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DIVERSITY OF WILD ORCHIDS IN SRINGERI REGION OF CHIKKAMAGALURU, KARNATAKA, INDIA

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Abstract

Orchids are an intrinsic component of forest ecosystems that contribute to a high proportion of plant diversity. The aim of this study was to investigate the diversity of orchids in the part of Western Ghats *i.e.* Sringeri. The present study revealed that 27 transects of 9 habitats of Sringeri recorded 29 species of orchids belonging to 22 genera in which most of them are epiphytic and two are terrestrial. Koradakallu region has the highest diversity and species richness. The highest Shannon's diversity index was observed for Koradakallu and Sindhodi, while Dyavagodu recorded the lowest Shannon's diversity index. Koradakallu recorded the highest Simpson's diversity index and the least was recorded by Dyavagodu. The highest species evenness was found in Masige indicating thereby that all the species present in that habitat is more even where the least evenness was found in Sirimane indicating thereby that the number of different orchid species varied greatly.

Introduction

ORCHIDS ARE the most ravishing and wondrous amongst all flowering plants on earth. These plants exhibit a wide range of diversity in size, shape, structure, form, adaptability, colour, and fragrance of the flowers; these have always been interesting to evolutionary biologists because of their remarkable diversity in pollination systems (Prakash and Pathak, 2019, 2020a, 2022). Orchids belong to the family called Orchidaceae, which is one of the largest in the plant kingdom with 705 genera (POWO, 2023) and 29,481 species (WFO, 2023); more than 1,50,000 man-made hybrids (De and Pathak, 2020). Economically, orchids are of great interest in horticulture on the other hand, the wild species have been employed as indicators of regions that have a robust ecosystem (Misra, 2004; Prakash and Pathak, 2020b).

India is a home for more than 1,256 species under 155 genera (Singh *et al*., 2019) which are distributed from Kanyakumari to Himalayas (5000 m amsl) while, the epiphytes are found upto 1800 m amsl (Bose *et al.,* 1999). About 800 species orchids in North-Eastern states, 200 species in Himalayas, 275 species in the Western Ghats, and 100 species in other regions are found (Gogoi *et al*., 2012). The Western Ghats is also known as one of the wealthiest regions in the world in terms of biodiversity making it the one among 25 Hotspots of the world (Singh *et al*., 2009). Due to the bewitching beauty of orchid flowers, easy access to the orchid habitats, and their high economical importance, it is posed to several damages by many anthropological activities and so they are at the verge of extinction due to loss of their natural habitats and over harvesting. There is an urgent need to understand the importance of orchids in daily lifestyle and to take some measures to conserve these *in situ* or *ex situ*. Attempts to conserve and mass propagate these orchids have been made earlier by a few workers (Anuprabha and Pathak, 2019, 2020; Bhowmik and Rahman, 2020, 2022; Kumari and Pathak, 2021; Lalduhsanga *et al.,* 2021; Mutum *et al.,* 2022; Pathak *et al*., 2016, 2017, 2022, 2023; Rahamtulla and Khasim, 2022; Sunita *et al.,* 2021; Thakur and Pathak, 2020, 2021; Tripura *et al.,* 2022; Vasundhra *et al.,* 2019; 2021). Hence, there is a need to study the diversity of wild orchids to develop conservation management of orchids in the area. The present paper briefly explains the diversity of the place called Sringeri which is a part of Western Ghats belonging to Chikkamagaluru district, Karnataka, India.

Material and Methods

Field Survey and Data Collection

The survey was made during 2020-21 to understand the diversity status of native orchids of Sringeri region, Chikkamagaluru district, Karnataka, India. The study area lies between 13°41' North latitude and 75°25' East

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longitude. The altitude of the explored area ranges from 600 to 700 m and the average rainfall is about 1800 mm. The belt transect method was followed for the analysis of the diversity, a transect of 100 m is laid with the help of rope and 1 m on either side of the rope formed a transect. Likewise three transects at a single place was laid and orchid diversity was calculated at the places like Masige, Gandaghatta, Sirimane, Dyavagodu, Kunchebailu, RTS Nagara, Koradakallu, Sindhodi, Uluve of Sringeri, and the map is depicted in the Fig. 1.

Identifications of Specimens

Identification of the wild orchids and the hosts were made mainly with the help of botanists, plant taxonomists, and also by referring to available literature in biodiversity portal.

Statistical Analysis

The data on various wild orchids in different transects were collected and analyzed through statistical methods (Deepa *et al.,* 2013 and Tuomisto, 2000).

Abundance

It is the study of the number of individuals of different species in the community per unit area. By quadrat method, samplings were made at random places and

Fig. 1. Map of Sringeri depicting the studied places for orchid diversity.

the number of individuals of each species was summed up for all the quadrats divided by the total number of quadrats in which the species occurred. It is represented by the equation.

$$\text{Abundance} = \frac{\text{Total number of individual species in all transects}}{\text{Total number of transects in which species has occured}} \times 100$$

Shannon's Diversity Index (H')

Shannon's diversity index is another index that is commonly used to characterize species diversity in a community. It accounts for both abundance and

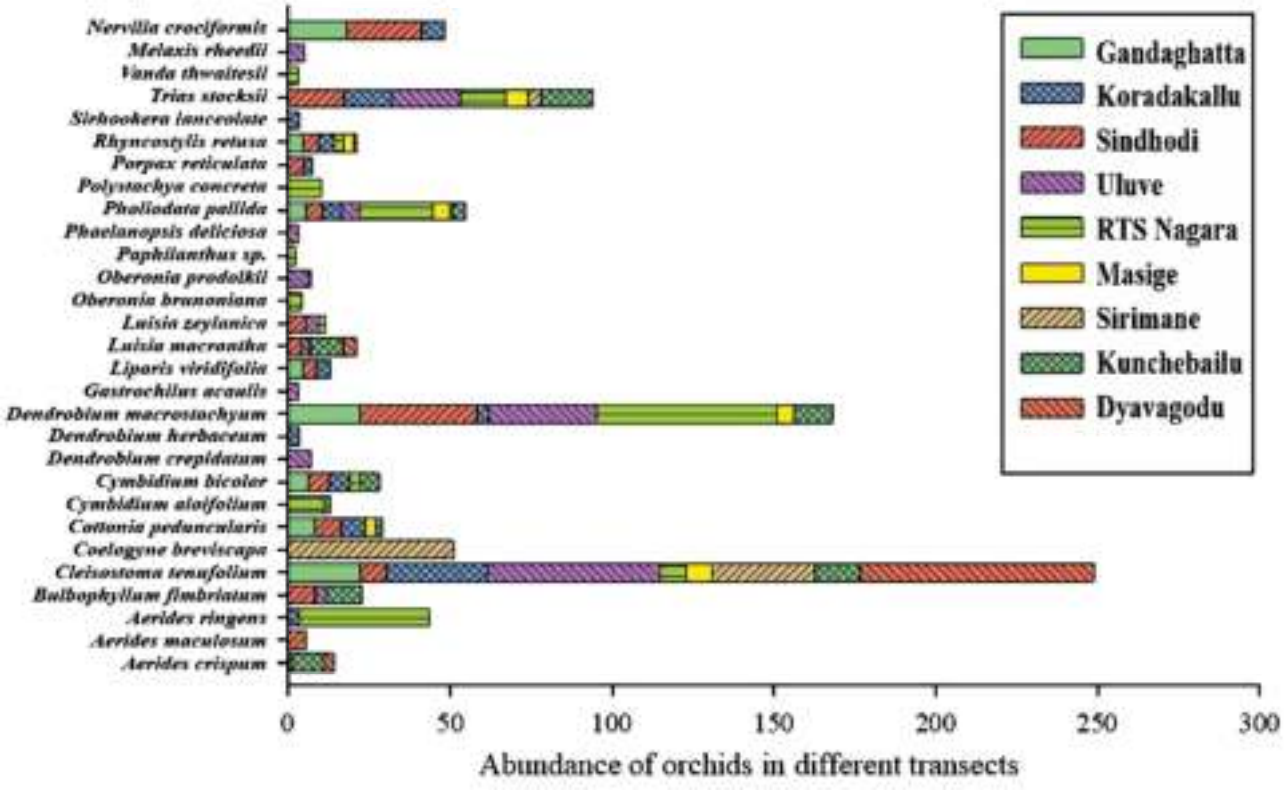

Fig. 2. Abundance of orchids in different transects of Sringeri.

evenness of the species present. Based on the data of the occurrence of the species in the transects, Shannon's diversity index was calculated which is represented as below (Shannon and Weiner, 1963).

$$H^1 = -\sum pi \ln pi$$

where,

H^1 = Shannon index of diversity

pi = the proportion of the important value of the i^{th} species (*pi* =Ni/N, ni is the important value index of i^{th} species and N is the important value index of all the species).

Simpson's Diversity Index (D)

Simpson's diversity index is a measure of diversity which takes into account the number of species present, as well as the relative abundance of each species. As species richness and evenness increase, diversity increases. It is calculated as follows (Simpson, 1949).

$$D = \frac{\sum ni(ni-1)}{N(N-1)}$$

where,

D = Simpson index of dominance, pi = the proportion of the important value of the i^{th} species (pi = ni /n, ni is the important value index of all the species) as D increases, diversity decreases, and Simpson's index was therefore usually expressed as 1 – D.

Beta Diversity Index

Beta diversity measures the change in the diversity of species from one environment to another. A high beta diversity index indicates a low level of similarity, while a low beta diversity index shows a high level of similarity.

It is calculated as follows $B = (S_1 - c) + (S_2 - c)$

where,

S_1 – Total number of species in the first environment

S_2 – Total number of species in the second environment

c – Number of species that the two environments have in common

Results

The results of diversity of native orchids in nine habitats/locations of Sringeri, Chikmagaluru possessed vegetation like evergreen forest and moist deciduous forests. The data pertaining to genera, habitats, and growth habits of different wild orchid species studied are presented in the Table 1.

Twenty nine species belonging to 22 genera were recorded from nine transects in which 27 species were epiphytic and two were terrestrial. *Aerides* and *Dendrobium* were the largest genera in the studied area having three species followed by *Cymbidium, Luisia,* and *Oberonia* with two species each, respectively. Seventeen genera with single species were recorded in the study area.

Amongst the 29 orchid species found in the studied area, 13 species were monopodials *i.e. Aerides crispa*, *A. maculosa*, *A. ringens*, *Cleisostoma tenuifolium*, *Cottonia pendicularis*, *Luisia macrantha*,

Table 1. List of wild orchid species found in Sringeri, Western Ghats of Karnataka.

Species	Habitat	Growth habit
Aerides crispa Lindl.	E	M
A. maculosum Lindl.	E	M
A. ringens (Lindl.) C.EC.Fisch.	E	M
Bulbophyllum fimbriatum (Lindl.) Rchb.f.	E	S
Cleisostoma tenuifolium (L.) Garay	E	M
Coelogyne breviscapa Lindl.	E	S
Cottonia peduncularis (Lindl.) Rchb.f.	E	M
Cymbidium aloifolium (L.) Sw.	E	S
C. bicolor Lindl.	E	S
Dendrobium crepidatum Lindl. & Paxton	E	S
D. herbaceum Lindl.	E	S
D. macrostachyum Lindl.	E	S
Gastrochilus acaulis (Lindl.) Kuntze	E	S
Liparis viridiflora (Blume) Lindl.	E	S
Luisia macrantha Blatt. & McCann	E	M
L. zeylanica Lindl.	E	M
Oberonia brunoniana Wight	E	S
O. proudlockii King & Pantl. (Lindl.) Seidenf.	E	S
Papilionanthe cylindrica	E	M
Phalaenopsis deliciosa Rchb.f.	E	M
Pholidota pallida Lindl.	E	S
Polystachya concreta (Jacq.) Garay & H.R. Sweet	E	M
Porpax reticulata Lindl.	E	S
Rhynchostylis retusa (L.) Blume.	E	M
Sirhookera lanceolata (Wight) Kuntze	E	S
Trias stocksii Benth. ex Hook.f.	E	S
Vanda thwaitesii Hook.f.	E	M
Malaxis rheedei B.Heyne ex Wallace	T	M
Nervilia crociformis (Zoll. & Moritzi) Seidenf.	T	S

E, Epiphytic; T, Terrestrial; M, Monopodial; S, Sympodial.

Table 2. Diversity indices of orchids in each habitat of Sringeri, Western Ghats.

	G	K	S	U	R	M	Si	Ku	D
Taxa (S)	8	14	14	13	13	6	7	10	3
Abundance	90	138	96	143	198	32	93	84	79
Dominance (D)	0.18	0.13	0.15	0.21	0.18	0.18	0.44	0.12	0.83
Simpson index (1 – D)	0.82	0.87	0.85	0.79	0.81	0.81	0.56	0.87	0.16
Shannon index (H)	1.87	2.34	2.26	1.92	2.02	1.73	1.03	2.14	0.36
Evenness (H/S)	0.81	0.74	0.68	0.53	0.58	0.94	0.4	0.85	0.48

G, Gandaghatta; K, Koradakallu; S, Sindhodi, U, Uluve; R, RTS Nagara; M, Masige; Si, Sirimane; Ku, Kunchebailu; D, Dyavagodu.

L. zeylanica, *Malaxis rheedei*, *Paphilanthus* sp., *Phalaenopsis deliciosa*, *Rhynchostylis retusa*, *Polystachya concreta,* and *Vanda thwaitesii*; while, 16 species were sympodials *i.e. Bulbophyllum fimbriatum*, *Coelogyne breviscapa*, *Cymbidium aloifolium*, *C. bicolor*, *Dendrobium crepidatum*, *D. herbaceum*, *D. macrostachyum*, *Gastrochilus acaulis*, *Liparis viridiflora*, *Nervilia crociformis*, *Oberonia brunoniana*, *O. proudlockii*, *Pholidota pallida*, *Porpax reticulata*, *Sirhookera lanceolata*, and *Trias stocksii*.

The data pertaining to Shannon's diversity index and Simpson's diversity index of different locations of the Western Ghats in Sringeri region is presented in Table 2. The highest Shannon's diversity index was observed for Koradakallu (2.34) followed by Sindhodi (2.26), Kunchebailu (2.14), RTS Nagara (2.02), Uluve (1.92), Gandaghatta (1.87), Masige (1.73), Sirimane (1.03), and Dyavagodu (0.36). Kunchebailu and Koradakallu recorded the highest Simpson's diversity index (0.87 each, respectively), followed by Sindhodi (0.85), Gandaghatta (0.82), Masige and RTS Nagara (0.81), Uluve (0.79), Sirimane (0.56), and Dyavagodu (0.16). The highest evenness was found in Masige (0.94), followed by Kunchebailu (0.85), Gandaghatta (0.81), Koradakallu (0.74), Sindhodi (0.68), RTS Nagara and Uluve (0.58), Dyavagodu (0.48), and Sirimane (0.4).

The data pertaining to beta diversity is presented in the Table 3. The highest beta diversity index was found between Sindhodi and Dyavagodu (0.88) followed by Dyavagodu and RTS Nagara (0.87). The least Beta diversity index was observed between Sindhodi and Koradakallu (0.21).

Discussion

Studies on diversity of orchids in Sringeri region will offer an insight into the occurrence of different orchid species in that particular area. The present preliminary survey indicated that the nine habitats of Sringeri represented a good amount of orchid diversity. Twenty nine species belonging to 22 genera were recorded, of which 27 species were epiphytic and 2 were terrestrial. *Aerides* and *Dendrobium* were the largest genera having three species followed by *Cymbidium, Luisia,* and *Oberonia* with two species each, respectively. Seventeen genera with single species were recorded in the study area. Due to the suitable hosts, habitat, and climate of the location seemed to encourage the diversity of wild orchids in the study area. Similar studies were made earlier in

Table 3. Beta diversity index of wild orchid diversity in Sringeri, Western Ghats of Karnataka.

	G	K	S	U	R	M	Si	Ku	D
G	0.00	-	-	-	-	-	-	-	-
K	0.27	0.00	-	-	-	-	-	-	-
S	0.27	0.21	0.00	-	-	-	-	-	-
U	0.71	0.48	0.63	0.00	-	-	-	-	-
R	0.50	0.46	0.46	0.60	0.00	-	-	-	-
M	0.29	0.40	0.40	0.58	0.44	0.00	-	-	-
Si	0.60	0.52	0.62	0.50	0.58	0.98	0.00	-	-
Ku	0.44	0.33	0.42	0.39	0.45	0.38	0.53	0.00	-
D	0.82	0.76	0.88	0.62	0.87	0.78	0.60	0.54	0.00

G, Gandaghatta; K, Koradakallu; S, Sindhodi; U, Uluve; R, RTS Nagara; M, Masige; Si, Sirimane; Ku, Kunchebailu; D, Dyavagodu.

wild orchids by Barbhuiya and Salunkhe (2016); Gogoi *et al.* (2012, 2015), and Kumar *et al.* (2011). The growth habit and habitat of the wild orchids present in the studied area are monopodial (13 species) and sympodial (16 species). This might be due to the fact that inherent genetic traits of particular orchid species influence its growth habit and this is in conformity with the studies made earlier by Akshatha (2018) and Jeevith *et al.* (2019).

Presently, the abundance of the particular orchid species and the abundance of orchids in the particular place were surveyed at 27 transects in Sringeri. Figure 2 presents the abundance of the wild orchid species in different habitats of Sringeri. The abundance was found to be more in the place called RTS Nagara and Uluve while, the least abundance was found for Dyavagodu, Kunchebailu, and *Cleisostoma tenuifolium* with the high number of individuals emerged as the most abundant species. This might be due to the reason that the particular species has occurred in maximum number per unit area and in the meanwhile destruction of habitat by anthropogenic activities, illegal removal of endangered or rare wild orchids from their native location, and tourism led to the lesser abundance of some species. Similar studies were made earlier by Jeevith *et al.* (2019); Malley (2009); Mitta *et al.* (2015); and Timsina *et al.* (2016).

Shannon-Weiner diversity index is the popular diversity measures which is generally based on information theory, the higher value indicates higher species diversity. The highest Shannon's diversity index was observed for Koradakallu and Sindhodi, while Dyavagodu recorded lowest Shannon's diversity index. Simpson diversity is another diversity measure, which ranged from 0.16 to almost 0.87. The higher value indicates high species richness. Kunchebailu and Koradakallu recorded the highest Simpson's diversity index and the least was recorded in Dyavagodu. Species evenness refers to how close in numbers each species is. The highest evenness was found in Masige indicating thereby that all the species present in that habitat is more even where the least evenness was found in Sirimane indicating that the number of different orchid species varied greatly. Beta diversity measures the change in the diversity of species from one environment to another. A high beta diversity index indicates a low level of similarity, while a low beta diversity index shows a high level of similarity. The highest beta diversity index found between Sindhodi and Dyavagodu indicated that the presence of orchids in these places are much different while the least beta diversity index was found between Sirimane and Koradakallu which indicated that no much difference was found in the orchid species between these two habitats. These results are in conformity with earlier studies made by Wilsey (2010).

The main reason for the highest diversity in Sringeri seems to be the presence of evergreen type of forest and low human activity in the region. Further, many host trees harboured the wild orchids due to their specific bark characteristics. In general, illegal possession and exploitation of the wild orchids which have high demand in the international markets and conversion of protected habitats into cultivatable land are the main reasons for the decline in the natural populations of the orchids. A great diversity of orchids is found in the undisturbed sites of the study area and limited or no development in the study area indicates the change in the microclimatic conditions in habitat by anthropogenic activities. Collection of orchids, in large scale from the forest areas led to decline of natural populations of orchids. Therefore, an immediate conservative measures need to be taken so as to save these species in their natural habitat.

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