J. Biodivers. Conservation 9(3): 80-88 ISSN: 2457-0761 (online)
2025 http://www.aprfjournal.in

Research Article

Diversity, ethnobotany, and conservation status of orchids in the Himalayan Botanical Garden, Nainital, India

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DOI: https://doi.org/10.5281/zenodo.17076205

Article Details: Received: 2025-06-01 | Accepted: 2025-09-08 | Available online: 2025-09-10

Abstract: Orchids (family Orchidaceae) represent one of the most species-rich and ecologically significant groups of flowering plants. India is home to approximately 1,300 orchid species, with the Himalayan region recognized as a hotspot of endemism and diversity. The Himalayan Botanical Garden (HBG) in Nainital, Uttarakhand, serves as a critical ex-situ conservation site for many native and medicinally important orchids of the Western Himalayas. This study documents 24 orchid species belonging to 15 genera conserved in HBG. Through detailed field surveys and ethnobotanical assessments conducted between 2022 and 2025, we recorded their morphological traits, ecological preferences, and traditional uses. Of these, 15 species were found to have ethnomedicinal significance, including applications for respiratory disorders, wound healing, fever, and rejuvenation. The findings highlight the value of integrating traditional knowledge with biodiversity conservation and underscore the need to prioritize orchid protection in both botanical gardens and native habitats. Many species are threatened by habitat loss, unsustainable harvesting, and climate variability. Our study reinforces the role of botanical gardens as biodiversity repositories and education centres and suggests strategies for orchid conservation involving community engagement and ecological restoration. These results contribute valuable data to the broader conservation discourse and provide a foundation for future pharmacological and ecological research on Himalayan orchids.

Keywords: Ecosystem, ethnobotany, Himalaya, orchids, endemism

Introduction

Orchids, belonging to the family Orchidaceae, represent one of the largest and most evolutionarily advanced families among angiosperms. Globally, the family comprises more than 28,000 accepted species and over 750 genera, displaying extraordinary morphological diversity and ecological specialization (Chase et al., 2015). Orchids are distributed across diverse ecosystems, ranging from tropical lowlands to alpine regions, and are particularly abundant in humid tropical and subtropical

forests. Their unique reproductive biology-featuring intricate pollination mechanisms and mycorrhizal dependencies-renders them ecologically significant and vulnerable to environmental disturbances (Dressler, 1993). India is home to approximately 1,300 orchid species, with the Himalayan region accounting for nearly 70% of the total diversity (Misra, 2007; Singh et al., 2019). The Western and Eastern Himalayas are recognized as major orchid-rich zones due to their altitudinal gradients, varied microclimates, and high endemism. Within this context, Uttarakhand, situated in the Western Himalayas, hosts a remarkable variety of terrestrial and epiphytic orchids, many of which are used in traditional medicine and ritual. Himalayan Botanical Garden (HBG) offers suitable conditions-cool temperatures, high humidity, and diverse host trees-for the cultivation and study of native orchid species. It functions as both an ex-situ conservation centre and a living laboratory for orchid ecology, propagation, and public awareness. Ethnobotanically, orchids have long held importance in Ayurvedic, Unani, and folk medicinal systems. Species such as *Malaxis muscifera* (locally known as “Jeevak”) and *Habenaria intermedia* (“Riddhi”) are included in the revered Ayurvedic formulation Ashtavarga, believed to rejuvenate the body and boost immunity (Kala, 2005). *Rhynchostylis retusa*, *Vanda cristata*, and *Calanthe tricarinata* are commonly used in indigenous medicine to treat respiratory disorders, wounds, and skin diseases. However, despite their pharmacological potential, many orchid species remain under-documented and are increasingly threatened by habitat degradation, climate variability, and unsustainable harvesting (Nayar and Sastry, 1987; Ved et al., 2003). Botanical gardens like HBG are instrumental in bridging the gap between conservation science and community knowledge. Through *ex-situ* cultivation, public education, and collaborative research, these institutions can help rescue orchid taxa from extinction and promote sustainable use models. Documenting the orchid diversity within HBG and recording associated ethnobotanical knowledge is, therefore, critical not only for scientific purposes but also for policy development, biodiversity management, and rural bioeconomy strategies. This study aims to:

a) Document and classify the orchid species present in the Himalayan Botanical Garden.
b) Record vernacular names and traditional uses of each species.
c) Assess their ethnobotanical relevance and conservation status.
d) Provide a basis for future orchid propagation, pharmacological research, and community-based conservation planning.

By integrating field botany, local knowledge systems, and conservation science, this research contributes to the broader effort of orchid bio-protection and biodiversity resilience in the Indian Himalayas.

Methodology

The study integrates floristic survey techniques, ethnobotanical interviews, and conservation assessment frameworks to document orchid diversity and traditional uses within the HBG, Nainital. The research was conducted over three years (2022–2025) to accommodate seasonal variations in orchid phenology, particularly flowering and fruiting patterns. The Himalayan Botanical Garden is situated in Nainital, Uttarakhand (latitude: 29.38°N; longitude: 79.45°E), at an elevation of approximately 1,700-

2100 meters above sea level. The site experiences a temperate to subalpine climate, with cool summers, cold winters, and high humidity-ideal for epiphytic and terrestrial orchid cultivation. The garden contains curated plant collections and natural forest patches with diverse microhabitats (Ifoundbutterflies.org). Orchid identification was carried out using systematic transect walks and quadrant sampling across different ecological niches of the garden-such as tree trunks, shaded slopes, moss-covered rocks, and orchidarium environments. Field observations were conducted May-September to capture the complete seasonal variation in flowering and growth. Representative specimens were collected under ethical guidelines, and herbarium vouchers were prepared following standard botanical protocols (Bridson and Forman, 1998). These specimens were dried, pressed, mounted, and deposited at HBG's local reference herbarium for taxonomic validation. Species identification was done using the literature such as "Flora of British India" (Hooker, 1890-1897), "Orchids of India: A Glimpse" (Misra, 2007), and "Flora of India, Volume 23: Orchidaceae" (Singh et al., 2019). Online taxonomic databases such as the Plants of the World Online (POWO) and The Plant List were also consulted for the latest nomenclatural updates and synonyms (POWO, 2024). Morphological features such as floral structure, labellum shape, leaf arrangement, and pseudobulb characteristics were documented using hand lenses and digital photography. Species were classified according to their life form (epiphytic, terrestrial, or lithophytic) and ecological niche. Ethnobotanical information on orchid use was obtained through structured and semi-structured interviews with local healers, forest dwellers, and gardeners associated with a plant nursery. Review of published Ayurvedic and ethnobotanical literature (Jalal et al., 2008; Kala, 2005; Ved et al., 2003)

Results and discussion

The floristic survey conducted at the HBG, Nainital, documented a total of 24 orchid species belonging to 15 genera, representing a significant component of the temperate Himalayan orchid flora (Plate 1; Table 1). The findings include both terrestrial and epiphytic life forms, with varied medicinal and ornamental values. The results are categorized under species richness, ecological observations, ethnobotanical uses, and conservation status. The orchid flora of HBG is represented by 24 species, distributed across the genera such as *Dendrobium*, *Aerides*, *Vanda*, *Habenaria*, *Calanthe*, *Rhynchostylis*, *Coelogyne*, *Thunia*, *Luisia*, *Goodyera*, *Malaxis,* *Neottia*, *Pholidota*, *Nervilia*, and *Herminium* (Table 1). Among these, the most species-rich genera are *Dendrobium* with 3 species, *Aerides* with 2 species, and *Habenaria* with 2 species. The orchids observed included both native and regionally endemic taxa, some of which are rare in the wild but are thriving under the semi-controlled conditions of the garden. Out of the 24 species, 15 were epiphytic (e.g., *Vanda cristata*, *Rhynchostylis retusa*, *Aerides odorata*, etc.), and 10 were terrestrial (e.g., *Habenaria intermedia*, *Malaxis muscifera*, *Brachycorythis obcordate*, etc.). Key observations include:

a. *Coelogyne cristata* showed prolific blooming between February and April, indicating successful adaptation to garden conditions.
b. *Malaxis muscifera* and *Habenaria intermedia* showed robust vegetative growth and seedling emergence, suggesting favourable microclimatic support.

c. Species like *Luisia trichorrhiza* and *Nervilia crociformis* were sparsely distributed and showed limited flowering, indicating potential vulnerability.

Plate 1: Conservation of orchids in Himalayan Botanical Garden (a-b) and their orchid wealth, c) *Coelogyne cristata*, d) *Malaxis muscifera*, e) *Luisia trichorrhiza* and f) *Vanda cristata*

Of the 24 recorded species, 15 orchids (approximately 67%) were found to have known ethnomedicinal uses, validated by literature review and local knowledge. Traditional uses include:

1. Respiratory disorders – e.g., *Rhynchostylis retusa*, *Thunia alba*, *Aerides odorata*
2. Skin conditions and wound healing – e.g., *Vanda cristata*, *Calanthe tricarinata*
3. Rejuvenation tonics – e.g., *Malaxis muscifera*, *Habenaria intermedia*
4. Digestive and metabolic ailments – e.g., *Pholidota articulata* (used for diabetes), *Brachycorythis obcordata*

Table 1. Summary of medicinal uses of orchids at HBG

Species	Common Name	Use(s)
Aerides odorata	Fragrant fox brush orchid, Fragrant Aerides	Pneumonia, inflammation, dyspepsia (Jalal and Jayanthi, 2012)
Aerides multiflora	Many-flowered fox brush orchid	Cuts and wounds (Rao, 2003)
Brachycorythis obcordata	Heart-shaped short-helmet orchid	Antidiarrheal, astringent (Mishra et al, 2016)
Cymbidium lowianum	Low's boat orchid	-

Calanthe tricarinata	Monkey orchid	Eczema, sores (Tiwari et al, 2007)
Coelogyne cristata	Snow queen, Swarna jibanti	High ornamental value (Bhatt et al, 2010)
Dendrobium amoenum	Lovely dendrobium	Tonic, astringent (Chhetri et al, 2013)
Dendrobium fimbriatum	Fringe-lipped Dendrobium	Antioxidant (Singh et al, 2011)
Dendrolirium lasiopetalum	The shaggy-petaled Eria	-
Epipactis helleborine	Broad-leaved helleborine	-
Goodyera repens	Creeping lady's-tresses	Burns (poultice) (Samant et al, 1998)
Habenaria intermedia	Riddhi	Ingredient in Chyawanprash (rejuvenative) (Gaur, 1999)
Habenaria marginata	Golden yellow Habenaria	Malignant ulcers (Sundriyal et al. 2003)
Herminium monorchis	Musk orchid	-
Luisia trichorrhiza	Hairy-root Luisia	-
Malaxis muscifera	Jeevak	Tuberculosis, fever, debility (Kala, 2004)
Neottia listeroides	Listera-like Neottia	-
Nervilia crociformis	Round shield orchid	-
Peristylus constrictus	Constricted Peristylus	-
Platanthera susannae	Susanna's Pecteilis	-
Pholidota articulata	Rattlesnake orchids, Haadajojen	Cough, diabetes (Sharma et al, 2010)
Rhynchostylis retusa	Foxtail orchid	Asthma, tuberculosis (Bhandari, 2005)
Thunia alba	White Thunia	Pneumonia, gastritis (Rawat and Bisht, 2009)
Vanda cristata	Comb Trudelia, Harchur	Cuts, wounds (Negi and Gaur, 2008)

The presence of flowering orchid displays, signage with scientific and local names, and guided educational walks has enhanced the garden's role as a public awareness and conservation education center. Visitor engagement with orchid collections has increased in recent years, indicating growing interest in plant-based conservation themes. The findings from the HBG reveal a significant concentration of orchid diversity in a relatively small, semi-natural *ex-situ* conservation setting. The 24 species documented represent a blend of both epiphytic and terrestrial orchids characteristic of the mid-altitude Western Himalayan zone. These species not only reflect the floristic composition of surrounding forest ecosystems but also illustrate the potential of botanical gardens as refuges for threatened orchid taxa. The prevalence of epiphytic species such as *Vanda cristata*, *Rhynchostylis retusa*, and *Coelogyne cristata* reflects their ecological adaptation to the cool, humid, and shaded environments maintained within HBG. Epiphytic orchids rely on host trees for mechanical support but do not parasitize them; instead absorb moisture and nutrients from the air and debris, making them highly sensitive to changes in microclimate and forest canopy structure (Dressler, 1993). The recorded terrestrial species, such as *Malaxis muscifera*, *Habenaria intermedia*, and *Brachycorythis obcordata,* typically inhabit moist forest floors and clearings. These orchids depend heavily on symbiotic relationships with mycorrhizal fungi, which are essential for seed germination and nutrient acquisition (Rasmussen, 2002). Their survival in

garden conditions suggest successful replication of essential habitat parameters, offering hope for broader *ex-situ* conservation applications. The diversity observed in HBG also supports the view that botanical gardens can function as effective microcosms of regional biodiversity, especially when garden design aligns with ecological zonation (Chen et al., 2009). However, several rare species, such as *Luisia trichorrhiza* and *Nervilia crociformis* showed limited flowering and vegetative vigour, indicating a need for improved horticultural management and fungal symbiont restoration. A notable finding is the ethnomedicinal utility of 15 out of the 24 species (67%), underlining the deep integration of orchids into traditional healthcare systems of the Himalayan communities. These uses, ranging from respiratory and digestive ailments to wound healing and rejuvenation, align with those reported in other studies across the Indian Himalayan region (Kala, 2005; Jalal et al., 2008). *Malaxis muscifera* (Jeevak) is historically revered in Ayurveda as a rasayana (rejuvenate), forming a component of the Ashtavarga group used in Chyawanprash and other health tonics (Ved et al., 2003). *Rhynchostylis retusa* and *Vanda cristata* are recognized in local folk medicine for their efficacy in treating respiratory disorders and external wounds. These findings reinforce the idea that orchid conservation must also prioritize preservation of cultural knowledge systems. However, many traditional uses remain undocumented in formal pharmacopoeias, suggesting a gap between ethnobotanical potential and scientific validation (Singh and Duggal, 2009).

Conservation challenges and opportunities

Despite their recognized ecological and medicinal value, orchids are one of the most threatened groups of flowering plants globally (Swarts and Dixon, 2009). The threats facing Himalayan orchids include habitat degradation due to deforestation and infrastructure development, climate change altering flowering cycles, host tree availability, fungal symbioses, Illegal collection and trade, especially of charismatic and medicinal species. Species such as *Coelogyne cristata* and *Dendrobium fimbriatum* are listed under Appendix II of CITES and Schedule VI of the Wildlife Protection Act of India (1972), which prohibits commercial exploitation. However, enforcement remains weak, particularly in remote areas. The success of in-situ conservation is often constrained by socio-economic pressures and land-use changes. In this context, ex-situ strategies like those adopted by HBG are vital, not only for maintaining living collections but also for research, education, and public engagement (Pritchard et al., 2014). Propagation of orchids through tissue culture, seed sowing, and symbiotic fungal inoculation is emerging as a promising tool in conservation biology. Furthermore, community engagement through orchid festivals, cultivation workshops, and inclusion in eco-tourism circuits could enhance protection efforts while providing livelihood opportunities to local populations (Hossain, 2011). Bridging scientific research with local stewardship models will be key to long-term conservation success.

Role of Botanical Gardens in Conservation Science

Botanical gardens, often undervalued in conservation discourse, are gaining recognition as living libraries of biodiversity. The HBG exemplifies how such spaces can contribute to:

1. *Ex-situ* gene bank preservation for rare and threatened orchids.

2. Public awareness campaigns through interpretative signage and orchid trails.
3. Training programs for students, horticulturists, and forest officials.
4. Baseline data generation for future restoration projects.

By aligning with national biodiversity strategies and integrating traditional ecological knowledge, botanical gardens can become hubs for integrated conservation approaches in biodiversity-rich regions like the Indian Himalayas (Chen et al., 2009; Pritchard et al., 2014).

Conclusion

The Himalayan Botanical Garden (HBG) in Nainital serves as a vital repository for the conservation and study of orchid diversity in the Western Himalayan region. Through the comprehensive survey conducted during this research, 24 orchid species belonging to 15 genera were documented, including a mix of both epiphytic and terrestrial orchids. This diversity reflects the rich floristic heritage of the mid-altitude temperate Himalayas and underscores the ecological importance of *ex-situ* conservation spaces. A significant outcome of the study is the documentation of ethnobotanical knowledge associated with these orchids. Nearly two-thirds of the recorded species are used in traditional medicinal systems for treating ailments ranging from respiratory conditions and skin diseases to general debility and metabolic disorders. Species such as *Malaxis muscifera*, *Habenaria intermedia*, *Rhynchostylis retusa*, and *Vanda cristata* are culturally significant and pharmacologically promising, highlighting the need to integrate traditional knowledge into modern scientific frameworks. Despite their importance, many of these orchids face threats due to habitat loss, climate change, and unsustainable harvesting. While *in-situ* conservation in wild habitats remains essential, this study confirms the critical role of botanical gardens like HBG in preserving rare and threatened orchid species. The favourable microclimatic conditions, controlled propagation facilities, and public engagement programs at HBG make it an exemplary model of conservation horticulture in the Himalayas. The results also point to several important considerations for orchid conservation and research: there is a pressing need to bridge ethnobotanical knowledge with phytochemical and pharmacological studies to validate and standardize the medicinal use of orchid species. Community-based conservation models should be promoted, where local knowledge holders and forest-dependent communities are actively involved in orchid stewardship, cultivation, and sustainable trade. Further studies on orchid ecology, mycorrhizal associations, and climate adaptability will be essential for building resilience in orchid conservation programs. In summary, this study contributes to the growing recognition of orchids not only as aesthetically and scientifically fascinating organisms but also as key components of Himalayan biodiversity and cultural heritage. The documentation of orchid species in HBG provides a foundation for future taxonomic, ethnobotanical, ecological, and conservation research. With strategic interventions in education, propagation, community engagement, and policy implementation, orchid conservation in Uttarakhand and across the Indian Himalayas can be significantly strengthened. The Himalayan Botanical Garden stands as a living testament to the possibilities of restorative biocultural conservation, where plants, people, and places are connected through knowledge, care, and shared responsibility.

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