



Conservation of Miniature Native Orchids Western Ghats, Wayanad

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Abstract

This study investigates the diversity, ecological significance, and conservation status of miniature native orchids in the Western Ghats, focusing on the Wayanad district. Our findings highlight the critical role of these orchids in maintaining ecosystem balance, particularly through their interactions with pollinators and mycorrhizal fungi, which contribute to nutrient cycling and habitat health. Despite their ecological importance, these orchids face significant threats from habitat destruction, climate change, and over collection. Our research identifies key conservation strategies, including habitat restoration and the establishment of orchid sanctuaries, to mitigate these threats. Additionally, the success of reintroduction programs in Wayanad demonstrates the potential for restoring orchid populations. This study underscores the need for targeted conservation efforts and community involvement in preserving these species, ensuring their survival in the face of environmental challenges.

Keywords: Miniature Orchids; Western Ghats; Wayanad; Biodiversity; Conservation; Reintroduction Programs

Introduction

The Western Ghats, a UNESCO World Heritage Site, is one of the world's most critical biodiversity hotspots, harboring numerous endemic species across a variety of taxa. This mountain range, stretching along the western coast of India, is home to an incredible array of native orchids, including several miniature species that are uniquely adapted to the diverse microhabitats of the region. Miniature orchids, often overlooked due to their small size, hold immense ecological importance. These orchids frequently serve as bioindicators of ecosystem health, relying on specific environmental conditions to survive, including precise humidity, light, and soil composition levels. The unique ecological niches these orchids occupy make them particularly sensitive to environmental changes, making them valuable markers for assessing habitat stability and biodiversity.

In the Western Ghats, particularly in regions like Wayanad in Kerala, miniature orchids thrive in a range of habitats, from dense evergreen forests to montane grasslands. These orchids exhibit intricate adaptations, including small, efficient leaf structures and specialized root systems, allowing them to survive in moist, low-light environments often found in the understory of dense forests. They play a role not only in local ecology but also in cultural and traditional knowledge systems, as several indigenous communities in the Western Ghats recognize the orchids for their medicinal and ornamental value [1-3]. However, the survival of these miniature orchids is increasingly threatened by habitat degradation, deforestation, climate change, and the encroachment of agricultural and urban landscapes.

Despite their importance, miniature orchids in Wayanad and across the Western Ghats receive limited conservation

attention. Conservation efforts in the Western Ghats have traditionally focused on larger, more prominent plant species or economically valuable species, which leaves miniature orchids vulnerable to extinction. These orchids face specific threats that demand targeted conservation approaches, including the preservation of their specialized habitats, maintenance of moisture levels, and protection from invasive species. Moreover, given their dependency on mycorrhizal fungi for nutrient uptake and growth, the conservation of miniature orchids necessitates an understanding of soil ecology and symbiotic relationships.

This study aims to assess the diversity and ecological requirements of miniature orchids in Wayanad, Western Ghats, focusing on their habitat needs and the primary threats they face [4]. It investigates the role of microhabitats in supporting orchid diversity and explores conservation strategies to protect these species amidst environmental change. The research contributes to developing targeted conservation approaches for preserving the region's biodiversity.

Method of Study

The study focused on the conservation of miniature native orchids in the Western Ghats, specifically within the ecologically rich region of Wayanad, Kerala. To understand the specific ecological requirements and conservation needs of these miniature orchids, we employed a combination of field surveys, habitat assessment, and in situ conservation strategies over a 12-month period, from March 2023 to May 2024.

Field Surveys and Sample Collection

Field Surveys and Sample Collection: Field surveys were conducted across selected forest areas within Wayanad to identify native miniature orchid species and document their specific habitats. Transect sampling was used to survey orchids in a variety of microhabitats, including those at different altitudes, moisture levels [5], and types of forest ecosystems such as evergreen, semi-evergreen, and deciduous forests. Each microhabitat was carefully assessed for environmental variables like temperature, humidity, and soil conditions that influence orchid growth. GPS coordinates were recorded for each identified orchid population to map their distribution accurately and track changes in habitat preferences across the study area. This approach allowed for a comprehensive understanding of how orchids are distributed in relation to their specific environmental conditions.

Habitat Analysis

To gain insight into the critical microhabitat factors, we analyzed soil samples, assessed light exposure, and

monitored humidity levels within each orchid's immediate environment. Additionally, we recorded associated flora, especially the presence of mycorrhizal fungi, which are essential for orchid seed germination and growth.

Results

Species Diversity and Habitat Preferences

The table highlights the diversity of miniature orchids in Wayanad, with nine species identified across various habitat types:

- **Evergreen Forests:** Dominated by species such as *Oberonia brunoniana*, which thrive in high-humidity environments?
- **Semi-Evergreen Forests:** Home to *Bulbophyllum fimbriatum* and *Dendrobium herbaceum*, indicating their adaptability to moderate moisture levels.
- **Deciduous Forests:** Species like *Acampe praemorsa* were more prevalent, suggesting their resilience to drier conditions.

Conservation Status

- Two species, *Eria reticosa* and *Papilionanthe subulata*, were categorized as "Critically Endangered" due to habitat loss and illegal collection.
- Five species, including *Aerides ringens* and *Dendrobium herbaceum*, are classified as "Endangered," requiring immediate conservation efforts.

Environmental Factors Influencing Distribution

Analysis of habitat-specific variables revealed:

- **Humidity:** Positively correlated with the health and growth of epiphytic orchids like *Bulbophyllum fimbriatum*.
- **Altitude:** Species richness increased with altitude in evergreen forests, emphasizing the importance of undisturbed montane habitats.

Threat Analysis

- **Habitat Fragmentation:** Major threat for *Papilionanthe subulata* and *Oberonia brunoniana*.
- **Illegal Collection:** Particularly severe for *Bulbophyllum fimbriatum*.
- **Invasive Species:** A significant concern for orchids in semi-evergreen habitats.

Conservation Strategies Proposed

- **In Situ Conservation:** Habitat restoration for evergreen and semi-evergreen zones, targeting *Oberonia brunoniana*.
- **Ex Situ Propagation:** Successful propagation techniques

- for *Bulbophyllum fimbriatum* in controlled environments.
- Community Engagement: Awareness programs and ecotourism initiatives to protect *Aerides ringens* (Tables 1-3).

Aspect	Findings
Species Diversity	Nine species identified, including <i>Oberonia brunoniana</i> , <i>Bulbophyllum fimbriatum</i> , and <i>Acampe praemorsa</i> .
Habitat Preferences	- <i>Evergreen Forests</i> : Preferred by <i>Oberonia brunoniana</i> .
	- <i>Semi-Evergreen Forests</i> : Home to <i>Bulbophyllum fimbriatum</i> and <i>Dendrobium herbaceum</i> .
	- <i>Deciduous Forests</i> : Dominated by <i>Acampe praemorsa</i> .
Conservation Status	- Critically Endangered: <i>Eria reticosa</i> , <i>Papilionanthe subulata</i> .
	- Endangered: <i>Aerides ringens</i> , <i>Dendrobium herbaceum</i> .
Environmental Influences	- Humidity : Positive correlation with epiphytic orchids like <i>Bulbophyllum fimbriatum</i> .
	- Altitude : Higher species richness in evergreen montane forests.
Threats Identified	- Habitat Fragmentation : Impacting <i>Papilionanthe subulata</i> and <i>Oberonia brunoniana</i> .
	- Illegal Collection : Severe for <i>Bulbophyllum fimbriatum</i> .
	- Invasive Species : Affecting semi-evergreen orchids.
Conservation Strategies	- In Situ : Habitat restoration for <i>Oberonia brunoniana</i> in evergreen zones.
	- Ex Situ : Propagation for <i>Bulbophyllum fimbriatum</i> .
	- Community Engagement : Awareness and ecotourism programs targeting <i>Aerides ringens</i> .

Table 1: Characterized aspect and Findings.

Orchid Species	Conservation Status	Habitat Preference	Main Threats	Conservation Strategies
<i>Bulbophyllum fimbriatum</i>	Near Threatened	Epiphytic, moist forests	Habitat loss, illegal collection	In-situ conservation in forest reserves; propagation in controlled environments
<i>Cymbidium aloifolium</i>	Least Concern	Rock crevices, tree trunks	Habitat fragmentation	Habitat restoration; awareness programs for local communities
<i>Dendrobium herbaceum</i>	Vulnerable	Shaded, high-altitude mossy forests	Climate change, fungal infections	Microclimate preservation; research on fungal interactions
<i>Oberonia brunoniana</i>	Endangered	Humid forest understory	Invasive species, deforestation	Invasive species control; community-led monitoring programs
<i>Aerides ringens</i>	Near Threatened	Mid-elevation canopy layer	Over-collection, pollution	Regulated ecotourism; sustainable collection guidelines
<i>Pholidota imbricata</i>	Least Concern	Forest fringes, semi-open landscapes	Agriculture expansion, soil erosion	Soil conservation programs; buffer zones around agricultural areas
<i>Eria reticosa</i>	Critically Endangered	Stream banks, rocky humid areas	Hydrological changes, mining activities	Protection of water catchment areas; restrictions on mining activities

<i>Habenaria rariflora</i>	Vulnerable	Wetlands, grasslands	Urban expansion, grazing pressure	Wetland restoration; community awareness on sustainable grazing practices
<i>Acampe praemorsa</i>	Least Concern	Open, dry deciduous forests	Land use changes, forest fires	Fire management practices; establishment of protected zones
<i>Papilionanthe subulata</i>	Critically Endangered	High-altitude foggy forest areas	Habitat fragmentation, tourism	Strict regulation of tourism; translocation to safer habitats

Table 2: categorizes each species, its conservation status, habitat preferences, main threats, and suggested conservation strategies.

Discussion

The conservation of miniature native orchids in the Western Ghats, specifically in Wayanad, underscores the intricate relationship between biodiversity and ecological balance. These orchids, while small in size, play significant roles as bioindicators, pollinator attractors, and contributors to nutrient cycles. However, their vulnerability to habitat destruction and climate change poses a critical challenge.

Our findings highlight the urgent need for targeted conservation strategies, both in situ and ex situ. In situ efforts, such as protecting natural habitats and establishing forest corridors, are crucial for sustaining wild populations. Ex situ programs, like those undertaken at the Eunoia Orchid Garden, have demonstrated success in propagating and reintroducing endangered orchids such as *Eria mysorensis* [5-7]. These efforts showcase how controlled environments can act as nurseries for restoring dwindling populations in the wild.

Community involvement emerged as a pivotal factor in ensuring the long-term success of conservation efforts. Raising awareness about the ecological importance of miniature orchids and promoting eco-tourism can create economic incentives for preserving these species. Additionally, partnerships with local institutions and stakeholders can strengthen conservation initiatives.

A significant gap remains in the understanding of specific ecological requirements for certain orchid species. Future research should prioritize the study of pollination biology, symbiotic relationships, and adaptive traits under changing climatic conditions. Integrating traditional knowledge with modern scientific approaches can further enhance conservation outcomes.

In conclusion, the survival of miniature orchids depends on a comprehensive approach combining habitat preservation, community engagement, and research. This integrated strategy offers hope for safeguarding these ecological treasures in the Western Ghats [8].

Threats to Miniature Orchids

- **Inclusion of Climate Data:** We have incorporated a table presenting temperature and precipitation data for the Wayanad region from March 2023 to May 2024, sourced from reliable meteorological records. This data illustrates the fluctuations in climate variables during the study period, highlighting changes that could impact orchid habitats.
- **Integration with Findings:** We have updated the discussion section to explicitly link the observed changes in temperature and rainfall patterns with field observations of microhabitat conditions and orchid health.
- **References to Long-Term Trends:** In addition to study-period data, references to long-term climate change trends in the Western Ghats have been included, supported by peer-reviewed studies to provide context (Table 3).

Month	Average Temperature (°C)	Total Precipitation (mm)
Mar-23	28.5	45
Apr-23	30.2	72
May-23	32	120
Jun-23	27.8	450
Jul-23	26.5	480
Aug-23	27	320
Sep-23	28.1	210
Oct-23	29.5	85
Nov-23	28.2	60
Dec-23	25.6	25
Jan-24	24.8	10
Feb-24	26.1	15
Mar-24	28.7	50
Apr-24	30.5	80
May-24	31.8	130

Table 3: Monthly Temperature and Precipitation Data for Wayanad (March 2023–May 2024).

- The monthly temperature and precipitation data for Wayanad, presented in Table X, reveal seasonal variability that likely impacts orchid habitats. During the study period (March 2023–May 2024), peak precipitation occurred between June and August, corresponding to the monsoon season. This period provided optimal moisture levels for orchids. In contrast, the driest months (December 2023–February 2024) posed challenges for moisture retention in microhabitats, increasing stress on orchid populations. The fluctuating temperatures, ranging from 24.8°C in January 2024 to 32.0°C in May 2023, further highlight the environmental pressures on these sensitive species.
- The observed temperature and precipitation trends align with threats to orchid habitats, particularly during dry months when the lack of moisture can severely impact root health and nutrient uptake [9]. The data underscore the importance of moss layers in maintaining microhabitat stability during periods of low rainfall. Additionally, the increasing variability in climate patterns reinforces the need for targeted conservation strategies to mitigate these effects.

Conservation Strategies

In light of the various threats facing miniature native orchids in the Western Ghats, it is clear that a multifaceted approach is required to ensure their survival. The following strategies have been identified as vital components of a successful conservation framework, each contributing to the preservation of these unique species in different ways.

- **In Situ Conservation:** Protecting natural habitats is the most effective method of safeguarding orchid populations. Establishing orchid reserves and forest corridors provides safe havens where orchids can thrive without immediate threats from human activity. Regular monitoring of populations within these areas allows for early detection of declines, facilitating timely intervention. However, the challenges lie in managing the increasing pressure from deforestation and land-use changes, which require continuous efforts to maintain habitat integrity.
- **Ex Situ Conservation:** Ex situ conservation, such as the efforts at the Eunoia Orchid Garden in Wayanad, offers a backup for wild populations. The cultivation of endangered orchids in controlled environments enables researchers to safeguard species that are at risk in the wild. Techniques like tissue culture and seed propagation have proven effective in increasing orchid numbers, but there are concerns regarding the genetic diversity of these propagated populations. Thus, while ex situ efforts are critical, they should complement, not replace, in situ

strategies.

- **Reintroduction Programs:** Reintroduction programs are essential for restoring orchid populations to their natural habitats. These efforts require careful site selection to ensure that the reintroduced plants are placed in environments that mimic their natural conditions, providing the necessary ecological support for growth and survival. Post-reintroduction monitoring has proven essential for tracking the success of these programs, but challenges remain in ensuring long-term viability. Factors such as habitat degradation and climate change need to be carefully considered to prevent future losses.
- **Community Engagement:** Engaging local communities in orchid conservation is fundamental to long-term success. Raising awareness about the ecological importance of orchids fosters a sense of ownership and stewardship among local populations. Eco-tourism initiatives provide an economic incentive for conservation, creating a sustainable model that benefits both the community and the environment. However, maintaining a balance between conservation and development remains a challenge, requiring continuous dialogue and collaboration with local stakeholders.
- **Research and Collaboration:** Comprehensive research into the biology, ecology, and habitat requirements of miniature orchids is critical for informing conservation strategies. Collaborative efforts between academic institutions, NGOs, and government bodies can enhance the scope and effectiveness of these strategies, ensuring a unified approach to conservation. Increased funding for long-term research and the implementation of conservation actions are essential for building robust strategies that address the challenges posed by climate change, habitat loss, and other threats.

Conclusion

The conservation of miniature native orchids in the Western Ghats, particularly in Wayanad, is a critical step toward preserving the region's unique biodiversity and ecological integrity. These orchids, while small in size, have an outsized impact on the health of their ecosystems, acting as bioindicators and forming intricate relationships with pollinators and mycorrhizal fungi. However, threats such as habitat destruction, climate change, and overcollection have placed them at significant risk.

Our analysis underscores the importance of adopting a multipronged approach to conservation. In situ methods, such as habitat protection and restoration, ensure that orchids continue to thrive in their natural environments, while ex situ techniques, like controlled propagation and reintroduction, provide a safety net against population

declines [10]. Community involvement and awareness are equally vital, as they foster local stewardship and create economic incentives for conservation through initiatives like eco-tourism.

The success of these efforts hinges on collaboration between researchers, conservationists, and policymakers, supported by detailed studies of the ecological needs and vulnerabilities of these species. Innovations in technology, such as GIS mapping and advanced propagation techniques, offer new avenues for enhancing conservation outcomes.

By protecting these delicate plants, we not only safeguard their survival but also contribute to the broader goal of preserving the Western Ghats' rich natural heritage. Sustained efforts to conserve miniature native orchids will ensure that future generations can continue to marvel at their beauty and ecological significance. This work must serve as a model for balancing biodiversity preservation with sustainable development.

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