globose; spores brownish and tetrahedral.

Dumortiera hirsuta (Sw) Nees, in Reinwardt, Blume & Nees, Nova Acta Phys.-Med. Acad. Caes. Leop.-Carol. Nat. Cur. 12: 410.1824; Kashyap, Liverw. W. Himal. 1: 42-43. 1929; Bapna & Kachroo, Hepatic. India 2: 440. 2000; Manju *et al*., Checklist Bryo. Kerala, Trop. Bryol Res. Rep. 7: 4. 2008; Daniels & Daniel, Bryo. South. W. Ghats 276. 2013; Sandhya Rani *et al*., Bryo. Andhra Pradesh. 54-55. 2014; Daniels *et al.,* Bryo. Indira Gandhi N.P., Anam. Hill. 459. 2018; Singh *et al.,* Liverw. & Hornw. India : 78-79. 2016; *Marchantia hirsuta* Sw., Prodr, 145. 1788. *M. irrigua* Wilson, *in* Hooker, Brit. Fl. 2: 106. 1833. *Hygrophila irrigua* (Wilson)

Taylor, *in* J. Mackay, Fl. Hibern. 2: 54. 1836. *Dumortiera irrigua* (Wilson) Nees. Naturgesch. Eur. Leberm. 4: 159. 1838. *Dumortiera hirsuta* var. *irrigua* (Wilson) Spruce, Trans. & Proc. Bot. Soc. Edinburgh 15: 566. 1885. *Hygrophila nepalensis* Taylor, Trans. Linn. Soc. 17: 392. 1835. *Dumortiera nepalenis* (Taylor) Nees. Naturgesch. Eur. Leberm, 4: 169. 1838. *D. hirsuta* var. *angustior* Gottsche, and fo. *depauperata* Gottsche, Lindenb. & Ness, Syn. Hepat. 544. 1846. *D. hirsuta* var. *intermedia* Gottsche, Lindenb. & Nees. Syn. Hepat. 544. 1846. *D. hirsuta* var. *latior* Gottsche, Lindenb & Nees, Syn. Hepat. 544. 1846. *D. hirsuta* var. *trichopus* Spuruce, Trans. & Proc. Bot. Soc. Edinburgh 15: 567. 1885. *D. hirsuta* var. *brasiliensis* Schiffn., in Schiffner & Arnell. Oesterr. Akad. Wiss., Math-Naturwiss. KI. Denkschr. 111:8. 1964.

Thallus forms patches, overlapping, dark green, flat, margin undulate, apex notched, repeat dichotomously branched, 7-10 × 1-1.5 µm; rhizoids hyaline, smooth; scales seen on each side of the midrib near the apex, hyaline; midrib prominent; air chambers absent; dorsal and ventral tissue not differentiated; gemma seen on dorsal side of the thallus at apex; male receptacle disciform, terminal, stalked with bristle like hairs; female receptacle stalked at maturity; capsule globose; spores brownish, tetrahedral, 25 µm wide; elaters reddish brown with 2-4 spiral thickening. (Plate 5.3).

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary: Kakkayam, Vattakkayam (1050 m), 10-05-03, *MCN 120181* (CALI); Kakkayam, Vattakkayam (1020 m), 27-09-12, *Prajitha 8556*; Peruvannamuzhi: Chenkottakkolli (410 m), 16-03-13, *Prajitha 8664*; 11-09-14, *Prajitha 14091* (MBGH).

Habitat: Seen on moist vertical land cuttings and on rocks near water falls along with *Heteroschyphus argutus* (Nees) Schiffner in the evergreen and semi evergreen forests.

Distribution: World: Africa, America, Bangladesh, Bhutan, Brazil, China, Hawaii, India, Jamaica, Japan, Mexico, Nepal, North Carolina, New Zealand, Sri Lanka.

India: Andra Pradesh (Sandhya Rani *et al*., 2014), Assam (Barbhuiya and Singh, 2012), Himachal Pradesh (Singh & Singh, 2015), Jammu and Kashmir (Rashid *et al*., 2012), Karnataka (Schwarz & Frahm, 2013; Aruna & Krishnappa, 2014), Madhya pradesh (Sharma & Alam, 2011), Meghalaya (Singh & Nath, 2007), Nagaland (Barbhuiya & Singh, 2012), Odisha (Mishra *et al*., 2016), Tamil Nadu (Daniels, 2010; Daniels & Daniel, 2013; Daniels *et al*., 2018)

Kerala: Idukki: Chinnar WLS (Nair *et al.*, 2006b, Kannur: Aralam WLS (Manju *et al.*, 2009b), Kozhikode: Kakkayam (Manju *et al.*, 2008a), Palakkad (Srivastava & Sharma, 2000), Thiruvananthapuram: Agasthyamala (Manju *et al.*, 2009d), Wayanad (Nair *et al.*, 2005a).

Economic importance: It is a source of antibiotics (Azuelo *et al.*, 2011). It has antibacterial activity against *E. coli* and *Staphylococus aureus* (Junairiah *et al.*, 2013) and antifungal activity against *Candida albicans* (Hayes, 1947).

Fossombroniales Schljakov.,

Bot. Zhurn. (Moscow & Leningrad) 57(4): 500. 1972.

Fossombroniaceae Hazsl.,

Magyar Bir. Moh. Fl. 20, 36. 1885.

Plants thallose or foliose, delicate; stem prostrate, cells not differentiated; rhizoids hyaline or purple; scales absent; leaves succubus, quadrate, irregularly lobed, papillae at the tip of the lobe, margin undulate; leaf cells polygonal, thin walled.

Note: This family represents two genera such as *Austrofossombronia* R.M. Schust. and *Fossombronia.* Of these one genus *viz*., *Fossombronia* Raddi present in India and which extends to the study area.

Fossombronia Raddi,

Jungermanniogr. Etrusca 29. 1818.

Plants solitary or seen in patches, delicate; stem prostrate; rhizoids hyaline or purple; leaves succubusly placed, laterally two rowed, quadrate, irregularly lobed, papillae at the tip of the lobe, margin undulate; leaf cells polygonal, thin walled.

Fossombronia japonica Schiffn., Oesterr. Bot. Z. 49 (11): 389. 1899; Manju & Rajesh, Bryoph. Kerala, Liv. (1): 47. 2017.

Thallus delicate, small, yellowish green, seen in patches; stem prostrate, dichotomously branched, 1 cm long and 2 mm wide including leaves; rhizoids purple; leaves succubusly placed, laterally two rowed, irregularly lobed, papillae at the tip of the lobe, margin undulate, 1.5 × 1.3 mm; leaf cells polygonal, thin walled, marginal cells 20-30 × 30-35 µm, middle cells 40-45 × 50 µm and extreme basal cells comparatively large, 45- 50 × 60-70 µm (Plate 5.4).

Specimen examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary: Peruvannamuzhi (400 m), 22-03-14, *Prajitha 11039* (MBGH).

Habitat: Seen on moist vertical land cuttings in the moist deciduous forests.

Distribution: World: China, India, Japan, Massachusettes, New York, North America and West Virgina

India: Kerala (Manju & Rajesh, 2017) and Tamil Nadu (Daniels, 2010).

Pallaviciniales W. Frey & M. Stech.,

Nova Hedwigia 81: 64. 2005.

Pallaviciniaceae Mig.,

Krypt. Fl. Deutschl 1:423. 1904.

Thallus prostrate, yellowish green or pale green; rhizoids brownish, arising from the midrib at the ventral side; wings transparent, margin undulate, apex acute

or obtuse; midrib prominent, cells; thallus cells polygonal; antheridial scales encloses the antheridium; antheridium globular and stalked.

Note: This family represents eight genera such as *Greeneothallus* Hassel, *Jensenia* Lindb., *Pallavicinia* Gray, *Podomitrium* Mitt., *Seppeltia* Grolle, *Symphyogyna* Nees & Mont., *Symphyogynopsis* Grolle and *Xenothallus* R.M. Schust. Of these one genus *viz, Pallavicinia* Gray present in India and which extends in the study area.

Pallavicinia Gray,

Nat. Arr. Brit. Pl. 1:775. 1821.

Thallus ribbon like, pale green, dichotomously branched or not; rhizoids brownish, smooth walled; wings transparent, margin undulate, apex obtuse; midrib very prominent, cell incrassate; thallus cell quadrangular to hexagonal; antheridial scales arising from midrib at the dorsal side of the thallus that encloses the antheridium.

Pallavicinia lyellii (Hook.) Gray, Nat. Arr. Brit. Pl. 1: 685, 775. 1821; Bapna & Kachroo, Hepatic. India 2: 349. 2000; Nair *et al.*, Bryoph. Wayanad 42. 2005; Singh & Nath, Hepatic. Khasi & Jaintia Hills 300. 2007; Singh & Barbhuiya, *Archive for bryol.*, 149: 18. 2012; Manju & Rajesh, Bryoph. Kerala, Liv. (1): 51. 2017. *Jungermannia lyellii* Hook., Brit. Jungermann., 77. 1816. *Pallavicinia byssophora* (Lehm. & Lindenb.) Trevis., Mem. Reale Ist. Lombardo Sci., Ser. 3, Cl. Sci. Mat. 4: 427. 1877. *P. pilifera* Steph., Hedwigia 30: 271. 1891. *P. attenuata* Steph., Bull. Soc. Bot. Belgique 32: 37. 1893.

Thallus unisexual, ribbon like, pale green in colour, dichotomously branched, 3× 0.5 cm; rhizoids brownish, smooth walled, arising from the midrib at the ventral side; scales not clear; wings transparent, margin undulate, apex obtuse, 3.5 cm long and 3 mm wide; midrib very prominent, cells incrassate, 20 cells thick; thallus cells quadrangular to hexagonal, 30-40 × 40-45 µm; antheridial scales arising from the midrib at the dorsal side of the thallus, encloses the antheridium;

antheridium globular in structure, shorty stalked and have single layered wall (Plate 5.5).

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary: Kakkayam, Vattakkayam (1050 m), 10-05-03, *MCN 120182* (CALI); Kakkayam, Ambalappara (810 m), 26-09-12, *Prajitha 8551*; Peruvannamuzhi: Chenkottakkolli (230-410 m), 16-03-13, *Prajitha 8642, Prajitha 8663*; 22-03-14, *Prajitha 11022* (MBGH)

Habitat: Seen on moist vertical soil cuttings, rocks near waterfalls and on rhizome of ferns in the evergreen and semi evergreen forests.

Distribution: **World**: Africa, America Brazil, China, Europe, India, Jamaica, Japan, Java, New Zealannd, North Carolina, Philippines, Russia, Sri Lanka, Singapore.

India: Andra Pradesh (Sandhya Rani *et al.,* 2014), Assam (Barbhuyia & Singh, 2012), Kerala, Madhya pradesh (Sharma & Alam, 2011), Maharashtra, (Lavate *et al*., 2015), Meghalaya (Singh & Nath, 2007), Karnataka (Aruna & Krishnappa, 2014), Tamil Nadu (Daniels, 2010; Daniel, 2013).

Kerala: Kozhikode: Kakkayam (Manju *et al.*, 2008a); Vallikkatukavu (Manju *et al.,* 2016), Thiruvananthapuram: Agasthyamala (Manju *et al.*, 2008b), Wayanad (Nair *et al.*, 2005a).

Economic importance: It is used as antimicrobial agent (Azeuelo *et al.*, 2011)

Metzgeriales Chalaud,

Ann. Bryol. 3: 41 (1930)

Key to the families

1a. Thallus with midrib; marginal hairs present; laminal cells trigonous, thick walled… ..... **Metzgeriaceae**

1b. Thallus without midrib; marginal hairs absent; laminal cells non trigonous, thin walled…… .....**Aneuraceae**

Metzgeriaceae H. Klinggr.,

Hoh. Crypt. Preuss. 10. 1858.

Thallus thin, delicate, pale green or yellow green, ribbon like, dichotomously branched or not, margin entire, apex notched; marginal hairs present; midrib present; laminal cells trigonous or nontrigonous, thick walled.

Note: This family represents four genera such as *Apometzgeria* Kuwah., *Austrometzgeria* Kuwah, *Metzgeria* Raddi and *Steereella* Kuwah. Of these two genera *viz*., *Apometzgeria* and *Metzgeria* are distributed in India. Of these *Metzgeria* is represented in the study area.

Metzgeria Raddi,

Jungermanniogr. Etrusca., 34. 1818.

Thallus flat, pale green or yellow green, ribbon like, delicate, dichotomously branched or not, margin entire, apex notched; hairs present on margin; midrib prominent; laminal cells trigonous, thick walled.

Metzgeria pandei S.C. Srivast. & Udar, New Bot. 2: 16. f. 5-6. 1975; Singh & Nath, Hepatic. Khasi & Jaintia Hills 306. 2007.

Thallus appressed to the substratum, pale green, ribbon like, delicate, dichotomously branched or not, margin entire and apex notched, 20 × 1 mm long; unicellular hairs present on the margin and also on the midrib; midrib prominent, epidermal cells 3 on the dorsal side and 2 on the ventral side, 23-25 × 10-11 µm; laminal cells trigonous, thick walled, 5 celled thick at the midrib region and became 1 celled towards the margin, 11-12 cells seen on either side of the midrib, epidermal cells 24 × 11 µm and median cells 17-25 × 10 µm (Plate 5.6).

Specimen examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary: Kakkayam, Sankaranpuzha (750 m), 27-09-12, *Prajitha 8620* (MBGH).

Habitat: Seen on logs in the semi evergreen forest.

Distribution: This species is endemic to India. Distributed in Andra Pradesh

(Sandhya Rani *et a*l., 2014), Meghalaya (Singh & Nath, 2007), Tamil Nadu (Verma & Srivastava, 2011); Nilgiri Hills (Verma *et al.*, 2013).

Note: The present collection is a new record to Kerala.

Aneuraceae H. Klinggr.,

Hoh. Crypt. Preuss, 11. 1858.

Thallus slender, ribbon like, pinnately or irregularly branched; apex obtuse or notched; margin entire; midrib absent; lamina many cells thick at the middle and became narrow one or few celled towards the margin, polygonal; oil body single or many; antheridia and archegonia seen on separate or same branches.

Note: This family represents four genera such as *Aneura* Dumort*., Lobatiriccardia* (Mizut. & S. Hatt.) Furuki*, Riccardia* Gray *and Verdoornia* R.M Schust.. Of these two genera *viz*., *Aneura* Dumort. and *Riccardia* Gray found in India. Of these *Riccardia* Gray is represented in the study area.

Riccardia Gray,

Nat. Arr. Brit. Pl. 1: 683. 1821

Thallus unistratose or multistratose, branched; apex obtuse; margin entire; midrib absent; thallus many cells thick at the middle became narrow one or few celled towards the margin; oilbodies present; antheridia enclosed; archegonia dorsaly placed, seta long; capsule globose.

Key to the genera

1a. Laminal cells containing many oil bodies; antheridia and archegonia seen on separate branches…….....***R. tenuicostata***

1b. Laminal cells containing single oil body; antheridia and archegonia seen on same branches .....***R. multifida***

Riccardia multifida (L.) Gray, Nat. Arr. Brit. Pl. 1: 684. 1821; Bapna & Kachroo, Hepatic. India 2: 355, 2000; Nair *et al.*, Bryoph. Wayanad 44. 2005; Singh &

Barbhuiya, *Archive for bryol.* 149: 22. 2012; Manju & Rajesh, Bryoph. Kerala, Liv. (1): 54. 2017. *Jungermannia multifida* L., Sp. pl. 2: 1136. 1753. *Aneura multifida* (L.) Dumort., Comment. Bot. 112. 1822. *A. luetzelburgii* Steph., Sp. Hepat. 6:33. 1917.

Thallus multistratose, pinnately branched, 5 × 0.5 mm long; apex obtuse; margin entire; midrib absent; t.s of the thallus shows 4-6 cell thick at middle became narrow one celled towards the margin; oil body single; antheridia short, cylindrical, enclosed; archegonia short, dorsally placed, seta greenish, long; capsule blackish and globose (Plate 5.7, a-e).

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary: Kakkayam, Ambalappara (750 m), 10-05-03, *MCN 120101* (CALI); 26-09-12, *Prajitha 8547*; Peruvannamuzhi (330 m), 11-09-14, *Prajitha 14081* (MBGH).

Habitat: Seen on rocks and roots of higher plants in the evergreen and semi evergreen forests.

Distribution: World: Brazil, China, Europe, India, Jamaica, Java, Philippines, Russia, Singapore and Sri Lanka.

India: Andra Pradesh (Sandhya Rani *et al*., 2014), Assam (Barbhuiya and Singh, 2012), Jammu and Kashmir (Rashid *et al*., 2012), Kerala, Madhya pradesh (Sharma & Alam, 2011), Meghalaya (Singh & Nath, 2007), Tamil Nadu: Palni Hills (Alam & Srivastava, 2009).

Kerala: Kozhikode: Kakkavayal Reserve Forest (Manju *et al.*, 2014); Kakkayam (Manju *et al.*, 2008a), Palakkad (Vohra *et al*., 1982), Wayanad (Nair *et al.*, 2005a).

Economic Importance: Riccardin isolated from this species have cytotoxic activity against leukemic cells (Glime, 2017).

Riccardia tenuicostata Schiffin., Denkschr. Math. Nat. Cl. Kais. Akad. Wiss. Wien. 67: 166. 1898; Bapna & Kachroo, Hepatic. India 2: 357. 2000; Nair *et al.*, Bryoph. Wayanad 44. 2005; Singh & Nath, Hepatic. Khasi & Jaintia Hills 310. 2007; Manju

& Rajesh, Bryoph. Kerala, Liv. (1): 55. 2017. *Aneura tenuicostata* (Schiffn) Steph., Sp. Hepat. 1: 245. 1899.

Thallus slender, fleshy, pinnately branched, branches short, apex obtuse or notched, margin entire, 10-15 × 5 mm; midrib absent; lamina 4-6 cell thick at middle and became unistratose towards the margin, dorsally convex, polygonal, non trigonous, thin walled; oil bodies dispersed; antheridia and archegonia seen on separate branches; antheridial branches long; archegonial branches short (Plate 5.7, f-i).

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary: Kakkayam (700 m), 10-05-13, *MCN 120094a* (CALI); Peruvannamuzhi, Chenkotakolli (450- 500 m), 22-03-14, *Prajitha 11002*; 11-09-14, *Prajitha 14095* (MBGH).

Habitat: Seen on rocks near waterfalls, roots of angiosperms and ferns' rhizomes in the semi evergreen and moist deciduous forests.

Distribution: World: India, Java and Singapore.

India: Arunachal Pradesh (Singh, 1996), Assam (Das & Sharma, 2016), Himachal Pradesh (Singh & Singh, 2009; 2015), Kerala (Nair *et al*.,2005a; Manju *et al*., 2008a), Meghalaya (Singh & Nath, 2007), Manipur (Singh *et al*., 2010), Sikkim (Singh *et al*., 2008), Tamil Nadu (Srivastava & Udar, 1976; Daniels, 2010), Uttarakhand (Srivastava & Udar, 1976).

Porellales Schljakov,

Moscow & Leningrad. 57 (40): 505. 1972.

Key to the Families

1a. Leaf lobes ovate to rectangular; under leaves absent…..... **Radulaceae**

1b. Leaf lobes ovate to oblong; under leaves present….....(2)

2a. Leaf lobules saccate or helmet shaped; under leaves bifid.....**Frullaniaceae**

2b. Leaf lobules ovate or triangle shaped; under leaves bifid or not..... **Lejeuneaceae**

Radulaceae K. Muell.,

Krypt. Fl. Deutschl. Ed. 2.6 (1): 404. 1909.

Plants prostrate, yellowish green, forms irregular pinnate branches; leaves imbricate; lobes rectangular to ovate or orbicular, apex rounded, margin entire; lobules quadrate; under leaves absent; leaf cells rounded- hexagonal; trigonous, nodules present.

Note: This family represent only one genus *viz*., *Radula* Dumort. *Radula* Dumort. present in India and which extends in the study area.

Radula Dumort.,

Comm. Bot. 112, 1822 & Rec. d' obs. 14. 1835.

Plants prostrate, yellowish green, irregularly pinnately branched; stem 6-12 cells wide, cortical cells thick or thin walled, medullary cells thick walled, trigonous or not; leaves concave, imbricate; lobes rectangular, orbicular or ovate-oblong, apex rounded, margin entire; lobules quadrate or sub quadrate; under leaves absent; leaf cells hexagonal or rounded- hexagonal, thin walled or thick walled; trigonous, nodules present or absent; oil bodies present.

Key to the species

1a. Leaf lobe orbicular; cells hexagonal…. .....***R. japonica***

1b. Leaf lobe ovate-oblong; cells rounded-hexagonal…. .....(2)

2a. Leaf lobules sub quadrate; leaf cells thick walled, trigonous prominent, triangular nodules present..... …***R. kurzii***

2b. Leaf lobules quadrate; leaf cells thin walled, minutely trigonous, nodules absent…… .....***R. javanica***

Radula japonica Gottsche ex Stephani, Hedwigia 23: 152. 1884; Nair *et al*., Bryoph. Wayanad. 76. 2005; Manju & Rajesh, Bryoph. Kerala, Liv. (1): 118. 2017. *Stephania Japonica* (Gottsche ex. Steph.) Yasuda, Shokub. Kab. 717. 1911.

Plants creeping, branching irregularly pinnate, yellowish green, 2-5 cm long and 1.5 mm wide including leaves; leaf lobe orbicular, margin entire, 7 × 0.5mm; lobule quadrate; under leaves absent; leaf cells thick walled, hexagonal, minutely trigonous, 10-15 × 12-15 μm; oil bodies present (Plate 5.8).

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary: Kakkayam, Vattakkayam (950 m), 10-05-03, *MCN 120149* (CALI); Peruvannamuzhi (900-1100 m), 22-03-14, *Prajitha 11045*; 11-09-14, *Prajitha 14092* (MBGH).

Habitat: Seen on wet rocks and on branches in the evergreen forests.

Distribution: World: India China, Japan and Korea.

India: Arunachal Pradesh (Singh *et al*., 2016), Kerala, Tamil Nadu (Daniels *et al*., 2018)

Kerala: Idukki: Chinnar WLS (Nair *et al.*, 2006), Kozhikode: Kakkayam (Manju *et al.*, 2008a); Vellarimala (Nair & Madhusoodanan, 2006), Wayanad (Nair *et al.*, 2005a).

Radula javanica Gottsche, Syn. Hepat. 257. 1845; Bapna & Kachroo, Hepatic. India, 2:139. 2000; Nair *et al.*, Bryoph. Wayanad, 78. 2005; Singh & Nath, Hepatic. Khasi & Jaintia Hills, 180. 2007; Manju & Rajesh, Bryoph. Kerala, Liverwort (1):119. 2017. *Stephania javanica* (Gottsche) Kuntze, Syn. Hepat. 257. 1845. *Radula macrostachya* Lindenb. & Gottsche, Syn. Hepat. 726. 1847. *R. caldana* Angstr., Ofvers. Forh. Kongl. Svenska Acad. 33 (7): 81. 1876. *R. amazonica* Spruce, Trans. & Proc. Bot. Soc. Edinburgh 15:321. 1885.

Plant prostrate, irregularly branched, yellowish green, 2-2.5 cm long and 1.5 mm wide including leaves; stem 10-12 cells wide, cortical and medullary cells thick walled, trigonous; leaves imbricate, concave; lobes ovate-oblong, apex rounded, margin entire, 1 × 0.7-0.8 mm; lobules quadrate, apex acute; under leaves absent; leaf cells rounded- hexagonal, marginal cells 25-35 × 7-8 μm and basal cells 17 × 15 μm, thin walled; trigonous minutely present, nodules absent; oil bodies present (Plate 5.9).

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary: Kakkayam, Ambalappara (1200 m), 26-09-12, *Prajitha 8546*; Sankaranpuzha (1140 m), 11-09-14, *Prajitha 14151* (MBGH).

Habitat: Seen on branches in the evergreen forests.

Distribution: World: China, Borneo, India, Java, Japan, New Caledonia, New Guinea, Philippines, Sri Lanka, Sumatra, Taiwan, Thailand and Vietnam.

India: Eastern Himalayas (Singh and Nath, 2007), Karnataka (Schwarz, 2013), Kerala (Nair *et al*., 2005a), Madhya Pradesh (Sharma & Alam, 2011), Meghalaya (Singh and Nath, 2007), Sikkim (Chopra, 1943), Tamil Nadu (Daniels, 2010; Daniels & Daniel, 2013).

Economic importance: It is used for ear ache by local inhabitants of Ponmudi hills (Murugan *et al*., 2014).

Radula kurzii Stephani, Hedwigia 23: 153, 1884; Bapna & Kachroo, Hepatic. India 2:140. 2000; Nair *et al.,* Bryoph. Wayanad 78. 2005; Singh & Nath, Hepatic. Khasi & Jaintia Hills 179. 2007; Manju & Rajesh, Bryoph. Kerala, Liv. (1):120. 2017.

Plants prostrate, yellowish green, 3-4 cm long and 1.5 mm wide including leaves; stem 6-8 cells wide, cortical cells thick walled, medullary cells thin walled, minutely trigonous; leaf lobe ovate-oblong, apex rounded, margin entire, 0.8-0.7 mm; lobules sub quadrate; under leaves absent; leaf cells rounded to hexagonal, thick walled,; cells near margin comparatively small, 0.5 × 0.5 µm, middle cells 15 × 15 µm and at the base 20-22 × 15-20 µm; trigonous very prominent, triangular nodules present; oil bodies present (Plate 5.10).

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary: Kakkayam, Vattappara (1050 m), 10-05-03, *MCN 120167* (CALI); Kakkayam, Ambalappara (800-1150 m), 12-09-14, *Prajitha 12564*; Peruvannamuzhi (510 m) 11-09-14, *Prajitha 14064* (MBGH).

Habitat: Seen on wet rocks in the evergreen and semi evergreen forests.

Distribution: World: Australia, Caledonia, China, India and SriLanka.

India: Kerala and Tamil Nadu: Palni Hills (Alam & Srivastava, 2009).

Kerala: Kozhikode: Kakkayam (Manju *et al.*, 2008a), Palakkad: Silent Vally National Park (Srivastava &Sharma, 2000), Wayanad (Nair *et al.*, 2005a).

Frullaniaceae Lorch,

Krypt. Fl. Anf. 6: 174. 1914.

Plant prostrate to sub erect, yellowish- brownish green, pinnately branched; leaves incubous, 2 lobed, dorsal lobes large imbricate, ovate-oblong, apex rounded, margin entire; cells quadrate or polyhedral, trigonous present; ocelli present or absent; ventral lobules small; under leaves bifid; sinus wide and deep; perianth many keeled; bract paired, dentate or not; archegonia terminal; capsule globose and blackish.

Note: This family represents six genera such as *Amphijubula* R.M. Schust., *Frullania* Raddi, *Neohattoria* Kamim, *Schusterella* S. Hatt. and *Steerea* S. Hatt. & Kamim. Of these one genus, *Frullania* Raddi is present in India and Kerala. Which is also represented in the study area.

Frullania Raddi,

Mem. Soc. Italiana Sci. Modena 18: 20. 1820.

Plant prostrate, yellowish- brownish green, pinnately branched; stem 9-12 cells across; leaf lobes closely or loosely imbricate, ovate-oblong, apex rounded, margin entire, cordite; leaf cells polyhedral, trigonous present; lobules small ovate or large helmet shaped; under leaves bifid, orbicular, margin entire or wavy; sinus wide and deep; perianth many keeled; bract paired, dentate; archegonia seen on the tip of main branches; seta thick and fleshy; capsule globose and blackish.

Key to the species

1a. Leaf lobules large, helmet shaped…..... ***F. wallichiana***

1b. Leaf lobules small, ovate…… .....***F. gaudichaudii***

Frullania gaudichaudii (Nees & Mont.) Nees & Mont., Syn. Hepat. 435. 1845; Manju *et al*., *Geophytology* 37: 60. 2008. *Jubula gaudichaudii* Nees & Mont., Ann. Sci. Nat., Bot., ser. 2, 4: 523. 1911.

Plant prostrate, apex sub erect, yellowish green to dark brownish, pinnately branched, 5 cm long and 2-3 mm wide including leaves; secondary branches short, 3 mm long; stem brownish, 0.15 mm wide, 9-12 cells across, cortical cells 10-18 × 12-14 µm, medullary cells 18-23 × 12-16 µm; leaf lobes closely imbricate, ovate-oblong, apex rounded, margin entire, cordite, wide at base, 1.5 × 1 mm; leaf cells polyhedral, trigonous, nodulose; marginal cells less trigonous, 12-15 × 12-15 µm; middle cells 25-30 × 20-30 µm; basal cells more trigonous, 30-45 × 15-20 µm; lobules small, ovoid, parallel to the stem, 0.1× 0.2 µm; under leaves appressed to the stem, bifid, orbicular, 0.9 × 1 mm; sinus wide, 160-174 µm deep (Plate 5.11).

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary: Kakkayam, Vattakkayam (1050 m), 10-05-03, *MCN 120185* (CALI); 26-09-12, *Prajitha 8526* (MBGH).

Habitat: Seen on branches in the evergreen forests.

Distribution: World: China, Brazil, India, Japan and Sri Lanka.

India: Kerala: Kakkayam (Manju *et al.*, 2008a) and Tamil Nadu (Daniels, 2010)

Frullania wallichiana Mitt., J. Proc. Linn. Soc., Bot. 5: 118. 1861; Singh & Nath, Hepatic. Khasi & Jaintia Hills 185. 2007; Singh *et al*., *Taiwania* 53(1): 54. 2008.

Plant prostrate, yellowish- brownish green, irregularly branched, 4-5 cm long and 2 mm wide including leaves; secondary branches 1-2 cm long; stem brownish, 0.14 mm wide, 9 cells across, cells thick walled, cortical cells 12-18 × 10-14 µm, medullary cells 18-19 × 14-16 µm; leaf lobes closely imbricate, ovate-oblong, apex

rounded, margin entire, cordite, wide at base, 1.3 × 1 mm; leaf marginal cells quadrate, less trigonous, 15-19 × 14-15 µm; middle cells polyhedral, trigonous present, 22-30 × 20-26 µm; basal cells more trigonous, 28-44 × 14-20 µm; lobules helmet shaped, large, parallel to the stem, 0.8 × 0.5 µm; under leaves appressed to the stem, bifid, orbicular, margin sometimes wavy, 0.8 × 1mm; sinus wide, 124-164 µm deep; perianth 10 keeled, 0.5× 0.1mm; bract 2 paired, dentate; archegonia seen on the tip of main branches; seta thick and fleshy; capsule globose and blackish. (Plate 5.12)

Specimen examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam, Athikode (1300 m), 14-11-14, *Prajitha 12987* (MBGH).

Habitat: Seen on branches along with *Actinodontium rhaphidostegium* (C.Muell.) Bosch & Lac. in the evergreen forests.

Distribution: World: India, Java, Philippines, Sri Lanka and Sumatra.

India: Meghalaya (Singh & Nath, 2007, Nagaland (Bansal *et al*., 2011) and Tamil Nadu (Verma & Srivastava, 2011).

Note: The present collection is a new record for Kerala.

Lejeuneaceae Casares- Gil,

Fl. Iber. Hepat. 703. 1919.

Plant prostrate, greenish or yellowish green or brownish; stem sparsely or irregularly branched; stem 5 – 12 cells across, thin or thick walled; leaves imbricate, ovate or oblong ovate, apex rounded, margin entire or dentate at apex; leaf cells rounded or quadrangular to hexagonal, trigonous present or not; oil bodies present; leaf lobules triangled or ovate or ligulate, constricted at apex, teeth double, first or second one indistinct; under leaves distantly placed or slightly imbricate, lobed or not lobed; if lobed sinus present, lobes sub-acute; if not lobed orbicular- reni form, margin entire or dentate, apex rounded or acute; male inflorescence arising laterally on the main axis; bracts closely imbricate and paired.

Note: The family Lejeuneaceae represents 94 genera. Of these 23 genera are present in India. Of which 11 genera are distributed in Kerala. Of these five genera such as *Cheilolejeunea* (Spruce) Schiffn., *Cololejeunea* (Spruce) Schiffn, *Lejeunea* Lib., *Lopholejeunea* (Spruce) Schiffn and *Spruceanthus* Verd. is represented in the study area.

Key to the genera

1a. Stem 7-12 cells across; under leaves present… .....(2)

1a. Stem 5-6 cells across; under leaves absent…..... .***Cololejeunea***

2a. Under leaves bi lobed; sinus deep… .....(4)

2b. Under leaves not bi lobed; sinus absent… .....(3)

3a. Leaf apex rounded, margin entire; under leaves orbicular, entire at apex…….....***Lopholejeunea***

3b. Leaf apex acute, margin dentate; under leaves orbicular, dentate at apex…… .. .. ***Spruceanthus***

4a. First teeth of lobule 1-2 celled, second teeth indistinct…..... .***Lejeunea***

4b. First teeth of lobule indistinct, second teeth one celled… ..... ***Cheilolejeunea***

Cheilolejeunea (Spruce) Schiffn.,

Engl. & Prantl, Nat. Pflanzenfam. 1(3): 124. 1895.

Plant prostrate, yellowish green or pale green to brownish; sparsely or irregularly branched, 7 cells across; leaves imbricate. widely spreading, ovate, apex rounded, margin entire; leaf cells rounded to irregularly quadrangular; lobes minute, constricted at apex, teeth double, first one indistinct, second one unicellular, small or large, sub-acute or obtuse; under leaves distantly placed, wider than stem, orbicular, bi lobed; lobes sub-acute, margin entire.

Key to the species

1a. Leaf cells mammilose; under leaves small, 0.2 × 0.2 mm; second tooth of lobule large and obtuse…..*C. intertexta*

1b. Leaf cells not mammilose; under leaves large, 0.3 × 0.3mm; second tooth of lobule small and subacute…..*C. serpentina*

Cheilolejeunea intertexta (Lindenb.) Stephani, Hedwigia 29: 85. 1890; Bapna & Kachroo, Hepatic. India, 2: 220. 2000; Nair *et al.*, Bryoph. Wayanad 68. 2005; Singh & Nath, Hepatic. Khasi Jaintia Hills 282. 2007; Manju & Rajesh, Bryoph. Kerala, Liv. (1): 91. 2017. *Lejeunea intertexta* Lindenb., Syn. Hepat. 379. 1845. *Cheilolejeunea kurzii* Stephani, Bot. Gaz. 15: 284. 1890. *C. inflata* Stephani, Sp. Hepat. 5: 645. 1914. *Rectolejeunea santae-mariae* Stephani, Sp. Hepat. 5: 680. 1914. *Cheilolejeunea compacta* (Steph.) M.E. Reiner, Nova Hedwigia 83: 477. 2006.

Plant prostrate; yellowish green; 0.5 mm wide including leaves, 1 cm long; stem sparsely or irregularly branched, 7 cells across; leaves obliquely spreading, ovate, apex rounded, margin entire, 0.4 × 0.3-0.4 mm; leaf marginal cells 12-15 × 13-17 µm, middle cells 21-22 × 19-25 µm, basal cells 25-26 × 26-32 µm; leaf lobules small, apex toothed, tooth double, first one indistinct, second one unicellular, large and obtuse; under leaves present, wider than stem, ovate, bilobed, entire, 0.2 × 0.2 mm, lobes sub-acute, 95.5 µm deep; male inflorescence arising laterally on the main axis; bracts closely imbricate, 3-4 paired. (Plate 5.13)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary: Kakkayam, Ambalappara (1050 m), 11-05-03, *MCN 120190* (CALI); Peruvannamuzhi (100-400 m), 22-03-14, *Prajitha 11040*; 12-09-14, *Prajitha 12544* (MBGH).

Habitat: Seen on rocks in the moist deciduous and semi-evergreen forests.

Distribution: **World**: Africa, America, China, India, Japan, Java, Malaya, Philippines, Sri Lanka, Sumatra and Thailand.

India: Andaman & Nicobar Islands (Lal, 2003), Kerala (Nair *et al.*, 2005a), Maharashtra (Lavate, 2015), Meghalaya (Singh & Nath, 2007), Tamil Nadu (Daniels, 2010; Daniels *et al*., 2018)

Cheilolejeunea serpentina (Mitt.) Mizut., J. Hattori Bot. Lab. 26: 171. 1963; Bapna & Kachroo, Hepatic. India, 2: 223, 2000; Nair *et al.*, Bryoph. Wayanad, 68. 2005; Singh & Nath, Hepatic. Khasi Jaintia Hills, 281. 2007; Singh & Barbhuiya, *Archive for bryol.* 149: 4. 2012. *Lejeunea serpentina* Mitt., J. Proc. Linn. Soc., Bot. 5: 112. 1861. *Cheilolejeunea principensis* Stephani ex Paris, Rev. Bryol. 33: 38. 1906. *Cheilolejeunea madagassa* Stephani, Sp. Hepat. 5: 648. 1914.

Plant prostrate, pale green to brownish; stem irregularly branched, 0.4 mm wide including leaves, 7 cells across, cells irregularly quadrangular, 15-20 × 23-27 µm; leaves imbricate more at the top of the branches, slightly towards the base, widely spreading, ovate, apex rounded, margin entire, 0.52 × 0.4-0.51 mm; leaf cells rounded to irregularly quadrangular, thick walled, trigonous, marginal cells 12-22 × 9-4 µm, middle cells 21-30 × 20-23 µm, basal cells 34-37 × 17-24 µm; lobules minute, constricted at apex, teeth double, first one indistinct, second one unicellular, small and sub-acute; under leaves distantly placed, wider than stem, orbicular, bilobed, 0.3 × 0.3mm; lobes sub-acute, margin entire, 0.16 mm deep.(Plate 5.14)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary: Kakkayam, Raveendra estate (800 m), 10-05-03, *MCN 120122* (CALI); Peruvannamuzhi (460 m), 22-03-14, *Prajitha 11044*; 11-09-14, *Prajitha 14065* (MBGH).

Habitat: Seen on branches in the evergreen and moist deciduous forests.

Distribution: World: Africa, Cameroon, Cariline Island, India, Java, Sri Lanka, Madagascar, Malacca, Philippines, Singapore, Thailand.

India: Assam (Barbhuiya & Singh, 2012)), Kerala, Madhya pradesh (Sharma & Alam, 2011), Meghalaya (Singh & Nath, 2007), Tamil Nadu (Daniels, 2010; Daniels *et al*., 2018)

Kerala: Kozhikode: Kakkavayal Reserve Forest (Manju & Rajesh, 2014), Kakkayam (Manju *et al.*, 2008a), Thiruvananthapuram: Agasthyamala (Manju *et al.*, 2009d).

Cololejeunea (Spruce) Schiffn.,

In Engl. & Prantl, Nat. Pflanzenfam. 1(3): 121. 1895.

Plant prostrate, closely appressed to the substratum, greenish; leaves imbricate; lobes oblong, apex rounded, margin entire; leaf cells quadrangular to hexagonal; lobules triangular or linguate, papillae at the apex.

Cololejeunea madothecoides (Stephani) Benedix, Feddes Repert. Spec. Nov. Regni Veg. Beih. 134: 81. 1953; Singh & Barbhuiya, *Archive for bryol.*, 149: 8. 2012; Manju & Rajesh, Bryophyt. Kerala, Liv. (1): 100, 2017. *Physocolea madothecoides* Stephani, Sp. Hepat. 5: 989. 1916.

Plant prostrate, closely appressed to the substratum, greenish; stem 5mm long and 0.1 mm wide including leaves; leaves imbricate; lobes oblong, apex rounded, margin entire, 1 × 0.5 mm; leaf cells quadrangular to hexagonal, marginal cells 10 × 9-12 µm, basal cells comparatively larger, 38- 42 × 25 µm; lobuless triangular or linguate, papillose at the apex. (Plate 5.15)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary: Peruvannamuzhi (410-600 m), 11-09-14, *Prajitha 14072*; 12-12-14, *Prajitha 12580*; 22-03-14, *Prajitha 11054;* Kakkayam (630 m), 29-12-17, *Prajitha 14153* (MBGH)

Habitat: Epiphyllous and base of tree trunk in the semi evergreen forests and moist deciduous forests.

Distribution: World: Bhutan, Borneo, India, Japan, Java, Sumatra and Vietnam.

India: Kerala [Kasargod: Kammadam kavu (Manju *et al.*, 2012)], Tamil Nadu (Daniels, 2010).

Lejeunea Libert.,

Ann. Gen. Sc. Phys. 6:372. 1820.

Plant prostrate, branched; leaves inccubously placed, ovate, margin entire, apex rounded; leaf cells quadrangular to hexagonal; lobules constricted at apex, first tooth 1 or 2 celled, second one indistinct; under leaves wider than stem, bilobed, lobes subacute, sinus deep.

Lejeunea cavifolia (Ehrh.) Lindb., Acta Soc. Sci. Fenn. 10: 43. 1871; Bapna & Kachroo, Hepatic. India 2: 235. 2000; Singh & Nath, Hepatic. Khasi Jaintia Hills 268. 2007; Singh & Barbhuiya, *Archive for Bryology*, 149: 14. 2012. *Jungermannia cavifolia* Ehrh., Hannover. Mag. 4: 45. 1789.

Plant prostrate, branched, 10 mm long, 0.7 mm wide including leaves; leaves inccubously placed, ovate, margin entire, apex rounded, 0.5 x 0.4mm; leaf cells quadrangular to hexagonal, 18-21 x 28-30 µm; lobules constricted at apex, first tooth 1 or 2 celled, second one indistinct; under leaves wider than stem, bilobed, 0.19 x 0.199 mm, lobes subacute; sinus 68 µm deep, cells 22-28 x 20-27 µm. (Plate 5.16, a-f)

Specimen examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary: Kakkayam: Urakkuzhii (560 m), 11-09-14, *Prajitha 14108* (MBGH).

Habitat: Epiphyllous in the semi evergreen forests.

Distribution: World: America, China, India, Nepal, North Carolina, Russia and Siberia.

India: Andra Pradesh (Sandhya Rani *et al*., 2014), Assam (Barbhuiya & Singh, 2012), Eastern Himalaya (Singh & Nath, 2007), Meghalaya (Singh & Nath, 2007), Kerala [Silent valley National Park (Manju *et al.*, 2013)], Tamil Nadu (Daniels, 2010), Uttarakhand (Mizutani, 1971).

Lopholejeunea (Spruce) Schiffn.,

Engl. & Prantl, Nat. Pflanzenfam. 1(3): 129. 1893.

Plant prostrate, yellowish green or greenish brown; stem sparsely or irregularly branched; stem 7 or 8 cells across, thin walled; leaves imbricate, ovate, apex rounded, margin entire; leaf cells rounded or quadrangular to hexagonal, trigonous; oil bodies densely present; leaf lobules 3 angled or ovate, teeth indistinct or obtuse; under leaves distantly or slightly imbricate, orbicular- reniform, margin entire, rounded at apex.

Key to the species

1a. Under leaves distantly placed; lobules three angled, teeth indistinct……. ……. .....***L. sikkimensis***

1b. Under leaves imbricately placed; lobules ovate, teeth obtuse……..… ……. .....***L. subfusca***

Lopholejeunea sikkimensis Stephani, Sp. Hepat. 5: 87. 1912; Nair *et al.*, Bryoph. Wayanad, 74. 2005; Singh & Nath, Hepatic. Khasi Jaintia & Hills 341. 2007; Singh & Barbhuiya, *Archive for bryology*, 149: 18. 2012.

Plant prostrate, yellowish green to brownish; stem sparsely branched, 1.5 cm long and 1 mm wide including leaves, 8 cells across, thin walled; leaves imbricate. ovate, apex rounded, margin entire, 0.5 × 0.4 mm; leaf cells rounded to polygonal, marginal cells 12-14 × 10-12 µm, non trigonous, middle cells minutely trigonous, 20-22 × 17-22 µm, basal cells more trigonous, 20-32 × 21-22 µm; oil bodies densely present; leaf lobules 3 angled, saccate, 0.2 × 0.1mm, teeth not distinct; under leaves distant, 2 times wide as stem; orbicular- reniform, margin entire, rounded at apex, 0.2 × 0.3mm. (Plate 5.17 a-f)

Specimen examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary: Kakkayam: Athikode (730 m), 11-09-14, *Prajitha 11069* (MBGH).

Habitat: Seen on upper part of tree trunk along with *Plagiochila parvifolia* Lindenb. in the evergreen forests.

Distribution: World: India and Nepal.

India: Assam (Barbhuiya and Singh, 2012), Karnataka (Schwarz, 2013), Kerala (Manju *et al.*, 2008b), Madhya pradesh (Sharma & Alam, 2011), Meghalaya (Singh & Nath, 2007), Sikkim (Singh *et al*., 2016), Tamil Nadu (Alam & Srivastava, 2009; Alam, 2012), Western Himalaya (Singh & Singh, 2008).

Lopholejeunea subfusca (Nees) Schiffner, Bot. Jahrb. Syst. 23: 593. 1897; Bapna & Kachroo, Hepatic. India 2:325. 2000; Nair *et al.*, Bryoph. Wayanad 74, 2005; Singh and Nath, Hepatic. Khasi & Jaintia Hills 245. 2007; Manju & Rajesh, Bryoph. Kerala, Liv. (1):112, 2017. *Jungermannia subfusca* Nees, Enum. Pl. Crypt. Jav. 36. 1830. *Lejeunea subfusca* (Nees) Nees & Mont., Ann. Sci. Nat., Bot., ser. 2, 5: 61. 1836. *Phragmicoma subfusca* (Nees) Nees, Naturgesch. Eur. Leberm. 3: 248. 1838. *Phragmicoma sagraeana* Mont., Hist. Phys. Cuba, Bot., Pl. Cell. 464. 1842. *Phragmicoma cyclostipa* Taylor, London J. Bot. 5: 387. 1846. *Lejeunea sagraeana* var. *pusilla* Spruce, Trans. & Proc. Bot. Soc. Edinburgh 15: 121. 1884. *Lopholejeunea boivinii* Stephani, Sp. Hepat. 5: 64. 1912. *Lopholejeunea pyriflora* Stephani, Sp. Hepat. 9: 88. 1912.

Plant prostrate, closely appressed to the substratum, green to brownish, forms irregular pinnate branches, 10 mm long and 0.6-0.8 mm wide including leaves; stem brownish, 7 cells across, cells thin walled, 15-20 × 20-25 µm; rhizoids brownish, forms cluster at the ventral side; leaves closely imbricate, widely spreading, ovate, margin entire or slightly wavy, apex rounded, 0.5 x 0.4 mm; leaf cells quadrangular to hexagonal, thin walled, trigonous; margin 10 -15 x 12 -15 µm, middle cells 20-23 × 25-27 µm, basal cells 20-25 × 25-30 µm; lobules ovate, tooth obtuse, 0.3 × 0.2 µm; under leaves slightly imbricate, orbicular, margin entire, cells quadrangular, 0.4 × 0.5 mm.(Plate 5.16 h-m)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary: Kakkayam, Vattappara (1000 m), 10-05-03, *MCN 120161* (CALI); Peruvannamuzhi (540 m), 22-03-14, *Prajitha 11053*; 11-09-14, *Prajitha 11056* (MBGH).

Habitat: Seen on base of tree trunk and branches along with *Foreauella orthothecia* (Schwaegr.) Dix. &Vard. in the semi evergreen forests.

Distribution: World: China, Brazil, Carolina Island, Fiji, India, Japan, Java, Madagaskar, Malaya, New Caledonia, New Guinea, Philippines, Sri Lanka, Sumatra, Taiwan,Vietnam, Tahiti, Thailand.

India: Andaman Islands (Singh *et al*., 2010), Karnataka (Schwarz & Frahm, 2013; Schwarz, 2013; Aruna & Krishnappa, 2014), Meghalaya, (Singh & Nath, 2007), Sikkim (Awasthi *et al*., 1999), Tamil Nadu (Alam & Srivastava, 2009; Daniels *et al*., 2018), West Bengal (Awasthi *et al*., 1999).

Kerala: Idukki: Chinnar WLS (Nair *et al.*, 2006), Kozhikode: Kakkayam (Manju *et al.*, 2008).

Spruceanthus Verd.,

Ann. Bryol. Suppl.4: 151. 1934.

Plant prostrate, green- brownish; stem branched irregularly, 12 cells across, thin walled, trigonous; leaves incubus, widely spreading; lobes concave, apex acute, margin dentate at apex; leaf cells rounded to polygonal, trigonous; oil bodies present; leaf lobules truncate at apex, teeth double, apex obtuse; under leaves distant, 2 times wide as stem, orbicular- reniform, margin dentate at apex.

Spruceanthus semirepandus (Nees) Verd., Ann. Bryol., Suppl. 4: 153. 1934; Bapna & Kachroo, Hepatic. India, 2: 315. 2000; Nair *et al.*, Bryoph. Wayanad 75. 2005; Singh and Nath, Hepatic. Khasi & Jaintia Hills 220. 2007. *Jungermannia semirepanda* Nees, Enum. Pl. Crypt. Jav. 39. 1830. *Phragmicoma lehmanniana* Nees, Syn. Hepat. 302. 1845. *Thysananthus lehmannianus* (Nees) Stephani, Sp. Hepat. 4: 785. 1912.

Plant prostrate, green to brownish; stem branched irregularly, 3.5 cm long and 3 mm wide including leaves; stem 12 cells across, polygonal, thick walled, trigonous, 6-12 × 13-18 µm; leaves incubous, widely spreading; lobes concave, ovate, acute at apex, margin dentate towards the tip, dorsal margin cordate at base, 2

× 1 mm; leaf cells rounded to polygonal, marginal cells 10-14 × 20-25 µm, trigonous, middle cells 20-25 × 25-30 µm, basal cells more trigonous, 30-42 × 42-45µm; oil bodies present; leaf lobules truncate at apex, teeth double, apex obtuse; under leaves distant, 2 times wide as stem, orbicular-reniform, margin dentate at apex, 0.3 × 0.4mm. (Plate 5.17 g-m)

Specimen examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary: Kakkayam: Athikode (1420 m), 13-11-14, *Prajitha 12832* (MBGH).

Habitat: Seen on branches along with *Plagiochila* sp. in the evergreen forests.

Distribution: World: China, India, Japan, Java, Philippines, Sri Lanka and Taiwan.

India: Karnataka (Schwarz, 2013; Aruna & Krishnappa, 2014), Kerala (Manju *et al.*, 2008), Meghalaya (Singh & Nath, 2007), Odisha (Mishra *et al*., 2016), Sikkim (Chopra, 1943), Tamil Nadu (Daniels, 2010; Alam, 2012; Daniels *et al*., 2018) Western Himalayas (Srivastava *et al*., 2016).

JUNGERMANNIALES H. Klinggr.,

Die Hoeh. Cryptog. Preus. 34, 1858.

Key to the families

1a. Stem cells differentiated; underleaves absent……..... (2)

1b. Stem cells mostly undifferentiated; underleaves present… ..... (3)

2a. Leaves imbricate, margin dentate; leaf cells with nodulous trigonous ……..... **Plagiochilaceae**

2b. Leaves distant, margin entire; leaf cells without nodulous trigonous ……..... **Cephaloziaceae**

3a. Plant robust; leaf lobed…..... **Anastrophyllaceae**

3b. Plant not robust; leaf not lobed….....4)

4a. Under leaves with narrow sinus, lateral teeth absent……..**Jungermanniaceae**

4b. Under leaves with broad sinus, 2 lateral teeth present……..**Lophocoleaceae**

Lophocoleaceae Vanden Berghen,

Fl. Gen. Belgique, Bryoph. 1(2): 208. 1956.

Plants prostrate, delicate, greenish or yellowish green; stem 8-12 cells across, cells not differentiated; leaves imbricate, transversely spreading, orbicular or sub quadrate, margin entire, apex obtuse or rounded; leaf cells thin walled, trigonous present or absent; under leaves distantly placed, deeply bilobed; sinus broad or narrow at the base, margin toothed on both sides at base; lobes uniseriate towards the tip; female infloresence seen at the tip of the main branches or on lateral branch, bracts and bracteoles oblong, lobed at apex, smaller or larger than leaves; capsule ovoid.

Note: This family includes 21 genera, of which three genera *viz*., *Chiloscyphus* Corda, *Heteroscyphus* Schiffn. and *Lophocolea* (Dumort.) Dumort. are present in India. Of these two geneara *viz*., *Chiloscyphus* Corda, *Heteroscyphus* Schiffn. are represented in the study area.

Chiloscyphus Corda,

Opiz, Beitrage 12: 651. 1828.

Plants forms patches, forms irregular lateral branches, greenish; stem cells thick walled, polygonal, not differentiated; rhizoids hyaline, forms small cluster at the base of under leaves; leaves imbricate, transversely spreading, orbicular or sub quadrate, margin entire, apex obtuse or rounded; leaf cells thin walled, trigonous present; under leaves distantly placed, bilobed, sinus broad or narrow at base, margin toothed on both side at base; lobes uniseriate at tip; female infloresence seen at the tip of the branches, bracts oblong, lobed at apex; bracteoles paired, oblong, tetra lobed; capsule ovoid, spores rounded, greenish.

Chiloscyphus polyanthos (L.) Corda, Naturalientausch 12: 651, 1829; Singh & Nath, Hepatic. Khasi & Jaintia Hills, 81. 2007; Manju & Rajesh, Bryoph. Kerala, Liv. (1): 61. 2017. *Jungermannia polyanthos* L., Sp. Pl., 1131. 1753.

Plants prostrate, branched laterally, greenish, 20 × 1.5 mm; stem cells thick walled, polygonal, not differentiated, 8 cells across, 15-20 × 17-20 μm; rhizoids

hyaline, forms small cluster at the base of under leaves; leaves imbricate, transversely spreading, sub quadrate, margin entire, apex obtuse, 0.9 × 0.8 mm; leaf cells thin walled, trigonous present, marginal cells sub quadrate, 12-16 × 15-16 µm, middle cells quadrate to rounded, 22-25 × 23-25 µm, basal cells quadrate to rounded, 25-30 × 30-35 µm; under leaves distantly placed, wider at base, bilobed, sinus broad at base, 0.2 mm deep, margin toothed on both side at base, 0.3 × 0.3 µm; lobes 4 cells wide at base, 5 cells at tip uniseriate; female infloresence seen at the tip of the branches; bracts oblong, lobed at apex; bracteoles paired, tetra lobed, 0.8 × 0.6 mm capsule ovoid, spores rounded, greenish. (Plate 5.18)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary: Kakkayam, Raveendra estate (800 m) 10-05-03, *MCN 120118* (CALI); 12-01-15, *Prajitha 13508* (MBGH).

Habitat: Seen on land cuttings in the evergreen and semi evergreen forests.

Distribution: World: China, India, Japan, Korea, Nepal, North Africa, North America, Russia, Siberia, Taiwan.

India: Himachal Pradesh (Singh & Singh, 2015), Eastern Himalayas (Srivastava & Srivastava, 2002), Kerala (Manju *et al.*, 2008), Meghalaya (Singh & Nath, 2007), Tamil Nadu (Daniels, 2010).

Economic importance: It is used as aquarium decorative (Glime, 2017).

Heteroscyphus Schiffin.,

Oesterr. Bot. Zeitschr. 60:171. 1910.

Plant prostrate, delicate, branched; dark green to yellowish green; stem cells thick walled, 11-12 cell across; rhizoids hyaline, forms bunches at the under leaf bases; leaves widely spreading succubously placed, rectangular, apex truncate, margin entire with 5-6 terminal dentitions; leaf cells thick walled, 5-6 angled; under leaves distant, deeply bilobed; lobes lanceolate, uniseriate at tip; lateral margin toothed; sinus broad.

Heteroscyphus argutus (Nees) Schiffner, Oesterr. Bot. Z. 60: 172. 1910; Bapna & Kachroo, Hepatic. India, 2: 62. 2000; Nair *et al.*, Bryoph. Wayanad 48. 2005; Singh & Nath, Hepatic. Khasi & Jaintia Hills 77. 2007; Singh & Barbhuiya, *Archive for bryol.*, 149: 13. 2012; Manju & Rajesh, Bryoph. Kerala, Liv. (1): 62, 2017. *Jungermannia arguta* Reinw., Blume & Nees, Nova Acta Phys. Med. Acad. Caes. Leop. Carol. Nat. Cur. 12: 206. 1825. *Chiloscyphus argutus* (Reinw., Nees & Blume) Nees, Syn. Hepat. 183. 1845.

Plant prostrate, branched; dark green to yellowish green, 4-6 cm long and 2 mm wide including leaves; stem thick walled, 11-12 cell across; cortical cells 12-16 × 15-20 μm; medullary cells 12-15 × 18-28 μm; rhizoids smooth, forms bunches at the under leaf bases; leaves parellel to the stem, widely spreading succubously placed, rectangular, apex truncate, margin entire with 5-6 terminal dentitions, 1 × 0.8 mm; leaf teeth 2-4 cells, uniseriate, 2 cells wide at base; marginal cells pentagonal, thick walled, 18-20 × 20-22 μm; median cells hexagonel, thick walled, 15-22 × 22-28 μm; basal cells hexagonal, thick walled, 20-25 × 30-35 μm; chloroplast many, rounded, bead like; under leaves distant, 0.1 × 0.2 mm, deeply bilobed; lamina 9 cells wide; sinus broad; lobes lanceolate, 3 cell wide at base became uniseriate at tip; lateral margin toothed, tooth 2-3 cell long, 2 cells wide at base. (Plate 5.19)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary: Kakkayam (110 - 1150 m), 10-05-03, *MCN 120111* (CALI); 14-11-14, *Prajitha 12868*; 16-03-13, *Prajitha 8664*, *8660*; Peruvannamuzhi: Chenkottakkolli, 15-11-12, *Prajitha 8640* (MBGH).

Habitat: Seen on the upper part of tree trunk, rocks and on landland cuttings along with *Dumortiera hirsuta* (Sw.) Nees in all type of vegetations.

Distribution: World: China, Brazil, India, Japan, Myanmar, New Guinea, New Zealand, Philippines, Sumatra, Taiwan and Vietnam.

India: Andra Pradesh (Sandhya Rani *et al*., 2014), Assam (Barbhuiya and singh, 2012), Himachal Pradesh (Singh & Singh, 2015), Karnataka (Schwarz, 2013),

Kerala, Manipur (Srivastava & Srivastava, 2002), Madhya pradesh (Sharma & Alam, 2011), Meghalaya (Singh & Nath, 2007), Odisha (Mishra *et al*., 2016), Sikkim (Srivastava & Srivastava, 2002), Tamil Nadu (Alam & Srivastava, 2009; Daniels *et al*., 2018), West Bengal (Srivastava & Srivastava, 2002).

Kerala: Idukki: Chinnar WLS (Nair *et al.*, 2006b), Kannur: Aralam WLS (Manju *et al.*, 2009b), Kozhikode: Kakkavayal (Rajesh & Manju, 2014); Kakkayam (Manju *et al.*, 2008a), Wayanad (Nair *et al*., 2005a).

Plagiochilaceae (Joerg.) C. Muell.,

Rabenh, Krypt. Fl. ed. 3, 6(2): 877. 1956.

Plants mostly creeping, simple, often terminal dichotomously or irregularly branched, dark brownish; stem cells differentiated; leaves imbricate, oblong, apex truncate, margin dentate; leaf cells quadrangular- polygonal, trigonous present; androecial and gynoecial bracts paired, dentate; perianth campanulate.

Note: This family represents nine genera. Of these three genera such as *Plagiochila* (Dumort.) Dumort*., Plagiochilion* S. Hatt*., Xenochila* R.M. Schust. are present in India. Of these one genus *viz*., *Plagiochila* (Dumort.) Dumort. is present in Kerala and which extends in the study area.

Plagiochila (Dumort.) Dumort.,

Rec. Obs. Jungerm. 14. 1835.

Plants creeping, simple, often terminal or irregularly branched, dark brownish; stem brownish, cells differentiated; cortical cells brownish, thick walled, 2 or 3 layered; medullary cells thin or thick walled, polygonal; leaves imbricate, oblong, apex truncate, ventral margin arched or straight, 6-13 teeth per leaf; leaf cells quadrangular to polygonal, trigonous small or large; androecia arising intercalary, bracts paired, margin dentate; gynoecia arising terminally, bracts paired, dentate; perianth campanulate.

Key to the species

1a. Stem cortical cells 2 layered, thick walled, medullary cells thin walled…… ……. ……. .....***P. fruticosa***

1b. Stem cortical cells 3 layered, thick walled, medullary cells thick walled…… ..... ***P. parvifolia***

Plagiochila fruticosa Mitt. J. Proc. Linn. Soc., Bot. 5: 94. 1861; Anderson, Syst. Bot. Mono. *Plagiochila* in China, 60: 66. 2001; Nair *et al.*, Bryoph. Wayanad 53. 2005; Singh & Nath, Hepatic. Khasi & Jaintia Hills 151. 2007; Manju & Rajesh, Bryoph. Kerala, Liv. (1): 69. 2017.

Plants creeping, glossy, brownish green, branches arising from the rhizome, up to 8 cm long; stem brownish, cells differentiated, hexagonal, 300 µm wide; cortical cells brownish, thick walled, 2 layered, 5-10 × 10-15 µm; medullary cells thin walled, 12-15 × 15-25 µm; leaves ovate to sub rectangular, ventral margin straight, entire, recurved at base, broader at base, 6-8 teeth per leaf, teeth 3 celled, 1-1.5 × 0.5-0.8 mm; leaf cells minutely trigonous, quadrangular at margin, 10-12 × 15-25 µm; middle cells polygonal, 15-20 × 20-28 µm; basal cells irregular, 25-30 × 15-25 µm; androecia arising intercalary, bracts 6, paired, margin dentate; gynoecia arising terminally, bracts paired, dentate; perianth campanulate, 2.5 × 2.5 mm. (Plate 5.20 a-g)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary: Kakkayam: Sankaranpuzha (1340 m), 12-01-15, *Prajitha 12969*; 11-09-14, *Prajitha 14010* (MBGH).

Habitat: Seen on branches in the evergreen forests.

Distribution: World: China, Bhutan, India, Japan, Philippines and Thailand.

India: Karnataka (Rawat & Srivastava, 2007; Schwarz, 2013), Kerala (Nair *et al*., 2005a; Nair & Madhusoodanan, 2006; Rawat & Srivastava, 2007; Manju *et al*., 2009b), Meghalaya (Singh & Nath, 2007); Sikkim (Hattori, 1966), Tamil Nadu (Rawat & Srivastava, 2007; Verma *et al*, 2013).

Kerala: Idukki (Rawat & Srivastava, 2007,), Kozhikode (Nair & Madhusoodanan, 2006), Thiruvananthapuram (Manju *et al*., 2009b), Wayanad (Nair *et al.,* 2005a).

Economic importance: Plagiochilal B and Plagiochilide isolated from this species have Neurotrophic activity (Alam, 2012).

Plagiochila parvifolia Lindenb. Species Hepathicarum (fasc.1): 28. 1839. Anderson, Syst. Bot. Mono., *Plagiochila* in China 60: 88. 2001; Singh & Barbhuiya, *Archive for Bryol.* 149: 20. 2012.

Plants creeping, often dichotomously branched, brownish, up to 5 cm long; stem brownish, cells differentiated; cortical cells brownish, thick walled, 3 layered, 10 × 12 µm; medullary cells thick walled, 20 × 25 µm; leaves slightly imbricate, oblong, apex truncate, ventral margin straight, broader at middle, 6-7 teeth per leaf, teeth 1-2 cells long, 1.8 × 0.5-1.5 mm; leaf cells irregular in shape, trigonous present; marginal cells 10-12 × 15-20 µm; middle cells 20-30 × 20-25 µm; basal cells 22-25 × 30-35 µm; oil bodies present; androecia arising intercalary, bracts 6 paires, imbricate, margin dentate; gynoecia arising terminally, bracts larger than leaves, margin dentate, 2 × 1.8 mm; perianth campanulate, 3 × 2.5 mm.(Plate 5.20 h-l)

Specimen examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary: Kakkayam (660 m), 14-11-14, *Prajitha 12947* (MBGH).

Habitat: Seen on the upper part of tree trunk along with *Lopholejeunea sikkimensis* Stephani in the evergreen forests.

Distribution: World: China, Bangladesh, Bhutan, India, Japan, Myanmar, New Guinea, Philippines, Sri Lanka, Thailand and Vietnam.

India: Assam (Barbhuiya & Singh, 2012), Himachal Pradesh (Singh & Singh, 2015), Jammu and Kashmir (Rashid *et al*., 2012), Kerala (Manju *et al.*, 2008b).

Cephaloziaceae Douin,

Bull. Soc. Bot. France, Mem. 29:1, 5, 13. 1920.

Plant prostrate, slender, pale green or yellowish green; stem sparsely or irregularly branched; rhizoids hyaline; leaves distant, alternate, bilobed; leaf cells polygonal, trigonous absent; underleaves absent; androecia intercalary, bracts bilobed; gynoecia terminal, bracts bilobed.

Note: This family represents 17 genera, of these six genera such as *Cephalozia* (Dumort.) Dumort., *Fuscocephaloziopsis* Fulford, *Metahygrobiella* R.M.Schust., *Nowellia* Mitt., *Odontoschisma* (Dumort.) Dumort. and *Schiffneria* Steph. are distributed in India. Of these three genera such as *Cephalozia* (Dumort.) Dumort. and *Odontoschisma* (Dumort.) Dumort. are present in Kerala and one genus *viz.*, *Cephalozia* (Dumort.) Dumort. is represented in the study area.

Cephalozia (Dumort.) Dumort.,

Rec. d' Obs., p. 18. 1835.

Plant prostrate, pale green or yellowish green; rhizoids hyaline; leaves alternate, narrowed towards the apex, bilobed; leaf cells hexagonal, except at margin where cells are quadrangular; trigonous absent; underleaves absent; androecia intercalary, bracts bilobed; gynoecia terminal, bracts bilobed, larger than leaves.

Cephalozia pandei Udar & D. Kumar, *Geophytology* 6: 38.f. 22–24. 1976; Singh & Nath, Hepatic. Khasi & Jaintia Hills 59. 2007.

Plant prostrate, delicate, pale green, sparsely branched, 1-1.5 cm long; stem 0.1 mm wide, cells differentiated, polygonal, thin walled; rhizoids hyaline, many, scattered; leaves distant, alternate, narrowed towards the apex, 0.35 × 0.26 mm, bilobed, lobes 2 cells long and 3 cells wide at base, 0.08 mm deep, 0.04 mm distance apart; marginal cells quadrangular, 32-37 × 24-27 µm, middle cells hexagonal, 44 - 58 × 23-26 µm, basal cells hexagonal, 48-58 × 28-38 µm; trigonous absent; underleaves absent; androecia intercalary, bracts bilobed; gynoecia terminal, bracts

bilobed larger than leaves, 1 × 0.15 mm. (Plate 5.21)

Specimen examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary: Peruvannamuzhi (150 m), 22-05-14, *Prajitha 12584* (MBGH).

Habitat: Seen on moist soil and on rocks in the moist deciduous forests.

Distribution: India: Assam (Das & Sharma, 2016), Meghalaya (Singh *et al*., 2003; Singh & Nath, 2007).

Kerala: Agasthyamala (Manju *et al.*, 2009d)

Scapaniaceae Mig.,

Krypt. Fl. Deutschl., Moose, 479. 1904

Plant robust, erect – procumbent, irregularly branched; stem cells thick walled, hexagonal; leaves obliquely inserted, contiguous –imbricate, ovate-oblong, apex acute or acuminate, margin entire, variously lobed; lobe toothed at base; sinus deep; under leaf present, bifid; sinus descends to the base.

Note: This family is represented by 25 genera. Of these five genera such as *Anastrepta* (Lindb.) Schiffn*., Anastrophyllum* (Spruce) Schiffn*., Isopaches* H. Buch, *Plicanthus* R.M. Schust*.,* and *Tetralophozia* (R.M. Schust) Schljakov are present in India. Of these one genus *viz*., *Plicanthus R.M. Schust* is represented in the study area.

Plicanthus Schust.,

Nova Hedwigia, 74: 484. 2002.

Plant robust, yellowish –brownish green, erect – procumbent, irregularly branched; stem cells thick walled, hexagonal; cortical cells yellowish, 1-2 layered; medullary cells hyaline, comparatively large; leaves obliquely inserted, contiguous-imbricate, ovate-oblong, apex acute or acuminate, margin entire, variously lobed; dorsal lobe large, ventral lobe small, toothed at base; lobe acute or narrowly acuminate at apex; sinus descends to the base; leaf cells trigonous; under leaf bifid;

sinus descends to the base; lobes oblong lanceolate, toothed at the base.

Plicanthus birmensis (Stephani) R.M. Schust., Nova Hedwigia 74: 486. 2002; Manju & Rajesh, Bryoph. Kerala, Liv. (1): 80. 2017. *Chandonanthus birmensis* Steph., Bull. Soc. Roy. Bot. Belgiqui 38 (1): 43. 1899.

Plant robust, yellowish–brownish green, procumbent, apex sub erect, irregularly branched, sometimes dichotomously branched at apex, 3-4 cm long; stem 0.1 mm wide, cells thick walled, hexagonal; cortical cells yellowish, 1-2 layered, 8-10 × 10-12 µm; medullary cells hyaline, comparatively large, 12-13 × 20-25 µm; leaves obliquely inserted, contiguous to imbricate, ovate-oblong, apex narrowly acuminate, margin entire, bilobed, 1 × 0.5 mm; dorsal lobe large, ventral lobe small, sometimes with few teeth at base; apex of the each lobe have 2-6 uniseriate cells; sinus descends to the base; leaf apical cells 30-42 × 8-10 µm, middle cells trigonous, 21 × 12 µm, basal cells trigonous, 20- 22 × 13 µm; under leaf bifid, 1 × 0.3 mm; sinus 0.5 mm deep; lobes oblong lanceolate, 2-4 teeth present at the base. (Plate 5.22)

Specimen examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary: Kakkayam, Ambalappara (1130 m), 26-09-12, *Prajitha 8530* (MBGH).

Habitat: Forms dense mat on branches in the evergreen forests.

Distribution: World: India, Japan, Myanmar, Madagaskar, Malaya, Sri Lanka

India: Karnataka (Schwarz, 2013 as *Chandonanthus birmensis*), Kerala (Manju *et al.*, 2008b), Meghalaya (Singh & Nath, 2007 as *Chandonanthus birmensis*), Sikkim (Chopra, 1943 as *Chandonanthus birmensis*).

Jungermanniaceae Rchb.,

Bot. Damen. P. 256, 1828.

Plant prostrate – ascending, simple or sparsely or laterally or irregularly branched; stem cells not differentiated, 6-9 cells across; cells polygonal, thin or thick walled and hyaline; rhizoids purple or hyaline, scattered or forms cluster at the

ventral side; leaves succubous or distant- contiguous, alternate, ovate- sub quadrate, apex rounded, not lobed, margin entire; leaf cells quadrangular or polygonal, trigonous or non trigonous; under leaves present or absent.

Note: This family is represented by 13 genera. Of these three genera such as *Jungermannia* L., *Nardia* Gray *and Notoscyphus* Mitt. are distributed in India and in the present study area.

Key to the genera

1a. Stem 6-7 cells wide; under leaves present.. .....(2)

1b. Stem 8-9 cells wide; under leaves absent….....***Jungermannia***

2a. Leaf cells thick walled, with large, nodulous trigonous; underleaves ovate-oblong, bifid….. ..... .***Notoscyphus***

2b. Leaf cells thin walled, without trigonous; underleaves small, ligulate…...***Nardia***

Jungermannia L.,

Sp. Plant. 1131. 1753**.**

Plant prostrate – ascending, branched laterally or irregularly; stem 8-9 cells across; cells polygonal, thin or thick walled and hyaline; rhizoids purple or hyaline, scattered or forms cluster at the ventral side; leaves imbricate or distant- contiguous, alternate, ovate- sub quadrate, reniform- rotundate, apex rounded or obtuse, not lobed, margin entire; leaf cells quadrangular or polygonal, trigonous or non trigonous; under leaves absent.

Key to species

1a. Rhizoids hyaline, forms cluster at the ventral side; leaf cells with prominent trigonous…. …..... 2)

1b. Rhizoids purple, scattered at the ventral side; leaf cells with trigonous less or absent…….....***J. rubripunctata***

2a. Stem simple or rarely branched; leaf cells quadrate… ..... ***J. comata***

2b. Stem laterally branched; leaf cells polygonal…..... ***J. truncata***

Jungermannia comata Nees, Enum. Pl. Crypt. Jav. 78. 1830. Singh & Nath, Hepatic. Khasi & Jaintia Hills, 97. 2007. *Plectocolea comata* S. Hatt., Bull. Tokyo Sci. Mus. 11:38. 1944.

Plant prostrate, procumbent, apex sub erect, pale green – brownish, 1cm long and 1.8 mm wide including leaves; stem rarely branched, 8 cells across, cells polygonal, thick walled, hyaline, 0.2 mm wide; cortical cells 12-14 × 15-17 μm; medullary cells 15-16 × 20-25 μm; rhizoids hyaline, forms fascicle at the base of the leaf; leaves obliquely inserted, imbricate or distant, contiguous, ovate- rotundate, apex rounded, margin entire, 1.5 × 0.7 mm; leaf cells thick walled, trigonous present; marginal cells quadrangular, 12-13 × 15-16 μm, trigonous small; middle cells sub quadrate, 16-18 × 20-25 μm; basal cells irregularly quadrate, trigonous large, 20-25 × 30-35 μm. (Plate 5.23 a-g)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary: Kakkayam, Athikode (900 m), 15-11-12, *Prajitha 8634*; Ambalappara (800 m), 11-09-14, *Prajitha* 1*4032* (MBGH).

Habitat: Seen on land cuttings and rocks in the semi evergreen forests.

Distribution: World: China, India, Java, Japan, Philippines, Sumatra and Thailand.

India: Assam (Barbhuiya & Singh, 2012), Meghalaya (Singh & Nath, 2007), Nagaland (Vana, 1972), Sikkim (Amakawa, 1970), West Bengal (Amakawa, 1970).

Note: No earlier report of this species from Peninsular India, hence the present collection is a new record for Peninsular India.

Jungermannia rubripunctata (S. Hatt.) Amak., J. Hattori Bot. Lab.22: 38. 1960; Singh and Nath, Hepatic. Khasi & Jaintia Hills 99. 2007; Manju & Rajesh, Bryoph. Kerala, Liv. (1): 76. 2017. *Plectocolea rubripunctata* S. Hatt., J. Hattori Bot. Lab. 3: 41. f. 36. 1948.

Plant prostrate to ascending, branched, 2 cm long and 0.8 mm wide including leaves; stem 0.2 mm wide, 8 cells across; cells thin walled and hyaline; cortical cells 10-15 × 15-18 μm; medullary cells 20-25 × 20-30 μm; rhizoids purple, scattered at

the ventral side; leaves imbricate or distant- contiguous, alternate, ovate- sub quadrate, apex rounded, margin entire, 0.56 × 0.57 mm; leaf marginal cells quadrangular, less trigonous, 19-28 × 18-23 µm, middle cells polygonal, non trigonous, 27-22 × 29-38 µm, basal cells polygonal, less trigonous, 49-56 × 13-16 µm. (Plate 5.23 h-l)

Specimen examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary: Peruvannamuzhi (385 m), 22-03-14, *Prajitha 11052* (MBGH).

Habitat: Seen on land cuttings in the moist deciduous forests.

Distribution: World: China, India, and Japan and Nepal.

India: Arunachal Pradesh (Singh,1996), Kerala (Manju & Rajesh, 2017), Meghalaya (Singh & Nath, 2007).

Jungermannia truncata Nees, Enum. Pl. Crypt. Jav. 29. 1830; Singh & Nath, Hepatic. Khasi & Jaintia Hills 105. 2007. *Jungermannia shinii* Amak., J. Hattori Bot. Lab. 33: 156. f. 27. 1970. *Plectocolea setulosa* Herzog, J. Hattori Bot. Lab. 14: 33. f. 3. 1955.

Plant prostrate - ascending, branched laterally; stem 9 cells across; cortical cells 12-15 × 16-18 µm; medullary cells 15-18 × 20-25 µm; rhizoids many, scattered; leaves obliquely inserted, widely spreading, imbricate or contiguous, ovate- subquadrate, margin entire, apex obtuse or rounded, 0.5 ×0.4 mm; leaf marginal cells sub quadrangular, 22-29 × 29-36 µm, middle cells polygonal, less trigonous, 36-49 × 25-26 µm, basal cells polygonal, more trigonous, 51-58 × 25-27 µm. (Plate 5.24 a-e)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary: Peruvannamuzhi (430 m), 22-03-14, *Prajitha 11051*; Kakkayam (480m), 11-09-14, *Prajitha 14013* (MBGH).

Habitat: Seen on land cuttings in the semi evergreen forests.

Distribution: World: China, India, Japan, Java, Nepal and Thailand.

India: Meghalaya (Singh & Nath, 2007), Kerala (Manju *et al.*, 2008b), Tamil Nadu (Alam & Srivastava, 2009), Western Himalayas (Chopra, 1943)

Nardia S.F. Gray,

Nat.Arr.Brit. Pl. 1:694. 1821.

Plants prostrate, sub erect at apex, yellowish to brownish green; stem sparsely branched, cortical cells smaller than medullary cells; leaves succubously placed or distant- contiguous, alternate, reniform to ovate, inserted obliquely, apex almost rounded, margin entire; under leaves lanceolate, small.

Nardia assamica (Mitt.) Amakawa, J. Hattorri Bot. Lab. 26:20-26. 1963; Singh & Nath, Hepatic. Khasi & Jaintia Hills 124. 2007. *Jungermannia assamica* Mitt., In.J. Proc. Linn. Soc., Bot. London 5:90. 1861. *J. sieboldii* Sande, Lac. Ann. Musc. Bot. Lugduno- Batavi1: 288. 1863; *Nardia grandistipula* Stephani, Bull. Herb.Boissier 5:100. 1897.

Plant prostrate, yellowish to brownish green, apex sub erect; stem sparsely branched, 2.5 cm long, 2mm wide including leaves, 7 cells wide (200 µm), quadrangular to hexagonal; cortical cells comparatively small, 10 × 11 µm; medullary cells 15-16 × 13-14 µm; rhizoids seen along the ventral side of the stem, purple in colour; leaves reniform to ovate, contiguous, inserted obliquely, apex almost rounded, margin entire, 1 × 1 mm; leaf cells containing many rounded chloroplast, which are placed near the cell wall; marginal cells quadrangular, 34-36 × 21µm; middle cells quadrangular to hexagonal, 53-57 × 29-38 µm; basal cells almost quadrangular, 75-79 × 24-35 µm; under leaves less prominent, very small, triangular, wider at middle, narrowed towards the base, apex notched, 0.2 × 0.1 mm. (Plate 5.25).

Note: In *Nardia assamica* (Mitt.) Amakawa, stem 11-12 cells across, but here it is seven cells across; rhizoids colorless in *N. assamica* but here rhizoides are purple in colour; underleaves obtuse or sub-acute at apex and wider at base in *N. assamica* but here the underleaf notched at the apex and narrowed towards the base. All other characters are similar to *Nardia assamica* (Mitt.) Amakawa. This may be due to the

microhabitat variation of the species.

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam: Sankaranpuzha (800 m), 11-09-14, *Prajitha 12761, 12763* (MBGH).

Habitat: Seen on land cuttings in the evergreen forests.

Distribution: World: China, India, Japan, Korea, Malaysia and North America.

India: Meghalaya (Singh & Nath, 2007).

Note: Prajitha *et al*., (2017) reported this species as new record to Peninsular India.

Notoscyphus Mitt.,

Fl. Vit. 407. 1873.

Plant prostrate, yellowish green; stem sparsely or irregularly branched, 7 cells wide, cells thick walled; rhizoids hyaline; leaves succubous, imbricate, ovate, sub quadrate, apex truncate or rounded or obtuse; leaf cells polygonal, thick walled with large nodulous trigonous; under leaves prominent, large, ovate-oblong, bifid, lobes uniseriate towards the apex.

Notoscyphus paroicus Schiffner, Denkschr. Kaiserl. Akad. Wiss., Math.-Naturwiss. Kl. 67: 192. 1898. Singh & Nath, Hepatic. Khasi & Jaintia Hills 127. 2007; Manju & Rajesh, Bryoph. Kerala, Liv. (1): 79. 2017.

Plant prostrate, yellowish green, 1.5 cm long 1 mm wide; stem irregularly branched, 7 cells wide, cells thick walled; cortical cells 6-8 × 10-12 µm; medullary cells 8-12 × 15-16 µm; rhizoids hyaline, arrising from the base of the under leaves; leaves imbricate, ovate, truncate at apex, 1 × 0.5-0.6 mm; leaf cells polygonal, thick walled trigonous present; marginal cells 18-23 × 30-33 µm; middle cells 30-35 × 40-45µm; basal cells with large nodulous trigonous, 35-40 × 44-45 µm; under leaves prominent towards the apex at the ventral side of the stem, large, ovate-oblong, erecto patent, bifid; lobes 4 cells long and 2 cells wide at base, 3 cells uniseriate towards the apex, 0.3 × 0.1 mm. (Plate 5.24 f-k)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary: Peruvannamuzhi: Chenkottakkolli (260-420 m), 12-01-15, *Prajitha 13503*; 11-09-14, *Prajitha 14128* (MBGH).

Habitat: Seen on land cuttings in the moist deciduous forests.

Distribution: World: India, Japan, Java, Sri Lanka, Sumatra and Thailand.

India: Kerala (Manju & Rajesh, 2017), Meghalaya (Singh & Nath, 2007), Tamil Nadu (Alam & Srivastava, 2009).

ANTHOCEROTOPHYTA Rothm. ex Stotler & Crand. Stotler,

The gametophyte is thalloid, flattened and lobed, which attached to the substratum is by unicellular rhizoids. Thalllus without internal tissue differentiation present; pyrenoid present in each cells. Capsule horn like, erect or horizontally placed.

Anthocerotales Limpr.,

Cohn, F. Krypt. Fl. Schlesien 1:239. 1877

Key to the families

1a. Capsule erect, arising from dorsal surface of the thallus, projected out from the involucre…….....**Anthocerotaceae**

1b. Capsule horizontal, arising from the marginal side of the thallus, enclosed in the involucre…….....**Notothyladaceae**

Anthocerotaceae Dumort.,

Analys. Fam. Pl.:68, 69. 1829

Plants thalloid, prostrate, forms rosettes, margin dissected; rhizoids hyaline, smooth walled; scales absent; antheridia club shaped, seen in 2 layered chamber; archegonia embedded in thallus; mucilage chambers present, 1-2 layered; seta long; capsule bivalved, erect; elaters branched or not, 2-4 celled; spore dark brown, rounded.

Note: The family is represented by three genera such as *Anthoceros* L.*, Folioceros* D.C. Bharadwaj and *Sphaerosporoceros* Hassel. Of these two genera *Anthoceros* L.*, Folioceros* D.C. Bharadwaj are present in Kerala. Of these one genus *viz*., *Anthoceros* is represented in the study area.

Anthoceros L.,

Sp.Pl., 2:1139. 1753

Thallus forms rosettes, spongy, dark green, margin dissected deeply; rhizoids hyaline, smooth walled; epidermal cells containing chloroplast and pyrenoides; mucilage chambers present, 1-2 layered; seta long; capsule bivalved, erect; pseudo elaters branched or not, 2-4 celled; spore dark brown, rounded, spinulate.

Anthoceros crispulus (Mont.) Douin, Rev. Bryol. 32: 27. 1905; Pande and Bharadwaj, J. Indian Bot. Soc. 28:5. 1949; Nair *et al.*, Bryoph. Wayanad 80. 2005; *Anthoceros punctatus* var. *crispulus* Mont., Hist. Nat. Iles Canaries 4: 195. 1840.

Thallus forms rosettes, dark green, 1.5 cm wide; rhizoids hyaline, smooth walled; epidermal cells containing chloroplast and pyrenoides; mucilage chambers present, 1-2 layered; seta 4 cm long; capsule bivalved, erect; elaters 2-4 celled, 250-300 µm long; spore dark brown, rounded, spinulate, 40-45 µm wide. (Plate 5.26)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary: Kakkayam: (320 m), 12-09-14, *Prajitha 12567*; Peruvannamuzhi (140 m), 14-11-14, *Prajitha 12979* (MBGH).

Habitat: Seen on forest floor in the moist deciduous forests.

Distribution: World: America, India, Japan, Korea, Malaysia, North Carolina and Sri Lanka.

India: Andra Pradesh (Sandhya Rani *et al*., 2014), Bihar (Bapna & Kachroo, 2000),, Karnataka (Aruna & Krishnappa, 2014), Kerala (Manju *et al*., 2008b), Maharashtra (Lavate, 2015), Tamil Nadu (Daniels, 2010).

Kerala: Idukki (Rajeevan, 1990), Palakkad (Srivastava & Sharma, 2000), Wayanad (Nair *et al*., 2005a).

Notothyladaceae (Milde) Muell.,

Frib. Ex Prosk. Phytomorph. 10: 1-19. 1960.

Plants thalloid, prostrate, delicate, yellowish green forms closely overlapping rosettes, margin crenulated, dissected; rhizoids smooth, hyaline; leaf cells chlorophyllous; 2-4 antheridia found in each chamber; archegonia embedded in thallus; sporophyte arising from marginal notches; capsule enclosed with in involucre; brownish, cylindrical, bivalved, without stomata, columella not seen; pseudo elaters linear, 2-3 celled; spore brownish.

Note: This family include five genera *viz.*, *Notothylas* Sull. *ex* A. Gray, *Phaeoceros* Prosk. and *Paraphymatoceros* Hassel., *Hattorioceros* (J. Haseg.) J. Haseg and *Mesoceros* Piippo. Of these two genera *viz*., *Notothylas* Sull. *ex* A. Gray and *Phaeoceros* Prosk. are distributed in India and Kerala. Of these one genus, *Notothylas* Sull. *ex* A. Gray is represented in the present study area.

Notothylas Sull. ex A. Gray,

Amer. J. Sci. Arts, 51:74. 1846

Plants prostrate, delicate, yellowish green forms closely overlapping rosettes, margin crenulated, dissected; 2-4 antheridia found in each chamber; archegonia embedded in thallus; sporophyte arising from marginal notches; capsule enclosed with in involucre; brownish, cylindrical, bivalved, without stomata, columella not seen; pseudo elaters 2-3 celled; spore brownish, tetrahedral.

Notothylas levieri Schiffner ex. Steph., Spec. Hep. 5:1021. 1917; Kashyap, Liv. W. Himalayas & Punjab, 129. 1929; Singh, Notothylaceae India & Nepal, 111. 2002; Nair *et al.*, Bryoph. Wayanad, 90. 2005; Singh & Barbhuiya, *Archive for bryol.*, 149: 25. 2012.

Thallus delicate, yellowish green forms closely overlapping rosettes, margin crenulated, dissected, 2 × 1 cm; rhizoids smooth, hyaline; leaf cells chlorophyllous; sporophyte arising from marginal notches; capsule brownish, cylindrical, bivalved, without stomata, columella not seen; pseudo elaters linear, 2-3 celled up to 50 µm

long; spore brownish, tetrahedral, 45 µm wide. (Plate 5.27)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary (140-380 m): Peruvannamuzhi 12-09-14, *Prajitha 12586*; 22-03-14, *Prajitha 11048* (MBGH).

Habitat: Seen on forest floor in the moist deciduous forests.

Distribution: India: Andra Pradesh (Sandhya Rani *et al*., 2014), Chhattisgarh, Gujarath, Himachal Pradesh (Singh & Singh, 2015), Kerala (Manju *et al*., 2008), Madhya Pradesh (Asthana & Gupta, 2015), Maharashtra (Lavate, 2015), Panjab, Odisha (Mishra *et al*., 2016), Rajasthan, Uttarakhand (Dandotiya *et al*. 2011).

BRYOPHYTA Schimp.

Mosses are the most diversified group of Bryophytes. Gametophyte is either erect or prostrate, branched or not; midrib prominent, single or double; rhizoids multicellular and branched; sporophyte differentiated in to foot, seta and capsule. Two types of mosses are there acrocarpic mosses, where the sporophyte arising from the tip of the erect gametophyte and pleurocarpic mosses, where the gametophyte is prostrate and sporophyte arising from the tip of lateral branches.

Polytrichales Cavers.,

New Phytol. 10 (1-2): 31. 1911.

Polytrichaceae Schwaeger,

Willd. Sp. Pl. ed. 4. 5(2): 1. 1830

Plants slender, dark green, rigid; stem unbranched, with central strand; leaves smaller at the base of stem, larger towards the apex, leaves lamellose, lanceolate, apex acute, margin dentate except at the base; costa strong, percurrent; leaf cells rounded and obscure at apex, rectangular and incrassate at apex; peristome with 32 teeth; operculum rostrate; calyptra hairy.

Note: This family includes 23 genera *viz*., *Alophozia* Card., *Atrichopsis* Card., *Atrichum* P. Beauv., *Bartramiopsis* Kindb., *Dawsonia* R. Br., *Dendroligotrichum* (Muell. Hal.) Broth., *Hebantia* G. L. Sm. Merr., *Itatiella* G. L. Sm., *Lyellia* R. Br.,

Meiotrichum (G. L. Sm.) G.L. Sm. Merr., *Notoligotrichum* G. L. Sm., *Oligotrichum* Lam. & DC., *Plagioracelopus* G. L. Sm. Merr., *Pogonatum* P. Beauv., *Polytrichadelphus* (Muell. Hal.) Mitt., *Polytrichastrum* G. L. Sm., *Polytrichum* Hedw., *Pseudatrichum* Reimers, *Pseudoracelopus* Broth., *Psilopilum* Brid., *Racelopodopsis* Ther., *Racelopus* Dozy & Molk. and *Stereobryon* G. L. Sm. Of these five genera *viz*., *Atrichum* P. Beauv., *Lyellia* R. Br., *Oligotrichum* Lam. & DC., *Pogonatum* P. Beauv. and *Polytrichum* Hedw. are distributed in India. Among these three genera *viz*., *Atrichum* P. Beauv., *Pogonatum* P. Beauv. and *Polytrichum* Hedw. occur in Kerala. The genus *Pogonatum* P. Beauv. is represented in the study area.

Pogonatum P. Beauv.,

Mag., Encycl. 5: 329. 1804.

Plants slender, greenish, simple, not branched; stem with central strand; leaves concave, lanceolate, apex acute, margin entire at extreme base and dentate towards the apex; costa strong, wider at the base; leaf cells at the base rectangular and incrassate, cells towards the apex obscure and rounded; seta erect and elongated; capsule erect; peristome with 32 teeth; operculum rostrate; calyptra hairy and covering the capsule.

Pogonatum patulum (Harv.) Mitt., J. Proc. Linn. Soc., Bot., Suppl. 2: 152. 1859; Gangulee, Moss. E. India 1 (1): 123. 1969. *P. hexagonum* Mitt., J. Proc. Linn. Soc., Bot., Suppl. 2: 151. 1859. *P. strictifolium* Broth. ex Gangulee, Nova Hedwigia 12: 419. pl. 2. 1966.

Plants slender, greenish, simple, unbranched, 3-4 cm long; stem with central strand; leaves smaller towards the base of the stem, curled when dry, concave, lanceolate, broad at base, apex acute, margin entire at extreme base and dentate towards the apex, 3-6 × 1 mm; costa strong, wider at the base; leaf cells at the base rectangular, incrassate, 30-40 × 15 µm, cells towards the apex obscure, rounded, 20-30 × 10-12 µm; seta erect, elongated, 2.5 cm long; capsule erect- sub erect; peristome with 32 teeth; operculum rostrate; calyptra hairy, covering the capsule. (Plate 5.28)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary: Kakkayam, Ambalappara (420-830 m), 26-09-12, *Prajitha 8515*; 12-01-15, *Prajitha 13520*; Peruvannamuzhi, Chenkottakkolli (260 m), 7-01-18, *Prajitha 14129* (MBGH).

Habitat: Terrestrial on soil and on land cuttings in the moist deciduous and semi evergreen forests.

Distribution: World: India and East Nepal (Gangulee, 1969).

India: Karnataka (Schwarz, 2013), Kerala (Manju *et al.*, 2008b) Tamil Nadu (Daniels, 2010) and Western Himalayas (Alam, 2013).

Dicranales M. Fleisch.,

Hedwigia 61(4): 392. 1920.

Key to the family

1a. Leaves distichous with sheathing lamina present … ..... **Fissidentaceae**

1b. Leaves not distichous, sheathing lamina absent… .....(2)

2a. Peristome teeth split at the base… ..... .**Ditrichaceae**

2b. Peristome teeth not split at the base…..... (3)

3a. Gemmiferous leaves present; alar cells absent ..... (4)

3b. Gemmiferous leaves absent; alar cells present… .....**Dicranaceae**

4a. Leaf cells differentiated into chlorocyst and leucocyst…..... .**Leucobryaceae**

4b. Leaf cells not differentiated into chlorocyst and leucocyst… ..... **Calymperaceae**

Fissidentaceae Schimp.,

Coroll. Bryol. Eur. 20.1856

Plants simple or branched, yellowish green; leaves curled when dry, dimorphic, oblong- lanceolate, apex acute or acuminate, margin crenulated by projection of marginal cells; dorsal lamina narrowing towards the base; sheathing lamina open, unequal or closed, equal; costa excurrent or percurrent; marginal 2-3

layers of semilimbidium present or absent; leaf cells quadrangular to hexagonal with conical mamillae present or not; seta reddish; capsule cylindrical or ovate; spore rounded.

Note: This family include only one genus, *Fissidens* Hedw.

Fissidens Hedw.,

Sp. Musc 152. 1801

Key to the species

1a. Semilimbidium present…..(2)

1b. Semilimbidium absent……..……..……(3)

2a. Leaves curled when dry, up to 15 pairs… .....***F. asperisetus***

2b. Leaves not curled when dry, up to 12 pairs…. .....***F. subfirmes***

3a. Dorsal lamina decurrent…. .....….***F. curvato- involutus***

3b. Dorsal lamina not decurrent…. .....(4)

4a. Sheathing lamina equal, closed…. .....***F. crispulus***

4b. Sheathing lamina unequal, open .....(5)

5a. Costa percurrent; leaf cells quadrangular to hexagonal…. ....***F. subpulchellus***

5b. Costa excurrent; leaf cells rounded to hexagonal…. .....***F. crenulatus***

Fissidens asperisetus Sande Lac. Verh. Kon. Ned. Akad. Wetensch. Afd. Natuurk. 13: 2. pl. 1: b. 1872; Gangulee, Moss. E. India 1(2): 507. 1971; Nair *et al.*, Bryoph. Wayanad 104. 2005. *Fissidens hollianus* var. *asperisetus* (Sande Lac.) M. Fleisch., Musci Buitenzorg 1: 34. 1904.

Plants mostly simple, dark green; leaves 13-15 paired, curled when dry, oblong, apex acuminate, margin crenulate by projection of marginal cells, dorsal lamina narrowing down at base, sheathing lamini almost equal, narrowing towards the top, 1.5 × 0.5 mm; costa yellowish, percurrent; laminal cells irregularly quadrangular-hexagonal with 1 or 2 papillae on each cells, 5-6 × 5-7 µm, semilimbidium boardering the sheathing lamina by 2-3 rows of narrow, elongated,

cells; seta reddish, 5mm long; capsule cylindrical, 0.3 mm long. (Plate 5.29 a-f)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam, Sankarnpuzha (480 m), 27-09-12, *Prajitha 8606*; 12-01-15, *Prajitha 13528*; Peruvannamuzhi, Moothaveedupuzha (320 m), 16-03-13, *Prajitha 8645*, *8646* (MBGH).

Habitat: Seen on wet rocks and soil cuttings in the semi evergreen and evergreen forests.

Distribution: World: Celebes, India, Java, Philippines and Sri Lanka.

India: Andaman Island (Gangulee, 1971) and Kerala (Nair*et al.*, 2005a).

Kerala: Kannur: Aralam WLS (Manju *et al.*, 2009) and Wayanad (Nair *et al.*, 2005a)

Fissidens crenulatus Mitt., J. Proc. Linn. Soc., Bot. Suppl. 1 (2): 140. 1859; Gangulee, Moss. E. India 1(2): 504. 1971; Nair *et al.*, Bryoph. Wayanad 105. 2005. *F. titalyanus* Muell. Hal., Linnaea 37: 165. 1872. *F. axilliflorus* Thwaites & Mitt., J. Linn. Soc., Bot. 13: 325. 1873. *F. treubii* M. Fleisch., Hedwigia 38 (Beibl.): 125. 1899. *F. elmeri* Broth., Leafl. Philipp. Bot. 2: 652. 1909. *F. semperfalcatus* Dixon, J. Siam Soc., Nat. Hist. Suppl. 10: 2. 1935. *F. hueckii* P. de la Varde, Rev. Bryol. Lichenol. 15: 145. 1945. *F. hillianus* H.A. Mill. & D.R. Sm., Micronesica 4: 218. f. 2. 1968.

Plants simple or branched at the base, stem brownish, rhizomatous at base, 4-5 mm long; leaves 10- 15 pairs, curled when dry, oblong to lanceolate, apex acute, margin crenulated by upturned marginal cells, dorsal lamina narrowing towards the base, sheathing lamina open, unequal, 1.5 × 0.3 mm; costa excurrent; leaf cells rounded to hexagonal, conical papillae present, 5-6 × 5 µm; percheatial leaves narrow, lanceolate; seta brownish, 5 mm long; capsule erect, ovate; spores rounded, 10 µm wide. (Plate 5.29g-l)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Peruvannamuzhi, Chenkottakkolli (130-380 m), 16-03-13, *Prajitha 8670*; 29-12-17, *Prajitha 14143*; Kakkayam, Urakkuzhi (490 m), 11-09-14, *Prajitha 14006* (MBGH).

Habitat: seen on soil cuttings in the moist deciduous forests.

Distribution: World: Burma, China, India, Nepal and Philippines.

India: Andhra Pradesh (Manjula and Manju, 2016), Karnataka (Aruna & Krishnappa, 2014), Kerala (Nair *et al.*, 2005a) , Maharashtra (Magdum *et al*., 2017), Orissa (Mishra *et al.*, 2016), Tamil Nadu (Daniels, 2010), and Uttar Pradesh (Sahu & Asthana, 2015)

Kerala: Wayanad (Nair *et al.*, 2005a)

Economic importance: It is used for stone in bladder and for desentery (Murugan *et al.*, 2014).

Fissidens crispulus Brid., Muscol. Recent. Suppl. 4: 187. 1819. var. ***crispulus*** Brid., Musc. Rec. Suppl. 4: 187. 1819; Nair *et al.*, Bryoph. Wayanad 105. 2005; Manju & Rajesh, *Archive for Bryol.* 92: 6. 2011; Asthana & Srivastava, *Taiwania* 60 (3): 3. 2015. *F. bryoides* var. *crispulus* (Brid.) Wijk & Margad., Taxon 8: 106. 1959. *F. sylvaticus* Griff., Calcutta J. Nat. Hist. 2: 507. 1842. *F. curvifolius* Mitt., Trans. Linn. Soc. London 23: 55. 6 f. 14. 1860. *Conomitrium amphibium* Muell. Hal., Linnaea 39: 356. 1875. *Fissidens procumbens* Mitt., Philos. Trans. 168: 395. 1879. *F. walkeri* var. *elimbatus* (Broth.) Dixon, J. Indian. Bot. 2: 177. 1921.

Plants simple, yellowish green, central strand absent, 1-1.5 × 0.2 cm; leaves oblong, lanceolate, margin crenulated by upturned marginal cells, apex acuminate, sheathing lamina equal; costa yellowish green, percurrent; leaf cells obscure, quadrangular to hexagonal, mamillose, 10-11 × 10 µm. (Plate 5.30)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Peruvannamuzhi, Chenkotakolli (330 m), 22-03-14, *Prajitha 11001*; 22-05-10, *Prajitha 12593*; Kakkayam, Ambalappara (900 m), 26-09-12, *Prajitha 8512*;

12-09-14, *Prajitha 12572*; Athikode (1100m) 13-11-14, *Prajitha 12802* (MBGH).

Habitat: Seen on soil cuttings in the semi evergreen forests.

Distribution: World: Algeria, Borneo, Burma, Celebs, Central Africa, China, Hong Kong, India, Japan, Java, Madagascar, Malaysia, New Guinea, New zealand, Philippines, Thailand and Vietnam

India: Kerala (Nair *et al*., 2005a), Madhya Pradesh (Nath *et al*., 2011), Tamil Nadu (Daniels, 2010)).

Kerala: Kozhikode (Rajesh & Manju, 2014), Wayanad (Nair *et al*., 2005a)

Fissidens involutus Wilson *ex.* Mitt. subsp. ***curvatoinvolutus*** (Dixon) Gangulee, Moss. E. India & Adj. 2: 548. 1971; Chaudhary & Deora. Moss Fl. Rajasthan 34. 1993 (as *F.curvato-involutus*); Chaudhary *et al*., Bryoph. Fl. Gujarat: 69. 2006 (as *F.curvatoinvolutus*); Daniels & Kariyappa, Curr. Sci. 93(7): 980. 2007; Madhusoodanan *et al*., *Curr. Trends Bryol*. 260. 2007(as *F. curvatoinvolutus*); Manju *et al*., Tropical Bryol. Res. Rep. 7: 12. 2008b; Daniels & Daniel, Bryo. South. W. Ghat. 43. 2013. *F. curvatoinvolutus* Dixon, Notes Roy. Bot. Gard. Edinburg 19: 279. 1938.

Plants simple or branched by basal innovations; stem brownish, rhizomatous, 1.5 long, 0.3 cm wide including leaves; leaves curled when dry, 14-15 paired, ovate-lanceolate, apex curved, acuminate, margin crenulated by projection of marginal cells, 2 × 0.5 mm;, sheathing lamini unequal, open; costa yellowish, percurrent; leaf cells quadrangular, conical mamillae seen on upper cells, 10-15 × 11-12 µm.(Plate 5.31)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam (1130 m), 22-03-14, *Prajitha 11012*; Peruvannamuzhi, Moothaveedupuzha (340 m), 16-03-13, *Prajitha 8642* (MBGH).

Habitat: Seen on wet rock and soil cuttings in the evergreen forests.

Distribution: World: Burma, Thailand and Vietnam.

India: Chhotanagpur (Gangulee, 1971), Gujarat (Chaudhary *et al*., 2006), Kerala (Manju *et al.*, 2008b), Madhya Pradesh (Gangulee, 1969), Tamil Nadu (Daniels, 2010) and Western Himalaya (Alam, 2013).

Fissidens subfirmus Dixon, J. Indian Bot. 2: 178. 1921.

Plants simple, stem brownish, rhizomatous, 1 cm long; leaves 12 paired, oblong lanceolate, margin crenulated, apex acuminate, sheathing lamini almost equal, semilimbidium present, dorsal lamina narrowing towards the base, 1.5 × 0.2-0.3mm; costa percurrent; leaf cells quadrangular, mamillose, 5-6 × 4-6 µm, marginal semilimbidium 40-50 × 2-3 µm. (Plate 5.32 a-f)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam (1280 m), 16-03-13, *Prajitha 8645*; 11-09-14, *Prajitha 11072*; Peruvannamuzhi, Moothaveedupuzha (450 m)13-11-14, *Prajitha 12804* (MBGH).

Habitat: Seen on the upper part of the tree trunk in the moist deciduous and semi evergreen forests.

Distribution: India: Karnataka (Schwarz, 2013).

Fissidens subpulchellus Nork. Mosses E. India 2: 521. f. 246. 1971; Gangulee, Moss. E. India 1(2): 521. 1971.

Plants erect, yellowish green; stem rhizomatous at base, branches arising from the base, 5mm long; leaves curled when dry, 12 pairs, oblong, margin crenulated by projection of marginal cells, apex acute, sheathing lamini open, semilimbidium absent, 0.8 × 0.3 mm; costa yellowish, percurrent or ends at tip; leaf cells quadrangular to hexagonal with conical mamillose projection, 4-5 × 6 µm towards the apex and 7-9 × 6 µm at base. (Plate 5.32 h-m)

Specimen examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Sankaranpuzha (760 m), 11-09-14, *Prajitha 11069* (MBGH).

Habitat: Seen on soil cuttings in the semi evergreen forests.

Distribution: India: Arunchal Pradesh (Dandotiya *et al.*, 2011), Kerala (Manju *et al.*, 2008b), Madhya Pradesh (Nath *et al.*, 2007), East India (Gangulee, 1971) .

Ditrichaceae Limpr.,

Laubm. Deutschl. 1: 482. 1887

Plants slender; leaves narrow, lanceolate, margin entire, apex narrowly acuminate; costa percurrent or excurrent; leaf cells linear to quadrangular, smooth, alar not differentiated; seta short, capsule immersed, peristome papillose or not.

Note: This family includes 24 genera, of these eight genera *viz., Ceratodon* Brid., *Distichium* Bruch & Schimp., *Ditrichopsis* Broth., *Ditrichum* Hampe, *Garckea* Muell. Hal., *Pleuridium* Rabenh., *Saelania* Lindb. and *Wilsoniella* Muell. Hal. are distributed in India. Of these three genera such as *Distichium* Bruch. & Schimp, *Ditrichum* Hampe and *Garckea* Muell. Hal. occur in Kerala. Only one genus, *Garckea* Muell. Hal. is represented in the study area.

Garckea Muell. Hal.,

Bot. Zeitung (Berlin) 3: 865. 1845.

Plants slender, erect, tufted; leaves narrow, lanceolate, margin entire, lower leaves smaller than upperleaves; costa percurrent or excurrent; leaf cells linear to quadrangular, alar not differentiated; seta short, capsule immersed within comal tuft.

Garckea flexuosa (Griff.) Margad. & Nork., J. Bryol. 7: 440. 1973; Nair *et al.*, Bryoph. Wayanad 95. 2005. *Grimmia flexuosa* Griff., Calcutta J. Nat. Hist. 2: 492. 1842. *Garckea bescherellei* Muell. Hal. *ex* Besch., Ann. Sci. Nat., Bot., ser. 6, 9: 339. 1880. *Dicranum phascoides* Hook., Bot. Misc. 1: 39. 21. 1829. *Grimmia comosa* Dozy & Molk., Ann. Sci. Nat., Bot., ser. 3, 2: 304. 1844. *Garckea phascoides* Muell. Hal., Bot. Zeitung (Berlin) 3: 865. 1845.

Plants erect, slender, tufted, yellowish green, 3 mm long; leaves crowded at tip, narrow lanceolate, apex long acuminate and recurved, margin entire, lower leaves distant, 1-1.5 mm, upper leaves forms comal tuft, 1.5-1.8 mm; costa percurrent; leaf cells linear, rectangular, 50-60 × 8-10 µm at apex and towards the

base 35-40 × 20 µm; capsule immersed, cylindrical, 0.5 mm long; operculum rostrate, calyptra campanulate, peristome 16, papillose; spore brownish, rounded, papillose, 20 µm wide. (Plate 5.33)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Peruvannamuzhi, Chenkotakolli (450 m), 22-03-14, *Prajitha 8700*; Kakkayam (400 m), 11-09-14, *Prajitha 14075* (MBGH).

Habitat: Seen on vertical land cuttings in the evergreen and semi evergreen forests.

Distribution: World: Africa, America, Australia, Bhutan, Brazil, India, Japan, Java, Madagascar, Malaysia, Myanmar, Nepal, New Guinea, Oceania, Philippines, Sri Lanka, Sumatra and Thailand.

India: Andra Pradesh (Sandhya Rani *et al.*, 2014), Karnataka (Schwarz, 2013), Kerala, Tamil Nadu (Daniels, 2010; Daniels *et al.*, 2018), Tripura and West Bengal (Gangulee, 1971 as *Garckea phascoides*; Lal. 2007).

Kerala: Kozhikode (Rajesh & Manju, 2014) and Wayanad (Nair *et al.*, 2005a)

Dicranaceae Schimp.,

Coroll. Bryol. Eur.11. 1856

Plants tufted, erect, slender or robust, caespitose or not, branched or not, stem without central strand; leaves spreading, falcate or not, narrow, elongate or lanceolate, apex subulate or setaceous, margin entire, broad at base; costa excurrent or percurrent; leaf cells elongate quadrate or short quadrate, papillose or not, alar cells present or absent; seta brownish; capsule brownish, ovate or cylindrical, straight; peristome splited or not; operculum rostrate; calyptra cucullate; spore rounded, papillose or not.

Note: This family include 41 genera of which 14 genera are present in India. Of these six genera *viz*., *Campylopodium* (Muell. Hal.) Besch., *Dicranella* (Muell. Hal.) Schimp., *Dicranoloma* (Renauld) Renauld, *Dicranum* Hedw. *Leptotrichella* (Muell. Hal.) Lindb. and *Leucoloma* Brid., are found in Kerala. Of these two genera *viz*., *Dicranella* (Muell. Hal.) Schimp. and *Leucoloma* Brid. are represented in the study area.

Key to the genera

1a. Leaf apical cells papillose; alar present… ..... ***Leucoloma***

1b. Leaf cells not papillose; alar absent…….……..…***Dicranella***

Dicranella (Muell. Hal) Schimp.,

Coroll. Bryol. Eur. 13. 1856

Plants erect unbranched; leaves narrow, elongate, apex subulate, margin entire; costa percurrent; leaf cells narrow, quadrate towards the apex and elongate, quadrangular, hyaline at base; capsule ovate and straight, operculum rostrate, calyptra cucullate, spore rounded.

Dicranella divaricata (Mitt.) A. Jaeger, Ber. Thatigk. St. Gallischen Naturwiss. Ges. 1870-71:376. 1872; Gangulee Moss. E. India 1(2): 259. 1971. *Leptotrichum divaricatum* Mitt., J. Proc. Linn. Soc., Bot., Suppl. 1:9. 1859.

Plants tufted, erect, not branched, 1 cm long; leaves spreading, narrow, elongate, apex subulate, margin entire, 4mm long; costa percurrent; leaf cells narrow, quadrate towards the apex and elongate, quadrangular, hyaline at base, 80-90 × 12-15 μm; seta 7mm long, capsule brownish, ovate, straight, 1.5 mm long, peristome split in to two-thirds down, operculum rostrate, calyptra cucullate, spore rounded, papillose. (Plate 5.34)

Specimen examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary: Kakkayam, Ambalappara (830m), 26-09-12, *Prajitha* 8515 (MBGH).

Habitat: Seen on vertical land cuttings along with *Pogonatum patulum* in the evergreen forest.

Distribution: This species is endemic to India: Kerala (Manju *et al.*, 2008b), Meghalaya (Gangulee, 1971), Tamil Nadu (Daniels, 2010), and Western Himalaya (Alam, 2013).

Leucoloma Brid.,

Bryol. Univ.2:218. 1827

Plants slender or robust, caespitose, yellowish green or yellowish brown; stem sparsely branched or not, without central strand; leaves flexouse, falcate, lanceolate, broad at base, setaceous at apex, margin entire often toothed at tip; costa excurrent or percurrent; leaf cells near costa rectangular, towards the base elongated, rhomboidal; margin boardered by several rows of narrow, elongated, hyaline cells, gradually decreasing towards the tip; upper leaf cells smaller, incrassate, papillose; alar cells yellowish near costa, rectangular; seta brownish; capsule cylindrical, calyptra cucullate; spore greenish, rounded, papillose or not.

Key to the species

1a. Plants small, slender; costa excurrent.....***L. taylorii***

1b. Plants large, robust; costa percurrent….....***L. amoene- virens***

Leucoloma amoene-virens Mitt**.,** J. Proc. Linn. Soc., Bot., Suppl. 1: 13. 1859; Gangulee Moss. E. India 1(2): 407. 1971; Nair *et al.,* Bryoph. Wayanad 99. 2005. *Dicranum amoenevirens* (Mitt.) Muell. Hal., Linnaea 36: 11. 1869.

Plants robust, caespitose, yellowish green to yellowish brown; stem sparsely branched or branched at base, without central strand, cells hexagonal, 2 cm long; leaves yellowish brown, flexouse, falcate, lanceolate, broad at the base, setaceous at apex, margin entire often toothed at tip, 4 × 0.3 mm; costa percurrent; leaf cells near costa ovate- rectangular, 7-10 x 4 µm; cells at base elongated, rhomboidal, 30-35 x 3-4 µm, margin bordered by 8-9 rows of narrow, elongated, hyaline cells, gradually decreasing towards the tip; upper leaf cells smaller, incrassate, papillose, 5 × 6 µm; alar cells yellowish near costa, rectangular, 30-45 x 25 µm; seta brownish, 7 mm long; capsule cylindrical, 3 mm long; calyptra cucullate; spore greenish, rounded. (Plate 5.35)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary: Kakkayam, Raveendra estate (780 m), 10-05-03, *MCN 120113* (CALI);

14-11-14, *Prajitha 12918*; Peruvannamuzhi, Moothaveedupuzha (510 m), 29-12-17, *Prajitha 14119* (MBGH).

Habitat: Seen on upper part of the tree trunk in the evergreen and semi evergreen forests.

Distribution: World: India and Sri Lanka.

India: Karnataka (Schwarz, 2013), Kerala, Madhya Pradesh (Nath *et al*., 2012), Meghalaya (Gangulee, 1971) and Tamil Nadu (Daniels, 2010; Daniels *et al.,* 2018)

Kerala: Agasthyamala (Manju *et al.*, 2009d), Idukki (Rajeevan, 1990), Kozhikode: Kakkayam (Manju *et al.*, 2008b), Palakkad (Rajeevan, 1990) and Wayanad (Nair *et al.*, 2005a).

Leucoloma taylorii (Schwagr.) Mitt., Hooker's J. Bot. Kew Gard. Misc. 8: 353. 1856; Gangulee, Moss. E. India 1(2): 407. 1971. *Syrrhopodon taylorii* Schwagr., Sp. Musc. Frond., Suppl. 2: 115. Pl. 132. 1824. *S. kurzii* Hampe, Ann. Sci. Nat., Bot., ser. 8, 1: 288. 1895. *Leucoloma walkeri* Broth., Rec. Bot. Surv. India 1(12): 313. 1899.

Plants slender, caespitose, yellowish green, sparsely branched, 1.5 cm long; leaves 4 mm long, 0.2 mm wide at base and 0.5 mm wide at middle; leaves falcate, narrow, lanceolate, apex setaceous or subulate, margin entire or minutely serrated at apex, 4 × 0.5 mm; costa excurrent; leaf cells at the margin forms 3 rows of narrow, elongate, transparent and hyaline cells; cells at the apex incrassate, quadrate, 10-12 x 6-7 µm, papillose; alar hyaline at boarder, towards the centre reddish brown, 47-57 x 25 µm; seta brownish, 1cm long; capsule cylindrical, 3 mm long; spore rounded, greenish, papillose, 15 µm wide. (Plate 5.36)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam, Raveendra estate (950 m), 10-05-2003, *MCN 120150* (CALI); Kakkayam, Urakkuzhi (970 m), 12-01-15, *Prajitha 12970*; Ambalappara (1200 m), 26-09-12, *Prajitha 8551*; 27-09-12, *Prajitha 8595*; Athikode (1100 m), 15-11-12, *Prajitha 8637*; Peruvannamuzhi: Moothaveedupuzha (510 m), 16-03-13,

Prajitha 8678 (MBGH).

Habitat: Seen on logs, base and upper part of the tree trunks in the evergreen, moist deciduous and semi evergreen forests.

Distribution: World: India and Nepal.

India: Karnataka (Schwarz, 2013), Kerala (Manju *et al.*, 2008) and Tamil Nadu (Daniels *et al*., 2018).

Kerala: Agasthyamala (Manju *et al*., 2009d), Kakkayam (Manju *et al*., 2008a)

Leucobryaceae Schimp.,

Coroll. Bryol. Eur. 19.1856.

Plants robust and tufted; stem without central strand; leaves lanceolate, apex subulate, margin entire or dentate; costa , broad, covering most of the leaf; leaf cells rhomboidal and incrassate at tip and rectangular at base; alar cells reddish and bulging out or hyaline.

Note: This family include 12 genera, of which eight genera *viz.*, *Atractylocarpus* Mitt., *Brothera* Muell. Hal., *Campylopodiella* Cardot, *Campylopus* Brid., *Dicranodontium* Bruch & Schimp., *Leucobryum* Hampe, *Microcampylopus* (Muell. Hal.) Fleisch. and *Ochrobryum* Mitt. are distributed in India. Of these three genera *viz.*, *Campylopus* Brid., *Leucobryum* Hampe and *Microcampylopus* (Muell. Hal.) Fleisch. are found in Kerala and two genera such as *Campylopus* Brid. and *Leucobryum* Hampe are represented in the study area.

Campylopus Brid.,

Musc. Recent. Suppl. 4:71. 1819

Plants tufted, tomentose below, yellowish green or yellowish brown; stem without central strand, cells hexagonal, unbranched or shows dichotomous branching; leaves lanceolate, apex subulate, margin entire or dentate towards the apex; costa, broad, covering 1/3 of leaf base; leaf cells at the tip rhomboidal and

incrassate, narrow near the margin and long, rectangular at base; alar cells reddish and bulging out or hyaline and inflated, quadrangular.

Key to the species

1a. Alar brownish or reddish, bulging out…...…….. .....***C. flexuosus***

1b. Alar hyaline, not bulged, inflated……....…….……... (2)

2a. Stem unbranched or branched at extreme base.…...……. …..….. ***C. ericoides***

2b. Stem dichotomously branched…….……...…. ***C. schimidii***

Campylopus ericoides (Griff.) A. Jaeger, Ber. Thatigk. St. Gallischen Naturwiss. Ges. 1870-71: 424. 1872; Gangulee Moss. E. India1 (2): 296-297. 1971; Nair *et al.*, Bryoph. Wayanad 98. 2005. *Dicranum ericoides* Griff., Calcutta J. Nat. Hist. 2: 499. 1842. *D. erythrognaphalon* Muell. Hal., Bot. Zeitung (Berlin) 11: 37. 1853. *D. involutum* Muell. Hal., Bot. Zeitung (Berlin) 11: 34. 1853. *Campylopus erythrognaphalus* (Muell. Hal.) A. Jaeger, Ber. Thatigk. St. Gallischen Naturwiss. Ges. 1870-71: 439. 1872. *C. involutus* (Muell. Hal.) A. Jaeger, Ber Thatigk. St. Gallischen Naturwiss. Ges. 1870-71: 418. 1872.

Plants caespitose, yellowish brown; stem reddish, without central strand, un branched, or branched from extreme bases, 2.2 cm long; leaves flexuose, narrow, lanceolate, apex subulate, serrated towards the apex, 5 × 0.5mm; costa yellowish brown, broad, covering 1/3 of leaf width; leaf cells rhomboidal at apex, 25-28 × 6-10 µm, quadrate at margin, 20-25 × 10-12 µm, basal cells 40-45 × 15 µm; alar not coloured, inflated. (Plate 5.37)

Specimen examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam, Sankaranpuzha (920 m), 26-09-12, *Prajitha 8618* (MBGH).

Habitat: Seen on rocks in the evergreen forests and grassland.

Distribution: World: China, India, Java, Myanmar, Nepal, Philippines, Sri Lanka, Thailand and Vietnam.

India: Karnataka (Schwarz, 2013), Odisha (Mishra *et al.*, 2016), Madhya Pradesh

(Gupta *et al*., 2016), Tamil Nadu (Daniels, 2010; Daniels *et al*., 2018) and West Bengal (Gangulee, 1971).

Kerala: Agasthyamala (Manju *et al.*, 2009d), Kannur: Aralam WLS (Manju *et al.*, 2009b) and Wayanad (Nair *et al*., 2005a)

Campylopus flexuosus (Hedw.) Brid, Muscol. Recent. Suppl. 4: 71. 1819; Gangulee Moss. E. India 1(2): 292. 1971; Nair *et al.*, Bryoph. Wayanad 98. 2005. *Dicranum flexuosum* Hedw., Sp. Musc. Frond. 145. 38 f. 1-4. 1801. *Campylopus arduennae* Lib., Pl. Cryptog. Arduen. Coll. 106. 1831. *C. micans* Wulfsb., Forh. Vidensk. Selsk. Kristiania 1876: 349. 1876. *C. boivinianus* Besch., Ann. Sci. Nat., Bot., ser. 6, 9:320. 1880. *C. leucophaeus* Stirt., Ann. Scott. Nat. Hist. 12 (46): 110. 1903. *C. alleizettii* Ther. & P. de la Varde, Ann. Cryptog. Exot. 1: 279. 1918. *C. mexicanus* Ther., Smithsonian Misc. Collect. 78 (2): 7. 5. 1926.

Plants tufted, tomentose below, yellowish green; stem without central strand, cells hexagonal, shows dichotomous branching, up to 2.5 cm long; mature leaves reddish brown, lanceolate, apex subulate, denticulate, wider at base, 5 mm long; costa broad, covering ½ of the leaf base, ends at apex; leaf cells at the tip rhomboidal and incrassate, 10-15 × 6-8 µm, narrow near the margin, long, rectangular at base, 25-30 × 12 µm; alar cells reddish, prominent at the base, bulging out and quadrangular, 40-60 × 30 µm. (Plate 5.38 a-g)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam, Ambalappara (470-930 m), 26-09-12, *Prajitha 8529*; 11-09-14, *Prajitha 14043* (MBGH).

Habitat: Seen on rocks in the semi evergreen and moist deciduous forests.

Distribution: World: Nepal, China, Algeria, Abyssinia, Madagascar, Oceania, New Zealand and Siberia.

India: Kerala, and Tamil Nadu (Daniels, 2010; Daniels *et al*., 2018)

Kerala: Agasthyamala (Manju *et al.*, 2009d), Idukki: Eravikulam National Park (Nair *et al.*, 2007), Parabikulam Tiger Reserve (Manju & Rajesh, 2011) and Wayanad (Nair *et al.*, 2005a).

Campylopus schmidii (Muell. Hal.) A. Jaeger, Ber. Thatigk. St. Gallischen Naturwiss. Ges. 1870-71: 439. 1872. *Dicranum schmidii* Muell. Hal. Bot. Zeitung (Berlin) 11: 37. 1853. *Campylopus chryseolus* Muell. Hal. ex Besch., Ann. Sci. Nat., Bot., ser. 6, 9: 325. 1880. *C. aureus* Bosch & Sande Lac., Bryol. Jav. 1: 80. 67. 1858. *C. subtricolor* Lorentz, Moosstudien 159. 1864. *C. calvus* Renauld & Cardot, I Bull. Soc. Roy. Bot. Belgique 33(2): 111. 1895. *C. deciduus* Renauld & Cardot, Bull. Soc. Roy. Bot. Belgique 33(2): 111. 1895. *C. herzogii* Broth., Hedwigia 50: 122. 1910. *C. robbinsii* E.B. Bartram, Rev. Bryol. Lichenol. 30: 187. 1962.

Plants tufted, tomentose below, brownish; stem without central strand, cells hexagonal, shows dichotomous branching, 5 cm long; leaves lanceolate, apex subulate, margin entire but minutely dentate at extreme apex, 5-7 × 0.5 mm; costa covering 2/3 of leaf base, excurrent; leaf cells rhomboid and incrassate at apex, 30-40 × 12 µm, basal cells rectangular, 55-60 × 12 µm, narrow near the margin; alar hyaline, not shows bulging, 50-55 × 25-30 µm. (Plate 5.38 h-n)

Specimen examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam, Ambalappara (1160 m), 26-09-12, *Prajitha 8537* (MBGH).

Habitat: Seen on rocks in the evergreen forests.

Distribution: World: Africa, Australia, Celebes, Ceylon, India, Japan, Java, New Caledonia, New Guinea, Philippines and Taiwan.

India: Kerala (Manju *et al.*, 2008b) and Tamil Nadu (Daniels, 2010).

Calymperaceae Kindb.,

Gen. Eur. N. Amer. Bryin. (Mosses) 11. 1897

Plants slender, tufted, pale green or dark green or yellowish green; stem without central strand, branched or unbranched; leaves narrow, lingulate, apex sub acute or obtuse, margin entire or serrate towards the tip; stereide bands present or absent; leaf cells at base quadrate, laminar hyaline cells cover ¼ of the length of leaf; upper leaf cells isodiametric, chlorophyllous; basal leaf cells hyaline, cancellinae present or not; tenioli present or absent; gemmiferous leaves present or not.

Note: This family include eight genera *viz.*, *Arthrocormus* Dozy & Molk., *Calymperes* Sw., *Exodictyon* Cardot, *Exostratum* L.T. Ellis, *Leucophanes* Brid., *Mitthyridium* H. Rob., *Octoblepharum* Hedw. and Syrrhopodon Schwagr.. Of these five genera *viz*., *Calymperes* Sw., *Exostratum* L.T. Ellis, *Leucophanes* Brid., *Octoblepharum* Hedw., *Syrrhopodon* Schwagr. occur in India. Of these four genera such *as Calymperes* Sw., *Leucophanes* Brid., *Octoblepharum* Hedw. and *Syrrhopodon* Schwagr. occur in Kerala. Three genera *viz*., *Calymperes*, *Leucophanes* and *Octoblepharum* are represented in the present study area.

Key to the genera

1a. Prominent midrib and stereide band present on leaves…….....***Leucophanes***

1b. Prominent midrib and stereide band absent on leaves……..……...…….2

2a. Gemmiferous leaves present……....***Calymperes***

2b. Gemmiferous leaves absent……...***Octoblepharum***

Calymperes Sw.F. Weber,

Tab. Exhib. Calyptr. Operc. Musc. Frond. Gen.2. 1813, 1814.

Plants tufted, dark green or yellowish green or pale green; branched or unbranched; leaves spirally twisted or curled when dry, lingulate, apex obtuse, margin entire or dentate towards the apex; costa percurrent or excurrent; upper leaf cells isodiametric, chlorophyllous; basal leaf cells hyaline, cancellinae many rowed, decreasing in height towards the margin like stair case steps; tenioli present or absent 3-4 rows of narrow, elongated, rectangular cells, ends at the tip or middle of leaf; gemmiferous leaves lingulate with gemma bearing proboscis; gemmae forms radial mass from the tip of the costa.

Key to the species

1a. Tenioli present……. ...……..(2)

1b. Tenioli absent…….……. ……...…***C. linguatum***

2a. Plants dark green, branched; tenioli ends at midleaf…… ...……..…***C. afzelli***

2b. Plants pale green, unbranched; tenioli ends at apex……...…… …...…***C. erosum***

Calymperes afzelii Sw., Jahrb. Gewachsk. 1: 3. 1. 1818; Nair *et al.,* Bryoph. Wayanad 109. 2005. *C. chlorosum* Hampe, Vidensk. Meddel. Dansk Naturhist. Foren. Kjobenhavn 1: 78. 1879. *C. donnellii* Austin, Bot. Gaz. 4: 151. 5. 1879. *C. integrifolium* Muell., Hal. Flora 69: 514. 1886. *C. thwaitesii* Besch., Ann. Sci. Nat., Bot., ser. 8, 1: 306. 1896. *C. dusenii* Muell., Hal. ex Besch. Ann. Sci. Nat., Bot., ser. 8, 1: 268, 284. 1896. *C. javanicum* M. Fleisch., Musci Buitenzorg 1: 260. 41. 1904. *C. annamense* Ther. & P. de la Varde, Rev. Gen. Bot. 29: 296. 23 f.6. 1917. *C. victoriae* Dixon, S. African J. Sci. 18: 308. 1922. *C. microdictyon* Dixon & P. de la Varde, Ann. Cryptog. Exot. 3: 172. 2 f.2. 1930.

Plants tufted, dark green, branched, 1-1.5 cm long; rhizoides brownish, arrising from the base of the stem; leaves spirally twisted when dry, lingulate, apex obtuse, margin dentate towards the apex, 4-5 mm long; costa percurrent; leaf cells isodiametric and chlorophyllous towards the top, 5-7 × 5-6 µm, basal cells hyaline, cancellinae 10 rowed, decreasing in height towards the margin like stair case steps, tip of the cancellinae round-oval in shape; tenioli present, 3-4 rows of narrow, elongated, rectangular cells, ends at middle of the leaf; gemmiferous leaves lingulate with gemma bearing proboscis; gemmae forms radial mass from the tip of the costa. (Plate 5.39)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary: Kakkayam, Raveendra estate (900 m), 10-05-03, *MCN 120124* (CALI); Peruvannamuzhi, Chenkotakolli (340 m), 22-03-14, *Prajitha 11014*; Kakkayam (480 m), 12-01-15, *Prajitha 13535* (MBGH).

Habitat: Seen on log in the moist deciduous forests.

Distribution: World: Africa, Australia, Brazil, Central America, China, India, Philippines and Sri Lanka.

India: Karnataka (Schwarz, 2013), Kerala (Nair *et al*., 2005a) and Tamil Nadu (Daniels, 2010). Tamil Nadu (Daniels *et al*., 2018).

Kerala: Agasthyamala (Manju *et al.*, 2009d), Kozhikode: Kakkayam (Manju *et al.*, 2008a) and Wayanad (Nair *et al.*, 2005a).

Economic importance: It has insecticidal activity and used against Maize stem borers (Ande *et al.*, 2010).

Calymperes erosum Muell. Hal. Linnaea 21: 182. 1848; Nair *et al.*, Bryoph. Wayanad 110. 2005. *C. intra-limbatum* Muell. Hal., Flora 69: 513. 1886. *C. burmense* Hampe, Ann. Sci. Nat., Bot., ser. 8, 1: 267, 279. 1896. *C. heterophyllum* (Mitt.) Besch. Ann. Sci. Nat., Bot., ser. 8, 1: 272, 286. 1896. *C. manii* Muell. Hal. ex Besch., Ann. Sci. Nat., Bot., ser. 8, 1: 267, 291. 1896. *C. naumannii* Besch., Ann. Sci. Nat., Bot., ser. 8, 1: 267, 294. 1896. *C. emersum* Muell. Hal., Bull. Herb. Boissier 5: 189. 3. 1897. *C. bodenii* Muell. Hal., Hedwigia 39: 262. 1900. *C. acuminatum* Broth., Bot. Tidsskr. 24: 118. 1901. *C. patentifolium* Paris, Rev. Bryol. 32: 102. 1905.

Plants tufted, pale green, unbranched, 1 cm long; leaves erectopatent, lingulate, apex acute, margin dentate towards the apex, 3-4 mm long; costa excurrent; upper leaf cells isodiametric, chlorophyllous, 5-6 × 6 µm; basal leaf cells hyaline, cancellinae 13 rowed, decreasing in height towards the margin like stair case steps, quadrate, hyaline cells, 30-35 × 30 µm; tenioli present, 2-3 rows of narrow, elongated, quadrangular cells, ends at the apex of leaf; gemmiferous leaves more elongate, canaliculated, 4-5 mm long; gemmae filamentous. (Plate 5.40)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam, Vattakkayam (970 m), 10-05-03, *MCN 120162* (CALI); Kakkayam, Ambalappara (1130-1200 m), 26-09-12, *Prajitha 8534, 8555*; Peruvannamuzhi, Moothaveedupuzha (490-530 m), 16-03-13, *Prajitha 8687*; 22-03-14, *Prajitha 11041* (MBGH).

Habitat: Seen on the base and upper part of the tree trunk along with *Neckeropsis andamana* in the evergreen and semi evergreen forests.

Distribution: World: Africa, America, Brazil, China, India, Myanmar, Philippines, Sri Lanka and Thailand.

India: Kerala and Tamil Nadu (Daniels *et al*., 2018)

Kerala: Kozhikode: Kakkayam (Manju *et al.*, 2008a), Kannur: Aralam WLS (Manju *et al.*, 2009b) and Wayanad (Nair *et al.*, 2005a).

Economic importance: It has antibacterial activity to human pathogenic bacteria *viz*., *Klebsiella pneumoniae, Enterococcus feacalis, Bacillus pumilis* and *Enterobacter cloaca*

Calymperes linguatum Muell. Hal. *ex* Besch., Ann. Sci. Nat., Bot., ser. 8, 1: 265, 290. 1896; Gangulee, Moss. E. India 1(2): 605. 1972.

Plants tufted, yellowish green, branched, 7 mm long; leaves curled when dry, lingulate, apex obtuse, margin entire, wide at base, 3 mm long; costa percurrent; upper leaf cells isodiametric, chlorophyllous, 9-12 × 6-8 µm, basal cells hyaline, cancellinae 13 rowed, decreasing in height towards the margin like stair case steps, 55-60 × 30 µm; tenioli absent; gemmiferous leaves lingulate with gemma bearing proboscis; gemmae forms radial mass from the tip of the costa. (Plate 5.41)

Specimen examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam, Ambalappara (630 m), 11-09-14, *Prajitha 11069* (MBGH).

Habitat: Seen on upper part of the tree trunk along with *Lopholejeunea sikkimensis* in the semi evergreen forests.

Distribution: This is an endemic species of Andaman Islands (Gangulee, 1972).

Note: Present study is a new addition to Kerala.

Leucophanes Brid.,

Bryol. Univ. 1:763. 1827

Plants slender, pale green; stem without central strand, unbranched; leaves narrow, lingulate, apex sub acute, margin serrate towards the tip, wide at base with median dorsal stereide band on the costa forms midrib and bordered throughout by 3-4 layers of stereide bands; leaf cells at base quadrate, laminar hyaline cells cover ¼ of the length of leaf, became one rows, vanishing below the apex.

Leucophanes glaucum (Scwagr.) Mitt., J. Proc. Linn. Soc., Bot., Suppl. 1: 25. 1859. *Syrrhopodon glaucus* Schwagr., Sp. Musc. Frond., Suppl. 2(2): 103. Pl. 181. 1827. *Leucophanes guadalupense* Lindb., Ofvers. Forh. Kongl. Svenska Vetensk. Akad. 21: 608. 1865. *L. sordidum* Muell. Hal., Forschungsr. Gazelle 4(5): 50. 1889. *L. beccarii* Broth. & Geh., i Biblioth. Bot. 44: 6. 5. 1898. *L. glaucescens* Muell. Hal. ex M. Fleisch., Musci Buitenzorg 1: 178. 23. 1904. *L. bogoriense* M. Fleisch., Musci Buitenzorg 1: 177. 1904. *L. neocaledonicum* Cardot & Ther, Diagn. Esp. Var. Nouv. Mouss. 8: 2. 1910. *L. subglaucescens* Muell. Hal. ex Dixon. J. Linn. Soc., Bot. 43: 296. 1916.

Plants slender, pale green; stem without central strand, unbranched, reddish brown, 0.5 cm long; rhizoids reddish brown; leaves narrow, lingulate, apex sub acute, margin serrate towards the tip, wide at base with central midrib and boardered throughout by 3-4 layers of stereide bands; lower leaves comparatively smaller, lingulate 2.5 x 0.1-0.3 mm; costa reach up to the top of the leaf, spinulose at tip; median dorsal stereide band on the costa forms midrib; leaf cells at base quadrate, 46 × 20 µm; laminar hyaline cells cover ¼ of the length of leaf, became one rows, vanishing below the apex. (Plate 5.42)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam, Ambalappara (1160 m), 26-09-12, *Prajitha 8503*; Urakkuzhi (1130 m) , 27-09-12, *Prajitha 8564* (MBGH).

Habitat: Seen on bark in the moist deciduous forests.

Distribution: World: Africa, Ceylon, India, Java, Sumatra and Vietnam

India: Andaman Island (Dandotiya *et al*., 2011), Kerala and Tamil Nadu (Daniels, 2010; Daniels *et al*., 2018)

Kerala: Parambikulam Tiger Reserve (Manju & Rajesh, 2011) and Thusharagiri (Mufeed *et al*., 2014)

Octoblepharum Hedw.,

Sp. Musc. 50, 1801

Plants tufted, pale green or whitish, glossy; stem without central strand, unbranched; leaves, ligulate, narrowly oblong, margin entire, apex acute, minutely serrulate, sheathing base wider; costa wide at apex, triangular chlorocyst seen in between 6 layers of leacocyst in the middle and two such layers on the ends; leaf cells quadrangular at base; seta short; capsule straight, ovate, peristome 8 teethed; calyptra cucullate; spore papillose.

Octoblepharum albidum Hedw., Sp. Musc. Frond. 50. 1801; Gangulee Moss. E. India 1(2): 441. 1971; Nair *et al.*, Bryoph. Wayanad 101. 2005. *Bryum albidum* (Hedw.) P. Beauv., Prodr. Aetheogam. 45. 1805. *Octoblepharum longifolium* Lindb., Ofvers. Forh. Kongl. Svenska Vetensk. Akad. 21: 608. 1865. *O. minus* Hampe, Vidensk. Meddel. Dansk Naturhist. Foren. Kjobenhavn 1: 83. 1879. *O. albidum var. cuspidatum* Muell. Hal., i Bot. Jahrb. Syst. 23: 318. 1896. *O. cuspidatum* Muell. Hal., Gen. Musc. Fr.ond. 88. 1900.

Plants tufted, pale green or whitish; stem without central strand, unbranched, 2-3 mm long; leaves, ligulate, narrowly oblong, margin entire, apex acute, minutely serrulate, sheathing base wider, 5 x 0.5 mm; costa wide at apex, triangular chlorocyst seen in between 6 layers of leacocyst in the middle and two such layers on the ends; chlorocyst 8-12 µm wide, leucocyst 23-29 µm wide; leaf cells 37.62 x 10 µm at apex, marginal cells 58 x 14 µm, cells at the base 85.5 x 33 µm; leaf base have 10 layers of hyaline laminar cells, inner 8 rows are rectangular bordered by a 2 narrow rows; seta 5 mm long; peristome 8 teethed, 105 x 72 µm; spore papillose, 19 µm wide. (Plate 5.43)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam, Vattakkayam (1000 m), 10-05-03, *MCN 120184a* (CALI); 12-01-15, *Prajitha 13580*; Peruvannamuzhi (350 m), 22-03-14, *Prajitha 11024*, *11055* (MBGH).

Habitat: Seen on the upper part of the tree trunk in the moist deciduous and semi evergreen forests.

Distribution: World: Bolivia, Brazil, China, Columbia, India, Java, Madagascar, Myanmar, Nepal, New Guinea, Peru, Philippines, Sri Lanka and Venezuela.

India: Andaman Is. (Gangulee, 1971), Andra Pradesh (Sandhya Rani *et al*., 2014), Karnataka (Schwarz, 2013), Kerala, Maharashtra (Magdum *et al*., 2017), Madhya Pradesh (Nath *et al.*, 2007), Odisha (Gangulee, 1971), Tamil Nadu ((Daniels, 2010; Daniels *et al*., 2018) and West Bengal (Lal, 2007).

Kerala: Idukki: ENP (Nair *et al.*, 2007), Kannur: Aralam WLS (Manju *et al.*, 2009b), Kozhikkode: Kakkayam (Manju *et al.*, 2008a), Palakkad (Easa, 2003) and Wayanad (Nair *et al.*, 2005a).

Economic importance: It is used as febrifuge and anodyne (Singh, 2011).

Pottiales M.Fleish.,

Hedwigia, 61: 392. 1920.

Pottiaceae Hampe,

Bot. Zeitung (Berlin) 11(18): 329. 1853.

Plants densely or loosely tufted, erect, slender, simple or branched, yellowish green; leaves lanceolate or spathulate, apex apiculate or acute or acuminate; costa excurrent or percurrent; leaf cells at apex chlorophyllose, rounded or quadrate, papillose and hyaline, rectangular at base; seta elongated; capsule erect and cylindrical; calyptra cucullate, peristome absent; spores rounded.

Note: This family include 82 genera, of which 38 genera are found in India and 19 genera in Kerala. Four genera *viz.*, *Barbula* Hedw., *Chionoloma* Dixon,

Hymenostylium Brid. and *Hyophila* Brid. are represented in the study area.

Key to the genera

1a. Leaves lanceolate, apex acute or acuminate……. ……2

1b. Leaves spathulate, apex apiculate……...……..….***Hyophila***

2a. Costa excurrent……..…… ……... ***Barbula***

2b. Costa percurrent…….……..…..3

3a. Leaf apex acuminate……..…… ……***Hymenostylium***

3b. Leaf apex acute with minute apiculus…… ……..……..***Chionoloma***

Barbula Hedw.,

Sp. Musc. Frond. 115. 1801

Plants tufted, slender, simple or branched; leaves ovate- lanceolate, apex broadly acute, margin entire at base, crenulated at apex by papillose projection of cells; costa excurrent; leaf cells obscure, multipapillose, rounded - quadrangular at apex, cells hyaline and rectangular at base.

Barbula indica (Hook.) Spreng., Nomencl. Bot. 2: 72. 1824; Nair *et al.*, Bryoph. Wayanad 113. 2005. *Tortula indica* Hook. Musci Exotici 2: 135. 1819. *Trichostomum orientale* F. Weber, Arch. Syst. Naturgesch. 1(1): 129. 4 f. 6. 1804. *Pottia apiculata* Muell. Hal. ex Renauld, Prodr. Fl. Bryol. Madagascar 124. 1898. *Barbula natalensis* Muell. Hal. Hedwigia 38: 106. 1899. *Hymenostomum malayense* M. Fleisch., Musci Buitenzorg 1: 315. f. 54. 1904. *Hyophila girodii* Renauld & Cardot, Bull. Soc. Roy. Bot. Belgique 41(1): 52. 1905. *Barbula ochrocarpa* Toyama, Acta. Phytotax. Geobot. 6(2): 103. 4. 1937. *Hyophila asanoi* Sakurai, Bot. Mag.Tokyo 67: 38. 1. 1954. *H. biloinsularis* Sakurai, Bot. Magazine Tokyo 67: 39. 3. 1954.

Plants densely tufted, slender, yellowish green; stem brownish, rhizomatous, 2 cm long; leaves wide at base, ovate- lanceolate, apex broadly acute with a blunt, margin entire at base, crenulated at apex by papillose projection of cells, 1.5 cm × 0.2 mm; costa excurrent with minute apiculus; leaf cells obscure, multipapillose,

rounded - quadrangular at apex, 6-8 × 6-8 µm, cells hyaline and rectangular at base, 12- 13 × 7-8 µm. (Plate 5.44)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam (820 m), 22-03-14, *Prajitha 11050*; 7-01-18, *Prajitha 14160* (MBGH).

Habitat: Seen on wet rocks in the moist deciduous forests.

Distribution: World: Africa, America, China, Colombia, Japan, India, Korea, Mexico, Malaysia, Myanmar, New Guinea and Philippines.

India: Andaman & Nicobar Islands (Aziz and Vohra, 2008), Andra Pradesh (Sandhya Rani *et al*., 2014), West Bengal, (Lal. 2007), Bihar (Lal. 2007), Central India, Jharkhand (Aziz and Vohra, 2008), Meghalaya (Aziz and Vohra, 2008), Karnataka (Schwarz, 2013), Kerala, Odisha (Aziz and Vohra, 2008), Sikkim (Aziz and Vohra, 2008), Tamil Nadu (Daniels *et al*., 2018), Uttarakhand (Aziz and Vohra, 2008), Uttar Pradesh (Aziz and Vohra, 2008), West Bengal (Aziz and Vohra, 2008).

Kerala: Wayanad (Nair *et al*., 2005a)

Chionoloma Dixon,

J. Bot. 60: 102. 1922.

Plants tufted, slender; leaves curled when dry, lanceolate, margin entire at base, crenulated towards the apex by papillose projection of marginal cells, apex acute with minute apiculus; costa percurrent; leaf cells rounded or quadrangular, obscure at apex, multipapillose, basal cells hyaline, rectangular, narrow towards the margin.

Chionoloma tenuirostre (Hook. & Taylor) M. Alonso, M.J. Cano & J.A. Jimenez Taxon 65(1): 15. 2016. Alonso, M., J. A. Jimenez & M. J. Cano., *Phytotaxa* 373(2): 147-154. 2018. *Weissia tenuirostris* Hook. & Taylor, Muscol. Brit. 2:83. 1827. *Didymodon tenuirostris* (Hook. & Taylor) Wilson, Hooker's J. Bot. Kew Gard. Misc 3: 378. 1841. *D. cuspidatus* Dozy & Molk., Syst. Verz. 31. 1854. *Barbula*

leptotortella Muell. Hal., Hedwigia 38: 110. 1899. *Oxystegus cylindricus* (Bruch ex Brid.) Hilp., Beih. Bot. Centralbl., Abt. 2. 50 (3): 610. 1933. *O. indicus* (Dixon & P. de la Varde) Hilp., Beih. Bot. Centralbl., Abt. 2. 50(2): 670, 702. 1933. *Tortella tenuirostris* (Hook. & Taylor) C.E.O. Jensen, Danmarks Mosser 2: 322. 16. 1923. *Oxystegus cuspidatus* (Dozy & Molk.) P.C. Chen, Hedwigia 80: 143. 13 f. 7. 1941.

Plants loosely tufted, slender, prostrate - erect, yellowish green, 5 mm long; leaves curled when dry, lanceolate, margin entire at base, crenulated towards the apex by papillose projection of marginal cells, apex acute with minute apiculus; costa percurrent; leaf cells rounded or quadrangular, obscure at apex, multipapillose, 8-10 × 10 μm, basal cells hyaline, rectangular, narrow towards the margin, 20-22 × 5 μm. (Plate 5.45)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam, Ambalappara (760 m), 15-11-12, *Prajitha 8631*; Athikode (1100 m) 11-09-14, *Prajitha 14090* (MBGH).

Habitat: Seen on wet rocks in the grasslands and semi evergreen forests.

Distribution: India and Nepal.

India: Darjeeling (Gangulee, 1972 as *Oxystegus cylindricus*), Kerala, Sikkim (Dandotiya *et al*., 2011 as *Oxystegus cylindricus*) and Tamil Nadu (Daniels, 2010 as *Oxystegus cylindricus*).

Kerala: Wayanad (Nair *et al*., 2005a as *Oxystegus cylindricus*).

Note: *Chionoloma tenuirostre* (Hook. & Taylor) M. Alonso, M.J. Cano & J.A. Jimenez is reported as *Oxystegus cylindricus* (Bruch ex Brid.) Hilp. earlier from India. Alonso *et al*. (2018) evaluated the taxonomic position of the names within *Chionoloma tenuirostre* and synonimised *Oxystegus cylindricus* under *Chionoloma tenuirostre*.

Hymenostylium Brid.,

Bryol. Univ. 2:81. 1827

Plants tufted, slender; leaves curled when dry, linear- lanceolate, apex acuminate, margin wavy; costa ends below the apex; leaf cells chlorophyllose, rounded, papillose at tip and hyaline, rectangular at base; seta elongated; capsule erect and cylindrical.

Hymenostylium recurvirostrum (Hedw.) Dixon, Rev. Bryol. Lichenol. 6: 96. 1933; Nair *et al.*, Bryoph. Wayanad 114. 2005. *Gymnostomum recurvirostrum* Hedw., Species Muscorum Frondosorum 33. 1801. *Bryum verticillatum* Dicks. ex With., Syst. Arr. Brit. Pl. (ed. 4) 3. 1801. *Gymnostomum recurvirostrum* Hedw. Sp. Musc. Frond. 33. 1801. *G. xanthocarpum* Hook., Musci Exot. 2: 153. 1819. *G. brevisetum* Nees & Hornsch., Bryol. Germ. 1: 164. 10 f. 21. 1823. *G. globosum* Hornsch., Flora 8: 79. 1825. *Pottia xanthocarpa* (Hook.) Muell. Hal., Syn. Musc. Frond. 1: 563. 1849. *Hymenostylium commutatum* Mitt., J. Proc. Linn. Soc., Bot., Suppl. 1: 32. 1859. *Gymnostomum commutatum* (Mitt.) Lorentz, Verz. Eur. Laubm. 28. 1865. *Zygodon firmus* Muell. Hal., Flora 82: 450. 1896. *Cynodontium asperellum* Stirt., Ann. Scott. Nat. Hist. 15(58): 106. 1906.

Plants slender, tufted, 5 mm long; leaves linear- lanceolate, apex acuminate, margin wavy, 2 × 0.5 mm; costa ends below the apex; leaf cells chlorophyllose, rounded, papillose, 5-8 × 5-6 µm at tip and hyaline, rectangular, 20-30 × 10-15 µm at base, towards the costa cells became larger; seta 5 mm long; capsule erect and cylindrical. (Plate 5.46)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam, Athikode (890 m), 15-11-12, *Prajitha 8631*; 11-09-14, *Prajitha 11070* (MBGH).

Habitat: Seen on wet rocks in the semi-evergreen forest.

Distribution: World: Afghanistan, Brazil, China, Japan, Korea, Myanmar, New Guinea, New Zealand, Pakistan, Philippines, South Africa, U.S, Western Tibet.

India: Himachal Pradesh (Aziz and Vohra, 2008), Kashmir (Aziz and Vohra, 2008), Kerala, Maharashtra (Magdum *et al*., 2017), Sikkim, Uttarakhand (Aziz and Vohra, 2008), West Bengal (Aziz and Vohra, 2008) and Western Himalaya (Aziz and Vohra, 2008).

Kerala: Wayanad (Nair *et al*., 2005a).

Hyophila Brid.,

Bryol. Univ.1:760. 1827

Plant densely tufted, erect, greenish; stem simple or branched, radiculous at base; leaves curled when dry, oblong, spathulate, margin entire at base, denticulate towards the tip, apex apiculate; costa ends below the apex, wide at base; leaf cells rectangular, hyaline at base, isodiametric and mammilose at apex; seta elongated; capsule cylindrical, opeculum rostrate, perstome teeth absent; calyptra cucullate; spores rounded.

Hyophila involuta (Hook.) A. Jaeger, Ber. Thatigk. St. Gallischen Naturwiss. Ges. 1871–72: 354. 1873; Gangulee, Moss. E. India 1(3): 681. 1972; Nair *et al.*, Bryoph. Wayanad 115. 2005. *Gymnostomum involutum* Hook., Musci Exotici 2: 154. 1819. *G. tortula* Schwagr., Sp. Musc. Frond., Suppl. 2 2(1): 78. pl. 175. 1826. *Barbula spathulata* Dozy & Molk., Ann. Sci. Nat., Bot., ser. 3, 2: 300. 1844. *Hyophila tortula* (Schwagr.) Hampe, Bot. Zeitung (Berlin) 4: 267. 1846. *Pottia contermina* Muell. Hal. Syn. Musc. Frond. 2: 623. 1851. *P. zollingeri* Muell. Hal., Bot. Zeitung (Berlin) 14: 419. 1856. *Hyophila stenocarpa* Renauld & Cardot, Bull. Soc. Roy. Bot. Belgique 38(1): 10. 1900. *H. commutata* Broth., Nat. Pflanzenfam. I (3): 403. 259. 1902. *H. wrightii* A. Jaeger ex Broth., Nat. Pflanzenfam. I (3): 403. 1902. *H. mollis* Broth., Symb. Antill. 3: 424. 1903. *H. flavipes* Broth., Philipp. J. Sci. 3: 14. 1908. *H. attenuata* Broth, Symb. Sin. 4: 37. 1929. *Tayloria coreana* Sakurai, Bot. Mag. (Tokyo) 54: 31. 1. 1940.

Plant densely tufted, erect, greenish up to 1.5 cm long; stem simple or branched, radiculous, brownish at base; leaves forms rosettes at tip, curled when dry, oblong, spathulate, margin entire at base, denticulate towards the tip, apex apiculate,

2 mm long; costa ends below the apex, wider at base; leaf cells rectangular, hyaline, 22-33 × 14-17 µm at base, isodiametric and mammilose at apex, 7-10 × 6-10 µm; seta 1.5 cm long; capsule cylindrical, 3 × 0.5 mm long; perstome teeth absent; opeculum rostrate; calyptra cucullate; spores rounded and 12 µm wide. (Plate 5.47)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam, Raveendra estate (700 m), 10-05-03, *MCN 120105* (CALI); 11-09-14, *Prajitha* 11074; Peruvannamuzhi (300 m), 26-09-12, *Prajitha 8540*; 22-03-14, *Prajitha 11025*.

Habitat: Seen on rocks, horizontal and vertical land cuttings and concrete walls in the semi evergreen and moist deciduous forests.

Distribution: World: Africa, America, Borneo, Brazil, Celebes, China, India, Japan, Java, Korea, Nepal, Mexico, Myanmar, New Guinea, Phippines, Sri Lanka, Taiwan, Thailand and Vietnam.

India: Andaman & Nicobar Islands (Aziz and Vohra, 2008), Andra Pradesh (Sandhya Rani *et al*., 2014), Arunachal Pradesh (Aziz and Vohra, 2008), Bengal (Gangulee, 1972), Bihar (Rawat *et al*., 2016), Chhotanagpur (Gangulee, 1972), Gujarat (Chaudhary *et al*., 2006), Himachal Pradesh (Aziz and Vohra, 2008), Karnataka (Schwarz, 2013), Kerala, Madhya Pradesh (Aziz and Vohra, 2008), Maharashtra (Magdum *et al*., 2017), Meghalaya (Aziz and Vohra, 2008), Odisha (Aziz and Vohra, 2008), Sikkim (Gangulee, 1972; Aziz and Vohra, 2008), Tamil Nadu (Daniels, 2010; Daniels *et al*., 2018) and Uttarakhand (Aziz and Vohra, 2008), Uttar Pradesh (Aziz and Vohra, 2008) and West Bengal (Aziz and Vohra, 2008) **Kerala:** Idukki: Chinnar WLS (Nair *et al.*, 2006), Kannur: Arlam WLS (Manju *et al.*, 2009b), Kozhikode: Kakkayam (Manju *et al.*, 2008a) and Wayanad (Nair *et al.*, 2005a)

Economic importance: It has antimicrobial activity to *Staphylococcus aureus* and *Aspergillus flavus. H. involuta* contain various secondary metabolites viz., alkaloids, anthraquinones, glycosides, flavonoids, saponins, steroid, tannins and triterpenes, etc. (Makinde *et al.*, 2015).

Bryales Limpr.,

Krypt. Fl. Schlesien 1(1): 55. 1876.

Bryaceae Schwagr.,

Sp. Musc. Frond. 47. 1830.

Plants erect, tufted, greenish-yellowish green or yellowish brown; stem tomentose at base; leaves ovate or ovate – lanceolate, apex acuminate or obtuse, margin entire or faintly serrate at apex; costa single, excurrent or percurrent or ends at tip; leaf cells linear or rhomboidal at apex, subrectangular – hexagonal at base; capsule inclined.

Note: This family include 12 genera of which five genera such as *Anomobryum* Schimp., *Brachymenium* Schwagr., *Bryum* Hedw., *Ptychostomum* Hornsch. and *Rhodobryum* (Schimp.) Limpr. are distributed in India and Kerala. Of these two genera *viz*., *Anomobryum* Schimp. and *Bryum* Hedw. are represented in the study area.

Key to the Genera

1a. Plants julaceous, slender; leaf cells linear above……..... ***Anomobryum***

1b. Plants not julaceous, not slender; leaf cells rhomboid above…… ...…….. ***Bryum***

Anomobryum Schimp.,

Syno. Musc. Eur. 1:382. 1860.

Plants slender, tufted, julaceous to filiform; leaves closely imbricate, ovate, obtuse, entire at apex; costa ending below the apex; leaf cells linear at apex, subrectangular to hexagonal at base.

Anomobryum auratum (Mitt.) A. Jaeger, Bericht, St. Gall.Naturw. Ges. 1873-1874: 142. 1875; Gangulee, Moss. E. India 2(4): 955. 1974; Chopra, Tax. Ind. Moss., 209. 1975; Nair *et al.*, Bryoph. Wayanad 124. 2005. *Bryum auratum* Mitt., J. Proc. Linn. Soc., Bot., Suppl. 1: 67. 1859. *B. cymbifolium* Lindb., Not. Sallsk. Fauna Fl. Fenn. Forh. 11: 45. 1870.

Plants slender, tufted, julaceous, yellowish green; stem brownish, sparingly branched, radiculous at base, 2.2-3.5 cm long; leaves closely imbricate, ovate, obtuse, faintly denticulate towards the apex, 1 × 0.5 mm; costa brownish, ending below apex; leaf cells linear, incrassate at apex, 45-52 × 5 µm, basal cells subrectangular to hexagonal and thin walled, 45-50 × 22-27 µm. (Plate 5. 48)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam, Ambalappara (800 m), 26-09-12, *Prajitha 8528, 8527, 8523, 8525* (MBGH).

Habitat: Seen on wet rocks in the semi evergreen and evergreen forests.

Distribution: World: Africa, Australia, Bhutan, China, India, Japan, Kenya, Korea, Madagaskar, Nepal, Philippines, Sri Lanka and Tanzania.

India: Darjeeling (Gangulee, 1974), Gujarat (Chaudhary *et al*., 2006), Karnataka (Schwarz, 2013), Kerala, Madhya Pradesh (Nath & Gupta, 2009), Manipur (Govindapyari, 2012), Tamil Nadu (Daniels, 2010; Daniels *et al*., 2018) and Western Himalaya (Vohra, 1969).

Kerala: Idukki: Chinnar WLS (Nair *et al.*, 2006), Wayanad (Nair *et al.*, 2005a).

Bryum Hedw.,

Sp. Musc. 178. 1801.

Plants mostly tufted, erect, greenish or yellowish brown, tomentose below; central strand present; leaves ovate- lanceolate or ovate-oblong, apex acuminate or obtuse, margin faintly serrated at apex; costa excurrent, percurrent or ends at tip; leaf cells rhomboid at apex, quadrangular-hexagonal at base.

Key to the species

1a. Plants large, 5-10 cm high…… ..... ***B. wightii***

1b. Plants small, 1-2 cm high……..... …2

2a. Costa excurrent…… ..... ***B. coronatum***

2b. Costa percurrent……..... ***B. cellulare***

Bryum cellulare Hook., Sp. Musc. Frond., Suppl. 3 1(1): 214. 1827; Gangulee, Moss. E. India 2(4): 969. 1974; Nair *et al.*, Bryoph. Wayanad 128. 2005. *Webera thermalis* Besch., Ofvers. Forh. Kongl. Svenska Vetensk. Akad. 57: 291. 1900. *Epipterygium thermale* (Besch.) Broth., Nat. Pflanzenfam. I (3): 555. 1903. *Bryum calabricum* Warnst. & M. Fleisch., Eur. Laubm. 2: 68. 8 f. 8. 1904. *B. formosanum* Broth., Oefvers. Forh. Finska Vetensk. Soc. 62 A (9): 17. 1921. *B. argenteum* var. *rotundifolium* Sim, Trans. Roy. Soc. South Africa 15: 328. 1926.

Plants tufted, erect, glossy, brownish, tomentose below, 2 mm long; stem branched by sub floral innovations; stem cells hexagonal, thick walled, central strand present; leaves overlapping, concave, ovate- lanceolate, apex obtuse, margin almost entire but slightly serrated at apex; costa reddish, percurrent; leaf cells rhomboid at apex, 65-75 × 10-12 µm, quadrangular-hexagonal at base, 80-90 × 15 µm.(Plate 5.49)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam, Urakkuzhi (730 m), 12-09-14, *Prajitha 12576*; 12-01-15, 13529 (MBGH).

Habitat: Seen on wet rocks and on land cuttings in the semi-evergreen forests.

Distribution: World: Africa, America, Australia, China, India, Java, Japan, Myanmar, Philippines and Sumatra

India: Andra Pradesh (Sandhya Rani *et al*., 2014) Arunachal Pradesh, Eastern Himalayas (Bansal & Nath, 2013), Gujarat (Chaudhary *et al*., 2006), Manipur (Govindapyari *et al*., 2012).

Kerala: Kozhikode: Vellarimala (Nair *et al.*, 2006) and Wayanad (Nair *et al.*, 2005a)

Bryum coronatum Schwagr., Sp. Musc.Frond., Suppl. 1 2: 103. pl. 71. 1816; Gangulee, Moss. E. India 2(4): 1002. 1974; Nair *et al.*, Bryoph. Wayanad 129. 2005. *B. mariei* Besch., Ann. Sci. Nat., Bot., ser. 6, 10: 235. 1880. *B. rufinerve* Muell. Hal., Linnaea 38: 549. 1874. *B. barbulaceum* Muell. Hal., Linnaea 39: 389. 1875. *B.*

zygodontoides Muell. Hal., Bot. Jahrb. Syst. 5: 83. 1883. *B. eurystomum* Renauld & Cardot, Rev. Bot. Bull. Mens. 9: 290. 1891. *B. balanocarpum* Besch., Bull. Soc. Bot. France 41: 82. 1894. *B. microbalanum* Cardot, Rev. Bryol. 36: 112. 1909. *B. microdecurrens* E. Britton, Bull. Torrey Bot. Club 42: 5. 1915.

Plants tufted, erect, greenish, tomentose below, branched at base, 2.2 cm long; leaves ovate- lanceolate, apex acuminate, margin faintly serrated at apex, 2.7 × 1 mm; costa reddish, excurrent; leaf cells rhomboid- hexagonal at apex, 55-58 × 7-8 µm, marginal cells form one layer of elongated cells, cells rectangular at base, 30-40 × 15 µm; seta erect, reddish, 2.5-3 cm long; capsule reddish, pendulous, 2.3 mm long; apophysis spongy, operculum conical; peristome reddish and papillose.(Plate 5.50)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam, Ambalappara (740 m), 12-09-14, *Prajitha 12533*, 13-11-14, *Prajitha 12821* (MBGH).

Habitat: Seen on wet rocks in the semi- evergreen forests.

Distribution: Afria, Bolivia, Borneo, Brazil, China, India, Japan, Peru, Philippines, Mexico and Thailand.

India: Andra Pradesh (Sandhya Rani *et al*., 2014), Calcutta (Gangulee, 1972), Gujarat (Chaudhary *et al*., 2006), Karnataka (Schwarz, 2013), Kerala, Madhya Pradesh (Nath & Gupta, 2009), Odisha (Gangulee, 1972), Tamil Nadu (Daniels, 2010; Daniels *et al*., 2018) and West Bengal (Lal. 2007),

Kerala: Kozhikode (Rajesh & Manju, 2014) and Wayanad (Nair *et al.*, 2005a)

Economic importance: It has insecticidal activity and act against Maize stem borer (Ande *et al.*, 2010).

Bryum wightii Mitt., J. Proc. Linn. Soc., Bot., Suppl. 1: 74. 1859; Gangulee, Moss. E. India 2(4): 983. 1974; Nair *et al.*, Bryoph. Wayanad, 130. 2005. *B. formosum* Mitt., J. Bot. 38: 329. 413. 1900. *B. bohnhofii* Muell. Hal. ex Broth., Nat. Pflanzenfam. I (3): 598. 1904. *B. srilankenese* Mohamed, J. Bryol. 12: 25. f. 2. 1982.

Plants tufted, erect, yellowish brown; stem reddish, tomentose, up to 5.5 cm long; leaves curled, appressed to the stem when dry, concave, ovate- oblong, margin faintly crenulated towards the tip, apex acuminate, 5 × 1 mm; costa brownish, narrower towards the tip, excurrent; leaf cells rhomboidal at apex, 60-70 × 15 μm, rectangular and hyaline at base, 50-52 × 20-25 μm. (Plate 5.51)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam, Ambalappara (700-840 m), 26-09-12, *Prajitha 8508,8531*; Sankaranpuzha (900 m), 27-09-12, *Prajitha 8613* (MBGH).

Habitat: Seen on wet rock, near water falling areas along with *Eriocaulon* sp. and *Utricularia* sp. in the evergreen, semi evergreen forests and grasslands.

Distribution: World: India and Sri Lanka.

India: Maharashtra (Dandotiya *et al*., 2011), Karnataka (Schwarz, 2013), Kerala, Tamil nadu (Daniels, 2010; Daniels *et al*., 2018)

Kerala: Agasthyamala (Manju *et al.*, 2009d), Kannur: Aralam WLS (Manju *et al.*, 2009b), Kozhikode: Vellarimala (Nair *et al.*, 2006) and Wayanad (Nair *et al.*, 2005a).

Bartramiales M. Menzel,

J. Hattori Bot. Lab. 71: 242. 1992.

Bartramiaceae Schwagr.,

Sp. Musc. Frond. 90. 1830.

Plants usually slender, tufted; leaves lanceolate, apex acuminate, margin serrated; costa excurrent or percurrent, sometimes spinous on back; leaf cells narrow, elongated towards the apex, quadrangular or rhomboidal at base, mamillose.

Note: This family include ten genera of which seven genera *viz.*, *Anacolia* Schimp., *Bartramia* Hedw., *Breutelia* (Bruch & Schimp.) Schimp., *Conostomum* Sw., *Fleischerobryum* Loeske, *Philonotis* Brid. and *Plagiopus* Brid. are distributed in India. Of these two genera such as *Bartramia* Hedw. and *Philonotis* Brid. occur in Kerala and only one genus, *Philonotis* Brid. is represented in the study area.

Philonotis Brid.,

Bryol. Univ. 2: 15. 1827

Plants slender, tufted, yellowish green, dichotomously branched, tomentose by interwoven rhizoids; leaves lanceolate, apex acuminate, margin serrate, spines often paired; costa percurrent or excurrent; leaf cells narrow, elongate towards the apex, quadrangular or rhomboidal at base, mamillose at upper or both ends.

Key to the species

1a. Leaf apex subulate…….. ***P. mollis***

1b. Leaf apex acute or acuminate……..2

2a. Leaf margin biserrated…….3

2b. Leaf margin serration single…….. ***P. secunda***

3a. Costa excurrent…….. ***P. fontana***

3b. Costa percurrent…….. ***P. hastata***

Philonotis fontana (Hedw.) Brid., Bryol. Univ. 2: 18. 1827; Gangulee, Moss. E. India 2(4): 1114. 1974; Nair *et al*., Bryoph. Wayanad 137. 2005. *Mnium fontanum* Hedw., Sp. Musc. Frond. 195-196. 1801. *Philonotis lutea* Mitt., J. Proc. Linn. Soc., Bot., Suppl. 1: 63. 1859. *Didymodon denticulatus* Schimp., Musci Gall. 11: n. 508. 1874. *Philonotis acutiflora* Kindb., Hedwigia 35: 67. 1896. *P. luteola* Cardot, Rev. Bryol. 38: 37. 1911.

Plants slender, tufted, yellowish green, tomentose, 3-5 cm long; stem with central strand; leaves falcate, lanceolate, apex acuminate, margin serrate towards the apex, teeth paired, 2 × 0.5 mm; costa excurrent, paired teeth found at the back; leaf cells narrow, linear at apex, with mamillae at both ends, 35-40 × 5-7 µm, cells rectangular with mamillae at base, 32-35 × 14-16 µm. (Plate 5.52)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam, Ambalappara (830 m), 26-09-12, *Prajitha 8533*; 11-09-14, *Prajitha 14029 (*MBGH).

Habitat: Seen on land cuttings in the semi- evergreen forests.

Distribution: World: Africa, America, China, India, Iran, Japan, Korea, New Zealand and Philippines.

India: Himalaya (Bahuguna *et al*., 2016), Kashmir, Karnataka (Aruna & Krishnappa, 2014), Kerala, Manipur (Govindapyari *et al*., 2012), Odisha (Mishra *et al*., 2016), Tamil Nadu: Palni hills (Daniels, 2010; Daniels *et al*., 2018) and Western Himalayas (Alam, 2013).

Kerala: Aralam WLS (Manju *et al.*, 2009b), Chinnar WLS (Nair *et al.*, 2006), Kozhikode: Vellarimala (Nair & Madhusoodanan, 2006) and Wayanad (Nair *et al.*, 2005a).

Economic importance: It is used to heal burns, adenoparyngitis and antipyretic (Asakawa, 2007).

Philonotis hastata (Duby) Wijk & Margad., Taxon 8:74. 1959; Gangulee, Moss. E. India 2(4): 1127. 1974; Bryophy. Wayanad 137. 2005. *Hypnum hastatum* Duby, Syst. Verz. 132. 1846. *Bartramia tahitensis* Muell. Hal., Bot. Zeutung (Berlin) 17: 220. 1859. *B. obtusifolia* Mitt., Fl. Vit. 381. 1873. *B. ambyoblasta* Muell. Hal., Linnaea 38: 631. 1874. *Philonotis curvifolia* Besch., Ann. Sci. Nat., Bot., Ser. 6, 10:245. 1880. *Bartramia elongatula* Muell. Hal., Linnaea 43: 415. 1882. *B. wallisii* Muell. Hal. Linnaea 38: 554. 1874. *B. curvifolia* (Besch.) Muell. Hal., Gen. Musc. Frond. 338. 1900.

Plants slender, yellowish green, sub- apical innovations present, 2.5 cm long; leaves curled when dry, ligulate, lanceolate, apex acute or shortly acuminate, margin dentate by upturned mamillae, 1× 0.2 mm; costa percurrent or ends below the apex; leaf cells rhomboidal to hexagonal, mamillae on tip, 35-40 × 10 µm. (Plate 5.53)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam, Athikode (830 m), 22-03-14, *Prajitha 11031*, 12-01-15, *Prajitha 13515*(MBGH).

Habitat: Seen on rocks and land cuttings in the semi evergreen and evergreen forests.

Distribution: World: Africa, Australia, Bolivia, Borneo, Celebes, India, Japan, Java, Oceanic Island, Peru, Philippines, Sri Lanka, South America, Thailand and Venezuela.

India: Andra Pradesh (Sandhya Rani *et al*., 2014), Calcutta (Gangulee, 1972), Gujarat (Chaudhary *et al*., 2006), Tamil Nadu (Daniels, 2010), Karnataka (Schwarz, 2013), Tamil Nadu (Daniels *et al*., 2018), and West Bengal (Lal, 2007)

Kerala: Aralam WLS (Manju *et al.*, 2009b), Kozhikode (Rajesh & Manju, 2014) and Wayanad (Nair *et al.*, 2005a).

Economic importance: Phytochemical screening revealed potential antimicrobial activity of this species against *Staphylococcus aureus, Aspergillus flavus* and *Candida albicans* (Makinde *et al.*, 2015).

Philonotis mollis (Dozy & Molk.) Mitt., J. Proc. Linn. Soc., Bot., Suppl. 1:60. 1859; Gangulee, Moss. E. India 2(4): 1120. 1974; Nair *et al*., Bryophy. Wayanad 137. 2005. *Bartramia mollis* Dozy & Molk., Ann. Sci. Nat., Bot., Ser.3, 2: 300. 1844. *B. secunda* Dozy & Molk., Pl. Jungh. 3; 332. 1854. *Philonotis mollis* var. *simplicicaulis* Zanten., Nova Guinea, Bot. 16:10(160): 293. Pl. 25:f.1. 1964.

Plants slender, erect, dichotomously branched, tomentose below; leaves ovate, lanceolate, margin denticulate, spines paired, apex subulate; costa excurrent or ends at tip; leaf cells narrow, elongated, rectangular at top, 65-75 × 4-5 µm, basal cells short, rectangular, wide, 26-46 × 10-12 µm. (Plate 5.54)

Specimen examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Peruvannamuzhi, Chenkotakolli (420 m), 22-03-14, *Prajitha 11011* (MBGH).

Habitat: Seen on land cuttings in the moist deciduous forests.

Distribution: World: Borneo, China, India, Indonesia, Japan, Java, Madagaskar,

Philippines, Sri Lanka, Sumatra and Tonkin.

India: Andra Pradesh (Sandhya Rani *et al*., 2014), Gujarat (Chaudhary *et al*., 2006), Karnataka (Schwarz, 2013), Kerala, Rajasthan (Alam *et al*., 2014)) and Tamil Nadu (Daniels, 2010), Uttar Pradesh (Sahu & Asthana, 2015)

Kerala: Wayanad (Nair *et al.*, 2005a).

Philonotis secunda (Dozy & Molk.) Bosch & Sande Lac., Bryol. Jav. 1. 156. 126. 1861; Nair *et al*., Bryoph. Wayanad 138. 2005. *Bartramia secunda* Dozy & Molk., Pl. Jungh. 3: 332. 1854. *Breutelia neocaledonica* Broth. & Paris, Oefvers. Forh. Finska. Vetensk. Soc. 53 A (11): 22. 1911.

Plants tufted, forms dense mat, yellowish below and greenish above, sparsely branched, 8 mm long; leaves falcate, lanceolate, apex sharply acute, margin serrated by upturned marginal cells, 1 × 0.2 mm; costa ends at tip; leaf cells rhomboidal towards the tip, 35-45 × 9 µm, sub rectangular at base, 24-30 × 9-5 µm. (Plate 5.55)

Specimen examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam, Ambalappara (900 m), 11-09-14, *Prajitha 11061* (MBGH).

Habitat: Seen on rocks in the evergreen forest areas.

Distribution: World: India, Indonesia, Philippines and Sri Lanka.

India: Karnataka (Schwarz, 2013), Kerala (Nair *et al*., 2005a) and Tamil Nadu (Daniels, 2010)

Kerala: Wayanad (Nair *et al.*, 2005a).

Orhotrichales Dixon,

Man. Bryol. 409, 1932.

Orthotrichaceae Arn.,

Disp. Meth. Mousses 13, 1825

Plants usually robust, tufted, yellowish green or brownish; main stem creeping, up to 5 cm long, secondary branches erect; leaves dense, curled when dry, lanceolate, apex acute, margin flat or revolute, entire but crenulated or entire at apex; costa reach up to the tip of the leaf or ends below the tip; leaf cells incrassated, papillose; capsule ovate, operculum rostrate, calyptra mitriform and hairy.

Note: This family represents 19 genera, of which nine genera *viz*., *Codonoblepharon* Schwagr., *Desmotheca* Lindb., *Groutiella* Steere, *Macrocoma* (Muell. Hal.) Grout, *Macromitrium* Brid., *Orthotrichum* Hedw., *Schlotheimia* Brid., *Ulota* D. Mohr, *Zygodon* Hook. & Taylor are distributed in India. Of these three genera *viz*., *Groutiella* Steere, *Schlotheimia* Brid. and *Macromitrium* Brid. are found in Kerala and one genus, *Macromitrium* Brid. is represented in the study area.

Macromitrium Brid.,

Muscol. Recent. Supp 4: 132. 1819.

Plants robust, tufted, yellowish green or brownish; main stem creeping, up to 5 cm long, secondary branches erect; leaves curled when dry lanceolate, apex acute, margin flat or revolute, entire but crenulate or entire at apex, base plicate; costa reach up to the tip of the leaf or ends below the tip; leaf cells incrassated, papillose, tip cells rounded to quadrate, narrow, elongated at middle and basal cells; marginal cells forms 2 rows of narrow, elongated cells; seta long, capsule ovate, sulcate or not, operculum rostrate, calyptra mitriform and hairy, covering the capsule, peristome papillose; spore rounded.

Key to species

1a. Capsule sulcate… .....***M. sulcatum***

1b. Capsule not sulcate…..... ***M. moorcroftii***

Macromitrium moorcroftii (Hook. & Grev.) Schwaegr., in Sp. Musc. Suppl. 2(2): 67. 1826; Gangulee, Moss. E. India 2(5): 1180. 1976; Nair *et al.*, Bryoph. Wayanad 140. 2005. *Orthotrichum moorcroftii* Hook. & Grev., Edinburgh J. Sci. 1: 116. 4. 1824. *Macromitrium pileatum* Wilson, Hooker's J. Bot. Kew Gard. Misc. 9: 327. 1857. *M. tortuosum* Wilson, Hooker's J. Bot. Kew Gard. Misc. 9: 327. 1857.

Plants robust, densely tufted, green to brownish; main stem creeping, up to 5 cm long, secondary branches erect; leaves curled when dry, lanceolate, apex acute, margin flat or revolute, entire but crenulate at apex, base plicate 3.7 × 0.6 mm; costa reach up to the top of the leaf; leaf cells incrassste, papillose, tip cells rounded to quadrate 10 × 11µm, narrow, elongated at middle, 15-17 × 8-9 µm and basal cells 25-27 × 3-4 µm; marginal cells forms 2 rows of narrow, elongated; seta up to 7 mm long; capsule ovate, 3.3 mm long, operculum rostrate, calyptra mitriform and hairy, covering the capsule, peristome papillose; spore rounded and 25 µm wide. (Plate 5.56)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam, Ambalappara (900- 1230 m), 26-09-12, *Prajitha 8519*; 22-03-14, *Prajitha 11064* (MBGH).

Habitat: Forms mat on branches in the evergreen forests and grassland. **Distribution: World:** Bangladesh, Bhutan, China, India, Myanmar and Nepal.

India: Karnataka (Schwarz *et al.*, 2013), Kerala (Nair *et al*., 2005a), Manipur (Govindapyari, 2014), Tamil Nadu (Daniels, 2010), Himalayas (Robinson, 1968), West Bengal (Gangulee, 1976).

Kerala: Agathyamala (Manju *et al.,* 2009d), Neyyar Wildlife Sanctuary (Brijithlal, 2010), Wayanad (Nair *et al*., 2005a).

Macromitrium sulcatum (Hook.) Brid., Bryol. Univ., 1: 319. 1826; Gangulee, Moss. E. India 2(5): 1181. 1976; Nair *et al.*, Bryoph. Wayanad 141. 2005. *Schlotheimia sulcata* Hook., Musci Exot. 2: 156. 1819. *M. neelgheriense* Muell. Hal., Syn. Musc. Frond. 1: 737. 1849. *M. ceylanicum* Mitt., Proc. Linn. Soc., Bot., Suppl.1: 52. 1859. *M. ramentosum* Thwaites & Mitt., J. Linn. Soc., Bot. 13: 301. 1873.

Plants tufted, yellow green to brownish in colour, main stem creeping, up to 7 cm long, secondary branches erect up to 0.8 mm long; leaves lanceolate, apex acute to apiculate, margin entire, 2 × 0.5 mm; costa ending below the apex; leaf cells incrassate, papillose, irregularly rounded at apex 5-7 × 6-9 µm, elongated at middle, 17-20 × 4-5 µm, cells rectangular at base, 22-25 × 7-8 µm; seta up to 7 mm long; capsule ovate and sulcate, 2.2 mm long; operculum rostrate, calyptra mitriform, peristome single, exostome only present, 220 µm long; spore rounded, 20 µm wide. (Plate 5.57)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam Raveendra estate (900 m), 10-05-03, *MCN 120143* (CALI); Ambalappara (800-1200 m), 26-09-12, *Prajitha 8516*; 11-09-14, *Prajitha 14059* (MBGH).

Habitat: Seen on branches along with *Myurium borii* in the evergreen forest areas.

Distribution: World: Sri Lanka, Nepal, Borneo, Madagaskar, Malaysia, Philippines, Vietnam, Thailand and Myanmar.

India: Arunachal Pradesh (Dandotiya *et al*., 2011), Karnataka (Schwarz, 2013), Tamilnadu (Daniels, 2010) and Maharashtra (Magdum *et al*., 2017)

Kerala: Agasthyamala (Manju *et al.*, 2009d), Chinnar WLS (Manju *et al.*, 2006), Kozhikode: Kakkayam (Manju *et al.*, 2008a) and Wayanad (Nair *et al.*, 2005a).

Hookeriales M. Fleisch.,

Hedwigia 61:397. 1920.

Plants tufted on tree trunk, yellowish green to brownish green; stem without central strand, branched sparsely or irregularly; leaves seen in several rows, symmetric or asymmetric, oblong or oblong – lanceolate, apex acuminate or apiculate, margin entire or serrated towards tip; costa single or double or none; leaf cells smooth or papillose, alar not differentiated; seta smooth or papillose or pubescent, capsule ovate or cylindrical, operculum rostrate, calyptra conical and mitrate, peristome double, exostome furrowed and papillose, spore smooth or papillose.

Pilotrichaceae Kindb.,

Bot. Centralbl. 77(2): 54. 1899.

Plants robust, forms mat; main stem creeping, make irregular pinnate branches; stem without central strand; leaves ovate-oblong, apex apiculate, margin denticulate at apex; costa double, parallel, strong and prominent, which extends middle of the leaf; leaf cells irregularly hexagonal or isodiametric in shape, papillose; seta long and smooth, capsule horizontally placed, inclined, operculum rostrate, peristome double, exostome papillose, spores smooth or papillose.

Note: This family represented by 21 genera of which five genera *viz*., *Actinodontium* Schwagr., *Callicostella,* (Muell. Hal.) Mitt., *Lepidopilidium* (Muell. Hal.) Broth*., Pilotrichum* P. Beauv and *Thamniopsis* (Mitt.) M. Fleisch are distributed in India. Of these one genera, *Callicostella* (,Muell. Hal.) Mitt. is earlier reported from Kerala and two genera *viz*., *Actinodontium* Schwagr. and *Callicostella* (Muell. Hal.) Mitt. are represented in the present study area.

Key to the genera

1a. Leaf margin entire, cells smooth; costa double, unequal…… ***Actinodontium***

1b. Leaf margin dentate towards the tip; costa double, equal…….. ***Callicostella***

Actinodontium Schwaegr.,

Sp. Musc. Suppl. 2(2): 75. 1826.

Plants seen in tufts, yellowish-green to brownish-green; main stem creeping, sparsely branched, tomentose below and central strand absent; leaves seen in eight whorls around the stem, dense, oblong- lanceolate, apex acuminate, margin entire, costa double, unequal; leaf cells elongated, rhomboidal, smooth; seta pubescent, capsule erect or inclined, cylindrical or sub cylindrical, calyptra conical, mitrate, operculum beaked and rostrate., peristome double, endostome short, exostome papillose, spore smooth or papillose.

Actinodontium rhaphidostegium (C. Muell.) Bosch & Lac., Bryol. Jav., 2: 37 .1862; Gangulee, Moss. E. India 2(6): 1509. 1977; Suleiman & Edwards, Tropical

Bryol., 21: 62. 2002; Frahm, Archive for Bryol., 181: 15. 2013. *Hookeria rhaphidostega* Muell. Hal., Syn. 2: 677. 1851.

Plants tufted, glossy, yellowish green to brownish in colour; stem brownish, 1-1.5 cm long, branched at base, without central strand , 0.25 mm wide, cortical cells quadrangular to hexagonal with brownish cell wall, 18-23 × 23-29 µm; medullary cells hexagonal with yellowish cell wall, comparatively larger, 30-38 × 32-36 µm; rhizoids brownish, arising from the ventral side of the stem; leaves octastichous, flexuose when dry, oblong- lanceolate, apex sharply acuminate, margin entire, faintly denticulate towards the tip, 2 × 0.5 mm; costa double, unequal, parallel; leaf cells elongated rhomboidal at middle, 90-100 × 15-16 µm and at top 55-71 × 16-17µm but quadrate- rectangular at base, 40-74 × 17-20 µm; sporophyte arising laterally on the stem, perichaetial leaves ovate - lanceolate, 1.5 × 0.8 mm, seta brownish, minutely pubescent, 8 mm long, capsule erect, cylindrical, 2 mm long with apophysis, operculum mitrate, peristome double, 440-450 µm long, 45-50 µm wide at base, endostome shorter than exostome, papillose, spore rounded, papillose, 19 µm wide. (Plate 5.58)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary: Kakkayam, Athikode (784-1200 m), 14-11-14, *Prajitha 12847*; 12-01-15, *Prajitha 13502*; 14-11-14, *Prajitha 12932* (MBGH).

Habitat: Epiphytic on branches in the evergreen and semi evergreen forests.

Distribution: World: Borneo, Celebes, China, India, Indonesia, Japan, Java Malaysia, Philippines and Vietnam.

India: Darjeeling (Gangulee, 1977), Karnataka (Schwarz, 2013) and Tamil Nadu (Daniels *et al*., 2018)

Notes: No earlier reports of this species from Kerala, hence the present study is a new record to Kerala.

Callicostella (Muell. Hal.) Mitt.,

J. Proc. Linn. Soc., Bot. 1: 6, 136. 1859.

Plants robust, tufted, yellowish green to reddish brown; stem creeping, sparsely branched, without central strand; leaves seen in several whorls around the stem, oblong-lingulate, apex broad, apiculate, margin denticulate towards the tip; costa double, reaching near the apex; leaf cells irregularly quadrangular in shape and papillose; perichaetial leaves narrow, lanceolate, seta almost smooth or rough at tip, capsule ovate or cylindrical, peristome double, calyptra mitriform, operculum rostrate, spore rounded.

Callicostella papillata (Mont.) Mitt., J. Proc. Linn. Soc., Bot., Suppl. 1: 136. 1859; Gangulee, Moss. Eastern India, 2(6): 1510. 1977; Nair *et al.*, Bryoph. Wayanad 166. 2005. *Hookeria papillata* Mont., Lond. J. Bot., 3: 632. 1844; *H. andamana* Paris., Index Bryol. Suppl. 184. 1900. *Callicostella andamana* Muell. Hal., Musci Buitenzorg 3: 1023. 1908.

Plants robust, tufted, yellowish green to brownish; stem creeping, reddish - brown, up to 2 cm long, sparsely branched, without central strand, 0.18 mm wide; stem cortical cells with brownish wall layers, quadrangular, 10 – 21 × 13 – 15 µm; stem medullary cells with yellowish wall layers, hexagonal, comparatively larger, 21 - 41 × 22- 30 µm; rhizoids brownish, clustered, arising from the ventral sides; leaves curled when dry and seen in several whorls around the stem, oblong, apex broad, apiculate, margin more denticulate towards the tip, 1-1.5 × 0.5 mm; costa double, vanishing below the apex, and are abaxially projected, reddish brown in colour; leaf cells papillose, basal cells irregularly quadrangular and 18 - 30 × 7-9 µm, boarder cells at base comparatively narrow, rectangular in shape and 32-39 × 5-7 µm, middle cells and top cells are small, quadrangular in shape and 7-16 × 6-7 µm; perichaetial leaves comparatively narrow, lanceolate, 1 × 0.5 mm, seta reddish, almost smooth, 1 cm long, capsule ovate, cylindrical, peristome double, 270-290 µm long and 40-50 µm wide at base, spore rounded, 9-10 µm wide. (Plate 5.59)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary: Kakkayam (940-1085 m), 14-11-14, *Prajitha* 12872, 12-01-15, *Prajitha* 12981 (MBGH).

Habitat: Seen on bark at the upper part of the tree trunk in the semi-evergreen forests.

Distribution: World: Australia, Borneo, China, Fiji, India, Indonesia, Japan, Java, Malaysia, Madagaskar, New Caledonia, New Guinea, Philippines, Sri Lanka, Thailand and Vietnam.

India: Darjeeling (Gangulee, 1977), Karnataka (Frahm *et al.*, 2013), Kerala (Nair *et al*., 2005a) and Tamil Nadu (Daniels, 2010).

Kerala: Wayanad (Nair *et al.*, 2005a).

Hypnales (M. Fleisch) W.R. Buck & Vitt,

Taxon 35:33. 1986.

Key to the Families

1a. Paraphyllia present; leaf cells obscure…..... **Thuidiaceae**

1b. Paraphyllia absent; leaf cells not obscure.....(2)

2a. Alar cells large oblong, coloured.....(3)

2b. Alar cells small, quadrate, not coloured….....(4)

3a. Capsule inclined ..... **Sematophyllaceae**

3b. Capsule erect… ..... **Myuriaceae**

4a. Leaves mostly assymetrical.....(5)

4b. Leaves mostly symmetrical….....(6)

5a. Costa single; alar cells differentiated… ..... **Stereophyllaceae**

5b. Costa single or short double; alar weakly differentiated….....**Neckeraceae**

6a. Plants with filamentous gemmae arising from the axil of the leaf..... …… ……... .....**Pyilaisiadelphaceae**

6b. Plants without filamentous gemmae…..... (7)

7a. Plants robust; leaf base auriculate or cordate… ..... (8)

7b. Plants slender; leaf base narrowed… ..... (9)

8a. Leaf cells papillose…..... **Meteoriaceae**

8b. Leaf cells smooth….....**Pterobryaceae**

9a. Leaves concave; costa double,..… ..... (10)

9b. Leaves not concave; costa single…..... **Brachytheciaceae**

10a. Costa double, distantly placed… ..... **Entodontaceae**

10b.Costa double but not distantly placed…..... (11)

11a. Leaves falcate; capsule asymmetric…..... **Hypnaceae**

11b. Leaves not falcate; capsule symmetric... ..... **Symphyodontaceae**

Thuidiaceae Schimp.,

Syn. Musc. Eur. 493. 1860.

Plants robust or slender; stem creeping, central srand present, bipinnately branched; paraphyllia dense, lanceolate, filamentous and branched; leaves dimorphic, branch leaves comparatively small, ovate to lanceolate but stem leaves are large, long acuminate; costa percurrent or excurrent; leaf cells rhomboid or quadrate to hexagonal, unipapaillose; seta elongate; capsule horizontal or cylindrical; peristome hypnoid; operculum rostrate; calyptra campanulate or cucullate.

Note: This family include eight genera *viz*., *Abietinella* Muell. Hal., *Boulaya* Cardot, *Cyrto-hypnum* (Hampe) Hampe & Lorentz, *Fauriella* Besch., *Pelekium* Mitt., *Rauiella* Reimers, *Thuidiopsis* (Broth.) M. Fleisch. and *Thuidium* Bruch & Schimp. are distributed in the world. Of which three genera *viz*., *Abietinella* Muell. Hal., *Pelekium* Mitt. and *Thuidium* Bruch & Schimp. are found in India and two genera *viz*., *Pelekium* Mitt and *Thuidium* Bruch & Schimp. are represented in the study area.

Key to the genera

1a. Plants robust; calyptra cucullate…… ..... ***Thuidium***

1b. Plants slender; calyptra campanulate……..... ***Pelekium***

Pelekium Mitt.,

J. Linn. Soc., Bot. 10: 176. 1868

Plants slender, delicate and tufted; stem creeping and irregularly bipinnately branched; leaves ovate, apex acute or acuminate; costa ending below the apex; leaf cells hexagonal with one papilla at each cells; perichaetial leaves narrow, elongate, aristate; seta elongate; capsule horizontal, ovate; peristome hypnoid; operculum rostrate; calyptra campanulate.

Pelekium velatum Mitt., J. Linn. Soc., Bot., 10:176. 1868; Gangulee, Moss. E. India 3(7): 1615. 1978. *Thuidium velatum* (Mitt.) Paris, Index Bryol. 1294. 1898. *T. trachypodum* Bosch & Sande Lac., Bryol. Jav. 2: 122. 225. 1865. *Lorentzia longirostris* Hampe., Nuov. Giorn. Bot. Ital., 4: 288. 1872. *Pelekium fissicalyx* Muell. Hal., Bot. Jahrb. Syst. 5:87. 1883. *P. lonchopodum* Muell. Hal., Biblioth. Bot. 13: 7. 1889. *Thuidium hispidipes* Muell. Hal., Biblioth. Bot. 44: 21. 1898. *T. bandaicum* Muell. Hal., Bull. Soc. Roy. Bot. Belgique 41(1): 89. 1906. *Pelekium calcicola* M. Fleisch, in Musci Buitenzorg, 4: 1511. F. 240. 1923.

Plants slender, tufted, delicate, dark green, bipinnately branched; paraphyllia branched; leaves ovate, apex acute or acuminate, 1 × 0.5 mm; costa ending below the leaf apex; leaf cells hexagonal with one papilla at each cells, 6 µm wide; perichaetial leaves narrow, elongate, aristate; seta upto 1.7 cm long; capsule horizontal, ovate, 1.2 × 0.5 mm; peristome hypnoid; operculum rostrate; calyptra campanulate. (Plate 5.60)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary: Kakkayam: Sankaranpuzha (670 m), 14-11-14, *Prajitha 12858*; 12-09-14, *Prajitha 12551*; Peruvannamuzhi (310 m), 22-03-14, *Prajitha 11038* (MBGH).

Habitat: Forms mat on rocks along with *Bryocrumia vivicolor* in the semi-evergreen and evergreen forests.

Distribution: World: Amboina, Borneo, Burma, Celebes, India, Java, New Guinea, Philippines, Solomon Is., Sumatra and Thailand.

India: Andaman Islands (Rajesh, 2010), Arunachal (Gangulee, 1978), Kerala (Manju *et al*., 2008) and Karnataka (Frahm *et al*., 2013).

Thuidium Schimp.,

Bryol. Eur. 5: 157. 1852.

Plants robust, yellow green; main stem creeping, central strand present; paraphyllia dense, lanceolate, filamentous and branched, papillose or not; leaves dimorphic, stem and branch leaf different, branch leaves comparatively small, ovate to lanceolate but stem leaves are large, long acuminate or aristate at apex and cordate at base; costa percurrent or excurrent; leaf cells rhomboid or quadrate to hexagonal, unipapaillose; seta long, capsule cylindrical and inclined, operculam conic-rostrate, calyptra cucullate.

Key to the species

1a. Costa back spinose, reach upto the middle in branchleaf ..... ***T. pristocalyx***

1b. Costa back not spinose, percurrent in branchleaf… ..... ***T. cymbifolium***

Thuidium cymbifolium (Doz. & Molk.) Doz. & Molk., Bryol. Jav., 2: 115. 1865; Gangulee, Moss. E. India 3(7): 1646. 1978. *Hypnum cymbifolium* Doz. & Molk., Ann. Sc. Nat. Bot. ser. 3, 2: 306. 1844. *Thuidium japonicum* Doz. & Molk. ex Lac., Ann. Mus. Bot. Lugd. Bat. 2: 297. 1866. *T. plicatum* Mitt., Fl. Vit. 402. 1873. *Hypnum casuarinum* Muell. Hal., Linnaea 38:569. 1874. *Thuidium pennula* Muell. Hal., Syn. Queensl. Fl. 3: 99. 1890. *T. lauterbachii* Broth., Fl. Schutzgeb. Sudsee 102. 1900. *T. oahuense* Broth., Boll. Soc. Bot. Ital. 1904. 24. 1904. *T. longissimum* Herzog, Hedwigia 49: 125. 1909. *T. subpycnothallum* Card., Bull. Soc. Bot. Geneve ser. 2, 3: 284. 1911. *T. viridiforme* Card., ibid. 3: 284. 1911. *T. paraviride* Sak., Bot. Mag. Tok., 57: 350. 1943.

Plants robust, yellow green to brownish; main stem creeping, central strand present, pinnately branched, paraphyllia dense, lanceolate, branched; stem leaves ovate, lanceolate, aristate, 3 × 1 mm long, costa excurrent; branch leaf concave, ovate- lanceolate, acute at apex and crenulated at margin, 0.5 × 0.2 mm, costa percurrent; leaf cells rhomboid, 10-15 × 7-8 µm, unipapillose, elongated towards the base, 18-20 × 8-10 µm, cells more broad at extreme base; seta long upto 5 mm long, capsule cylindrical, inclined, 3 × 1.5 µm, operculam conic-rostrate, 1 mm long, calyptra cucullate. (Plate 5.61)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary: Kakkayam, Sankaranpuzha (1200 m), 27-09-12, *Prajitha 8623*; Urakkuzhi (900 m), 27-09-12, *Prajitha 8558* (MBGH).

Habitat: Forms mat on rocks near waterfalls in the semi evergreen forests.

Distribution: World: Australia, Burma, China, Hawaii, India, Japan, Java, Korea New Guinea, New Zealand, Philippines, Thailand and Vietnam.

India: Garhwal Himalaya (Bahuguna *et al*., 2016), Karnataka (Schwarz, 2013), Kerala (Manju *et al*., 2008), Odisha (Mishra *et al*., 2016), Tamil nadu (Daniels 2010; Daniels *et al*., 2018) and Western Himalayas (Alam, 2013).

Kerala: Agasthyamala (Manju *et al*., 2009d).

Thuidium pristocalyx (Muell. Hal) A. Jaeger., Ber. Thatigk. St. Gallischen Naturwiss. Ges. 257: 1876-77. 1878; Nair *et al.*, Bryoph. Wayanad 178. 2005. *Hypnum pristocalyx* Muell. Hal, Bot. Zeitung (Berlin) 12: 573. 1854. *Leskea glaucina* Mitt., J. Proc. Linn. Soc., Bot., Suppl. 2:133. 1859. *Thuidium orientale* Mitt. ex Dixon, J. Bot. 51: 329. 1913. *T. glaucinoides* var. *verrucosum* M. Fleisch., Musci Buitenzorg 4: 1527. 1923.

Plants robust, yellowish green, main stem creeping, bipinnately branched; paraphyllia dense, branched, filamentous, papillose; stem leaf ovate-lanceolate, apex acuminate, 2 × 0.7 mm, costa percurrent; branch leaf ovate, acute at apex, margin

crenulated, 0.5 × 0.2 mm, costa reach at the middle of leaf; leaf cells quadrate to hexagonal, obscure, incrassate, 8-15 × 5-6 µm, papilla single on lumen. (Plate 5.62)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary: Kakkayam, Vattakkayam (1050 m), 10-05-03, *MCN 120183* (CALI); Peruvannamuzhi, Chenkotakolli (340 m), 22-03-14, *Prajitha 11012*; 29-12-17, *Prajitha 14135* (MBGH).

Habitat: Seen on rocks in the moist deciduous and evergreen forests.

Distribution: World: China, Hawaii, India, Indonesia, Japan, Malaysia Philippines, Thailand and Vietnam.

India: Karnataka (Aruna & Krishnappa, 2014), Kerala, Manipur (Dandotiya *et al*., 2011), Tamil Nadu (Daniels, 2010) and Western Himalayas (Alam, 2013).

Kerala: Agasthyamala (Manju *et al.*, 2009d), Aralam WLS (Manju *et al.,* 2009b), Kozhikode: Kakkayam (Manju *et al.*, 2008a) and Wayanad (Nair *et al.*, 2005a).

Stereophyllaceae W.R. Buck & R.R Ireland,

Nova Hedwigia. 41:95. 1985.

Plants slender to robust, thin to dense, forms glossy mats, yellowish to brownish green; stem creeping, sparingly and irregularly branched; rhizoids brownish, forms clusters below the leaf insertions; leaves symmetric or asymmetric, flat or concave, ovate to lanceolate, apex acute or obtuse or acuminate, margin sometimes incurved at base, entire, serrulate towards the apex; costa single, strong, reaching below or beyond the mid leaf; leaf cells linear to rhomboidal, smooth or prorulose at distal ends; alar cells rectangular to quadrate, distributed equally or unequally on either side of the costa.

Note: This family include eight genera *viz*., *Catagoniopsis* Broth., *Entodontopsis* Broth., *Eulacophyllum* W.R.Buck & Ireland, *Juratzkaea* Lorentz, *Pilosium* (Muell. Hal.) M. Fleisch., *Sciuroleskea* Broth., *Stenocarpidium* Muell. Hal., *Stereophyllum* Mitt. Of these three genera *viz*., *Entodontopsis* Broth*., Juratzkaea* Lorentz and

Stereophyllum Mitt. are occur in India. Of these two genera *viz.*, *Entodontopsis* Broth. and *Stereophyllum* Mitt. are represented in the study area.

Key to the genera

1a. Leaf margin serrulate towards the tip, cells rhomboidal, smooth or prorulose at distal ends ..... ***Entodontopsis***

1b**.** Leaf margin entire, cells isodiametric, smooth..... ***Stereophyllum***

Entodontopsis Broth.,

Nat. Pflanzenfam. 1(3): 895–896, f. 657. 1907.

Plants thin to dense, forms glossy mats, yellowish to brownish green in colour; stem sparingly and irregularly branched, creeping; rhizoids brownish, forms cluster on the abaxial side; leaves symmetric or asymmetric, oblong or ovate to lanceolate, margin serrulate at apex, apex acute or acuminate; costa ends at or below the middle of the leaf; leaf cells smooth or prorulose at distal ends, narrow, linear to rhomboidal; alar cells quadrate or rectangular distributed equally or un equally on either side of the costa; seta elongate, smooth, reddish brown; capsule erect or inclined, cylindric or ovoid; peristome double, papillose; spore rounded and papillose.

Key to the species

1a. Leaf apex acute, costa ends at middle of the leaf.....(2)

1b. Leaf apex acuminate, costa ends below the middle of the leaf ..... ***E. anceps***

2a. Leaves wider, apical cells comparatively small, irregularly quadrangular to rhomboidal..... ***E. nitens***

2b. Leaves narrow, apical cells elongated, quadrangular to rhomboidal....***E. wightii***

Entodontopsis anceps (Bosch & Sande Lac.) W.R. Buck & R.R. Ireland, Nova Hedwigia 41: 103. 1985. *Hypnum anceps* Bosch & Sande Lac, Bryol. Jav. 2: 161. pl. 260. 1867. *H. llanosii* Duby, Flora 60: 92. 1877. *Stereophyllum oahuense* Broth.,

Bernice P. Bishop Mus. Bull. 40: 28. 8 f. 29. 1927. *S. philippinense* Broth., Philipp. J. Sci. 31: 294. 1926.

Plants slender, yellowish green, stem sparsely branched, creeping, 0.5 to 1cm long; leaves symmetric, oblong, margin minutely serrate towards the tip, acuminate at apex, 1.4 × 0.3 mm; costa ending below the middle of the leaf; leaf apical cells irregularly quadrangular, 15-31 × 0.7 µm, narrow, elongated at middle, 87-105 × 5-6 µm; alar cells quadrate to rectangular, distributed almost uniformly on either side of the costa, 20 × 9-10 µm. (Plate 5.63)

Specimen examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary: Kakkayam, Ambalappara (970 m), 26-09-12, *Prajitha 8553* (MBGH).

Habitat: Seen on bark in the semi evergreen forests.

Distribution: World: Bangladesh, China, India, Indonesia, Philippines, Sri Lanka, Thailand and Vietnam.

India: Chhotanagpur (Gangulee, 1980 as *Stereophyllum anceps*), Gujarat (Chaudhary *et al*., 2006 as *Stereophyllum anceps*), Karnataka (Schwarz, 2013), Kerala (Manju *et al.*, 2008b), Madhya Pradesh (Nath *et al*., 2007), Tamil Nadu (Daniels *et al*., 2018)

Entodontopsis nitens (Mitt.) W.R. Buck & Ireland, Nova Hedwigia 41: 104. 1985. *Stereophyllum nitens* Mitt., Trans. Linn. Soc. London 23: 51. pl. 5: f. 3. 1860. *Hypnum ligulatum* Muell. Hal., Bot. Zeitung (Berlin) 14: 438. 1856. *Stereophyllum obtusum* Mitt., J. Linn. Soc., Bot. 12: 542. 1869. *Homalia linguifolia* Welw. & Duby, Mem. Soc. Phys. Geneve 21: 431. 3 f. 6. 1872. *Stereophyllum ligulatum* A. Jaeger, Ber. Thatigk. St. Gallischen Naturwiss. Ges. 1877–78: 277 (Gen. Sp. Musc. 2: 1295). 1880. *S. combaniense* Besch., Ann. Sci. Nat., Bot., ser. 7, 2: 97. 1885. *S. homalioides* Besch., J. Bot. (Morot) 5: 348. 1891. *S. laetevirens* Broth., Bot. Jahrb. Syst. 20: 210. 1894. *S. pobeguinii* Broth. & Paris, Rev. Bryol. 35: 5. 1908.

Plants robust, yellowish to dark green, main stem creeping, sparsely branched up to 4 cm long; leaves ovate to lanceolate, widely acute at apex, cordite at

base, margin minutely crenulated towards the apex and recurved at base, 1.5× 0.3 mm; costa ending at middle of the leaf; leaf apical cells irregularly quadrangular, 10-24 × 6-8 µm, narrow, elongated at middle, 58- 80 × 5-7 µm; alar cells quadrangular, uniformly distributed on either side of the costa, 11-22 × 14-15 µm; seta brownish, 0.5 mm long; capsule cylindrical, 0.5 mm long; peristome double, papillose, 403 µm long and 106 µm wide at base; spore rounded, 254 µm wide. (Plate 5.64)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam (800-900 m), 13-11-14, *Prajitha 12847*; 12-09-14, *Prajitha 12522* (MBGH).

Habitat: Seen on rocks in the semi-evergreen forests.

Distribution: Africa, India, Nepal, Philippines and Thailand.

India: Andra Pradesh (Sandhya Rani *et al*., 2014), Gujarat, Kerala (Manju *et al*., 2008), Karnataka (Schwarz, 2013), Madhya Pradesh (Nath *et al*., 2007), Rajasthan (Dandotiya *et al*, 2011), Tamil Nadu (Daniels, 2010; Daniels *et al*., 2018) and Western Himalayas (Alam, 2013)

Kerala: Kozhikode (Rajesh & Manju, 2014)

Entodontopsis wightii (Mitt.) W.R. Buck & Ireland, nova Hedwigia 41: 106. 1985. *Hypnum wightii* Mitt., J. Proc. Linn. Soc. Bot., Suppl. 1:82. 1859.

Plants robust, main stem creeping, forms small pinnate or irregular branches, branches up to 3 cm long, appressed to the bark; leaves ovate to oblong, margin entire, serrulate at apex, 1.3- 0.4 mm; costa ends at the middle of the leaf; leaf cells prorulose at distal ends, irregularly quadrangular to rhomboidal at apex, 17-31 × 4-5 µm, cells narrow elongated at middle, 89-106 × 6 µm; alar cells quadrangular, 10-36 × 15-13 µm; perichaetial leaves ovate to lanceolate, 0.56 mm long and 0.3 mm wide at base, seta reddish, upto 5 mm long, capsule cylindrical, 1.5 mm long, spore rounded, papillose, 40 µm wide. (Plate 5.65)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Peruvannamuzhi (450 m), 22-03-14, *Prajitha 11032*; Kakkayam (480 m), 11-09-14, *Prajitha 14030* (MBGH).

Habitat: Seen on bark, at the upper part of the tree trunk along with *Neckeropsis andamana* in the moist deciduous and semi evergreen forests.

Distribution: World: China, India, Indonesia, Myanmar, Sri Lanka, Thailand and Vietnam

India: Andra Pradesh (Sandhya Rani *et al*., 2014), Bengal (Gangulee, 1980 as *Stereophyllum anceps*), Chhotanagpur, (Gangulee, 1980 as *Stereophyllum anceps*), Karnataka (Schwarz, 2013), Kerala (Manju *et al.*, 2008b), Odisha (Gangulee, 1980 as *Stereophyllum anceps*) and Tamil Nadu (Daniels, 2010; Alam *et al.*, 2011).

Kerala: Kozhikode (Rajesh & Manju, 2014)

Stereophyllum Mitt.,

J. Linn. Soc. Bot. Suppl. 1:117. 1859.

Plants glossy, yellowish green, forms mats, stem prostrate, sparingly branched; leaves symmetric or asymmetric, concave, oblong or ovate to lanceolate, margin entire or serrate towards the apex; costa strong, single, ends beyond the mid leaf; leaf cells incrassate, isodiametric or rhomboidal, smooth or papillose; alar differentiated, quadrate to rectangular, distributed on either side of the costa.

Stereophyllum confusum Ther., Annuaire Conserv. Jard. Bot. Geneve 20: 17. 1 f. 2. 1916. Gangulee, Moss. E. India 3(8): 1814. 1980.

Plants slender to robust, yellowish brown when dry, stem creeping, sparsely branched, branches small, up to 6.5 cm long; leaves mostly asymmetrical, erectopatent, appressed to the stem when dry; leaves oblong, apex acute, margin entire, reflexed at the base, 2 × 0.5 mm; costa strong ending above the mid leaf; leaf cells incrassate and short, isodiametric to rhomboidal, 20-30 × 0.5- 7.5 µm; alar short, quadrate, 10 × 12.5 µm. (Plate 5.66)

Specimen examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Pruvannamuzhi, Moothaveedupuzha (1100 m), 16-03-13, *Prajitha 8682* (MBGH).

Habitat: Seen on bark in the middle of the tree trunk in the evergreen forests.

Distribution: This species is endemic in India: Andra Pradesh (Sandhya Rani *et al*., 2014), Maharashtra (Magdum *et al*., 2017), Odisha (Gangulee, 1980; Mishra *et al.,* 2016), and Tamil Nadu (Dandotiya *et al*., 2011)

Note: No earlier report of this species from Kerala, hence it is a new addition to the State.

Brachytheciaceae Schimp.,

Syn. Musc. Eur., ed. 2. XCV: 637. 1876.

Plant slender or robust, tufted, glossy; central strand present; heterophyllous or homophyllous, leaves ovate- lanceolate, apex narrow acuminate or acute, margin dentate more towards the apex; costa ending above the mid leaf; leaf cells narrow, rhomboidal at apex and rectangular at base.

Note: This family include 43 genera of which ten genera *viz*., *Aerobryum* Dozy & Molk., *Brachythecium* Schimp*., Bryhnia* Kaurin*, Cirriphyllum* Grout*, Eurhynchium* Bruch & Schimp*., Homalothecium* Schimp*., Oxyrrhynchium* (Schimp.) Warnst*., Palamocladium* Muell. Hal*., Rhyncostegiella* (Schimp.) Limpr. and *Rhynchostegium* Bruch & Schimp. are occur in India. Of these seven genera *viz*., *Aerobryum* Dozy & Molk. *Brachythecium* Schimp*., Bryhnia* Kaurin*, Eurhynchium* Bruch & Schimp*., Palamocladium* Muell. Hal*., Rhyncostegiella* (Schimp.) Limpr. and *Rhynchostegium* Bruch & Schimp. are distributed in Kerala. Of these three genera *viz*., *Aerobryum* Dozy & Molk., *Eurhynchium* Bruch & Schimp. and *Rhyncostegiella* (Schimp.) Limpr. are represented in the study area.

Key to the Genera

1a. Leaves broadly ovate……..… ***Aerobryum***

1b. Leaves ovate to lanceolate……... (2)

2a. Plant robust, heterophyllous……..……...…***Eurhynchium***

2b. Plant slender, homophyllous…….***Rhyncostegiella***

Aerobryum Dozy & Molk.,

Ned. Kruidk. Arch. 2(4): 279, 1851.

Plants robust, irregularly branched, hanging; leaves squarrose, ovate margin serrate, apex narrowly acuminate; costa single ending above the mid leaf; leaf cells linear, rhomboid, marginal cells quadrangular, basal cells linear to rhomboid.

Aerobryum speciosum Dozy & Molk., Ned. Kruidk. Arch. 2(4): 279. 1851; Gangulee, Moss. E. India, 2(5): 1347. 1976; Nair *et al.*, Bryoph. Wayanad 154. 2005. *Meteorium speciosum* (Dozy & Molk.) Mitt., J. Proc. Linn. Soc., Bot., Suppl. 1: 87. 1859.

Plants robust, light green, irregularly branched, hanging, upto 8 cm long; leaves squarrose, broadly ovate margin minutely serrate, apex narrowly acuminate; costa single ending above the mid leaf; leaf cells linear, rhomboid, marginal cells quadrangular, 2-18 × 6-9 μm; cells at the base linear-rhomboid, 38-58 × 3-4 μm. (Plate 5.67)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary: Kakkayam, Vattakkayam (1000 m), 10-05-03, *MCN 120163* (CALI); Kakkayam, Ambalappara (1100 m), 26-09-12, *Prajitha 8543*; Sankaranpuzha (1300 m), 27-09-12, *Prajitha 8612* (MBGH).

Habitat: Hanging from branches in the evergreen, semi evergreen and moist deciduous forests.

Distribution: China, Bhutan, Sri Lanka, Taiwan, Celebes, Indonesia, Japan, New Guinea, Philippines Philippines and Tonkin.

India: Arunachal Pradesh, Kerala (Nair *et al*., 2005a), Meghalaya, Manipur, Sikkim (Dandotiya *et al*., 2011) and Tamil Nadu (Daniels, 2010).

Kerala: Agasthyamala (Manju *et al.*, 2009d), Aralam WLS (Manju *et al.*, 2009b), Kozhikode: Kakkayam (Manju *et al.*, 2008a) and Wayanad (Nair *et al.*, 2005a).

Eurhynchium Shimp.,

Bryol. Eur. 5: 217. 1854

Plants tufted, glossy, branches erect; heterophyllous, apex acuminate in stem leaves, acute or obtuse in branch leaves, margin denticulate more towards the apex; costa ending above the mid leaf; leaf cells narrow, rhomboidal at apex and rectangular at base.

Eurhynchium hians (Hedw.) Sande Lac., Ann. Mus. Bot. Lugduno- Batavi 2:299, 1866; Gangulee, Moss. E. India, 3(7): 1738. 1978. *Hypnum hians* Hedw., Sp. Musc. Frond. 272-273, pl. 70, f. 11-14. 1801. *H. swartzii* Turner, Muscol. Hibern. Spic.151 pl. 14:f.1. 1804. *Pterigynandrum apiculatum* Brid. Muscol. Recent. Suppl. 1:137. 1806. *Eurhynchium swartzii* (Turner) Curn., Bryoth. Eur. 12:593. 1862. *Hypnum distans* Lindb., Musci Scand. 34. 1879. *Eurhynchium orotavense* Renauld & Cardot, Bull. Herb. Boissier, Ser.2, 439. 7f. 1-8. 1902.

Plants glossy, robust, yellowish green, pinnately branched, main stem long creeping, 8 cm long; stem leaves narrow, acuminate at apex; branch leaves ovate, lanceolate, apex acute, margin denticulate more towards the apex, 1 × 0.5 mm; costa ending above the mid leaf; leaf cells narrow, rhomboidal at apex, 45-50 × 5-7 µm, basal cells are rectangular, 35-40 × 10-12 µm. (Plate 5.68)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam, Urakkuzhi (1300 m), 27-09-12, *Prajitha, 8571*; 12-01-15, *Prajitha 13523* (MBGH).

Habitat: Seen on rocks in the semi evergreen and evergreen forests.

Distribution: Africa, Algeria, Bhutan, China, Japan, Nepal, North America and Siberia.

India: Andra Pradesh (Sandhya Rani *et al*., 2014), Kerala and West Bengal (Gangulee, 1978).

Rhynchostegiella (Schimp.) Limpr.,

Laubm. Deutschl., 3: 207. 1896.

Plant tufted, yellowish green, irregularly pinnately branched; homophyllous lanceolate, apex narrow acuminate, margin dentate; costa single, covering more than half of the leaf; leaf cells linear, basal angular cells rectangular.

Rhynchostegiella humillima (Mitt.) Broth., Nat. Pflanzenfam. I (3): 1161. 1909; Gangulee, Moss. E. India 3(8): 1726. 1978. *Hypnum humillimum* Mitt., J. Proc. Linn. Soc., Bot., Suppl. 1: 80. 1859.

Plant tufted, slender, glossy, yellowish green, forming short irregularly pinnate branches, 2.5 cm long; leaves lanceolate, apex narrow acuminate, margin minutely dentate towards the tip, base narrow, 1.2 × 0.3 mm; costa single, covering more than half of the leaf; leaf cells linear, 65-66 × 4-7 µm at tip, middle cells 63-89 × 5-6 µm, basal angular cells rectangular, 17-21 × 8-13 µm. (Plate 5.69)

Specimen examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary (840 m), 12-01-15, *Prajitha 12988* (MBGH).

Habitat: Seen on branches in the semi- evergreen forests.

Distribution: India: Garhwal (Bahuguna *et al*., 2016), Maharashtra (Magdum *et al*., 2017), Manipur (Givindapyari, 2014), Tamil Nadu (Daniels *et al*., 2018).

Note: No earlier report of this species from Kerala, hence the present study is a new addition to the state.

Meteoriaceae Kindb.,

Gen. Eur. N. Amer. Bryin. 7. 1897.

Plants mostly robust, hanging from branches; leaves ovate or oblong lanceolate, acuminate, margin more or less denticulate towards the tip, base auriculate or cordate or narrowed; costa ends below or above the mid leaf; leaf cells narrow and elongate, papillose except at extreme tip and base.

Note: This family include 21 genera, of which nine genera are distributed in India *viz*., *Aerobryidium* M. Fleisch., *Aerobryopsis* M. Fleisch., *Barbella* M. Fleisch., *Chrysocladium* M. Fleisch., *Cryptopapillaria* M. Menzel, *Duthiella* Renauld, *Floribundaria* M. Fleisch., *Meteoriopsis* Broth. and *Meteorium* (Brid.) Dozy & Molk. Among these five genera *viz.*, *Aerobryopsis* M. Fleisch., *Cryptopapillaria* M. Menzel, *Duthiella* Renauld, *Floribundaria* M. Fleisch. and *Meteoriopsis* Broth. are represented in the study area.

Key to the genera

1a. Leaves auriculte at base, two rows of seriate papillae seen on cell wall …… ……..... . ***Cryptopapillaria***

1b. Leaves cordate or narrowed at base, papillae seen on cell lumen…… ..... (2)

2a. Leaf cells with serially arranged papillae; costa ends below the mid leaf…… ……..... ***Floribundaria***

2b. Leaf cells with 1 or 2 papillae; costa ends above the mid leaf…… ..... (3)

3a. Plants slender or moderately robust; leaf cells unipapillate….....(4)

3b. Plants robust; leaf cells with 2 papillae…… ....***Meteoriopsis***

4a. Branch leaf lanceolated, cells near margin narrow, elongated… .....***Aerobryopsis***

4b. Branch leaf oblong, cells near margin short, quadrangular… .....***Duthiella***

Aerobryopsis Fleisch.,

Hedwigia, 44:304. 1905

Plants slender to robust, yellowish green, branches usually hanging; leaves lanceolate, wider at base, sharply acuminate at the tip, margin denticulate; costa ending above the mid leaf; leaf cells narrow, elongate with one papilla on lumen.

Aerobryopsis longissima (Doz. & Molk.) Fleisch., Hedwigia 44:305. 1905. Gangulee, Moss. E. India, 2(5): 1318. 1976; Nair *et al.*, Bryoph. Wayanad 154. 2005. *Neckera longissima* Dozy & Molk., Ann. Sci. Nat., Bot., ser. 3, 2: 313. 1844. *Aerobryum crispicuspis* Besch., J. Bot. (Morot) 5: 145. 1891. *A. pseudolanosum* Broth., & Geh. (Biblioth. Bot.) 44: 17. 1898. *Trachypodopsis warburgii* Broth., Blumea 9: 514. 1959. *Trachypus erosus* Besch. Blumea 9: 489. 1959.

Plants slender, yellowish green, 6-10 cm long, pinnately branched, branches hanging; leaves lanceolate, wider at base, sharply acuminate at the tip, margin denticulate, 2 - 3 × 4- 7 mm mm; costa ending above the mid leaf; leaf cells narrow, elongate with one papilla (in some cells two) on lumen except at tip cells and basal cells, tip cells 36 × 8 µm, middle cells 47-61 × 4-5 µm and at basal cells 38-42 × 5-6 µm. (Plate 5.70)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam: Ambalappara (890 m), 26-09-12, *Prajitha 8502, 8544*; Sankaranpuzha (930 m), 27-09-12, *Prajitha 8600* (MBGH).

Habitat: Seen on branches and spreading on leaves in the moist deciduous and semi evergreen forests.

Distribution: World: Australia, Caroline Islands, Ceylon China, Madagascar, Malacca, Nepal, New Guinea, Philippines, Sri Lanka, Sumatra, Tonkin and Yunnan.

India: Karnataka (Schwarz, 2013), Kerala (Manju *et al*., 2008), Manipur (Givindapyari, 2014), Odisha (Mishra *et al*., 2016) and Tamil Nadu (Verma *et al*., 2011).

Cryptopapillaria M. Menzel,

Willdenowia 22:181. 1992

Plants robust, yellowish green, pinnately branched, branches up to 18 cm long; leaves appressed to the stem when dry, erectopatent, imbricate, oblong lanceolate, apex sharply acuminate, margin serrated, auriculate at base; costa single, ending below the apex; leaf cells rhomboidal to linear, with two rows of seriate papillae on the wall, except at the tip, margin and base, basal cells hyaline, smooth, auricular cells in oblique rows.

Cryptopapillaria fuscescens (Hook.) M. Menzel, Willdenowia 22: 183. 1992. Gangulee, Moss. E. India, 2(5): 1284. 1976; Nair *et al.*, Bryoph. Wayanad, 155. 2005; *Neckera fuscescens* Hook., Musc. Exot. 2: 157. 1819.

Plants robust, yellowish green, pinnately branched, branches up to 18 cm long; leaves appressed to the stem when dry, erectopatent, imbricate, oblong lanceolate, apex sharply acuminate, margin serrated, auriculate at base, 1.4 x 0.7 mm; costa single, ending below the apex; leaf cells rhomboidal to linear, with 2 rows of seriate papillae on the wall, except at the tip, margin and base, basal cells hyaline, smooth, auricular cells in oblique rows, 11-16 x 3-4 µm and cells at apex 16 x 3 µm. (Plate 5.71)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam, Ambalappara, (800-1200 m), 26-09-12, *Prajitha 8506*; 12-01-15, *Prajitha 13562* (MBGH).

Habitat: Seen on tree trunks and hanging from branches in the moist deciduous, evergreen and semi evergreen forests.

Distribution: Bhutan, India, Indonesia, Myanmar, Nepal, Philippines, Sri Lanka, Thailand, Tonkin and Yunnan.

India: Arunachal Pradesh, Himalaya, Karnataka (Schwarz, 2013), Kerala, Sikkim (Gangulee, 1976), Tamil Nadu (Daniels, 2010; Daniels *et al*., 2018).

Kerala: Aralam WLS (Manju *et al.*, 2009b), Chinnar WLS (Nair *et al.*, 2006), Kozhikode: Vellarimala (Nair & Madhusoodanan, 2006) and Wayanad (Nair *et al.*, 2005a).

Duthiella Muell. Hal. ex Broth.,

Nat. Pflanzenfam. 1(3): 109. 1908.

Plants robust, irregularly pinnately branched, main stem creeping; heterophyllous, branch leaf oblong, margin serrated, apex acuminated; stem leaf oblong, margin entire, apex sharply acuminate, auriculate at base; costa prominent, ending below the apex; leaf cells quadrangular to rhomboidal, unipapillose; cells near margin short, quadrangular; basal cells near costa elongated, quadrangular.

Duthiella wallichii (Mitt.) Muell. Hal. Nat. Pflanzenfam 1(3): 1010. 733. 1908; Gangulee, Moss. E. India 2(5), 1238. 1976. *Leskea wallichii* Mitt., J. Proc. Linn. Soc., Bot., Suppl. 1(2): 132. 1859. Hypnum wallichii Hook., Sp. Musc. Frond., Suppl. 3, 1(1): 219. 1827. *H. sigmatodictyon* Muell. Hal. Bryol. Jav. 2: 100. 1865. *Duthiella robusta* Nog., Trans. Nat. Hist. Soc. Taiwan 24: 470, 2. 1936.

Plants moderately robust, yellowish to brownish green, pinnately branched, primary stem creeping, up to 5 cm long, branches 5 mm long; branch leaf oblong, margin serrated, apex acuminated, 1 mm long and 0.3 mm wide; stem leaf oblong, margin entire, apex sharply acuminate, auriculate at base, 1.3 mm long and 0.5 mm wide; costa prominent, ending below the apex; leaf cells at extreme tip narrow, elongated, 9-14 × 1-2 µm, apical cells quadrangular, unipapillate at centre of lumen, 11-19 × 4 µm, middle cells narrow, rhomboidal, unipapillate at centre of lumen, 25-31 × 3-4 µm, cells near margin short, quadrangular, 10-12 × 7 µm , basal cells near costa elongated, quadrangular, 15-25 × 8-6 µm. (Plate 5.72)

Specimen examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam, Ambalappara (600 m), 11-09-14, *Prajitha 14019* (MBGH).

Habitat: Seen on branches in the moist, shaded condition in the semi evergreen forests.

Distribution: World: China, India, Japan, Java, Philippines and Thailand.

India: Kerala (Manju *et al.*, 2008) and Western Himalaya (Gangulee, 1976).

Floribundaria M. Fleisch.,

Hedwigia 44:301. 1905

Plants forms dense masses, robust or slender, yellowish green, long, pinnately branched; leaves. ovate, lanceolate, acuminate, margin more or less denticulate towards the tip, base cordate or narrowed; costa reach up to the middle or below the mid leaf; leaf cells narrow, elongate, a row of serially arranged papillae seen on the lumen, except at the base, tip and marginal cells.

Key to the species

1a. Plants robust; leaf base cordate…….……...…….***F. floribunda***

1b. Plants slender; leaf base narrowed…….…...***F. walkeri***

Floribundaria floribunda (Doz. & Molk.) Fleisch., Hedwigia 44: 302. 1905; Gangulee, Moss. E. India, 2(5): 1301. 1976. *Leskea floribunda* Doz. & Molk, Ann. Sc. Nat. Bot. ser. 3, 2: 310. 1844. *Meteorium floribundum* (Dozy& Molk.) Dozy & Molk, Musci Frond. Ined. Archip. Ind. 6:162. 1848. *M. aeruginosum* Mitt., J. Linn. Soc. Bot. 10:171. 1868. *Neckera floribunda* var. *minor* Muell. Hal., Linnaea 36: 9. 1869. *Papillaria floribunda* (Dozy & Molk) Muell. Hal., Linnaea 40: 267. 1876. *P. fulvastra* Besch., Ann. Sci. Nat., Bot., Ser. 6, 10: 265. 1880. *P. robillardii* Muell. Hal., Ann. Sci. Nat., Bot., Ser, 6, 10: 266. 1880. *P. floribunda* var. *brevifolia* Renauld & Cardot., Bull. Soc. Roy. Bot. Belgique 38 (1): 21. 1900. *Floribundaria baldwinii* Broth., Bernice P. Bishop Mus. Bull. 40: 22. 1927. *Trachypus pilifolius* Dixon, Blumea 9: 489. 1959.

Plants seen in dense masses, yellowish green, pinnately branched, 15-20 cm long; leaves widely spreading, lanceolate, margin minutely denticulate towards the tip, apex long acuminate, base cordate, 2 × 0.5 mm; costa reach up to the middle of

the leaf; leaf cells narrow, elongate, 35- 40 × 3 µm, a row of serially arranged papillae seen on the lumen, except at the base, tip and marginal cells. (Plate 5.73)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam, Ambalappara (400-1200 m), 26-09-12, *Prajitha 8550*; 12-09-14, *Prajitha 12532*; Peruvannamuzhi (320 m), 7-01-18, *Prajitha 14138* (MBGH).

Habitat: Seen on tree trunks and hanging from branches in the moist deciduous, evergreen and semi-evergreen forests.

Distribution: World: Africa, Australia, Burma, China, Ceylon, Japan, Java, Madagaskar, Nepal, North Borneo, New Guinea, Phillippines, Sumatra, Thailand and Tonkin.

India: Karnataka (Schwarz, 2013), Kerala (Manju *et al*., 2008b), Manipur, Nagaland (Bansal *et al*., 2011), Tamil Nadu (Daniels, 2010; Alam *et al*., 2011), West Bengal (Gangulee, 1976) and Western Himalayas (Alam, 2013).

Floribundaria walkeri (Renauld & Cardot) Broth., Engl. & Prantl, Nat. Pflanzenfam. 1(3): 822. 1906; Gangulee, Moss. E. India 2(5): 1306. 1976; Nair *et al.*, Bryoph. Wayanad 157. 2005. *Papillaria walkeri* Renauld & Cardot, Bull. Bot. Soc. Belgique 34(2): 70. 1896. *Floribundaria emodi* Muell. Hal., Hedwigia 44: 304. 1905. *F. samoana* Broth., Mitt. Inst. Allg. Bot. Hamburg. 8: 404. 1931. *F. brevifolia* Dixon., Ann. Bryol. 9: 66. 1937.

Slender, yellowish green; pinnately branched; 5-8 cm long; secondary branches 0.5 cm long; leaves ovate, lanceolate, acuminate, margin denticulate towards the tip, base narrowed, 1 × 0.29 mm; costa ending below the middle of the leaf; leaf cells narrow, linear, multi papillate, 30 × 3-4 µm at tip and 13 × 4.8 µm at base. (Plate 5.74)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam, Ambalappara (975 m), 11-05-03, *MCN 120209* (CALI); Kakkayam, Ambalappara (700- 1300 m), 26-09-12, *Prajitha* 8505; 12-01-15, *Prajitha 13524* (MBGH).

Habitat: Hanging from branches in the evergreen and semi evergreen forests.

Distribution: This species is endemic to India: Karnataka (Aruna & Krishnappa, 2014), Kerala (Nair *et al*., 2005), Odisha (Mishra *et al*., 2016), Tamil Nadu (Daniels *et al*., 2018) and Western Himalayas (Alam, 2013)

Kerala: Kozhikode: Kakkayam (Manju *et al*., 2008a) and Wayanad (Nair *et al*., 2005b)

Meteoriopsis M. Fleisch. ex Broth.,

Nat. Pflanzenfam.1 (3): 825. 1906.

Plants robust, glossy, yellowish green, stem pinnately or irregularly branched, branches long, densely covered with leaves; leaves squarrose, ovate, acuminate, margin minutely serrate, base cordate; costa ending at or above the middle of leaf; leaf cells linear, papillose except at extreme tip and base.

Key to the species

1a. Leaves canaliculate, costa ends at mid leaf……...…….. ***M. reclinata***

1b. Leaves not canaliculate, costa ends above the mid leaf……..... ***M. squarrosa***

Meteoriopsis reclinata (Muell. Hal.) M. Fleisch., Nat. Pflanzenfam. I (3): 826. 1906; Gangulee, Moss. E. India, 2(5): 1354. 1976; Nair *et al.*, Bryoph.Wayanad 159. 2005. *Pilotrihum reclinatum* Muell. Hal., Bot. Zeitung (Berlin) 12: 572. 1854. *Meteorium sinense* Muell. Hal., Nuovo Giorn. Bot. Hal., n.s., 4: 264. 1897. *Floribundaria robustula* Broth. & Wattsin, Proc. Linn. Soc. New South Wales 43: 560. 1918. *Meteoriopsis formosana* Nog., J. Hattori Bot. Lab. 3: 92. f. 40. 1948. *M. reclinata* var. *ceylonensis* M. Fleisch., Musci Buitenzorg 3: 834. 1908.

Plants robust, glossy, yellowish green, primary branches up to 12 cm long; secondary branches 1-2 cm long; stem densely covered with leaves; leaves squarrose, canaliculated, ovate, acuminate, margin minutely serrate, 2.7 x 15 mm; costa ending at the middle of leaf; leaf cells linear, 42 µm x 6 µm at apex , at the

middle narrow, alongated 35-63 x 3 µm and at the base 24 -37 x 5-7 µm, each cells with 2 prominent papillae except at apex and base. (Plate 5.75)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam, Sankaranpuzha (700- 1400 m), 27-09-12, *Prajitha 8601*; 11-09-14, *Prajitha 14040* (MBGH).

Habitat: Hanging from branches in the moist deciduous, evergreen and semi evergreen forests.

Distribution: World: Australia, China, Celebes, Japan, Indonesia, Malacca, Myanmar, Nepal, New Guinea, Philippines, Sri Lanka, Sumatra and Thailand.

India: Arunachal Pradesh (Rawat *et al*., 2017), Andra Pradesh (Sandhya Rani *et al*., 2014), Karnataka (Schwarz, 2013, Aruna & Krishnappa, 2014), Kerala (Nair *et al*., 2005a), Meghalaya (Gangulee, 1976), Maharashtra (Magdum *et al*., 2017), Sikkim Tamil Nadu (Daniels *et al*., 2018) and W. Himalaya (Alam, 2013).

Kerala: Chinnar WLS (Nair *et al.*, 2006) and Wayanad (Nair *et al.*, 2005a)

Meteoriopsis squarrosa (Hook. ex Harv.) M. Fleisch., Nat. Pflanzenfam. I (3): 826. 1906; Gangulee, Moss. E. India, 2 (5): 1349. 1976; Nair *et al.*, Bryoph. Wayanad 159. 2005. *Neckera squarrosa* Hook. ex Harv., Icon. Pl. Rar., 1: 22. 1836. *Meteorium squarrosum* var. *brevifolium* Muell. Hal., Nuovo Giorn. Bot. Ital. 23: 601. 1891.

Plants robust, yellowish green, irregularly branched; primary branches more than 15 cm long, secondary branches up to 2.5 cm long, densely foliate; leaves, squarrose, obovate, acuminate at apex, deflexed, margin minutely serrate, cordate at base, 2.5 × 1.3 mm; costa ending above the mid leaf; leaf cells rectangular at base, 53-57 × 7-11 µm became linear- rhomboid towards top, 45-60 × 4-5 µm, 1 or 2 papillae seen at the middle cells except at the base and tip, cells at alar region 26-29 × 12 µm. (Plate 5.76)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam, Vattakkayam (1050 m), 10-05-03, *MCN 120176* (CALI);

Raveendra estate (900 m), 10-05-03, *MCN 120139* (CALI); 11-09-14, *Prajitha 14042*; Urakkuzhi (800-1300 m), 12-01-15, *Prajitha 13567*; Peruvannamuzhi (340 m), 29-12-17, *Prajitha 14188* (MBGH).

Habitat: Hanging from branches in the moist deciduous, evergreen and semi evergreen forests.

Distribution: World: Bhutan, Java, Myanmar, Nepal, New Guinea, Philippines, Sri Lanka, Sumatra, Thailand, Vietnam and Yunnan.

India: Karnataka (Schwarz, 2013; Alam, 2011), Kerala (Manju *et al*., 2008b), Maharashtra (Magdum *et al*., 2017), Manipur, Odisha (Mishra *et al*., 2016), Tamil Nadu (Daniels, 2010; Daniels *et al*., 2018) and Western Himalayas (Alam, 2013).

Kerala: Agasthyamala (Manju *et al*., 2009), Eravikulam NP (Madhusoodanan *et al*, 2007), Kozhikode: Vellarimala (Nair & Madhusoodanan, 2006); Kakkayam (Manju *et al.*, 2008a) and Wayanad (Nair *et al*., 2005b).

Hypnaceae Schimp.,

Coroll. Bryol. Eur. 113. 1856

Plants slender or moderately robust, soft, glossy, forms mat; main stem creeping, irregularly or pinnately branched, central strand absent, branches complanate or not; leaves arranged in 2 rows or not in distinct rows, elliptic or oblong- ovate or ovate- lanceolate, apex rounded or broadly obtuse or acute or long acuminate, margin denticulate or minutely crenulated; ecostate or short, double if present; leaf cells narrow, rhomboidal or narrow linear or broadly hexagonal, prorate or not; alar not differentiated or formed by a row of short, irregularly rectangular cells; capsule horzondally placed or drooping, operculum conic, rostrate, perostome double, hypnoid.

Note: This family include 67 genera, of which 20 genera are distributed in India. Of these eight genera *viz*., *Bryocrumia* L. E. Anderson, *Ectropothecium* Mitt., *Foreauella* Dixon & P. de la Varde, *Hypnum* Hedw., *Nanothecium* Dixon & P. de la Varde, *Phyllodon* Bruch & Schimp., *Taxiphyllum* M. Fleisch. and *Vesicularia*

(Muell. Hal.) Muell. Hal. are found in in Kerala and six genera *viz*., *Bryocrumia* L. E. Anderson*, Ectropothecium* Mitt*., Foreauella* Dixon & P. de la Varde, *Phyllodon* Bruch & Schimp*. Taxiphyllum* M. Fleisch. and *Vesicularia* (Muell. Hal.) Muell. Hal. are represented in the study area.

Key to the genera

1a. Leaves elliptic or oblong- ovate, apex rounded or broadly obtuse.....(2)

1b. Leaves ovate- lanceolate, apex acute or acuminate.....(3)

2a. Margin denticulate above the mid leaf, spines double..... ***Phyllodon***

2b. Margin minutely crenulated at apex, spines absent…….....***Bryocrumia***

3a. Leaf cells narrow, linear or narrow rhomboidal, prorate.....(4)

3b. Leaf cells broader and hexagonal, not prorate.....***Vesicularia***

4a. Branches complanate.....(5)

4b. Branches not complanate.....***Ectropothecium***

5a. Leaves falcate; alar forms a row of hyaline cells……..***Foreauella***

5b. Leaves not falcate; alar undifferentiated……...…***Taxiphyllum***

Bryocrumia L.E. Anderson,

Phytologia 45 (1): 65-66. 1980

Plants slender, soft, small, yellowish to dark green; stem prostrate, irregularly or sparsely branched, without central strand, large, thin walled cells surrounded by small, thick walled cells; leaves symmetric or assymetric, elliptic-oblong to ovate, apex broadly obtuse, margin serrulate at apex; ecostate or faintly small, double if present; leaf cells short, smooth or prorulose; alar few in the extreme angles.

Key to the genera

1a. Leaves with distinct trinerve on one half of leaf; stem with few inconspicuous central strand .... ***Bryocrumia*** sp.nov.

1b. Leaves with indistinct double costa or no visible costa at the centre of the leaf; stem lacks central strand ..... ***B. vivicolor***

Bryocrumia vivicolor (Broth. & Dixon) W.R. Buck, Mem. New York Bot. Gard. 45: 522.1987; O'Shea & Buck, *Tropical Bryology*, 20: 103-107. 2001; W.R Buck, *Bryophyt. Fl. of North America*, 1. 2009. *Taxithelium vivicolor* Broth. & Dixon, Rec. Bot. Surv. India 6(3): 86-87. 1914. *Glossadelphus andersonii* E.B. Bartram, Bryologist 54:81.1-6. 1951. *Taxiphyllum andersonii* (E.B. Bartram) H.A. Crum, Bryologist 68: 220. 1965. *Bryocrumia andersonii* (E.B. Bartram) L.E. Anderson, Phytologia 45:66. 1980.

Plants slender, thin, delicate, yellowish to dark green in colour; stem prostrate, sparsely branched, up to 1.2 cm long; rhizoids purple, forms clusters on the main stem, where the branches arises; stem without central strand, 117.5µm wide, cortical cells thick walled, 2-3 rowed, surrounding inner few, large, hyaline cells, 9-10 × 9-10 µm; leaves elliptical, apex broadly obtuse, margin minutely crenulated at apex, 0.7 × 0.3 mm; costa not prominent or faintly small if present; leaf cells small, irregularly quadrangular at apex 4-10 × 4-5 µm, narrow rhomboidal and comparatively long at middle, 13-20 × 3-4 µm; alar cells small, rectangular, 2-5 rowed, seen at the extreme basal angles, 10-24 × 5-7 µm. (Plate 5.77)

Specimen examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary: Kakkayam: Sankaranpuzha (500-600 m), 14-11-14, *Prajitha* 12858 (MBGH).

Habitat: Seen on wet rock along with *Pelekium velatum* in the evergreen forests.

Distribution: World: Africa (O'Shea, 2006), China, Kenya, North America (Buck, 2009), Sri Lanka and Uganda (O' Shea & Buck, 2001).

India: Tamil Nadu: Palni hills (Daniels, 2010).

Note: Prajitha *et al*., 2017 reported it as new record to Kerala.

Bryocrumia sp. nov.

TYPE: INDIA. KERALA: Malabar Wildlife Sanctuary, Kakkayam, Ambalappara (650m) *Prajitha 11036* (Holotype: CALI!; Isotypes: MBGH, ZGC, CAL).

Plants light green, glossy, tufted, primary and secondary stem prostrate, upto 2 cm long and 2–2.4 mm wide with leaves, moderately complanate-foliate, branches simple; stem epidermal cells small, distinct outer and inner cortex, outer walls thick, in 2–3 rows, larger, 5-8 µm wide, thinner inner wall 6-8 cells across, 9-25 µm wide, few cells form an inconspicuous central strand; leaves closely arranged on the stem, simple, soft, 0.5–0.8mm long, 0.4–0.6 mm wide at upper region and 0.15-0.2 mm wide at extreme base of leaf, homalia type leaves, leaves ovate-rotundate, upper margin of leaf rounded with fine serrations, middle and basal margin entire, leaves asymmetric with prominent trinerve on all leaves, occur on one half of leaf, not plicate when dry; leaf cells smooth, 1–2 layers of apical marginal cells very shorter, 10-15 x 6-8 µm, upper half of cells quadrate to rhomboid, middle cells 26-42 x 5-7 µm, cells near costa rectangular, 6 × 16µm, alar cells distinct, occur at the extreme basal region in 2–5 rows, 5 -6 × 38-40 µm; reproductive structures not observed (Plate 5.78).

Diagnostic characters. *Brocrumia* sp. nov. looks similar to the members of *Homalia* in morphology. But *Bryocrumia* has its own characters to separate the genus from Neckeraceae. The present species shows similarity with *Bryocrumia vivicolor*, the only one species known earlier in this genus. Plant looks similar in morphology, with primary and secondary branches prostrate with very short secondary branches, leaves of the two species is similar in shape such as ovate to rotundate and the leaf cells are elongate-rhomboid. But *Bryocrumia.* sp. nov. shows specific characters to separate it from *B. vivicolor* such as distinct trinerve on all leaves compared to indistinct binerve on *B. vivicolor.* In *Bryocrumia* sp.nov. the leaves are asymmetric with distinct trinerve on one half of the leaf. But in *B. vivicolor* the binerve occur at the centre. In *Bryocrumia* sp. nov. the leaves are arranged parallel to stem and distant compared to closely arranged leaves in *B. vivicolor*. Leaf tip is rounded to elongate in *B. vivicolor* but in *Bryocrumia* sp. nov. it is flat with rotundate serrate upper margin. In *Bryocrumia* sp. nov. stem shows few inconspicuous central strand which is absent in *B. vivicolor*.

Specimens examined India, Kerala, Kozhikode district, Malabar Wildlife Sanctuary, Kakkayam, Ambalappara (650m) 11.09.2014 *Prajitha 11036* (CALI, MBGH, ZGC, CAL), 12.09.2014, *Prajitha 12560* (MBGH, ZGC).

Habitat: This species is known from two localities in Malabar Wildlife Sanctuary. It was found on rocky patch in stream side along with *Pelekium velatum* Mitt. where water flows regularly at an altitude of 600–700m in evergreen forests.

Note: Till date *Bryocrumia* Anderson was a monotypic genus with a single species *B. vivicolor* (Broth. & Dixon) Buck. The present study reports a second species to the genus.

Ectropothecium Mitt.,

J. Linn. Soc., Bot. 10:180. 1868

Plants more or less tufted, semi robust, glossy, yellowish green; main stem creeping, long, central strand absent, pinnately branched, branches short; leaves falcate, ovate to lanceolate, apex acuminate, margin denticulate towards the tip; costa double, short; leaf cells narrow, rhomboidal, alar not distinct.

Ectropothecium rostellatum (Mitt.) A. Jaeger, Ber. Thatigk. St. Gallischen Naturwiss. Ges., 877–78: 258. 1880; Gangulee, Moss. E. India, 3(8): 1993. 1980. *Stereodon rostellatus* Mitt., J. Proc. Linn. Soc., Bot., Suppl. 1: 100. 1859.

Plants less tufted, semi-robust, glossy, yellowish green, main stem creeping, upto 7 cm long, pinnately branched, stem without central strand, cortical cells comparatively smaller than the medullary cells; leaves falcate, ovate to lanceolate, apex narrow acute to acuminate, margin denticulate towards the apex, 1 × 0.3 mm; costa short, double; leaf cells narrow, rhomboidal, 26- 39 × 5 µm at apex, midleaf cells have papillose tips, 54-70 × 3-5 µm, extreme base with two rows of quadrangular, hyaline cells, 11-37 × 10-12 µm. (Plate 5.79)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Peruvannamuzhi (620 m), 26-09-12, *Prajitha 8538*; 22-03-14, *Prajitha 11057*; Kakkayam (780 m), 11-09-14, *Prajitha 14067* (MBGH).

Habitat: Seen on bark in the semi-evergreen forests.

Distribution: India: Kerala and East Nepal (Gangulee, 1980).

Foreauella Dixon & P. de la Varde,

Arch. Bot. Bull. Mens. 1:175. 1927

Note: This is a monotypic genus.

Foreauella orthothecia (Schwagr.) Dixon & P. de la Varde, J. Bot., 75: 129. 1937; Gangulee, Moss. E. India 3 (8): 1886. 1980; Nair *et al.*, Bryoph. Wayanad 188-189. 2005. *Hypnum orthothecium* Schwaegr., Sp. Musc. Suppl. 3, 1(1); 220b. 1827. *H. curvatirameum* Hampe, Rev. Bryol., n.s 2: 24. 1929. *Leskea secunda* Harv., Icon. Pl 1: pl. 23: f. 1. 1836. *Rhaphidostegium orthothecium* (Schwagr.) A. Jaeger, Ber. Thatigk. St. Gallischen Naturwiss. Ges. 876–77: 401 (Gen. Sp. Musc. 2: 467). 1878. *Foreauella indica* Dixon & P. de la Varde, Arch. Bot. Bull. Mens. 1(8-9): 175. 9. 1927.

Plants slender, yellowish to golden green, dense, forms mat; stem creeping, pinnately branched, branches curled inwards and leaves falcate when dry; stem leaves appreessed to the stem, broadly deltoid, apex acuminate, margin faintly dentate, base obovate, 1 × 0.3 mm, costa short, double; branch leaves concave, ovate- lanceolate, apex broadly acuminate, margin dentate, costa double, short; leaf cells rhomboid, 15-40 × 4-5 µm, alar forms a row of 3 large, hyaline cells, 16-20 × 10-15 µm. (Plate 5.80)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Peruvannamuzhi, Chenkotakolli (300 m), 16-03-13, *Prajitha 8699*; 22-03-14, *Prajitha 11053* (MBGH).

Habitat: Seen on branches in the semi-evergreen forest.

Distribution: World: India, Nepal, Philippines and Thailand.

India: Kerala (Manju *et al*., 2008b), Odisha (Mishra *et al*., 2016), Tamil Nadu (Daniels, 2010) and West Bengal (Gangulee, 1980).

Kerala: Agasthyamala (Manju *et al*., 2009d), Kozhikode (Rajesh & Manju, 2014)

Phyllodon Schimp.,

Brusch, Schimp. & W. Gumbel

Plants soft, loosely spreading, yellowish green; stem creeping, irregularly or pinnately branched; leaves concave, elliptic-oblong to ovate, apex rounded to obtuse, margin entire or serrate at apex, spines double; costa short, single or double; leaf cells narrow elongated to rhomboidal, prorate; alar not differentiated.

Key to the species

1a. Leaf with prominent short double costa present; apical cells narrow, elongated and rhomboid, extreme base formed by a row of short, irregularly rectangular cells..... ***P. bilobatus***

1b. Leaf ecostate or single or faint double if present; apical cells formed by short, rhomboidal cells; extreme base have two rows of small, quadrangular cells……..…….***P. subretusus***

Phyllodon bilobatus (Dixon) P.E.A.S. Camara, Novon 20 (2): 140. 2010. *Taxithelium bilobatum* Dixon, Bull. Torrey Bot. Club 51: 244. 4 f. 2. 1924. *Glossadelphus bilobatus* (Dixon) Broth., Nat. Pflanzenfam. Ed. 2, 11: 535. 1925.

Plants slender to moderately robust, glossy, yellowish green to brownish in colour; main stem creeping, pinnately branched, branches short; leaves ovate to oblong, apex rounded, margin denticulate above the midleaf, spines double; costa short and double; leaf cells narrow, rhomboid, apex shows papillose extension of cells, 40-50 × 5-6 μm, at base narrow, rectangular cells, 35-40 × 18-20 μm; alar region formed by a row of short, irregularly rectangular cells. (Plate 5.81)

Specimen examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary (560 m), 14-11-14, *Prajitha 12995* (MBGH).

Habitat: Seen on base of the tree trunk in the moist deciduous forests.

Distribution: World: Ceylon, India and Moluccas.

India: Kerala, Nagaland and.Tamil Nadu (Daniels *et al*., 2011) as *Glossadelphus bilobatus.*

Note: This species was known from India as *Glossadelphus bilobatus* (Dixon) Broth. Camara (2010) synonymised this species under *Phyllodon bilobatus.*

Phyllodon subretusus (Thwaites & Mitt.) Ochyra & Ireland, Novon 19: 488. 2009. *Ectropothecium subretusum* Thwaites & Mitt. J. Linn.soc., Bot. 13: 321. 1873.

Plants slender, soft, yellowish green,; stem creeping, pinnately branched, upto 6 cm long, stem 0.3 mm wide, medullary cells thin walled, 22-36 × 17- 19 µm, cortical cells thick walled, comparatively small, 10-21 × 12- 17 µm; leaves concave, ovate-oblong, margin entire at base, sharply serrrulate towards tip, spines double, apex rounded to obtuse, 0.7-1 × 0.4-0.5 mm; ecostate or faint double or some leaves shows the presence of a single costa, which ends at middle of the leaf; leaf extreme base have two rows of small, quadrangular cells, 22-30 × 7 µm, followed by narrow elongated, rhomboidal cells, 51-68 × 5 µm, marginal cells at base are narrow, elongated, 39- 90 × 4 µm, towards the tip short, rhomboidal, 20-24 × 5-9 µm; cells prorate, except at extreme base. (Plate 5.82)

Specimen examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary (637 m), Malabar Wildlife Sanctuary, Peruvannamuzhi (637 m), 16-03-13, *Prajitha 8667* (MBGH).

Habitat: Seen on wet rocks in the evergreen forests.

Distribution: This species is known from Sri Lanka (Ochyra & Ireland, 2009) only.

Note: Present study is a new record to India.

Taxiphyllum Fleisch.,

Musci Fl. Buitenz., 4:1434.1923.

Plants glossy, soft, yellowish green to dark green in colour; main stem creeping, irregularly or pinnately branched; leaves ovate to lanceolate, margin dentate at apex, apex narrow, acuminate; costa short, double; leaf cells narrow, elongate, papilla on cell tip; alar undifferentiated.

Key to species

1a. Cost indistinct..... ***T. taxirameum***

1b. Cost distinct, short double.....(2)

2a. Leaf cells with distinct apical papillae.....***T. isopterygioides***

2b. Leaf cells with indistinct apical papillae.....***T. giraldii***

Taxiphyllum giraldii (Muell. Hal.) M. Fleisch., Musci Buitenzorg. 4: 1435. 1923; Gangulee, Moss. E. India, 3 (8): 1947. 1980. *Plagiothecium giraldii* Muell. Hal., Nuov. Giorn. Bot. Ital. n.s. 3: 114. 1896.

Plants tufted, glossy, yellowish green, main stem creeping, irregularly pinnately branched, up to 3 cm long, secondary branches short, up to 5-6 mm long; leaves erectopatent, concave, ovate to lanceolate, apex acute or shortly acuminate, margin denticulate more towards the apex, 1 × 0.4 mm; costa short, double; leaf cells narrow, rhomboidal, 12-20 × 3-4 µm, at middle 34-35 × 3-4 µm and quadrangular to rhomboid at base, 12- 26 × 5-6 µm. (Plate 5.83)

Specimen examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam, Urakkuzhi (800 m), 26-09-12, *Prajitha 8569* (MBGH).

Habitat: Forms mat on rocks in the semi evergreen forests.

Distribution: World: China, Japan, India and Nepal and Taiwan.

India: Himalaya (Gangulee, 1980), Kerala (Mithun & Manju, 2017), Madhya Pradesh (Nath *et al*, 2007) and Odisha (Mishra *et al*., 2016).

Taxiphyllum isopterygioides (Dixon) W.R. Buck, Mem. New York Bot. Gard. 45: 521. 1987. *Taxithelium isopterygioides* Dixon, J. Bot. 53: 295. Pl. 540. F. 9. 1915.

Plants tufted, greenish, up to 1 cm long, sparingly branched; leaves ovate, apex acute to shortly acuminate, margin serrulate, except at the base, 0.6 × 0.2 mm; costa short, forked; leaf cells narrow, rhomboid, with distinct apical papillae, 14-26 × 7 µm at apex, at the middle 50-60 × 5 µm and short to elongate quadrangular at the base, 15- 35 × 4-6 µm. (Plate 5.84)

Specimen examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam, Athikode (1400 m), 12-09-14, *Prajitha 12508* (MBGH).

Habitat: Seen on rocks in the evergreen forests.

Distribution: Sri Lanka.

Note: Present study is a new record to India.

Taxiphyllum taxirameum (Mitt.) M. Fleisch., Musci Fl. Buitenz. 4: 1435. 1923; Gangulee, Moss. E.India 3(8): 1945. 1980; Nair *et al.*, Bryoph. Wayanad 193-194. 2005. *Stereodon taxirameus* Mitt., J. Proc. Linn. Soc., Bot., Suppl. 1(2): 105. 1859. *Isopterygium planissimum* Mitt., J. Linn. Soc. Bot. 12:498. 1869. *Rhyncostegium geophilum* Austin, Musci Appalach., 345. 1870; *Isopterygium elegantifrons* Muell. Hal., Hedwigia 37:251. 1898. *I. maniae* Renauld & Paris, Rev. Bryol. 29: 84. 1902. *Hylocomium isopterigioides* Broth. &Paris, Rev. Bryol. 33: 27. 1906. *Isopterygium cavernicola* Cardot, Rev. Bryol., 37: 56. 1910. *I. tsunodae* Broth., Ofvers. Finska Vetensk.Soc. Forh., 62 A (9): 42. 1921. *Taxiphyllum maniae* (Renauld & Paris) M. Fleisch., Musci Buitenzorg, 4: 1435-1436. 1923.

Plants glossy, yellowish green in colour; main stem creeping, 2.5 cm long, irregularly pinnately branched, secondary branches short, 2-3 mm long; stem rhizomatous; leaves ovate, lanceolate, acute or shortly acuminate at apex, margin denticulate strongly at apex and weekly towards the base, at the base margin revolute at one side, 0.8 × 0.3 mm; costa indistinct; leaf cells narrow, elongated,

rhomboid, at the tip cells 10-23 × 3.5 µm, middle cells 60-67 × 3-4 µm, and basal cells 35-42 × 15-16 µm. (Plate 5.85)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Peruvannamuzhi (460 m), 22-03-14, *Prajitha 11023*; 29-12-17, *Prajitha 14148*; Kakkayam (620 m), 11-09-14, *Prajitha 14025* (MBGH).

Habitat: Epiphytic on the bases of the tree trunk and on logs in the moist deciduous forests.

Distribution: World: Australia, Siberia, Sumatra, India, Japan, Java, Korea, Myanmar, New Guinea, Philippines, Sri Lanka, Taiwan and Yunnan.

India: Andra Pradesh (Sandhya Rani *et al*., 2014), Karnataka (Schwarz, 2013; Aruna & Krishnappa, 2014), Kerala (Nair *et al*., 2005a), Odisha (Mishra *et al*., 2016), Simla (Gangulee, 1980) and Tamil Nadu (Daniels, 2010; Daniels *et al*., 2018) and West Bengal (Gangulee, 1980).

Kerala: Agasthyamala (Manju *et al*., 2009d), Aralam WLS (Manju *et al*., 2009b), Chinnar WLS (Nair *et al*., 2006) and Wayanad (Nair *et al*., 2005a)

Economic importance: It is used for hemostasis and external wounds (Asakawa, 2007).

Vesicularia (Muell. Hal.) Muell. Hal.,

Bot. Jahrb. 23: 330. 1896

Plants tufted, moderately robust, yellowish green, forms mats; main stem long, creeping, pinnately branched, branches short; leaves concave, ovate or lanceolate. apex acute or long, acuminate or subulate, margin entire or minutely dentate at apex; costa absent or short, double if present; leaf cells rhomboidal or hexagonal, alar not differentiated; capsule horzondally placed or drooping, operculum conic, rostrate, perostome double, hypnoid.

Key to the species

1a. Leaf ecostate..... ***V. vesicularis***

1b. Leaf with short, double costa.....(2)

2a. Leaf tip narrow, long acuminate, margin minutely dentate at apex..***V. montagnei***

2b. Leaf tip short, acute, margin entire.....***V. kurzii***

Vesicularia kurzii (A. Jaeger) Broth., Nat. Pflanzenfam. I (3): 1095. 1908. Gangulee, Moss. E. India, 3 (8): 2000. 1980. *Ectropothecium kurzii* A. Jaeger, Ber. Thatigk. St. Gallischen Naturwiss. Ges. 1877–78: 272 (Gen. Sp. Musc. 2: 536). 1880.

Plants tufted, soft, glossy, yellowish green, main stem creeping, pinnately branched 6-8 cm long, branches short, 5-6 mm long; leaves falcate, ovate, acuminate at apex, margin entire; costa short, double; leaf cells rhomboid, 48 × 5 µm at apex and 50-70 × 15 µm at base, alar cells not differentiated; sporophyte seen on the main stem, seta reddish brown, 2 cm long, capsule horzondally placed or drooping, operculum conic, rostrate, perostome double, hypnoid. (Plate 5.86)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam, Ambalappara (1100 m), 26-09-12, *Prajitha 8511*; 11-09-14, *prajitha 14016* (MBGH).

Habitat: Forms mat on rocks and on ferns' rhizomes in the semi-evergreen forests.

Distribution: World: India, Java and Malaysia.

India: Kerala and Andaman Islands (Gangulee, 1980).

Vesicularia montagnei (Bel.) Broth., Nat. Pflanzenfam 1(3): 1094. 1908; Gangulee, Moss. E. India, 3(8): 2001-2002. 1980. *Pterygophyllum montagnei* Bel., Voy. Indes Or., Bot. 2: 85. 1834. *Hookeria meyeniana* Hampe, Icon. Musc.: 3. 1844. *Acosta meyeniana* (Hampe) Muell. Hal., Linnaea 21: 194. 1848.

Plants tufted, forms mat, more or less glossy, yellowish green; stem creeping, irregularly, pinnately branched; leaves concave, ovate, apex narrow, long, acuminate, minutely denticulate towards the tip 1 × 0.6 mm; costa short, double; leaf cells rhomboidal, 50-60 × 18- 20 µm at apex and 60-70 × 18-20 µm at base, alar formed by short, sub quadrangular cells; capsule horzondally placed or drooping, operculum conic, rostrate, perostome double, hypnoid. (Plate 5.87)

Specimen examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam, Ambalappara (1200 m), 26-09-12, *Prajitha 8520* (MBGH).

Habitat: Seen on rocks in the evergreen forests.

Distribution: World: Bangladesh, China, Ceylon, Thailand, Vietnam, Sumatra, Java, Sunda Is. Borneo, Philippines, Australia and Oceania.

India: Bengal, (Gangulee, 1980), Calcutta (Rawat *et al*., 2016), Himalaya (Gangulee, 1980), Kerala (Mufeed *et al*., 2014), Madhya Pradesh (Gupta *et al*., 2013), Maharashtra (Magdum *et al*., 2017), Manipur (Govindapyari, 2014) and Western Himalayas (Alam, 2013).

Kerala: Kozhikode: Thusharagiri (Mufeed *et al*., 2014).

Economic importance: It is used in aquaria as decorative (Glime, 2017).

Vesicularia vesicularis (Schwagr.) Broth., 1(3): 1094. 1908; Nair *et al.*, Bryoph. Wayanad 194. 2005. *Hypnum vesiculare* Schwagr., Sp. Musc. Suppl. 2 (2): 167. 1827. *Leskea rutilans* Brid., Bryol. Univ. 2: 332. 1827. *Acosta rutilans* (Brid.) Muell. Hal., Linnaea 21: 194. 1848. *Ectropothecium subdenticulatum* var. *latifolium* Renauld & Cardot Bull. Soc. Roy. Bot. Belgique 41(1): 145. 1905. *Vesicularia caloosiensis* (Austin) H.A. Crum, Bryologist 74: 169. 1971.

Plants tufted, slender to moderately robust, more or less glossy, forms mat on the floor; stem long, creeping, pinnately branched, 5-8 cm long, secondary branches short upto 1 cm long; leaves ovate, apex acute, margin minutely dentate at apex, 1 × 0.5 mm; costa absent; leaf cells rhomboidal, 60-70 × 12-15 µm at apex and 65-70 ×

15-18 µm at base; capsule drooping, operculum conic, rostrate, perostome double, hypnoid. (Plate 5.88)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam, Raveendra estate (750 m), 10-05-03, *MCN 120102* (CALI); Kakkayam, Ambalappara (850 m), 26-09-12, *Prajitha 8501*; 12-01-15, *Prajitha 13530* (MBGH).

Habitat: Forms dense mat on wet rocks in the semi evergreen forests.

Distribution: World: Australia**,** Borneo, China, India, Java, Oceania, Philippines, Sumatra and Thailand.

India: Kerala (Nair *et al*., 2005a), Tamil Nadu (Sathish *et al*., 2014) and West Bengal (Gangulee, 1976).

Kerala: Agasthyamala (Manju *et al*., 2009d), Kozhikode: Kakkayam (Manju *et al*., 2008a) and Wayanad (Nair *et al*., 2005a).

Symphyodontaceae M. Fleisch.,

Musci Buitenzorg 4: 1110.1923

Plants slender, glossy; stem creeping, pinnately branched; leaves ovate, apex acute, margin serrate towards the tip; costa short, double; leaf cells narrow, rhomboidal, papillose at tip, basal cells quadrangular.

Note: This family include six genera *viz*., *Chaetomitriopsis* M. Fleisch., *Chaetomitrium* Dozy & Molk., *Dimorphocladon* Dixon, *Symphyodon* Mont., *Trachythecium* M. Fleisch. and *Unclejackia* Ignatov, T. Kop. & D. Norris. Of these two genera *viz*., *Chaetomitriopsis* M. Fleisch. and *Symphyodon* Mont., occur in India and Kerala. Of these one genus, *Symphyodon* Mont. is represented in the study area.

Symphyodon Mont.,

Ann. Sc. Nat. Bot. ser. 2, 16: 279. 1841.

Plants tufted, soft, glossy, yellowish green, forms mat; main stem creeping, without central strand, pinnately branched; leaves ovate, apex acute, margin serrate towards the apex; costa short, double; leaf cells papillose at tip, narrow, rhomboidal at apex and elongated quadrangular at base.

Symphyodon orientalis (Mitt.) Broth. Ex Paris., Coll. Nom. Broth. 33. 1909; Gangulee, Moss. E. India, 2(6): 1518. 1977. *Stereodon orientalis* Mitt., J. Proc. Linn. Soc., Bot., Suppl. 2: 111. 1859. *Eurhynchium orientale* (Mitt.) A. Jaeger, Ber. Thatigk. St. Gallischen Naturwiss. Ges. (Gen. Sp. Musc. 2: 412). 1878.

Plants slender, soft, glossy, yellowish green; stem creeping, pinnately branched, up to 3.5 cm long; leaves ovate, apex acute, margin serrate towards the tip, 0.8 × 0.3 mm; costa short, double; leaf cells papillose at tip, narrow, rhomboidal at apex, 21-23 × 4 µm, middle cells 36-43 × 3-4 µm, basal cells short quadrangular to elongate quadrangular, 10-40 × 3-9 µm. (Plate 5.89)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam (1200 m), 13-11-14, *Prajitha 12875*; 12-01-15, *Prajitha 13550* (MBGH).

Habitat: Epiphytic on branches in the evergreen forests.

Distribution: India: Assam (Gangulee, 1977) and Kerala.

Kerala: Idukki (Shantanu, 2010).

Entodontaceae Kindb.,

Gen. Eur. N. Amer. Bryin. (Mosses) 7. 1897.

Plants glossy, slender or robust; main stem creeping, irregularly or pinnately branched; leaves concave, ovate-lanceolate, apex acute or obliquely acute; costa double, short; leaf cells linear, alar quadrate.

Note: This family include four genera *viz*., *Entodon* Muell. Hal., *Erythrodontium* Hampe, *Mesonodon* Hampe and *Pylaisiobryum* Broth.. Of these two genera *viz*., *Entodon* Muell. Hal. and *Erythrodontium* Hampe are occure in India and Kerala. Of these one genus, *Entodon* Muell. Hal. is represented in the study area.

Entodon Muell. Hal.,

Linnaea 18 (6): 704. 1845

Plants tufted, glossy, slender or robust, yellowish green, forms mat; main stem creeping, pinnately or sparingly branched, branches complanate or not; leaves concave, ovate- lanceolate, apex acute or obliquely acute margin faintly serrated at tip; costa double, short, distantly placed; leaf cells linear, alar quadrate, more at the basal angles.

Key to species

1a. Plants long, branches not complanate…… ***E. nepalensis***

1b. Plants medium sized, branches complanate…….. ***E. laetus***

Entodon nepalensis Mizush., Fl. E. Himalaya 1:584. f. 42. 1966; Gangulee, Moss. E. India 3(8): 1773. 1980.

Plants glossy, slender, yellowish green; stem creeping, sparingly branched, forms mat, 4 - 6.5 cm long; leaves concave, ovate - lanceolate, margin sometimes reflexed, shows slight serration towards the tip, apex acute or obliquely acute, 1.3 × 0.8 mm; costa double, short, distantly placed; leaf cells linear, 13-22 × 3-5 µm at apex, 40-58 × 2-3 µm at middle, 8-15 × 5-3 µm at base, alar quadrate. (Plate 5.90)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkaym, Ambalappara (920-980 m), 12-09-14, *Prajitha 12530*; 13-11-14, *Prajitha 12842* (MBGH).

Habitat: Forms mat on rocks, where water flows regularly and on upper part of tree trunk in the semi-evergreen forests.

Distribution: India and Nepal.

India: Kerala and Rajasthan (Gangulee, 1980).

Kerala: Mathiketan shola National Park (Rajilesh *et al*., 2017)

Economic importance: It has antibacterial activity against pathogenic bacteria *Escherichia coli, Salmonella typhimurium* and *Bacillus subtilis* (Alam *et al.*, 2012).

Entodon laetus (Griff.) A. Jaeger Ber. Thatigk. St. Gallischen Naturwiss. Ges. 1876-77: 295. 1878; Gangulee, Moss. E. India, 3 (8): 1771. 1980. *Neckera laeta* Griff., Calcutta J. Nat. Hist. 3: 67. 1843.

Plants tufted, glossy, yellowish green to brownish, medium sized; main stem creeping, pinnately branched, branches erect, complanate; leaves concave, ovate-lanceolate, apex acute, margin faintly serrated at tip, 1.5 × 0.5 mm; costa short, double, distantly placed; leaf cells narrow, elongate, 50- 60 × 5-6 µm, at the basal angles cells quadrangular in shape, 30-35 × 20 µm. (Plate 5.91)

Specimen examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam, Urakkuzhi (1100 m), 27-09-12, *Prajitha 8578* (MBGH).

Habitat: Forms mat on rock, where water flows regularly in the evergreen forests.

Distribution: Bhutan, India and Nepal.

India: Gujarat (Chaudhary *et al*., 2006), Khasia Hills (Gangulee, 1980), Maharashtra (Magdum *et al*., 2017).

Note: Present study is a new addition to Peninsular India.

Pylaisiadelphaceae Goffinet & W.R. Buck,

Monogr. Syst. Bot. Missouri Bot. Gard. 98: 238. 2004.

Plants slender or robust; stem creeping, pinnately branched; branches with or without filamentous gemmae; leaves concave, ovate to lanceolate, apex acute or acuminate; ecostate; leaf cells narrow, linear smooth or papillose; alar distinct or not; seta elongate, capsule ovate, horizontal, peristome double.

Note: This family include 16 genera *viz*., *Aptychella* (Broth.) Herzog, *Brotherella* M. Fleisch., *Clastobryopsis* M. Fleisch., *Clastobryum* Dozy & Molk., *Heterophyllium* (Schimp.) Kindb., *Isocladiella* Dixon, *Isopterygium* Mitt., *Mastopoma* Cardot, *Platygyrium* Bruch & Schimp., *Pterogonidium* Broth., *Pseudotrismegistia* H. Akiyama & Tsubota, *Pylaisiadelpha* Cardot, *Taxitheliella* Dixon, *Taxithelium* Mitt., *Trismegistia* (Muell. Hal.) Muell. Hal. and *Wijkia* H.A. Crum. Of these ten genera *viz., Aptychella* (Broth.) Herzog, *Brotherella* M. Fleisch., *Clastobryopsis* M. Fleisch., *Clastobryum* Dozy & Molk., *Heterophyllium* (Schimp.) Kindb., *Isopterygium* Mitt., *Platygyrium* Bruch & Schimp., *Pylaisiadelpha* Cardot, *Taxithelium* Mitt. and *Wijkia* H.A. Crum are distributed in India. Of these except *Platygyrium* Bruch & Schimp., all others are found in Kerala and six genera *viz*., *Aptychella* (Broth.) Herzog, *Clastobryopsis* M. Fleisch., *Clastobryum* Dozy & Molk., *Isopterygium* Mitt., *Taxithelium* Mitt. and *Wijkia* H.A. Crum are represented in the study area.

Key to the genera

1a. Branches with filamentous gemmae present…….(2)

1b. Branches with filamentous gemmae absent……...…….(4)

2a. Leaf cells smooth……..…….***Aptychella***

2b. Leaf cells papillose……..(3)

3a. Leaves falcate; alar inflated and tinted…….……***Clastobryopsis***

3b. Leaves not falcate; alar not inflated, outermost cells hyaline…...….***Clastobryum***

4a. Plants robust…….***Wijkia***

4b. Plants slender……...…(5)

5a. Leaf cells papillose at tip; alar indistinct……...…***Isopterygium***

5b. Leaf cells serially papillose; alar distinct……...…….***Taxithelium***

Aptychella (Broth.) Herzog,

Biblioth. Bot. 87: 157. 1916.

Plant tufted, slender, yellowish-brownish green, irregularly pinnately branched; stem reddish, filamentous gemmae densely found along the stem; leaves

concave, ovate-lanceolate, apex acuminate, margin serrated; ecostate or faintly short, double costate; leaf cells narrow, linear-rhomboidal; alar coloured, sub quadrate, larger ones at extreme base and shorter ones at top.

Aptychella speciosa (Mitt.) Tixier, Rev. Bryol. Lichenol. 43: 423. 1977; Pollawatn *et al*., *Bryol. In the New Millenium* 44. 2008. *Stereodon speciosus* Mitt., J. Proc. Linn. Soc., Bot., Suppl. 1: 95. 1859. *Clastobryum serrulatum* Cardot & P. de la Varde, Rev. Bryol. 50: 75. 1923.

Plant loosely tufted, slender, glossy, yellowish-brownish green, forms irregular, short, pinnate branches, up to 5 cm long; stem reddish, filamentous gemmae densely found along the stem, which arising from the leaf bases, yellow green-brownish; leaves concave, ovate- lanceolate, apex acuminate, margin slightly serrated at base, more towards the apex, base reflexed, 1.5 × 0.5 mm; ecostate; leaf cells narrow, smooth, linear-rhomboidal, 23-26 × 5-7 µm at tip, middle cells 50-76 × 3-5 µm; alar cells yellowish brown, sub quadrate, shorter towards the top, 12-28 × 9 µm. (Plate 5.92)

Specimen examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam, Athikode (1250 m), 12-09-14, *Prajitha 12554* (MBGH).

Habitat: Seen on branches in the evergreen forests.

Distribution: World: India and Thailand (Pollawatn *et al*., 2008).

India: Himalayas (Gangulee, 1976).

Note: Present study is a new record to Peninsular India

Clastobryopsis M. Fleisch.,

Musci Buitenzorg 4: 1179. 1923.

Plants more or less tufted, glossy, yellowish green; stem creeping, brownish; leaves ovate to lanceolate, apex acute, margin dentate towards the apex; ecostate; leaf cells narrow, rhomboid; alar inflated, rectangular, yellowish brown; filamentous gemmae arising from the axils of the leaves at the top of the stem.

Clastobryopsis planula (Mitt.) M. Fleisch., Musci Buitenzorg 4: 1180. 1923; Gangulee, Moss. of E. India 3(8): 1833. 1980. *Stereodon planulus* Mitt., J. Proc. Linn. Soc., Bot., Suppl. Musci 1(2): 111. 1859. *Clastobryopsis delicata* M.Fleisch, Musci. Buitenzorg. 4: 1180. 1923. *Aptychella yuennanensis* Broth., Symb. Sin. 4: 117. 5f.1. 1929. *Clastrobryum caudiforme* Dixon, Ann. Bryol. 6: 36. 1933.

Plants loosely tufted, glossy, yellowish green; pinnately branched, stem brownish upto 1.5 cm long; leaves falcate, concave, ovate to lanceolate, apex acute, margin dentate towards the apex; ecostste; leaf cells narrow, rhomboid, 12-29 × 4 μm at apex, 45-53 × 4 μm at middle, alar inflated, rectangular, tinted, yellowish brown, 13-20 × 10-15 μm; filamentous gemmae arising from the axils of the leaves at the top of the stem. (Plate 5.93)

Specimen examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam (500 m), 13-11-14, *Prajitha 12825* (MBGH).

Habitat: Epiphytic on branches in the semi-evergreen forests.

Distribution: Bhutan, China, Hawaii, India, Japan, Java and Philippines.

India: North- East Himalayas (Vashistha, 1998).

Note: Present study is a new record to Peninsular India.

Clastobryum Dozy & Molk.,

Musc. Frond. Ined. Archip. Ind. 2: 41. 1846.

Plants slender, glossy, yellowish green; main stem creeping forms short, erect branches; leaves ovate-lanceolate, apex sharply acuminate, margin serrate; costa faint or absent; leaf cells narrow, elongated, alar quadrangular and coloured.

Clastobryum wichurae Dixon, Ann. Bryol. 6: 34. 1933. Gangulee, Moss. of E. India 3(8): 1847. 1980.

Plants slender, glossy, yellowish green; main stem creeping, brownish, pinnately branched; leaves ovate-lanceolate, apex sharply acuminate, margin serrate;

ecostate; leaf cells narrow, elongated, papillose at ends, 28- 33 × 4-5 µm at tip, middle cells 29-46 × 4 µm and alar cells quadrangular, slightly yellowish brown, outermost cells hyaline, 12- 22 × 8 µm. (Plate 5.94)

Specimen examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam, Sankaranpuzha (880 m), 11-09-14, *Prajitha 11079* (MBGH).

Habitat: Seen on branches in the evergreen forests.

Distribution: This species is endemic to India: Darjeeling (Gangulee, 1980).

Note: Present study is a new record to Peninsular India.

Isopterygium Mitt.,

J. Linn. Soc. Bot. 12(1): 21, 497. 1869.

Plants more or less tufted, slender, glossy; stem creeping, irregularly or pinnately branched, branches short, complanate; leaves ovate to lanceolate, apex acute or long acuminate, margin mostly denticulate at apex only; costa absent or short, double if present; leaf cells narrow rhomboidal or linear, papillose at tips, alar indistinct.

Key to the species

1a. Leaf ecostate.....***I. albescens***

1b. Leaf with short, double costa.....***I. serrulatum***

Isopterygium albescens (Hook.) A. Jaeger, Ber. Thatigk. St. Gallischen Naturwiss. Ges. 1876–77: 433 (Gen. Sp. Musc. 2: 1251). 1878; Gangulee, Moss. E. India, 3 (8), 1960. 1980; Nair *et al.*, Bryoph. Wayanad 193. 2005. *Hypnum albescens* Hook., Sp. Musc. Frond., Suppl. 3 1(2): 226b. 1828. *H. candidum* Muell. Hal., Linnaea 35: 624. 1868. *Plagiothecium anderssonii* Angstr., Ofvers. Forh. Kongl. Svenska Vetensk. Akad. 29 (4): 15. 1872. *Isopterygium anderssonii* (Angstr.) A. Jaeger, Ber. Thatigk. St. Gallischen Naturwiss. Ges. 1876–77: 433 (Gen. Sp. Musc. 2: 499). 1878. *I. candidum* (Muell. Hal.) A. Jaeger, Ber. Thatigk. St. Gallischen Naturwiss. Ges. 1876–77: 437 (Gen. Sp. Musc. 2: 503). 1878. *Taxicaulis anderssonii* (Angstr.)

Muell. Hal., Flora 82: 469. 1896. *T. hawaiicus* Muell. Hal., Flora 82: 469. 1896. *Isopterygium argyrocladum* Besch., Bull. Soc. Bot. France 45: 123. 1898. *I. hawaicum* (Muell. Hal.) Paris, Index Bryol. Suppl. 219. 1900. *Taxithelium anderssonii* (Angstr.) Broth. Nat. Pflanzenfam. I (3): 1237. 1909. *Isopterygium pilicuspis* Broth., Ofvers. Finska Vetensk. Soc. Forh. 53A (11): 36. 1911.

Plants less tufted, slender, glossy, yellowish green; main stem creeping, up to 3 cm long, pinnately branched, branches short, upto 5 mm long; leaves concave, ovate, apex long acuminate, margin denticulate at apex; ecostate; leaf cells narrow, linear, 35-40 × 5-6 µm at apex, and 60-70 × 6 µm at base; alar not distinct, but a row of sub rectangular cells present at extreme base with irregular cells above, 30-40 × 15 µm. (Plate 5.95)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam, Athikode (1400 m), 15-11-12, *Prajitha 8635*; Peruvannamuzhi (450 m), 22-03-14, *Prajitha 11029* (MBGH).

Habitat: Seen on variety of habitat such as bark, log, ferns' rhizomes and on Mushrooms (Polypores sp.) in the semi-evergreen forests.

Distribution: World: Borneo, Burma, Celebes, Hawaii, India, Japan Java, Nepal, Singapore, Sri Lanka, Sumatra, New Zealand, Pacific Island, Philippines, Thailand and Vietnam.

India: Karnataka (Aruna & Krishnappa, 2014), Kerala (Nair *et al*., 2005a), Khasia Hills (Gangulee, 1980) and Tamil Nadu (Daniels, 2010; Daniels *et al*., 2018).

Kerala: Agasthyamala (Manju *et al*., 2009d), Kozhikode (Rajesh & Manju, 2014) and Wayanadu (Nair *et al*., 2005a).

Isopterygium serrulatum M. Fleisch., Musci Buitenzorg., 4: 1433. 1923; Gangulee, Moss. E. India, 3(8): 1951. 1980.

Plants slender, glossy, yellowish green; stem creeping, irregularly branched; leaves cocave, ovate to lanceolate, apex acute to acuminate, margin dentate towards the tip, 1 × 0.5 mm; costa indistinct, short, double if present; leaf cells narrow,

rhomboid, 65-7 × 6-8 µm, extreme base with irregular, rectangular cells, 30-33 × 18 µm. (Plate 5.96)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Peruvannamuzhi (530 m), 16-03-13, *Prajitha 8692*; Kakkayam (800 m), 12-01-15, *Prajitha 13526* (MBGH).

Habitat: Seen on bark in the semi-evergreen forests.

Distribution: This is an Indian endemic species distributed in Kerala (Manju *et al*., 2008b) and Sikkim (Gangulee, 1980).

Taxithelium Spruc. ex Mitt.,

J. Linn. Soc. Bot., 12:21, 496. 1869.

Plants slender, tufted, yellowish green to dark green, creeping, forms mat; stem mostly forms pinnate branches, apex sub erect; leaves concave, ovate to lanceolate, apex acute or acuminate, margin dentate; ecostate; leaf cells narrow, linear and serially papillate; alar mostly hyaline, quadrangular; seta elongate, capsule ovate, horizontal, peristome double.

Key to species

1a. Papillae prominent on cells.....***T. nepalense***

1b. Papillae not prominent on cells.....***T. vernieri***

Taxithelium nepalense (Schwagr.) Broth., Monsunia 1: 51. 1899; Gangulee, Moss. E. India, 3(8): 1920-1921. 1980; Manju *et al.*, *Archive For Bryol.*, 108: 5. 2011. *Hypnum nepalense* Schwaegr., Sp. Musc. Suppl. 3(1): 226. 1828. *H. punctulatum* Harv., Icon. Pl. 1: pl. 13: f. 10. 1836. *H. turgidellum* C. Muell., Bot. Jahrb., 5: 87. 1883. *Taxithelium trachaelophyllum* Dixon, Bull. Torrey Bot. Club 51: 243, f. 3: 17. 1924.

Plants appressed to form mat, tufted, creeping, main stem up to 3 cm long , yellowish green, apex sub erect, pinnately branched, branches unequal; leaves attenuate, concave, ovate, acute at apex, margin dentate, 1 × 0.3 mm; ecostate; leaf

cells serially papillose, narrow, rhomboidal, 16-31 × 3 µm at apex and 45-48 × 3 µm at middle; alar rectangular to quadrangular, 17-21 × 12-18 µm, basal row of attachment cells smooth; perichaetial leaves narrow, elongated; seta elongated, up to 2 cm long, capsule ovate, horizontally placed, 1mm long, peristome double, spore rounded, 6-7 µm wide. (Plate 5.97)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Peruvannamuzhi (450 m), 16-03-13, *Prajitha 8648*; 13-11-14, *Prajitha 12823* (MBGH).

Habitat: Seen on the bases of tree trunk in evergreen and semi evergreen forests.

Distribution: Bangladesh, Burma, Central Africa, China, Fiji, India, Java, New Guinea, Philippines, Tasmania and Thailand.

India: Calcutta (Rawat *et al*., 2016), Eastern Himalaya, Karnataka (Schwarz, 2013), Kerala (Rajesh & Manju, 2014), Odiaha (Mishra *et al*., 2016) and Tamil Nadu (Daniels *et al*., 2018).

Kerala: Kozhikode (Rajesh & Manju, 2014).

Taxithelium vernieri (Duby) Besch., Bull. Soc. Bot. France 45: 123. 1898; Gangulee, Moss. E. India, 3(8): 1922-1924. 1980. *Hypnum vernieri* Duby, Flora 58: 285. 1875. *Trichosteleum lindbergii* A. Jaeger, Ber. Thatigk. St. Gallischen Naturwiss. Ges. 1876–77: 412. 1878.

Plants delicate, thin, yellowish to dark green in colour; main stem creeping, apex sub erect, pinnately branched, up to 3.5 cm long, branches up to 3 mm long; leaves concave, ovate, apex acute, margin dentate, reflexed at base, 0.9 × 0.29 mm; ecostate; leaf cells narrow, linear, papillae forms row on the lumen, apical cells comparatively short, 14-30 × 4 µm and middle cells 56-66 × 3 µm; alar cells quadrate, hyaline, 24-28 × 10 µm. (Plate 5.98)

Specimen examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Peruvannamuzhi, Moothaveedupuzha (770 m), 15-11-12, *Prajitha 8639* (MBGH).

Habitat: Forms mat on the base of tree trunk and on logs in the semi evergreen forests.

Distribution: World: Bangladesh, Borneo, Ceylon, India, Java, Moluccas, New Guinea, Philippines and Thailand.

India: Kerala (Brijithlal, 2010).

Wijkia H.A. Crum,

Bryologist 74: 170. 1971.

Plants robust, tufted, glossy, yellowish green to brownish green; main stem creeping, pinnately branched, branches erect; leaves ovate – lanceolate or oblong-lanceolate, apex sharply acuminate, deflexed or not, margin entire or faintly serrate towards the tip; ecostate; leaf cells narrow, linear or narrow, elongate, rhomboidal; alar yellowish brown and large.

Key to species

1a. Leaf tip deflexed, margin faintly serrate towards the tip.....***W. deflexifolia***

1b. Leaf tip not deflexed, margin entire.....***W. surcularis***

Wijkia deflexifolia (Mitt. ex Renauld & Cardot) H.A. Crum, Bryologist 74: 171. 1971; Gangulee, Moss. E. India, 3(8): 1860. 1980. *Acanthocladium deflexifolium* Mitt. ex Renauld & Cardot, Bull. Soc. Roy. Bot. Belgique 41(1): 92. 1905. *A. benguetense* Broth., Philipp. J. Sci. 31: 294. 1926. *Brotherella subintegra* Broth., Ann. Bryol. 1: 24. 1928.

Plants tufted, robust, glossy, yellowish green to brownish green; main stem creeping, 1.5 cm long, pinnately branched, branches erect; leaves ovate-lanceolate, apex sharply acuminate, deflexed at tip, margin faintly serrate towards the tip, 2 × 0.4 mm; ecostate; leaf cells narrow, linear, 23- 30 × 5-6 µm at apex, middle cells 77-89 × 4-5 µm and alar large one row of cells, yellowish brown, quadrangular in shape, 65-70 × 26 µm, followed by some irregular cells on top. (Plate 5.99)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Peruvannamuzhi (240 m), 12-09-14, *Prajitha 12589*; 22-03-14, *Prajitha 11049*; Kakkayam (760 m), 12-09-14, *Prajitha 12548*; 13-11-14, *Prajitha 12836*; 14-11-14, *Prajitha 12941* (MBGH).

Habitat: Seen on upper part of tree trunk and branches in the moist deciduous and semi evergreen forests.

Distribution: World: Bhutan, China and India.
India: Kerala, North- East Himalayas (Vashistha, 1998) and Tamil Nadu (Palani *et al*., 2017)

Kerala: (Manju & Prajitha, 2010).
Wijkia surcularis (Mitt.) H.A. Crum, Bryologist 74: 173. 1971; Gangulee, Moss. E. India 3(8): 1862. 1980. *Stereodon surcularis* Mitt., J. Proc. Linn. Soc., Bot., Suppl. 1(2): 112. 1859.

Plants tufted, robust, glossy, yellowish green to brownish green; main stem creeping, 4.5 cm long, pinnately branched, branches erect, short; leaves appressed to the stem, oblong- lanceolate, tip forms narrow, acumen, margin almost smooth; ecostate; leaf cells narrow, linear at apex, 30-39 × 5 µm, middle cells narrow, elongated, rhomboid, 85- 61 × 4-5 µm; alar yellowish brown, peripheral cells inflated, 40-70 × 22-25 µm. (Plate 5.100)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam, Vattakkayam (1050 m), 10-05-03, *MCN 120186* (CALI); Kakkayam (800-1300 m), 22-03-14, *Prajitha 11049*; 12-09-14, *Prajitha 12539*; 13-11-14, *Prajitha 12836* (MBGH).

Habitat: Seen on bark in the semi-evergreen forests.
Distribution: Burma, China, India, Nepal, and Thailand.
India: Andaman Island (Rajesh, 2010), Kerala (Manju *et al*., 2008b), Meghalaya and Tamil Nadu (Palani *et al*., 2017)

Kerala: Agasthyamala (Manju *et al*., 2009d), Kozhikode (Rajesh & Manju, 2014).

SEMATOPHYLLACEAE Broth.,

Engl. & Prantl, Nat. Pflanzenfam. 1(3): 1098. 1908.

Plants more or less tufted, slender or robust, glossy; yellowish or brownish green; main stem creeping, pinnately or irregularly branched, branches erect or creeping, central strand absent; leaves ovate lancelate or oblong lanceolate, apex acute or acuminate, margin entire or dentate; ecostate or short double costa; leaf cells narrow, rhomboid or narrow, elongated, alar hyaline or tinted; capsule ovate to cylindrical, inclined, nodding, operculum rostrate, peristome double, calyptra cucullate.

Note: This family include 28 genera. Of these five genera *viz*., *Acroporium* Mitt., *Chionostomum* Muell. Hal., *Meiothecium* Mitt., *Rhaphidostichum* M. Fleisch and *Trichosteleum* Mitt. are represented in the study area.

Key to the genera

1a. Cells above the alar short, rhomboidal forms diagonal rows to the margin ……...……...…….……..……..***Meiothecium***

1b. Cells above the alar irregular in shape, not forms diagonal rows to the margin…….....(2)

2a. Leaf cells smooth…… .....(3)

2b. Leaf cells papillose……..…… ..... …(5)

3a. Leaf cells narrow, elongated, porose…… ..... ***Acroporium***

3b. Leaf cells narrow, rhomboidal, not porose…… ..... (4)

4a. Leaf margin entire; alar many rowed, rectangular in shape…..... ***Chionostomum***

4b. Leaf margin dentate towards the tip; alar one rowed, oblong in shape……..... ***Rhaphidostichum***

5a. Alar hyaline, rectangular cells…… ..... ***Rhaphidostegium***

5b. Alar tinted, oblong cells……..... ***Trichosteleum***

Acroporium Mitt.,

J. Linn. Soc. Bot., 10: 182. 1868.

Plants densely tufted, glossy, yellowish green; stem creeping, pinnately branched, branches mostly sub erect, densely foliate, sometimes cuspidate at apex; leaves concave, erect to spreading, ovate to lanceolate, apex acuminate, margin incurved, almost entire or minutely dentate at apex, base cordate to auriculate; ecostate; leaf cells smooth, porose, narrow, elongated; alar coloured, outermost cells curved inward; capsule ovate to cylindrical, nodding, peristome double.

Key to the species

1a. Leaves ovate to lanceolate, shortly acuminate at apex.....***A. stramineum***

1b. Leaves oblong to lanceolate, long acuminate at apex.....***A. strepsiphyllum***

Acroporium stramineum (Reinw. & Hornsch.) M. Fleisch., Musci Buitenzorg 4: 1301. 1923; Ramsay, Australian Mosses Online. 1: 3. 2012. *Leskea straminea* Reinw. & Hornsch., Nova Acta Phys. Med. Acad. Caes. Leop. Carol. Nat. Cur. 14(2): 717–718, pl. 2, f. a. 1829. *Hypnum hyalinum* Reinw. ex Schwagr., Sp. Musc. Frond., Suppl. 1, 20: 227b. 1828. *Acroporium hyalinum* (Reinw. ex Schwagr.) Mitt., J. Linn. Soc., Bot. 10: 183. 1868. *Sematophyllum erythropodium* (Hampe) A. Jaeger, Ber. Thatigk. St. Gallischen Naturwiss. Ges. 1876-77: 384 (Gen. Sp. Musc. 2: 450). 1878. *Hypnum erythropodium* Hampe, Linnaea 37: 161. 1871-1873. 1872. *Rhynchostegium erythropodium* (Hampe) Mitt., Trans. & Proc. Roy. Soc. Victoria 19: 89. 1882.

Plant loosely tufted, glossy, yellowish green; main stem creeping, closely appressed to the bark; stem brownish, irregularly pinnately branched, branches 1.5 cm long; rhizoids forms small clusters on the ventral side; leaves ovate, margin entire, apex acuminate, 1.8 × 0.8 mm; ecostate; leaf cells smooth, narrow, rhomboidal in shape, not porous, 32-34 × 5 µm at top and 44 – 46 × 4 µm at middle; alar ovate, yellowish brown, hyaline at periphery, 45- 66 µm × 22 µm. (Plate5.101)

Specimen examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Peruvannamuzhi, Chenkotakolli (500 m), 16-03-12, *Prajitha 8695* (MBGH).

Habitat: Seen on logs and upper part of tree trunk in the semi-evergreen forests.

Distribution: World: China, India, Japan, Philippines and Singapore.

India: Andaman Islands, Kerala and Sikkim

Kerala: Kakkavayal Reserve Forest (Manju *et al.*, 2011) and Thusharagiri hills (Mufeed *et al.*, 2014).

Acroporium strepsiphyllum (Mont.) B.C. Tan, J. Hattori Bot. Lab. 71: 353. 1992; Chiang & Kuo, *Taiwania*, 34 (1): 77-78. 1989; Ramsay, *Australian Mosses Online* 1:4. 2012. *Hypnum strpsiphyllum* Mont., London J. Bot. 3: 632. 1844. *H. alto-pungens* Muell. Hal., Linnaea 37: 179. 1872. *Sematophyllum falcifolium* M. Fleisch., Hedwigia 44: 318. 1905. *Acroporium falcifolium* (M. Fleisch) M. Fleisch, Musci Buitenzorg 4: 1296. 1923. *A. alto-pungens* (Muell. Hal.) Broth. (C. Muell.) Broth., Nat. Pflanzenfam. 2, 11: 437. 1925.

Plants tufted, glossy, yellowish to dark green in colour; stem creeping, branched irregularly, branches 1-1.5 cm long; rhizoids brownish, spreading on the stem; leaves ovate, apex narrow, elongated, acuminated; margin almost entire, but minutely crenulated at apex, 2-2.5 × 0.8 mm; ecostate; leaf cells smooth, narrow elongated, porous; cells at top 57-63 × 6 µm and at middle 47-72 × 4-7 µm; alar curved inwards, one rowed, large, oblong, yellowish brown cells but hyaline at periphery, 93-132 × 22-29 µm, above alar cells irregular in shape; pericheatial leaves ovate, lanceolate, long pointed and serrate at apex, 1.2 mm long and 0.38 mm wide at base; seta brownish, curved at apex, 1-1.2 mm long, capsule ovate, 1.5 mm long, peristome 238-254 µm long, 80 µm wide at base. (Plate 5.102)

Specimen examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Peruvannamuzhi (520 m), 27-09-12, *Prajitha 8646* (MBGH).

Habitat: Seen on land cuttings in the semi evergreen forests.

Distribution: Australia, China, Malesia, Oceania, Philippines and Thailand.

Note: Present study is a new record to India.

Chionostomum C.Muell.,

Linnaea, 36:21, 1869.

Plants densely tufted, yellowish to golden green; stem creeping, forms irregular, pinnate branches; leaves concave, oblong or ovate to lanceolate, apex acuminate; ecostate; leaf cells smooth, narrow, rhomboidal; alar coloured, rectangular; seta long, smooth, capsule inclined, cylindrical, operculum rostrate, long, peristome double, calyptra cucullate.

Chionostomum rostratum (Griff.) Mull. Hal. Linnaea 36: 21. 1869; Gangulee, Moss. of E. India, 3(8): 1840. 1980. *Neckera rostrata* Griff., Calcutta J. Nat. Hist. 23: 70. 1843. *Chionostomum latifolium* Ther. & R. Henry, J. Siam Soc., Nat. Hist. Suppl. 10 (1): 20. 1935. *C. rostratum* var. *microcarpum* Broth, Ofvers. Finska Vetensk.-Soc. Forh. 62A (9): 50. 1921.

Plant dense, tufted, yellowish to golden green; main stem creeping , up to 2.5 cm long, irregularly pinnately branched, branches 1-1.5 cm long, cells thick walled, cortical cells quadrangular to hexagonal, comparatively small, 13-16 × 10-15 µm, middle cells hexagonal, 19-21 × 20-23 µm; leaves appressed to the stem, stem and branch leaves not much differentiated, oblong to lanceolate, concave, acuminate at apex, margin entire, reflexed at middle; ecostate; leaf cells smooth, narrow, rhomboidal, 60-70 × 2-4 µm at middle, shortening towards the tip, 40 × 5 µm; alar differentiated in to rectangular, yellowish cells, 40-45 × 25 µm; perichaetial leaves ovate, lanceolate, margin serrated towards the tip, 1.3 × 0.4 µm; seta reddish, 1.2 cm long, capsule cylindrical in shape, inclined, peristome double, up to 500 µm long, spore rounded, 115 µm wide. (Plate 5.103)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam, Ambalappara (1100 m), 26-09-12, *Prajitha 8551, 14028* (MBGH).

Habitat: Seen on upper part of the tree trunk and on logs along with *Leucoloma taylorii* in the semi-evergreen forests.

Distribution: World: China, Ceylon, India, Philippines, Thailand and Vietnam.

India: Garhwal Himalaya (Bahuguna *et al*., 2016), Karnataka (Schwarz, 2013) and Kerala

Kerala: Agasthyamala (Manju *et al.*, 2009d), Aralam WLS (Manju *et al*., 2009b) and Kozhikode (Jyothilakshmi & Manju, 2016).

Meiothecium Mitt.,

J. Linn. Soc. Bot., 10:185, 1868.

Plants slender, glossy, yellowish to brownish green; stem creeping, sparsely branched; leaves concave, ovate, acute at apex; ecostate; leaf cells short, rhomboidal at apex and narrow, rhomboidal at base; alar coloured, one rowed along the basal line of attachment; capsule cylindrical, horizontally placed, exostome papillose, placed distantly, operculum small, rostrate.

Meiothecium jagorii (Mull. Hal.) Broth., Nat. Pflanzenfam. I (3): 1103. 1908. Gangulee, Moss. of E. India, 3: 1872-1874, 1980. *Neckera jagorii* Muell. Hal. Bot. Zeitung 22: 373.1864. *Pterogoniella microcarpa* fo. *latifolia* M. Fleisch. Musci Frond. Archip. Ind. Exsic. 444. 1907.

Plant loosely tufted, yellowish to brownish green; stem creeping, sparsely branched, up to 2 cm long; rhizoids forms clusters on ventral side of the stem; leaves appressed to the stem, concave, oblong to ovate, recurved at base, minutely denticulate at apex due to the extension of papillose leaf tip, apex acute with a blunt, 1.5 × 0.45 mm; ecostate; leaf cells smooth, comparatively short, rhomboidal at apex, 12 -14 × 5-6 µm; cells above the alar short, rhomboidal forms diagonal rows to the margin, 23-35 × 5-6 µm, cells at the axial row are comparatively narrow, elongated, porose, 50-76 × 3-4 µm, alar oblong, golden yellow in colour, one rowed, 51-57 × 19-28 µm. (Plate 5.104)

Specimen examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Peruvannamuzhii (263 m), 22-03-14, *Prajitha 11033* (MBGH).

Habitat: Seen on branches in the moist deciduous forests.

Distribution: Borneo, Burma, Celebes, Ceylon, India, Java, Moluccas, Oceania, Singapore and Philippines.

India: Andaman Is and South India (Gangulee, 1980).

Notes: Present study is a new record to Kerala.

Rhaphidostegium (Schimp.) De Not.,

Comment. Soc. Crittog. Ital. 2: 297 [Cronaca Briol. Ital. 2: 31]. 1867

Plants slender or robust, glossy, yellowish to brownish green; main stem creeping, pinnately branched; leaves falcate, appressed to the stem when dry, concave, ovate to lanceolate, apex acute, margin dentate, base decurrent; ecostate; leaf cells narrow, rhomboid, papillose, median basal cells porose, alar hyaline, rectangular cells, with short, irregular cells above.

Rhaphidostegium confertissimum (Mitt.) A. Jaeger, Ber. Thatigk. St. Gallischen Naturwiss. Ges. 1876–77: 392 (Gen. Sp. Musc. 2: 458). 1878. *Stereodon confertissimus* Mitt., J. Proc. Linn. Soc., Bot. Suppl. 1(2): 102. 1859. *Rhaphidorrhynchium confertissimum* (Mitt.) Broth., Nat. Pflanzenfam. 11: 424. 1925.

Plants slender, glossy, yellowish to brownish green; main stem creeping, pinnately branched, 1.5 - 3 cm long; leaves falcate, appressed to the stem when dry, concave, ovate to lanceolate, apex acute, margin dentate, base decurrent, 0.5- 0.8 × 0.2 mm; ecostate; leaf cells narrow, rhomboid, papillose, 25-33 × 5-6 µm at apex, middle cells 40-58 × 4 µm, median basal cells porose, alar hyaline, rectangular, 21-30 × 7 µm, with short irregular cells above. (Plate 5.105)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Peruvannamuzhi (360-540 m), 22-03-14, *Prajitha 11036*, *11047,* (MBGH).

Habitat: Seen on branches and upper part of tree trunk in the moist deciduous forests.

Distribution: It is an endemic species in India: North- East India (Vashistha, 1998) as *Rhaphidorrhynchium confertissimum*) and Kerala (Manju & Prajitha, 2010) as *Rhaphidorrhynchium confertissimum*.

Rhaphidostichum M. Fleisch.,

Musci Buitenzorg. 4:1307, 1923.

Plants slender, greenish; stem creeping, brownish, sparingly branched; leaves ovate to lanceolate, margin minutely dentate towards the tip, apex narrow acuminate; ecostate; leaf cells narrow, rhomboid; basal alar cells one rowed, oblong, inflated, yellowish, largest at extreme angles.

Rhaphidostichum glaucovirens (Mitt.) Broth., Nat. Pflanzenfam 2, 11: 435. 1925; *Stereodon glaucovirens* Mitt., J. Proc. Linn. Soc., Bot. 2: 103. 1859. *Chionostomum glaucovirens* (Mitt.) A. Jaeger, Ber. Thatigk. St. Gallischen Naturwiss. Ges. 1876–77: 272 (Gen. Sp. Musc. 2: 338). 1878.

Plants slender, greenish, creeping; stem brownish, sparingly branched, up to 1.5 cm long; leaves ovate to lanceolate, margin minutely dentate towards the tip, apex narrow acuminate, 1.5-2 mm; ecostate; leaf cells narrow, rhomboid, 24-25 × 5-6 µm, middle cells 52-63 × 5 µm, basal alar cells one rowed, oblong, inflated, yellowish, largest at extreme angles, 23-56 × 18-24 µm. (Plate 5.106)

Specimen examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, (830 m), 12-09-14, *Prajitha 12513* (MBGH).

Habitat: Seen on branches in the semi-evergreen forests.

Distribution: India: Assam and Himalayas (Robinson, 1968).

Note: Present study is a new record to Penninsular India.

Trichosteleum Mitt.,

J. Linn. Soc.Bot., 10: 181, 1868.

Plants slender, forms mat, yellowish green; stem creeping, pinnately branched, branches short, attenuate; leaves concave, ovate to lanceolate, sometimes falcate, apex narrow, acuminate, margin denticulate at apex; ecostate; leaf cells narrow, rhomboidal, papillose; alar mostly coloured, large, oblong cells; seta long, papillose at apex, capsule cylindric or oblong and hanging, peristome double, calyptra cucullate.

Key to the genera

1a. Unipapillose leaf cells, alar tinted, overlapping..... ***T. boschii***

1b. Pleuripapillose leaf cells, alar hyaline, not overlapping.....***T.punctipapillosum***

Trichosteleum boschii (Dozy & Molk.) A. Jaeger, Ber. Thatigk. St. Gallischen Naturwiss. Ges Ber. S. Gall. Naturw. Ges., 1876–77: 421 (Gen. Sp. Musc. 2: 487). 1878. Gangulee, Moss. E. India, 3: 1910. 1980. *Hypnum boschii* Dozy & Molk. Ann. Sc. Nat. Bot. ser., 3 (2): 306. 1844. *H. brachypelma* Muell. Hal., Syn. Musc. Frond. 2: 404. 1851. *H. thelidictyon* Sull. & Lesq., Proc. Amer. Acad. Arts, 4: 280. 1859. *Trichosteleum thelidictyon* (Sull. & Lesq.) A. Jaeger, Ber. Thatigk. St. Gallischen Naturwiss.Ges., 1876-77: 417 (Gen. Sp. Musc. 2: 483). 1878. *T. brachypelma* (Muell. Hal.) Paris, Index Bryol., 656. 1897.

Plants slender, forms mat, horizontally spreading, but sub erect at apex, yellowish green; main stem creeping, appressed to the bark, forms small, pinnate branches, secondary branches short, up to 2 mm long, attenuate; rhizhoides brownish, arising from the ventral side of the main stem; leaves concave, ovate-lanceolate, margin more denticulate towards the tip, apex narrow acuminate or subulate, 0.8 mm × 0.1 mm; ecostate; leaf cells narrow, rhomboidal with one papilla present on the centre of lumen except at the extreme base and tip cells, 22-40 × 1.5 µm at apex, at the middle cells comparatively long and wide, 66-90 × 4-5 µm; alar tinted, bulging out, large, oblong, overlapping, 32-43 × 16-22 µm, differentiated in

to small quadrangular cells above, 22-49 × 3-5 µm; sporophyte arising laterally on the main stem, perichaetial leaves ovate, lanceolate, 0.7 mm long and 0.2 mm wide at base, seta brownish, curved at apex. 0.7 mm long, capsule oblong, placed horizontally, peristome double, 156 µm long and 52 µm wide at the base. (Plate 5.107)

Specimen examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam (900 m), 14-11-14, *Prajitha 12968* (MBGH).

Habitat: Seen on bark at the upper part of the tree trunk in the semi-evergreen forests.

Distribution: Borneo, China, East Nepal, Fiji, India, Java, Philippines, Sumatra and Thailand.

India: Kerala, North- West Himalayas (Vashistha, 1998) and Tamil Nadu.

Kerala: Agasthyamala (Manju *et al*., 2009d).

Trichosteleum punctipapillosum Paris ex Gangulee, Moss. E. India 3: 1913 -1915. 1980.

Plants slender, closely appressed to the bark, horizontally spreading, yellowish green in colour; stem brownish, pinnately branched, main stem up to 1.5 cm long, secondary branches short, 3 mm long; rhizoids brownish, arising from the ventral side of the main stem; leaves concave, ovate, lanceolate, projection of papillose tips at the ends of marginal cells makes margin crenulated, apex narrow acuminate; ecostate; leaf cells narrow, rhomboidal, 27-32 × 4-5 µm at apex, comparatively long at the middle, 46-56 × 3-4 µm, pleuripapillose, except at base; alar forms large, oblong, hyaline cells, 18-20 × 12-16 µm, which differentiated in to irregularly quadrangular cells above, 15-24 × 5-10 µm; perichaetial leaves ovate, lanceolate, 1mm long, 0.2 mm wide at base, sporophyte arising laterally from the base of main stem, seta reddish, 1.7 mm long; peristome double, 0.29 mm long and 0.07 mm wide at base. (Plate 5.108)

Specimen examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Peruvannamuzhii (1200 m), 22-03-14, *Prajitha 11020* (MBGH).

Habitat: Seen on the upper part of the tree trunk in the semi-evergreen forests.

Distribution: India: Andaman Islands (Gangulee, 1980) and Tamil Nadu (Daniels & Kariyappa, 2007)

Note: This species is reported as endemic in Andaman Islands. (Gangulee, 1980). Present collection is a new record to Kerala.

Pterobryaceae Kindb.,

Eur. N. Amer. Bryin. 1: 15. 1897.

Plants slender or robust, yellowish green to brownish, main stem creeping, central strand absent; leaves ovate, acuminate, margin entire or serrated; costa single or double; leaf cells narrow, elongated or rhomboidal, alar differentiated or not.

Note: This family include 24 genera, of which 11 genera are distributed in India. Of these three genera *viz*., *Calyptothecium* (Muell. Hal.) Hampe, *Pterobryopsis* M. Fleisch. and *Symphysodontella* M. Fleisch. are found in Kerala. Of which two genera *viz*., *Calyptothecium* (Muell. Hal.) Hampe and *Pterobryopsis* M. Fleisch. are represented in the study area.

Key to the genera

1a. alar differentiated.....***Pterobryopsis***

1b. alar not differentiated ..... ***Calyptothecium***

Calyptothecium Mitt.,

J. Linn. Soc. Bot. 10: 190. 1868

Plants more or less tufted, robust, yellowish green above and brownish below, main stem creeping, pinnately branched, secondary branches short and pendant, central strand absent; leaves ovate, acuminate, and auriculate at base,

margin minutely serrulated; costa ends just above the mid leaf; leaf cells rhomboidal, alar not differentiated.

Calyptothecium wightii (Mitt.) M. Fleish., Hedwigia 45:62. 1905; Gangulee, Moss. E. India 2(5): 1377. 1976; Nair *et al.*, Bryoph. Wayanad 161. 2005. *Meteorium wightii* Mitt., J. Proc. Linn. Soc., Bot., Suppl. 1: 85. 1859. *M. nematosum* Muell. Hal., Flora 61: 84. 1878. *Pterobryon patulum* Broth., Rec. Bot. Surv. India 1 (2): 325, 1899. *Pterobryopsis subacuminata* Broth. & Paris, Rev. Bryol. 34: 45. 1907. *Calyptothecium dixonii* Gangulee, Mosses E. India 5: 1371. f. 674. 1976.

Plants loosely tufted, robust, yellowish green above and brownish below, main stem creeping, slender, 6-10 cm long, pinnately branched, secondary branches erect or pendulous, short, 2-2.5 cm long, 0.3 mm wide, brownish, central strand absent, cortical cells sub quadrangular, 4-10 × 4-5 µm, medullary cells hexagonal, comparatively large, 11-17 × 14-25 µm; stem leaves small, ovate acuminate, margin minutely serrulate, leaf cells rhomboidal, 36-45 × 5-9 µm at apex, narrow, rhomboidal at middle, 63-86 × 4-6 µm and sub quadrangular at extreme base, 15-31 × 8-15 µm, 1 × 0.5 mm; branch leaves erectopatent, ovate, apex acuminate, auriculate at base, 2.5 × 1.7 mm; costa ends just above the midleaf; leaf cells rhomboidal, 52-69 × 6-8 µm at apex, middle cells 68-96 × 4-5 µm and 38-68 × 4-9 µm at base; multicellular, filamentous gemmae present, 300-305 µm long. (Plate 5.109)

Specimen examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam, Athikode grassland (1300 m), *Prajitha 12957* (MBGH).

Habitat: Seen on rocks in the grasslands.

Distribution: World: Bangladesh, Burma, Ceylon, East Nepal, India, Sri Lanka, Thailand, Vietnam and Yunnan.

India: Karnataka (Schwarz & Frahm, 2013), Kerala (Nair *et al*., 2005a) and Tamil Nadu (Daniels *et al*., 2018).

Kerala: Kozhikode (Mufeed *et al*., 2014), Wayanad (Nair *et al*., 2005a).

Pterobryopsis M. Fleisch.,

Hedwigia 45: 56. 1905.

Plants tufted, yellowish green to brownish green in colour, main stem creeping; leaves concave, ovate or oblong;, margin entire or serrated towards the tip, cordite or not, auricled or not; costa present, single or double; leaf cells narrow, elongate; alar differentiated, colourled.

Key to the species

1a. Leaf base auricled.....***P. flexipes***

1b. Leaf base not auricled.....(2)

2a. Costa short, double.....***P. gedehensis***

2b. Cost long, single.....(3)

3a. Leaves cordite at base.....***P. acuminata***

3b. Leaves not cordite at base.....***P. orientalis***

Pterobryopsis gedehensis M. Fleisch., Hedwigia 45: 57. 1905. *P. clemensiae* Broth., Philipp. j. Sci. 5: 152. 1910. *P. carifolia* Dixon & P. de la Varde, Ann. Cryptog. Exot. 3(4): 179, 4. f. 3. 1930.

Main stem creeping, sparsely branched, stem brownish, branches erect with flagelliform branches, yellowish above, brownish below, 2-3 cm long; stem 1 mm wide, with 3-4 peripheral layers of thick walled, yellowish brown cells and inner hyaline cells, leaves squarrose, ovate, margin faintly serrate at base and more towards the tip, apex sharply acuminate, cordite at base, 2.5 × 1.2 mm; costa short, double; leaf cells narrow elongate, at tip, 42-61 × 5-6 µm, at middle, 53-65 × 5-6 µm and at base, 24-33 × 8-10 µm; alar rectangular to quadrate, cells at leaf attachment reddish brown, 25-32 × 13-17 µm. (Plate 5.110)

Specimen examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam (800 m), 13-11-14, *Prajitha 12827* (MBGH).

Habitat: Seen on branches in the semi-evergreen forests.

Distribution: World: China, India, Indonesia and Philippines.

India: Karnataka (Schwarz, 2013) and Tamil Nadu (Daniels, 2010).

Note: Present study is a new record to Kerala.

Pterobryopsis acuminata (Hook) M. Fleisch., Hedwigia, 45: 59. 1905; Gangulee, Moss. E. India 2 (5): 1273. 1976; Nair *et al.*, Bryoph. Wayanad 152. 2005. *Neckera acuminata* Hook., Musci Exot., 2: 15. 1819. *Garovaglia conchophylla* Reauld & Cardot, Bull. Soc. Roy. Bot. Belgique 41 (1): 69. 1905. *Pterobryopsis handelii* Broth. Akad. Wiss. Wien Sitzungsber., Math. Naturwiss. Kl., Abt. 1, 133: 572. 1924. *P. morrisonicola* Nog., J. Hattori Bot. Lab. 2: 69. 16f. 3-5. 1947

Yellowish to brownish green in colour, main stem creeping, slender, wire like, 3.5 cm long, branching irregularly, secondary branches short, robust, 1.5 cm long; leaves squarrose, ovate, margin entire, sometimes minutely serrulate at tip, cordite at base, 2.3 × 1 mm; costa ending above the middle of the leaf; leaf cells narrow elongate, 32-48 × 5-6 µm at apex and 66-79 × 6-7 µm at middle; alar quadrangular, yellowish brown, 17-26 × 22-23 µm; cells at the leaf attachment yellowish brown. (Plate 5.111)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam (700 m), 14-11-14, *Prajitha 12886*; 12-01-15, *Prajitha 13564* (MBGH).

Habitat: Seen on branches in the semi-evergreen forests.

Distribution: World: Burma, East Nepal and India.

India: Kerala (Nair *et al*, 2005a), Khasia Hills (Gangulee, 1976), Maharashtra (Magdum *et al*., 2017), and Tamil Nadu (Daniels, 2010).

Kerala: Aralam (Manju *et al*., 2009b) and Wayanad (Nair *et al.,* 2005a).

Pterobryopsis orientalis (Mull. Hal.) M. Fleisch., Hedwigia 59: 217. 1917; Gangulee, Moss. E. India 2 (5): 1272. 1976; Nair *et al.*, Bryoph. Wayanad 152-153. 2005. *Neckera orientalis* Muell. Hal., Bot. Zeitung 14: 437. 1856. *Endotrichum*

foulkesianum A. Jaeger, Ber. Thatigk. St. Gallischen Naturwiss. Ges. 1875-76: 233. 1877. *Garovaglia juliramea* Muell. Hal., Bull. Soc. Roy. Bot. Belgique, 38 (1): 19. 1900.

Yellowish to dark green in colour; main stem creeping, slender, wire like, up to 5.5 cm long, sparsely branched, branches short, robust, 1- 1.5 cm long; leaves squarrose, ovate, apex sharply acuminate, margin entire, minutely serrate at apex, 3.3 × 1.7 mm and extreme base 0.14 mm wide; costa ending below the middle of the leaf; leaf cells narrow elongate, 29-49 × 5 µm at tip and 85 – 88 × 7 µm at middle; alar yellowish brown, quadrangular, 17-33 × 22-23 µm. (Plate5.112)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam (580 m), 22-03-14, *Prajitha 11075*; 11-09-14, *Prajitha 12788*; Peruvannamuzhi (460 m), 29-12-17, *Prajitha 14167* (MBGH).

Habitat: Seen on branches in the evergreen and moist deciduous forests.

Distribution: World: Myanmar, North Vietnam, Thailand and Yunnan.

India: Karnataka (Schwarz, 2013; Aruna & Krishnappa, 2014), Kerala (Nair *et al*., 2005), Tamil Nadu (Daniels, 2010) and Western Himalayas (Alam, 2013).

Kerala: Aralam (Manju *et al*., 2009b), Eravikulam NP (Madhusoodanan *et al*., 2007) and Wayanad (Nair *et al*., 2005a).

Pterobryopsis flexipes (Mitt.) M. Fleisch., Hedwigia 45: 62. 1905; Gangulee, Moss. E. India 2 (5): 1267-1267. 1976. *Meteorium flexipes* Mitt., J. Proc. Linn. Soc., Bot., Suppl. 1: 85. 1859.

Yellowish to dark green in colour; main stem creeping, slender, wire like forms small, pinnate branches, up to 4.5 cm long; leaves oblong ovate, apex narrowly acuminate or forms small acumen, margin minutely serrulate, 2 × 0.7 mm; costa ends above the middle of the leaf; leaf cells narrow, elongate, 44-49 × 4-6 µm at apex and 59-74 × 3 µm; alar yellowish brown, quadrangular, 21-25 × 4-5 µm.(Plate 5.113)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Peruvannamuzhi (530 m), 22-03-14, *Prajitha 11075*; Kakkayam (640 m), 12-01-15, *Prajitha 13558* (MBGH).

Habitat: Seen on branches in the moist deciduous forests.

Distribution: Burma, Ceylon, India and Nepal.

India: Karnataka (Schwarz & Frahm, 2013), Kerala (Manju *et al.,* 2008b) and Tamil Nadu (Daniels, 2010; Daniels *et al*., 2018).

NECKERACEAE Schimp.,

Coroll. Bryol. Eur. 99. 1855

Plants slender or robust, glossy, yellowish green, main stem ceeping, secondary branches erect, pinnately branched, central strand absent; leaves assymetrical, oblong lingulateor spathulate, margin minutely or deeply serrated at apex; costa present, mostly single; leaf cells incrassate, papillose or not, sub rhomboidal at apex, rhomboidal at middle and elongated at base; alar absent or short quadrangular cells at leaf attachment.

Note: This family include 28 genera, of which eleven genera *viz.*, *Dixonia* Horik. & Ando., *Handeliobryum* Broth*., Himantocladium* (Mitt.) M. Fleisch, *Homalia* (Brid.) Bruch & Schimp., *Homaliodendron* M. Fleisch., *Neckera* Hedw., *Neckeropsis* Reichardt*, Noguchiodendron* Ninh & Pocs, *Pinnatella* M. Fleisch*., Porotrichum* (Brid.) Hampe and *Thamnobryum* Nieuwl. are distributed in India. Of these seven genera such as *Handeliobryum, Himantocladium, Homaliodendron, Homalia, Neckera, Neckeropsis* and *Pinnatella* occur in Kerala. Except *Handeliobryum* and *Homalia* all other genera are represented in the study area.

Key to the genera

1a. Papillae seen on lumen……..……2

1b. Papillae absent on lumen…….……..3

2a. Intralaminal zone formed by elongated cells.....***Pinnatella***

2b. Intralaminal zone absent.....***Dixonia***

3a. Costa ending just below the apex.....(4)

3b. Costa ends at the middle or well below the apex…….***Homaliodendron***

4a. Leaves 8 rowed, margin serrated only at apex.....***Himantocladium***

4b. Leaves 4 rowed, margin fully serrated.....***Neckeropsis***

Dixonia Horik. & Ando,

Nat. Life S.E. Asia, 3: 23. 1964.

Plants slender; main stem creeping, sparsely branched; leaves ovate, apex acute, margin serrated towards the tip; costa absent or faint if present; leaf cells linear, papillose, except at extreme tip and base; seta long, capsule cylindrical, inclined, operculam rostrate, peristome double.

Dixonia orientalis (Mitt.) H. Akiyama & H. Tsubota, Bryol. Res. 8(8): 236. 2004. *Stereodon orientalis* Mitt., J. Proc. Linn. Soc., Bot., Suppl. 1(2): 111. 1859. *Dixonia thamnioides* (Broth. & Dixon) Horik. & Ando, Nat. Life S.E. Asia 3: 23. 1964.

Plants slender, glossy, yellowish green; main stem creeping, wiry, sparsely branched, brownish, with small scale leaves; Leaves ovate, apex acute, margin serrated towards the tip, base incurved, 1 × 0.5 mm; costa faint or absent; leaf cells linear, papillose, except at extreme tip and base, 18- 28 × 4-7 µm at apex, 57-69 × 4-5 µm at middle and 12-22 × 7 µm at base; seta upto 2 cm long, capsule cylindrical, inclined, operculam rostrate, peristome double. (Plate5.114)

Specimen examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary: Kakkayam (980 m), 12-01-15, *Prajitha 13541* (MBGH).

Habitat: Forms mat on rocks near waterfalling areas in the semi-evergreen forests.

Distribution: World: India, Nepal and Thailand.

India: Assam, Darjeeling, Karnataka (Schwarz, 2013; Schwarz & Frahm, 2013) and Kerala (Manju *et al*., 2008b)

Kerala: Neyyar Wildlife Sanctuary (Brijithlal, 2010).

Himantocladium (Mitt.) M. Fleisch.,

Musci Buitenzorg 3: 883. 1908

Plants slender or robust, more or less glossy, dark green to yellow green, main stem creeping, pinnately branched; leaves octastichous, oblong lingulate, apex rounded with acute apiculus, base wider and auriculate; costa ending just below the apex; leaf cells incrassate, sub rhomboidal towards apex and narrow, elongated at base; alar absent.

Himantocladium plumula (Nees) M. Fleisch., Musci Buitenzorg 3: 889. 1908; Gangulee, Moss. E. India, 2(5): 1406-1408, 1976; Nair *et al.*, Bryoph. Wayanad 161. 2005. *Pilotrichum plumula* Nees, Bryol. Univ. 2: 759. 1827. *Neckera hookeri* Dozy & Molk., Ann. Sc. Nat. Bot. ser. 3, 2: 313. 1844. *Thamnium liguliferum* Bosch & Sande Lac, Bryol. Jav. 2:72. 1863. *Neckera arbuscula* Hamp. ex. Muell. Hal., Flora 61: 83. 1878. *N. baeuerlenii* Geh., Biblioth. Bot. 13: 4. 2. 1889. *Pinnatella lingulata* Dixon, Bull. Torrey Bot. Club. 51: 236. 3f. 11. 1924. *Neckera plumuloides* Broth., Gard. Bull. Straits Settlem. 4: 25. 1926

Plants robust and less glossy, dark green to yellow green, main stem creeping, scale leaves present on the main stem, secondary branches erect, pinnately branched; leaves complanate, erecto-patent, longitudinally plicate, octastichous, oblong elongate, margin entire and inflexed at base but minutely dentate at apex, apex rounded with acute apiculus, base wider and auriculate, 2.7 × 1-1.2 mm; costa strong and ending just below the apex; leaf cells short, sub quadrangular to sub rhomboidal, incrassate, 28-34 × 13-15 µm at apex, at middle 22-30 × 10-12 µm and basal cells comparatively long, narrow, rectangular, 47-81 × 2-3 µm. (Plate5.115)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Peruvannamuzhi (400-390 m), 22-03-14, *Prajitha 11059*; 29-12-17, *Prajitha 14114* (MBGH).

Habitat: Seen on upper part of the tree trunk in the semi-evergreen forests.

Distribution: Bangladesh, Burma, Thailand, Vietnam, Malaya, Sumatra, Java, Borneo, New Guinea, Philippines, Japan, Australia and New Caledonia.

India: Karnataka (Schwarz & Frahm, 2013; Aruna & Krishnappa, 2014), Kerala (Nair *et al*., 2005a), Khasia Hills (Gangulee, 1976), Odisha (Mishra *et al*., 2016).

Kerala: Aralam W.L.S (Manju *et al*., 2009b), Eravikulam N.P (Madhusoodanan *et al.,* 2007), Kozhikode: Kakkayam (Manju *et al*., 2008a) and Wayanad (Nair *et al*., 2005a).

Homaliodendron M. Fleisch.,

Hedwigia 45:74. 1906.

Plants slender or robust, glossy, yellowish –green, main stem creeping, having small leaves, secondary branches erect, pinnately branched, central strand absent; leaves assymetrical, oblong to lingulate or oblong to spathulate, margin deepely serrated or minutely crenulated at apex, leaves at the base of the stem smaller; costa ends at or above the middle of the leaf; leaf cells sub rhomboidal at apex, rhomboidal at middle and elongated at base, alar cells short, rectangular to quadrate.

Key to the species

1a. Leaf oblong to ovate or oblong to lingulate, margin deeply serrated at apex..... ***H. flabellatum***

1b. Leaf oblong to spathulate, margin minutely crenulated at apex..... …. …… .....***H. microdendron***

Homaliodendron flabellatum (Sm.) M. Fleisch., Hedwigia 45: 74. 1906; Gangulee, Moss. E. India, 2(5): 1426-1427. 1976; Nair *et al.*, Bryoph. Wayanad 162. 2005. *Hookeria flabellata* Sm., Trans. Linn. Soc., 9: 280. 1808. *Climacium neckeroides* Brid., Bryol. Univ. 2: 276. 1827. *Pterygophyllum decompositum* Brid., Bryol. Niv. 2: 764. 1827. *Neckera javanica* Muell. Hall., Syn. Musc. Frond 2: 41. 1850. *N. scalpellifolia* Mitt. J. Proc. Linn. Soc., Bot., Suppl. 2:119. 1859. *Homalia intermedia* Angstr. Ofvers. Forh. Kongl. Svenska Vetensk. Akad. 29(4): 17. 1872. *Neckera mohriana* Muell. Hal., Linnaea 38: 646. 1874. *Homalia paraelonga* Reichardt., Sitzungsber. Kaiserl. Akad. Wiss. Math. Naturwiss. CL Abt. 175: 573. 1877. *Homalia densa* Bosw., J. Bot. 30: 98. 1892. *Porotrichum grandidens* var. *Domingense* Muell. Hal., Hedwigia 37: 243. 1898. *Homaliodendron densum* (Bosw.) Broth., Nat. Pflanzn Fam. 1(3): 851. 1906.

Plants robust, glossy, yellowish green, main stem creeping, upto 6 cm long, pinnately branched, secondary branches horizontally placed, stem with out central strand, 0.5 mm wide; leaves assymetrical, oblong to ovate or oblong to lingulate, margin deepely serrate apex, inflexed at base, 2 × 0.9-1 mm, leaves at the base of the stem comparatively smaller; costa reach up to the middle, forked at tip; leaf cells incrassate, sub rhomboidal at apex, 11-12 × 6-7 µm, middle cells rhomboidal, 26-28 × 15-18 µm, but narrow, elongated at base, 124-172 × 15-25 µm. (Plate 5.116)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary. Peruvannamuzhi, Chenkotakolli (340 m), 16-03-13, *Prajitha 8661*; 22-03-14, *Prajitha 8697*; Kakkayam (830 m), 13-11-14, *Prajitha 12758* (MBGH).

Habitat: Seen on upper part of the tree trunk in the evergreen and semi-evergreen forests.

Distribution: Africa, Australia, Burma, Ceylon, Hawaii, Japan, Java, Malay, North Borneo, New Caledonia, Sumatra, Philippines and Thailand.

India: Darjeeling (Gangulee, 1976), Karnataka (Schwarz & Frahm, 2013), Kerala (Manju *et al*., 2008b) and Tamil Nadu (Daniels *et al*., 2018).

Kerala: Agasthyamala (Manju *et al*., 2009d), Wayanad (Nair *et al*., 2005a).

Homaliodendron microdendron (Mont.) M. Fleisch., Hedwigia 45: 78. 1906; Gangulee, Moss. E. India, 2 (5): 1414-1416. 1976. *Hookeria microdendron* Mont., Ann. Sc. Nat. Bot. ser.2, 19: 240. 1843. *Hypnum spathulaefolium* Muell. Hal., Syn. Musc. Frond. 2:231. 1851. *Neckera glossophylla* Mitt., J. Proc. Linn. Soc., Bot., Suppl. 2: 119. 1859. *Homaliodendron excisum* M. Fleisch, Hedwigia 45: 78. 1906. *Homaliodendron glossophyllum* (Mitt.) M. Fleisch, Hedwigia 45: 78. 1906. *H. spathulaefolium* (Muell. Hal.) M. Fleisch, Hedwigia 45: 78. 1906. *H. elegantulum* Ther., Rev. Bryol. 49: 7.1. 1922.

Plants slender, yellowish green, main stem creeping, secondary branches erect, up to 8 cm long, pinnately branched; leaves assymetrical, oblong to spathulate, apex rounded, wider, margin minutey crenulated at apex, base reflexed at one side, 2.5 ×1 mm; costa ends above the middle of the leaf; leaf cells incrassate, quadrate to sub rhomboidal at apex, 8-12 × 7 µm, middle cells irregularly quadrangular, 35-46 × 11-12 µm, and cells at the base elongated, rectangular, 38-49 × 4 µm, cells at the leaf attachment short, quadrangular. (Plate 5.117)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Peruvannamuzhi, Chenkotakolli (440 m), 16-03-13, *Prajitha 8698*; 12-01-15, *Prajitha 13556* (MBGH).

Habitat: Seen on upper part of the tree trunk in the moist deciduous forests.

Distribution: World: Borneo, Burma, Japan, Philippines, North Vietnam, Thailand and Yunnan.

India: Darjeeling (Gangulee, 1976), Kerala (Manju *et al*., 2008b),Tamil Nadu (Daniels, 2010) and Western Himalaya (Gangulee, 1976; Alam, 2013).

Kerala: Aralam WLS (Manju *et al*., 2009b).

Neckeropsis Reichardt,

Verh. K.K. Zool. Bot. Ges. Wien 18: 192. 1868.

Plants more or less robust, glossy, yellowish green, primary stem creeping, secondary branches sparingly branched; leaves assymetrical, horizontally spreading, 4 rowed, oblong to lingulate; costa ending just below the apex; leaf cells rhomboidal above and elongated below.

Neckeropsis andamana (Mull. Hal.) M. Fleisch., Musci Fl. Buitenze., 3: 878. 1908; Gangulee, Moss. E. India, 2(5): 1404. 1976. *Distichia andamana* Muell. Hal., Flora 61: 84. 1878.

Plants semi-robust, glossy, yellowish green, primary stem creeping, secondary branches sparingly branched, upto 5 cm long; leaves assymetrical, horizontally spreading, 4 rowed, oblong to lingulate, apex obtuse to apiculate, margin minutely serrulated, base recurved and auriculate, 2 × 0.6 mm; costa ending just below the apex; leaf cells incrassate, irregularly quadrangular at apex, 6-12 × 6 µm, rhomboidal at middle, 19-24 × 5 µm and cells at the base narrow elongated 23-28 × 4 µm. (Plate5.118)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Peruvannamuzhi (450-540 m), 22-03-14, *Prajitha* 11032, 11047 (MBGH).

Habitat: Seen on upper part of the tree trunk in the moist deciduous and semi-evergreen forests.

Distribution: World: Burma, Ceylon, India, Java, Philippines, Singapore, Thailand and Vietnam.

India: Andaman-Nicobar Islands (Gangulee, 1976), Karnataka (Schwarz, 2013) and Kerala (Manju *et al*., 2009).

Pinnatella Fleisch.,

Hedwigia, 45:79. 1906.

Plants more or lerss robust, yellowish green, brownish at base, main stem creeping, wire like, with scale leaves, secondary branches erect, pinnately or irregularly pinnately branched; leaves concave, longitudinally plicate; leaves oblong, apex acute, margin sharply serrated towards the tip, incurved at base; costa strong ends below the apex; leaf cells papillose, incrassate or not, short, quadrangular at apex, elongated at base, intralaminal zone formed by elongated cells.

Key to the species

1a. Leaves ovate to oblong, margin reflexed at base, with poorly perceptible intralaminal zone..... ..... ***P. foreauana***

1b. Leaves oblong, margin not reflexed at base, with intralaminal zone..... ***P. alopercuroides***

Pinnatella alopecuroides (Mitt.) M. Fleisch., Hedwigia, 45: 84. 1906; Gangulee, Moss. E. India, 2(5): 1439- 1440. 1976. *Neckera alopercuroides* Mitt., J. Proc. Linn. Soc., Bot., Suppl. 2: 123. 1859. *N. efructifera* Griff., Not. Pl. Asiat., 2: 465, t. 87-3. 1849. *Pinnatella intralimbata* M. Fleisch., Hedwigia 45: 82. 4. 1906. *Porotrichum zollingeri* Muell. Hal., Musci Buitenzorg 3: 923. 1908.

Plants robust, yellowish green, brownish at base, main stem creeping, secondary branches erect, sparingly branched, 10-15 cm; leaves oblong, apex acute, margin sharply serrated towards the tip, incurved at base, 2 × 0.7 mm; costa strong ends below the apex; leaf cells short, quadrangular at apex, 9-11 × 5-8 µm, cells at the middle comparatively short, 5-8 × 5-8 µm, elongate, quadrangular at base, 20-29 × 6-9 µm, intralaminal zone formed by elongated cells, 40-45 × 7 µm, which cover two thirds of the leaf length. (Plate5.119)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam (780 m), 12-09-14, *Prajitha 12555, 12557*; Peruvannamuzhi (440 m), 13-11-14, *Prajitha 12727*, *12749* (MBGH).

Habitat: Seen on branches in the moist deciduous and semi-evergreen forests.

Distribution: Bhutan, Burma, Ceylon, East Nepal, Darjeeling, N. Vietnam, Philippines and Thailand.

India: Assam (Gangulee, 1976), Karnataka (Schwarz, 2013; Schwarz & Frahm, 2013), Maharashtra (Magdum *et al*., 2017), Odisha (Mishra *et al*., 2016), Tamil Nadu (Daniels, 2010; Daniels *et al*., 2018) and West Bengal (Gangulee, 1976).

Pinnatella foreauana Ther. & P. de la Varde, Rev. Bryol. 52: 39. 1925. *Pinnatella sikkimensis* Broth., Mitt. Inst. Allg. Bot. Hamburg 8: 404. 1931.

Plants robust, Yellowish green, brownish at base, main stem creeping, wire like, with scale leaves, secondary branches erect, pinnately branched, upto 6 cm long; leaves many rowed, concave, ovate – lingulate, apex acute, margin minutely serrate towards the tip, 1 × 0.5 mm; costa ends below tip; leaf cells incrassate, obscure at apex and basal margin due to the presence of papillae, cells short, quadrangular at apex , 10 × 5-6 µm, middle cells 9-11 × 5-7 µm and cells at the base elongated, 12-20 × 6-7 µm, intralaminal zone poorly perceptible. (Plate 5.120)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Peruvannamuzhi (340 m), 22-03-14, *Prajitha 11037*; Kakkayam (460 m), 11-09-14, *Prajitha14055* (MBGH).

Habitat: Seen on upper part of the tree trunk in the semi evergreen forests.

Distribution: Bhuttan, Burma, Ceylon, India, Nepal, Thailand and Vietnam.

India: Darjeeling, Kerala (Manju *et al*., 2008a), and Tamil Nadu (Daniels, 2010).

Myuriaceae Broth. ex M. Fleisch.,
Musci Buitenzorg. 4: 1663. 1923.

Plants robust, glossy, tufted, yellowish or golden green, brownish below; stem slender, pinnately or sparsely branched, secondary branches sub erect, flagelliform branches sometimes present, central strand absent; leaves concave, ovate – lanceolate, apex acute or apiculate, margin minutely dentate at apex; ecostate; leaf cells narrow, elongated, pitted; alar coloured; seta long, capsule ovate, erect.

Note: This family include four genera *viz*., *Eumyurium* Nog., *Myurium* Schimp., *Oedicladium* Mitt. and *Palisadula* Toyama. Of which one genus, *Myurium* Schimp. is found in India and in Kerala and the same genus is represented in the study area.

Myurium Schimp.,
Syn. Musc. Eur. 695. 1860.

Plants robust, glossy, tufted, yellowish or golden green, brownish below; stem slender, pinnately or sparsely branched, secondary branches sub erect, flagelliform branches sometimes present; leaves concave, ovate – lanceolate, apex acute or apiculate, margin minutely dentate at apex; ecostate; leaf cells narrow, elongated, pitted; alar coloured; seta long, capsule ovate, erect.

Myurium borii (Dixon) Magill, J. Hattori Bot. Lab. 48: 68. 1980. *Symphysodontella borii* Dixon, J. Bombay Nat. Hist. Soc. 39:7 81. 1937.

Plants robust, glossy, tufted, yellowish or golden green, brownish below; stem slender, pinnately branched, secondary branches suberect, 2-3 cm long, flagelliform branches sometimes present; leaves concave, ovate – lanceolate, apex acute or apiculate, margin minutely dentate at apex; ecostate; leaf cells narrow, elongated, 30 × 4 µm at apex, 43-73 × 4 µm at middle, cells at the stem attachment coloured, pitted, alar coloured, hyaline at perifery, 58-78 × 25µm; perchaetial leaves narrow, elongated, seta long, upto 2 cm long, capsule ovate, erect, 1.2 mm long, peristome papillose. (Plate 5.121)

Specimens examined: India, Kerala, Kozhikode District, Malabar Wildlife Sanctuary, Kakkayam, Ambalappara (890-1200 m), 26-09-12, *Prajitha 8516, 8539* (MBGH).

Habitat: Seen on rocks and on branches along with *Macromitrium sulcatum* in the evergreen and semi evergreen forests.

Distribution: This species is endemic to India: North- East India (Gangulee, 1972 as *Symphysodontella borii*)

Ecology of Bryophytes of Malabar Wildlife Sanctuary

Bryophytes survive in every ecosystem except salt water and permanently frozen ecosystem (Vanderpoorten & Goffinet, 2009). They helps in soil formation, rock binding, keep the soil moisture and helps in nutrient cycling. Most of the Bryophytes are ectohydric (Bahuguna *et al.*, 2013), they have the ability to absorb water, minerals and inorganic nutrients from the atmosphere rather than substratum and soil.

Many animals such as small invertebrates, protozoa, nematodes, earthworms, amphibians, insects, spiders, reptiles, birds, etc. inhabitants the Bryophytes. They classified as bryobionts, bryophiles, bryoxenes and occasionals (Glime, 2017). Which depends bryophytes for food or shelter or nesting materials. They provide habitat for Cyanophycean members like *Nostoc* and *Scytonema* (Basilier, 1979).

Bryophytes have different life forms of which some terrestrial species forms mat on soil and reduce run off water by its water holding capacity and there by prevent soil erosion. Epiphytic species accumulate humus on branches by absorbing water from the atmosphere. There are reports of many species of bryophytes from a single tree (Bargali, 2014). Each species not occurred as single but they forms colony and associated with each other species. Distribution of species vary according to altitude, vegetation and habitats. Ecological studies of bryophytes are very less in Kerala and as part of taxonomic studies associated ecological aspects such as altitude, macrohabitat and microhabitats of bryophytes of Wayanad is studied by Nair *et al.*, 2005 and ecological aspects of the genus *Fissidens* in Western Ghats is done by Manjula (2018).

The Malabar Wildlife Sanctuary is facing serious ecological threats due to climatic changes, such as earthquake, heavy rain, etc. along with anthropogenic activities such as removal of forest to make shelter, agricultural purpose, river valley project, road construction and tourism which make habitat destruction and cause considerable damage to the forest and seriously affect species diversity.

Altitude and bryophyte distribution

The altitude zonation is mainly based on the distribution of species and species composition. There are several classifications on altitudinal zonation based on the distribution of species and type of vegetation. In the present study to compare the diversity and distribution of species in each zone it is divided in to 100m difference starting from 40m. Among the 130 species 39 species were distributed in between 800-900 m altitudinal zone shows the highest species diversity followed by 400-500 m range showing 37 species and only six species are distributed in between 40-100 m altitudinal zone shows the lowest species diversity in the study area. Table 1 & Fig. 5.1 shows the distribution of species based on altitudinal zonation in Malabar Wildlife Sanctuary.

Fig. 5.1 Altitudes and species distribution

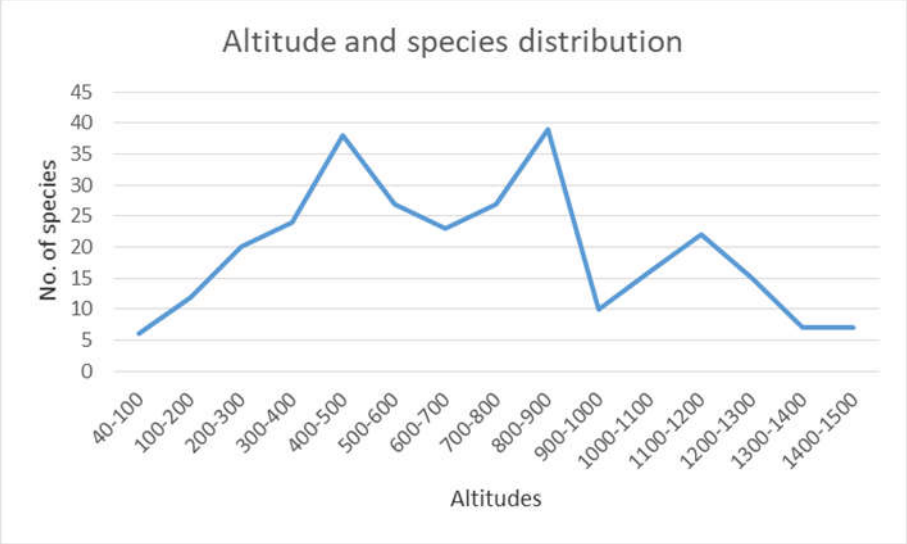


Table. 1 Distribution of species based on altitudinal zonation

Sl. No.	Species	40-100 m	100-200m	200-300 m	300-400m	400-500 m	500-600m	600-700 m	700-800m	800-900 m	900-1000m	1000-1100m	1100-1200 m	1200-1300 m	1300-1400m	1400-1500 m
1.	*Acroporium stramineum* (Reinw. & Hornsch.) M. Fleisch.	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
2.	*Acroporium strepsiphyllum* (Mont.) B.C. Tan	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-
3.	*Actinodontium rhaphidostegum* (Muell. Hal.) Bosch & Sande Lac.	-	-	-	-	-	-	-	+	-	-	-	+	-	-	-
4.	*Aerobryopsis longissima* (Dozy & Molk.) M. Fleisch.	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
5.	*Aerobryum speciosum* Dozy &Molk.	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-
6.	*Anomobryum auratum* (Mitt.) A. Jaeger	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-
7.	*Anthoceros crispulus* (Mont.) Douin	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-
8.	*Aptychella speciosa* (Mitt.) Tixier	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-
9.	*Barbula indica* (Hook.) Spreng.	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
10.	*Bryocrumia* sp. nov.	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
11.	*Bryocrumia vivicolor* (Broth. & Dixon) W.R. Buck	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-
12.	*Bryum cellulare* Hook.	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
13.	*Bryum coronatum* Schwagr.	+	+	+	+	+	+	+	+	-	-	-	-	-	-	-
14.	*Bryum wightii* Mitt.	-	-	-	-	+	+	+	+	+	+	+	+	-	-	-
15.	*Callicostella papillata* (Mont.) Mitt.	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-
16.	*Calymperes afzelii* Sw.	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-

17.	*Calymperes erosum* Muell. Hal.	-	-	-	-	+	+	-	-	-	-	-	-	+	-	-
18.	*Calymperes linguatum* Muell. Hal. exBesch.	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
19.	*Calyptothecium wightii* (Mitt.) M. Fleisch.	-	-	-	-	-	-	-	-	+	-	-	-	+	-	-
20.	*Campylopus ericoides* (Griff.) A. Jaeger	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-
21.	*Campylopus flexuosus* (Hedw.) Brid.	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-
22.	*Campylopus schmidii* (Muell. Hal.) A. Jaeger	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-
23.	*Cephalozia pandei* Udar & D. Kumar	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-
24.	*Cheilolejeunea intertexta* (Lindenb.) Steph.	-	+	+	+	-	-	-	-	-	-	-	-	-	-	-
25.	*Cheilolejeunea serpentina* (Mitt.) Mizut.	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
26.	*Chiloscyphus polyanthos* (L.) Corda	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
27.	*Chionoloma tenuirostre* (Hook. & Taylor) M. Alonso, M.J. Cano & J.A. Jimenez	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
28.	*Chionostomum rostratum* (Griff.) Muell. Hal.	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
29.	*Clastobryopsis planula* (Mitt.) M. Fleisch.	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
30.	*Clastobryum wichurae* Dixon	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
31.	*Cololejeunea madothecoides* (Steph.) Benedix	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-
32.	*Cryptopapillaria fuscescens* (Hook.) M. Menzel	-	-	-	-	-	-	+	+	-	-	+	+	-	-	-
33.	*Cyathodium cavernarum* Kunze	+	+	+	+	+	+	+	+	+	-	-	-	-	-	-

34.	*Dicranella divaricata* (Mitt.) A. Jaeger	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
35.	*Dixonia orientalis* (Mitt.) H. Akiyama & H. Tsubota	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
36.	*Dumortiera hirsuta* (Sw.) Nees	-	-	-	-	+	+	+	+	+	+	+	+	-	-	-
37.	*Duthiella wallichii* (Mitt.) Muell. Hal.	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-
38.	*Ectropothecium rostellatum* (Mitt.) A. Jaeger	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-
39.	*Entodon laetus* (Griff.) A. Jaeger	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
40.	*Entodon nepalensis* Mizush.	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
41.	*Entodontopsis anceps* (Bosch &Sande Lac.) W.R. Buck & Ireland	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
42.	*Entodontopsis nitens* (Mitt.) W.R. Buck & Ireland	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
43.	*Entodontopsis wightii* (Mitt.) W.R. Buck & Ireland	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
44.	*Eurhynchium hians* (Hedw.) Sande Lac	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-
45.	*Fissidens asperisetus* Sande Lac.	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-
46.	*Fissidens crenulatus* Mitt.	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-
47.	*Fissidens crispulus*Brid.	-	-	+	-	-	-	-	-	+	-	-	-	-	-	-
48.	*Fissidens involutus* subsp. *curvatoinvolutus* (Dixon) Gangulee	-	-	+	-	-	-	-	-	-	-	-	+	-	-	-
49.	*Fissidens subfirmus* Dixon	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-
50.	*Fissidens subpulchellus* Nork.								+							
51.	*Floribundaria floribunda* (Dozy & Molk.) M. Fleisch.	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+

52.	*Floribundaria walkeri* (Renauld & Cardot) Broth.	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+
53.	*Foreauella orthothecia* (Schwagr.) Dixon & P. de la Varde	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
54.	*Fossombronia japonica* Schiffn.	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
55.	*Frullania gaudichaudii* (Nees & Mont.) Nees & Mont.	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
56.	*Frullania wallichiana* Mitt.	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-
57.	*Garckea flexuosa* (Griff.) Margad. & Nork.	+	+	+		+	-	-	-	-	-	-	-	-	-	-
58.	*Heteroscyphus argutus* (Reinw., Blume & Nees) Schiffn.	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+
59.	*Himantocladium plumula* (Nees) M. Fleisch.	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
60.	*Homaliodendron flabellatum* (Sm.) M. Fleisch.	-	-	-	+	+	+	+	-	-	-	-	-	-	-	-
61.	*Homaliodendron microdendron* (Mont.) M. Fleisch.	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
62.	*Hymenostylium recurvirostrum* (Hedw.) Dixon	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
63.	*Hyophila involuta* (Hook.) A. Jaeger	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
64.	*Isopterygium albescens* (Hook.) A. Jaeger	-	-	-	-	+	-	-	-	-	-	-	-	-	+	-
65.	*Isopterygium serrulatum* M. Fleisch.	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-
66.	*Jungermannia comata* Nees	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
67.	*Jungermannia rubripunctata* (S. Hatt.) Amakawa	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
68.	*Jungermannia truncate* Nees	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-

69.	*Lejeunea cavifolia* (Ehrh.) Lindb.	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-
70.	*Leucoloma amoene-virens* Mitt.	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-
71.	*Leucoloma taylorii* (Schwagr.) Mitt.	-	-	-	-	-	+	-	-	+	-	+	+	-	-	-
72.	*Leucophanes glaucum* (Schwagr.) Mitt.	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-
73.	*Lopholejeunea sikkimensis* Steph.	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
74.	*Lopholejeunea subfusca* (Nees) Schiffn.	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-
75.	*Macromitrium moorcroftii* (Hook. &Grev.) Schwagr.	-	-	-	-	-	-	-	-	+	-	-	-	+	-	-
76.	*Macromitrium sulcatum* (Hook.) Brid.	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-
77.	*Meiothecium jagorii* (Muell. Hal.) Broth.	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
78.	*Meteoriopsis reclinata* (Muell. Hal.) M. Fleisch.	-	-	-	-	-	-	+	+	+	-	-	-	+	-	-
79.	*Meteoriopsis squarrosa* (Hook. ex Harv.) M. Fleisch.	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+
80.	*Metzgeria pandei* S.C. Srivast. &Udar	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-
81.	*Myurium borii* (Dixon) Magill	-	-	-	-	-	-	-	-	+	-	-	+	-	-	-
82.	*Nardia assamica* (Mitt.) Amakawa	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
83.	*Neckeropsis andamana* (Muell. Hal.) M. Fleisch.	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-
84.	*Notoscyphus paroicus* Schiffn.	-	-	+	-	+	-	-	-	-	-	-	-	-	-	-
85.	*Notothylas levieri* Schiffn. Ex Steph.	+	+		+	-	-	-	-	-	-	-	-	-	-	-
86.	*Octoblepharum albidum* Hedw.	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-

87.	*Pallavicinia lyellii* (Hook.) Gray	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-
88.	*Pelekium velatum* Mitt.	-	-	-	+	-	-	+	-	-	-	-	-	-	-	-
89.	*Philonotis fontana* (Hedw.) Brid.	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
90.	*Philonotis hastata* (Duby) Wijk & Margad.	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
91.	*Philonotis mollis* (Dozy &Molk.) Mitt.	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
92.	*Philonotis secunda* (Dozy & Molk.) Bosch & Sande Lac.	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
93.	*Phyllodon bilobatus* (Dixon) P.E.A.S. Camara	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-
94.	*Phyllodon subretusus* (Thwaites & Mitt.) Ochyra & Ireland	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
95.	*Pinnatella alopecuroides* (Mitt.) M. Fleisch.	-	-	-	-	+	-	-	+	-	-	-	-	-	-	-
96.	*Pinnatella foreauana* Ther. & P. de la Varde	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-
97.	*Plagiochila fruticosa* Mitt.	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-
98.	*Plagiochila parvifolia* Lindenb.							+								
99.	*Plicanthus birmensis* (Steph.) R.M. Schust.	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-
100.	*Pogonatum patulum* (Harv.) Mitt.	-	-	+	+	+	+	-	-	+	-	-	-	-	-	-
101.	*Pterobryopsis acuminata* (Hook.) M. Fleisch.	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
102.	*Pterobryopsis flexipes* (Mitt.) M. Fleisch.	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-
103.	*Pterobryopsis gedehensis* M. Fleisch.	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-

104.	*Pterobryopsis orientalis* (Muell. Hal.) M. Fleisch.	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-
105.	*Radula japonica* Gottsche ex Steph.	-	-	-	-	-	-	-	-	+	-	+	-	-	-	-
106.	*Radula javanica* Gottsche	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-
107.	*Radula kurzii* Steph.	-	-	-	-	-	+	-	-	+	-	-	+	-	-	-
108.	*Rhaphidostegium confertissimum* (Mitt.) A. Jaeger	-	-	+	-	-	+	-	-	-	-	-	-	-	-	-
109.	*Rhaphidostichum glaucovirens* (Mitt.) Broth.	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
110.	*Rhynchostegiellahumillima* (Mitt.) Broth.	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
111.	*Riccardiamultifida* (L.) Gray	-	-	-	+	-	-	-	+	-	-	-	-	-	-	-
112.	*Riccardia tenuicostata* Schiffn.	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
113.	*Riccia huebeneriana* Lindenb.	-	-	-	+	-	-	-	-	+	-	-	-	-	-	-
114.	*Spruceanthus semirepandus* (Nees) Verd.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
115.	*Stereophyllum confusum* Ther.	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
116.	*Symphyodon orientalis* (Mitt.) Broth. ex Paris	-	-	-	-	-	-	-	-	-	-	-	+	-	-	--
117.	*Taxiphyllum giraldii* (Muell. Hal.) M. Fleisch.	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
118.	*Taxiphyllum isopterygioides* (Dixon) W.R. Buck	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
119.	*Taxiphyllum taxirameum* (Mitt.) M. Fleisch.	-	-	-	-	+	-	+	-	-	-	-	-	-	-	-
120.	*Taxithelium nepalense* (Schwagr.) Broth.	-	-	-	-	+	-	-	-	-	-	-	-	-	-	
121.	*Taxithelium vernieri* (Duby) Besch.	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
122.	*Thuidium cymbifolium* (Dozy & Molk.) Dozy & Molk.	-	-	-	-	-	-	-	-	+	-	-	+	-	-	-

123.	*Thuidium pristocalyx* (Muell. Hal.) A. Jaeger	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
124.	*Trichosteleum boschii* (Dozy & Molk.) A. Jaeger	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
125.	*Trichosteleum punctipapillosum* Paris ex Gangulee	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-
126.	*Vesicularia kurzii* (A. Jaeger) Broth.	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
127.	*Vesicularia montagnei* (Bel.) Broth.	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-
128.	*Vesicularia vesicularis* (Schwagr.) Broth.	-	-	-	-	-	-	-	-	+	-	-	-	-	-	--
129.	*Wijkia deflexifolia* (Mitt. ex Renauld & Cardot) H.A. Crum	-	-	+	-	-	-	-	+	-	-	-	-	-	-	-
130.	*Wijkia surcularis* (Mitt.) H.A. Crum	-	-	-	-	-	-	-	+	-	-	-	-	+	-	-

Vegetation and species distribution

The study area represents variety of vegetation such as West-coast Tropical evergreen forest, West-coast semi-evergreen forest, Southern moist deciduous forest and grasslands. Of these the area is mostly occupied by semi-evergreen forest and moist deciduous forest.

Evergreen forests: About 55 species are distributed in evergreen forests. *Entodon laetus* (Griff.) A. Jaeger, *Fissidens involutus* subsp. *curvatoinvolutus* (Dixon) Gangulee, *Macromitrium moorcroftii* (Hook. & Grev.) Schwagr., *Vesicularia montagnei* (Bel.) Broth., etc. are the commonly occuring species with wide distribution.

Semi evergreen forests: About 84 species are distributed in the semi evergreen forests. *Callicostella papillata* (Mont.) Mitt., *Philonotis fontana* (Hedw.) Brid., *Pinnatella foreauana* Ther. & P. de la Varde, *Rhaphidostichum glaucovirens* (Mitt.) Broth., *Taxiphyllum giraldii* (Muell. Hal.) M. Fleisch., *Wijkia surcularis* (Mitt.) H.A. Crum, etc. are commonly found in this area. Comparing all the vegetational type it is seen that semi evergreen forests is with maximum diversity of bryophytes.

Moist deciduous forests: Among the 130 species about 42 species occur in moist deciduous forests. *Calymperes afzelii* Sw., *Calyptothecium wightii* (Mitt.) M. Fleisch., *Phyllodon bilobatus* (Dixon) P.E.A.S. Camara, *Jungermannia rubripunctata* (S. Hatt.) Amakawa, etc. are commonly occurring species in this area.

Grasslands: Grassland occupies only a very few species. Among the 130 species only eight species occur here. *Bryum wightii* Mitt., *Calyptothecium wightii* (Mitt.) M. Fleisch., *Campylopus ericoides* (Griff.) A. Jaeger and *Spruceanthus semirepandus* (Nees) Verd., are distributed in grasslands.

Some species are found in all kinds of vegetation. This may be due to the species richness or adaptability of species. The diversity of species in different vegetation are represented in Table: 2 & Figure 5.2.

Fig. 5.2. Vegetation and species distribution

(E. Evergreen forests, S. Semi evergreen forests, M. Moist deciduous forests, G. Grasslands**)**

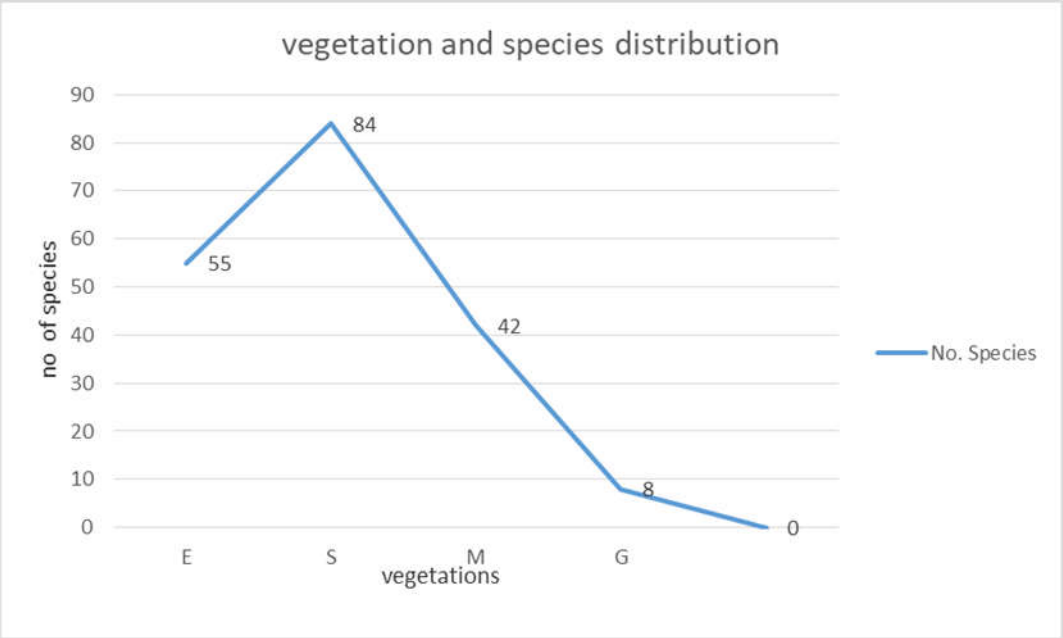


Table 2. Vegetation and species distribution

Sl. No	Species	Evergreen forest	Semi-evergreen forest	Moist deciduous forest	Grassland
1.	*Acroporium stramineum* (Reinw. & Hornsch.) M. Fleisch.	-	+	-	-
2.	*Acroporium strepsiphyllum* (Mont.) B.C. Tan	-	+	-	-
3.	*Actinodontium rhaphidostegum* (Muell. Hal.) Bosch & Sande Lac.	+	+	-	-
4.	*Aerobryopsis longissima* (Dozy & Molk.) M. Fleisch.	-	+	+	-
5.	*Aerobryum speciosum* Dozy &Molk.	+	+	+	-
6.	*Anomobryum auratum* (Mitt.) A. Jaeger	+	+	-	-
7.	*Anthoceros crispulus* (Mont.) Douin	-	-	+	-

8.	*Aptychella speciosa* (Mitt.) Tixier	+	-	-	-
9.	*Barbula indica* (Hook.) Spreng.	-	-	+	-
10.	*Bryocrumia* sp. nov.	+	-	-	-
11.	*Bryocrumia vivicolor* (Broth. & Dixon) W.R. Buck	+	-	-	-
12.	*Bryum cellulare* Hook.	-	+	-	-
13.	*Bryum coronatum* Schwagr.	-	+	-	-
14.	*Bryum wightii* Mitt.	+	+	-	+
15.	*Callicostella papillata* (Mont.) Mitt.	-	+	-	-
16.	*Calymperes afzelii* Sw.	-	-	+	-
17.	*Calymperes erosum* Muell. Hal.	+	+	-	-
18.	*Calymperes linguatum* Muell. Hal. exBesch.	-	+	-	-
19.	*Calyptothecium wightii* (Mitt.) M. Fleisch.	-	-	-	+
20.	*Campylopus ericoides* (Griff.) A. Jaeger	+	-	-	+
21.	*Campylopus flexuosus* (Hedw.) Brid.	-	+	+	-
22.	*Campylopus schmidii* (Muell. Hal.) A. Jaeger	-	+	-	-
23.	*Cephalozia pandei* Udar & D. Kumar	-	-	+	-
24.	*Cheilolejeunea intertexta* (Lindenb.) Steph.	-	+	+	-
25.	*Cheilolejeunea serpentina* (Mitt.) Mizut.	+	-	+	-
26.	*Chiloscyphus polyanthos* (L.) Corda	+	+	-	-
27.	*Chionoloma tenuirostre* (Hook. & Taylor) M. Alonso, M.J. Cano & J.A. Jimenez	-	+	-	-
28.	*Chionostomum rostratum* (Griff.) Muell. Hal.	-	+	-	+
29.	*Clastobryopsis planula* (Mitt.) M. Fleisch.	-	+	-	-
30.	*Clastobryum wichurae* Dixon	+	-	+	-
31.	*Cololejeunea madothecoides* (Steph.) Benedix	-	-	+	-
32.	*Cryptopapillaria fuscescens* (Hook.) M. Menzel	+	+	+	-

33.	*Cyathodium cavernarum* Kunze	-	+	+	-
34.	*Dicranella divaricata* (Mitt.) A. Jaeger	+	-	-	-
35.	*Dixonia orientalis* (Mitt.) H. Akiyama & H. Tsubota	-	+	-	-
36.	*Dumortiera hirsuta* (Sw.) Nees	+	+	-	-
37.	*Duthiella wallichii* (Mitt.) Muell. Hal.	-	+	-	-
38.	*Ectropothecium rostellatum* (Mitt.) A. Jaeger	-	+	-	-
39.	*Entodon laetus* (Griff.) A. Jaeger	+	-	-	-
40.	*Entodon nepalensis* Mizush.	-	+	-	-
41.	*Entodontopsis anceps* (Bosch &Sande Lac.) W.R. Buck & Ireland	-	+	-	-
42.	*Entodontopsis nitens* (Mitt.) W.R. Buck & Ireland	-	+	-	-
43.	*Entodontopsis wightii* (Mitt.) W.R. Buck & Ireland	-	+	+	-
44.	*Eurhynchium hians* (Hedw.) Sande Lac	+	+	-	-
45.	*Fissidens asperisetus* Sande Lac.	+	+	-	-
46.	*Fissidens crenulatus* Mitt.	-	-	+	-
47.	*Fissidens crispulus*Brid.	-	+	-	-
48.	*Fissidens involutus* subsp. *curvatoinvolutus* (Dixon) Gangulee	+	-	-	-
49.	*Fissidens subfirmus* Dixon	-	+	+	-
50.	*Fissidens subpulchellus* Nork.	-	+	-	-
51.	*Floribundaria floribunda* (Dozy & Molk.) M. Fleisch.	+	+	+	-
52.	*Floribundaria walkeri* (Renauld & Cardot) Broth.	+	+	-	-
53.	*Foreauella orthothecia* (Schwagr.) Dixon & P. de la Varde	-	+	-	-
54.	*Fossombronia japonica* Schiffn.	-	-	+	-
55.	*Frullania gaudichaudii* (Nees & Mont.) Nees & Mont.	+	-	-	-
56.	*Frullania wallichiana* Mitt.	+	-	-	-

57.	*Garckea flexuosa* (Griff.) Margad. & Nork.	+	+	-	-
58.	*Heteroscyphus argutus* (Reinw., Blume & Nees) Schiffn.	+	+	+	-
59.	*Himantocladium plumula* (Nees) M. Fleisch.	-	+	-	-
60.	*Homaliodendron flabellatum* (Sm.) M. Fleisch.	+	+	+	+
61.	*Homaliodendron microdendron* (Mont.) M. Fleisch.	-	-	+	-
62.	*Hymenostylium recurvirostrum* (Hedw.) Dixon	-	+	-	-
63.	*Hyophila involuta* (Hook.) A. Jaeger	-	+	+	-
64.	*Isopterygium albescens* (Hook.) A. Jaeger	-	+	-	-
65.	*Isopterygium serrulatum* M. Fleisch.	-	+	-	-
66.	*Jungermannia comata* Nees	-	+	-	-
67.	*Jungermannia rubripunctata* (S. Hatt.) Amakawa	-		+	-
68.	*Jungermannia truncata*Nees	-	+	-	-
69.	*Lejeunea cavifolia* (Ehrh.) Lindb.	-	+	-	-
70.	*Leucoloma amoene-virens* Mitt.	+	+	-	-
71.	*Leucoloma taylorii* (Schwagr.) Mitt.	+	+	+	-
72.	*Leucophanes glaucum* (Schwagr.) Mitt.	-	-	+	-
73.	*Lopholejeunea sikkimensis* Steph.	+	-	-	-
74.	*Lopholejeunea subfusca* (Nees) Schiffn.	-	+	-	-
75.	*Macromitrium moorcroftii* (Hook. &Grev.) Schwagr.	+	-	-	+
76.	*Macromitrium sulcatum* (Hook.) Brid.	+	+	-	-
77.	*Meiothecium jagorii* (Muell. Hal.) Broth.	-	-	+	-
78.	*Meteoriopsis reclinata* (Muell. Hal.) M. Fleisch.	+	+	+	-
79.	*Meteoriopsis squarrosa* (Hook. ex Harv.) M. Fleisch.	+	+	+	-

80.	*Metzgeria pandei* S.C. Srivast. &Udar	-	+	-	-
81.	*Myurium borii* (Dixon) Magill	+	+	-	-
82.	*Nardia assamica* (Mitt.) Amakawa	+	-	-	-
83.	*Neckeropsis andamana* (Muell. Hal.) M. Fleisch.	-	+	+	-
84.	*Notoscyphus paroicus* Schiffn.	-	-	+	-
85.	*Notothylas levieri* Schiffn. Ex Steph.	-	-	+	-
86.	*Octoblepharum albidum* Hedw.	-	+	+	-
87.	*Pallavicinia lyellii* (Hook.) Gray	+	+	-	-
88.	*Pelekium velatum* Mitt.	+	+	-	-
89.	*Philonotis fontana* (Hedw.) Brid.	-	+	-	-
90.	*Philonotis hastata* (Duby) Wijk & Margad.	+	+	-	+
91.	*Philonotis mollis* (Dozy &Molk.) Mitt.	-	-	+	-
92.	*Philonotis secunda* (Dozy & Molk.) Bosch & Sande Lac.	+	-	-	-
93.	*Phyllodon bilobatus* (Dixon) P.E.A.S. Camara	-	-	+	-
94.	*Phyllodon subretusus* (Thwaites & Mitt.) Ochyra & Ireland	+	-	-	-
95.	*Pinnatella alopecuroides* (Mitt.) M. Fleisch.	-	+	+	-
96.	*Pinnatella foreauana* Ther. & P. de la Varde	-	+	-	-
97.	*Plagiochila fruticosa* Mitt.	+	-	-	-
98.	*Plagiochila parvifolia* Lindenb.	+	-	-	-
99.	*Plicanthus birmensis* (Steph.) R.M. Schust.	+	-	-	-
100.	*Pogonatum patulum* (Harv.) Mitt.	-	+	+	-
101.	*Pterobryopsis acuminata* (Hook.) M. Fleisch.	-	+	-	-
102.	*Pterobryopsis flexipes* (Mitt.) M. Fleisch.	-	-	+	-
103.	*Pterobryopsis gedehensis* M. Fleisch.	-	+	-	-
104.	*Pterobryopsis orientalis* (Muell. Hal.) M. Fleisch.	+	-	+	-
105.	*Radula japonica* Gottsche ex Steph.	+	-	-	-

106.	*Radula javanica* Gottsche	+	-	-	-
107.	*Radula kurzii* Steph.	+	+	-	-
108.	*Rhaphidostegium confertissimum* (Mitt.) A. Jaeger	-	-	+	-
109.	*Rhaphidostichum glaucovirens* (Mitt.) Broth.	-	+	-	-
110.	*Rhynchostegiellahumillima* (Mitt.) Broth.	-	+	-	-
111.	*Riccardiamultifida* (L.) Gray	+	+	-	-
112.	*Riccardia tenuicostata* Schiffn.	-	+	+	-
113.	*Riccia huebeneriana* Lindenb.	+	+	-	-
114.	*Spruceanthus semirepandus* (Nees) Verd.	-	-	-	+
115.	*Stereophyllum confusum* Ther.	+	-	-	-
116.	*Symphyodon orientalis* (Mitt.) Broth. ex Paris	+	-	-	-
117.	*Taxiphyllum giraldii* (Muell. Hal.) M. Fleisch.	-	+	-	-
118.	*Taxiphyllum isopterygioides* (Dixon) W.R. Buck	+	-	-	-
119.	*Taxiphyllum taxirameum* (Mitt.) M. Fleisch.	-	-	+	-
120.	*Taxithelium nepalense* (Schwagr.) Broth.	+	+	-	-
121.	*Taxithelium vernieri* (Duby) Besch.	-	+	-	-
122.	*Thuidium cymbifolium* (Dozy & Molk.) Dozy & Molk.	+	+	-	-
123.	*Thuidium pristocalyx* (Muell. Hal.) A. Jaeger	-	+	-	-
124.	*Trichosteleum boschii* (Dozy & Molk.) A. Jaeger	-	+	-	-
125.	*Trichosteleum punctipapillosum* Paris ex Gangulee	-	+	-	-
126.	*Vesicularia kurzii* (A. Jaeger) Broth.	-	+	-	-
127.	*Vesicularia montagnei* (Bel.) Broth.	+	-	-	-
128.	*Vesicularia vesicularis* (Schwagr.) Broth.	-	+	-	-
129.	*Wijkia deflexifolia* (Mitt. ex Renauld & Cardot) H.A. Crum	-	+	+	-
130.	*Wijkia surcularis* (Mitt.) H.A. Crum	-	+	-	-

Habitat and species distribution

Bryophytes in the study area are mainly found in epiphytic and terrestrial habitats. Epiphytic species are found on bark, logs, exposed rhizomes of ferns, epiphyllous, etc. and terrestrial species are found on rocks, soils and concrete walls. From the study area a total 86 species are found in epiphytic habitats and 79 species are found in terrestrial habitats. Table 3 shows the habitat and species distribution.

a. Epiphytes: Epiphytic species are abundant in the sanctuary. Based on the species occurrence epiphytic habitat is devided into base of tree trunk, middle part of bark of trees, upper part of bark, branches and twigs. The species diversity more seen on trees especially on branches. Of the 130 species studied 86 species prefer epiphytic habitat. Epiphytic species are found on Base of tree trunk, upper part of trunk, branches & twigs, logs, on leaf surface and on exposed ferns' rhizomes.

Base of tree trunk: A total of seven species grow on base of tree trunk like *Calymperes erosum* Muell. Hal., *Leucoloma taylorii* (Schwagr.) Mitt., *Leucophanes glaucum* (Schwagr.) Mitt., *Lopholejeuneasubfusca* (Nees) Schiffn., *Phyllodon bilobatus* (Dixon) P.E.A.S. Camara, etc. Among these *Leucoloma taylorii* and *Calymperes erosum* are grows on upper part of trunk also.

Upper part of Trunk: A total of 27 species are distributed in upper part of trunk. Some species prefer to grow on the upper part of trunk only such as *Acroporium stramineum* (Reinw. & Hornsch.) M. Fleisch., *Calymperes linguatum* Muell. Hal. ex Besch., *Callicostella papillata* (Mont.) Mitt., *Chionostomum rostratum* (Griff.) Muell. Hal., *Himantocladium plumula* (Nees) M. Fleisch., *Homaliodendron flabellatum* (Sm.) M. Fleisch. (Plate: 5.122). But some species which are extended to branches also.

On branches & Twigs: A total of 41 species are found on branches and twigs. The species diversity on the branches and small twigs also varies. The species mostly hang from the branches and twigs were the availability of light is very high (Plate: 5.123). The species like *Aerobryopsis longissima* (Dozy & Molk.) M. Fleisch., *Aerobryum speciosum* Dozy & Molk., *Cryptopapillaria fuscescens* (Hook.) M.

Menzel, *Floribundaria floribunda* (Dozy & Molk.) M. Fleisch., *Frullania gaudichaudii* (Nees & Mont.) Nees & Mont. *Meteriopsis squarrosa* (Hook. ex Harv.) M. Fleisch. *Meteriopsis reclinata* (Muell. Hal.) M. Fleisch. etc. are very common.

Log: Log or dead branches harbour a good number of species such as *Macromitrium sulcatum* (Hook.) Brid., (Plate 5.124a) *Phyllodon bilobatus* (Dixon) P.E.A.S. Camara, *Metzgeria pandei* S.C. Srivast. & Udar *Taxithelium vernieri* (Duby) Besch., etc.

Epiphyllous: Leaves of trees and shrubs provide microhabitats for some species like *Aerobryopsis longissima* (Dozy & Molk.) M. Fleisch., *Cololejeunea madothecoides* (Steph.) Benedix and *Lejeunea cavifolia* (Ehrh.) Lindb (Plate 5.124 d&e).

On Ferns' rhizomes: Exposed rhizomes of ferns' make habitat for species like *Pallavicinia lyellii* (Hook.) Gray, *Riccardia tenuicostata* Schiffn. and *Isopterygium albescens* (Hook.) A. Jaeger.

b.Terrestrial

Of the 130 species 79 species prefer terrestrial habitat. Terrestrial habitats of bryophyte include rocks (lithophytes), land cuttings and concrete walls, etc.

On large rocks and stones: Rocks near streams and waterfalls are rich in bryodiversity. Species such as *Anomobryum auratum* (Mitt.) A. Jaeger, *Campylopus ericoides* (Griff.) A. Jaeger, *Calyptothecium wightii* (Mitt.) M. Fleisch., *Dixonia orientalis* (Mitt.) H. Akiyama & H. Tsubota, *Myurium borii* (Dixon) Magill, etc. make rocks for their habitat. (Plate: 5.125)

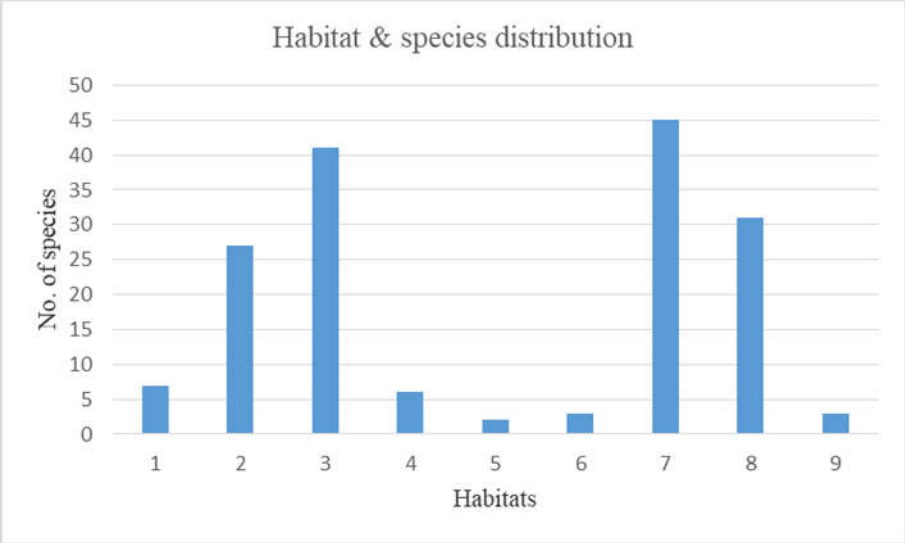
On land cuttings: Bryophytes are found in land cuttings with high moisture content under the shady areas. Forest floor also make ideal habitat for terrestrial species which prefer soil. Species like *Acroporium strepsiphyllum* (Mont.) B.C. Tan, *Chiloscyphys polyanthus* (L.) Corda, *Garckea flexuosa* (Griff.) Margad. & Nork. (Plate: 5.124.c), *Nardia assamica*, (Mitt.) Amakawa, *Pogonatum patulum* (Harv.) Mitt. (Plate: 5.124.b), etc. are found on soil.

On concrete walls: Humus in the concrete walls makes ideal growth of species like

Cyathodium cavernarum Kunze and *Hyophila involuta* (Hook.) A. Jaeger.

Same species prefer to grow in different microhabitats due to the species richness and adaptability of species to grow in different kinds of habitats. The distribution of species in different habitat is represented in Table 3. & Fig. 5.3.

Fig. 5.3. Habitat and species distribution



Legend: 1.Base of tree trunk, 2. Upper part of tree trunk, 3. Branches & twigs, 4. Logs, 5. Epiphyllous, 6. Ferns' rhizomes, 7. Large rocks & stones, 8. Land cuttings, 9. Concrete walls

Table 3. Habitat and species distribution

Sl.No.	Species	Epiphytes						Terrestrial		
		Base of tree trunk	Upper part of tree trunk	Branches & twigs	Logs	Epiphyllous(on leaf)	Ferns' rhizoime	Rock	Soil	Concre-te wall
1.	*Acroporium stramineum* (Reinw. & Hornsch.) M. Fleisch.	-	+	-	+	-	-	-	-	-
2.	*Acroporium strepsiphyllum* (Mont.) B.C. Tan	-	-	-	-	-	-	-	+	-
3.	*Actinodontium rhaphidostegum* (Muell. Hal.) Bosch & Sande Lac.	-	-	+	-	-	-	-	-	-
4.	*Aerobryopsis longissima* (Dozy & Molk.) M. Fleisch.	-	-	+	-	+	-	-	-	-
5.	*Aerobryum speciosum* Dozy &Molk.	-	-	+	-	-	-	-	-	-
6.	*Anomobryum auratum* (Mitt.) A. Jaeger	-	-	-	-	-	-	+	+	-
7.	*Anthoceros crispulus* (Mont.) Douin	-	-	-	-	-	-	+	-	-
8.	*Aptychella speciosa* (Mitt.) Tixier	-	-	+	-	-	-	-	-	-
9.	*Barbula indica* (Hook.) Spreng.	-	-	-	-	-	-	+	-	-
10.	*Bryocrumia* sp. nov.	-	-	-	-	-	-	+	-	-
11.	*Bryocrumia vivicolor* (Broth. & Dixon) W.R. Buck	-	-	-	-	-	-	+	-	-
12.	*Bryum cellulare* Hook.	-	-	-	-	-	-	+	+	-
13.	*Bryum coronatum* Schwagr.	-	-	-	-	-	-	+	-	-
14.	*Bryum wightii* Mitt.	-	-	-	-	-	-	+	-	-

15.	*Callicostella papillata* (Mont.) Mitt.	-	+	-	-	-	-	-	-	-
16.	*Calymperes afzelii* Sw.	-	-	-	+	-	-	-	-	-
17.	*Calymperes erosum* Muell. Hal.	+	+	-	-	-	-	-	-	-
18.	*Calymperes linguatum* Muell. Hal. exBesch.	-	+	-	-	-	-	+	-	-
19.	*Calyptothecium wightii* (Mitt.) M. Fleisch.	-	-	+	-	-	-	+	-	-
20.	*Campylopus ericoides* (Griff.) A. Jaeger	-	-	-	-	-	-	+	-	-
21.	*Campylopus flexuosus* (Hedw.) Brid.	-	-	-	-	-	-	+	-	-
22.	*Campylopus schmidii* (Muell. Hal.) A. Jaeger	-	-	-	-	-	-	+	-	-
23.	*Cephalozia pandei* Udar & D. Kumar	-	-	-	-	-	-	+	+	-
24.	*Cheilolejeunea intertexta* (Lindenb.) Steph.	-	-	-	-	-	-	+	-	-
25.	*Cheilolejeunea serpentina* (Mitt.) Mizut.	-	-	+	-	-	-	-	-	-
26.	*Chiloscyphus polyanthos* (L.) Corda	-	-	-	-	-	-	-	+	-
27.	*Chionoloma tenuirostre* (Hook. & Taylor) M. Alonso, M.J. Cano & J.A. Jimenez	-	-	-	-	-	-	+	-	-
28.	*Chionostomum rostratum* (Griff.) Muell. Hal.	-	+	-	-	-	-	-	-	-
29.	*Clastobryopsis planula* (Mitt.) M. Fleisch.	-	-	+	-	-	-	-	-	-
30.	*Clastobryum wichurae* Dixon	-	-	+	-	-	-	-	-	-

31.	*Cololejeunea madothecoides* (Steph.) Benedix	-	+	-	-	+	-	-	-	-
32.	*Cryptopapillaria fuscescens* (Hook.) M. Menzel	-	+	+	-	-	-	-	-	-
33.	*Cyathodium cavernarum* Kunze	-	+	-	-	-	-	+	+	+
34.	*Dicranella divaricata* (Mitt.) A. Jaeger	-	-	-	-	-	-	-	+	-
35.	*Dixonia orientalis* (Mitt.) H. Akiyama & H. Tsubota	-	-	-	-	-	-	+	-	-
36.	*Dumortiera hirsuta* (Sw.) Nees	-	-	-	-	-	-	+	+	-
37.	*Duthiella wallichii* (Mitt.) Muell. Hal.	-	-	+	-	-	-	-	-	-
38.	*Ectropothecium rostellatum* (Mitt.) A. Jaeger	-	-	+	-	-	-	-	-	-
39.	*Entodon laetus* (Griff.) A. Jaeger	-	-	-	-	-	-	+	-	-
40.	*Entodon nepalensis* Mizush.	-	+	-	-	-	-	+	-	-
41.	*Entodontopsis anceps* (Bosch &Sande Lac.) W.R. Buck & Ireland	-	-	+	-	-	-	-	-	-
42.	*Entodontopsis nitens* (Mitt.) W.R. Buck & Ireland	-	-	-	-	-	-	+	-	-
43.	*Entodontopsis wightii* (Mitt.) W.R. Buck & Ireland	-	+	-	-	-	-	-	-	-
44.	*Eurhynchium hians* (Hedw.) Sande Lac	-	-	-	-	-	-	+	-	-
45.	*Fissidens asperisetus* Sande Lac.	-	-	-	-	-	-	+	+	-
46.	*Fissidens crenulatus* Mitt.	-	-	-	-	-	-	-	+	-
47.	*Fissidens crispulus*Brid.	-	-	-	-	-	-	-	+	-

48.	*Fissidens involutus* subsp. *curvatoinvolutus* (Dixon) Gangulee	-	-	-	-	-	-	+	+	-
49.	*Fissidens subfirmus* Dixon	-	+	-	-	-	-	-	-	-
50.	*Fissidens subpulchellus* Nork.	-	-	-	-	-	-	-	+	-
51.	*Floribundaria floribunda* (Dozy & Molk.) M. Fleisch.	-	-	+	-	-	-	-	-	-
52.	*Floribundaria walkeri* (Renauld & Cardot) Broth.	-	-	+	-	-	-	-	-	-
53.	*Foreauella orthothecia* (Schwagr.) Dixon & P. de la Varde	-	-	+	-	-	-	-	-	-
54.	*Fossombronia japonica* Schiffn.	-	-	-	-	-	-	-	+	-
55.	*Frullania gaudichaudii* (Nees & Mont.) Nees & Mont.	-	-	+	-	-	-	-	-	-
56.	*Frullania wallichiana* Mitt.	-	-	+	-	-	-	-	-	-
57.	*Garckea flexuosa* (Griff.) Margad. & Nork.	-	-	-	-	-	-	-	+	-
58.	*Heteroscyphus argutus* (Reinw., Blume & Nees) Schiffn.	-	+	-	-	-	-	+	+	-
59.	*Himantocladium plumula* (Nees) M. Fleisch.	-	+	-	-	-	-	-	-	-
60.	*Homaliodendron flabellatum* (Sm.) M. Fleisch.	-	+	-	-	-	-	-	-	-
61.	*Homaliodendron microdendron* (Mont.) M. Fleisch.	-	+	-	-	-	-	-	-	-
62.	*Hymenostylium recurvirostrum* (Hedw.) Dixon	-	-	-	-	-	-	+	-	-

63.	*Hyophila involuta* (Hook.) A. Jaeger	-	-	-	-	-	-	+	+	+
64.	*Isopterygium albescens* (Hook.) A. Jaeger	-	-	-	+	-	+	-	-	-
65.	*Isopterygium serrulatum* M. Fleisch.	-	-	+	-	-	-	-	-	-
66.	*Jungermannia comata* Nees	-	-	-	-	-	-	+	+	-
67.	*Jungermannia rubripunctata* (S. Hatt.) Amakawa	-	-	-	-	-	-	-	+	-
68.	*Jungermannia truncate* Nees	-	-	-	-	-	-	-	+	-
69.	*Lejeunea cavifolia* (Ehrh.) Lindb.	-	-	-	-	-	-	-	-	+
70.	*Leucoloma amoene-virens* Mitt.	-	+	-	-	-	-	-	-	-
71.	*Leucoloma taylorii* (Schwagr.) Mitt.	+	+	-	-	-	-	-	-	-
72.	*Leucophanes glaucum* (Schwagr.) Mitt.	+	-	-	-	-	-	-	-	-
73.	*Lopholejeunea sikkimensis* Steph.	-	+	-	-	-	-	-	-	-
74.	*Lopholejeunea subfusca* (Nees) Schiffn.	+	-	+	-	-	-	-	-	-
75.	*Macromitrium moorcroftii* (Hook. &Grev.) Schwagr.	-	-	+	-	-	-	-	-	-
76.	*Macromitrium sulcatum* (Hook.) Brid.	-	-	+	-	-	-	-	-	-
77.	*Meiothecium jagorii* (Muell. Hal.) Broth.	-	-	+	-	-	-	-	-	-
78.	*Meteoriopsis reclinata* (Muell. Hal.) M. Fleisch.	-	-	+	-	-	-	-	-	-

79.	*Meteoriopsis squarrosa* (Hook. ex Harv.) M. Fleisch.	-	-	+	-	-	-	-	-	-
80.	*Metzgeria pandei* S.C. Srivast. &Udar	-	-	-	+	-	-	-	-	-
81.	*Myurium borii* (Dixon) Magill	-	-	+	-	-	-	+	-	-
82.	*Nardia assamica* (Mitt.) Amakawa	-	-	-	-	-	-	-	+	-
83.	*Neckeropsis andamana* (Muell. Hal.) M. Fleisch.	-	+	-	-	-	-	-	-	-
84.	*Notoscyphus paroicus* Schiffn.	-	-	-	-	-	-	-	+	-
85.	*Notothylas levieri* Schiffn. Ex Steph.	-	-	-	-	-	-	-	+	-
86.	*Octoblepharum albidum* Hedw.	-	+	-	-	-	-	-	-	-
87.	*Pallavicinia lyellii* (Hook.) Gray	-	-	-	-	-	+	+	+	-
88.	*Pelekium velatum* Mitt.	-	-	-	-	-	-	-	+	-
89.	*Philonotis fontana* (Hedw.) Brid.	-	-	-	-	-	-	-	+	-
90.	*Philonotis hastata* (Duby) Wijk & Margad.	-	-	-	-	-	-	+	+	-
91.	*Philonotis mollis* (Dozy &Molk.) Mitt.	-	-	-	-	-	-	-	+	-
92.	*Philonotis secunda* (Dozy & Molk.) Bosch & Sande Lac.	-	-	-	-	-	-	+	-	-
93.	*Phyllodon bilobatus* (Dixon) P.E.A.S. Camara	+	-	-	-	-	-	-	+	-
94.	*Phyllodon subretusus* (Thwaites & Mitt.) Ochyra & Ireland	-	-	-	-	-	-	+	-	-
95.	*Pinnatella alopecuroides* (Mitt.) M. Fleisch.	-	-	+	-	-	-	-	-	-
96.	*Pinnatella foreauana* Ther. &	-	+	-	-	-	-	-	-	-

	P. de la Varde									
97.	*Plagiochila fruticosa* Mitt.	-	-	+	-	-	-	-	-	-
98.	*Plagiochila parvifolia* Lindenb.	-	+	-	-	-	-	-	-	-
99.	*Plicanthus birmensis* (Steph.) R.M. Schust.	-	-	+	-	-	-	-	-	-
100.	*Pogonatum patulum* (Harv.) Mitt.	-	-	-	-	-	-	-	+	-
101.	*Pterobryopsis acuminata* (Hook.) M. Fleisch.	-	-	+	-	-	-	-	-	-
102.	*Pterobryopsis flexipes* (Mitt.) M. Fleisch.	-	-	+	-	-	-	-	-	-
103.	*Pterobryopsis gedehensis* M. Fleisch.	-	-	+	-	-	-	-	-	-
104.	*Pterobryopsis orientalis* (Muell. Hal.) M. Fleisch.	-	-	+	-	-	-	-	-	-
105.	*Radula japonica* Gottsche ex Steph.	-	-	+	-	-	-	+	-	-
106.	*Radula javanica* Gottsche	-	-	+	-	-	-	-	-	-
107.	*Radula kurzii* Steph.	-	-	-	-	-	-	+	-	-
108.	*Rhaphidostegium confertissimum* (Mitt.) A. Jaeger	-	+	+	-	-	-	-	-	-
109.	*Rhaphidostichum glaucovirens* (Mitt.) Broth.	-	-	+	-	-	-	-	-	-
110.	*Rhynchostegiellahumillima* (Mitt.) Broth.	-	-	+	-	-	-	-	-	-
111.	*Riccardiamultifida* (L.) Gray	-	-	-	-	-	-	+	-	-
112.	*Riccardia tenuicostata* Schiffn.	-	-	-	-	-	+	+	-	-
113.	*Riccia huebeneriana* Lindenb.	-	-	-	-	-	-	-	+	-
114.	*Spruceanthus semirepandus* (Nees) Verd.	-	-	+	-	-	-	-	-	-
115.	*Stereophyllum confusum* Ther.	-	+	-	-	-	-	-	-	-

116.	*Symphyodon orientalis* (Mitt.) Broth. ex Paris	-	-	+	-	-	-	-	-	-
117.	*Taxiphyllum giraldii* (Muell. Hal.) M. Fleisch.	-	-	-	-	-	-	+	-	-
118.	*Taxiphyllum isopterygioides* (Dixon) W.R. Buck	-	-	-	-	-	-	+	-	-
119.	*Taxiphyllum taxirameum* (Mitt.) M. Fleisch.	-	-	-	+	-	-	-	-	-
120.	*Taxithelium nepalense* (Schwagr.) Broth.	+	-	-	-	-	-	-	-	-
121.	*Taxithelium vernieri* (Duby) Besch.	+	-	-	+	-	-		-	-
122.	*Thuidium cymbifolium* (Dozy & Molk.) Dozy & Molk.	-	-	-	-	-	-	+	-	-
123.	*Thuidium pristocalyx* (Muell. Hal.) A. Jaeger		-	-	-	-	-	+	-	-
124.	*Trichosteleum boschii* (Dozy & Molk.) A. Jaeger	-	+	-	-	-	-	-	-	-
125.	*Trichosteleum punctipapillosum* Paris ex Gangulee	-	+	-	-	-	-	-	-	-
126.	*Vesicularia kurzii* (A. Jaeger) Broth.	-	-	-	-	-	-	+	-	-
127.	*Vesicularia montagnei* (Bel.) Broth.	-	-	-	-	-	-	+	-	-
128.	*Vesicularia vesicularis* (Schwagr.) Broth.	-	-	-	-	-	-	+	-	-
129.	*Wijkia deflexifolia* (Mitt. ex Renauld & Cardot) H.A. Crum	-	+	+	-	-	-	-	-	-
130.	*Wijkia surcularis* (Mitt.) H.A. Crum	-	-	+	-	-	-	-	-	-

Ex-situ conservation of Bryophytes of MWLS in MBGIPS

Ex- situ conservation aims the preservation of species diversity and sharing the knowledge. It is highly significant now a days because of the threats due to global warming, climate change, anthropogenic activities there by habitat destruction and loss of species diversity. Bryophytes conservation seeks less attention in India, this may be due to the lack of knowledge about the significance and species diversity. In India some efforts are made by The National Botanical Research Institite (NBRI), Lucknow, Jawaharlal Nehru Tropical Botanical Garden & Research Institute (JnTBGRI) and Gurukula Botanical Sanctuary (GBS), Periya were made effort to establish Bryophytes in their gardens.

Ecological adaptability of species and occurrence of rare species call for conservation. Ex-situ conservation of bryophytes done by providing suitable microhabitat. It minimise the collection from wild/forest and helps to further studies such as seasonal variations, reproduction, association of species, etc. It educates the teachers and students by providing basic information about the bryodiversity.

Bryophytes seen in a variety of habitat and most of the species are specific in their habitat. Loss of habitat should seriously affect the diversity of species. Out of the 130 species collected from the study area, 34 species are successfully established in the Malabar Botanical Garden and Institute for Plant Sciences' lower group plant conservatory by providing suitable micro habitat and automated fog system. Automated fog system make atmosphere cool and lower the temperature. This is essential because most of the bryophytes survive in high humid conditions.

Specimens were collected along with its' substratum from different microhabitat of the study area planted in MBGIPS' conservatory. Epiphytic species were tied on logs or on coconut husk with coir. Terrestrial species were kept on round bonsai pots filled with mixture of soil, coconut fibre and cow dung. Saxicolous species were kept on rocks. (Plate:5.126 & 5.127).

Easily and quickly established species are *Cyathodium cavernarum* Kunze, *Dumortiera hirsuta* (Sw.) Nees, *Heteroscyphus argutus* (Reinw., Blume & Nees)

Schiffn., *Pallavicinia lyellii* (Hook.) Gray, *Pogonatum patulum* (Harv.) Mitt., *Riccardia multifida* (L.) Gray, *Riccardia tenuicostata* Schiffn., etc. Liverworts are growing widely than mosses. Total 34 species were successfully established in conservatory, others are difficult to thrive. This may be due to the difference in vegetation, altitude, etc. List of species in conservatory are represented in Table 4.

Table: 4. Bryophytes Growing at MBGIPS Conservatory

Sl. No	Species	Family
1.	*Anomobryum auratum* (Mitt.) A. Jaeger	Bryaceae
2.	*Anthoceros crispulus* (Mont.) Douin	Anthocerotaceae
3.	*Bryum coronatum*Schwagr.	Bryaceae
4.	*Bryum wightii* Mitt.	Bryaceae
5.	*Calymperes erosum* Muell. Hal.	Calymperaceae
6.	*Campylopus flexuosus* (Hedw.) Brid.	Leucobryaceae
7.	*Cryptopapillaria fuscescens* (Hook.) M. Menzel	Meteoriaceae
8.	*Cyathodium cavernarum* Kunze	Cyathodiaceae
9.	*Dumortiera hirsuta* (Sw.) Nees	Dumortieraceae
10.	*Fissidens crispulus*Brid.	Fissidentaceae
11.	*Floribundaria walkeri* (Renauld & Cardot) Broth.	Meteoriaceae-
12.	*Foreauella orthothecia* (Schwagr.) Dixon & P. de la Varde	Hypnaceae
13.	*Garckea flexuosa* (Griff.) Margad. &Nork.	Ditrichaceae
14.	*Heteroscyphus argutus* (Reinw., Blume & Nees) Schiffn.	Lophocoleaceae
15.	*Himantocladium plumula* (Nees) M. Fleisch.	Neckeraceae
16.	*Homaliodendron flabellatum* (Sm.) M. Fleisch.	Neckeraceae
17.	*Hyophila involuta* (Hook.) A. Jaeger	Pottiaceae
18.	*Leucoloma amoenevirens* Mitt.	Dicranaceae
19.	*Leucoloma taylorii* (Schwagr.) Mitt.	Dicranaceae
20.	*Macromitrium moorcroftii* (Hook. &Grev.) Schwagr.	Orthotrichaceae
21.	*Pallavicinia lyellii* (Hook.) Gray	Pallaviciniaceae
22.	*Pelekium velatum* Mitt.	Thuidiaceae
23.	*Philonotis fontana* (Hedw.) Brid.	Bartramiaceae
24.	*Philonotis hastata* (Duby) Wijk & Margad.	Bartramiaceae
25.	*Plagiochila fruticosa* Mitt.	Plagiochilaceae

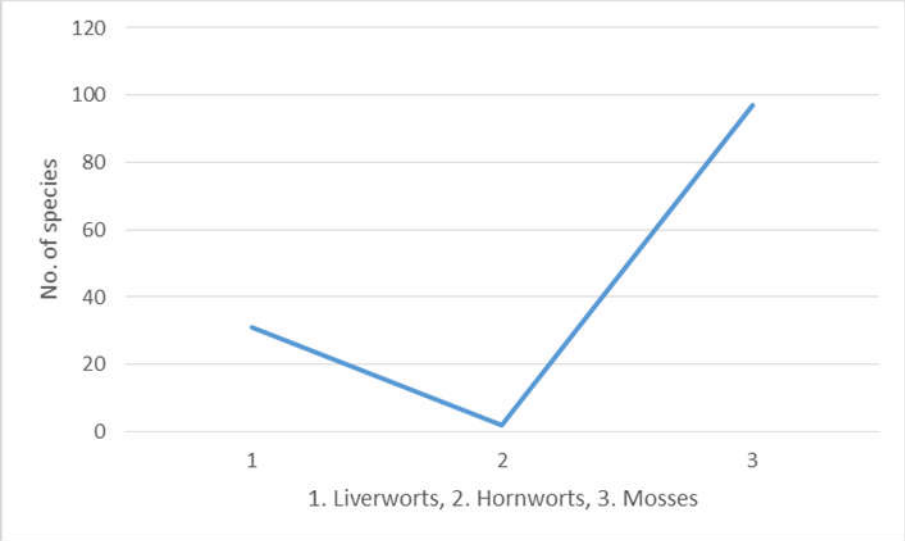
26	*Pogonatum patulum* (Harv.) Mitt.	Polytrichaceae
27	*Riccardia multifida* (L.) Gray	Aneuraceae
28	*Riccardia tenuicostata* Schiffn.	Aneuraceae
29	*Taxiphyllum taxirameum* (Mitt.) M. Fleisch.	Hypnaceae
30	*Taxithelium nepalense* (Schwagr.) Broth.	Pylaisiadelphaceae
31	*Thuidium pristocalyx* (Mull. Hal.) A. Jaeger	Thuidiaceae
32	*Vesicularia kurzii* (A. Jaeger) Broth.	Hypnaceae
33	*Vesicularia montagnei* (Bel.) Broth.	Hypnaceae
34	*Wijkia surcularis* (Mitt.) H.A. Crum	Sematophyllaceae

DISCUSSION

India is blessed with rich bryodiversity, however documentation of these floristic resources is incomplete. Bryo-exploration programmes in unexplored areas are essential because there may be chances for disappearance of species before being documented. Climate changes and anthropogenic activities are the major threats which can lead to habitat destruction and disappearance of species. Bryophytes are probably the least documented group. Their small size, difficulty in identification, inconspicuous position in the ecosystem may be the couse of ignorance about bryophytes (Glime, 2017). Studies done earlier are mainly dealt with the northern Indian region and however the south Indian region largely remains unexplored. Manju *et al*. (2001-2019) explored the bryodiversity of Kerala and estimated that the State is holding rich bryophyte diversity consisting more than 600 species.

The Malabar Wildlife Sanctuary is part of Western Ghats, one of the hot spots in the country, rich in bryodiversity, about 52 species of bryophytes including 28 liverworts and 24 mosses were reported (Manju *et al.*, 2008) earlier. Present study reports a total of 130 species from an area of 74.2 sq. km, belonging to 84 genera and 38 families. Mosses consist of 97 species belonging to 59 genera and 23 families, liverworts consist of 31 species belonging to 22 genera and 15 families and hornworts consist of 2 species belonging to 2 genera and 2 families. Number of species in different categories are represented in Fig. 6.1. Hypnaceae is the largest moss family with 12 species followed by Pylaisiadelphaceae with nine species. Lejeuneaceae are the largest liverwort family with seven species, followed by Jungermanniaceae with six species.

Fig 6.1. Number of species in different categories



Among the 130 species one species is proposed as new to science. The genus *Bryocrumia* is known by a single species till date. The proposed species adds the second species of the genus from India. The present study resulted in recording new distributional records such as three species to India, five to Peninsular India and 10 species to Kerala. The study also recorded populations of 10 endemic species to India.

New species

1. *Bryocrumia* sp.nov. (*inedit*)

Species new to India

1. *Acroporium strepsiphyllum* (Mont.) B.C.Tan
2. *Phyllodon subretusus* (Thwaites & Mitt.) Ochyra & R.R Ireland
3. *Taxiphyllum isopterygioides* (Dixon) W.R. Buck

Species new to Peninsular India

1. *Aptychella speciosa* (Mitt.) Tixier
2. *Clastobryopsis planula* (Mitt.) Fleisch.

3. *Clastobryum wichurae* Dixon
4. *Nardia assamica* (Mitt.) Amakawa
5. *Jungermannia comata* Nees.
6. *Rhaphidostichum glauco- virens* (Mitt.) Broth..

Species new to Kerala

1. *Actinodontium rhaphidostegium* (C.Muell.) Bosch & Lac.
2. *Bryocrumia vivicolor* (Brotherus & Dixon) W.R. Buck
3. *Calymperes linguatum* Muell. Hal.
4. *Frullania wallichiana* Mitt.
5. *Meiothecium jagorii* (C.Muell.) Broth.
6. *Metzgeria pandei* S.C. Srivast. & Udar
7. *Pterobryopsis gedehensis* Fleisch.
8. *Rhynchostegiella humillima* (Mitt.) Broth.
9. *Stereophyllum confusum* Ther.
10. *Trichosteleum punctipapillosum* Par. ex Gangulee.

Species Endemic to India reported from the study area

1. *Cephalozia pandei* Udar & D. Kumar
2. *Metzgeria pandei* S.C. Srivast. & Udar
3. *Nardia assamica* (Mitt.) Amakawa
4. *Calymperes linguatum* Muell.
5. *Stereophyllum confusum* Ther.
6. *Floribundaria walkerii* (Renauld & Cardot.) Broth.
7. *Ectropothecium rostellatum* (Mitt.) A.Jaeger
8. *Isopterygium serrulatum* Fleisch.
9. *Rhaphidorrhynchium confertissimum* (Mitt.) Broth.
10. *Rhyncostegiella humillima* (Mitt.) Broth.

The area provides a wide variety of macro and micro habitat. Diversity of species varies according to habitat, altitude and vegetation types. Bryophytes of

Malabar Wildlife Sanctuary enjoy variety of habitats. Out of the 130 species, 86 species prefer epiphytic habitat and 79 species prefer terrestrial habitat. Most of the species in the study area prefer epiphytic habitat. The altitudes of the study area ranges from 40-1500 m. Distribution of species found highest in between altitudinal range 800-900 m and lowest in between 40-100 m. Study area comprises variety of vegetation in which bryodiversity is high in semi evergreen forest areas. A total of 84 species are found in the semi evergreen forests, 42 species are found in the moist deciduous forests and 55 species are found in the evergreen forests and eight species are found in the grasslands. Most of the species are specific in their habitat, vegetation type and altitudinal range. Some Species found growing in different habitats, vegetations and altitudinal ranges may due to the richness of that species in the study area or adaptability of that species, which grow in different kinds of habitat, vegetation and altitude.

Ex-situ conservation

Of the 130 species collected from Malabar Wildlife Sanctuary, 34 species coming under 25 families were successfully established in MBGIPS' lower group plant conservatory. Others are difficult to thrive, this may be due to the difference in vegetation, altitude, humidity, etc. Easily occupied species are *Cyathodium cavernarum* Kunze, *Dumortiera hirsuta* (Sw.) Nees, *Heteroscyphus argutus* (Reinw., Blume & Nees) Schiffn., *Pallavicinia lyellii* (Hook.) Gray, *Pogonatum patulum* (Harv.) Mitt., *Riccardia multifida* (L.) Gray and *Riccardia tenuicostata* Schiffn.

SUMMARY

Comprehensive field studies were conducted during 2012 -2018 in different seasons and collected more than thousands of specimens of bryophytes from Malabar Wildlife Sanctuary. All the specimens were deposited in MBGH. Among these a total of 130 species of bryophytes from an area of 74.2 sq. km, belonging to 84 genera and 38 families are identified. Liverworts consist of 31 species belonging to 22 genera and 15 families. Lejeuneaceae are the largest liverwort family with 7 species, followed by Jungermanniaceae with 6 species. Hornworts consist of 2 species belonging to 2 genera under 2 families. Mosses consist of 97 species belonging to 59 genera and 23 families. Largest family is Hypnaceae with 12 species followed by Pylaisiadelphaceae with nine species. Updated the nomenclature and prepared taxonomic account of all the species. Anatomical and morphological details of all the species were described. Out of the 130 species one is a new species, 3 are new addition to India, 6 are new addition to Peninsular India and 10 are new to Kerala. Of the 130 species described 10 species are endemic to India.

Out of the 130 species, 34 species of bryophytes were successfully established in MBGIPS' conservatory, others are found difficult to thrive. This may be due to the difference in altitude, vegetation and humidity. Liverworts were found growing luxuriantly than mosses. Out of the 130 species ten species are endemic to India.

Diversity of species varies according to different altitude, vegetation and habitat. Bryophytes distributed in various vegetation types of which diversity of species found higher in semi evergreen forest areas. Bryophytes are adapted to growing in different kinds of habitat. Epiphytic species are abundant in the study area and mostly prefer branches for their habitat. The loss of habitat leads to disappearance of many species. Some species are found growing in all kinds of altitude, vegetation and habitats. This increases the species richness in the study area.

Bryodiversity documentation in the ecologically fragile area is essential because ecological threats due to climatic changes causes considerable habitat destruction and disappearance of species.

BIBLIOGRAPHY

Alam, A. 2012a. Liverworts Flora of Parson's Valley, Nilgiri Hills (Western Ghats), South India. *Archive for Bryology* 119, 1-18.

Alam, A. 2012b. Some Indian bryophytes known for their biologically active compounds. *Int. J. Appl. Biol. Pharm. Tech.* 3(2):239-246.

Alam, A. 2013. *Moss flora of Western Himalayas, India-An updated Checklist*. Univ.-Bibliothec.

Alam, A. and Srivastava, S.C. 2009. Liverwort diversity in Palni hills (Tami Nadu), - A checklist. *Nelumbo*. 51: 99-122.

Alam, A., Sharma, V. and Sharma, S.C. 2011. Bryoflora of Ranthampore Tiger Reserve, Rajasthan (India) *Archive for Bryology* 106: 3.

Alam, A., Sharma, V., Sharma, S. C., and Kumari, P. 2012. Antibacterial activity of the alcoholic extracts of *Entodon nepalensis* Mizush. against some pathogenic bacteria. *Report and Opinion*, 4(10): 44-47.

Alam, A., Pandey, S. Singh, V., Sharma, S.C. and Sharma, V. 2014. Moss flora of Mount Abu (Rajasthan), India: An updated checklist. www. Tropical Plant Research. Com 1(1): 11.

Alam, A., Krishnakumar, R., Verma, P.K., Sharma V. and Gupta, D.S. 2015. Moss flora of Central India. *Plant Sci. Today* 2(4): 159-171.

Amakava, T. 1964. A short revision of Himalayan Scapania (Hepaticae), *J. Hattori Bot. Lab.*. No. 27: 1 – 19.

Amina, P. and Rajmohana, K. 2016. *Glyptotermes chiraharitae* n. sp., a new damp wood termite species (Isoptera: Kalotermitidae) from India. *Zoosystema*, *38*(3): 309-316.

Ande, A., Wahedi, P.M. and Fatoba. P.O. 2010. Biocidal Activities of some tropical moss extracts against Maize Stem Borers. *Ethnobotanical Leaflets*: Vol. 2010 : Issue. 4, Article 11.

Aruna, K.B. and Krishnappa, M. 2014. Distribution of Bryophytes in Malnad Regions of Chick Mangalore district, Karnataka, The Western Ghats. *Life Science Leaflets.* 49:65-68.

Asakawa, Y. 1981. Biologically Active Substances Obtained from Bryophytes. *J. Hattori Bot. Lab.* 50: 123.

Asakawa, Y. 2007. Biologically active compounds from Bryophytes. *Pure and applied Chemistry* 79(4): 557-580.

Asakawa, Y. 2008. Liverworts-potential source of medicinal compounds. *Curr. Pharm. Des.* 14 (29). 3067-3088.

Asthana, A.K. and Gupta, R. 2015. Hornwort diversity at Pachmarhi Biosphere Reserve (Madhya Pradesh), India. *Pl. Sci. Today*, 2(4), pp.145-150.

Asthana, A.K. and Srivastava, A. 2015. A study on genus Fissidens Hedw. in Meghalaya (North-Eastern Hills), India. *Taiwania*, *60*(3).

Asthana, G. and Srivastava, S.C. 2003. *Indian Cololejeunea*. A taxonomic study. Bryophtorum Bibliotheca, J. Cramer.

Athira, R.K.N., Brijithlal, N.D., Prakash, G., Williams and Lubaina, A. S. 2018. *In vitro* anti-cancerous effect of the *Taxithelium nepalense* (Schwager) Broth. studied by Mitt assay. *World Journal of Pharmaceutical Research* 7(2):1049-1060

Awasthi, U.S., Srivastava S.C. and Sharma, D. 1999. *Lopholejeunea* (Spruce) Schiffn. in India. *Geophytology* 29(1,2): 35-60.

Aziz M.N. and Vohra J.N. 2008. *Pottiaceae (Musci) of India*, Bishen Singh Mahendra Pal Singh1-366

Azuelo, A.G, Sariana, L.G and Pabualan, M.P, 2011. Some Medicinal Bryophytes: their Ethnobotanical Uses and Morphology. *Asian Journal of Biodiversity* .2: 49-80

Bahuguna, Y.M. Sumeet Gairola, Semwal, D.P, Uniyal, P.L., Bhatt, A.B. 2013. Bryophytes and Ecosystem. *Biodiversity of lower plants*. 279-296.

Bahuguna, Y.M., Gairola, S., Uniyal, P.L. and Bhatt, A.B. 2016. Moss Flora of Kedarnath Wildlife Sanctuary (KWLS), Garhwal Himalaya, India. *Proceedings of the National Academy of Sciences, India Section B: Biological Sciences*, *86*(4), pp.931-943.

Banerjee, S.K. and Srivastava, A.K., 2019. Assessment of Diversity and Traditional Uses of Bryophytes Along Some Hill Roads in a Biodiversity Hot Spot Region of India-A Case Study of Mizoram. *International Journal of Natural Resource Ecology and Management*, *4*(3), p.73.

Bansal, P., Nath, V. and Chaturvedi, S.K. 2011. Epiphytic bryophytes on Thuja orientalis in Nagaland, North-eastern India. *Bangladesh Journal of Plant Taxonomy*, *18*(2), pp.163-67.

Bansal, P. and Nath, V. 2013. Current Status of Genus Bryum Hedw. in Eastern Himalaya, India. Taiwania, 58(3).

Bansal, P. and Nath, V. 2015. Diversity in the reproductive structures of Bryum Hedw. (Bryophyta) of Garhwal hills, Uttarakhand, India. *The International Journal of Plant Reproductive Biology*, *7*(2), pp.92-103.

Bapna, K.R. 1980. Occurrence of *Fissidens* Hedw. in Rajasthan. *J. lndian Bot. Soc*. 59: 20.

Bapna, K.R. and Kachroo, P. 2000. *Hepaticology in India*, 1. Himanshu Publication, Delhi.

Barbhuiya, H.A. and Singh, S.K. 2012. *Liverwort and Hornwort of Borail Wild Life Sanctuary, Assam, India*. Univ.-Bibliothek.

Bargali V. Aswathi, V. and Pande, N. 2014. Ecological Study of Bryophytes on *Platanusorientalis* L. Trees in Nainital (Western Himalaya). *American J. Plant Sci.* 5(26):3880-3888.

Bartram, E.B. 1938. Mosses of the Aleutian Islands, Alaska.

Bartram, E.B. 1951. *Glossadelphus* Andersoni, a new genus to the United States Moss Flora. *The Bryologist*. 54(2). 240-242.

Bartram, E.B. 1954. Mosses of the Ungava Peninsula, North Eastern Canada. *The Bryologist* 57(4): 273-277.

Basilier, K. 1979. Moss-associated nitrogen fixation in some mire and coniferous forest environments around Uppsala, Sweden. *Lindbergia* 5: 84-88.

Bates, J.W. 2000. Mineral nutrition, substratum ecology, and pollution. *Bryophyte Biology*, pp.248-311.

Bhardwaj, D.C. 1948. Studies in Indian Hepaticae. *J. lndian Bot. Soc*. 27: 3-7.

Brijithlal, N.D. 2010. Studies on the bryoflora of Neyyar Wildlife Sanctuary, Kerala, India.

Brown, R. 1866. The miscellaneous botanical works Robert Brown, *Royal Society* 1:1- 612.

Bruggeman-Nannenga, M.A., Manjula, K.M. and Manju, C.N. 2016. *Fissidens enervis* Sim (Fissidentaceae) new to Asia. *Lindbergia* 39: 29-32.

Buck, W.R. and Goffinet, B. 2000. Morphology and classification of mosses. *Bryophyte Biology*, ed. A.J.Shaw & Goffinet.B, pp.71-123.Cambridge University Press.

Campell, E.O. 1971. Problems in the origin and classification of Bryophytes with particular reference to Liverwort. *New Zealand J. Bot*. vol.9.no.4.

Cargill, D.C., Manju C.N., Deepa, K.M., Chandini V. K. and Rajesh, K.P. 2019. A New Indian Species of *Riccia* with connections to Northern Australia. *Journal of Bryology* 41(3): 1-7.

Chaudhary B.L, Sharma T.P., and Sandhya C. Haru. 2006. *Bryophyte Flora of Gujarat. (India)* 1-196, The Aryas' Book Centre Udaipur.

Chopra, R.N. 1960. Mosses of Nainital (Himalayas, India). *J, Hattori Bot. Lab*. 23: 80-84.

Chopra, R.S. 1938. Notes on Indian Hepatics. *Proc. Indian Acad. Sci. Ser*.38: 427-439.

Chopra, R.S. 1943. *A census of Indian Hepatics. J. Indian Bot. Soc.* 22: 237-259

Crandall-Stotler, B. and Stotler, R. 2000. Morphology and classification of the Marchantiophyta. In *Bryophyte Biology*, ed. A.J. Shaw & B. Goffinet, pp.21-70. Cambridge University Press.

Dandotiya, D., Pyari, G.H., Santhanu, S. and Uniyal, P.L. 2011. Checklist of the Bryophytes of India. *Arch. Bryol.* 88:1-126.

Daniels, A.E.D. 1998. Ecological adaptations of some bryophytes of the Western Ghats. *J.Ecobiol.* 10(3): 261 -270.

Daniels, A.E.D and Daniel, P. 2003. Addition to the Bryoflora of Peninsular India, *Indian J. Forest*. 26(4): 389- 396.

Daniels, A.E.D. and Kariyappa, K.C. 2007. Bryophyte diversity along a gradi entof human disturbance in the southern Western Ghats. *Current science*, pp.976-982.

Daniels, A.E.D., 2010. *Checklist of the bryophytes of Tamil Nadu, India*. Univ.-Bibliothek.

Daniels, A.E.D. and Mabel, J.L. 2011. Two mosses new to the bryoflora of the Indian mainland. *Nelumbo*. 51: 179-189.

Daniels, A.E.D., Kariyappa, K.C. and Daniel, P. 2011. The moss genus *Ochrobryum* Mitt. (Leucobryaceae) added to the Bryoflora of the Western Ghats. *Nelumbo*. 53: 155-160.

Daniels A. E. D, Kariyappa K.C. and Daniel P. 2011a. Two species of *Daltonia* Hook. & Tailor (Daltoniaceae: Bryophyta) new to the moss flora of India, *Nelumbo*. 53: 133 – 139.

Daniels, A. E. D, Mabel, J.L. and Sreeji, S, 2011b. Mosses new to the Bryoflora of the Western Ghats from the Agasthymalai Biosphere Reserve, *Nelumbo*. 53: 145 – 154.

Daniels, A.E.D and Kariyappa, K.C. 2012a. A little known moss from the Western Ghats, *Nelumbo.* 54: 213 – 217.

Daniels, A.E.D and Kariyappa, K.C. 2012b. The liverworts *Mastigophora diclados* and *Plagiochilion oppositum* – new to the hepatic flora of Peninsular India, *Nelumbo*. 54: 207 – 212.

Daniels, A.E.D, Mabel, J.L and Daniel, P. 2012. The Erpodiaceae (Bryophyta: Isobryales) of India, *Taiwania*. 57(2): 168 – 182.

Daniels A.E.D, Sreebha R. and Kariyappa, K.C. 2018. *Bryoflora of Indira Gandi National Park in Anamalai Hills, India*. Bishen Singh Mahendra Pal Singh, Dehra Dun, India, 1-513.

Daniels, A.E.D., Preetha, M.M., Asha, V. and Biju, P.M. 2018. Genus *Symphysodontella* M. Fleisch. (Pterobryaceae: Bryophyta) - new to the moss flora of the Eastern Ghats. *Pl. Sci. Today*, 5(1): 19-23.

Das, S. and Singh, D.K. 2009. Three new records of liverworts for Himalayan region from Mehao wildlife sanctuary, Arunachal Pradesh. *Nelumbo*. 51: 191-198.

Das, S. and Sharma, G.D. 2016. Some noteworthy and new records of liverworts from Barail Wildlife Sanctuary, Assam, India. Plant Science Today, 3(2), pp.100-108.

Deepa K.M. and Manju C.N. 2016. *Clevea pusilla* (Steph.) Rubasinghe & D.G. Long (Cleveaceae; Marchantiophyta) a rare species from the Western Ghats of Tamil Nadu, India. Cryptogam Biodiversity and Assessment Vol 1(1): 52-54. e-ISSN-2456-0251.

Deepa, K.M., Mufeed, B. and Manju, C.N. 2019. *Wiesnerella denudata* (Mitt.) Steph. (Marchantiales; Marchantiophyta) a rare species in the Western Ghats of India. *Lindbergia* 42: 1-4 (https://doi.org/10.25227/linbg.01106.

Delgadillo, M. 1975. Taxonomic revision of *Aloina, Aloinella* and *Crossidium* (Musci).*The Bryologist*. 78(3): 245-303.

Dey, M. and Singh, D.K. 2011. A new *Lopholejeunea* (Spruce) Schiffn.(Hepaticae: Lejeuneaceae) from India. *Nelumbo*. 53:197-200.

Dillenius, J.J. 1741. *Historia Muscorum*. Oxford.

Ding, H. 1982. *Medicinal spore bearing plants of China*. Shanghai Science and Technology Press.

Dixon, H. N. 1930. Additions to the Moss flora of the North – Western Himalayas, *Annales Bryologici*. Vol. III. 52 – 70.

Dixon, H.N. 1932. Contributions to the Moss flora of Sumatra. *Annales Bryologici*. V.

Dixon, H.N. 1937. Mosses collected in Assam. *J. Bombay Nat. Hist. Soc*. 39: 769-795.

Easa, P.S. 2003. *Biodiversity documentation for Kerala. Part 4: Bryophytes*. KFRI Handbook No.17. KFRI Peechi, Kerala.

Eichler, A.W. 1883. *Syllabus der vorlesungen uber soecielle und medicinisch - pharmaceutische Botanik*. 3rd ed. Berlin.

Ellis, L.T. 1989. Taxonomic revision of *Calymperes* in Southern lndia and neighbouring Islands. *J. Bryol*. 15: 697-732.

Enroth, J. 1989. Bryophyte flora of the Huon Peninsula, Papua New Guinea. XXVII. Neckeraceae (Musci) *Acta. Bot. Fennici*. 137:41-80

Enroth, J. and Tan, B.C. 2007. *Stereophyllum linisii* (Stereophylaceae), a new moss species from the Philippines. *Ann. Bot. Fennici*. 44: 146-148.

Frahm, J.P. 1983. The taxonomic status of *Neckera besseri* (Lob.) Jur. and *Homalia webbiana* Mont. *J. Bryol.* 12:337-341.

Furuki, T. and Mizutani, M. 1994. Checklist of Japanese Hepaticae and Anthocerotae. *Proc. Bryol. Soc. Japan*. 6:75-83.

Gangulee, H.C. 1969-1980. *Mosses of Eastern India and adjacent regions*. Vol. 1-111**, (**Fasc1-8), BSI, Caicutta.

Glime, J.M. 2017. *Bryophyte Ecology*. E.book sponsored by Michigan Technological University and the International Association of Bryologist. 5 (chapter 1-7).

Goffinet, B. and Shaw, A.J. 2009. *Bryophyte Biology*. Cambridge university press.

Goffinet, B., Shaw A.J. and W. Buck. 2009. Morphology and classification of the Bryophyta, Bryophyte Biology, 2nd ed. Cambridge University Press.

Govindapyari, H., Kumari, P., Bahuguna, Y.M. and Uniyal, P.L. 2012. Evaluation of species richness of acrocarpous mosses in Imphal District, Manipur, India. *Taiwania*, *57*(1), pp.14-26.

Govndapyari, H. 2014. Habitat preference in pleurocarpus mosses of Imphal district, manipur, India. *Evansia*, *31*(3), pp.99-109.

Griffith, W. 1849. *Notulae and Plantae Asiaticae*. 1-IV. Culcutta.

Gujar, R.V., Shah, D.G. and Singh, A.P. 2016. The Diversity and Distribution of Mosses in Gujarat: Current Status. *Cryptogam Biodiversity and Assessment*, *1*(2), pp.83-86.

Gupta, R., Nath, V. and Asthana, A.K. 2013. Present scenario of moss diversity at Tamia hills and Patalkot valley (Madhya Pradesh) India. National Academy Science Letters, 36(6), pp.629-634.

Gupta, R., Nath, V. and Asthana, A.K., 2016. Present Status of Family Dicranaceae (Bryophyta) in Pachmarhi Wildlife Sanctuary, Central India. *Taiwania*, *61*(3).

Gururaja, K.V., Dinesh, K.P., Palot, M.J., Radhakrishnan, C. and Ramachandra, T.V. 2007. A new species of *Philautus* Gistel (Amphibia: Anura: Rhacophoridae) from southern Western Ghats, India. *Zootaxa*, *1621*(1), pp.1-16.

Hayes, L. 1947. Survey of higher plants for presence of antibacterial substances. *Bot. Gaz.,* 108: 408-414.

He, S. and Snider, A.J. 2000. A Taxonomic Revision of Symphyodon (Musci: Symphyodontaceae). *The Bryologist*. 103(1): 52-81.

Hooker, W.J. 1808. Musci Nepalensis. *Trans. Linn. Soc. Lond*. (Bot.). 9: 307-322.

Howe, M.A. 1899. Hepaticae and Anthocerotes of California. *Mem. Torrey Bot. Club.* 7: 1-208.

Inoue, H. 1976. Notes on the Plagiochilaceae. V. Studies in the Genus Plagiochila (Dum) Dum. In the Hawaiian Islands. *Journ. Hattori Bot. Lab.* 40:411-440.

Inoue, H. and Schuster, R.M. 1971. A monograph of the New Zealand and Tasmanian Plagiochilaceae- *Journ. Hattori Bot. Lab.* 34.

Iwatsuki, Z. 1991. *Cat. Mosses Japan*. Hattori Botanical Laboratory, Nichinan.182.

Jones, E.W, 1975. African Hepatics. XXVII. Bazania. *J. Bryol.* 8: 299-316.

Junairiah, Sukarti, M., Endang. S., and Ni'matuzahroh, 2013. Antibacterial and Antifungal Activities of *Dumortiera hirsuta* Active Fractions. *J. Basic. Appl. Sci. Res*., 3(1):802-806.

Jyothilakshmi, G.R., Manju, C.N., Mithun, V., Chandini, V.K. 2016. Bryophyte diversity in the Sacred Groves, with special reference to Vallikatukavu of Kozhikode district in Western Ghats. *Plant Science Today*. 3(2): 135-141.

Kapoor, R., Nath, V., and Asthana, A.K. 2010. Studies on the bryoflora of Achanakmar wildlife sanctuary, Chhattisgarh, India. *Geophytology*. 38(1-2): 25-35.

Kariyappa, K.C. and Daniels, A.E.D. 2010. The African Moss *Trachyphyllum dusenii* (Mull. Hal. *Ex.* Broth.) Broyh. Hypnobryales: Entodontaceae) in India, *Nelumbo*. Vol. 52: 131 – 134.

Kashyap, S.R. 1912. Morphological and biological notes on new and little known West-Himalayan liverworts. *New Phytologist*. 14, 15.

Kashyap, S.R. 1932. *Liverworts of the Western Himalayas and the Punjab Plain,* 1. Research co. Publications, Trinagar, Delhi

Kaushik, P., Upadhyay, V., and Singh, P. 2000. Antibacterial potential of Bryophytes. *The Botanica*. 50: 132-136.

Kerketta, M.A. and Dixit, A.K. 2017. Enumeration of the new hornworts from Bilaspur (Chhattisgarh), India. *Annl. Plant Sci.* 6 (11): 1758-1762

Kitagawa, N. 1969. Studies on the Hepaticae of Thailand. *J. Hattori Bot. Lab.* 32. Koponen, T. 1971. A monograph of Plagiomnium Sect. (Mniaceae). *Ann. Bot. Fennici* 8:305-367.

Kitagawa, N., 1966. A revision of the family Lophoziaceae of Japan and adjacent regions, II. J. Hattori Bot. Lab., 29, pp.101-149.

Koponen, T. 1974. A guide to the Mniaceae in Canada. *Lindbergia* 2:160-184.

Koponen, T. 1982. The family Mniaceae in Australia and Pacific. *Journ. Hattori. Bot. Lab*.52: 75-86.

Koponen, T., Enroth, J. and Fang, Y.M. 2000. Bryophyte flora of Hunan Province, China 1. Ann. Bot. Fennici. 37: 11-39.

Koushik, P., Upadhyay, V. and Sing, P. 2000. Antibacterial potential of Bryophytes. *The Botanica*, 50:132-136.

Krutha, K., Dahanukar, N. and Molur, S. 2017. *Nyctibatrachus mewasinghi*, a new species of night frog (Amphibia: Nyctibatrachidae) from Western Ghats of Kerala, India. *Journal of Threatened Taxa*, *9*(12), pp.10985-10997.

Kumar, K., Singh, K.K., Asthana, A.K. and Nath, V. 2000. Ethno therapeutics of *Plagiochasma appendiculatum* among the Gaddi tribes of Kangra valley, Himachal Pradesh, India. 38(5) :353-356.

Kumar, S. and Singh, D.K. 2002. Contribution to the Mosses of Gobind National Park, Uttaranchal, India. *Nelumbo*, *44*(1-4), pp.119-134.

Kuwahara, Y. 1986. The Metzgeriaceae of the Neotropics. Bryophytorum Bibliotheca, Band 28. Berlin- Stuttgart: Lubrecht & Cramer

Lal, J. 2003. Studies in Epiphyllous Liverworts of India-Its Present Position. Nelumbo, 45(1-4), pp.179-186.

Lal, J. 2007. Mosses of Gangetic plains–A neglected Biogeographic zone of India. Current Trends in Bryology, Bishen Singh Mahendra Pal Singh, Dehradun, India, pp.131-147.

Lara, F., Garilleti and Vicente, M. 1994. *The Bryologist*. 97(4): 402-408.

Lavate R.A. 2015. Studies on the Hepaticae and Anthocerotae of Kolhapur District. Ph. D. Thesis submitted to Shivaji University, Kolhapur.

Levinsky, J. 1985. The family Orthotrichaceae in Greenland, a Taxonomic revision. Lindbergia. 4:57-103.

Lewinsky, J., 1977. The family Orthotrichaceae in Greenland a taxonomic revision. Lindbergia, pp.57-103.

Linnaeus, C. 1753. *Species Plantarum*. Ed. 2. Vol. II. Musci. Holmiae.

Ma, W., Shevock, J. R., & He, S. 2016. The first discovery on the sporophytes of a rheophytic moss: *Bryocrumia vivicolor* (Bryophyta, Hypnaceae). *Phytotaxa*. 265(1):73-78.

Madhusoodanan, P. V. and Manju, C.N. 2003. *Ricciocarpus natans* (L.) corda (Ricciaceae) and *Notothylas levieri* Schiffn. *ex.* Steph. (Notothylaceae), Two new bryophyte records for South India, *Indian J. Forest*. 26 (3): 295 – 298.

Madhusoodanan, P.V., Manju, C.N. and Easa, P.S. 2007. Diversity of Bryophytes in Eravikulam National park, Kerala (South India). *Current trends in Bryology:* 255-267.

Magdum, S.M., Patil, S.M., Lavate, R.A. and Dongare, M.M. 2017. Checklist of Mosses from Western Ghats of Maharashtra, India. *Plant Science discovery*. 8(1):73-81.

Mahabale, T.S. 1958. Taxonomy of liverworts and mosses. *Mem. lndian Bot. Soc.* 1: 37-42.

Makinde, M., Eunice, A. F, Musibau, O. 2015. Secondary Metabolites and Bioactivity of *Hyophila involuta* (Hook) Jaeg.. *Not Sci Biol*, 7(4):456-459.

Mani, B; Thomas, S. and Britto, J. 2018. Two new species of *Impatiens* (Balsaminaceae) from the Western Ghats, India. *Phytotaxa*. 334(3): 4.

Manju, C.N., Rajesh, K.P. and Madhusoodanan, P.V. 2008a. Bryophytes of Kakkayam Forests in the Western Ghats and its conservation. *Geophytology* 37: 59-63.

Manju, C. N., Rajesh, K.P. and Madhusoodanan, P.V. 2008b. Checklist of the Bryophytes of Kerala, India, *Tropical Biology Research Reports*. Vol. 7: 1 – 24.

Manju, C.N., Rajesh, K.P. and Madhusoodanan, P.V. 2008c. Ecological observations on the bryophytes of Eravikulam National Park, South India. *Geophytology*. 37: 51-53.

Manju, C.N., Rajesh, K.P. and Madhusoodanan, P.V. 2009a. *Jungermannia obliquifolia* (Schiffn.) Vana (Marchantiophyta, Hepaticae) from India. *Bangladesh J. Plant Taxon. 16(1): 95-97.*

Manju, C.N., Rajesh, K.P. and Madhusoodanan, P.V. 2009b. Contribution to the bryophyte flora of India: the Aralam Wildlife sanctuary in the Western Ghats. *Archive for Bryology*. 42: 1-12.

Manju, C.N., Rajesh, K.P. and Madhusoodanan, P.V. 2009c. *Lindbergia* Kindb. (Leskeaceae: Bryopsida)- a new genus record for Peninsular India. *Indian J For.* 32(2):295-296.

Manju, C.N., Rajesh, K.P. and Madhusoodanan, P.V. 2009d. Contribution to the bryophyteflora of India: Agasthyamalai Biosphere Reserve in Western Ghats. *Taiwania*, *54*(1), pp.57-68.

Manju, C.N. and Rajesh, K.P. 2009a. *Notoscyphus pandei* Udar & Kumar (Marchantiophyta, Hepaticae) from the Western Ghats of Kerala State, India. *J. Econ. Tax. Bot. 33(2).342-344.*

Manju, C. N. and Rajesh, K.P. 2009b. Bryophyte diversity in the high altitude grasslands of the Western Ghats. *Acta Botanica Hungarica* 51(3-4): 329-335.

Manju, C.N. and Rajesh, K.P. 2010. *Leptohymenium Schwaegr.* (Hylocomiaceae: Bryopsida) a new generic record for Western Ghats, Peninsular India. *J.Econ. Tax. Bot*. 34: 391-393.

Manju, C.N. and Prajitha, B. 2010. Systematic studies on Bryophytes of Northern Western Ghats in Kerala. KSCSTE Project Report.

Manju, C.N., Rajesh, K.P. and Madhusoodanan, P.V. 2011a. *Chiloscyphus chinnarensis* (Lophocoleaceae, Hepaticae): A new species from the Western Ghats of India. *Acta Bot. Hungarica* 53: 151-157.

Manju, C.N., Nikesh, P.R. and Rajesh, K.P. 2011b. *Exormotheca tuberifera* (Marchantiophyta, Exormothecaceae) from the Western Ghats of Kerala, India- *Taiwania*, 56(4):330-332.

Manju, C.N. and Rajesh, K.P. 2011c. Contribution to the Bryophyte flora of India: the Parambikulam Tiger Reserve in the Western Ghats. *Archive for Bryology* 42: 1-10.

Manju, C.N., Rajesh, K.P., Jitha, S., Reshma, P.K. and Prakashkumar, R. 2011. Bryophyte diversity of Kakkavayal Reserve Forest in the Western Ghats, Kerala. *Archive for Bryology.* 108: 1-7.

Manju C.N., Leena, T.N., Deepa K.M., Rajesh, K.P. and Prakashkumar, R. 2012. *Lejeunea cocoes* (Lejeuneaceae; Marchantiophyta) in the Western Ghats of India. *Acta Botanica Hungarica* 54: 341-343.

Manju, C.N., Rajesh, K.P and Prakashkumar, R. 2012. Life forms of Bryophytes in the Western Ghats, India. Pp. 1-10. *In* : Nagarajan, B., Kunhikannan, C., Sasidharan, K.R. and Krisnakumar, N. (eds.) *Tropical Ecosystems: Structure, Function and Services*. Institute of Forest Genetics and Tree Breeding, Coimbatore.

Manju, C.N. Prakashkumar, R., Prajitha, B**.**, Rajilesh, V.K. and Anoop, K.P. 2012a. '*Trichosteleum stigmosum* Mitt. (Sematophyllaceae) from Silent Valley National Park, a New Record for India'**.** *Taiwania,* 57(2): 222-224.

Manju, C.N., Rajesh, K.P., and Prakashkumar, R. 2012b. Lejeuneaceae (Marchantiophyta) of the Western Ghats, India. *Acta Biologica Plantarum Agriensis*.2.

Manju, C.N., Martin, K.P., Sreekumar, V.B. and Rajesh, K.P. 2012c. Morphological and molecular differentation of *Aerobryopsis eravikulamensis* sp. nov. (Meteoriaceae: Bryophyta) and closely related taxa of the Western Ghats of India. *The Bryologist*, 115(1): 42-50.

Manju, C.N, Rajilesh, V.K, Prajitha, B., Prakashkumar R and Rajesh K.P, 2014. Contribution to the Bryophyte flora of India: Silent Valley National Park in the Western Ghats, India. *Acta Biologica Plantarum Agriensis*.73-93.

Manju, C.N., Rajilesh, V.K. Deepa, K.M. and Prakashkumar, R. 2015. The genus *Calycularia* (Marchantiophyta) in Kerala part of the Western Ghats. *Acta Botanica Hungarica*. 57(3-4):401-406.

Manju C.N., Chandini V.K. and Mufeed, B. 2017. *Physcomitrium immersum* (Funariales; Bryophyta) an addition to the bryoflora of Western Ghats. *Geophytology* 47(1): 45-47.

Manju, C.N, and Rajesh, K.P. 2017. *Bryophytes of Kerala Liverworts*. CRIKSC, Vol,1.

Manju, C.N., Aswathy, T., Pournami, K.V. and Rajesh, K.P. 2017. *Amblystegium serpens* (Hedw.) Schimp. (Amblystegiaceae: Bryophyta) from Indian Peninsula. Asian Journal of Biological and Life Sciences 6: 412-413.

Manju, C.N., Chandini, V.K., and Rajesh, K.P. 2017. *Cololejeunea manilalia* (Lejeuneaceae: Marchantiophyta) a new species from Western Gahts of India. *Acta Botanica Hungarica*. 59:1-2.

Manju, C.N., Chandini, V.K. and Rajesh, K.P. 2019. *Micromitrium vazhanicum* (Micromitriaceae; Bryophyta) a new species from the Western Ghats of India. *Bryologist* 122(2): 297-306.

Manju, C.N., Chandini, V.K., Rajesh, K.P. and Sabarish Sivaprakasam. 2019. Rediscovery of *Oreoweisia brevidens* Herzog (Dicranaceae; Bryophyta) an Indian endemic species from Western Ghats after 75 years. ***Lindbergia*** 42: (inedit)**.**

Manjula, K.M., Vidya, M. V. and Manju, C. N. 2013a. The genus *Bazzania* (Marchantiophyta) in Kerala (India), Samagra. Vol.9.

Manjula, K.M., Vidya, V., Manju, C.N., and Prakash Kumar, R. 2013b. Systematic studies on the family Geocalycaceae (Marchantiophyta) of Kerala, India. *Archive for Bryology*. 176: 1-11.

Manjula K.M. and Manju C.N. 2016. Genus *Fissidens* Hedw. (Fissidentaceae; Bryophyta) from Eastern Ghats of Andhra Pradesh, India. Cryptogam Biodiversity and Assessment Vol 1(2): 1-19. e-ISSN-2456-0251.

Manjula, K.M. 2018. Taxonomic studies on the family Fissidentaceae Schimp. (Bryophyta) of the Western Ghats. Ph.D. thesis, University of Calicut

Manjula, K.M. and Manju, C.N. 2016. Genus Fissidens Hedw. (Fissidentaceae; Bryophyta) from Eastern Ghats of Andhra Pradesh, India. *Cryptogam Biodiversity and Assessment*, *1*(2), pp.49-63.

Manjula, K.M., Manju, C.N., Rajilesh, V.K. and Chandini, V.K. 2015a. *Fissidens linearis*, Fissidentaceae: Bryophyta. a new record for India. *Acta Bot. Hung.* 57(1): 165-168.

Manjula, K.M., Manju, C.N., and Rajesh, K.P. 2015b. *Fissidens macrosporus* (Fissidentaceae: Bryophyta). A little known species of the Western Ghats rediscovered after more than 90 years. *Lindbergia.* 38:1-3.

Manjula, K.M., Manju, C.N., and Rajesh, K.P. 2017. *Fissidens manilalia* sp. nov. (Fissidentaceae), a new corticolous species from a semi- urban habitat in India. *The Bryologist*. 120 (3): 263-269.

Markert, B., Herpin, U., Siewers, U., Berlekamp, J. and Lieth, H. 1996. The German heavy metal survey by means of mosses. *Science of the total environment*, *182*(1-3), pp.159-168.

Mishra, R., Pandey, V.K. and Chandra, R. 2014. Potential of bryophytes as therapeutics. *IJPSR*. 5(9): 3584-3593.

Mishra, M., Dash, P.K., Alam, A., Sahoo, S. and Das, R. 2016. Current status of diversity and distribution of Bryophytes of Odisha. Plant Science Today, 3(2), pp.186-194.

Mithun, V. and Manju, C.N. 2017. Bryophyte diversity of Thamarassery pass Wayanad in the Western Ghats of Kerala. *Plant Sci. Today*. 4(1):41-48.

Mitten, W. 1859. Musci lndiae Orientalis, an enumeration of the mosses of East Indies. *J. Linn. SOC. Bat. SUPPI*. 1: 1-171.

Mitten, W. 1860. Hepaticae lndiae Orientale, an enumeration of the Hepaticae of the East.

Mizutani, M. 1971. Lejeunea from the Himalayan region. *Hattori Bot Lab J*.

Monalisa, D. and Sing, D.K. 2011. A new *Lopholejeunea* (Spruce) Schiffn. (Hepaticae: Lejeuneaceae) from India, *Nelumbo*. 53: 197 – 200.

Mufeed, B. and Manju C.N. 2017. *Porella perrottetiana* (Mont.) Trevis. (Jungermanniales) a species from Western Ghats of Kerala. *Acta Botanica Hungarica.* 59(1-2): 269-272.

Mufeed, B and Manju C.N. 2018. New distribution record of a rare taxa *Gottschelia schizopleura* (Spruce) Grolle, of Jungermanniales occurring in Anamudi shola National Park in the Western Ghats of Kerala. *Plant Science Today*. 5(1): 29-31.

Mufeed, B., Chandini V.K., Manju C.N. and Rajesh, K.P. 2018. *Colura calyptrifolia* (Hook.) Dumort. (Lejeuneaceae;Marchantiophyta) a rare leafy liverwort from the Western Ghats of India. *Nelumbo* Vol. 60. 147-152.

Murugan, K., Meenu Krishnan, V.G., Pradeep, D.P., Aswathy, J.M., Remya Krishnan, Lubaina, A.S. 2014. Wonder herbals- Bryophytes, of the Ponmudi hills, of Southern Western Ghats: Window in to the need for conservation. *J. Pharm. Pharmaceu. Sci.* 3(4):1548-1562.

Nair, M.C. and Madhusoodanan, P.V. 2001. Contribution to the bryophyte flora of Eravikulam National Park, Kerala. *J. Econ. Tax. Bot*. 25: 569-574.

Nair, M.C. and Madhusoodanan, P.V. 2002. Studies on the bryophyte flora of Kerala (South India) – An Introduction. *J. Econ. Tax. Bot.* 26(3): 697-708.

Nair, M.C., Madhusoodanan, P.V. and Rajesh, K.P. 2002. Bryophyte diversity in Kerala- an introduction *In*: Augustin, J. and Puthur, J.T. (eds.). Proc. Nat. Conf. Recent Trends in Plant Sci. Res. Nov. 14-15, pp. 116-121, Department of Botany, St. Thomas College, Pala.

Nair, M.C. and Madhusoodanan, P.V. 2003. Bryophyte diversity of Wayanad district, Kerala-A preliminary report. 13th Swadeshi Science Congress November 7-9, MSSRF, Kalpetta, Wayanad.

Nair, M. C., Rajesh, K.P. and Madhusoodanan, P.V. 2004. *Bryum tuberosum* Mohamed and Damanhuri, a new record for India, *Indian J. Forest*. Vol. 27(1): 39- 40.

Nair, M.C and Madhusoodanan, P.V. 2004. Bryophyte diversity of Kerala- A bird's eye view account. 16th Kerala Science Congress, 29-31 January, CWRDM, Kozhikode.

Nair, M.C., K.P. Rajesh and Madhusoodanan P.V. 2005a. Bryophytes of Wayanad in Western Ghats. Malabar Natural History Society, Kozhikode, i-iv + 284pp.

Nair, M.C., Rajesh, K.P. and Madhusoodanan, P.V. 2005b. Little known *Plagiochila* (Dum.) Dum. (Plagiochilaceae: Hepaticae) from India. *Geophytology* 35: 39-44.

Nair, M.C, Rajesh, K.P. and Madhusoodanan, P.V. 2006a. *Lejeunea exilis* (Lejeuneaceae: Hepaticae): a new record to India. *Acta Botanica Hungarica* 48 (1-2): 85-87.

Nair, M.C., Rajesh, K.P. and Madhusoodanan P.V. 2006b. Bryophytes of Chinnar wildlife sanctuary (South India)- A preliminary account. *Geophytology*. 36(1&2): 7-15.

Nair, M.C., Rajesh, K.P. and Madhusoodanan, P.V. 2006c. Addition to the bryoflora of Peninsular India. *J. Econ. Taxon. Bot.* 30 (2): 221-224.

Nair, M.C., Rajesh, K.P. and Madhusoodanan, P.V. 2007a. The genus *Philonotis* Brid. (Bartramiaceae: Bryopsida) in Peninsular India. *Folia Malaysiana* 18(1): 21-31.

Nair, M.C., Rajesh, K.P. and Madhusoodanan, P.V. 2007b. *Duthiella* (Moss: Bryophyta) a new genus record for Peninsular India. *Phytomorphology*. 57: 13-14.

Nair, M.C., Rajesh, K.P. and Madhusoodanan, P.V. 2007c. Three new bryophyte records for Peninsular India. *Indian J. For.* 30: 349-352.

Nath, V, Asthana, A.K. and Singh, A.P. 2000. Role of Bryophytes in soil management and rock binding. *Geophytology* 28: 95-1 00.

Nath, V. and Gupta, R. 2009. Taxonomic assessment of family Bryaceae (Bryopsida) of Pachmarhi Biosphere reserve (Madhya Pradesh), India. *Nelumbo*, 51: 161-174.

Nath, V. and Shalini Sharma, 2006. Scanning electron microscopic studies on spores of some West Himalayan Mosses, *Phytotaxonomy* Vol. 6. 53 – 60.

Nath, V., Asthana, A.K. and Kapoor, R. 2007. Enumeration of the Mosses in Amarkantak (Madhya Pradesh), India-□. Taiwania, 52(2), pp.168-176.

Nath, V., Pande, N., Asthana, A.K. and Gupta, R. 2012. Epiphytic moss flora of Pachmarhi Biosphere Reserve (MP): An important aspect of Bryophyte diversity. *National Academy Science Letters*, *35*(3), pp.195-200.

Negi, H.R. and Gadgil, M. 1997. Species diversity and community ecology of mosses: A case study from Garhwal Himalaya. Int. *J. Ecol. & Envt. Sci*. 23: 445-462.

Nicolson, D.H., Suresh, C.R. and Manilal, K.S. 1988. *An Interpretation of Rheeds' Hortus Malabaricus.* Koeltz Scientific Book, FRG.

Niranjana, M.R., Madhusoodanan, P.V. and Prakashkumar, R. 2013. The Pteridophyte Flora of Malabar Wildlife Sanctuary, Kerala, S. India: A Preliminary Report. *Indian Fern J.,* 30, pp. 119-127.

Noguchi, A. 1958. A small collection of mosses from southern India. Kumamoto. *J. Sci. Ser. B. Sec*. 4: 1 -4.

Noguchi, A. 1967. Musci. Japonici. VII. The genis Macromitrium. *J. Hattori Bot. Lab*. 30.

O'Shea, B. J., and Buck, W.R. 2001. Bryophytes of Uganda. 5. *Bryocrumia* L.E.Anderson (Hypnaceae), a monotypic moss genus new to Africa. *Tropical Bryology*, 20: 103-107.

Ochyra, R. 1985. On the Antarctic species of the family Orthotrichaceae. *Lindbergia*. 11:141-146.

Ochyra, R. 1989. *Miehea himalaya*, a new species and genus of Hylocomiaceae (Musci) from the Himalayas, *Nova Hedwigia*. 49: 323 – 332.

Ochyra, R. and Ireland, R.R., 2009. A New Species of Taxiphyllum (Musci: Hypnaceae) from Sri Lanka. *Novon: A Journal for Botanical Nomenclature*, *19*(4), pp.485-490.

Palani, R., Sathish, S.S., Thamizharasi, T. and Vijayakanth, P. 2017. Checklist of Mosses (Bryophyta) of Bodamalai Hills in Eastern Ghats, Tamil Nadu. *Plant Science Today*, *4*(1), pp.49-54.

Pande, S. K. 1936. Studies in Indian Liverworts: A Review, *J. Indian Bot. Soc.*. Vol. XV August, No. 4.

Pande, S.K. 1958. Some aspects of lndian Hepaticology (Presidential address). *J. lndian Bot. Soc*. 37. 7-26,

Pande, S.K., Misra, K.C.,and Srivastava, K.P. 1954. A species of *Riella* Mont., *R. vishwanathai* Pande, Misra & Srivastava, sp. nov., fron India. *Revue Bryol. et Lichenol*. 23: 165-172.

Pande, S.K., Srivastava, K.P. and Ahmad, S. 1957. Epiphyllous liverworts of lndia and Ceylon II. *J. lndian Bot. Soc*. 36: 335-347.

Prabhukumar, K.M., Robi, A.J., Hareesh, V.S., Dantas, K.J., Sujanapal, P. and Indira, B. 2017. *Artabotrys sahyadricus* (Annonaceae), a new species from Western Ghats of India. *Webbia*, *72*(1), pp.117-120.

Prajitha, B., Manju, C.N. and Prakashkumar, R. 2017a. New record of two mosses from Malabar Wildlife Sanctuary in the Western Ghats of India. *Geophytology*. 47(2): 155-159.

Prajitha, B., Rajilesh, V.K., Madhusoodanan, P.V. and Prakashkumar, R. 2017b. *Nardia assamica* (Mitt.) Amakawa (Jungermanniaceae) from Malabar Wildlife Sanctuary, a new record for Peninsular India. *Res. & Rev.: J. Bot.*. 6,3: 11-13.

Qian, L., You-Fang, W., and Qin, Z. 2010. Notes on Brachytheciaceae (Bryophyta) of China. *J. Wuhan Bot. Res.* 28(1): 10-15.

Qiu, Y.L. and Palmer, J.D. 1999. Phylogeny of early land plants: Insights from genes and genomes. *Trends in Pl. Sci.* 4:26-30.

Rajeevan, B. 1990. *Studies on the Bryophyte flora of the Idukki district, Kerala*. Ph.D thesis, Bharathiar University, Coimbatore.

Rajesh, K.P. 2010. Three new bryophyte records for Andaman Islands, India. *Taiwania*, *55*(2), pp.172-176.

Rajesh, K.P. and Manju, C.N. 2014. Bryophyte diversity of the lowlands and midlands of Kozhikode District, Kerala, India. *Frahmia* 5:1-10.

Rajilesh, V.K. 2017 and Prakashkumar, R. The Genus Entodon (Entodontaceae; Bryophyta) from Mathikettan Shola National Park in Kerala, India. *Research & Reviews: Journal of Botany*. 2017; 6(2): 1–8p.

Ramesh, M. and Manju, C.N. 2009. Ethnobryological notes from Western Ghats, India. *The Bryologist*, 112(3): 532-537.

Ramsay, H.P. 2012. Australian Mosses Online. 1. Sematophyllaceae: *Acroporium*. http://www.anbg.gov.au/abrs/Mosses_Online/Semat_ Acroporium.pdf

Rani, S.S., Sowghandika, M., Susheela, B., Nagesh, K. S., and Pullaiah, T. 2011. Additions to the Bryoflora of Southern Peninsular India. *J. Indian bot. Soc*. 90(1&2): 75-79.

Rashid, A., Mishra, R. and Sharma, A. 2012. Bryoflora of District Rajouri- Jammu and Kashmir State, India, *Archive for Bryology* 6. 145, *Academy of Sciences, India Section B: Biological Sciences*, *86*(4), pp.931-943.

Rawat, K.K. and Srivastava, S.C. 2007. *Genus Plagiochila in Eastern Himalaya, India*. Bishen Singh Mahendra Pal Singh. Dehra Dun. pp.258.

Rawat, K.K., Alam, A. Verma, P.K. 2015. Moss flora of Rajasthan and Punjab Plains. *Plant Sci. Today*, 2(4): 154-158.

Rawat, K.K., Alam, A. and Verma, P.K. 2016. Checklist of mosses (Bryophyta) of Gangetic Plains, India. *Bangladesh J. Pl. Taxon.*, 23(2), pp.97-106.

Rawat, K.K., Sahu, V.I.N.A.Y., Singh, C.P. and Verma, P.K. 2017. Additions to the bryophyte flora of Tawang, Arunachal Pradesh, India. *Frahmia*, *14*, pp.1-17.

Renzaglia, K.S. and Vaughn, K.C. 2000. Anatomy, development and classification of hornworts. In *Bryophyte biology*, ed. A.J. Shaw & B. Goffinet, pp.1-35. Cambridge University Press.

Rheede, H.A.Van. 1678-1703. *Hortus Indicus Malabaricus*. Amsterdam.

Robi, A.J., Jose, P.A. and Udayan, P.S. 2014. *Thottea sasidharaniana* sp. nov. (Aristolochiaceae) from Peninsular India. *Nordic J. Bot.*, *32*(1): 11-14.

Robi, A.J., Udayan, P.S., Li, H.W. and Li, J. 2017. A new species of *Litsea* (Lauraceae) from Kerala part of Western Ghats, India. *Phytotaxa* 303(3), pp. 285–289.

Robi, A.J. and Udayan, P.S. 2017. A new variety of *Alseodaphne semecarpifolia* Nees (Louraceae) from the Western Ghats of Kerala, India. *Taiwania* 62(3): 252-256.

Robinson, H. 1968. Notes on bryophytes from the Himalayas and Assam. *Bryologist*, 6: 82-97.

Sabu V. and Asthana, A.K. 2015, Bryophyte diversity in Terai regions of Uttar Pradesh, India with some new additions to the State. Tropical Plant Research 2(3): 180-191.

Sandhya Rani S., Sowghandika, M., Nagesh K.S, Susheela B. and Pullaiah, 2014. *Bryophytes of Andra Pradesh,* Bishen Singh Mahendra Pal Singh, Dehra Dun, India

Sathish, S., Kavitha, R. and Kumar, S.S. 2013. Bryophytes in India- The Current Status. *IJREB*. 1(4):23-31.

Sathish, S., Mohana, D.C., Ranhavendra, M.P., and Raveesha, K.A. 2007. Antifungal activity of some plant extracts against important seed borne pathogens of *Aspergillus* sp. *J. Agri. Tech.* 3:109-119.

Sathish, S.S., Thamizharasi, T., Palani, R., Vijayakanth, P. and Vimala, A. 2014. Checklist of mosses (Bryopsida) of the Kalrayan Hills in the Eastern Ghats of Tamil Nadu, India. *Eng. Biosci*, *2*, pp.28-33.

Saxena, D.K. and Harinder, 2004. Use of Bryophytes. *Resonance*. 9(6): 56-65.

Schuster, R.M. 1958. Annotated key to the orders, families and genera Hepaticae of America and north of Mexico. *Bryologist 61: 1-66*

Schwarz, U. 2013. An updated checklist of Bryophytes of Karnataka. *Archive for Bryology*. 181: 1-42.

Schwarz, U. and Frahm, J.P. 2013. A contribution to the bryoflora of the Western Ghats in Karnataka State, India. *Polish Bot. J.*, 58(2), pp.511-524.

Shanthanu, S. 2010. *Mosses of Idukki In Western Ghats, India.* Ph.D Thesis, Delhi University, Delhi, India.

Sharma, D. and Alam, A. 2011. Present status of liverwort diversity at Pachmarhi (Madhya Pradesh). *J. Indian Bot. Soc*, *90*(3&4): 332-338.

Sharma, A., Langer, A. and Uniyal, P.L., 2016. A Preliminary Report on the Mosses of Rajouri and Poonch Districts of Jammu & Kashmir, India. *Evansia*, *33*(1), pp.26-34.

Shuvadeep, M., Siddhartha Singh, D. and Singh, D.K. 2013, *Plagiochilion braunianum* (Plagiochilaceae, Marchantiophyta)- an addition to the Indian bryoflora from E. Himalaya. *Lindbergia* 36: 19-24, 2013.

Simona, C., Michele, A., Sara, B. and Vincenzo, Z. 2012. Aquatic bryophytes as ecological indicators of the water quality status in the Tiber River Basin (Italy). *Ecological Indicators*. 14(1): 74-81.

Sing, D. and Singh, D.K. 2011. *Ptilidium pulcherrimum* (G. Weber) Vainio (Hepaticae: Ptilidiaceae) – An addition to Indian Bryoflora, *Nelumbo*. 53: 205 - 210.

Singh D.K. and Singh, S.K. 2015. *Manual of liverworts and Hornworts of Himachal Pradesh*, India, 1-205 Bishen Singh Mahendra Pal Singh, Dehradun

Singh, A.P., Nath, V. and Asthana, A.K. 2003. Studies on *Cephalozia pandei* Udar et Kumar from Meghalaya: India. Crypt.. Bryol. Et Lichenol., 24(4): 335-340.

Singh, A.P. and Nath, V. 2007. *Hepaticae of Khasi and Jaintia Hills: Eastern Himalaya.* Bishen Singh Mahendrapal Singh, Dehradun, India. Pp.382.

Singh, D and Singh, D.K. 2011. *Ptilidium pulcherrimum* (G. Webber) Vainio (Hepaticae: Ptilidiaceae). An addition to the Indian Bryoflora. *Nelumbo*. 53: 205-210.

Singh, D. K. and Sidhartha Singh Deo, 2014. Notes on scarcely collected Indian Liverworts *Horikawaella subacuta* and *Pleurozia purpurea* (Marchantiophyta), *Indian J. Forest.* 37(4): 465 – 472.

Singh, D., Dey, M. and Upadhyay G.K. 2010. A preliminary survey of Hepaticae of littke Andaman Island. *Nelumbo*. 52: 125-130.

Singh, D.K. and Dey, M. 2010. *Genus Tuyamaella* S. Hatt. (Lejeuneaceae) in India. *Nelumbo* 52: 135-137.

Singh, D.K. and Singh, S.K. 2008. Diversity in Liverworts and Hornworts of Great Himalayan National Park, Western Himalaya, India. Bryology in the New Millennium. Kuala Lumpur, pp.57-81.

Singh, D.K., Singh, D. and Singh, S.K. 2016. *Liverworts and hornworts of India: an Annotated Checklist.* Botanical Survey of India, Ministry of Environment, Forest & Climate Change.

Singh, M. 2011. Antibacterial activity of some bryophytes used traditionally for the treatment of burn infections. *Pharmaceu. Biol.*. 49: 5.

Singh, S.D. and Singh, D.K. 2014. *Bazzania bhutanica* (Lepidoziaceae, Marchantiophyta) a critically endangered liverwort recorded in Indian bryoflora. *Lindbergia.* 37: 42-46.

Singh, D.K., Majumdar, S. Deo. S.S. 2016. *Radula* (Radulaceae, Marchantiophyta) in India with three new additions from Arunachal Pradesh in Eastern Himalaya, Cryptogamie, Bryologie, 37(2), 167-180.

Smith, G.M. 1955. Cryptogamic Botany-11: Bryophytes and Pteridophytes. *McGraw Hill Book Co. Inc., New York.*

Soderstrom, L., Hagborg, A., von Konrat, M., Bartholomew-Began, S. E., Bell, D., Briscoe, L., Brown, A., Cargill, D.C., da Costa, D. P., Crandall-Stotler, B. J., Cooper, E. D., Dauphin López, G., Engel, J., Feldberg, K., Glenny, D.S.,

Gradstein, S.R., He, X.-L., Heinrichs, J., Hentschel, J., Ilkiu-Borges, A. L., Katagiri, T., Konstantinova, N. A., Larraín, J., Long, D.G., Nebel, M., Pocs, T., Puche, F., Reiner-Drehwald, M. E., Renner, M.A.M., Gyarmati, A. A., Schafer-Verwimp, A., Segarra-Moragues, J.G., Stotler, R.E., Sukkharak, P., Thiers, B.M. Uribe, J.C., Váňa, J., Villarreal, J. C., Wigginton, M. J., Zhang, L. and Zhu, R.-L. 2016. World checklist of hornworts and liverworts. *PhytoKeys* 59(1–2): 1–828.

Srivastava, A. and Srivastava, S.C. 2002, *Indian Geocalycaceae (Hepaticae),* Bishen Singh Mahendra Pal Singh, Dehradun, 39. 1-245.

Srivasta, S.N. and Srivastava, P. 2007. *Scapania stephani* K. Muell: A Hepatic new to Indian bryoflora. *Phytomorphology*. 53(3&4):133-135.

Srivastava S.N., Rai, M. and Srivastava, P. 2016. On the occurrence of *Spruceanthus semirepandus* (Nees) Verd. (Lejeuneaceae; Marchantiophyta) in Western Himalaya, India. *Indian J. Pl. Sci.* 5 (1): 27-32.

Srivastava, S. C. and Udar, 1975. Taxonomy of the Indian Metzegriaceae – A monographic study, *New Botanist*. 2(1): 1 – 57.

Srivastava, S.C. and Udar, R. 1976. Indian Aneuraceae- A monographic study. *Biol. Mem.*1: 121-154.

Srivastava, S.C. and Sharma, D. 2000. A preliminary study on the liverwort and hornwort flora of Silent Valley (Kerala). *In:* Chauhan (ed.), *Prof D.D. Nautiyal Commemoration Volume Recent Trends in Botanical Researches*, pp. 55-75.

Srivastava, S.C. and Rawat, K.K. 2001. A long- loast endemic liverwort (Hepaticae) from India. *Curr. Sci.* 80: 12.

Srivastava, S. C. and Rawat, K.K. 2011. On an endangered liverwort (Marchantiophyta) from India, proposal for Red Listing, *Nelumbo*. 53: 201 – 204.

Stankovic, J.D., Sabovljevic, A.D. and Sabovljevic, M.S. 2018. Bryophytes and heavy metals: a review. *Acta Bot. Croatica*, *77*(2), pp.109-118.

Stephani, F. 1906-1924. Species Hepaticarum 2-6: Geneva. *New Botanist* 2: 1-57.

Stotler, C.B. and Stotler, R. 2000. Morphology and classification of the Marchantiophyta. In *Bryophyte Biology*. ed. A. J. Shaw & B. Goffinet, pp. 21-70. Cambridge: Cambridge University Press.

Sudipa, D. and Sing, D.K. 2011. A new species of *Calypogeia* raddi (Marchantiophyta: Calypogeiaceae) from Eastern Himalaya, India, *Nelumbo*. 53: 194 – 196.

Sujanapal, P., Robi, A.J. and Dantas, K.J. 2017. A new tuberous species of *Sonerila* Roxb. (Melastomataceae) from Malabar Wildlife Sanctuary, Kerala, India. *Webbia*, *72*(1), pp.93-96.

Tan, B.C. 1991. A new annotated Philippines moss checklist. *Harward Pap. Bpt*. 3:1-64

Tan, B.C. 2003. *in*: *Bryophyte Ecology*. E. book sponsored by Michigan Technological University and the International Association of Bryologist. 5

Tessler, M. 2016. An updated checklist of Bryophytes of the Shawangunk Mountains, New York. *Evansia*. 33(4):154-164.

Thamizharasi, T., Sathish, S.S., Palani, R., Vimala, A. and Vijayakanth, P. 2018. Enumeration and phytogeographical pattern of mosses (Bryopsida) in Kalrayan Hills of Eastern Ghats of Tamilnadu, India. *Int. J. Develop. Res.*, *8*(1): 18212-18216.

Thieret, J, W. 1956. Bryophytes as economic plants. *Econ. Bot*. 10: 75-91.

Turetsky, M.R. 2003. The role of Bryophytes in Carbon and Nitrogen cycling. *The Bryologist*. 106(3): 395-409.

Udar, R. 1976a. Recent advances in Hepaticae (liverworts) in India. In: P. Kachroo (ed.), *Recent Advances in Botany*, Prof. P.N. Mehra Comm. Vol. Dehra Dun, Delhi.

Udar, R. 1976b. *Bryology in India*. Cronica Botanica. New Delhi.

Udar, R. and Singh, D.K. 1977. Studies in East Himalayan Hepaticae I. The genus Trichocolea Dumort. *Geophytology* 7: 65-72.

Udar, R. and Jain, A. 1984. Liverworts of Kerala-1. Marchantiales. *Indian J. For*. 7:300-304.

Udayan, P.S., Tushar, K.V. and George, S. 2007. A new variety of *Humboldtia* (Fabaceae: Caesalpinioideae) from the Western Ghats of India. *J. Bot. Res. Inst. Texas* 1(1): 121-127.

Udayan, P.S., Raghu, A.V., Sreekumar, V.B, Muraleedaran, C.M. 2014. A new variety of *Salacia* (Celastraceae) from the Western Ghats of Kerala, South India. *International Journal of Plant, Animal and Environmental Sciences* 4(3):100-102.

Udayan, P.S., Raghu, A.V., Begum, S.N. and Pradeep, A.K. 2015. *Diospyros udaiyanii* (Ebenaceae), a new species from Western Ghats, India. *Bangladesh J. Plant Taxon. 22*(2): 83-86.

Vanderpoorten, A. and Goffinet, B. 2009. *Introduction to bryophytes*. Cambridge University Press.

Vashistha, B.D. 1998. Distribution of mosses in India. *Topics in Bryology. allied Publishers limited,* New delhi, pp.86-111.

Verma, P. K. 2009. Genus *Cololejeunea* (Spruce) Schiffn. in Nilgiri Hills (Western Ghats). *Nelumbo* 51: 157-160.

Verma, P.K. and Srivastava, S.C. 2011. Endemism in Liverworts of Western Ghats and their present status. *Archive for Bryology* 99 1-21, 2011

Verma, P.K., Alam, A. and Rawat, K.K. 2013. Assessment of liverwort and hornwort flora of Nilgiri hills, Western Ghats (India). *Polish Bot. J.* 58(2): 525-537.

Vitt, D.H. 2000. Functional characteristics and indicators of boreal peatlands. *In: Boreal peatland ecosystems*, Springer, Berlin, Heidelberg, pp.9-24

Vohra, J.N. 1969. A contribution to the moss flora of Western Himalayas. *Nelumbo*, *11*(1-2): 41-50.

Wallich, N. 1828-1832. A numerical list of dried specimens of plants in the East lndia company's Museum (Calcutta) collected under supervision of Dr. Wallich. (Mosses- Nos. 7545-7582).

Watson, L. and Dallwitz, M.J. 2005. The moss families of the British Isles. http://delta-intkey.com.

William, P. Haines and Alan, J. 2009. Bryophytes as food: Comparative consumption and utilization of mosses by a generalist insect herbivore. *Entomol. Exper. et Appl.*. 133(3): 296-306.

Yokinobu, K. 1986, *The Metzgeriaceae of the Neotropics*. Berlin. Stuttgart.

Zheng, G., Chang, C., Stout, T.J., Clardy, J. and Cassady, J.M. 1989. Ohioensin-A: A novel benzonaphthoxanthenone from Polytrichum ohioense. *Jour. Amer. Chem. Soc*. 111.

INDEX TO SPECIES DESCRIBED

List of Papers Published

- **Prajitha, B.**, Manju, C.N. and Prakashkumar, R., 2017**.** 'New record of two mosses from Malabar Wildlife Sanctuary in the Western Ghats of India'. *Geophytology* 47(2): 155-159.

- **Prajitha, B.,** Rajilesh, V.K., Madhusoodanan, P.V., Prakashkumar, R., 2017. *'Nardia assamica* (Mitt.) Amakawa (Jungermanniaceae), from Malabar Wildlife Sanctuary, a New Record for Peninsular India'. *Research &Reviews: Journal of Botany.* 6(3):11-13.

- Manju, C.N., Rajilesh, V.K., **Prajitha, B.**, Prakashkumar, R. and Rajesh, K.P., 2014. 'Contribution to the Bryophyte flora of India: Silent Valley National Park in the Western Ghats, India'. *Acta Biologica Plantarum Agriensis*.73-93.

- **Prajitha, B**., Manju, C.N. and Prakashkumar, R., 2013. *Aerobryopsis wallichii* (Bryophyta),a new record for India. *Geophytology*. 42(2):147-149.

- Manju, C.N. Prakashkumar, R., **Prajitha, B.**, Rajilesh, V.K. and Anoop, K.P., 2012. '*Trichosteleum stigmosum* Mitt. (Sematophyllaceae) from Silent Valley National Park, a New Record for India'**.** *Taiwania,* 57(2): 222-224.

List of Papers Presented

- **Prajitha, B**., Madhusoodanan, P.V. and Prakashkumar, R., 2017. '*Acroporium strepsiphyllum* (Mont.) B.C. Tan (Sematophyllaceae) from Malabar Wildlife Sanctuary, a new record for India'. GMF National Seminar, University of Kerala, Karyavattom.

- **Prajitha, B.** and Prakashkumar, R., 2017. 'Diversity of Liverworts in Malabar Wildlife Sanctuary'. UGC Sponsored National Seminar. ST. Mary's College, Wayanad.