



# Impact of Moss Species on Orchid Conservation in the Dry Climates of the Western Ghats in Wayanad

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## Abstract

This study investigates the role of specific moss species in supporting orchid conservation under dry climate conditions in the Western Ghats, with a particular focus on Wayanad. Conducted over a three-year period, the research centered on five key moss species—*Sphagnum squarrosum*, *Hypnum plumosum*, *Polytrichum commune*, *Rhodobryum ontariense*, and *Octoblepharum albidum*—and their capacity to foster orchid establishment and sustainability. These mosses contribute essential ecological functions that benefit native orchids, particularly in challenging, arid environments. Our observations demonstrated that *Sphagnum squarrosum* and *Hypnum plumosum* have superior moisture retention abilities, maintaining a stable, humid microclimate around orchid roots, which is crucial during seasonal dry spells. This humidity facilitates orchid seed germination, improves root development, and mitigates desiccation stress for orchid species adapted to Wayanad, such as *Dendrobium* and *Vanda*. Additionally, *Polytrichum commune* and *Rhodobryum ontariense* contribute to soil nutrient enrichment. The gradual breakdown of these mosses releases nutrients essential for orchids, enhancing growth and vigor, particularly in nutrient-limited substrates common in dry forest areas. Moreover, these mosses serve as a protective barrier, shielding orchids from harsh temperature fluctuations and physical damage due to their dense, cushion-like structure. This protection supports orchids by reducing environmental stresses that can impair growth and reproduction. Over the three years of study, orchids cultivated in close association with these mosses exhibited enhanced survival rates, healthier root systems, and more robust flowering and seeding compared to orchids grown in non-moss environments. This research underscores the importance of mosses as ecological allies for orchids in dry climates, offering multiple benefits that extend to overall biodiversity. As climate variability increases, the resilience provided by these moss-microhabitats becomes even more critical. Our findings advocate for integrated conservation strategies that protect both mosses and orchids, emphasizing the need for habitat management that acknowledges their interdependent roles. By conserving these moss-rich microhabitats, we can foster the growth and persistence of native orchids, thereby supporting the biodiversity and ecological stability of the Western Ghats' fragile ecosystems.

**Keywords:** Orchid Conservation; Moss-Orchid Interaction; Dry Climate Adaptation; Western Ghats Biodiversity; *Sphagnum Squarrosum*; *Hypnum Plumosum*; *Polytrichum Commune*; *Rhodobryum Ontariense*; *Octoblepharum Albidum*; Microhabitat and Moisture Retention

## Introduction

The Western Ghats, a UNESCO World Heritage site, is one of the world's biodiversity hotspots, rich in endemic flora and fauna. This mountain range, spanning six states in India, harbors several ecosystems, including tropical rainforests, montane grasslands, and dry forests. Wayanad, located in the northern part of Kerala, is a region within the Western Ghats renowned for its unique biodiversity, particularly its orchid species [1]. However, like many other parts of the Western Ghats, Wayanad is facing increasing pressures from climate change, deforestation, and habitat fragmentation, which threaten the conservation of its native orchids.

Orchids are among the most vulnerable plant species in the region, as they require specific environmental conditions for growth and reproduction. Many orchids in Wayanad are epiphytic, meaning they grow on other plants like trees or rocks, and rely on their immediate environment for moisture and nutrients. While orchids have evolved to survive in these unique niches, their growth is highly influenced by the surrounding ecological components, particularly mosses.

Mosses play a critical, though often overlooked, role in the ecosystem. They are key players in nutrient cycling, moisture retention, and soil formation. Mosses create favorable microhabitats for orchid growth, especially in harsh, dry climates like those found in certain parts of Wayanad. Moss species such as *Sphagnum squarrosum*, *Hypnum plumosum*, *Polytrichum commune*, *Rhodobryum ontariense*, and *Octoblepharum albidum* are found in close association with orchids and are known to provide essential support for their survival. These moss species are capable of maintaining high moisture content, even in dry periods, creating an ideal environment for the delicate orchids.

The relationship between orchids and mosses has long been acknowledged in forest ecosystems, but research on their interaction in dry climate zones, especially in the Western Ghats, remains limited. Previous studies have focused on the role of mosses in tropical rainforests or temperate zones, where orchids grow in more stable, humid conditions [2,3]. However, the unique climatic and ecological conditions of dry regions, like parts of Wayanad, necessitate further investigation into how moss species specifically impact orchid growth and conservation in these areas.

This study seeks to explore the role of key moss species—*Sphagnum squarrosum*, *Hypnum plumosum*, *Polytrichum commune*, *Rhodobryum ontariense*, and *Octoblepharum albidum*—in supporting orchid conservation in the dry climates of the Western Ghats, particularly in Wayanad. Through three years of field observations, we aim to assess how these mosses influence orchid establishment,

growth, and overall survival rates under variable moisture conditions. Understanding this relationship will contribute valuable insights into ecosystem dynamics in Wayanad and inform conservation strategies for both orchids and mosses in the face of changing environmental conditions.

## Methodology

This study investigates the role of specific moss species in supporting orchid conservation in the dry climates of the Western Ghats, particularly in Wayanad, over three years. The moss species observed in relation to orchid growth include *Sphagnum squarrosum*, *Hypnum plumosum*, *Polytrichum commune*, *Rhodobryum ontariense*, and *Octoblepharum albidum* [4]. The study aimed to determine how each species contributes to moisture retention, nutrient availability, and overall orchid health in dry conditions, where orchids face significant environmental stress.

Orchid species were planted in various locations with these moss species covering substrates such as tree trunks, rocks, and logs. Parameters such as orchid root development, growth rate, moisture retention, and overall plant health were monitored and compared across different moss species. The effects of moss cover on germination rates, survival rates, and long-term orchid health were also observed.

## Study Objective

This study aims to examine the influence of specific moss species—*Sphagnum squarrosum*, *Hypnum plumosum*, *Polytrichum commune*, *Rhodobryum ontariense*, and *Octoblepharum albidum*—on the conservation of native orchids in the dry climates of the Western Ghats, particularly in Wayanad. Over a three-year period, the study investigates how these mosses contribute to the growth, establishment, and health of orchids in an environment that experiences significant seasonal variation in temperature and rainfall.

## Study Area

The study was conducted in the Wayanad region of Kerala, India, located within the Western Ghats, a biodiversity hotspot and a UNESCO World Heritage Site. The area is characterized by a tropical montane climate with distinct wet and dry seasons. Wayanad's dry periods are marked by lower humidity and water availability, making it an ideal location to study the interaction between mosses and orchids under stress conditions.

The study was carried out in multiple conservation zones within Wayanad that are rich in native orchids, with a focus on the species that grow in proximity to moss-covered surfaces such as tree trunks, rocks, and forest floors. The five moss species selected for the study were chosen based on their prevalence in the region and their ability to thrive in

varying moisture conditions.

### Selection of Moss Species

- *Sphagnum squarrosum*: Known for its high water-holding capacity, this moss is commonly found in wetlands but also occurs in drier environments, making it relevant for the study.
- *Hypnum plumosum*: A moss species that forms dense mats, commonly found in shaded environments, contributing to moisture retention and creating a favorable microhabitat.
- *Polytrichum commune*: This moss thrives in dry conditions, helping to retain moisture for surrounding plants.
- *Rhodobryum ontariense*: Known for its resilience to arid conditions, this moss plays a role in regulating microhabitats and enhancing plant health during dry spells.
- *Octoblepharum albidum*: Often found in forest ecosystems, this moss supports ecological processes by fostering biodiversity and moisture retention.

### Orchid Species Selection

The orchids selected for this study were native species of the Western Ghats that are known to grow in association with moss-covered surfaces. These orchids include:

- *Dendrobium malabaricum* (Malabar Dendrobium)
- *Vanda tessellata* (Spotted Vanda)
- *Phaius tancarvilleae* (Swamp Orchid)
- *Rhynchostylis retusa* (Foxtail Orchid)

These species were selected based on their vulnerability, ecological importance, and dependence on moist microhabitats for successful germination, root development, and survival.

### Research Design

The study was designed as a field experiment with the following parameters:

- **Moss Presence vs. Absence:** Orchids were monitored in locations with both moss and non-moss-covered substrates to assess the impact of moss presence on orchid growth. The study included two groups:
  1. **Control Group (Non-Moss):** Orchids growing in areas devoid of moss.
  2. **Experimental Group (Moss):** Orchids growing on or near the moss species selected for the study.
- **Environmental Monitoring:** To understand how the moss species influence orchid growth, the study measured several environmental parameters:
  1. **Soil Moisture:** Soil moisture was measured at regular intervals using soil moisture meters. Mosses were expected to enhance moisture retention in the surrounding soil, which is critical for orchids, especially

during dry periods.

2. **Humidity Levels:** Humidity was monitored using digital hygrometers at various points within the study area. Moss-covered substrates were hypothesized to create more stable humidity levels.
3. **Temperature:** Temperature fluctuations, particularly between day and night, were monitored to assess the role of moss in temperature regulation.
4. **Growth Metrics:** The growth of orchids was tracked by measuring:
  5. **Germination Rate:** The number of seeds germinated in moss-covered versus non-moss-covered environments.
  6. **Root Health:** The development of root systems was observed, with special attention to root length, branching, and health.
  7. **Overall Plant Growth:** The height, leaf development, and flower production were monitored across all orchid species to assess the overall health and growth rate of orchids in different environmental conditions.
- **Data Collection and Statistical Analysis:**
  1. **Data Collection:** Data were collected quarterly, encompassing three growing seasons. Each observation period involved the measurement of environmental parameters, plant growth metrics, and orchid health.
  2. **Statistical Analysis:** Data were analyzed using ANOVA to assess the statistical significance of the differences between moss and non-moss groups. Regression analysis was performed to determine correlations between moss moisture retention and orchid growth metrics.

### Field Studies

Field observations were conducted in the dry season, from March to June, to examine the impact of low rainfall on orchids and mosses. During the wet season (June to September), measurements focused on humidity and growth rates under more favorable conditions Frahm JP [5]. The study also involved periodic sampling of moss and orchid tissues for laboratory analysis to study the physiological effects of moss interaction on orchid roots, including nutrient uptake and fungal associations that support orchid seedling development.

### Findings and Discussion

The three-year study found that mosses play a critical role in supporting orchid growth in dry climates by creating a conducive microenvironment. Key findings include:

- **Improved Moisture Retention:** Orchids in moss-covered areas exhibited significantly higher moisture retention in the soil, contributing to better growth rates, especially during dry periods. Mosses acted as natural water reservoirs that improved the orchid's ability to withstand drought.

- **Enhanced Germination and Root Health:** Orchids growing near mosses showed higher germination success rates and healthier root systems compared to those in non-moss environments. The mosses' ability to retain moisture and nutrients contributed to more vigorous root growth.
- **Fungal Associations:** The moss species also provided a better substrate for the development of beneficial fungal relationships, which are essential for orchid seedling survival. The interaction between mosses and the mycorrhizal fungi positively impacted the orchid's nutrient absorption and growth.

This study highlights the significant role that moss species play in supporting the growth and conservation of orchids in the dry climates of the Western Ghats, particularly in Wayanad. By retaining moisture, enhancing nutrient availability, and fostering beneficial fungal associations,

mosses create a more favorable environment for orchids. Given these findings, it is imperative to consider moss species in conservation strategies for orchids, especially in regions experiencing increasing climate variability.

Future studies could delve into specific mechanisms by which mosses and fungi work together to support orchid growth and survival in arid conditions. This research contributes to broader conservation efforts by providing insights into the complex relationships between plants in the unique ecosystems of the Western Ghats.

### Key Findings

The following table summarizes the comparative effects of these moss species on orchid growth and conservation in the dry climates of Wayanad:

Moss Species	Moisture Retention	Nutrient Availability	Root Development	Germination Success	Orchid Health (Growth Rate)	Resilience in Dry Climates
<i>Sphagnum squarrosum</i>	High	Moderate	Excellent	High	Strong	Very High
<i>Hypnum plumosum</i>	Moderate	Moderate	Good	Moderate	Moderate	Moderate
<i>Polytrichum commune</i>	Moderate	High	Moderate	Low	Good	Moderate
<i>Rhodobryum ontariense</i>	Low	Low	Poor	Low	Poor	Low
<i>Octoblepharum albidum</i>	High	High	Excellent	High	Strong	High

**Table:** Summarizes the comparative effects of these moss species on orchid growth and conservation in the dry climates of Wayanad.

### Observations and Discussion

- *Sphagnum squarrosum* exhibited the most significant impact on orchid growth, offering superior moisture retention and excellent root development. Orchids grown with this moss species showed robust growth, high germination rates, and remarkable resilience to dry conditions. This species creates an ideal microhabitat for orchids, maintaining high humidity levels around the roots and providing essential nutrients.
- *Hypnum plumosum* and *Polytrichum commune* provided moderate benefits in terms of moisture retention and nutrient availability. While orchids grown with these mosses did well, their growth was not as robust compared to those grown with *Sphagnum squarrosum*. These species appear to be more suitable for regions with slightly higher humidity or where drought conditions are not as prolonged.
- *Rhodobryum ontariense* showed minimal support for orchid growth, particularly in dry conditions. Orchids planted in this moss showed poor root development and low germination success, likely due to the moss's low

moisture retention capabilities.

- *Octoblepharum albidum* performed similarly to *Sphagnum squarrosum*, providing a conducive environment for orchid health. It supported excellent root development and growth rates, and orchids cultivated in this moss showed strong resilience to environmental stresses.

Moss species play a pivotal role in supporting orchid conservation in dry climates like those of the Western Ghats. *Sphagnum squarrosum* and *Octoblepharum albidum* emerged as the most effective moss species for supporting orchids in such harsh environments, enhancing their growth, survival, and resilience [6-9]. These findings highlight the importance of selecting the right moss species for orchid cultivation, especially in conservation efforts aimed at maintaining orchid biodiversity in dry climates.

This study provides valuable insights into how moss species can be incorporated into orchid conservation strategies, emphasizing the need for targeted conservation efforts that consider not only the orchids themselves but also the supporting moss species that can help mitigate the challenges posed by dry conditions in the Western Ghats.

## Conclusion

The three-year observation of moss species' impact on orchid conservation in the dry climates of the Western Ghats, particularly in Wayanad, reveals the critical role mosses play in supporting orchid populations in challenging environmental conditions. Species such as *Sphagnum squarrosum*, *Hypnum plumosum*, *Polytrichum commune*, *Rhodobryum ontariense*, and *Octoblepharum albidum* provide a unique habitat that mitigates water loss, supplies nutrients, and maintains a microenvironment favorable to orchids.

These moss species create moisture-retentive layers that protect orchid roots from desiccation, an essential feature in the drier areas of the Western Ghats where orchids face significant water stress. Furthermore, they promote a stable microhabitat by moderating soil and root temperature fluctuations, which is crucial for the delicate orchid root structures. The study also found that these mosses encourage beneficial microbial activity around orchid roots, supporting better nutrient uptake and resilience against environmental stressors.

Our findings suggest that conservation efforts in the Western Ghats should include protecting and restoring moss-rich environments to facilitate orchid preservation [10]. The interdependence of mosses and orchids highlights the need for integrated conservation strategies that recognize the role of moss species as a fundamental component of the orchid habitat. By preserving these moss species, we can improve the viability of orchid populations, ensuring the continued biodiversity and ecological health of the Western Ghats amidst climate challenges. This symbiotic conservation approach offers a sustainable path forward for protecting both native orchids and the ecosystems that support them.

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