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DIVERSITY AND DISTRIBUTION OF TERRESTRIAL ORCHIDS IN WESTERN GHATS OF CHIKKAMAGALURU DISTRICT, KARNATAKA

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Abstract

The Western Ghats is a biodiversity rich region with remarkable diversity of wild orchids, especially terrestrial orchids occupying highly diverse environments. The present study was conducted to explore the terrestrial orchid diversity in Western Ghats of Chikkamagaluru (Karnataka). Extensive field surveys were conducted across various vegetation types using stratified random sampling method. It revealed the occurrence of 35 species belonging to 15 genera. The maximum species diversity was observed in the genus *Habenaria* (12). With regard to density, *Habenaria heyneana* was densely populated (111.11), whereas the lowest density was observed in *Eulophia picta (*earlier known as *Geodorum densiflorum)* (0.02). Similarly, *H. heyneana* was found to be the most abundant species (118.33), while *Eulophia picta* and *Calanthe tricarinata* exhibited the lowest abundance (0.20). Due to high species richness and evenness, Devaramane region recorded the highest Shannon (2.41) and Simpson (0.88) diversity index while Sakkarayapattana and Kalasapura regions recorded the lowest. The present communication was an attempt to provide important insights on the population dynamics of terrestrial orchids and richness of different habitats. Sustained research and targeted management interventions are crucial to safeguard these species and to maintain the ecological integrity of the Western Ghats.

Introduction

THE FAMILY Orchidaceae, commonly known as the orchid family, is one of the ecologically prominent and second-largest flowering plant family representing 693 genera with 29,481 orchid species distributed worldwide (POWO, 2025; WFO, 2023). Beyond their ornamental value, orchids are the most intriguing plant species, displaying diverse ecological, morphological, physiological, and embryological characteristics. Their flowers exhibit considerable variations in size, shape, and colour, often mimicking the appearance of insects, birds, animals, and even humans. These plants occupy a vast range of environment including epiphytic, terrestrial, lithophytic and mycoheterotrophic habitats. Terrestrial orchids generally grow on the forest floor in shaded environments, maintaining a symbiotic relationship with mycorrhizal fungi. Since ancient times, many terrestrial orchid species like *Crepidium acuminatum, Habenaria intermedia, Herminium edgeworthii*, and *Malaxis muscifera* have been traditionally incorporated in ayurvedic formulations like Ashtavarga and Chyavanprash tonic (Bazzicalupo *et al.,* 2023; Pathak, 2013; Yonzone *et al.,* 2012). Despite their medicinal importance and evolutionary significance, these are most threatened taxa due to their specialized habitat needs, patchy distribution, limited dispersal, specific pollinator interactions, and mycorrhizal associations. Unlike epiphytic orchids, these plants bear very small and delicate flowers that are often difficult to identify without critical taxonomic studies.

India is renowned for its rich biodiversity, with a remarkable diversity of orchids. The country is home to around 1,256 orchid species across 155 genera (Singh *et al.,* 2019), with the highest concentrations found in the NorthEastern regions and the Western Ghats. The Western Ghats, a unique and crucial biodiversity hotspot, harbours a diverse array of wild orchids, including approximately 375 species, 15 of which are considered endangered (Gunaga *et al*., 2024; Halagatti *et al*., 2024; Hegde and Krishnaswamy, 2021a). In recent years, extensive studies on orchid diversity have been conducted in the Western Ghats. Udupa *et al*. (2011) documented 18 terrestrial orchid species in the grasslands of Chikkamagaluru. Later, Hegde and Krishnaswamy (2024) identified 30 terrestrial orchids in Hosanagara taluk and 25 species in the Sharavati river valley of Shimoga district (Hegde and Krishnaswamy, 2021b). Additionally, Patel *et al*. (2024) reported 15 species from Narsinghpur district. More recently, Chaitra *et al*. (2023) documented 29 species of terrestrial orchids in the Sringeri region, and Betageri and Savadi (2025) recorded 31 species from Koppa taluk, both in Chikkamagaluru district.

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Epiphytic orchids are comparatively easier to locate since these grow openly on host trees, while terrestrial orchids mostly occur as small and seasonally emergent under dense canopies and concealed within leaf litter. Moreover, research on orchid diversity has predominantly centered on epiphytic species owing to their wide spread cultivation for cut flower purpose and high ornamental value, whereas terrestrial species have attracted relatively less attention. Terrestrial orchids remain highly unexplored due to their occurrence in inaccessible and private owned habitats, coupled with their frequent misidentification. The present communication was therefore an attempt to provide important insights on the population dynamics of terrestrial orchids and richness of different habitats in Chikkamagaluru district, in Karnataka.

Material and Methods

Study Area

Chikkamagaluru district lies between 12°54' to 13°53' North latitude and 75°04' to 76°21' East longitude, a prominent region in the Western Ghats. The elevation of the region ranges between 615 to 1930 m (amsl) with an average annual rainfall of approximately 2420 mm. The district harbours different vegetation types including evergreen, semi-evergreen, moist deciduous, scrub forests, and grasslands with moderate to cool climate. Based on the preliminary studies, ten different regions in the district were selected for the study (Table 1).

Table 1. Details of the different regions with vegetation type in the study area.

Region	Vegetation type
Devaramane	Montane grasslands with patches of shola forest
Mullayanagiri	Shola grasslands, moist deciduous and semi-evergreen forest
Inam Dattathreya Peeta	Shola grasslands, evergreen and semi-evergreen forest
Byrapura	Evergreen, semi-evergreen, moist deciduous and shola grasslands
Kottigehara	Evergreen, semi-evergreen and moist deciduous forest
Malayamarutha	Moist deciduous and evergreen forest
Kudremukha	Evergreen, semi-evergreen, moist-deciduous and grasslands
Sakkarayapattana	Dry deciduous and shrub forests
Kalasapura	Dry deciduous and shrub forests
Aldur	Moist deciduous, semi-evergreen and evergreen forest

Methodology

Extensive field surveys were conducted during 2024-2025 in the selected regions during summer, winter, and rainy seasons. In the present study, stratified random sampling method was employed and within each site, belt transects of 100 m length and 5 m width was laid. Within each transect, quadrats of $1m^2$ were randomly placed to record terrestrial orchid populations. Terrestrial orchids were identified with the help of botanists, plant taxonomists, and also by referring to available literature, biodiversity portal. The location of the identified species was recorded using a GPS instrument.

Data Analysis

The collected data on orchid populations were quantitatively analysed through statistical analysis including density and abundance using the formulae (a) and (b), respectively.

a) $\text{Density} = \dfrac{\text{Total number of individual species}}{\text{Total number of transects studied}}$

b) $\text{Abundance} = \dfrac{\text{Total number of individual species}}{\text{Number of transects in which species occurred}}$

Diversity indices were used to examine the overall health of orchid populations across different habitats. Shannon-Wiener (H') index was used to assess the species richness and evenness (Shannon and Weiner, 1963), whereas, Simpson's index of dominance (D) indicates species dominance (Simpson, 1949). It was calculated as follows:

$$\text{Shannon} - \text{Wiener index (H')} = -\sum_{i=1}^{s} \left({}^{n_i}/_{N}\right) \times \ln\left({}^{n_i}/_{N}\right)$$

$$\text{Simpson's index (D)} = 1 - \frac{\sum n_i(n_i - 1)}{N(N - 1)}$$

Where, H' - Shannon-Wiener diversity index; n_i -Number of individuals of i^{th} species; N - Total number of all the individuals; ln - Natural logarithm; D – Simpson index of dominance and Σ is the sum of the calculations. Since higher values of D indicate lower diversity, Simpson's index was usually expressed as 1-D.

Results and Discussion

Species Diversity

The surveys conducted across different types of vegetation in Western Ghats of Chikkamagaluru district documented 35 terrestrial orchid species representing 15 different genera including *Acanthophippium, Calanthe, Dienia, Disperis, Eulophia, Habenaria, Liparis, Malaxis, Nervilia, Pecteilis, Peristylus, Satyrium, Tainia, Tropidia,* and *Zeuxine* (Fig. 1). The number of terrestrial orchid species

found in ten regions were: 20 (Devaramane), 15 (Mullayanagiri), 10 (Inam Dattathreya Peeta), 13 (Byrapura), 12 (Kottigehara), 8 each (Kudremukha; Malayamarutha), 5 (Aldur), 1 each (Sakkarayapattana, Kalasapura). The highest species diversity was documented in Devaramane region followed by Mullayanagiri. Table 2 shows the data on flowering season, altitude range and IUCN status of these terrestrial orchids.

In the study area, *Habenaria* was the most commonly found genus with 12 species namely, *H. crinifera*, *H. dentata*, *H. elwesii*, *H. grandifloriformis*, *H. heyneana*, *H. lociniata*, *H. longicorniculata*, *H. longicornu*, *H. marginata*, *H. modesta*, *H. plantaginea,* and *H. roxburghii*. Of these, occurrence of *H. heyneana* was mainly noticed in all the vegions, excepting for Sakkarayapattana, Kalsapura and Malayamarutha regions. This could be due to the extensive montane grasslands and rainfall which supports the great diversity of *Habenaria* orchids in the region (Udupa *et al.,* 2011). It was followed by *Liparis* and *Peristylus* (4 species each) and *Malaxis* and *Nervilia* (2 species

Table 2. Flowering season, altitude range, and IUCN status of terrestrial orchids in Western Ghats of Chikkamagaluru.

Orchid species	Flowering season	Altitude range (m amsl)	IUCN Status
Acanthophippium bicolor Lindl.	April-May	900-1200	NE
Calanthe tricarinata Lindl.	April-July	1500-3000	NE
Crepidium versicolor (Lindl.) Sushil K.Singh, Aggarwala & Jalal	August-September	900-1600	NE
Dienia ophrydis (J.Koenig) Seidenf.	May-August	900-2000	NE
Disperis neilgherrensis Wight	May-June	800-1200	NE
Eulophia nuda Lindl.	April-August	900-2000	NE
E. picta (R.Br.) Ormerod	June-October	700-1400	NE
Habenaria crinifera Lindl.	August-September	1000-2000	NE
H. dentata (Sw.) Schltr.	August-September	800-2000	NE
H. elwesii Hook.f.	August-September	600-1800	NE
H. laciniata Dalzell	July-September	600-1800	NE
H. grandifloriformis Blatt. & McCann	June-September	1000-2500	NT
H. heyneana Lindl.	July-September	900-1200	NE
H. longicorniculata J.Graham	July-September	800-2000	NE
H. longicornu Lindl.	August-October	500-1500	NE
H. marginata Colebr.	July-September	1000-2200	NE
H. modesta Dalzell	July-September	900-2000	NE
H. plantaginea Lindl.	July-September	900-1300	NE
H. roxburghii Nicolson	July-October	800-1800	NE
Liparis nervosa (Thunb.) Lindl.	July-August	900-1400	NE
Liparis nervosa var. *khasiana* (Hook.f.) P.K.Sarkar	July-August	900-1400	NE
L. odorata (Willd.) Lindl.	April-July	900-1800	NE
L. wightiana Thwaites	August-September	1000-2000	NE
Malaxis intermedia (A.Rich.) Seidenf.	June-September	1600-2500	NE
Nervilia plicata (Andrews) Schltr.	May-June	200-1000	NE
N. simplex (Thouars) Schltr.	May-June	900-1500	NE
Pecteilis gigantea (Sm.) Raf.	August-October	800-1200	NE
Peristylus aristatus Lindl.	August-September	900-2000	LC
P. densus (Lindl.) Santapau & Kapadia	May-October	1000-1800	NE
P. goodyeroides (D.Don) Lindl.	June-August	500-1500	NE
P. plantagineus (Lindl.) Lindl.	June-July	1000-1500	NE
Satyrium nepalense D.Don	July-November	900-2000	NE
Tainia bicornis (Lindl.) Rchb.f.	Nov-December	900-1500	NE
Tropidia angulosa (Lindl.) Blume	August-September	800-1800	NE
Zeuxine gracilis (Breda) Blume	February-May	800-1900	NE

NE, Not Evaluated; LC, Least Concern; NT, Near Threatened

Fig. 1. Some of the terrestrial orchids of Chikkamagaluru district, Karnatak: A, *Habenaria heyneana* Lindl.; B, *Eulophia picta*; C, *Peristylus densus*; D, *Habenaria grandifloriformis*; E, *Habenaria longicorniculata*; F, *Satyrium nepalense*.

each). Most of the grassland species, particularly *H. elwesii, H. grandifloriformis, H. heyneana, Peristylus densus,* and *Pecteilis gigantea,* predominantly occurred amidst patches of *Strobilanthes sessilis,* a dominant shrub in the habitat. Amongst the species reported, *H. elwesii, H. heyneana,* and *H. modesta* are endemic to the Western Ghats (Jalal and Jayanthi, 2018).

Terrestrial orchids show a wide range of flowering periods, typically from the months of April to October with peak flowering activity noticed during the months of June-September. Flowering of genus *Habenaria* was mostly noticed during the months of June-September after the onset of monsoon, showing strong interaction with rainfall patterns. During this period, the warm temperature combined with optimum rainfall and adequate moisture promotes the formation of new sprouts, which coincides with the peak flowering season (Hegde and Krishnaswamy, 2021a).

Species belonging to the genera *Nervilia* and *Zeuxine* were observed to flower between February and May. Maximum orchid species diversity was recorded at elevation between 900-2000 meters, preferring mid-elevation zones. Jalal (2012) reported that altitudinal zones ranging from 1000 to 2000 meters above sea level receive significantly more rainfall than higher elevations, creating an ideal environment for orchid growth. Amongst the orchids reported, *Habenaria grandifloriformis* was assessed under Near Threatened (NT) category in IUCN Red list.

Species Composition and Quantitative Analysis

Quantitative analysis including density and abundance reflects the numerical strength of the species. In the present study, density of the species ranged from 0.02 to 111.11 and the highest density was observed for *Habenaria heyneana.* Population of this species was greater in open grasslands as compared to that of other vegetations with its occurrence observed nearly across all regions. Vegetation types significantly affected patterns of distribution and abundance of orchids, as well as separation of their ecological niches (Djordjevic and Tsiftsis, 2020). It was followed by *Peristylus densus, Habenaria longicorniculata, Satyrium nepalense,* and *Habenaria grandifloriformis.* According to Dangat and Gurav (2022), *Habenaria* species possess adaptive features such as thick leaf cuticle, which minimizes transpiration, and a higher seed-to-embryo air ratio that enhances seed buoyancy and facilitates wider dispersal, collectively enabling the species to thrive in challenging environments. In contrast, *Eulophia picta* recorded the lowest density with only two individuals observed in the study area. Due to their minute and non-endospermic seeds requiring specific mycorrhizal fungus during germination in nature, the seed germination is very low. Moreover, these plants are highly habitat-specific hence require specific environmental conditions, elevation range and complex nutritional requirement for their growth and survival. Many species of orchids are rare due to their narrow geographic range and restricted habitat preferences resulting thereby in low population densities (Prakash and Pathak, 2019; Wang *et al.,* 2015).

In terms of abundance, the most abundant species was found as *Habenaria heyneana* (118.33) which was followed by *Peristylus densus* and *H. longicorniculata*. Least abundant species found in the study area were *E. picta* and *Calanthe tricarinata* (0.20 each). Zhang *et al.* (2015) indicated that orchid species abundance or richness along the elevation gradient might get affected by climatic conditions such as mean annual temperature and mean annual rainfall. Orchid growth, in general is strongly influenced by microclimatic conditions such as temperature, light and moisture. The richness, distribution and abundance of terrestrial orchids may be impacted by several environmental, ecological and biological factors. The density and abundance of terrestrial orchids of Chikkamagaluru district in Western Ghats is presented in Table 3.

Table 3. Density and abundance of terrestrial orchids of Chikkamagaluru district in Western Ghats.

Acanthophippium bicolor Lindl.	0.57	1.50
Calanthe tricarinata Lindl.	0.04	0.20
Crepidium versicolor (Lindl.) Sushil K.Singh, Aggarwala & Jalal	5.52	12.97
Dienia ophrydis (J.Koenig) Seidenf.	10.27	22.38
Disperis neilgherrensis Wight	3.96	9.11
Eulophia nuda Lindl.	0.13	0.63
E. picta (R.Br.) Ormerod	0.02	0.20
Habenaria crinifera Lindl.	1.33	4.43
H. dentata (Sw.) Schltr.	0.36	0.90
H. elwesii Hook.f.	9.94	13.07
H. laciniata Dalzell	3.09	4.41
H. grandifloriformis Blatt. & McCann	11.92	14.27
H. heyneana Lindl.	111.11	118.33
H. longicorniculata J.Graham	40.19	50.71
H. longicornu Lindl.	6.55	9.55
H. marginata Colebr.	0.82	1.64
H. modesta Dalzell	3.70	5.65
H. plantaginea Lindl.	1.52	2.53
H. roxburghii Nicolson	0.58	1.45
Liparis nervosa (Thunb.) Lindl.	7.49	13.23
L. nervosa var. *khasiana* (Hook.f.) P.K.Sarkar	0.12	0.60
L. odorata (Willd.) Lindl.	2.59	6.87
L. wightiana Thwaites	4.91	10.68
Malaxis intermedia (A.Rich.) Seidenf.	3.73	9.22
Nervilia plicata (Andrews) Schltr.	0.16	1.60
N. simplex (Thouars) Schltr.	0.98	2.98
Pecteilis gigantea (Sm.) Raf.	4.70	7.12
Peristylus aristatus Lindl.	9.80	22.40
P. densus (Lindl.) Santapau & Kapadia	40.76	59.68
P. goodyeroides (D.Don) Lindl.	0.12	0.40
P. plantagineus (Lindl.) Lindl.	1.17	3.11
Satyrium nepalense D.Don	12.70	15.90
Tainia bicornis (Lindl.) Rchb.f.	0.07	0.23
Tropidia angulosa (Lindl.) Blume	0.46	2.23
Zeuxine gracilis (Breda) Blume	1.91	4.53

Diversity Indices of Terrestrial Orchids in Different Regions

Chikkamagaluru district of Western Ghats is dominated by different types of vegetations which caused significant variation in diversity indices with respect to species richness and distribution. Diversity indices of presently studies 10 different regions are presented in Table 4.

Shannon-Wiener diversity index is a measure commonly used to quantify the diversity of species within a community. A higher index value generally indicates greater diversity of the region. Devaramane region harboured highest number of terrestrial orchid species, with the highest Shannon-weiner index (2.41), reflecting both high species richness and evenness. Montane grasslands, semi-evergreen and moist deciduous forests, enriched with moisture and humidity, supporting a greater number of species (Jalal and Jayanthi, 2018). On the other hand, Sakkarayapattana and Kalasapura regions recorded the lowest Shannon index. Minimum diversity in these regions might be because of the dry deciduous forests prone to forest fires easily, unsustainable logging and high anthropogenic activities (Jayanthi and Jalal, 2023). Besi *et al.* (2023) indicated that in logged forests, orchids are exposed to elevated heat and desiccation, that gradually lead to their decline.

Similarly, the highest Simpson diversity index was observed in Devaramane with a value of 0.88 as compared to other 9 regions indicating greater species dominance. Because of habitat heterogeneity, this region supports maximum diversity of orchids (Wraith *et al.,* 2020). Simpson diversity index was lower in Sakkarayapattana and Kalasapura regions as only one species was identified in each region. Factors such as habitat fragmentation, increased human disturbances, low elevation and agricultural activities may reduce the species richness and evenness in various regions.

By implementing efficient conservation strategies such as *in vitro* propagation techniques, terrestrial orchids may be prevented from extinction risk by ensuring

Table 4. Diversity indices of terrestrial orchids in Western Ghats region of Chikkamagaluru.

	DE	MU	ID	BY	KO	MA	KU	SA	AL	KA
Shannon Index (H')	2.41	2.07	1.98	1.68	1.47	0.98	1.06	0.00	0.97	0.00
Simpson index (1-D)	0.88	0.84	0.84	0.72	0.71	0.50	0.47	0.00	0.46	0.00

DE, Devaramane; MU, Mullayanagiri; ID, Inam Dattathreya peeta; BY, Byrapura; KO, Kottigehara; MA, Malayamarutha; KU, Kudremukha; SA, Sakkarayapattana; AL, Aldur; KA, Kalasapura.

long-term survival, in this connection, attempts have already been made to conserve some of the terrestrial orchid species through *in vitro* asymbiotic germination and regeneration using different explants (Dhillon and Pathak, 2023; Jaryal *et al.*, 2025a,b; Thakur and Pathak, 2020;Vasundhra *et al.,* 2019, 2021).

Conclusion

Orchids are of primary conservation concern and the present study highlighted the richness, diversity and distribution of terrestrial orchid species in Chikkamagaluru district of Western Ghats. A total of 35 species (in 15 genera) of terrestrial orchids were reported with *Habenaria* as the dominant genus. *Habenaria heyneana* achieved the highest density and abundance across all regions exhibiting its adaptability and dominance in various habitats. Amongst the studied 10 different regions, Devaramane recorded the highest Shannon and Simpson diversity index due to their habitat heterogeneity. Through accurate population estimation and by implementing efficient conservation strategies, terrestrial orchids may be prevented from extinction risk by ensuring long-term survival thereby maintaining the biological diversity.

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