# An overview of bryophytes in Western Ghats

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The bryophytes of the Western Ghats are a vital component of the biodiversity and ecological functioning. Their conservation is essential not only for preserving the unique flora of the Western Ghats but also for maintaining the ecological balance of the region. Research, habitat protection and public awareness are key to ensuring the survival of the important plants. Mosses, belonging to the class Bryopsida, are a significant component of the bryophyte flora in the Western Ghats which are small, non-vascular plants that found in a wide range of habitats within the Western Ghats, from the lowland rainforests to the high-altitude montane regions. It plays a critical role in the ecology of the region, contributing to soil formation, water retention and providing microhabitats for various organisms. Liverworts, belonging to the division Marchantiophyta, are a significant group of non-vascular plants, often overlooked due to their small size and play an essential role in the ecology of the region. Liverworts are among the earliest land plants and thrive in the moist, shaded environments that characterize the Western Ghats.

**Keywords**: Liverworts, Mosses, Non-vascular plants, Western Ghats, Microhabitats

## 1. Introduction

Bryophytes, a group of non-vascular plants, include mosses, liverworts and hornworts that play a crucial role in the ecosystem by contributing to soil formation, water retention and providing habitats for microfauna (Qing et al., 1999). The Western Ghats is a biodiversity hotspot in India, known for its rich flora and fauna, including a variety of bryophytes

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together with different pteridophytes and angiosperms (Subramanyam and Nayar 1974). The Western Ghats provide an ideal environment for bryophytes due to its varied climate and topography and hosts over 850 species, making it one of the richest areas for bryophyte diversity in India. Mosses are the most dominant group, followed by liverworts and hornworts which are commonly found in moist, shaded environments such as forest floors, tree trunks, rocks and along streams (Kumar et al., 2011).
The term Bryophyta was derived from two Greek words; Bryon meaning moss and Phyton meaning plant, that introduced by Robert Brown in 1864 to include the algae, fungi, lichens and mosses. Recently, the term has been used to mention the group of plants which includes the members of non-vascular cryptogams. The bryophytes are highly specialized group of plants having enormous surviving capacity as they survive under wide variety of environmental conditions (Mogensen, 1981). They grow in different habitats like forests, wet lands, desert etc. Though basically terrestrial, some of them are aquatic like *Riccia fluitans, Ricciocarpus natans* and *Riella* spp., while *Cryptothallus* and *Buxbaumia* are saprophytic genera of liverworts. Mosses on contrary to the rest of the bryophytes are autotrophic. Generally, they have been classified under three diversified classes viz., Hepaticae, Anthocerotae and Musci (liverworts, hornworts and mosses respectively).

Bryophytes play an important role in nutrient cycling, soil formation and provide microhabitat for other plants and animals. Beyond this, they have been widely used for pollution monitoring and bioremediation (Wei and Fang,

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2004). Due to rapid urbanization and pressures inflicted by growth of human population and their intense activities, the bryophyte diversity is greatly influenced. Hence, the conservation of bryophyte is very important in ecosystem dynamics which can be established by creating moss gardens and protected areas, sacred groves and in-vitro technique. The regular monitoring and periodic collection of data on rare and threatened species is also relevant in conservation strategy (Das et al., 2006). The bryophytes are the second largest group of plants after angiosperms. Due to the wide distribution, recent researches regarding Molecular Biology, Anatomy, Systematics, Cytology etc. are focused on the group.

## 2. Diversity in bryophytes

Bryophyte are diverse and heterogenous division of the plant kingdom include three groups, *viz*. Liverworts, Hornworts, and Musci (True moss). They are viewed as three monophyletic lineages emerging from the earliest land plants by observing from the cell ultrastructure and Molecular Biology including Liverwort (Hepaticopsida), Moss (Bryopsida) and Hornwort (Anthocerotopsida) (Troitsky et al., 2007).

### 2.1. Liverwort

Liverworts include a number of species ranges from 5000, consists of 141 genera and 59 tribes (Grace, 1995). Leafy forms are represented by nearly 85% that show extensive amount of morphological, anatomical and ecological diversity. The plants with leafy shoot system are the predominant growth forms in this class (*Radula*, *Frullania*, *Jubulopsis* and *Cololejeunea*). Thalloid forms such as Metzgeriales and

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Marchantiales are widely seen in semi aquatic places and wet climate forests. Sporophyte of liverworts grows with the gametophyte up to the time of the capsules. The dispersal mechanism of the spores is by the twisting motion of elaters and by splitting of sporophyte into four segments (Fenton and Frego, 2005).

### 2.2. Mosses

Mosses are the largest group with estimates of the number of species ranging from 10000 to 15000. In India mosses portray 2300 species in 330 genera. It is one of the dominant plants in the highlands that grows in cold and humid conditions (Groombridge and Jenkins, 2002). In most cases, leaves are arranged spiral and have leaf veins. For the effective spore dispersal, the capsule has a unique structure called peristome. The sphagnum mosses are one of the most economically and ecologically important types of bryophytes (Bahuguna et al., 2014).

### 2.3. Hornworts

Hornworts consists of approximately 200 species in the world. This class similar to liverwort except the thalloid gametophyte in the form of discs and chiselled edges. It possesses *Nostoc* colonies ventrally in their thallus. These algae show the symbiotic nature of providing organic nitrogen for thallus metabolism and the thallus provide food and shelter. This type has sporangia like a cylindrical horn called sporophyte. The released spore from sporophytes takes place gradually over a long period. The spores are dispersed through water movement and not by wind. Hornworts is different from all

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other land plants in having only one large, algal-like chloroplast in each thallus (Feldberg et al., 2021).

### 3. Classification

Bryophytes, the non-vascular plants, are typically small and complete their life cycle in moist environments that include mosses, liverworts and hornworts. These are classified into three main classes based on their morphological and reproductive features including Hepaticopsida, Bryopsida and Anthocerotopsida (Renzaglia et al., 2007).

Hepaticopsida members has thalloid or leafy structure with simple, lobed leaves arranged in two or three rows. Rhizoids (root-like structures) are unicellular and reproduce asexually through gemmae and sexually through antheridia and archegonia. The sporophyte is relatively simple and often lacks stomata. The class includes *Marchantia* and *Riccia* species.

The Bryopsida possesses the most common and diverse group of bryophytes having leafy gametophytes with spirally arranged leaves and multicellular rhizoids. The sporophyte has a complex structure with a capsule and stomata which reproduce sexually, with a prominent sporophyte that is attached to the gametophyte. *Funaria* and *Polytrichum* include in the class with specific features.

The species of Anthocerotopsida have thalloid gametophytes with a flattened, lobed appearance. They have a unique horn-like sporophyte that grows continuously from the base. Stomata are present in the sporophyte which is photosynthetically active. Each cell typically contains a single

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large chloroplast. *Anthoceros* and *Notothylas* are the prominent species of the class. These classes represent the diversity within bryophytes, showcasing different adaptations to their environments and life cycles (Shaw and Goffinet, 2000).

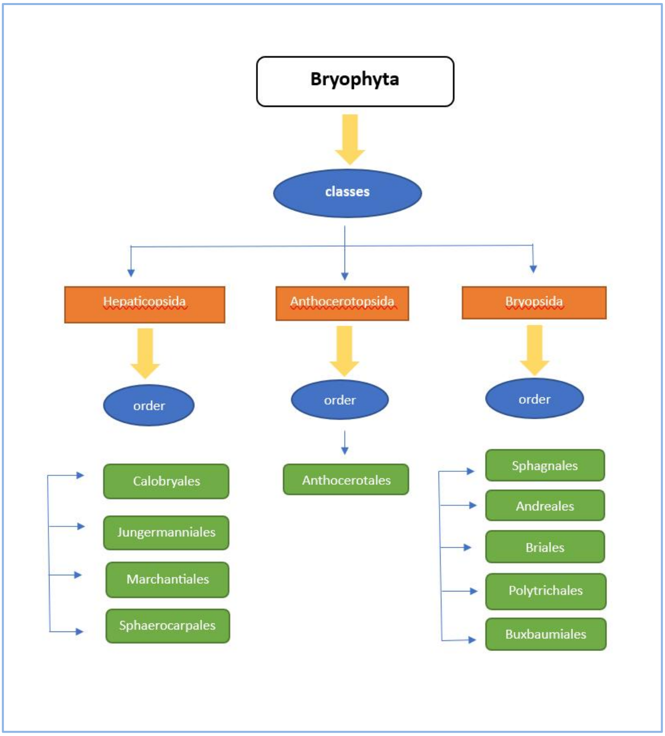


Figure 1. Classification of bryophytes

## 4. Ecological importance

Bryophytes have many ecological uses in turn balance the ecosystem, even though these are smaller flora. Some of the

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important roles of bryophytes are given below which maintain the normal functioning of the ecosystem.

### 4.1. As pioneer colonizers in succession

The nutrient-poor, barren areas, where no other plants may flourish, are normally colonized by bryophytes. Following a protracted period, these bryophyte colonies formed an organic layer on that desolate area, aiding in the development of microorganisms. These microorganisms alter the mineral state of substratum, making the area favourable for the growth of more vegetation. During periods of excessive moisture, the colonies of epiphytic bryophytes that grow on tree trunks and branches absorb water. As a result, the branches break and their weight increases. As a result, a new succession is created together with the breakdown wood, changes in moisture and lighting conditions (Ogwu, 2020).

### 4.2. As pollution and heavy metal indicator

Bryophytes are heavy metal accumulators and bioindicators of pollution in the air and water. Under such disturbed environmental conditions viz. air pollution, communities of liverworts, lichens and mosses gradually shrink. With the exception of a few resilient species including *Bryum*, *Ceratodon*, *Dicranoweisia*, *Funaria*, *Hyophila* and *Tortula*, mosses vanish from such contaminated regions. A good picture of the level of pollution can be obtained by examining the relationship between the distribution of communities, Index of Atmospheric Purity (IAP) values, and sulfur dioxide levels. The vegetative propagule, protonemata, is particularly sensitive to the contaminant that affect the growth of microflora. While, mosses can flourish in environments with

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even low $SO_2$ concentrations. Hydrogen fluoride (HF) can harm bryophytes, even at low concentrations (0.001 to 0.1 ppm), as they are highly sensitive to it. When exposed to an HF-polluted environment, *Pylaisiella* and *Orthotrichum* have been found to alter the color of their leaves as a result of chlorophyll degradation (Leblanc and Rao, 1974). *Sphagnum* is utilized to filter contaminated waste water and has a unique ability to bind radioactive substances through cation exchange. Caesium can accumulate in certain species of *Anomodon*, *Dicranum*, *Eurhynchium*, *Leucodon*, *Mnium*, *Rhynchostegium*, and *Thuidium*. It has been discovered that leafy liverworts are more susceptible to ionizing radiation. More strontium can be concentrated by species of *Brachythecium*, *Buxbaumia*, and *Grimmia* than can be found in their substrata. Similarly, certain alien bryophytes can store uranium. Many moss-sporophytes growth is inhibited by high amounts of contaminants such as heavy metals, sulphur dioxide, fluoride and acidified rain. Because aquatic bryophytes can accumulate heavy metals and release them only after decomposing, they are the greatest monitoring agents for heavy metal contamination. Some bryophytes have high cadmium concentrations, which causes a noticeable shift in these lower plant's growth rate and pigmentation. Zinc concentrations greater than 50 ppm inhibit spore germination in *Marchantia* and *Funaria*. Certain species of *Bryum*, *Dicranella* and *Polytrichum* can withstand high concentrations of copper (2700 ppm), cadmium (610 ppm), and zinc (55000 ppm) in their tissues (Printarakul and Meeinkuirt, 2022).

### 4.3. As site indicators

Compared to vascular plants, bryophytes have a greater capacity to hold onto certain minerals in their substrata. For this reason, they are employed in geobotanical research. *Barbula*, *Gymnocolea*, *Mereya*, *Mielichhoferia*, *Scopelophila* and *Solenostoma* species are found on zinc, iron and lead sulphides, and they grow best in substrates containing high copper concentrations (320-770 ppm). Several species belonging to *Campylopus*, *Barbula*, *Brachythecium*, *Bryum* and *Gymnostomum* have been shown to flourish on gypsum (pH 4.9-7.8) and to frequently have this material encrusted on them (Tewari and Pant 1998). Certain bryophytes accumulate deposits of tufa and the precipitation of calcium from the surrounding soil produces calcareous tufas. Certain species are related to the seed plants because the particular community of seed plants provide a favourable habitat for the bryophytic plants. As a result, it helps to describe a site in certain contexts, even when the vascular plant dies, bryophyte vegetation can provide information about the particular community. They can also be used as markers to plant specific taxa in that region and can show the sort of flora that was present in the past. *Solenostoma* thrives on the seepage water from copper mines. Certain bryophytes are able to grow in such soil, which has a high concentration of copper which collect copper from the soil (Hylander et al., 2002). Rainfall readily accumulates K, Ca, and Mg in mosses. The patterns found on *Hyophila*, *Oxystegus*, and *Zygodon* denote substrates containing iron hematite at that specific location. Bryophytes have a well-defined ecological range and are useful for assessing soil quality and environmental conditions. A sign of acidic soil is *Polytrichum* which flourish in acidic conditions.

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A few indicators of soil pH were listed by Hydbom et al. (2012), including *Atrichum undulatum* (4.5-6.0), *Marchantia polymorpha* (6-7.5), *Tortula rhyzophylla* (6.1-7.4) and others.

### 4.4. Ecophysiology of the group

Globally, bryophytes are extensively dispersed and play a role in the cycling of nutrients, water retention, availability, increased biomass in plants and community maintenance (Song et al., 2015). Therefore, the services, activities and processes of the ecosystem benefit other members of the ecological community of bryophytes. The water that bryophytes collect benefits other plants ecologically by utilizing it for internal operations (Atwood and Buck, 2020). In general, these services might be referred to as 'buffer systems'. Because of their diversity of chemical groups and sensitivity to atmospheric moisture levels, bryophytes serve as indicators of environmental quality. According to Lobs et al. (2019), bryophyte responses to environmental variations are a reflection of their ecological and reproductive strategies for ensuring their establishment, permanence and spread. The results of Perera-Castro et al. (2022) have refuted an earlier concept that suggested bryophyte fertility declines with increasing latitude and consequently climate severity. Furthermore, their sex expression is persistent over extended periods of time, irrespective of locales, seasons and small environmental differences; yet, the maturity of gametangia and sporophytes may be influenced by seasonal variations (Maciel-Silva et al., 2012). In mosses, carbon fixation reaches saturation at moderate light levels. According to Proctor and Smirnoff (2011), mosses have a high capacity for

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photosynthetic electron transfer to oxygen, a high level of non-photochemical quenching that is activated at high irradiance, and a high tolerance to reactive oxygen species as means of protecting themselves against excess excitation energy. According to Wagner et al. (2014), bryophytes, being poikilohydric organisms, adjust to external moisture conditions quite quickly. Moreover, bryophyte development and survival are heavily reliant on their external environment because of their poikilohydric strategy for nutrients and water (Marschall, 2017).

**5. Diversity of bryophytes in Western Ghats**

The checklist reports that total 2489 taxa of bryophytes recorded from India, comprising 1786 species in 355 genera of mosses, 675 species in 121 genera of liverworts and 25 species in six genera of hornworts (Sathish et al., 2013). The bryophyte flora of the *Agasthyamalai* Biosphere Reserve consists of 90 taxa (58 mosses, 32 liverworts), of which 16 species are newly reported for the Peninsular India (*Asterella reticulata, Bazzania sumbavensis, Cephalozia pandei, Clastobryopsis muelleri, Cyathophorella adiantum, Dicranoloma subreflexifolium, Herbertus dicranus, Himantocladium cyclophyllum, Hypnum plumaeforme, H. sikkimense, Leucobryum cucullifolium, Radula grandifolia, Symblepharis vaginata, Symphyodon echinatus, Trichocolea udarii* and *Trichostelium boschii*) and another 6 are new for the Kerala State (*Campylopus involutus, Cephaloziella willisiana, Frullania ericoides, Macromitrium moorcroftii, Metzgeria decipiens* and *Leucobryum mittenii*) (Manju and Rajesh, 2009). Coorg District of Karnataka, a small area of the Western Ghats, includes 18 species of liverworts and

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hornworts as well as 76 species of mosses. 27 species of mosses are newly reported for the state of Karnataka, in which 6 species are new for Coorg province. *Holomitrium javanicum* is reported as new one to India and *Campylopus sedgwickii* described from Sri Lanka (Schwarz and Frahm, 2013).

Table 1. Species of bryophytes in Western Ghats

| Sl. No | Species | Family |
|---|---|---|
| 1 | *Asterella reticulata* | Aytoniaceae |
| 2 | *Dumortiera hirsuta* | Marchantiaceae |
| 3 | *Plagiochasma appendiculatum* | Marchantiaceae |
| 4 | *Targionia hypophylla* | Targioniaceae |
| 5 | *Riccardia tenuicostata* | Aneuraceae |
| 6 | *Metzgeria decipiens* | Metzgeriaceae |
| 7 | *Pallavicinia lyellii* | Pallaviciniaceae |
| 8 | *Pallavicinia ambigua* | Pallaviciniaceae |
| 9 | *Trichocolea udarii* | Trichocoliaceae |
| 10 | *Chandonanthus birmensis* | Jungermanniaceae |
| 11 | *Schistochila aligera* | Schistochilaceae |
| 12 | *Jubula hutchinsiae* | Jubulaceae |
| 13 | *Frullania ericoides* | Jubulaceae |
| 14 | *Frullania tamarisci* | Jubulaceae |
| 15 | *Bazzania tridens* | Lepidoziaceae |
| 16 | *Bazzania sumbavensis* | Lepidoziaceae |
| 17 | *Cephalozia pandei* | Cephaloziellaceae |
| 18 | *Cephaloziella willisiana* | Cephaloziellaceae |
| 19 | *Cephalozia willisiana* | Cephaloziellaceae |
| 20 | *Cephalozia andreana* | Cephaloziellaceae |
| 22 | *Cylindrocolea tagawae* | Cephaloziellaceae |
| 23 | *Herbertus dicranus* | Herbertaceae |
| 25 | *Radula grandifolia* | Radulaceae |
| 26 | *Cololejeunea lanciloba* | Lejeuneaeceae |
| 27 | *Lejeunea obfusca* | Lejeuneaeceae |
| 28 | *Lejeunea eifrigii* | Lejeuneaeceae |
| 29 | *Cheilolejeunea serpentina* | Lejeuneaeceae |
| 30 | *Spruceanthus semirepandus* | Lejeuneaeceae |
| 31 | *Plagiochila beddomei* | Plagiochilaceae |
| 32 | *Plagiochila devexa* | Plagiochilaceae |

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| | | |
|---|---|---|
| 33 | *Plagiochila fruticosa* | Plagiochilaceae |
| 34 | *Plagiochila nepalensis* | Plagiochilaceae |
| 35 | *Pogonatum leucopogon* | Polytrichaceae |
| 36 | *Pogonatum microstomum* | Polytrichaceae |
| 37 | *Diphyscium mucronifolium* | Diphysciaceae |
| 39 | *Entosthodon wichurae* | Funariaceae |
| 40 | *Calymperes afzelii* | Calymperaceae |
| 41 | *Calymperes lonchophyllum* | Calymperaceae |
| 43 | *Fissidens anomalus* | Fissidentaceae |
| 45 | *Dicranoloma subreflexifolium* | Dicranaceae |
| 46 | *Campylopus ericoides* | Dicranaceae |
| 47 | *Campylopus flexuosus* | Dicranaceae |
| 48 | *Campylopus involutus* | Dicranaceae |
| 49 | *Campylopus pilifer* | Dicranaceae |
| 50 | *Symblepharis vaginata* | Dicranaceae |
| 51 | *Leucobryum cucullifolium* | Leucobryaceae |
| 52 | *Leucobryum juniperoideum* | Leucobryaceae |
| 53 | *Leucobryum mittenii* | Leucobryaceae |
| 54 | *Leucoloma amoene-virens* | Leucobryaceae |
| 55 | *Leucoloma taylorii* | Leucobryaceae |
| 57 | *Tortella tortuosa* | Pottiaceae |
| 58 | *Bryum paradoxum* | Bryaceae |
| 59 | *Bryum wightii* | Bryaceae |
| 60 | *Rhodobryum roseum* | Bryaceae |
| 61 | *Pyrrhobryum spiniforme* | Rhizogoniaceae |
| 62 | *Racopilum orthocarpum* | Racopilaceae |
| 63 | *Macromitrium sulcatum* | Orthotrichaceae |
| 64 | *Macromitrium moorcroftii* | Orthotrichaceae |
| 65 | *Garovaglia plicata* | Pterobryaceae |
| 68 | *Himantocladium cyclophyllum* | Pterobryaceae |
| 69 | *Homaliodendron flabellatum* | Pterobryaceae |
| 70 | *Homaliodendron microdendron* | Pterobryaceae |
| 71 | *Trachypus bicolor* | Trachypodaceae |
| 72 | *Aerobryum speciosum* | Meteoriaceae |
| 73 | *Meteoriopsis squarrosa* | Meteoriaceae |
| 74 | *Pinnatella calcutensis* | Neckeraceae |
| 75 | *Thuidium cymbifolium* | Thuidiaceae |
| 76 | *Thuidium pristocalyx* | Thuidiaceae |
| 77 | *Symphyodon echinatus* | Symphyodontaceae |
| 78 | *Cyathophorum adiantum* | Hypopterigiaceae |
| 79 | *Hypopterygium aristatum* | Hypopterigiaceae |

| | | |
|---|---|---|
| 80 | *Chionostomum rostratum* | Sematophyllaceae |
| 81 | *Clastobryopsis muelleri* | Sematophyllaceae |
| 82 | *Foreauella orthothecia* | Sematophyllaceae |
| 83 | *Taxiphyllum taxirameum* | Sematophyllaceae |
| 84 | *Trichostelium boschii* | Sematophyllaceae |
| 85 | *Isopterygium albescens* | Isopterygiaceae |
| 86 | *Wijkia surcularis* | Isopterygiaceae |
| 87 | *Ctenidium lychnites* | Isopterygiaceae |
| 88 | *Vesicularia vesicularis* | Isopterygiaceae |
| 89 | *Hypnum plumaeforme* | Hypnaceae |
| 90 | *Hypnum sikkimense* | Hypnaceae |
| 91 | *Ectropothecium sikkimense* | Hypnaceae |
| 92 | *Macrothamnium macrocarpum* | Hylocomiaceae |
| 93 | *Sphagnum ceylanicum* | Sphagnaceae |
| 94 | *Atrichum aculeatum* | Polytrichaceae |
| 95 | *Atrichum flavisetum* | Polytrichaceae |
| 96 | *Atrichum longifolium* | Polytrichaceae |
| 97 | *Atrichum obtusulum* | Polytrichaceae |
| 98 | *Atrichum pallidium* | Polytrichaceae |
| 99 | *Atrichum subserratum* | Polytrichaceae |
| 100 | *Lyellia aspera* | Polytrichaceae |
| 101 | *Lyellia platycarpa* | Polytrichaceae |
| 102 | *Pogonatum aloides forma- neesii* | Polytrichaceae |
| 103 | *Pogonatum decolyi* | Polytrichaceae |
| 104 | *Pogonatum himalayanum* | Polytrichaceae |
| 105 | *Pogonatum junghuhnianum* | Polytrichaceae |
| 107 | *Pogonatum leucopogon* | Polytrichaceae |
| 108 | *Pogonatum microstomum* | Polytrichaceae |
| 109 | *Pogonatum juniperinum* | Polytrichaceae |
| 110 | *Diphyscium fasciculatum* | Diphysciaceae |
| 111 | *Diphyscium involutum* | Diphysciaceae |
| 112 | *Diphyscium mucronifolium* | Diphysciaceae |
| 113 | *Theriotia lorifolia* | Diphysciaceae |
| 114 | *Timmia megapolitana* | Timmiaceae |
| 115 | *Entosthodon buseanus* | Funariaceae |
| 116 | *Entosthodon diversinervis* | Funariaceae |
| 117 | *Entosthodon perrottetti* | Funariaceae |
| 118 | *Entosthodon pulchra* | Funariaceae |
| 119 | *Entosthodon wichurae* | Funariaceae |
| 120 | *Funaria buseana* | Funariaceae |
| 121 | *Funaria diversinervis* | Funariaceae |

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| | | |
|---|---|---|
| 122 | *Funaria hygrometrica* | Funariaceae |
| 123 | *Funaria hygrometrica* var.*calvescens* | Funariaceae |
| 124 | *Funaria hygrometrica* var. *hygrometrica* | Funariaceae |
| 125 | *Funaria perrottetti* | Funariaceae |
| 126 | *Funaria physcomitrioides* | Funariaceae |
| 127 | *Funaria submarginata* | Funariaceae |
| 128 | *Physcomitrium coorgense* | Funariaceae |
| 129 | *Physcomitrium insigne* | Funariaceae |
| 130 | *Physcomitrium repandum* | Funariaceae |
| 131 | *Dryptodon fuscoluteus* | Grimmiaceae |
| 132 | *Racomitrium crispulum* | Grimmiaceae |
| 133 | *Schistidium apocarpum* | Grimmiaceae |
| 134 | *Glyphomitrium calycinum* | Ptychomitriaceae |
| 135 | *Archidium birmannicum* | Archidiaceae |
| 136 | *Fissidens angustiusculus* | Fissidentaceae |
| 137 | *Fissidens anomalus* | Fissidentaceae |
| 138 | *Fissidens asperisetus* | Fissidentaceae |
| 139 | *Fissidens asperisetus* var. *andamanensis* | Fissidentaceae |
| 140 | *Fissidens biformis* | Fissidentaceae |
| 141 | *Fissidens bryoides* | Fissidentaceae |
| 142 | *Fissidens ceylonensi* | Fissidentaceae |
| 143 | *Fissidens ceyloninsis* | Fissidentaceae |
| 144 | *Fissidens ceylonensis* var. *ceylonensis* | Fissidentaceae |
| 145 | *Fissidens crenulatus* var. *crenulatus* | Fissidentaceae |
| 146 | *Fissidens cristatus* | Fissidentaceae |
| 147 | *Fissidens crispulus* var. *crispulus* | Fissidentaceae |
| 148 | *Fissidens crispulus* var. *robinsonii* | Fissidentaceae |
| 149 | *Fissidens curvatoinvolutus* | Fissidentaceae |
| 150 | *Fissidens diversifolius* | Fissidentaceae |
| 151 | *Fissidens dubius* | Fissidentaceae |
| 152 | *Fissidens ganguleei* | Fissidentaceae |
| 153 | *Fissidens grifithii* | Fissidentaceae |
| 154 | *Fissidens hyalinus* | Fissidentaceae |
| 155 | *Fissidens incognitus* | Fissidentaceae |
| 156 | *Fissidens intromarginatulus* | Fissidentaceae |
| 157 | *Fissidens involutus* subsp. *involutus* | Fissidentaceae |
| 158 | *Fissidens jungermannioides* | Fissidentaceae |

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| | | |
|---|---|---|
| 159 | *Fissidens kalimpogensis* | Fissidentaceae |
| 160 | *Fissidens kalimpongensis* | Fissidentaceae |
| 161 | *Fissidens minutes* | Fissidentaceae |
| 162 | *Fissidens nymanii* | Fissidentaceae |
| 163 | *Fissidens pulchellus* | Fissidentaceae |
| 164 | *Fissidens pullucidus* | Fissidentaceae |
| 165 | *Fissidens serratus* var. *serratus* | Fissidentaceae |
| 166 | *Fissidens subangustus* | Fissidentaceae |
| 167 | *Fissidens subryoides* | Fissidentaceae |
| 168 | *Fissidens subpulchellus* | Fissidentaceae |
| 169 | *Fissidens sylvatus* var. *auriculatus* | Fissidentaceae |
| 170 | *Fissidens sylvatus* var. *teraicola* | Fissidentaceae |
| 171 | *Fissidens sylvatus* var. *zippenlianus* | Fissidentaceae |
| 172 | *Fissidens teraicola* | Fissidentaceae |
| | *Fissidens virens* | Fissidentaceae |
| 173 | *Fissidens xiphioides* | Fissidentaceae |
| 174 | *Ceratodon purpureus* var. *purpureus* | Ditrichaceae |
| 175 | *Ceratodon purpureus* var. *stenocarpous* | Ditrichaceae |
| 176 | *Ceratodon stenocarpous* | Ditrichaceae |
| 177 | *Ditrichum amoenum* | Ditrichaceae |
| 178 | *Garckea flexuosa* | Ditrichaceae |
| 179 | *Garckea phascoides* | Ditrichaceae |
| 180 | *Trematodon brevicalyx* | Bruchiaceae |
| 181 | *Trematodon ceylonensis* | Bruchiaceae |
| 182 | *Trematodon schmidii* | Bruchiaceae |
| 183 | *Aulacopilum abbreviatum* | Erpodiaceae |
| 184 | *Aulacopilum mangiferae* | Erpodiaceae |
| 185 | *Solmsiella biseriata* | Erpodiaceae |
| 186 | *Solmsiella ceylonica* | Erpodiaceae |
| 187 | *Oreoweisia laxifolia* | Rhabdoweisiaceae |
| 188 | *Symblepharis vaginata* | Rhabdoweisiaceae |
| 189 | *Braunfelsia edentula* | Dicranaceae |
| 190 | *Campylopodium griffithii* | Dicranaceae |
| 191 | *Campylopodium khasianum* | Dicranaceae |
| 192 | *Dicranella divaricata* | Dicranaceae |
| 193 | *Dicranoloma fragile* | Dicranaceae |
| 194 | *Dicranum crispifolium* | Dicranaceae |
| 195 | *Dicranum lorifolium* | Dicranaceae |
| 196 | *Dicranum psathyrum* | Dicranaceae |
| 198 | *Leptotrichella assamica* | Dicranaceae |

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|---|---|---|
| 199 | *Leptotrichella schmidii* | Dicranaceae |
| 200 | *Leucoloma amoene-virens* | Dicranaceae |
| 201 | *Leucoloma brevifolium* | Dicranaceae |
| 202 | *Leucoloma insigne* | Dicranaceae |
| 203 | *Leucoloma rennauldii* | Dicranaceae |
| 204 | *Leucoloma taylorii* | Dicranaceae |
| 205 | *Leucoloma tennerum* | Dicranaceae |
| 206 | *Microdus brasiliensis* | Dicranaceae |
| 207 | *Campylopus albescens* | Leucobryaceae |
| 208 | *Campylopus ericoides* | Leucobryaceae |
| 209 | *Campylopus flexuosus* | Leucobryaceae |
| 210 | *Campylopus goughii* | Leucobryaceae |
| 211 | *Campylopus involutus* | Leucobryaceae |
| 212 | *Campylopus laetus* | Leucobryaceae |
| 213 | *Campylopus pilifer* | Leucobryaceae |
| 214 | *Campylopus recurvus* | Leucobryaceae |
| 215 | *Campylopus richardii* | Leucobryaceae |
| 216 | *Campylopus schmidii* | Leucobryaceae |
| 217 | *Campylopus schimperi* | Leucobryaceae |
| 218 | *Campylopus zollingerianus* | Leucobryaceae |
| 219 | *Leucobryum aduncum* | Leucobryaceae |
| 220 | *Leucobryum bowringii* | Leucobryaceae |
| 221 | *Leucobryum cucullifolium* | Leucobryaceae |
| 222 | *Leucobryum humillimum* | Leucobryaceae |
| 223 | *Leucobryum javense* | Leucobryaceae |
| 224 | *Leucobryum juniperiodeum* | Leucobryaceae |
| 225 | *Leucobryum mittenii* | Leucobryaceae |
| 226 | *Leucobryum scalare* | Leucobryaceae |
| 227 | *Anoectangium walkeri* | Pottiaceae |
| 228 | *Barbula indica* | Pottiaceae |
| 229 | *Didymodon recurvus* | Pottiaceae |
| 230 | *Hydrogonium consanguineum* | Pottiaceae |
| 231 | *Hymenostomum edentulum* | Pottiaceae |
| 232 | *Hymenostylium recurvirostre* | Pottiaceae |
| 233 | *Hymenostylium recurvirostre* var. *aurantiacum* | Pottiaceae |
| 234 | *Hymenostylium recurvirostrum* var. *recurvirostrum* | Pottiaceae |
| 235 | *Oxystegus cylindricus* | Pottiaceae |
| 236 | *Oxystegus stenophyllus* | Pottiaceae |
| 237 | *Oxystegus tenuirostris* | Pottiaceae |

| | | |
|---|---|---|
| 238 | *Semibarbula orientalis* | Pottiaceae |
| 239 | *Splachnobryum indicum* | Pottiaceae |
| 240 | *Tayloria indica* | Splachnaceae |
| 241 | *Tayloria subglabra* | Splachnaceae |
| 242 | *Tayloria subglabra* var. *nosa* | Splachnaceae |
| 243 | *Meesia indica* | Meesiaceae |
| 244 | *Meesia triquetra* | Meesiaceae |
| 245 | *Anomobryum auratum* | Bryaceae |
| 246 | *Anomobryum cymbifolium* | Bryaceae |
| 247 | *Anomobryum schmidii* | Bryaceae |
| 248 | *Brachymenium acuminatum* | Bryaceae |
| 249 | *Brachymenium capitulatum* | Bryaceae |
| 250 | *Bryum argenteum* | Bryaceae |

*Physcomitrium eurystomum* is a temperate to tropical species, located on the way to Mattupetty from Munnar of Idukki district in the Western Ghats of Kerala. *Splachnobryum obtusum* observed from the lateritic midland of Malappuram district of Kerala. Both these species are of rare occurrence and poorly known in the Western Ghats (Manju et al., 2023). *Acidodontium indicum* is described and illustrated from the Western Ghats of Kerala. Since the genus has not been reported from India, it represents a new generic record as well. *Acidodontium indicum* is distinguished by small broadly lanceolate to more or less spathulate leaves having a strong, short excurrent costa, margin completely entire, bordered by 1-4 rows of long incrassate cells, short setae, capsule clavate with short apophysis, operculum conic without apiculus and endostome with high basal membrane and forked endostome segments diverging at a different angle (Vineesha et al., 2023). The Anamudi Shola NP is composed of three shola patches, Mannavan Shola, Pullaradi Shola and Idivara Shola and ranging between the altitude zone of 1600 to 2440 m in the Western Ghats of Idukki district of Kerala. A total of 153 species of bryophytes identified from the Western Ghats, especially the hilly areas (Rajilesh, 2019). The mosses *Chaetomitrium papillifolium, Entodon ovicarpus, E. scariosus, Glossadelphus bilobatus, Pseudobarbella ancistrodes, Sematophyllum micans* and *Taxithelium kerianum*, earlier known to be distributed in the Himalaya, Northeast or the Andaman and Nicobar Islands, are recorded for the Western Ghats (Singh, 2020).

**Conclusion**

Bryophytes play a crucial ecological role in the unique ecosystem of the Western Ghats, a biodiversity hotspot in India. The humid and shaded environments of Western Ghats provide an ideal habitat for a rich diversity of various bryophytes including mosses, liverworts and hornworts. These bryophytes contribute to soil stabilization, water retention and nutrient cycling that supporting the rich vegetation of the areas. Together with this, the Western Ghats are home to several endemic and rare bryophyte species; hence the conservation of botanical diversity is significant for proper maintenance of ecosystem.

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