

ADDITIONS TO THE ORCHID FLORA OF THE ANAMALAI TIGER RESERVE, WESTERN GHATS, TAMIL NADU, INDIA

Abstract

The Anamalai Tiger Reserve, located in the Western Ghats biodiversity hotspot, is a highly protected area. It boasts the highest species diversity in the region. However, the orchids in this area face numerous threats such as habitat loss, fragmentation, illegal trade, reckless collection, and various other human activities. Angiosperms, the largest plant cluster in India, are prevalent in this region. This study was conducted to document the diverse range of wild orchids in the Anamalai Tiger Reserve (ATR), situated in the Southern Western Ghats of Tamil Nadu. The reserve spans a core area of 958.59 km² and a buffer area of 521.28 km². The primary objective was to investigate and assess the orchid diversity within the reserve while providing crucial information on their conservation status. A comprehensive survey revealed the presence of 137 orchid species belonging to 56 genera in the Anamalai Tiger Reserve. Additionally, 37 species were newly documented as part of the reserve's flora. The dominant genus in ATR were found to be *Dendrobium* sp., *Habenaria* sp., and *Oberonia* sp.. To ensure the preservation of these endangered genus, it is imperative that conservation efforts are not only undertaken by research institutions but also supported by the government and the private sector. Hence, the conservation of orchid species can be achieved through both in-situ (on-site) and ex-situ (off-site) conservation strategies.

Keywords: Western Ghats, Anamalai Tiger Reserve, Endemic, Biological wealth, Exploration, Orchid assessment, Preservation, Tropical region.

INTRODUCTION

The Western Ghats, recognized as one of the 36 global hotspots alongside Sri Lanka, boasts an incredibly rich biodiversity. However, the flora and fauna in this region face severe threats as a result of habitat loss, fragmentation, and escalating human population and activities. Situated in the Western Ghats mountain range in southwest India, the Anamalai Tiger Reserve is home to a remarkable array of flora and fauna that exemplify the region's diversity. The reserve encompasses diverse habitat types, including moist evergreen forests, semi-evergreen forests, tropical deciduous forests, dry deciduous forests, dry thorn forests, and shola forests. Additionally, unique habitats such as Montane grassland, Savanna, and Swampy grassland can be found within its boundaries.

The Orchidaceae family, which comprises approximately 24,500 species across 788 genera is the world's second-largest family of flowering plants (Mabberley 1997). Recent estimates suggest that

there are around 28,000 orchid species worldwide, distributed among 736 genera (Christenhusz & Byng, 2016). In India, there are 1,256 orchid species belonging to 155 genera, with 388 species being endemic to the country (Paramjit Singh, 2019). Orchids are not only aesthetically and medicinally significant but also serve as important ecological indicators. However, due to ongoing destruction of natural habitats, illicit trade, and indiscriminate collection by orchid enthusiasts, numerous orchid species are rapidly disappearing from the wild. The high commercial demand for orchids has further underscored the need for mass propagation and conservation efforts for key species. Successful conservation management of orchids requires knowledge of the ecological preferences and distribution patterns of plant species [Kirillova et al.2023; Djordjević, et al. 2020].

Therefore, it is crucial to conduct a comprehensive assessment of orchid diversity and update the data to safeguard and preserve orchid species in all biodiversity hotspots, including the Anamalai Tiger Reserve. The primary objective of this study is to investigate the orchid diversity within the reserve and provide valuable insights into their conservation status.

MATERIALS AND METHODS

The study was conducted March 2019 to March 2023 within the Anamalai Tiger Reserve (ATR), which is located in the Anamalai Hills spanning Pollachi, Valparai, and Udumalpet taluks of Coimbatore District and Tiruppur District in the state of Tamil Nadu. As per the National Tiger Conservation Authority, the reserve comprises a core area of 958.59 km² and a buffer/peripheral area of 521.28 km², resulting in a total extent of 1479.87 km². Geographically, ATR is situated at coordinates 10.4170°N 77.0567°E, with a minimum elevation of 175.86 meters above sea level (masl) and a maximum elevation of 2514.51 masl.

The study specifically focused on seven forest ranges: Pollachi, Valparai, Manomboly, Ulandy, Udumalpet, Amaravathy, and Kodaikanal. The Pollachi and Valparai ranges are located in Coimbatore District, the Udumalpet range is in Tiruppur District, and the Kodaikanal taluk falls within Dindigul District of Tamil Nadu. (Refer to Figure 1 for the geographical distribution of these ranges.)

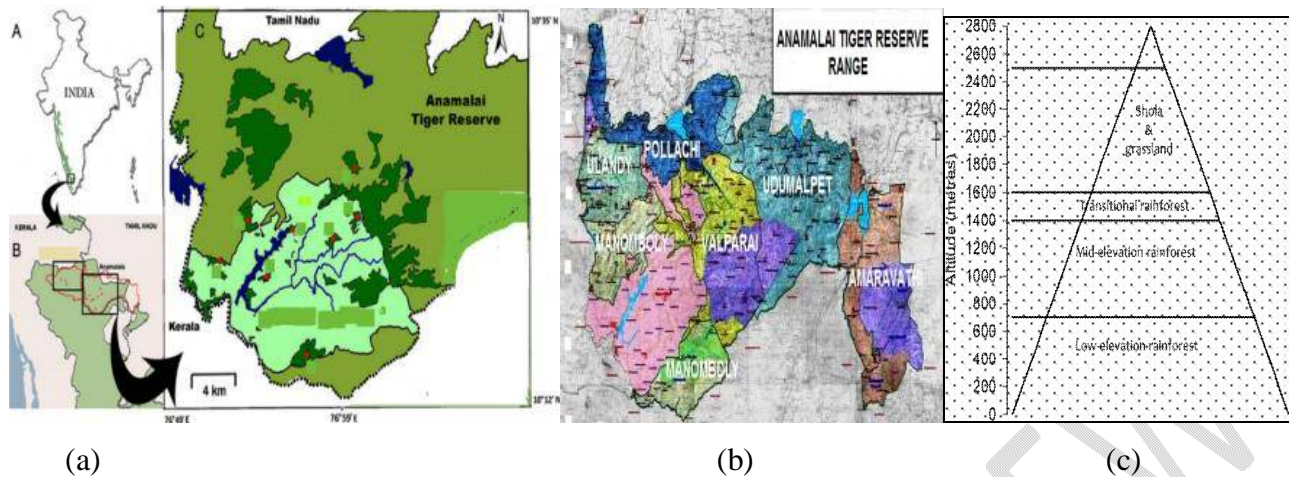


Figure 1. a). Map of the Anamalai Tiger Reserve, b). ATR range, c). ATR Altitude (meters)

The Anamalai Tiger Reserve consists of six distinct types of forests. These include:

1. Grassland vegetation: Found in low altitude and low rainfall areas such as Udumalpet, Pollachi, and Amaravathi.
2. Shola forest: Present in high altitude and high rainfall areas like Manamboly, Valparai plateau, and Grass hills.
3. Moist deciduous forest: Occurring in medium altitude and medium rainfall areas around the Topslip environs.
4. Tropical evergreen forest: A type of forest characterized by year-round greenery and found in varying altitudes and rainfall conditions within the reserve.
5. Teak dry deciduous forest: These forests consist of teak trees and are classified as dry deciduous due to the seasonal shedding of leaves. They are distributed across different parts of the Anamalai Tiger Reserve.
6. Thorn forest: This type of forest is characterized by thorny vegetation and is found in specific areas within the reserve.

The distribution of these forest types corresponds to the varying altitudes and rainfall patterns within the reserve, with different areas experiencing low, medium, or high levels of both.

Procedure/methodology survey and collection

The present study primarily relied on an extensive and systematic field survey conducted in various explored and unexplored areas of the Anamalai Tiger Reserve (ATR). Field tours were carefully planned to cover the pre-monsoon, mid-monsoon, and post-monsoon periods, ensuring periodic surveys

throughout. The survey areas within the reserve included wildlife regions in Pollachi, Valparai, Ulandy, Manambolly, Udumalpet, Amaravathy, and Kangeyam. The documentation of orchids was the specific focus of these field studies conducted from 2019 to 2022.

All collected orchid specimens were processed at the IFGTB herbarium (FRC) in Coimbatore. The major field explorations took place after the rainy season, spanning from July 2019 to February 2022. Monthly field visits were undertaken, covering different seasons and maximizing coverage across areas such as Grass hills, Chinnakallar, Periyakallar, Highforest, Urlikal, Anali, Manambolly, Shekalmudi, Topslip, Aliyar, Attakatti, Villonie, Gopalsamymalai, Varagaliyar, Poonachi, Upper Aliyar, Tanakkamalai, Iyerpadi, Kadampari, Itliyar, Valparai Estates, Kokkanamalai, Vandal, Thirumoorthimalai, Kurumalai, Esalthittu, Thalinji, Keelanavayal, Manajampatti, Moongilpallam, Kookal, Kudirayar, Samikkanal, Kathirikai Odai, Pulavachiar, and Vandaravu.

Most of the explorations were conducted on foot, except for areas like Attakatti, Highforest, Kookal, and Grass hills, where assistance was provided by Forest Department staff and local residents.

To identify the orchid specimens, relevant literature sources such as Abraham and Vatsala (1981), Joseph (1987), Ansari and Balakrishnan (1990), and Matthew (1991) were consulted. Online databases including IPNI (updated, 2015) at www.ipni.org, the Plant List (2013) at www.theplantlist.org, the Herbarium Catalogue at Kew (www.kew.org), and the IUCN Red List (www.iucnredlist.org) were utilized to ensure accurate nomenclature. The respective habitat and ecological patterns of the orchids were also observed in the field.

Table 1: Forest types at the Anamalai Tiger Reserve

Sl. No.	Name of Forest type	Classification number
1.	Southern sub-tropical hill forest	8A/ C1
2.	Southern dry mixed deciduous forest	5A/ C3
3.	Southern moist mixed deciduous forest	3B/C2
4.	Secondary moist mixed deciduous forest	3B/2S1
5.	West coast Tropical evergreen forest	1A / C4
6.	Southern Montane Wet forest (Wet temperate)	11A /C1
7.	Southern Montane Wet temperate grassland	11A/C1/D S2
8.	Dry Grasslands Savanna (Rocky and vacant portions)	5B S4
9.	Moist bamboo Wet bamboo breaks	2B/ E3, 2B E3
10.	Thorn forest	6A C1
11	Dry Deciduous forest	5/2S1

Study of orchids diversity in the Anamalai Tiger Reserve, Western Ghats, Tamil Nadu and their IUCN conservation status

During the field surveys conducted within the Anamalai Tiger Reserve (ATR), various species of orchids were observed and documented. Photographs were taken as part of the documentation process. Subsequently, each recorded orchid species was evaluated and classified according to its conservation status using the IUCN Red List of Threatened Species (IUCN, 2022).

IUCN. 2022. Guidelines for Using the IUCN Red List Categories and Criteria. Version 15.1. Prepared by the Standards and Petitions Committee. <https://www.iucnredlist.org/documents/RedListGuidelines.pdf>.

The IUCN Red List classifies species into different categories based on their risk of extinction. These categories include Extinct (EX), Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), Least Concern (LC), Data Deficient (DD), and Not Evaluated (NE). The classification of orchids was determined by assessing them against the criteria outlined in the 1994, 2000, and 2022 versions of the IUCN Red List (as referenced in Kumar et al., 2001).

RESULTS AND DISCUSSION

The field surveys conducted in the Anamalai Tiger Reserve (ATR) have resulted in the documentation of 137 orchid species belonging to 56 genera (refer to Table 1 and Figure 2). Among these species, 100 orchids had been previously identified and reported in a study by Ganesan et al. in 2019.

Orchids exhibit a wide distribution range, from tropical to alpine zones, and can be found on forest trees, secondary vegetation, riverbanks, bamboo and palm thickets, forest floors, grassy slopes, and rocky areas (White & Sharma, 2000; Pant, 2013). Arisdason (2006) conducted a study on the flora of the Indira Gandhi National Park, which documented 30 orchid species belonging to 18 genera. Gamble (1928) reported 46 orchid species from 26 genera. Ahmedullah & Nayar (1987) documented 123 species from 33 genera in Peninsular India. More recently, Ganesan et al. (2019) documented 100 orchid species from 18 genera. Different geographic areas are compared. Is it possible to find one objective key for these data?

In the Western Ghats, a Conservation Assessment and Management Plan (C.A.M.P) assessed 98 endemic and threatened orchid species. Saravanan & Kaliamoorthy (2017) discovered *Zeuxine grandis* and *Z. chowdheryi* as new records in the Eastern Ghats of Peninsular India. *Z. chowdheryi* is endemic to Tamil Nadu and is primarily distributed in the Velliangiri hills of Coimbatore district in the Western Ghats and Sanyasimalai Reserve Forest in Yercaud, Salem district in the Eastern Ghats. Additionally,

Kiruthika et al. (2017) reported *Vanilla walkeriae* Wight as a new addition to the flora of Coimbatore, Tamil Nadu, India.

The present study conducted in ATR has recorded the highest number of orchid species compared to previous studies. It has documented 37 additional orchid species not previously recorded in the orchid flora of ATR, highlighting the area's significant biodiversity conservation value. Of new discovered species, 15 are endemic orchids. Among the recorded orchids, there are 15 endemic species, 2 endangered species, 4 vulnerable species, 1 critically endangered species, 1 least concern species, and 14 species that have not been evaluated according to the IUCN Red List criteria (Kumar et al., 2001). Based on literature and herbarium references, other areas surrounding ATR, such as Coimbatore District and the Pollachi region, likely harbor several other orchid species.



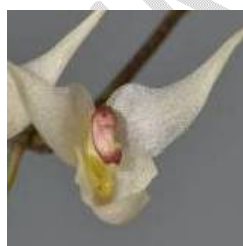
Fig. 2: GPS coordinates of additional new orchid species in the Anamalai Tiger Reserve, Western Ghats, Tamil Nadu

Table 2: Assessment and the IUCN status Rarity and Endemism of additional new orchid species to diversity in the Anamalai Tiger Reserve, Western Ghats, Tamil Nadu, India

Sl. No	Genera	Orchid Species	IUCN Status	Endemism	Habit	Lat	Long	Alt (masl)	Collection Place
1	Bulbophyllum	<i>Bulbophyllum acutiflorum</i> A.Rich.		Endemic	Epiphytic	N 10°18'28.8"	E077°01'23.5"	1241	Valparai range, Chinnakallar falls
2		<i>Bulbophyllum keralensis</i> Muktesh & Stephen		Endemic	Epiphytic	N 10°19'53.3"	E077°02'55.0"	1949	Grass hills, Valparai
3		<i>Bulbophyllum mysorensense</i> (Rolfe)J.J.Sm	Endangered		Epiphytic	N 10°19'39.7"	E077°01'30.0"	1634	Marappalam river, Grass hills, Akkamalai
4		<i>Bulbophyllum orezii</i> Sathish	Endangered		Epiphytic	N 10°19'38.8"	E077°01'28.1"	1630	Before Marappalam river, Grass hills, Akkamalai
5	Calanthe	<i>Calanthe triplicata</i> (Willem.) Ames	Not Evaluated		Terrestrial	N 10°23'07.7"	E076°59'46.5"	1462	Kavarkal, Valparai range
6	Conchidium	<i>Conchidium filiforme</i> (Wight) Rauschert		Endemic	Epiphytic	N 10°18'28.8"	E077°01'23.5"	1241	Chinnakallar falls, Valparai range
7	Dendrobium	<i>Dendrobium barbatulum</i> Lindl.		Endemic	Epiphytic	N 10°19'42.5"	E 076°53'43.6'	1072	Valparai range, Urilikal
8		<i>Dendrobium wightii</i> A.D.Hawkes & A.H.Heller		Endemic	Epiphytic	N 10°18'23.4"	E 076°52'24.9'	944	Sheikalmudi, Kalyanapant hal bus stand near.
9	Diplocentrum	<i>Diplocentrum congestum</i> Wight		Endemic	Epiphytic	N 10°21'14.7"	E 076°59'56.3'	1206	After Iyerpadi, Valparai Range
10	Eria	<i>Eria exilis</i> Hook.f.	Vulnerable		Epiphytic	N 10°25'58.9"	E 076°59'10.0'	1063	Urilikal check post to Manampally, Valparai range
11		<i>Eria pauciflora</i> Wight		Endemic	Epiphytic	N 10°19'39.7"	E 077°01'23.1'	1542	Marappalam, Grass hills, Akkamalai
12		<i>Eria polystachya</i> (A.Rich.) Kuntze		Endemic	Epiphytic	N 10°18'28.5"	E077°01'23.0"	1242	Chinnakallar falls, Valparai range
13	Eulophia	<i>Eulophia flava</i> (Lindl.)Hook.f		Endemic	Terrestrial	N 10°20'20.6"	E076°57'53.5"	1151	Puthuthottam, Valparai

14	Flickingeria	<i>Flickingeria nodosa</i> (Dalzell) Seidenf.	Vulnerable		Epiphytic	N 10°16'57.03"	E076°58'41.0"	1141	Chinhona tea estate, Valparai range
15	Gastrochilus	<i>Gastrochilus calceolaris</i> (Buch. To Ham.ex Sm.) D.Don	Critically endangered		Epiphytic	N 10°21'40.1"	E076°52'34.2"	657	Manampally river area, Valparai range
16		<i>Gastrochilus flabelliformis</i> (Blatt. & McCann) C.J.Saldanha		Endemic	Epiphytic	N 10°19'42.1"	E077°00'37.6"	1088	Pachamalai, Valparai range
17	Habenaria	<i>Habenaria acuminata</i> (Thwaites) Trimen	Not Evaluated		Terrestrial	N 10°19'54.8"	E 077°02'49.3'	1927	Edaisholai, Siriyakan, Grasshills
18		<i>Habenaria brachyphylla</i> (Lindl.)	Not Evaluated		Terrestrial	N 10°19'55.2"	E 077°02'16.7'	1841	5 Km bend, Grasshills
19		<i>Habenaria crinifera</i> Lindl.,	Not Evaluated		Terrestrial	N 10°19'45.7"	E 077°02'01.2'	1777	Aattupparai kurukku, Grasshills
20		<i>Habenaria digitata</i> Lindl.		Endemic	Terrestrial	N 10°19'43.3"	E 077°01'51.2'	1775	Before Rest Rock area, Grasshills, Akkamalai
21		<i>Habenaria furcifera</i> Lindl.	Not Evaluated		Terrestrial	N 10°19'42.3"	E 077°01'39.2'	1681	Before Aattupparai kurukku, Grasshills
22		<i>Habenaria marginata</i> Colebr. In Hook	Not Evaluated		Terrestrial	N 10°19'40.2"	E 077°01'33.1'	1656	Before Aattupparai kurukku, Grasshills
23		<i>Habenaria multicaudata</i> Sedgw.	Vulnerable		Terrestrial	N 10°19'39.7"	E 077°01'30.0'	1634	After Marapalam river area, Grass hills
24		<i>Habenaria richardiana</i> Wight		Endemic	Terrestrial	N 10°19'44.2"	E 077°01'53.8'	1786	Rest Rock area, Grasshills, Akkamalai
25		<i>Habenaria roxburghii</i> Nicolson	Not Evaluated		Terrestrial	N 10°19'49.0"	E 077°03'02.1'	1950	Old camp, Grass hills
26	Liparis	<i>Liparis atropurpurea</i> Authors?	Not Evaluated		Terrestrial	N 10°19'53.6"	E 077°00'34.8'	935	Shloayar Valparai range
27		<i>Liparis elliptica</i> Wight	Not Evaluated		Epiphytic	N 10°18'29.9"	E 077°01'24.8'	1249	Chinnakallar falls bridge, Valparai range
28		<i>Liparis walkeriae</i>	Not Evaluated		Terrestrial	N 10°19'39.7"	E 077°01'23.1'	1542	LTM after Marappalam,

		Graham in Lindl							Grass hills, Valparai
29	Malaxis	<i>Malaxis rheedii</i> B. Heyne ex Wallace	Not Evaluated		Terrestrial	N 10°19'42.3"	E 077°00'37.4'	1447	Akkamalai post office near, Valparai range
30	Nervilia	<i>Nervilia crociformis</i> (Zoll. & Moritzi) Seidenf.	Not Evaluated		Terrestrial	N 10°18'31.7"	E 076°52'13.4'	932	After Sheikalmudi top bungalow area
31		<i>Nervilia infundibulifolia</i> Blatt. & McCann	Not Evaluated		Terrestrial	N 10°21'44.3"	E 076°52'36.2'	634	Manampally powerhouse, Valparai range
32	Oberonia	<i>Oberonia brunoniana</i> Wight		Endemic	Epiphytic	N 10°18'31.7"	E076°52'13.4"	932	Valparia range, Murukali,
33		<i>Oberonia sebastiana</i> B.V.Shetty & Vivek.	Vulnerable		Epiphytic	N 10°17'49.1"	E077°01'05.1"	1077	Valparai range, Chinnakallar
34		<i>Oberonia verticillata</i> Wight		Endemic	Epiphytic	N 10°21'44.3"	E076°52'36.2"	617	Valparai range, Manompally
35	Peristylus	<i>Peristylus spiralis</i> A.Rich.	Not Evaluated		Terrestrial	N 10°19'56.9"	E077°02'44.3"	1905	Periyakaan Grasshills
36	Spiranthes	<i>Spiranthes sinensis</i> (Pers.) Ames		Endemic	Terrestrial	N 10°19'54.8"	E077°02'49.3"	1927	Sriyakaan Grasshills
37	Vanda	<i>Vanda tessellata</i> (Roxb.) Hook. ex G.Don	Least Concern		Epiphytic	N 10°25'58.9"	E076°59'10.0"	1129	Valparai range, Attakatti to Valparai (24 Hairpin bend)



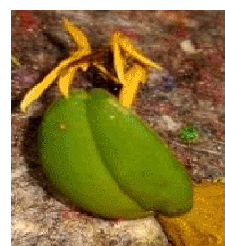
Bulbophyllum acutiflorum A.rich



Bulbophyllum keralensis Muktesh & Stephen



Bulbophyllum mysorensense (Rolfe) J.J.Sm.



Bulbophyllum orezii Sathish



Calanthe triplicate (Willem.) Ames



Conchidium filiforme
(Wight) Rauschert



Dendrobium wightii
A.D.Hawkes &
A.H.Heller Lindl.



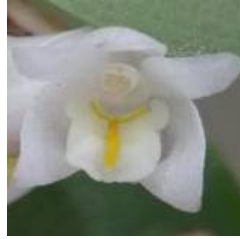
Dendrobium wightii
Hawkes & Heller



Diplocentrum
congestum Wight



Eria exilis Hook.f.



Eria pauciflora Wight



Eria polystachya
(A.Rich.) Kuntze



Eulophia flava (Lindl.)
Hook.f.



Flickingeria nodosa
(Dalzell) Seidenf.



Gastrochilus calceolaris
(Buch.-Ham. ex Sm.)
D. Don



Gastrochilus
flabelliformis (Blatt. &
McCann) C.J.Saldanha



Habenaria acuminata
(Thwaites) Trimen



Habenaria brachyphylla
(Lindl.)



Habenaria crinifera
Lindl.



Habenaria digitata Lindl.



Habenaria furcifera
Lindl.



Habenaria marginata
Colebr. In Hook



Habenaria multicaudata
Sedgw.



Habenaria richardiana
Wight



Habenaria roxburghii
Nicolson



Liparis atropurpurea
Authors?



Liparis elliptica Wight



Liparis walkeriae
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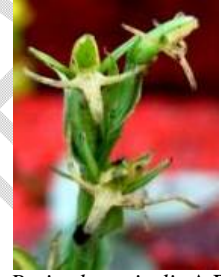
Oberonia brunoniana
Wight



Oberonia sebastiana
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Oberonia verticillata
Wight



Peristylus spiralis A.Rich.



Spiranthes sinensis
(Pers.) Ames



Vanda tessellata (Roxb.)
Hook. ex G.Don

Fig. 3: Images of additional orchids in the Anamalai Tiger Reserve

Conclusion

The primary objective of this study was to document the diversity of orchids in the Anamalai Tiger Reserve (ATR). The researchers recorded a total of 137 orchid species belonging to 56 genera within the reserve. Out of these, 37 species were newly reported in the ATR, indicating an expanded distribution range for these orchids within the Western Ghats.

The conservation of orchid species is a crucial goal that requires the involvement of various sectors, including the government, private individuals, research institutions, non-governmental organizations, and breeders. International cooperation is also essential in achieving effective conservation efforts for

orchids. Both in situ (on-site) and ex situ (off-site) conservation approaches are important for the preservation of orchid species.

Conserving and managing the biodiversity of a specific area requires a thorough understanding of its biotic components, which can only be achieved through consistent exploration and systematic analysis. The conservation of orchid species can be facilitated through both in situ (on-site) and ex-situ (off-site) conservation approaches, coupled with domestication and the involvement of community-based organizations (Pant, 2013). This is a critical issue that necessitates the engagement of various sectors, including the government, private individuals, research institutions, non-governmental organizations, and breeders.

Recognizing the significance of documenting and identifying the various biotic units of a specific area or region, consistent exploration and systematic analysis are essential. The present study has recorded the highest number of orchid species in the ATR compared to previous studies conducted in this tiger reserve in Tamil Nadu. Furthermore, based on literature and herbarium references, areas surrounding the ATR, such as Coimbatore District and the Pollachi region, have the potential to harbor several additional species of orchids. Therefore, it is expected that the number of orchid species in the ATR will continue to increase with further studies in these areas.

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