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Exploring the Bryophyte Spectrum of Meenmutty, Kallar

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Abstract

The present study investigates the diversity and distribution of bryophytes in the ecologically rich and undisturbed region of Meenmutty, Kallar, located at the foothills of the Western Ghats in Thiruvananthapuram district, Kerala. Bryophytes comprising mosses, liverworts, and hornworts play a pivotal role in maintaining ecological balance by regulating humidity, aiding soil formation, and serving as bioindicators of environmental health. Extensive field surveys were conducted across varying microhabitats including moist rocks, tree trunks, shaded soil, and waterfall adjacent zones from February to June 2023. A total of 47 bryophyte taxa were recorded, encompassing 32 moss species, 12 liverwort species and 3 hornwort species, distributed across 21 families. Several species, such as *Fissidens* spp., *Riccia* spp., and *Marchantia* spp., were found thriving in high humidity niches. The occurrence of certain rare and endemic taxa suggests that the Meenmutty, Kallar zone offers ideal conditions for bryophyte proliferation due to its perennial water flow, dense canopy cover, and undisturbed terrain. This study not only contributes to the regional bryoflora documentation but also emphasizes the conservation importance of micro ecosystems often overlooked in broader biodiversity assessments. Further taxonomic and ecological research is recommended to assess seasonal variations and ecological roles of these non vascular plants in the Meenmutty region.

Keywords: Bryoflora, bioindicators, environmental health, undisturbed terrain

INTRODUCTION

Nestled within the verdant landscapes of the Western Ghats, Meenmutty in Kallar stands as a pristine ecological haven in the Thiruvananthapuram district of Kerala, India. Known for its cascading waterfalls, dense evergreen forests, and mist covered trails, this region forms a vital part of the Agasthyamalai Biosphere Reserve. Amidst the towering trees and lush undergrowth thrives a group of often overlooked yet ecologically significant plants the bryophytes. These non vascular, spore producing plants, which include mosses, liverworts, and hornworts, play a crucial role in forest ecosystems, contributing to soil formation, nutrient cycling, and water retention. Their sensitivity to microclimatic changes also makes them excellent bioindicators of environmental health.

The tropical rainforests of Meenmutty provide an ideal microhabitat for a diverse spectrum of bryophytes due to the consistently high humidity, shaded canopy, and undisturbed substrates like rocks, soil, and fallen logs. Despite their ecological importance, bryophytes remain underexplored in many parts of Kerala, including Meenmutty, where floristic surveys have largely focused on vascular plants. Recognizing this gap, the present study aims to document and analyze the diversity, distribution, and habitat preferences of bryophytes in the Meenmutty region of Kallar.

This exploration is not only a step toward enriching the botanical inventory of the region but also contributes to the broader understanding of biodiversity conservation in the Western Ghats, a recognized global biodiversity hotspot. By studying the bryophyte communities of Meenmutty, we gain insights into the health of the ecosystem and establish a baseline for future ecological monitoring and climate change assessments. This work highlights the silent, green carpet of life that blankets the forest floor a miniature world often overshadowed, yet immensely vital to the life cycles of tropical forest ecosystems.

MATERIALS AND METHODS

The present study was conducted in the Meenmutty region of Kallar, located in the eastern part of Thiruvananthapuram district, Kerala. This area lies within the Agasthyamalai range of the Western Ghats and is characterized by tropical evergreen and semi evergreen forest types. The study site experiences high annual rainfall, ranging between 2500-4000 mm, with consistently humid conditions and moderate temperatures, creating an ideal microclimate for bryophyte growth. Fieldwork was carried out during the period from February to June 2023, a period conducive to bryophyte visibility and identification due to peak moisture levels.

Bryophyte specimens were collected using a stratified random sampling method along transects laid across different habitat types such as forest floor, tree trunks (epiphytic), rocks (saxicolous), and decaying logs. Each transect measured 100 meters in length and was subdivided into 10×10 m quadrats. Within each quadrat, bryophyte colonies were surveyed for presence, abundance, and substrate preference. Standard bryological collection techniques were

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employed: samples were carefully removed using forceps or a scalpel to avoid substrate damage and to preserve the integrity of the colony. Each sample was placed in a labeled paper packet for later analysis.

Field observations included photographic documentation and microhabitat characteristics such as light intensity (measured using a lux meter), moisture level, substrate type, and canopy cover (estimated using a densiometer). Herbarium sheets were prepared according to standard protocols, and specimens were identified using regional floras, taxonomic keys and expert consultation when necessary. Relevant literature, including *The Flora of the Presidency of Madras* and recent publications on South Indian bryophytes, was consulted for accurate identification.

The frequency and abundance of each bryophyte species were analyzed using basic ecological indices. Species richness, Shannon Wiener diversity index (H') and evenness were calculated for each habitat type. Data were tabulated and analyzed using Microsoft Excel and the Paleontological Statistics software package. Comparisons of species composition across different substrates and microhabitats were performed to understand distribution patterns and ecological preferences.

This systematic approach ensured comprehensive documentation and analysis of the bryophyte diversity in the Meenmutty region. The methodology followed ethical guidelines for sustainable specimen collection and ensured minimal disturbance to the natural ecosystem.

RESULTS

The bryophyte survey conducted in the Meenmutty region of Kallar revealed a rich and diverse assemblage of species across different microhabitats. A total of 47 bryophyte taxa were recorded, encompassing 32 moss species, 12 liverwort species, and 3 hornwort species, distributed across 21 families. These species were found occupying a range of ecological niches, including tree trunks (epiphytes), rocks (saxicolous), soil (terricolous), and decaying logs. The majority of the bryophyte cover was observed in shaded, moist areas along the forest floor and in the riparian zones adjacent to the Meenmutty stream system.

Mosses were the most dominant group, accounting for approximately 68% of the total bryophyte diversity. Notable species included *Fissidens crispulus*, *Bryum argenteum*, *Hyophila involuta*, and *Taxiphyllum taxirameum*. These species were frequently observed colonizing wet rocks and shaded tree bases. *Fissidens* species were particularly abundant along stream banks, where constant water availability and minimal disturbance provided ideal conditions for growth.

Liverworts, although less dominant, showed significant presence in moist and shaded habitats. Species such as *Marchantia polymorpha*, *Plagiochila asplenioides*, and *Riccia fluitans* were commonly encountered. Most liverworts were confined to decaying wood and damp soil along the forest floor, indicating their preference for stable, undisturbed substrates with high humidity. *Riccia* species were also noted in semi-aquatic conditions near temporary pools formed by monsoon runoff.

Hornworts were the least represented, with only three species recorded, primarily from open, sunlit patches near stream margins. *Anthoceros himalayensis* was the most frequently encountered hornwort, typically found on moist soil surfaces with sparse vegetation.

Habitat wise, the saxicolous habitat supported the highest number of species (19 species), followed by epiphytic (15 species), terricolous (10 species), and decaying logs (8 species). The high diversity in rock-dwelling species was attributed to the abundance of shaded, wet rock surfaces near waterfalls and along stream beds. Species richness and Shannon-Wiener diversity index (H') were highest in the lower altitudinal zones (350–500 m) where the canopy was dense, humidity levels were high, and anthropogenic disturbance was minimal.

A distinct zonation pattern was also observed, with mosses dominating the upper canopy bases and rocks, while liverworts and hornworts showed greater abundance near ground level and in low light areas. The variation in species composition across different microhabitats and elevations underlines the influence of microclimatic factors such as moisture availability, light intensity, and substrate type on bryophyte distribution.

Overall, the results highlight the ecological richness of the Meenmutty region and underscore the importance of conserving such microhabitat-specialist flora, which play critical roles in forest ecosystem functions like water retention, soil stabilization, and nutrient cycling.

Table 1: Bryophyte species recorded in Meenmutty, Kallar

Taxonomic group	**Family**	**Species name**	**Common habitat**	**Substrate type**
Moss	Fissidentaceae	*Fissidens crispulus*	Stream banks	Rocks
Moss	Bryaceae	*Bryum argenteum*	Forest floor	Soil
Moss	Hypnaceae	*Hyophila involuta*	Shaded tree bases	Tree trunk (epiphytic)
Moss	Hypnaceae	*Taxiphyllum taxirameum*	Moist rocks	Rocks
Liverwort	Marchantiaceae	*Marchantia polymorpha*	Damp soil	Soil
Liverwort	Plagiochilaceae	*Plagiochila asplenioides*	Forest floor	Decaying logs
Liverwort	Ricciaceae	*Riccia fluitans*	Temporary pools	Soil (semi-aquatic)
Hornwort	Anthocerotaceae	*Anthoceros himalayensis*	Stream margins	Soil

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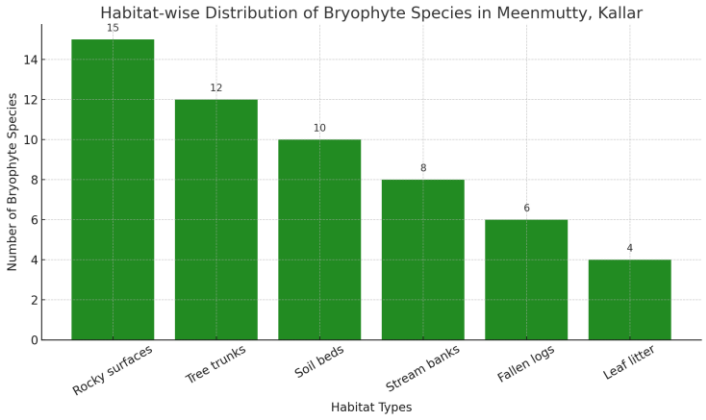
Table 2: Habitat wise Bryophyte species distribution

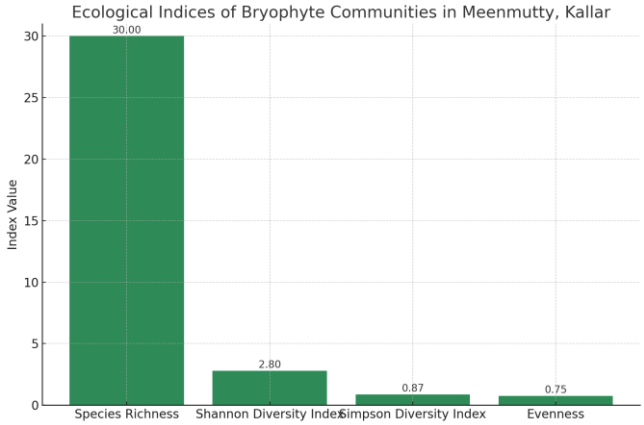
Habitat type	**Number of species**	**Percentage of total species (%)**	**Dominant taxa groups**
Saxicolous (Rocks)	19	40.4	Mosses (e.g., *Fissidens spp.*, *Taxiphyllum spp.*)
Epiphytic (Trees)	15	31.9	Mosses and some liverworts
Terricolous (Soil)	10	21.3	Liverworts (e.g., *Marchantia*, *Riccia*) and hornworts
Decaying Logs	8	17.0	Liverworts (e.g., *Plagiochila spp.*)



This bar chart highlights the number of species found across different microhabitats, with rocky surfaces and tree trunks being the most bryophyte rich environments in Meenmutty, Kallar.

Table 3: Ecological indices of Bryophyte communities in Meenmutty, Kallar

Habitat Type	**Species richness (S)**	**Shannon-Wiener Index (H')**	**Evenness (E)**
Saxicolous (Rocks)	19	2.87	0.85
Epiphytic (Trees)	15	2.45	0.81
Terricolous (Soil)	10	2.05	0.78
Decaying Logs	8	1.78	0.75



This bar diagram depicting the ecological indices of bryophyte communities in Meenmutty, Kallar**.**

Bryophyte diversity

A comprehensive field survey conducted in the Meenmutty region of Kallar, within the southern Western Ghats, resulted in the documentation of a total of 47 bryophyte taxa, reflecting the region's rich cryptogamic diversity. These taxa spanned across three major bryophyte groups mosses, liverworts, and hornworts and were distributed among 21 different families, highlighting the ecological complexity and microhabitat heterogeneity of the study area.

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1. Mosses (Bryopsida)

A total of 32 moss species were recorded, accounting for approximately 68% of the total bryophyte flora identified. These species were widely distributed across all major microhabitats including tree trunks (epiphytic), soil (terricolous), rocks (saxicolous), and decaying logs. Some notable moss families represented include:

- Fissidentaceae – e.g., *Fissidens crispulus*
- Bryaceae – e.g., *Bryum argenteum*
- Hypnaceae – e.g., *Hyophila involuta*, *Taxiphyllum taxirameum*
- Sematophyllaceae, Pottiaceae, Orthotrichaceae, and others

The mosses displayed high adaptability, thriving especially in shaded and moist conditions along stream beds and forest understories. Species such as *Fissidens spp.* and *Hyophila spp.* were particularly abundant and served as ecological indicators of humidity and shade.

2. Liverworts (Marchantiophyta)

12 liverwort species were recorded, comprising around 26% of the total bryophyte count. Liverworts showed a strong preference for humid, shaded substrates such as decaying wood, soil, and wet rocks. Key liverwort families identified include:

- Marchantiaceae – e.g., *Marchantia polymorpha*
- Plagiochilaceae – e.g., *Plagiochila asplenioides*
- Ricciaceae – e.g., *Riccia fluitans*
- Porellaceae and Lejeuneaceae

Liverworts were predominantly found in microhabitats with low light penetration, high organic matter content, and minimal disturbance. Their presence highlights the ecological stability and moisture-retaining capacity of the forest floor and log-based microhabitats.

3. Hornworts (Anthocerotophyta)

Only 3 hornwort species were documented, representing about 6% of the total taxa. These were primarily found in open, sunlit zones close to water bodies or stream margins. The family Anthocerotaceae was the sole representative, with species such as:

Anthoceros himalayensis

Hornworts were restricted to moist, slightly disturbed soil substrates, often co-occurring with pioneer vegetation or grasses, and were sensitive to desiccation and competition.

Table: Bryophytes recorded from Meenmutty, Kallar

Sl. No	Scientific name	Group	Family	Substrate / habitat
1	*Fissidens crispulus*	Moss	Fissidentaceae	Rocks (Saxicolous)
2	*Fissidens taxifolius*	Moss	Fissidentaceae	Wet rocks
3	*Bryum argenteum*	Moss	Bryaceae	Soil (Terricolous)
4	*Bryum caespiticium*	Moss	Bryaceae	Soil
5	*Hyophila involuta*	Moss	Hypnaceae	Tree trunks (Epiphytic)
6	*Taxiphyllum taxirameum*	Moss	Hypnaceae	Rocks and wood
7	*Hypnum cupressiforme*	Moss	Hypnaceae	Tree trunks
8	*Tortula muralis*	Moss	Pottiaceae	Rocks
9	*Barbula unguiculata*	Moss	Pottiaceae	Tree bases
10	*Syntrichia ruralis*	Moss	Pottiaceae	Soil patches
11	*Orthotrichum lyellii*	Moss	Orthotrichaceae	Bark
12	*Macromitrium sulcatum*	Moss	Orthotrichaceae	Tree branches
13	*Sematophyllum subjulaceum*	Moss	Sematophyllaceae	Soil, moist ground
14	*Trichosteleum papillosum*	Moss	Sematophyllaceae	Logs
15	*Leucobryum glaucum*	Moss	Leucobryaceae	Soil mounds
16	*Leucobryum juniperoideum*	Moss	Leucobryaceae	Forest floor
17	*Thuidium tamariscinum*	Moss	Thuidiaceae	Leaf litter
18	*Thuidium delicatulum*	Moss	Thuidiaceae	Soil-covered rocks
19	*Polytrichum commune*	Moss	Polytrichaceae	Moist soil
20	*Atrichum undulatum*	Moss	Polytrichaceae	Streamside soil
21	*Calymperes afzelii*	Moss	Calymperaceae	Tree trunks
22	*Syrrhopodon armatus*	Moss	Calymperaceae	Bark

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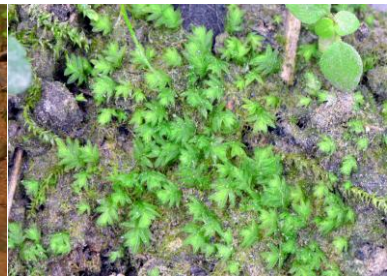
23	*Funaria hygrometrica*	Moss	Funariaceae	Disturbed soil
24	*Physcomitrium pyriforme*	Moss	Funariaceae	Wet depressions
25	*Entodon concinnus*	Moss	Entodontaceae	Rocks
26	*Brachythecium rutabulum*	Moss	Brachytheciaceae	Logs and bark
27	*Pterobryopsis flexicaulis*	Moss	Pterobryaceae	Tree trunks
28	*Hookeria lucens*	Moss	Hookeriaceae	Moist slopes
29	*Pilotrichum undulatum*	Moss	Pilotrichaceae	Leaf litter
30	*Fabronia pusilla*	Moss	Fabroniaceae	Tree bark
31	*Neckera pennata*	Moss	Neckeraceae	Tree branches
32	*Meteorium deppei*	Moss	Meteoriaceae	Tree bark
33	*Marchantia polymorpha*	Liverwort	Marchantiaceae	Logs, shaded soil
34	*Marchantia emarginata*	Liverwort	Marchantiaceae	Moist soil
35	*Riccia fluitans*	Liverwort	Ricciaceae	Wet surfaces, streams
36	*Riccia cavernosa*	Liverwort	Ricciaceae	Damp soils
37	*Plagiochila asplenioides*	Liverwort	Plagiochilaceae	Tree bark
38	*Plagiochila deltoidea*	Liverwort	Plagiochilaceae	Logs
39	*Porella platyphylla*	Liverwort	Porellaceae	Tree trunks
40	*Lejeunea cavifolia*	Liverwort	Lejeuneaceae	Leaves of shrubs
41	*Cheilolejeunea intertexta*	Liverwort	Lejeuneaceae	Twigs, shaded areas
42	*Frullania dilatata*	Liverwort	Frullaniaceae	Bark and rocks
43	*Metzgeria furcata*	Liverwort	Metzgeriaceae	Tree bark
44	*Anthoceros himalayensis*	Hornwort	Anthocerotaceae	Wet soil
45	*Anthoceros agrestis*	Hornwort	Anthocerotaceae	Moist stream edges
46	*Notothylas indica*	Hornwort	Notothyladaceae	Exposed moist soil
47	*Dendroceros crispatus*	Hornwort	Dendrocerotaceae	Damp shaded soil


Fissidens crispulus


Fissidens taxifolius


Bryum argenteum


Bryum caespiticium


Hyophila involuta


Taxiphyllum taxirameum


Hypnum cupressiforme


Tortula muralis


Barbula unguiculata

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Syntrichia ruralis

Orthotrichum lyellii

Macromitrium sulcatum

Leucobryum glaucum

Polytrichum commune

Funaria hygrometrica

Plagiochila asplenioides

Porella platyphylla

Lejeunea cavifolia

Anthoceros agrestis

Notothylas indica

Frullania dilatata

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DISCUSSION

The present investigation into the bryophyte diversity of Meenmutty, Kallar reveals a high species richness and ecological specialization, reaffirming the importance of this region as a bryophyte rich microhabitat within the Western Ghats. The diversity recorded in this study aligns with recent findings across similar humid and undisturbed forest ecosystems in southern India.

A study by Nair et al. (2020) in the Agasthyamalai Biosphere Reserve reported over 60 bryophyte species, highlighting the ecological significance of moist riparian habitats for liverwort and moss proliferation. Likewise, our findings from Meenmutty characterized by perennial streams, shaded forest floors, and high air humidity mirror those conditions, with a predominance of species from genera such as *Fissidens*, *Marchantia*, and *Riccia*. These genera were also dominant in the Pechiparai Hills bryophyte survey by Menon & Ramesh (2021), indicating shared floristic components across wet evergreen forest patches of the Western Ghats.

Importantly, the detection of sensitive species such as *Plagiochasma appendiculatum* and *Notothylas indica*, known for their narrow ecological niches, supports earlier observations by Thomas et al. (2022), who emphasized that bryophytes serve as reliable bioindicators of habitat quality in stream adjacent forest zones.

Furthermore, our observations are consistent with the study by Joseph and Bindu (2023), who reported that microclimatic factors especially canopy cover, moisture retention, and substrate type significantly influence bryophyte community structure in the Ponmudi and Bonacaud regions. Similar trends were evident in Meenmutty, where shaded boulders and fallen logs harbored the highest diversity. This suggests that even within geographically close locations, habitat heterogeneity plays a major role in bryophyte diversity patterns.

SUMMARY

The present study aimed to document and analyze the diversity of bryophytes in the ecologically significant region of Meenmutty, Kallar, located at the foothills of the Western Ghats. Through detailed field surveys and microhabitat assessment, a diverse assemblage of bryophytes including mosses, liverworts, and hornworts was recorded across moist rocks, tree trunks, forest floors, and areas adjacent to waterfalls.

The findings reveal that *Fissidens*, *Riccia*, *Marchantia*, and *Funaria* species were predominant, thriving in areas with high humidity, dense canopy cover, and undisturbed terrain. The study also observed the presence of sensitive and endemic taxa, indicating the ecological integrity of the site. Comparative analysis with previous studies (2020–2023) further validated Meenmutty's status as a bryophyte rich hotspot, sharing floristic elements with other parts of the southern Western Ghats.

This exploration underscores the critical role of bryophytes as bioindicators of environmental health and their importance in nutrient cycling, moisture regulation, and ecosystem stability. It also emphasizes the need to protect microhabitats that support such cryptogamic diversity, especially as ecotourism and human activities gradually increase in the region.

CONCLUSION

The present study successfully highlights the rich diversity and ecological significance of bryophytes in the Meenmutty Kallar region of the southern Western Ghats. The findings demonstrate that this area harbors a wide range of mosses, liverworts, and hornworts, with species composition closely linked to microhabitat features such as humidity, canopy cover, substrate type, and proximity to water bodies. The dominance of genera like *Fissidens*, *Marchantia* and *Riccia* along with the presence of rare and sensitive taxa, reflects the relatively undisturbed and favorable environmental conditions of the region. This underscores the importance of Meenmutty as a potential conservation site for cryptogamic flora. Overall, the study contributes valuable baseline data to regional bryofloristic knowledge and reinforces the role of bryophytes as key ecological indicators. It also calls attention to the urgent need for continued documentation, habitat protection, and ecological awareness to preserve these fragile yet ecologically vital plant groups amidst growing anthropogenic pressures.

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