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ORCHID DIVERSITY OF SINDHUDURG, MAHARASHTRA

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The Western Ghats of India, including the Sindhudurg District of Maharashtra, are renowned for their rich and endemic plants diversity. This study aimed to conduct a comprehensive assessment of the orchid flora of Sindhudurg, with a focus on their taxonomy, distribution, habitat, and conservation status. A total of 66 species of orchids, belonging to 26 genera, were recorded from the study area. *Habenaria* and *Dendrobium* emerged as the most diverse genera, with 16 and 9 species, respectively. The orchid assemblage comprised 34 terrestrial, 32 epiphytic. Notably, *Habenaria* dominated the terrestrial orchids, while *Dendrobium* was prominent among epiphytes. The study highlights the presence of 27 orchid species that are endemic to India. The orchids were found to inhabit a range of habitats, including evergreen forests, deciduous forests, and grasslands. Habitat destruction, over-collection, and climate change were identified as major threats to the orchid diversity of the region. This study provides valuable insights into the orchid diversity of Sindhudurg District, highlighting the need for conservation efforts to protect these ecologically important and threatened species.

Keywords Conservation, Endemic species, Orchids, Sindhudurg, Western Ghats.

Introduction

Orchids are one of the most ecologically and morphologically diverse group of angiosperms. Since ancient times, people have been aware of them because of their attractive flowers and therapeutic properties. The family Orchidaceae comprises approximately 736 genera and 27,800 species of orchids across the globe[1]. Their distinctive floral form, pollination strategy, affiliation with particular fungi (mycorrhizae), and minuscule seeds are their defining traits. These plants have a wide range of floral forms, sizes, colors, scents, and textures. Commercial production has grown significantly and developed into a very profitable industry. Many species, including *Cymbidium, Paphiopedilum* and *Phalaenopsis,* are cultivated for the beauty of their flowers[2].

In addition to their decorative appeal, orchids have ethnobotanical significance. Since the "Vedic time," orchids have been revered for their therapeutic and healing properties[3,4]. The "Charaka Samhita" a historic Indian medical treatise authored by Charaka in Sanskrit a thousand years ago, discussed the ethnobotanical significance of several orchids. In the Ayurveda system of medicine, orchids were used to treat different diseases like tuberculosis, malaria, nervous disorders and dermal related disease, etc.

India is home to a diverse range of orchids, with 1,256 Taxa under 155 genera present in the country. Based on various factors India is classified into 10 biogeographic zone, among these zones 305 species of orchid with 73 genera documented in Western Ghats which is

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highest after Himalayan zone and North Zone[5]. The nation serves as a significant endemic Centre for the orchidaceae family with 352 endemics[6].

Many rare orchid species habitat found in the Western Ghats evergreen woods. Sindhudurg District, located in the southernmost part of Maharashtra, is a part of Western Ghats. Sindhudurg shows a remarkable assortment of orchid species that boast vibrant colors and unique shapes. The district's moderate climate, with its ample rainfall and temperate conditions, provides an ideal environment for these delicate yet resilient flowers to flourish. Local communities in Sindhudurg often cherish these orchids for their cultural significance and aesthetic appeal. Some orchids are integral to traditional practices and rituals, while others are important into the local art forms, inspiring artisans and craftsmen in their creations[7].

Climate

A hot and humid climatic condition prevails in the district. The peak summer season in the district occurs between March to May. The district experiences rainfall from June to October, while winters are mild from November to February. The district's average annual rainfall is recorded at 3182.9 mm, reflecting its high rainfall regime. From March onwards, summer temperatures rise steadily. The month of May experiences the maximum temperature. During the rainy season, temperature decreases by 3 - 4° C, dropping to levels even lower than those experienced during the cold season. Humidity remains relatively high throughout the year in this coastal District, seldom falling below 60% even during peak summer and winter months.

Vegetation

Four primary types of vegetation are found in this region[8], namely

- Littoral or Mangrove type
- Open scrub type
- Moist deciduous type
- Semi evergreen type

Plant communities in this region blend seamlessly into one another, lacking distinct boundaries, and dominant species are difficult to identify. The climatic climax in this area is characterized by a plant community consisting of *Careya arborea, Mangifera indica, Lagerstroemia microcarpa*, *Tectona grandis, Terminalia* spp. and, *Syzygium cumini*.

An updated orchid documentation can be used for educational purposes, raising awareness among the general public, students, and enthusiasts about the richness of orchid diversity. It emphasises the significance of protecting these species and their natural environments. In the present study, we performed an extensive survey to explore the orchid diversity in the Sindhudurg region and documented it for conservation and further research purposes.

Material and Methods

Study Area

Sindhudurg district, located in the southernmost part of Maharashtra. It covers an area of 5207 square kilometres, which accounts for only 1.69 % area of the Maharashtra state. Notably, the District comprises 8 Taluka, namely Devgad, Dodamarg, Kankavli, Kudal, Malvan, Sawantwadi, Vaibhavwadi, and Vengurla, providing a diverse range of habitats for orchid species to thrive.

Data Collection

Field visits were conducted across various localities within the study area to collect and investigate the distribution patterns of orchids. The compilation of the present study was facilitated through extensive field surveys undertaken over a three-year period, spanning from 2022 to 2024. During the field visits, detailed observations were made on the habitat, phenology, morphology, and reproductive

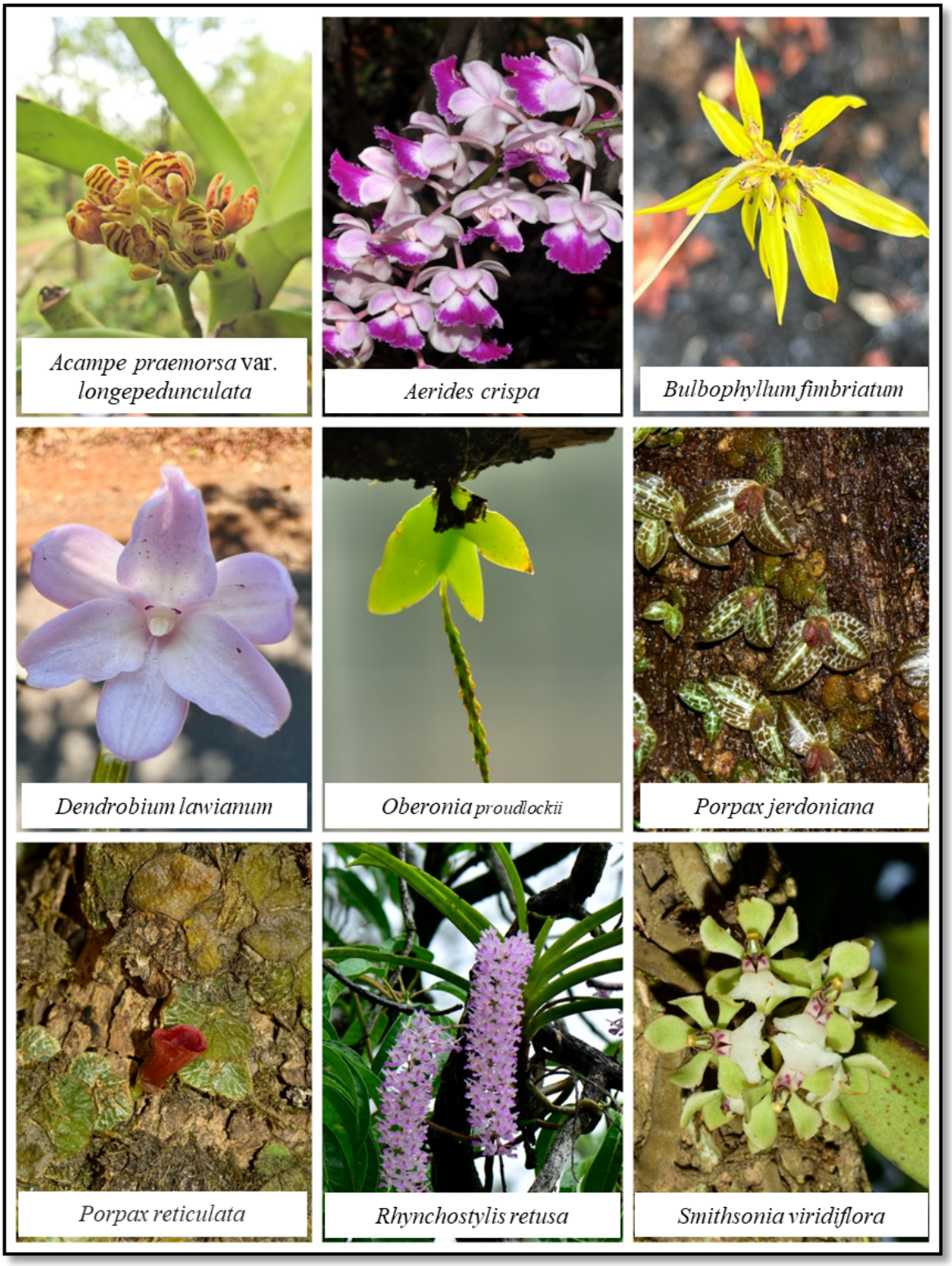

Figure 1. Epiphytic orchid species in Sindhudurg District.

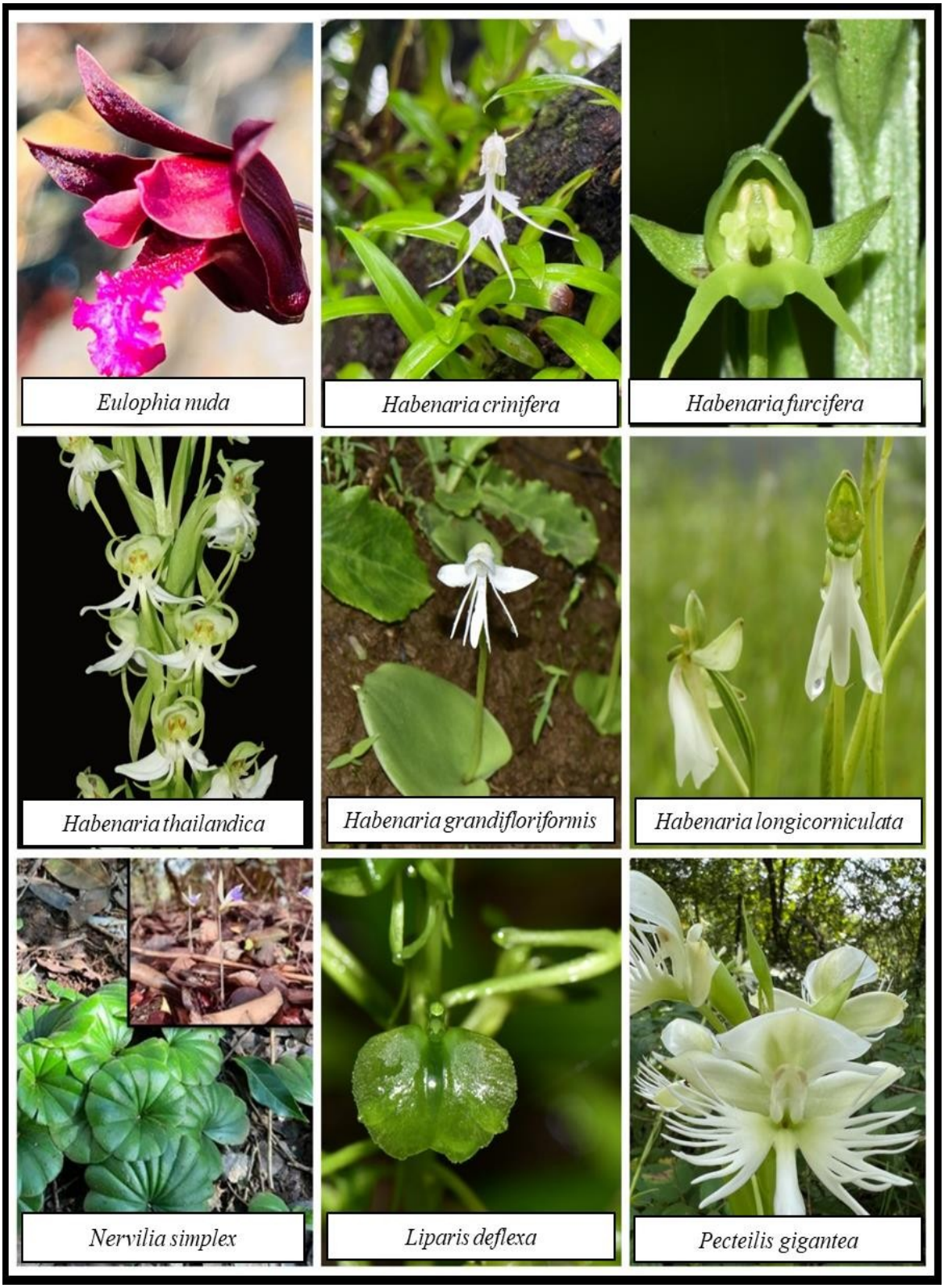

Figure 2. Terrestrial orchid species in Sindhudurg District.

patterns (including flowering and fruiting) of orchids. Photographs were captured using a Nikon digital camera to document the species. Select specimens were carefully collected for further laboratory analysis.

Results and Discussion

In the present study, a total of 66 orchid species belonging to 26 genera were collected (Table 1). Finding shows out of 66 orchid species documented, 32 species were epiphytic (Figure 1) and 34 species were terrestrial (Figure 2). The District's largest genus *Habenaria*, with 16 species, followed by *Dendrobium* (9), *Porpax* (6), *Nervilia* (4), *Peristylus* (3), *Smithsonia*, (3), *Aerides* (2), *Cymbidium (2), Eulophia* (2), *Liparis* (2), *Oberonia* (2) and single species of *Acampe, Bulbophyllum, Cheirostylis, Cleisostoma, Cottonia, Crepidium, Dienia, Epipogium, Gastrochilus, Luisia*, *Pecteilis*, *Rhynchostylis*, *Thunia*, *Vanda* and *Zeuxine* were documented. Among these species *Acampe praemorsa, Aerides maculosa, Porpax filiforme, Dendrobium ovatum, Liparis ordorata, Oberonia brachystachys, Pecteilis gigantean, peristylus plantagineus,* and *Rhynchostylis retusa* were present in all 8 Taluka of the District.

There have been 66 orchid species identified during the present investigation, that classified into 26 genera. A checklist of Orchidaceae was compiled in 2018, based on herbarium records and recent botanical expeditions[9]. Their publication, 'An updated checklist of the orchids of Maharashtra, India', reported the presence of 53 species, representing 23 genera, within the Sindhudurg District of Maharashtra, thereby contributing significantly to the documentation of the regional orchid diversity. A subsequent investigation also conducted by[10] yielded a notable discovery, reporting the presence of *Aerides maculosa* Lindl. an epiphytic orchid species, within the mangrove ecosystems of Maharashtra. This finding constitutes the first documented distribution record of this species within the state's mangrove habitats.

The outcomes demonstrate that 32 orchids of the 66 species were epiphytic, whereas 34 were terrestrial. *Habenaria* emerges as the biggest genus in the district with the highest number of species. The present research also revealed significant variations in orchid diversity across the different Taluka. Sawantwadi and Dodamarg emerged as a hotspot for orchid diversity in Sindhudurg, harboring the highest number of species, whereas Malvan and Devgarh exhibited relatively low orchid diversity.

Sawantwadi was inhabited by 60 of the 66 species that were documented, of which 29 were terrestrial, 31 were epiphytic. Dodamarg presented 36 species of orchids, the second-highest number after Sawantwadi, of which 18 were epiphytic and 18 were terrestrial (Figure 3). In terms of species richness, Dodamarg is further followed by Vengurla (20 spp.), Vaibhavawadi (17 spp.), Kudal (16 spp.), Kankavli (13 spp.), Devgarh (12 spp.) and Malvan (11 spp.) (Figure 4). This observed variation in orchid diversity across the Taluka may be attributed to factors such as differences in habitat types, topography, and climate

The District Sindhudurg is a home to a diverse range of orchid species. From 66 reported species, 27 species belonging to 8 genera are endemic to India. These species are *Aerides maculosa, Bulbophyllum fimbriatum, Dendrobium aqueum, Dendrobium barbatulum, Dendrobium herbaceum, Dendrobium lawianum, Dendrobium microbulbon, Dendrobium ovatum, Dendrobium nodosum, Gastrochilus flabelliformis, Habenaria elwesii, Habenaria grandifloriformis, Habenaria heyneana, Habenaria longicorniculata, Habenaria multicaudata, Habenaria ovalifolia, Habenaria rariflora, Habenaria suaveolens, Oberonia proudlockii, Porpax*

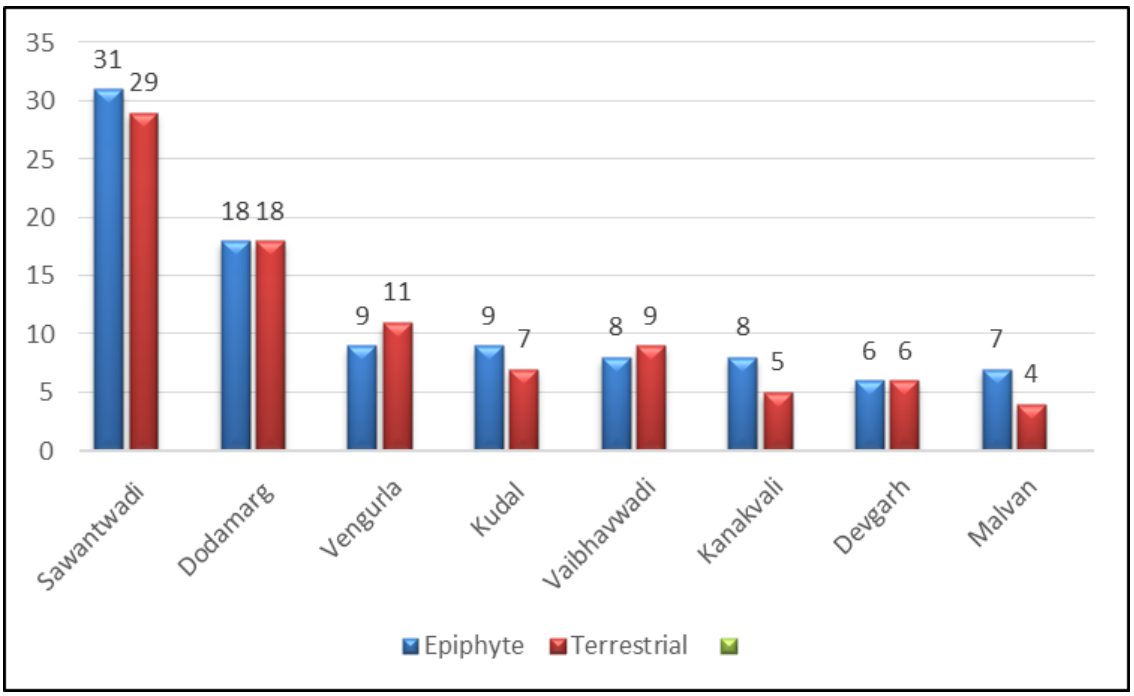

Figure 3. Habitat wise distribution of orchid species in different Taluka of Sindhudurg.

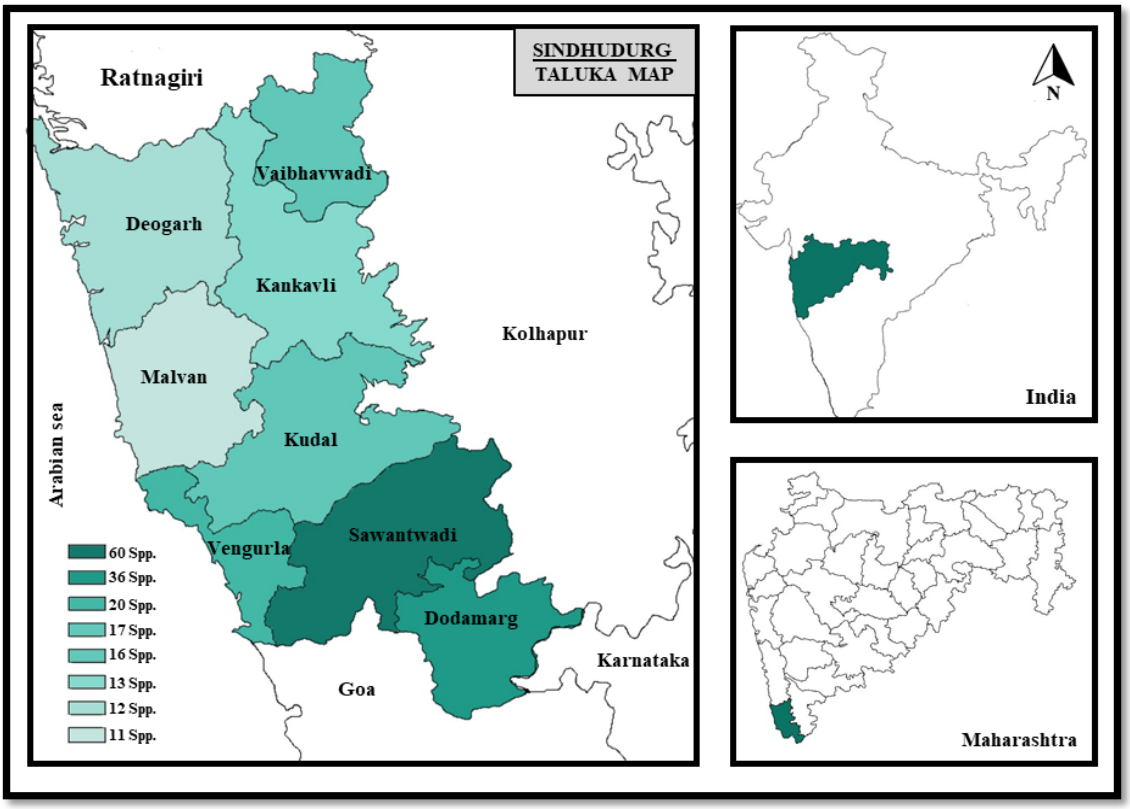

Figure 4. Study area map with distribution pattern of orchid richness in Sindhudurg District.

Table 1: Distribution of orchids in each Taluka of Sindhudurg District.

S. No.	Orchid Species	Habitat	Phenology	Taluka							
				Sawantwadi	Vengurla	Kankavali	Devgad	Vaibhawadi	Dodamarg	Malwan	Kudal
1.	*Acampe praemorsa* var. *longepedunculata* (Trimen) Govaerts	E	03-06	+	+	+	+	+	+	+	+
2.	*Aerides crispa* Lindl.	E	03-06	+					+		
3.	*Aerides maculosa* Lindl.	E	05-07	+	+	+	+	+	+	+	+
4.	*Bulbophyllum fimbriatum* (Lindl.) Rchb.f.	E	12-06	+							
5.	*Cheirostylis parvifolia* Lindl.	T	11-02	+							
6.	*Cleisostoma tenuifolium*(L.) Garay	E	06-11		+						
7.	*Cottonia peduncularis* (Lindl.) Rchb.f.	E	03-04	+		+					+
8.	*Crepidium versicolor* (Lindl.) Sushil K.Singh, Agrawala & Jalal	T	07-08	+							
9.	*Cymbidium aloifolium*(L.) Sw.	E	05-06	+							
10.	*Cymbidium bicolour* Lindl.	E	05-06	+							+
11.	*Dendrobium aqueum* Lindl.	E	09-10	+					+		
12.	*Dendrobium barbatulum* Lindl.,	E	01-05	+					+		
13.	*Dendrobium crepidatum* Lindl. & Paxton	E	02-04	+							
14.	*Dendrobium crispum* Dalzell	E	12-02	+							
15.	*Dendrobium herbaceum* Lindl.	E	02-03	+							
16.	*Dendrobium lawianum* Lindl.	E	03-04	+					+		
17.	*Dendrobium microbulbon* A. Rich.	E	12-01	+							
18.	*Dendrobium nodosum* Dalzell	E	07-08	+							
19.	*Dendrobium ovatum* (L.) Kraenzl.	E	09-02	+	+	+	+	+	+	+	+
20.	*Dienia ophrydis* (J.Koenig) Seidenf.	T	06-07	+					+		
21.	*Epipogium roseum* (D.Don) Lindl.	T	05-06	+					+		
22.	*Eulophia nuda* Lindl.	T	05-06	+					+		
23.	*Eulophia picta* (R.Br.) Ormerod	T	07-08	A	+				+		
24.	*Gastrochilus flabelliformis* (Blatt. & McCann)	E	03-07	+					+		
25.	*Habenaria commelinifolia* (Roxb.) Wall. ex Lindl.	T	08-11	+							
26.	*Habenaria crinifera* Lindl.	T	07-08	+			+				
27.	*Habenaria digitata* Lindl.	T	07-09	+	+				+		
28.	*Habenaria diphylla* (Nimmo) Dalzell	T	08-10	+	+	+		+			

29. *Habenaria elwesii* Hook.f.	T	09-10									+
30. *Habenaria furcifera* Lindl.	T	08-09	+					+			
31. *Habenaria grandifloriformis* Blatt. & McCann	T	05-07	+			+	+	+			
32. *Habenaria heyneana* Lindl.,	T	07-09	+				+	+			
33. *Habenaria longicorniculata* J.Graham	T	07-12	+				+	+			
34. *Habenaria marginata* Colebr.	T	08-10	+	+	+						+
35. *Habenaria multicaudata* Sedgw.	T	08-10									+
36. *Habenaria ovalifolia* Wight.	T	08-10	+								
37. *Habenaria plantaginea* Lindl.	T	08-10	+								
38. *Habenaria rariflora* A.Rich.	T	07-09	+								
39. *Habenaria suaveolens* Dalzell	T	07-09	+	+				+			
40. *Habenaria thailandica* Seidenf.	T	07-08	+	+							
41. *Liparis deflexa* Hook.f.	T	09-10	+								
42. *Liparis odorata* (Willd.) Lindl.	T	06-09	+	+	+	+	+	+	+	+	
43. *Luisia zeylanica* Lindl.	E	05-06	+	+	+		+	+	+	+	
44. *Nervilia concolor* (Blume) Schltr.	T	05-08	+	+		+	+	+	+		
45. *Nervilia infundibulifolia* Blatt. & McCann	T	05-06	+					+			
46. *Nervilia plicata* (Andrews) Schltr.	T	05-08	+								
47. *Nervilia simplex* (Thouars) Schltr..	T	05-06	+					+			
48. *Oberonia brachystachys* Lindl.	E	10-03	+	+	+	+	+	+	+	+	
49. *Oberonia proudlockii* King & Pantl.	E	02-03	+								
50. *Pecteilis gigantea* (Sm.) Raf.	T	09-10	+	+	+	+	+	+	+	+	
51. *Peristylus aristatus* Lindl.	T	07-09	+								
52. *Peristylus densus* (Lindl.) Santapau& Kapadia	T	08-09	+				+	+			
53. *Peristylus plantagineus* (Lindl.) Lindl.	T	08-10	+	+	+	+	+	+	+	+	
54. *Porpax exilis* (Hook.f.) Schuit., Y.P.Ng & H.A.Pedersen	E	10-12	+					+			
55. *Porpax filiformis* (Wight) Schuit., Y.P.Ng & H.A.Pedersen	E	07-08	+	+	+	+	+	+	+	+	
56. *Porpax jerdoniana* (Wight) Rolfe	E	06-07	+				+	+			
57. *Porpax microchilos* (Dalzell) Schuit., Y.P.Ng & H.A.Pedersen	E	07-08	+					+			
58. *Porpax reticosa* (Wight) Schuit	E	05-06	+					+			
59. *Porpax reticulata* Lindl.	E	04-06	+					+			
60. *Rhynchostylis retusa* (L.) Blume	E	06-07	+	+	+	+	+	+	+	+	
61. *Smithsonia maculata* (Dalzell) C.J.Saldanha	E	05-06	+					+			
62. *Smithsonia straminea* C.J.Saldanha	E	05-06	+	+				+		+	
63. *Smithsonia viridiflora* (Dalzell) C.J.Saldanha,	E	05-06	+								
64. *Thunia alba* (Lindl.) Rchb.f.	T	08-09		+						+	
65. *Vanda testacea* (Lindl.) Rchb.f.	E	04-05						+			
66. *Zeuxine longilabris* (Lindl.) Trimen	T	02	+					+			

exile, Porpax filiforme, Porpax microchilos, Porpax reticosa, Porpax jerdoniana, Smithsonia maculate, Smithsonia straminea and *Smithsonia viridiflora.*

The presence of these endemic species in Sindhudurg District underscores the region's significance as a biodiversity hotspot and warrants targeted conservation efforts to protect these species and their habitats. They have experienced over exploitation due to their commercial significance to the pharmaceutical and floral sectors, so many species are now becoming endangered.

The overexploitation of orchids is a pressing concern as these exquisite flowers face increasing threats due to human activities. One of the primary reasons for overexploitation is the commercial demand in the floral industry for these flowers[11]. Additionally, orchid species are believed to possess medicinal properties, leading to their excessive harvesting for herbal remedies[12]. Habitat destruction due to deforestation, urbanization, and agricultural expansion also poses a threat to orchids[13]. These factors contribute significantly to the depletion of orchid populations in their natural habitats.

Orchids play crucial roles in the ecosystem as pollinators and contributors to biodiversity[14]. Their decline can disrupt the delicate balance of the ecosystem, affecting not only the orchids themselves but also the myriad of organisms dependent on them. A survey conducted in Maharashtra from 2011 to 2014[15] evaluated 101 orchid species, categorizing them as follows: 6 probably extinct, 7 highly endangered, 24 vulnerable, 25 near threatened, 23 least concern, and 9 data deficient. Therefore, efforts to address this issue are needed that involve raising awareness about the importance of conserving orchids and their habitats.

Conclusion

Orchids are diverse and intricate species with various ecological roles. In the present research, a checklist has been updated that highlights Sindhudurg's unique orchid flora, their diversity across the region and emphasizes the importance of conserving these orchid species. The findings have been collected and noted in systematic format as a purpose to represent an informative literature for future studies related to the orchids present in Sindhudurg. A total 66 orchid species belonging to 26 genera were reported. Out of 66 noted species 27 orchid species related to 8 genera were found endemic in Sindhudurg. Among 26 genera, *Hebenaria* genus shows highest orchid diversity with 16 species. It is concluded that sustainable conservation efforts need to be taken to protect these species and their natural habitats as they face serious threats on their existence. Present studies hold significant importance in the realm of conservation, research, and biodiversity documentation. It enables to track changes in orchid populations, conduct studies on their ecology, genetics, and evolution, and assess the impacts of environmental changes on these plants.

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