PROJECT REPORT

Documentation of Orchids & Associated Pollinators of Dalma Wildlife Sanctuary, Jharkhand

APRIL, 2026

GRAPHIC ERA DEEMED TO BE UNIVERSITY

DALMA WILDLIFE SANCTUARY
DALMA, JHARKHAND

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CENTRE FOR SUSTAINABLE ECOLOGY AND BIODIVERSITY RESEARCH (CSEBR)
DEPARTMENT OF BIOSCIENCES, GRAPHIC ERA (DEEMED TO BE UNIVERSITY),
DEHRADUN

FINANCIAL SUPPORT:
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PHOTO CREDITS:
DR. V. P. UNIYAL
DR. VANDANA MEHRWAR
MR. PRABHAT KUMAR
MR. RAJA GHOSH

MAP LAYOUT :
MR. PRATIK P. PANSARE

CITATION:
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PROJECT TEAM

MR. SHABA ALAM, IFS
FIELD DIRECTOR, ELEPHANT PROJECT
JAMSHEDPUR, JHARKHAND

DR. V.P. UNIYAL
PROFESSOR

DR. MANU PANT
PROFESSOR & HEAD

DR. VANDANA MEHRWAR
SENIOR PROJECT ASSOCIATE

CENTRE FOR SUSTAINABLE ECOLOGY AND BIODIVERSITY RESEARCH (CSEBR)
DEPARTMENT OF BIOSCIENCES,
GRAPHIC ERA (DEEMED TO UNIVERSITY) DEHRADUN



DALMA WILDLIFE SANCTUARY
DALMA, JHARKHAND

Executive Summary

The report Documentation of Orchids & Associated Pollinators of Dalma Wildlife Sanctuary, Jharkhand presents the results of a six-month field study (October 2025–March 2026) undertaken by the Centre for Sustainable Ecology and Biodiversity Research, Graphic Era (Deemed to be University), Dehradun, in collaboration with the Jharkhand Forest Department. Dalma Wildlife Sanctuary, covering 193 km² on the Chhotanagpur plateau, is a vital dry deciduous protected area and a key Asian elephant corridor. Despite its recognized ecological importance, detailed information on its orchid diversity and plant–pollinator interactions had remained limited. Orchids, owing to their specialized reproductive biology, obligate mycorrhizal associations, and sensitivity to microclimatic conditions, function as effective bioindicators of forest health in seasonally dry ecosystems. This study was designed to address this knowledge gap by providing a comprehensive, geo-referenced baseline inventory of wild orchid species and characterising their associated pollinator guilds.

The investigation pursued two primary, interlinked objectives. First, it aimed to document the diversity, distribution, growth forms (epiphytic and terrestrial), microhabitat preferences, phenological patterns, and local abundance of orchid species across different ranges, beats, and habitat types within the sanctuary. Second, it sought to identify major pollinator taxa through direct field observations where feasible and through established pollination-syndrome analysis supported by peer-reviewed literature and expert consultation from the Botanical Survey of India.

A stratified random sampling design was employed across dry sal forests, mixed deciduous slopes, riparian patches, and forest-grassland ecotones. Identification followed dichotomous keys from Misra (2014), with geo-referenced coordinates recorded using handheld GPS units. Given the project duration, direct pollinator observations were constrained; pollinator guilds were therefore inferred from floral traits (colour, morphology, scent, nectar reward, and spur characteristics) and cross-validated with regional references.

The study recorded 20 wild orchid species belonging to 12 genera, comprising 12 epiphytic and 8 terrestrial taxa. Epiphytic species were predominantly associated with mature host trees such as *Shorea robusta*, *Terminalia tomentosa*, and *Diospyros melanoxylon* in closed-canopy mixed deciduous forests at 400–750 m elevation. Terrestrial species occupied shaded forest-floor and rocky substrates in riparian and ecotone habitats. Flowering peaked during the pre-monsoon to monsoon period, with melittophily (bee pollination) predominant among most species and sphingophily (hawk-moth pollination) noted in *Habenaria* taxa. Abundance was highest for *Vanda tessellata*, *Vanda testacea*, and *Aerides multiflora*, while several rarer taxa underscore conservation priorities.

The findings confirm Dalma's role as a significant orchid refuge within the Chhotanagpur plateau and an ecological stepping stone between major Indian biodiversity hotspots. Key challenges include habitat fragmentation, grazing, fire regimes, and anthropogenic pressures. The report provides targeted conservation recommendations, including the designation of "Orchid Conservation Zones," protection of key phorophytes, retention of leaf-litter layers, and integration of orchid monitoring into the sanctuary's management plans. Extension of the study for a full annual cycle is strongly advised to verify syndromes through direct observations and assess reproductive success.

This report delivers a scientifically robust baseline that links orchid diversity to pollinator networks and habitat associations. It elevates the conservation profile of Dalma Wildlife Sanctuary beyond its charismatic megafauna and offers an evidence-based framework for orchid-inclusive protected-area management across the region. Adoption of the recommended measures will strengthen ecosystem resilience and support long-term biodiversity stewardship in one of eastern India's ecologically significant landscapes.

Acknowledgement

The research team extends its sincere gratitude to the Jharkhand Forest Department, particularly to Shri Shaba Alam, IFS, Field Director, Dalma Wildlife Sanctuary, for granting the necessary permissions to undertake field surveys within the Sanctuary and for providing essential logistical support throughout the study.

Our heartfelt thanks to officials and field staff of Jharkhand Forest Department specially, Shri Sanjeev Kumar, IFS, Principal Chief Conservator of Forests and Head of Forest Force; Shri S. R. Natesh, IFS, Chief Conservator of Forests (Wildlife); Shri Ravi Ranjan, IFS, Principal Chief Conservator of Forests (Wildlife) and Chief Wildlife Warden; and Ms. Smitha Pankaj, IFS, Regional Chief Conservator of Forests, Singhbhum, for their valuable encouragement and facilitation.

We are especially indebted to Shri Prabhat Kumar for his unwavering guidance, selfless motivation, and profound encouragement during the fieldwork. His generous contribution of rare books, catalogues, and photographs of orchid species greatly enriched the quality and accuracy of our documentation.

Heartfelt thanks are also due to our dedicated field assistants: Shri Raja Ghosh (Forester), Shri Achindra Rana (Forester), Shri Bhramar Paharia, Shri Bhushan Mardi, Shri Imran A. Mallick (Wildlife Biologist), Shri Vikram, and Shri. Sandeep Mardi, whose extensive knowledge of the terrain, tireless assistance, and guidance through challenging habitats enabled the successful completion of the surveys conducted from October 2025 to March 2026.

We are deeply thankful to Dr. Jeevan Singh Jalal, Scientist 'E', Botanical Survey of India, Kolkata, for his expert assistance in the identification of orchid species. We also acknowledge the institutional support extended by Graphic Era (Deemed to be University), Dehradun, and the resources provided by the Department of Biosciences.

This report is a reflection of the collective dedication, kindness, and shared passion of everyone who stood by us. It is our humble contribution towards conserving the rich orchid and pollinator heritage of Dalma Wildlife Sanctuary, a place that has left a lasting imprint on our hearts.

TABLE OF CONTENTS



i EXECUTIVE SUMMARY ..... i-ii

ii ACKNOWLEDGEMENT iii

1 INTRODUCTION 1-2

2 OBJECTIVES OF THE STUDY 3

3 REVIEW OF LITERATURE 4-6

4 METHODOLOGY 7

4.1. Study design and protocols followed 7

4.2. Keys used to identify the major species of Orchids 7-9

4.3. Methodological Approach to Pollinator Observations and Taxa Inference Using Pollination Syndromes 10-12

4.4. Study Area 13

4.5. Floral-Faunal Diversity 14-18

5 RESULTS 19

5.1 Orchid Species Inventory 19

5.2 Growth Forms, Habitat Associations, and Mycorrhizal Considerations 19-20

5.3 Fieldwork and Habitat Diversity Analysis 21

5.4 Species and Abundance Patterns 21

5.5 Associated Flora Supporting Epiphytic Orchid Assemblages 21-22

5.6 Phenological Patterns and Pollination Dynamics 22-23

5.7 Environmental Gradients and Threats 24-38

6 DISCUSSION 39

6.1 Orchid Diversity and Habitat Associations 39

6.2 Phenological Patterns and Pollination Syndromes 39

6.3 Distribution, Abundance, and Environmental Gradients 40

6.4 Comparison with Literature and Conservation Implications 40

TABLE OF CONTENTS



7 **POLICY RELEVANCE AND SCOPE OF RECOMMENDATIONS** 41-43

7.1 Protection of Critical Habitats and Host Trees 42

7.2 Pollination Syndromes - Interpretation and Limitations 42

7.3 Extension of the Present Study and Justification for a One-Year Research Programme 42

7.4 Community Engagement and Awareness 42

7.5 Integration with Landscape-Level Management 43

8 **CONCLUSION** 44

REFERENCES 45-46

1.Introduction

Dalma Wildlife Sanctuary stands as one of the most ecologically and culturally significant protected areas in eastern India. Nestled on the Chhotanagpur plateau of Jharkhand, it spans approximately 193 km² across East Singhbhum and Saraikela-Kharsawan districts. The sanctuary encompasses the Dalma hill range, with elevations rising to about 915 m above sea level. Its forests, classified predominantly as “Dry Peninsular Sal” and “Northern Dry Mixed Deciduous Forest”, exhibit striking seasonal rhythms. During the intense summer months, most trees shed their leaves under scorching heat often exceeding 42-46 °C, creating an open canopy that allows intense sunlight to reach the forest floor. With the arrival of the southwest monsoon, which delivers 1200–1400 mm of annual rainfall, the landscape transforms dramatically as the canopy becomes lush and green once again. These pronounced seasonal shifts in light, moisture, and habitat structure generate unique ecological windows that support a remarkable diversity of flora and fauna, including highly specialized plant–pollinator interactions.

Geologically, Dalma occupies an ancient landscape where major shear zones separate Precambrian provinces more than a billion years apart in origin. This complex geological history has shaped a mosaic of habitats ranging from dry deciduous slopes and rugged hilltops to riparian patches and forest-grassland ecotones. The sanctuary drains into the Subarnarekha River and Dimna Lake, playing a vital role in the region’s hydrological system. Administratively, it is managed through two main ranges: Dalma Wildlife East and Dalma Wildlife West, each further divided into beats and sub-beats such as Bhadudih, Nutandih, Patamda, Mango, Chakulia, and Dalma.

This hierarchical structure facilitates effective protection, habitat management, and biodiversity monitoring across the varied terrain.

Culturally, Dalma is deeply interwoven with local traditions. The sanctuary derives its name from “Dalma Mai”, a revered local goddess whose hilltop temple and cave continue to attract large gatherings of devotees during annual rituals in the month of Asarh. This intimate link between sacred geography and forested hills has helped foster strong community connections to the landscape and has indirectly contributed to the long-term conservation of its natural resources.

Ecologically, Dalma is best known as a natural stronghold for the Asian elephant. Herds move across its streams, seasonal waterholes, and forested slopes, particularly visible around dwindling water sources during the peak of summer. The same mosaic of habitats also supports an impressive assemblage of wildlife, including pangolin, sloth bear, Indian grey wolf, wild dog, giant red squirrel, and diverse reptiles such as the Indian rock python and bamboo pit viper. A rich avian community featuring the crested serpent eagle, plum-headed parakeet, and paradise flycatcher further enhances its biodiversity value.

Despite its recognized importance for charismatic megafauna, the sanctuary’s orchid diversity and associated pollinator networks remain poorly documented. Orchids, with their exceptional sensitivity to microclimatic changes, dependence on specific pollinators, and obligate mycorrhizal associations, serve as excellent bioindicators of forest health in dry deciduous ecosystems.

In such seasonally dry landscapes, epiphytic orchids like *Vanda tessellata, Vanda testacea, Acampe praemorsa, Aerides multiflora, and Rhynchostylis retusa* are closely tied to particular canopy assemblages and moisture regimes, while terrestrial genera such as *Eulophia, Habenaria, Nervilia,* and *Zeuxine* exploit narrow seasonal windows on the forest floor. However, most regional and state-level orchid accounts, including those for Jharkhand, provide very limited information on pollination biology, phenology, or ecological interactions. Pollinators are rarely identified beyond broad guilds, and quantitative data on visitation rates or fruit-set are almost entirely lacking. This represents a critical knowledge gap, especially in the context of ongoing pressures from habitat fragmentation, fire regimes, grazing, extraction, and climate variability.





The present study, titled “Documentation of Orchids and Associated Pollinators of Dalma Wildlife Sanctuary”, was conceived to address this gap. By generating a comprehensive, geo-referenced inventory of wild orchid species across different ranges, beats, and habitat types, and by characterising their associated pollinator guilds, the project provides essential baseline data for evidence-based conservation planning. It highlights orchids not merely as botanical curiosities but as keystone components of Dalma’s living heritage linking geological history, sacred traditions, seasonal ecology, and contemporary biodiversity stewardship in a single, coherent landscape narrative. In doing so, the study contributes to both regional orchid research and practical management strategies for this important protected area.

2.Objectives of the Study

The present study, titled Documentation of Orchids and Associated Pollinators of Dalma Wildlife Sanctuary, was undertaken to generate a scientific baseline on orchid diversity and plant–pollinator interactions within this ecologically significant dry deciduous landscape.

Situated on the Chhotanagpur plateau, the sanctuary comprises a mosaic of habitats including sal-dominated forests, mixed deciduous slopes, riparian patches, and forest–grassland ecotones. Orchids, owing to their sensitivity to microclimatic variations, dependence on specific pollinators, and obligate mycorrhizal associations, serve as effective indicators of forest ecosystem health. Despite the ecological importance of the sanctuary, systematic information on orchid diversity and associated pollinator guilds remains limited, thereby constraining informed conservation planning and habitat management.

This study was designed to address these knowledge gaps by integrating floristic documentation with ecological observations. Emphasis was placed on recording orchid species across different habitat types and understanding their ecological relationships with pollinators. Direct observations were undertaken for species flowering during the study period, while pollination syndromes were inferred for others based on floral traits and existing literature, acknowledging the limitations of such inference.

The main objectives of the study are:

- To document the diversity, distribution, and habitat associations of orchid species in the sanctuary.
- To identify key pollinator taxa associated with these orchids through direct observation (where feasible) and pollination syndrome analysis.
- To assess ecological interactions and dependencies between orchids and their pollinators.
- To generate baseline data to support long-term conservation planning, habitat management, and monitoring of orchid–pollinator systems.





3.Review of Literature

Orchids (family Orchidaceae) represent one of the largest and most diverse angiosperm families, with an estimated 25,000-28,000 species distributed across nearly every terrestrial habitat on Earth, except Antarctica (Chase et al., 2015). Their extraordinary diversity in floral morphology, life-history strategies, and ecological interactions has made them a focal group in plant evolutionary biology. Orchids are particularly notable for their highly specialized reproductive biology, including intricate floral structures, precise pollinator interactions, and obligate associations with mycorrhizal fungi during germination and early growth stages. These characteristics render them highly sensitive to environmental disturbances, thereby making them reliable bioindicators of ecosystem health, especially in forested landscapes.

The study of orchid pollination biology has historically played a central role in advancing evolutionary theory, beginning with the pioneering work of Charles Darwin, who demonstrated the remarkable adaptations of orchids to specific pollinators. Modern ecological and evolutionary research has further refined this understanding through the concept of pollination syndromes sets of convergent floral traits such as colour, morphology, scent, nectar production, and flowering time that are associated with particular groups of pollinators (Faegri & van der Pijl, 1979; Fenster et al., 2004). In orchids, these syndromes range from melittophily (bee pollination) and psychophily (butterfly pollination) to sphingophily (hawk-moth pollination), as well as highly specialized and often deceptive systems that mimic food sources, mates, or oviposition sites without providing actual rewards.

Such deceptive strategies, although evolutionarily advantageous in reducing energetic costs, make orchids particularly dependent on the presence and behaviour of specific pollinators, thereby increasing their vulnerability to environmental changes.

In India, orchids constitute a significant component of the country's floristic diversity, with approximately 1,300-1,400 species distributed across about 186 genera (Misra, 2014; Singh et al., 2020). The foundational taxonomic framework for Indian orchids was established during the colonial period by eminent botanists such as John Lindley, Joseph Dalton Hooker, and George King along with Robert Pantling. Among these, Hooker's Flora of British India (1888–1890) and A Century of Indian Orchids (1895) remain landmark contributions that described numerous species and established taxonomic concepts that continue to inform modern classifications. Subsequent regional floras, revisions, and monographs have significantly expanded knowledge of orchid diversity and distribution, particularly in biodiversity-rich regions such as the Eastern Himalaya, Northeast India, and the Western Ghats.

Despite this progress, ecological and functional studies, especially those focusing on pollination biology, phenology, and plant–pollinator interactions, remain comparatively underdeveloped in India. This gap is particularly evident in the dry deciduous and plateau ecosystems of central and eastern India, where orchid diversity has historically been underestimated. The Chhotanagpur plateau, encompassing much of Jharkhand, represents one such underexplored region.

Early botanical explorations by Prain, Duthie, and Haines documented scattered orchid occurrences, but comprehensive and systematic accounts were largely absent.

A significant advancement in understanding the orchid diversity of this region came with the work of Kumar et al. (2005), who compiled the first dedicated checklist of orchids for Jharkhand. This study documented 63 species, comprising 33 terrestrial, 29 epiphytic, and one lithophytic species, and included 26 species recorded for the first time from the state. A subsequent study by Kumar et al. (2007) further consolidated these findings for the broader Chhotanagpur region, emphasizing the dominance of terrestrial orchids in the dry deciduous forest ecosystem. These studies also highlighted the increasing threats to orchid diversity, including habitat degradation, deforestation, anthropogenic disturbances, and climate variability.

Comparative insights from adjacent regions, particularly Odisha, have further enriched our understanding of orchid distribution patterns in eastern India. The comprehensive work by Misra (2014) documented over 170 orchid species in Odisha, revealing a higher diversity compared to Jharkhand and underscoring the ecological heterogeneity of the Eastern Ghats region. Notably, epiphytic orchids such as Vanda tessellata, Vanda testacea, Acampe praemorsa, Aerides multiflora, and Rhynchostylis retusa are characteristic of Sal (Shorea robusta)-dominated forests and contribute significantly to canopy-level biodiversity.

Recent ecological research has increasingly emphasized the role of orchids as indicators of forest health and environmental stability.

In dry deciduous and plateau ecosystems, epiphytic orchids are closely associated with specific host tree species, bark characteristics, and microclimatic conditions, particularly moisture availability. In contrast, terrestrial orchids belonging to genera such as Eulophia, Habenaria, Nervilia, and Zeuxine are adapted to seasonal niches, often emerging and flowering within a narrow temporal window during or immediately after the monsoon. These adaptations allow them to exploit transient favourable conditions on the forest floor, but also make them highly susceptible to changes in rainfall patterns, soil disturbance, and grazing pressure (Kumar & Pandey, 2011).

Importantly, plateau regions such as the Chhotanagpur landscape may function as ecological “stepping stones,” facilitating species dispersal and genetic exchange between major biodiversity hotspots, including the Eastern Ghats, Western Ghats, and the Himalayan region. This biogeographical significance adds further conservation value to the orchid flora of Jharkhand, despite its comparatively lower species richness.

Nevertheless, substantial knowledge gaps persist. Most available studies, including those from Jharkhand, remain largely descriptive, focusing on taxonomy and species distribution, with limited integration of ecological or functional data. Detailed studies on pollination biology, reproductive ecology, phenological patterns, and mycorrhizal associations are scarce. In particular, pollinators are seldom identified beyond broad functional groups, and quantitative data on visitation rates, pollination efficiency, and fruit set are largely lacking.

This is of concern because orchids often rely on highly specialized pollination systems, which can be easily disrupted by habitat fragmentation, altered fire regimes, overgrazing, and climate-induced shifts in pollinator populations.

Global syntheses have highlighted that specialized and deceptive pollination systems, which are common in Orchidaceae, are particularly vulnerable to environmental change (Schiestl & Schlüter, 2009; Phillips et al., 2020). The breakdown of these finely tuned plant–pollinator interactions can lead to reduced reproductive success and, ultimately, population decline.

In this context, the present study conducted in Dalma Wildlife Sanctuary assumes significant importance. Situated within the Chhotanagpur plateau, Dalma represents a typical dry deciduous forest ecosystem where both epiphytic and terrestrial orchids coexist across multiple microhabitats. By integrating geo-referenced floristic surveys with pollination syndrome analysis and preliminary field observations of pollinator activity, this study moves beyond traditional taxonomic inventories to incorporate functional ecological perspectives.
Building upon earlier regional works (Kumar et al., 2005, 2007; Misra, 2014), the study provides site-specific and seasonally resolved data on orchid diversity, phenology, and ecological interactions. It offers insights into flowering patterns, habitat preferences, and potential pollinator assemblages, thereby contributing to a more comprehensive understanding of orchid ecology in dry deciduous landscapes. Furthermore, the findings generate a scientifically robust baseline that can inform conservation planning, habitat management, and biodiversity monitoring in Dalma Wildlife Sanctuary.

Given the sanctuary's role as an important elephant corridor and its exposure to anthropogenic pressures, integrating orchid conservation into broader landscape management strategies is both timely and necessary. The study thus not only fills a critical knowledge gap but also supports evidence-based conservation interventions, including community engagement, habitat restoration, and long-term ecological monitoring in one of Jharkhand's ecologically significant protected areas.



4.Methodology

4.1. Study design and protocols followed

The study was designed to document wild orchids and their associated pollinators across key habitat types of Dalma Wildlife Sanctuary using a stratified sampling framework. The sanctuary was first stratified by range and beat, altitude, and dominant vegetation (dry Sal forest, mixed deciduous slopes, riparian patches, forest-grassland ecotones), and within each stratum plots and transects were selected using stratified random sampling to ensure representative spatial coverage. Seasonal surveys were conducted across pre-monsoon, monsoon and post-monsoon/winter periods so that orchid emergence, flowering, fruiting and pollinator activity could be captured through a full annual cycle. Within each plot or transect, all orchids encountered were recorded, and their growth form, micro-habitat, phenological stage and local abundance were noted using a standardised field datasheet (Annexure 1).

Orchid documentation combined classical taxonomic approaches with visual records suitable for training and outreach. Identification was based primarily on floral and vegetative morphology using regional floras, taxonomic monographs and dichotomous keys, cross-checked where necessary with herbarium images and expert opinions. For each species, photographs were taken of the whole plant, inflorescences, individual flowers (when sighted). For focal species, repeated visits were made across the flowering season to refine phenological information and assess fruit-set.

All geo-referenced coordinates were collected with handheld GPS units (accuracy ±5 m) and verified against official sanctuary boundary maps prior to entry into a QGIS database. Orchid abundance was recorded using a standardised semi-quantitative scale (rare, occasional, frequent, abundant) with no additional parametric statistical treatment applied, consistent with the baseline inventory objectives of the study.

4.2. Keys used to identify the major species of Orchids

The dichotomous keys used for the identification of major orchid species were referenced from Sarat Misra's, Orchids of Odisha: A Handbook (2014). These keys comprise sequentially numbered couplets with contrasting morphological characters related to vegetative and floral features such as stem habit, leaf architecture, inflorescence structure, flower size, colour, lip morphology, and spur characteristics. Each couplet leads to the next relevant pair until the specimen is identified to species level. The keys were directly consulted and followed as presented in the book for accurate and systematic identification.



17b. Plants with modified underground stem
18b. Base of stem erect, with a cluster of roots
28b. Lobules obliquely narrow obovate, apices irregularly dentate.....***Zeuxine longilabris***
34a. Leaf radical; inflorescence 1–2 flowered
35a. Scape 1-flowered; lip distinctly 3-lobed
36a. Leaf-blade glabrous on both surfaces with dark purple bands along the veins when young; flower horizontal; mid-lobe of lip entire
34b. Leaf-blade held up by long petioles, apex acuminate; inflorescence many-flowered
38a. Leaf-blade strongly plicate; sepals about 21 mm long..... ***Nervilia aragoana***
38b. Leaf-blade less plicate; sepals about 13 mm long
40b. Inflorescence erect
44b. Pseudobulb underground, ovoid or subglobose; leaves broad, plicate; inflorescence on a separate lateral shoot from base of pseudobulb, simple
45b. Plants 30–40 cm high; flowers yellow, smaller; column foot not forked .....***Eulophia ochreata***
46b. Raceme lax-flowered, flowers 20–25 mm across; sepals and petals reflexed, light yellow with maroon stripes, margins sparingly denticulate .....***Eulophia explanata***
65b. Leaves 1–2, subopposite when two, adpressed to ground, broadly ovate to suborbicular
69b. Flowers many; lip three-partite to the base, segments linear-filiform .....***Habenaria commelinifolia***
63b. Flowers green or yellow
70a. Flowers green; spur linear, curved at apex; leaves clustered about middle of the stem, not margined .....***Habenaria furcifera***
1b. Plants epiphytic or lithophytic
71a. Leafy erect shoots of limited growth, connected to a creeping and rooting base; new shoots arising from base every year (therefore plants tufted); inflorescence from axil of a leaf or on a separate leafless shoot from base of the leafy shoot
90b. Stem pseudobulbous, 35–65 mm long, compressed; leaves pure green; bracts close-fitted
89b. Flowers glabrous, large or small, white or brightly coloured, often showy
92a. Stem branching profusely; flowers very small, white.....***Dendrobium herbaceum***
92b. Stem not branching; flowers medium-sized or large, coloured or white
93a. Leaves persistent (at least for two seasons); flowering in leafy condition
100b. Stem drooping; flowers and lip various
101a. Flowers glossy white, sometimes with a purplish hue; lip with a large orbicular yellow blotch, edge entire .....***Dendrobium crepidatum***
101b. Flowers coloured; lip panduriform; edge fimbriate
102a. Flowers 20-25 mm across, greenish yellow; mid-lobe of lip abruptly narrowed to a mucronately emarginate tip.....***Dendrobium macrostachyum***
105b. Pseudobulb one-two-leaved; leaves persistent or deciduous; lateral sepals free
124b. Plants large and robust; leaves longer, not turning reddish; lip saccate or shortly spurred

125a. Plants to 40 cm high, inflorescence corymbose, to 6 cm long; lip saccate at base; plants inhabiting open forests .....***Acampe praemorsa***

120b. Inflorescence simple

130a. Stem erect; flowering axis straight; flowers variously coloured

131a. Leaves arched, more than 10 cm long, not constricted before apices

132a. Inflorescence racemose, elongate

133a. Lip with a forwardly pointing spur; column foot distinct

134a. Leaves deeply channelled, turning reddish in exposed condition; inflorescence abruptly pendent; flowers violet.....***Aerides multiflora***

134b. Leaves flat, not turning reddish when exposed; inflorescence deflexed; flowers waxy-white speckled with rose.....***Aerides odorata***

133b. Lip with a downwardly pointing spur; column foot indistinct or lacking

135a. Leaves pure green; inflorescence erect, laxly few flowered; flowers yellow

136a. Plants to 20 cm high; inflorescence 10-15 cm long; flowers 12-15 mm across, margins not undulated; pale yellow on both surfaces.....***Vanda testacea***

136b. Plants to 90 cm high; inflorescence 30-35 cm long; flowers 50-60 mm across, margins undulated; variable greenish yellow, brown-tessellated within; white without .....***Vanda tessellata***

135b. Leaves deep green; inflorescence pendent; densely many flowered; flowers white with pink markings; rarely pure white; lip with a compressed spur .....***Rhynchostylis retusa***

(Identification Key - Source: Sarat Misra. Orchids of Odisha: A Handbook, 2014).



4.3. Methodological Approach to Pollinator Observations and Taxa Inference Using Pollination Syndromes

Owing to the limited six-month duration of the project (October 2025-March 2026), direct pollinator observations could be conducted only for those few orchid species whose peak flowering periods overlapped with the survey window. For the majority of the 20 recorded species, flowering occurred either before the surveys began or after they concluded, rendering comprehensive in-situ documentation of pollinator interactions extremely challenging.

To address this constraint, pollinator taxa were broadly identified on the basis of each species' established pollination syndrome, a well-recognized concept in floral biology that refers to the suite of convergent floral traits (such as colour, shape, size, scent, nectar reward, and timing of anthesis) that have evolved to attract specific groups of pollinators (Faegri & van der Pijl, 1979; Fenster et al., 2004). For instance, melittophily (bee pollination) is typically indicated by bright colours, UV-reflective nectar guides, and diurnal anthesis, whereas sphingophily (hawk-moth pollination) is characterised by white or pale flowers, strong nocturnal fragrance, and long nectar spurs. These syndromes were determined through extensive consultation of peer-reviewed scientific literature, standard reference books on orchid pollination biology, and expert advice from Dr. Jeevan Singh Jalal, Scientist 'E', Botanical Survey of India, Kolkata and Shri Prabhat Kumar, orchid specialist from Ranchi, Jharkhand.

Where flowering individuals were encountered during the study period, observations were systematically carried out at regular intervals (early morning, mid-day, late afternoon, and, where relevant, dusk).

Supplementary sampling using hand nets and low-impact coloured pan traps (placed near but not directly beneath target plants) was undertaken to collect representative insect specimens, which were later identified using standard entomological keys and, when necessary, with the assistance of specialist taxonomists.

Direct pollinator observations were not recorded for any of the 20 orchid species during the survey window (October 2025-March 2026), despite repeated diurnal and nocturnal monitoring across all sampled plots and transects. For all 20 recorded species, pollinator taxa were therefore inferred exclusively through established pollination-syndrome analysis, integrating floral morphology, colour, scent, nectar reward, and spur characteristics with peer-reviewed literature and consultation from Dr. Jeevan Singh Jalal. Supplementary hand-netting and low-impact coloured pan traps were deployed but yielded no insect specimens. This approach provided a scientifically reliable baseline characterisation of pollinator guilds while fully acknowledging the temporal constraints of the six-month field programme.

It is important to note that a thorough understanding of pollinator specificity for all 20 species would require at least one full year of rigorous, season-long fieldwork and data collection. The present study therefore supplies a scientifically robust baseline derived from established pollination syndromes, supported by comprehensive literature review and expert consultation. All syndrome inferences were cross-validated against regional orchid pollinator references to ensure reliability.

Plate 1: Research Team during the field work







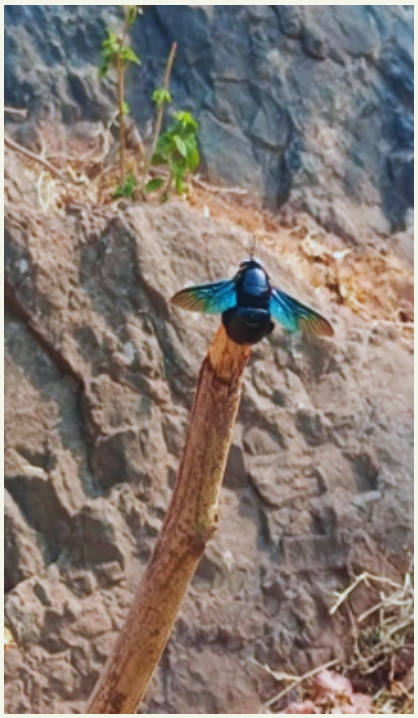


Plate 2: Research Team during the field work







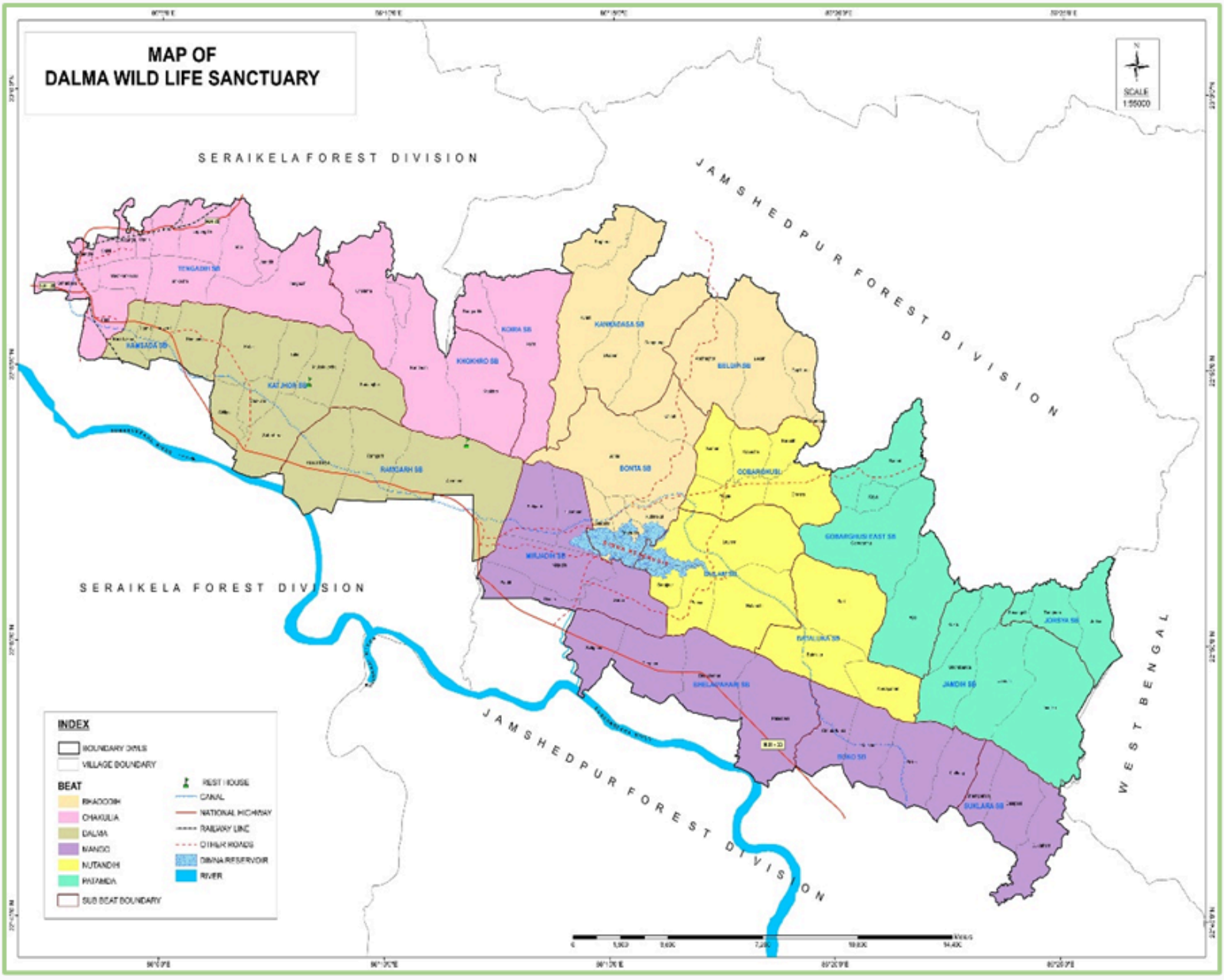






4.4. Study Area

Dalma Wildlife Sanctuary is situated on the Chhotanagpur plateau of Jharkhand, extending over approximately 193 km² across East Singhbhum and Saraikela-Kharsawan districts. The sanctuary follows the Dalma hill range, with elevations rising to about 900–915 m above sea level and the forests draining towards the Subarnarekha River and Dimna Lake. Administratively, the area is divided into Dalma Wildlife East and Dalma Wildlife West Ranges, each with multiple beats and sub-beats (e.g. Bhadudih, Nutandih, Patamda, Mango, Chakulia and Dalma), which provide a practical framework for stratifying sampling and locating permanent monitoring sites. The climate is tropical monsoonal, with a hot, dry summer (often exceeding 42-46 °C in the foothills), a southwest monsoon delivering roughly 1200–1400 mm of annual rainfall, and a cool, often foggy winter with minimum temperatures around 5 °C in sheltered valleys. These strong seasonal and altitudinal gradients in temperature and moisture create distinct windows of growth and reproduction for both plants and insects.



Map 1: Map of Dalma WLS

4.5.Floral-Faunal Diversity

The sanctuary supports a rich assemblage of associated flora and fauna that directly influence orchid distribution and pollination networks. Epiphytic orchids were predominantly recorded on host trees such as *Shorea robusta, Terminalia tomentosa, Adina cordifolia, and Pterocarpus marsupium,* which provide suitable bark texture, canopy cover, and microclimatic moisture regimes. Terrestrial and lithophytic species occurred on forest-floor substrates and rocky outcrops within mixed deciduous and riparian patches. Faunal elements relevant to orchid pollination included a diverse butterfly community *(Plate 3)* and other insect guilds (bees, hawk-moths, and flies) whose activity patterns were documented or inferred. These floral–faunal associations underscore the ecological linkages between orchid species, their phorophytes, and pollinator taxa within the dry deciduous ecosystem of Dalma Wildlife Sanctuary.

The vegetation is dominated by Dry Peninsular Sal and Northern Dry Mixed Deciduous Forest types. *Shorea robusta* forms extensive stands, especially on ridges and upper slopes, while associated mixed forest species include *Aegle marmelos* (Bael), *Albizia procera* (Safed Siris), *Anogeissus latifolia* (Axlewood Tree), *Azadirachta indica* (Neem), *Bombax ceiba* (Semal), *Bauhinia variegata* (Kachnar), *Buchanania lanzan* (Chironji), *Careya arborea* (Kumbhi / Wild Guava), *Carissa carandas* (Karonda), *Clerodendrum infortunatum* (Bhat / Glory Bower), *Colocasia esculenta* (Arbi), *Costus speciosus* (Keokand), *Dillenia indica* (Elephant Apple), *Diospyros melanoxylon* (Tendu), *Drimia indica syn. Urginea indica* (Drimia indica / Wild Onion), *Ficus benghalensis* (Banyan), *Ficus racemosa* (Gular), *Ficus religiosa* (Peepal), *Holoptelea integrifolia syn.* (Indian Elm / Chilbil), *Hyptis suaveolens* (Hyptis / Wild Tulsi), *Lannea grandis* (Jhingan), *Mangifera indica* (Mango), *Murraya paniculata* (Kamini), *Phyllanthus emblica* (Amla), *Psidium guajava* (Guava), *Ricinus communis* (Castor), *Schleichera oleosa* (Kusum), *Selaginella bryopteris* (Sanjeevani), *Shorea robusta* (Sal), *Pterocarpus marsupium* (Bija Sal), *Smilax zeylanica* (Kumarika), *Syzygium cumini* (Jamun), *Tamarindus indica* (Tamarind), *Tectona grandis* (Sagwan), *Terminalia arjuna* (Arjun), *Terminalia bellirica* (Bahera), *Terminalia chebula* (Harar), *Terminalia elliptica* (Asan), and *Ziziphus mauritiana* (Ber) (Kumari *et al., 2017).*

The major faunal groups of the protected area include a diverse assemblage of mammals, birds, reptiles, amphibians, and invertebrates characteristic of dry and moist deciduous forests, sal-dominated landscapes, and plateau ecosystems. Carnivores recorded from the region comprise *Panthera pardus* (Leopard), *Canis lupus pallipes* (Indian Grey Wolf), *Melursus ursinus* (Sloth Bear), *Hyaena hyaena* (Striped Hyena), *Felis chaus* (Jungle Cat), *Viverricula indica* (Small Indian Civet), *Herpestes edwardsii* (Indian Grey Mongoose), and *Canis aureus* (Golden Jackal). Herbivores include *Elephas maximus* (Asian Elephant), *Bos gaurus* (Gaur), *Axis axis* (Spotted Deer/Chital), *Rusa unicolor* (Sambar), and *Muntiacus muntjak* (Barking Deer). Omnivores commonly recorded are *Sus scrofa* (Wild Boar), *Melursus ursinus* (Sloth Bear), *Semnopithecus entellus* (Hanuman Langur), *Macaca mulatta* (Rhesus Macaque), and *Paradoxurus hermaphroditus* (Common Palm Civet).

The avian fauna is rich and includes forest, grassland, and wetland birds such as *Pavo cristatus* (Indian Peafowl), *Gallus gallus* (Red Junglefowl), *Buceros bicornis* and *Ocyceros birostris* (Hornbills), *Psittacula eupatria* (Alexandrine Parakeet), *Alcedo atthis*

(Common Kingfisher), *Dicrurus paradiseus* (Racket-tailed Drongo), *Oriolus oriolus* (Golden Oriole), and several raptors including *Milvus migrans* (Black Kite) and *Spilornis cheela* (Crested Serpent Eagle). Herpetofauna comprises reptiles and amphibians such as *Python molurus* (Indian Rock Python), *Naja naja* (Indian Cobra), *Daboia russelii* (Russell's Viper), *Bungarus caeruleus* (Common Krait), *Varanus bengalensis* (Bengal Monitor), *Calotes versicolor* (Oriental Garden Lizard), *Hoplobatrachus tigerinus* (Indian Bullfrog), and *Duttaphrynus melanostictus* (Common Indian Toad).





Key butterflies commonly observed include *Papilio demoleus* (Lime Butterfly), *Papilio polytes* (Common Mormon), *Danaus chrysippus* (Plain Tiger), *Leptosia nina* (Psyche), *Euploea core* (Common Crow), *Cepora nerissa* (Common Gull), *Junonia almana* (Peacock Pansy), *Junonia lemonias* (Lemon Pansy), *Graphium agamemnon* (Tailed Jay), *Eurema hecabe* (Common Grass Yellow), and *Catopsilia pomona* (Common Emigrant) (Verma, 2009). Important invertebrate guilds include pollinators (honey bees *Apis dorsata, Apis cerana; Xylocopa spp.,* solitary bees; butterflies), decomposers (termites, dung beetles), soil engineers (ants, earthworms), predators (praying mantids, spiders), and detritivores (millipedes, isopods), all of which play critical roles in maintaining ecosystem functioning across Dalma's forested landscapes.

PLATE 3: Diversity of Butterflies in Dalma WLS



Table 1: Diversity of Butterflies in Dalma WLS

S.No.	Common Name	Scientific Name
Family: Hesperiidae (Skippers)		
B1	Common Snow Flat	*Tagiades japetus (Stoll, 1781)*
B2	Indian skipper	*Spialia galba (Fabricius, 1793)*
B3	Bush hopper	*Ampittia dioscorides (Fabricius, 1793)*
B4	Chestnut bob	*Iambrix salsala (Moore, 1865)*
B5	Grass demon	*Udaspes folus (Cramer, 1775)*
B6	Indian palm bob	*Suastus gremius (Fabricius, 1798)*
B7	Common red eye	*Matapa aria (Moore, 1865)*
B8	Continental swift	*Parnara ganga (Evans, 1937)*
B9	Oriental straight swift	*Parnara bada (Moore, 1878)*
B10	Rice swift	*Borbo cinnara (Wallace, 1866)*
B11	Obscure Branded Swift	*Pelopidas agna (Moore, 1866)*
B12	Small branded swift	*Pelopidas mathias (Fabricius, 1798)*
B13	Common dartlet	*Oriens gola gola (Moore, 1877)*
B14	Dark palm dart	*Telicota ancilla bambusae (Moore, 1878)*

S.No.	Common Name	Scientific Name
Family: Lycaenidae (Blues)		
B15	Indian sunbeam	*Curetis thetis (Drury, 1773)*
B16	Apefly	*Spalgis epius (Westwood, 1851)*
B17	Common silverline	*Spindasis vulcanus (Fabricius, 1775)*
B18	Common ciliate blue	*Anthene emolus (Godart, 1824)*
B19	Pointed ciliate blue	*Anthene lycaenina (Felder, 1868)*
B20	Common cerulean	*Jamides celeno (Cramer, 1775)*
B21	Forget-me-not	*Catochrysops strabo (Fabricius, 1793)*
B22	Pea blue	*Lampides boeticus (Linnaeus, 1767)*
B23	Zebra blue	*Leptotes plinius (Fabricius, 1793)*
B24	Common pierrot	*Castalius rosimon (Fabricius, 1775)*
B25	Black-spotted pierrot	*Tarucus balkanicus nigra (Bethune-Baker, 1918)*
B26	Rounded pierrot	*Tarucus nara (Kollar, 1848)*
B27	Dark grass blue	*Zizeeria karsandra (Moore, 1865)*
B28	Pale grass blue	*Pseudozizeeria maha (Kollar, 1844)*
B29	Tiny grass blue	*Zizula hylax (Fabricius, 1775)*
B30	Quaker	*Neopithecops zalmora (Butler, 1870)*
B31	Gram blue	*Euchrysops cnejus (Fabricius, 1798)*
B32	Plains cupid	*Chilades pandava (Horsfield, 1829)*

5. Results

The results of the six-month field surveys (October 2025-March 2026) provide a comprehensive baseline inventory of orchid diversity and associated ecological parameters within Dalma Wildlife Sanctuary. They detail the documented species assemblage, growth forms, habitat preferences, mycorrhizal considerations, phenological patterns, and inferred pollination syndromes, while also presenting quantitative data on species abundance, distribution across habitat types, and key environmental gradients. No direct pollinator observations were recorded despite systematic monitoring, reinforcing the reliance on established pollination-syndrome analysis for guild characterisation. Collectively, these findings fulfil the study's dual objectives by generating geo-referenced floristic and functional data essential for evidence-based conservation planning.

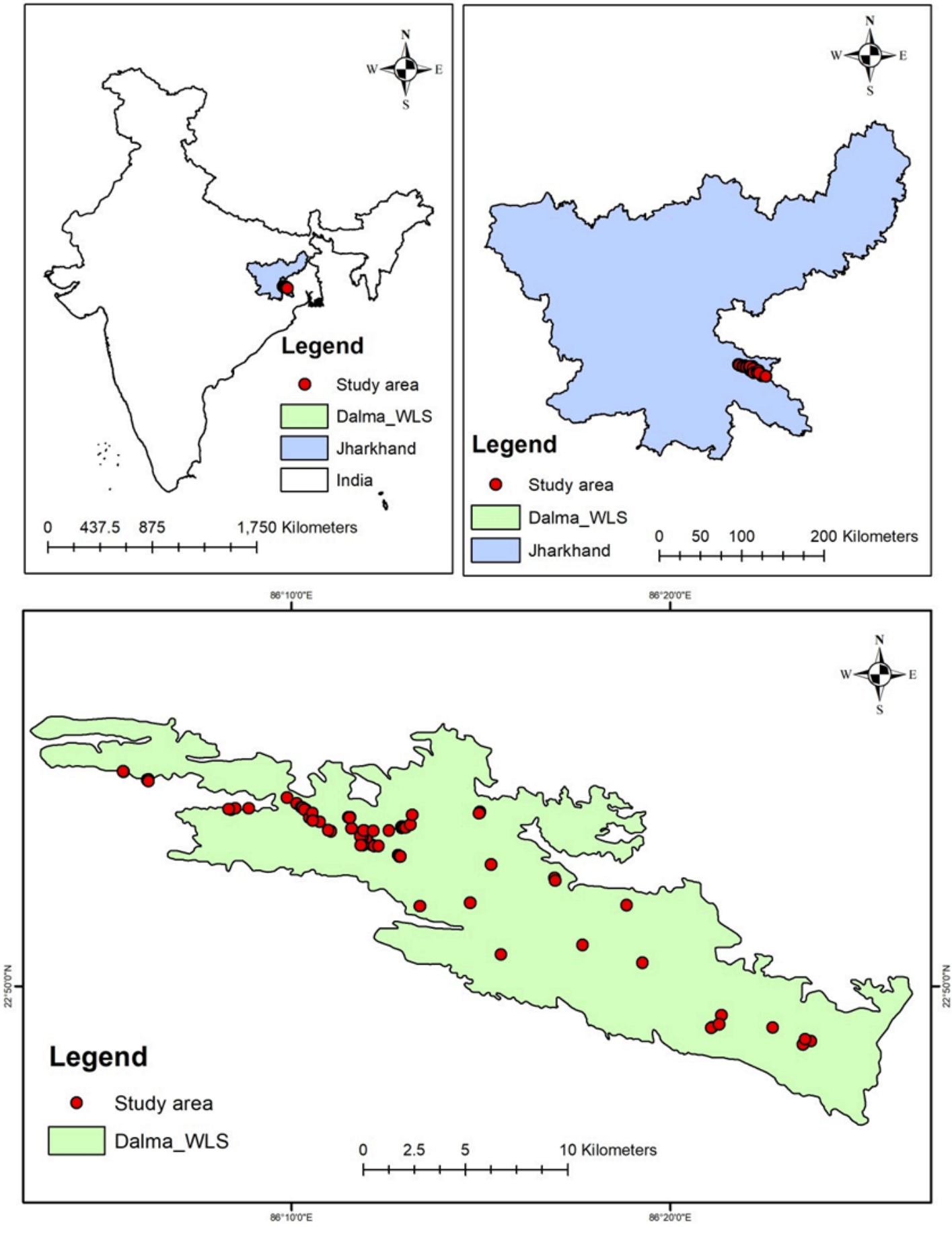
5.1 Orchid Species Inventory

A total of 20 wild orchid species belonging to 12 genera were documented across Dalma Wildlife Sanctuary during the October 2025–March 2026 surveys. The inventory comprised 12 epiphytic and 8 terrestrial species. All identifications were confirmed using the dichotomous keys of Misra (2014) and cross-verified with expert consultation. Representative photographs of each species are presented in Plates 4-17.

5.2 Growth Forms, Habitat Associations, and Mycorrhizal Considerations

Epiphytic species were predominantly associated with mature *Shorea robusta* and *Terminalia tomentosa* trees in closed-canopy dry sal forest and mixed deciduous slopes at 400–750 m elevation. Terrestrial species occurred on shaded forest-floor substrates and rocky outcrops in riparian patches and forest-grassland ecotones. All 20 recorded species form obligate mycorrhizal associations essential for seed germination and early establishment. The consistent occurrence of epiphytes on specific phorophytes and terrestrials on undisturbed substrates indirectly indicates the presence of suitable mycorrhizal fungal partners in these microhabitats.





Map 2 : Distribution Map of Recorded Orchid Species in Dalma WLS

5.3 Fieldwork and Habitat Diversity Ananlysis

Fieldwork was carried out from October 2025 to March 2026 through 25-30 transect-based surveys covering northern and southern stretches of the sanctuary (Map 2). Surveys focused on reconnaissance, vegetation types, host trees for epiphytes, and occurrence of terrestrial orchids along trails, rocky slopes, and shaded patches. Several orchid-bearing trees were geo-tagged for future monitoring. Mixed forest habitats supported the highest orchid diversity (5-7 co-occurring species per locality) at sites such as Manjhla bandh, Bijli ghati, and near Badka bandh. These hotspots featured 50–70 % canopy cover, elevations of 400–600 m, relative humidity of 60–80 %, and gravel-red-black soils. Epiphytes (*Vanda testacea, Acampe praemorsa, Luisia zeylanica*) grew on hosts including *Terminalia bellirica* and *Diospyros melanoxylon,* while terrestrials (*Habenaria furcifera, Nervilia concolor)* occupied organic-rich soils. Roadside forests supported frequent *Vanda tessellata* and *Aerides odorata* on *Madhuca longifolia*, but terrestrial diversity was lower due to disturbance. Open scrub forests and paddy fields showed reduced richness (1-3 species), consistent with lower canopy cover (10–40 %). Dalma's dry deciduous and mixed forests, dominated by *Shorea robusta* and associates, provide ideal phorophytes and litter layers, harbouring two to three times higher diversity than monocultures (Kumar et al., 2005).

5.4 Species and Abundance Patterns

Vanda tessellata, Vanda testacea, and *Aerides multiflora* were classified as "Frequent" (>20 individuals in 60 % of records), indicating resilience in fragmented landscapes.

Rarer species such as *Luisia zeylanica* and *Dendrobium macrostachyum* (classified as "Rare", 1–5 individuals) highlight conservation priorities and often occur on specific hosts (e.g., *Pterocarpus marsupium*) at higher elevations (>500 m). Epiphytes dominate the assemblage (85 % of records), reflecting arboreal niche availability, while terrestrials (15 %) cluster near streams and termite mounds and remain vulnerable to soil disturbance. Abundance was scored using the standardised semi-quantitative scale (rare, occasional, frequent, abundant).

5.5 Associated Flora (Phorophytes) Supporting Epiphytic Orchid Assemblages

Phorophytes are host plants, typically trees or shrubs, that provide structural support to epiphytes (such as mosses, ferns, and orchids) without supplying them with nutrients. Derived from the Greek meaning 'plant bearer,' phorophytes function as physical substrates, enabling epiphytes to access enhanced light and moisture conditions, particularly in the forest ecosystem. The landscape is characterised by native tree species providing critical substrates for epiphytic orchids. Dominant hosts include *Madhuca longifolia* (highest frequency), *Diospyros melanoxylon, Terminalia elliptica,* and *Terminalia bellirica*. Moderately represented species are *Bombax ceiba, Butea monosperma, Ficus benghalensis,* and *Pterocarpus marsupium*. Additional contributors at lower frequencies include *Azadirachta indica, Careya arborea, Mangifera indica, Syzygium cumini,* and *Semecarpus anacardium*. *Ficus* spp. and *Garuga pinnata* enhance moisture retention and faunal interactions. The floristic composition reflects a tropical dry deciduous system where suitable bark texture, canopy spread, and moisture retention sustain rich epiphytic diversity (Fig. 1).

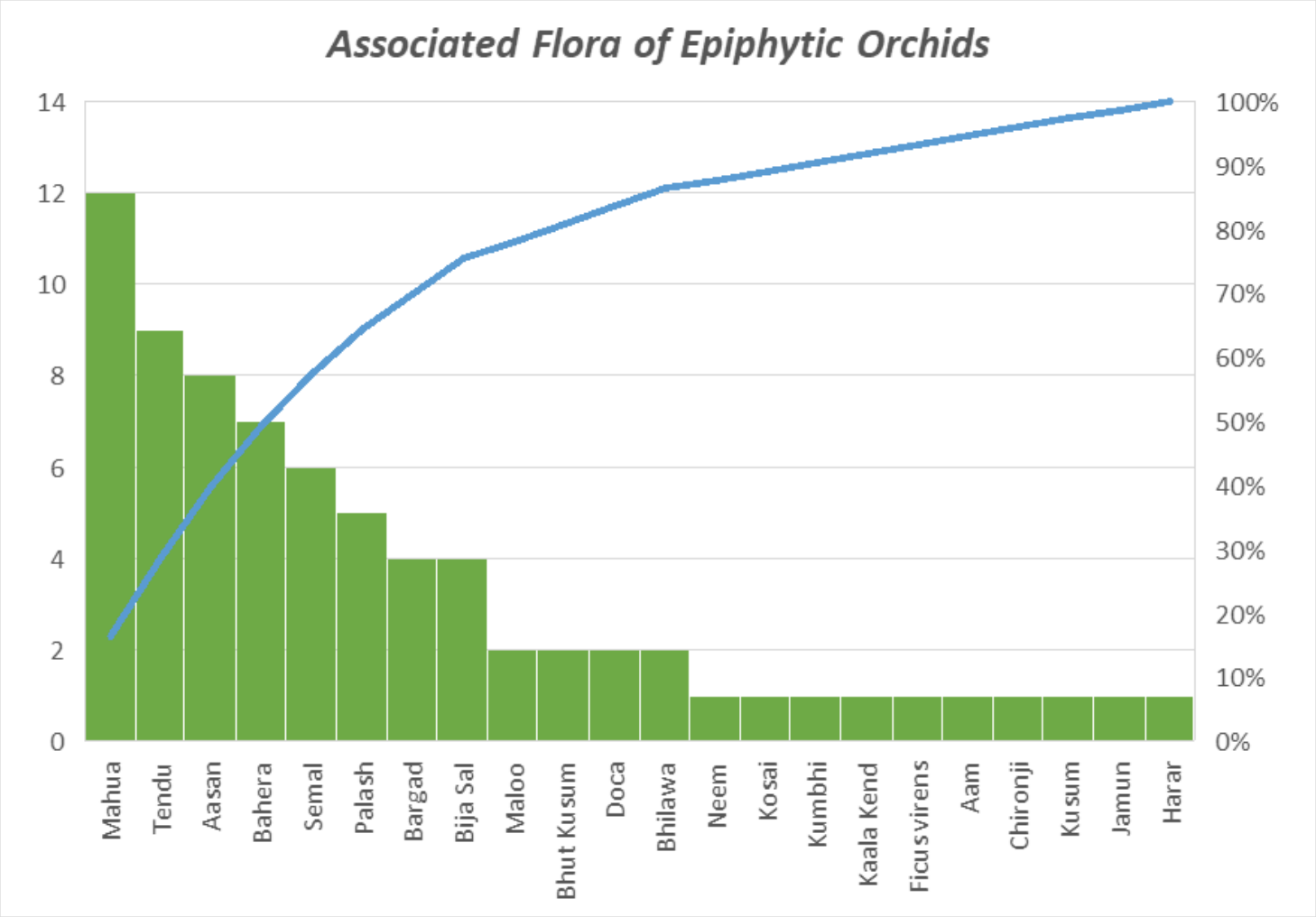


Fig. 1: Associated Flora (Phorophytes) of Epiphytic Orchids in Dalma Wildlife Sanctuary

5.6 Phenological Patterns and Pollination Dynamics

Most species exhibit peak flowering during the pre-monsoon to monsoon period (March-September), with a concentration in April-July *(Aerides multiflora, Vanda tessellata, Acampe praemorsa)*. Fruiting extends into the late monsoon and post-monsoon seasons. A few terrestrials (*Zeuxine strateumatica*) flower in winter to early summer (January-April). Pollination syndromes are dominated by melittophily (bee pollination) in *Aerides, Vanda, Eulophia,* and *Dendrobium*. *Habenaria* species show sphingophily (moth pollination).

Generalist entomophily occurs in *Acampe praemorsa* and *Luisia zeylanica,* while *Nervilia* employs deceptive strategies and *Zeuxine strateumatica* shows partial autogamy. These patterns indicate a functionally resilient orchid community synchronised with seasonal climatic cycles and pollinator availability (Zotz, 2013; Gentry & Dodson, 1987).

Table 2 : Flowering Periods, Pollinators, and Pollination Syndromes of Orchid Species in Dalma Wildlife Sanctuary

S.No.	Species Name	Flowering Period	Pollinators (Taxa)	Pollination Syndrome
1	*Acampe praemorsa*	Mar–Jun	*Apis spp., solitary bees*	Generalist entomophily
2	*Aerides multiflora*	Apr–Jul	*Apis spp., Xylocopa spp.*	Melittophily
3	*Aerides odorata*	Apr–Jun	Bees; butterflies	Melittophily (fragrant)
4	*Dendrobium crepidatum*	Mar–Apr	Solitary bees	Bee pollination
5	*Dendrobium herbaceum*	Jul–Sep	Small bees, flies	Generalist pollination
6	*Dendrobium macrostachyum*	Jun–Sep	*Apis spp., Xylocopa spp.*	Melittophily
7	*Dendrobium primulinum*	Mar-Apr	*Bombus spp., Andrena spp.*	Bee pollination
8	*Eulophia explanata*	May–Jul	*Apis spp., solitary bees*	Melittophily
9	*Eulophia ochreata*	Jun	Ground bees	Bee pollination
10	*Habenaria commelinifolia*	Jul–Sep	Moths (Sphingidae)	Sphingophily
11	*Peristylus constrictus (Lindl.)*	Jul–Sep	Hawk moths (Sphingidae)	Sphingophily
12	*Habenaria furcifera*	Jul–Sep	Hawk moths (Sphingidae)	Sphingophily
13	*Luisia zeylanica*	Mar–Apr	Small bees, flies	Generalist pollination
14	*Nervilia argoana*	Early monsoon	Small bees, flies, fungus gnats (suspected)	Generalist / deceptive
15	*Nervilia concolor*	Early monsoon	Small bees, gnats	Generalist/deceptive
16	*Rhynchostylis retusa*	May–Jul	Bees *(Apis spp., Xylocopa spp.)*, butterflies	Melittophily
17	*Vanda tessellata*	Apr–Jul	*Apis spp., Xylocopa spp.*	Melittophily
18	*Vanda testacea*	Apr–May	Bees, butterflies	Generalist entomophily
19	*Zeuxine longilabris*	Jul–Sep	Small bees, flies	Generalist
20	*Zeuxine strateumatica*	Jan–Apr	Ants, small bees, flies	Autogamy + facultative

5.7 Environmental Gradients and Threats

Peak diversity occurs at 400–800 m under moderate canopy cover, correlating with host-tree girth (>40 ft) and organic soils. Climatic conditions (22–31 °C, 54–89 % humidity) suggest optimal post-monsoon windows. Threats include habitat fragmentation along roadsides, climber competition, and anthropogenic pressures. Compared with the sanctuary's 417 flowering plants, orchids represent a sensitive guild. The survey adds site-specific data to existing floristic inventories and emphasises the need for host-tree protection and microhabitat conservation.



PLATE 4: Orchid Diversity in Dalma WLS (Epyphytic)



Acampe praemorsa



Aerides multiflora



Luisia zeylanica



Dendrobium crepidatum



Dendrobium herbaceum



Dendrobium macrostachyum

PLATE 5: Orchid Diversity in Dalma WLS (Epiphytic)



Aerides odorata



Rhynchostylis retusa



Vanda tessellata



Vanda testacea

PLATE 6: Orchid Diversity in Dalma WLS (Terrestrial)



Eulophia ochreata



Eulophia explanata



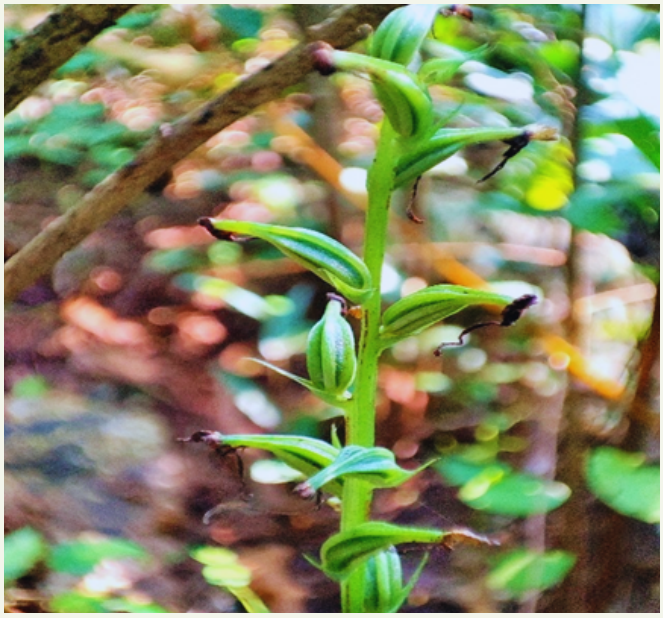
Nervilia argoana



Nervilia concolor



Habenaria furcifera



Habenaria furcifera (Seed pods)

PLATE 7: Orchid Diversity in Dalma WLS (Terrestrial)



Habenaria commelinifolia



Peristylus constrictus



Zeuxine longilabris



Zeuxine strateumatica

PLATE 8: *Acampe praemorsa & Aerides multiflora*

Order: Asparagales
Family: Orchidaceae
Subfamily: Epidendroideae

Acampe praemorsa **(Roxb.) Blatt. & McCann.**
Common Name: Brittle Tiger / Clipped Orchid
Tribe: Vandeae
Sub-tribe: Aeridinae

Growth form & habitat
Robust epiphytic orchid forming clumps on tree trunks and larger branches.
Common on deciduous trees in well-lit mid-canopy and forest edges of Dalma WS.

Phenology
Flowering: mainly March-June.
Fruiting: late summer into early post-monsoon.

Diagnostic field traits
Leaves stiff, strap-shaped, overlapping.
Flowers small (1-1.5 cm), creamy-yellow with reddish-brown transverse bands. Lip small, 3-lobed.



Aerides multiflora Roxb.
Common Name: Many-Flowered Fox Brush Orchid
Tribe: Vandeae
Sub-tribe: Aeridinae

Growth form & habitat
Medium-sized epiphyte on trunks and larger branches. Spur prominent.
Occurs in semi-evergreen pockets and moist slopes where humidity remains high.

Phenology
Flowering: April-July.
Fruiting: late monsoon to early winter.

Diagnostic field traits
Upright to slightly arching stems with strap-shaped, leathery leaves.
Long pendent racemes with many waxy white to pale-pink flowers flushed with purple.
Flowers slightly larger than *A. praemorsa,* faint pleasant scent.



PLATE 9: *Aerides odorata & Dendrobium crepidatum*

ORDER: ASPARAGALES
FAMILY: ORCHIDACEAE
SUBFAMILY: EPIDENDROIDEAE

***Aerides odorata* Lour.**
Common Name: Fragrant Foxtail / Foxbrush Orchid
Tribe: Vandeae
Sub-tribe: Aeridinae

Growth form & habitat
Epiphytic orchid with arching stems, open & airy forest canopy.
Often found on exposed branches where it receives filtered sun and good air movement.

Phenology
Flowering: late April to June.
Fruiting: late monsoon.

Diagnostic field traits
Arching stems with strap-like leaves; numerous long, pendent racemes.
Strongly fragrant flowers, white to pale pink with purple tips and a distinct spur.
Attractive fox-brush appearance when in full bloom.



***Dendrobium crepidatum* Lindl. & Paxton**
Common Name: Shoe-lip Dendrobium
Tribe: Malaxideae
Sub-tribe: Dendrobiinae

Growth form & habitat
Epiphytic, often on trunk forks or lower branches. Prefers semi-shaded interior of mixed deciduous forest.

Phenology
Flowering: March-April, usually when canes are leafless or with very few leaves.
Fruiting: late summer

Diagnostic field traits
Pendulous, swollen canes that become leafless in dry season.
Flowers borne singly or in pairs; pale pink to lilac with yellow throat; delicate texture.



PLATE 10: *Dendrobium herbaceum & Dendrobium macrostachyum*

ORDER: ASPARAGALES
FAMILY: ORCHIDACEAE
SUBFAMILY: EPIDENDROIDEAE

Dendrobium herbaceum Lindl.
Common Name: Grassy Dendrobium
Tribe: Dendrobieae
Sub-tribe: Dendrobiinae

Growth form & habitat
Small epiphytic orchid on thin branches and twigs.
Often in semi-open forest edges and secondary growth.

Phenology
Flowering: mainly July-September.
Fruiting: late monsoon to early winter.

Diagnostic field traits
Slender, almost herbaceous stems bearing small leaves along their length.
Tiny pale yellow-green to whitish flowers on short racemes.



***Dendrobium macrostachyum* Lindl.**
Common Name: Long-spike Dendrobium
Tribe: Malaxideae
Sub-tribe: Dendrobiinae

Growth form & habitat
Medium epiphyte occurring on trunks and large branches. Found in moderately moist, partially shaded forest patches.

Phenology
Flowering: June–September.
Fruiting: post-monsoon.

Diagnostic field traits
Upright to arching canes with linear-lanceolate leaves.
Long, many-flowered racemes with pink to purple flowers and a contrasting lip.
Inflorescences conspicuous against green canopy when in mass bloom.



PLATE 11: *Dendrobium primulinum & Eulophia ochreata*

ORDER: ASPARAGALES
FAMILY: ORCHIDACEAE
SUBFAMILY: EPIDENDROIDEAE

***Dendrobium primulinum* Lindl.**
Common Name: Primrose Dendrobium
Tribe: Dendrobieae
Sub-tribe: Dendrobiinae

Growth form & habitat
Thrives in warm areas with high humidity.
Stems are covered in white sheaths and are found in deciduous forests.
Leafless flowering.

Phenology
Flowering: January-April.
Fruiting: May-June.

Diagnostic field traits
Large, pendant epiphyte with long, slender, cane-like stems that are over hanging / drooping.
Highly Fragrant, pale pink to lavender or white flower with a prominent yellow to orange lip and throat.



***Eulophia ochreata* Lindl.**
Common Name: Golden-Yellow Eulophia / Gold Crest
Tribe: Cymbidieae
Sub-tribe: Eulophiinae

Growth form & habitat
Terrestrial orchid emerging from underground pseudobulbs.
Occurs in open forest glades and grassland edges.

Phenology
Flowering: mainly June (early monsoon).
Fruiting: July-August

Diagnostic field traits
Leafless when flowering; erect scape 20–40 cm tall bearing 5-15 golden-yellow flowers.
Later produces 2-5 oblong-lanceolate leaves from pseudobulbs.
Flowers relatively large, showy and easily visible in open habitats.



PLATE 12: *Eulophia explanata & Habenaria commelinifolia*

ORDER: ASPARAGALES
FAMILY: ORCHIDACEAE
SUBFAMILY: ORCHIDOIDEAE

Eulophia explanata **Lindl.**
Common Name: Flattened Eulophia
Tribe: Cymbidieae
Sub-tribe: Eulophiinae

Growth form & habitat
Terrestrial, sympodial, deciduous herb (geophyte) with fleshy, irregularly ovoid, annulated, or flattened underground pseudobulbs.
Forests, open grassy slopes, and shady places with humus-rich, moist soil.

Phenology
Flowering: April-June.
Fruiting: May-July.

Diagnostic field traits
Golden-yellow flowers (3-lobed) on erect scape.
Inflorescence appears from the ground before the leaves.



Habenaria commelinifolia **(Roxb.) Wall. ex Lindl.**
Common Name: Grass-leaved Habenaria
Tribe: Orchideae
Sub-tribe: Orchidinae

Growth form & habitat
Terrestrial with grass-like leaves, erect herb, ellipsoid or cylindrical tubers.
Found in grassy slopes, forest edges, and grasslands, particularly in moist places in humus-rich soil.

Phenology
Flowering: August-October.
Fruiting: September-November.

Diagnostic field traits
Greenish-white flowers with night-blooming tendency.
Prominent, long, curved, and cylindric-clavate spur.



PLATE 13: *Peristylus constrictus & Habenaria furcifera*

ORDER: ASPARAGALES
FAMILY: ORCHIDACEAE
SUBFAMILY: ORCHIDOIDEAE

Peristylus constrictus **(Lindl.) Lindl.**
Common Name: Slender Habenaria
Tribe: Orchideae
Sub-tribe: Orchidinae

Growth form & habitat
Slender terrestrial. Narrow floral morphology adapted for moth pollination.
Cylindrical to oblong, velvet-hairy tuber.
Found in open forests, moist shaded forest floors, dry deciduous Sal forests.

Phenology
Flowering: June-August.
Fruiting: July-October.

Diagnostic field traits
Leaves are arranged in a rosette or whorl displaying prominent, net-like veins.
Very small, pendulous, globose (spherical) spurs.



Habenaria furcifera **Lindl.**
Common Name: Forked Habenaria
Tribe: Orchideae
Sub-tribe: Orchidinae

Growth form & habitat
Terrestrial orchid of moist grassland patches and forest clearings.
Often associated with seasonally wet depressions and gentle slopes.

Phenology
Flowering: July-September (monsoon).
Fruiting: late monsoon to early winter.

Diagnostic field traits
Slender, erect stem with few lanceolate leaves near the base.
Spike of greenish-white flowers with deeply forked lateral lobes on the lip and a long spur.
Flowers open mostly at night and early morning.



PLATE 14: *Luisia zeylanica & Nervilia argoana*

ORDER: ASPARAGALES
FAMILY: ORCHIDACEAE
SUBFAMILY: EPIDENDROIDEAE

***Luisia zeylanica* Lindl.**
Common Name: Cylindrical-leaved Orchid / Ceylon Luisia
Tribe: Vandeae
Sub-tribe: Aeridinae

Growth form & habitat
Small epiphyte tightly attached to trunks of native trees. Prefers moist deciduous forest with moderate shade.

Phenology
Flowering: approximately March-April.
Fruiting: late summer.

Diagnostic field traits
Short stems with closely spaced, terete (cylindrical) leaves 3-5 cm long.
Small greenish flowers with purple-striped ovary; borne on short, few-flowered racemes.



***Nervilia aragoana* Gaudich.**
Common Name: Tall shield Orchid
Tribe: Nervilieae
Sub-tribe: Nerviliinae

Growth form & habitat
Tuberous geophytes having smaller tuber than *N. concolor*.
Grows on the moist, shady forest floor in deep humus or leaf litter.

Phenology
Flowering: May-June.
Fruiting: May-September.

Diagnostic field traits
Grows in colonies, leaf emerges after flowering.
More or less circular/kidney-shaped leaves with prominent radiating veins.
Short-lived greenish-yellow, up to 16 flowers per stem.



PLATE 15: *Nervilia concolor & Rhynchostylis retusa*

ORDER: ASPARAGALES
FAMILY: ORCHIDACEAE
SUBFAMILY: EPIDENDROIDEAE

Nervilia concolor (Blume) **Schltr.**
Common Name: One-leaf Orchid
Tribe: Nervilieae
Sub-tribe: Nerviliinae

Growth form & habitat
Geophytic terrestrial orchid of shaded forest floor.
Grows in leaf litter under deciduous and mixed forest, sometimes near streams.

Phenology
Flowering: April-May.
Fruiting: May-September.

Diagnostic field traits
Also grows in colonies, single cordate (heart-shaped) leaf.
Short-lived flower on a leafless stalk, flower greenish to purplish, 2–6 flowers per plant.



Rhynchostylis retusa **(L.) Blume**
Common Name: Foxtail / Bottlebrush Orchid
Tribe: Vandeae
Sub-tribe: Aeridinae

Growth form & habitat
Stout, monopodial epiphytic herb with thick, woody stems.
Tropical/subtropical forests, prefers hosts with high bark pH and moisture.

Phenology
Flowering: May-August.
Fruiting: July-December

Diagnostic field traits
Long pendent inflorescences (Foxtail-like pendulous raceme).
White to pale pink flowers with purple lip, strong fragrance.
Leaves with 3-toothed apex; unlobed purple lip.



PLATE 16: *Vanda tessellata & Vanda testacea*

ORDER: ASPARAGALES
FAMILY: ORCHIDACEAE
SUBFAMILY: EPIDENDROIDEAE

***Vanda tessellata* (Roxb.) Hook. ex G.Don**
Common Name: Checkered Vanda
Tribe: Vandeae
Sub-tribe: Aeridinae

Growth form & habitat
Found in open canopy positions where it receives good light and air circulation.

Phenology
Flowering: April-July.
Fruiting: late monsoon.

Diagnostic field traits
Large robust epiphyte with long strap-shaped leaves.
Erect or slightly arching racemes with showy, tessellated yellow-brown flowers bearing darker net-like pattern and a blue-purple lip.
Strong fragrance, particularly on warm days.



***Vanda testacea* (Lindl.) Rchb.f.**
Common Name: Yellow Vanda
Tribe: Vandeae
Sub-tribe: Aeridinae

Growth form & habitat
Small to medium epiphyte on trunks and outer branches. Prefers well-lit but not fully exposed canopy in mixed Sal Forest.

Phenology
Flowering: April-May; capsules develop by June.
Fruiting: early monsoon.

Diagnostic field traits
Narrow terete to semi-terete leaves; dense clumps of aerial roots.
Many-flowered racemes of small copper-yellow to orange flowers with striking blue to violet lip.



PLATE 17: *Zeuxine longilabris & Zeuxine strateumatica*

ORDER: ASPARAGALES
FAMILY: ORCHIDACEAE
SUBFAMILY: ORCHIDOIDEAE

***Zeuxine longilabris* (Lindl.) Trimen**
Common Name: Long-Lipped Zeuxine
Tribe: Cranichideae
Sub-tribe: Goodyerinae

Growth form & habitat
Slender, terrestrial perennial herb with a creeping fleshy rhizome at base.
Damp, shady places in evergreen or moist deciduous forests.

Phenology
Flowering: January-May.
Fruiting: January till May.

Diagnostic field traits
Fragrant, greenish/yellowish-white flower.
Terminal, glandular-pubescent (hairy) raceme
Copper-brown or reddish leaves; lip mid-lobe is 2-winged and toothed (serrated).



***Zeuxine strateumatica* (L.) Schltr.**
Common Name: Lawn / Soldier Orchid
Tribe: Cranichideae
Sub-tribe: Goodyerinae

Growth form & habitat
Small, erect terrestrial herb with a decumbent base.
Grasslands, streambanks, and moist wetlands, often a "weed" in lawns.

Phenology
Flowering: December-March.
Fruiting: January-March.

Diagnostic field traits
Grass-like linear leaves, dense spike of white flowers with a prominent yellow lip.



6. Discussion

The results of the present study provide a scientifically robust baseline inventory of orchid diversity and associated ecological parameters in Dalma Wildlife Sanctuary, directly fulfilling the two primary objectives. Twenty wild orchid species (12 epiphytic and 8 terrestrial) were documented across stratified habitats, with detailed information on growth forms, microhabitat preferences, phenology, abundance, and inferred pollinator guilds. No direct insect visits were observed despite systematic monitoring, underscoring the value of pollination-syndrome analysis as a reliable proxy for guild characterization within the constraints of the six-month survey period.

6.1 Orchid Diversity and Habitat Associations

Mixed deciduous forests emerged as the most species-rich habitats, supporting up to five to seven co-occurring orchid taxa per locality in areas such as Manjhla bandh, Bijli ghati, and near Badka bandh. This pattern aligns closely with regional findings from the Chhotanagpur plateau and Odisha, where mixed stands harbour two to three times higher orchid diversity than sal monocultures (Kumar et al., 2005; Misra, 2014). The strong association of epiphytic species with mature phorophytes (e.g., *Madhuca longifolia, Terminalia bellirica, Diospyros melanoxylon*) and terrestrial species with organic-rich soils and riparian patches highlights the critical role of canopy cover (50–70 %) and microclimatic stability in sustaining orchid populations. These observations confirm the sanctuary's dry deciduous and mixed forests as key refugia for orchid diversity within the broader Jharkhand landscape.

6.2 Phenological Patterns and Pollination Syndromes

The documented phenology revealed tight synchrony with the sanctuary's monsoonal climate, with peak flowering concentrated in the pre-monsoon to monsoon window (March-September) for most epiphytes and a narrower post-monsoon peak for terrestrials. This temporal partitioning reduces interspecific competition for pollinators and optimises resource utilisation, consistent with patterns reported in seasonally dry tropical forests (Krömer et al., 2005). Pollination syndromes were dominated by melittophily in *Vanda, Aerides, Eulophia,* and *Dendrobium* species, sphingophily in *Habenaria*, and generalist entomophily or deceptive strategies in several others. The inferred guilds, supported by floral trait analysis and expert consultation, mirror those described in Indian orchid literature (Faegri & van der Pijl, 1979; Fenster et al., 2004) and provide a functional baseline for future quantitative studies.

6.3 Mycorrhizal and Pollinator Dependencies

All 20 species exhibit obligate mycorrhizal associations, a fundamental requirement for germination and establishment in Orchidaceae (Chase et al., 2015). The consistent presence of epiphytes on specific phorophytes and terrestrials on undisturbed substrates indirectly indicates the persistence of suitable fungal partners. The complete absence of direct pollinator observations reinforces the methodological reliance on syndromes and highlights the need for year-round monitoring to fully elucidate plant–pollinator–mycorrhizal networks. Such dependencies position orchids as sensitive bioindicators of forest health in dry deciduous ecosystems.

6.4 Distribution, Abundance, and Environmental Gradients

Highest richness and abundance were recorded at 400–800 m elevation under moderate canopy cover, correlating with host-tree girth and organic soils. Frequent species (*Vanda tessellata, Vanda testacea, Aerides multiflora*) demonstrated resilience in fragmented landscapes, while rarer taxa (*Luisia zeylanica, Dendrobium macrostachyum*) signal conservation priorities. These patterns are consistent with state-level checklists (Kumar et al., 2007) and underscore the sanctuary's role as an ecological stepping stone between major Indian biodiversity hotspots.

6.5 Comparison with Literature and Conservation Implications

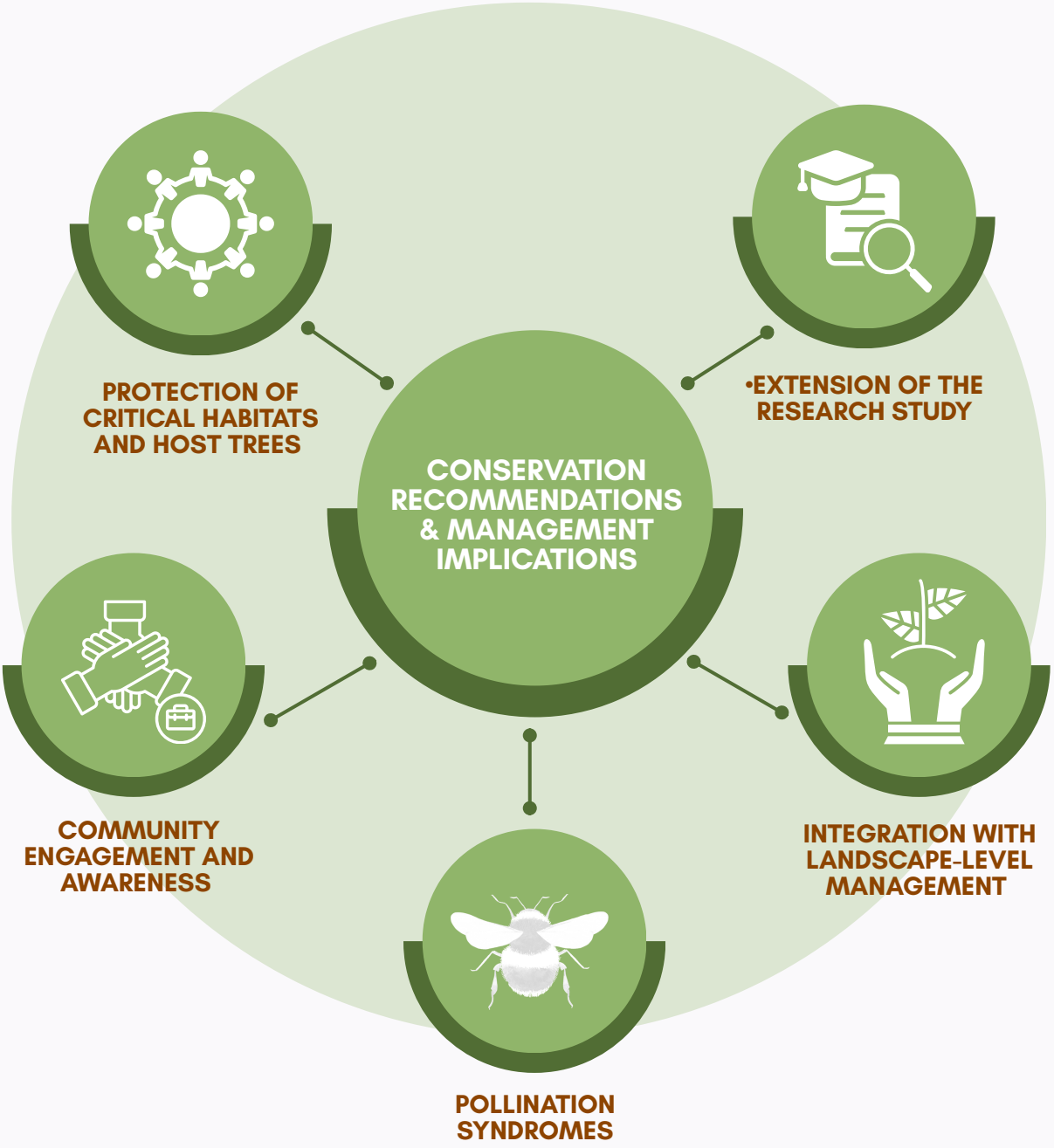
The recorded diversity (20 species) is modest relative to the 63 taxa reported for Jharkhand (Kumar et al., 2005) yet significant for a single protected area. It expands site-specific knowledge beyond earlier descriptive accounts and aligns with Misra (2014) in emphasising the importance of mixed forests and key host trees. The inferred pollination syndromes and mycorrhizal dependencies further reinforce global concerns regarding specialized reproductive systems in Orchidaceae (Phillips et al., 2020; Schiestl & Schlüter, 2009). Threats such as habitat fragmentation, climber competition, and anthropogenic pressures echo those identified in regional studies and necessitate targeted protection of mature phorophytes, soil integrity, and seasonal moisture regimes.

In summary, the findings fulfil the study objectives by delivering a geo-referenced inventory and functional ecological insights that link orchid diversity to pollinator guilds and mycorrhizal networks. They highlight Dalma Wildlife Sanctuary's conservation value beyond its charismatic megafauna and provide an evidence-based foundation for long-term monitoring, habitat management, and community-led conservation in this ecologically significant dry deciduous landscape. Future multi-year studies should prioritise direct pollination observations and mycorrhizal sampling to refine these baseline data.



7. Policy Relevance and Scope of Recommendations

While the present study provides valuable insights into orchid diversity, distribution, and associated ecological patterns within Dalma Wildlife Sanctuary, the findings are based on a relatively short-term survey (six months) and limited ecological observations.
Accordingly, the recommendations derived from this study should be considered as preliminary in nature, intended to inform and support ongoing management planning rather than serve as definitive policy prescriptions. These suggestions provide an initial framework that can be refined and strengthened through long-term monitoring, expanded datasets, and targeted ecological investigations. The recommendations below are explicitly aligned with the sanctuary's existing management framework, the Biological Diversity Act (2002), and the National Wildlife Action Plan, thereby ensuring direct integration into annual working plans and the forthcoming 2027–2032 management plan.



7.1 Protection of Critical Habitats and Host Trees

Mixed deciduous forest patches at elevations of 400–800 m, characterised by 50–70 % canopy cover and organic-rich soils, constitute the primary orchid hotspots. These areas, together with their associated mature phorophytes (*Madhuca longifolia, Terminalia bellirica, Diospyros melanoxylon,* and *Shorea robusta*), warrant immediate designation as "Orchid Conservation Zones." Roadside populations require 50 m buffer strips to mitigate edge effects. Such zoning will be incorporated into the sanctuary's habitat zonation map and enforced through existing patrol protocols.

7.2 Pollination Syndromes – Interpretation and Limitations

Pollination syndromes for the recorded orchid species were inferred based on floral morphology and trait analysis, including flower colour, structure, and presumed attractants. The observed patterns suggest a predominance of melittophily (bee pollination), with possible contributions from sphingophily (moth pollination). However, it is important to note that these interpretations are indicative rather than confirmatory, as no direct observations of pollinator visitation or quantitative data on pollination events were recorded during the study period. Consequently, the assigned pollination syndromes should be treated as hypothesis-driven inferences requiring further validation through targeted field observations, including diurnal and nocturnal monitoring.

7.3 Extension of the Present Study and Justification for a One-Year Research Programme

The survey successfully documented presence, distribution, and inferred pollinator guilds; however, it captured only a partial phenological cycle and yielded no direct insect observations.

A scientifically robust understanding of orchid-pollinator specificity, full seasonal phenology, and reproductive success necessitates at least one complete annual cycle of data collection. Extension of the current project for a further six months (April-September 2026) is therefore recommended. This modest extension will enable:

- documentation of additional orchid taxa potentially present outside the surveyed window,
- verification of inferred syndromes through direct diurnal and nocturnal observations, and
- preliminary mycorrhizal sampling.

Such an extended programme will double the scientific output while requiring minimal additional resources, thereby providing the Jharkhand Forest Department with a comprehensive dataset suitable for evidence-based decision-making and compliance with national biodiversity reporting obligations.

7.4 Community Engagement and Awareness

Targeted training modules for forest guards, eco-tourism guides, and local communities will reduce incidental collection and promote non-destructive documentation. Revenue from regulated ecotourism may be ring-fenced for habitat restoration.

7.5 Integration with Landscape-Level Management

Orchid conservation must be mainstreamed into the Singhbhum elephant corridor plan to avoid inadvertent microhabitat degradation during fire-line creation or water-hole development. Coordination with the Biodiversity Management Committee will embed these recommendations into the sanctuary's official management plan.

Adoption of the foregoing policy-focused recommendations will secure the documented orchid diversity, strengthen ecosystem resilience, and position Dalma Wildlife Sanctuary as a model for orchid-inclusive protected-area management across the Chhotanagpur plateau. The proposed one-year extension represents a high-return investment that directly addresses the temporal constraints acknowledged in this study and will generate the additional data required for informed, long-term conservation planning.



8. Conclusion

In conclusion, the present study has successfully documented a comprehensive baseline inventory of orchid diversity and associated ecological interactions within Dalma Wildlife Sanctuary, thereby addressing the two primary objectives outlined at the outset. Twenty wild orchid species across 12 genera, 12 epiphytic and 8 terrestrial were recorded through systematic stratified surveys conducted. Detailed information on growth forms, microhabitat preferences, phenological patterns, abundance, distribution, and inferred pollination syndromes has been generated, fulfilling the requirement for geo-referenced floristic and functional data essential to evidence-based conservation planning.

The findings affirm the sanctuary's dry deciduous and mixed forests as important refugia for orchid assemblages, with peak diversity observed in mixed deciduous patches supporting mature phorophytes and organic-rich soils at 400-800 m elevation. Phenological synchrony with the monsoonal climate and the predominance of melittophily, supplemented by sphingophily and generalist or deceptive strategies, underscore the functional integration of orchids within the broader pollinator network. The absence of direct pollinator observations during the survey period highlights the methodological value of pollination-syndrome analysis while emphasising the need for extended, year-round monitoring. Collectively, these results expand site-specific knowledge beyond earlier state-level checklists and position Dalma as a significant orchid habitat within the Chhotanagpur plateau.

The survey captured only a partial phenological cycle, precluding comprehensive direct observations of pollinator activity and preliminary mycorrhizal sampling. Abundance estimates relied on semi-quantitative scales rather than exhaustive population censuses, and the study did not encompass potential additional taxa flowering outside the survey window. These constraints suggest productive avenues for future research, including a recommended one-year extension to verify syndromes, assess reproductive success, and elucidate plant–pollinator–mycorrhizal networks more fully.

The practical implications of this work are substantial. Stakeholders, particularly the Jharkhand Forest Department, are encouraged to designate critical orchid hotspots as "Orchid Conservation Zones," protect key host trees, safeguard pollinator guilds and mycorrhizal communities, and integrate these measures into the sanctuary's management plans. Community engagement initiatives will further enhance local stewardship and reduce incidental threats. By mainstreaming orchid conservation into landscape-level strategies, including the Singhbhum elephant corridor plan, the sanctuary can serve as a model for inclusive protected-area management across the region.

Ultimately, this research underscores the importance of evidence-based approaches in conserving specialized floral guilds within seasonally dry ecosystems. As Dalma Wildlife Sanctuary continues to face pressures from habitat fragmentation, climate variability, and anthropogenic activities, the insights derived herein offer a constructive pathway for sustained biodiversity protection. The study does not represent a final statement but rather a foundational step toward informed action, continued scholarly inquiry, and the long-term preservation of the sanctuary's rich orchid and pollinator heritage.

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Annexure 1

Sr. No.	Area/ Locality Name	GPS Coordinates (Latitude)	GPS Coordinates (Longitude)	Elevation (m/ft)	Habitat Type	*Orchid Species Scientific Name*	Type (Epiphytic/ Terrestrial)	Plant Height (m/cms)	*Associated Flora*	Notes / Threats Observed	Abundance Scores (RARE scale: Rare=1–5 plants, Occasional=6–20, Frequent=>20)
PROJECT: Documentation of Orchids, Dalma Wildlife Sanctuary (Field Datasheet), ORDER: Asparagales, FAMILY: Orchidaceae											
1	From Guest house towards Kadamjhor	22.911188	86.139059	150.5	Forest	*Vanda tessellata*	Epiphytic	1.5 m	*Madhuca longifolia (Mahua)*		Frequent
2		22.911609	86.14192	147.6	Open Forest	*Acampe praemorsa*	Epiphytic	1.5 m	*Diospyros melanoxylon (Tendu)*	Every branch had dense orchids	Frequent
3		22.916346	86.164595	278.56	Roadside Forest	*Vanda tessellata*	Epiphytic	1.5-2 m	*Semecarpus anacardium (Bhilawa)*		Occasional
4		22.913666	86.168855	317.8		*Aerides multiflora*	Epiphytic	1.5 m	*Bombax ceiba (Semal)*		Occasional
5		22.912071	86.170925	355.31		*Rhynchostylis retusa*	Epiphytic	1.5-3 m	*Diospyros melanoxylon (Tendu)*	Flooded with orchids	Occasional
6		22.911903	86.17145	358.6		*Vanda testacea*	Epiphytic	1-2 m	*Pterocarpus marsupium (Bija Sal)*	Less climbers	Frequent

7		22.911003	86.172857	356.17		*Vanda testacea*	Epiphytic	1-2 m	*Semecarpus anacardium (Bhilawa)*	Less climbers	Occasional
8		22.911049	86.172329	360		*Luisia zeylanica* Lindl.	Epiphytic	2m	*Diospyros melanoxylon (Tendu)*	Slender & thin leaf	Rare
9		22.906199	86.175893	442.6		*Vanda tessellata*	Epiphytic	~1-2m	*Terminalia elliptica (Aasan)*		Occasional
10	Opp. Jubla Kocha range	22.927695	86.092809	138.77	Paddy field	*Aerides multiflora*	Epiphytic	~1m	*Madhuca longifolia (Mahua)*		Occasional
11		22.924343	86.103775	131.35	Open	*Acampe praemorsa*	Epiphytic	upto 2m	*Madhuca longifolia (Mahua)*		Frequent
12	Hamsa Dah Village (Main Entrance gate towards guest house ~4kms)	22.923908	86.103317	133.05	Open forest, Field with trees of Mahua, Banyan, and Palash	*Aerides multiflora*	Epiphytic	~1-2m	*Madhuca longifolia (Mahua)*		Frequent
13		22.924196	86.103341	130.72		*Vanda testacea*	Epiphytic	~2-3m	*Madhuca longifolia (Mahua) & Ficus benghalensis (Bargad)*		Frequent
14		22.924343	86.103775	131.35		*Aerides odorata*	Epiphytic	2m	*Madhuca longifolia (Mahua) & Ficus benghalensis (Bargad)*		Frequent
15		22.927933	86.092612	134.5		*Vanda testacea*	Epiphytic	~1-2m	*Madhuca longifolia (Mahua)*		Frequent
16	Opp. Jubla Kocha range (watch tower on tree, small water body)	22.923407	86.103801	131.61		*Aerides multiflora*	Epiphytic	~2m	*Azadirachta india (Neem), Madhuca longifolia (Mahua) & Ficus benghalensis (Bargad)*		Frequent

17	Towards Pinderabeda Rest House	22.911141	86.138973	158	Stream Forest	*Vanda testacea*	Epiphytic	~1-1.5m	*Madhuca longifolia (Mahua)*		Frequent
18		22.911503	86.147886	167.4	Open ground, 1 km towards RH	*Vanda testacea*	Epiphytic	Upto 1.5m	*Butea monosperma (Palash)*	Two different species, slender leaf and broader leaf	Frequent
19		22.905608	86.179109	492.4		*Acampe praemorsa*	Epiphytic	~1-2m	*Lannea coromandelica (Indian ash tree, Doca)*		Frequent
20	Towards Penderabeda' RH	22.901424	86.184061	562.6	7kms from Mukulakocha RH	*Eulophia ochreata*	Terrestrial	<15-20 cm	*Herbs, shrubs, grasses*		Occasional
21		22.895494	86.201961	643.61	1km from Pinderabeda RH towards temple	*Vanda testacea*	Epiphytic	~1-2m	*Terminalia bellirica (Bahera)*		Frequent
22		22.898087	86.19962	597.02	Right side of the road, 50m inside	*Aerides odorata*	Epiphytic	1m	*Pterocarpus marsupium (Bija Sal)*		Occasional
23		22.897914	86.199542	590.12	Left side of road	*Luisia zeylanica Lindl.*	Epiphytic	~1m	*Diospyros melanoxylon (Tendu)*		Rare
24		22.898896	86.197771	589.1	Right side of the road, 50m inside	*Acampe praemorsa*	Epiphytic	~1m	*Terminalia chebula (Harar)*		Occasional
25		22.899256	86.196943	565.64	Left side of road	*Eulophia ochreata*	Terrestrial	~1-2m	-		Occasional

26	Manjhla bandh, Southern	22.901915	86.198421	560.83	Mixed forest	*Acampe praemorsa*	Epiphytic	~2-3m	*Terminalia bellirica (Bahera)*		Frequent
27		22.901814	86.198391	552.5		*Vanda tessellata*	Epiphytic	2m	*Lannea coromandelica (Indian ash tree, Doca) (dried)*		Frequent
28	Chota bandh, 100mts	22.901666	86.202551	560.1		*Vanda testacea*	Epiphytic	1-2m	*Terminalia bellirica (Bahera)*		Frequent
29	Aam daarhi naala	22.902718	86.193095	521.7		*Vanda tessellata*	Epiphytic	1-2m	*Terminalia bellirica (Bahera)*		Frequent
30	150mt from old bijli ghaati	22.907614	86.191655	500.5	Mixed forest	*Luisia zeylanica* Lindl.	Epiphytic	1	*Diospyros montana (Kaala Kend)*	Collected fallen orchid for propagation	Rare
31	Near Bijli ghati	22.907599	86.192414	479.25			Epiphytic	1	*Terminalia elliptica (Aasan)*		Rare
32	Bijli ghati right side of road	22.907549	86.192408	486.2		*Dendrobium macrostachyum*	Epiphytic	1-2m	*Bridelia retusa (Kosai)*		Rare
33	Bijli ghati right side of road	22.907471	86.192258	482.81		*Not orchid*	Epiphytic	0.5m	*Kukdi Champa*		
34	Towards Badka bandh road	22.895293	86.197955	608.41		*Rhynchostylis retusa*	Epiphytic	0.5-1m	*Terminalia elliptica (Aasan)*		Occasional
35	Towards Badka bandh road	22.895368	86.197139	599.3		*Not orchid*	Epiphytic	0.5m	*Kukdi Champa*		
36	Rest house premises	22.19629	86.196129	598.8		*Luisia zeylanica*	Epiphytic	1	*Karkat*		Rare

37	Baak Mor, Right side of the road	22.895079	86.203145	690.8	Mixed forest	*Vanda testacea*	Epiphytic	0.5m	*Terminalia bellirica (Bahera)*		Frequent
38	50m from Bahera Bak	22.895087	86.205042	695.29		*Aerides odorata*	Epiphytic	3.5m	*Garuga pinnata (Bhut Kusum)*		Occasional
39	Left side of road, 1km to temple	22.890891	86.213664	812.6		*Dendrobium herbaceum*	Epiphytic	0.5-1m	*Bombax ceiba (Semal)*		Occasional
40	Teesri, 4kms from Pendabeda RH	22.909529	86.175842	373.2		*Aeides multiflora*	Epiphytic	1-2m	*Diospyros melanoxylon (Tendu)*		Occasional
41	Chimti Naka, After bridge left side of road	23.0816667	86.4511111	658	Open, road side	*Aerides multiflora*	Epiphytic	0.5m	*Schleichera oleosa (Kusum)*		Occasional
42	Chimti Naka, Before bridge left side of road	23.0641667	86.4316667	626	Open, road side	*Vanda testaces, Aerides multiflora, Aerides odorata,Rhyncho stylis retusa*	Epiphytic	0.5-1m	*Bombax ceiba (Semal)*		Frequent
43	Forest towards Rest house 4kms, left side of road	23.0641667	86.2558333	1498	Forest climber (Combretum decandrum), Bauhinia roxburghii	*Unidentified*	Terrestrial	~upto 30cm			Rare
44	Bandar Jal, Aam Jharna	22.909525	86.2493	384.3ft	Mixed Semi-deciduous forest - Dense, high OM, prevalence of orchid Species near termite mounds	*Habenaria furcifera*	Terrestrial	Upto 15-45cms with stalk	-	Maoist activity noted, Leaves lie at the ground in 5-6 in number, waxy and shiny, multiple sightings at a distance of 100-200 mts	Occasional
45		22.909931	86.249609	476.4ft		*Habenaria furcifera*	Terrestrial		-		Occasional

46		22.909394	86.249213	451.7ft		*Habenaria furcifera*	Terrestrial		-		Occasional
47	Saal Doha Village	22.9586111	86.4980556	602ft	Rice field, agroforestry, stream flowing	*Vanda tessellata*	Epiphytic	Upto 1m	*Madhuca longifolia*		Frequent
48		22.9594444	86.4955556	598ft		*Vanda tessellata*	Epiphytic	Upto 1m	*Madhuca longifolia*		Frequent
49		22.9572222	86.4944444	614ft		*Acampe praemorsa*	Epiphytic	Upto 1m	*Madhuca longifolia*		Frequent
50		23.0277778	86.4883333	821ft	On hill forest beyond	*Vanda sp.*	Epiphytic	1-3m	*Diospyros melanoxylon (Tendu) & Madhuca longifolia*		Frequent
51		23.0280556	86.4888889	814ft	River stream	*Dendrobium macrostachyum*	Epiphytic	1-3m	*Diospyros melanoxylon (Tendu)*		Rare
52		23.0294444	86.4916667	815ft	600m from river stream	*Habenaria furcifera*	Terrestrial	~50cm	-		Occasional
53		23.0294444	86.4916667	815ft		*Vanda sp.*	Epiphytic	1-2m	*Pterocarpus marsupium*		Frequent
54		23.0333333	86.4927778	830ft		*Vanda sp.*	Epiphytic	1	*Pterocarpus marsupium*		Frequent
55		23.035	86.4938889	846ft		*Dendrobium crepidatum*	Epiphytic	Upto 3m	*Bombax ceiba (Semal)*		Occasional
56		22.875	86.2452778	566ft	Halud Bane, left side of the road	*Vanda tessellata*	Epiphytic	1-2m	*Madhuca longifolia (Mahua)*		Frequent

57		22.890447	86.214217	837	Near Dalma temple	*Dendrobium herbaceum*	Epiphytic	Upto 3m	Garuga pinnata & Bombax ceiba		Occasional
58		22.89047	86.21473	820	Dalma Mandir Gufa	*Dendrobium herbaceum*	Epiphytic	Upto 3m	*Ficus virens*		Occasional
59		22.998611	86.445833	810		*Dendrobium macrostachyum*	Epiphytic	Upto 3m	*Syzigium cumini (Jamun)*		Occasional
60		22.903061	86.216753	473.1	Left side of road	*Dendrobium herbaceum, Dendrobium macrostachyum, Vanda sp.*	Epiphytic	Upto 3m	*Mangifera indica (Aam)*		Occasional
61	Paagda Ground	22.880863	86.28234	138	Scrub Open forest, shrubs bushes,	*Acampe praemorsa*	Epiphytic	~1-2m	*Diospyros melanoxylon (Tendu)*		Frequent
62		22.879719	86.282746	136	Roadside Forest	*Vanda tessellata*	Epiphytic	~1-2m	*Diospyros melanoxylon (Tendu)*		Frequent
63	Pathipani	22.868483	86.223186	115.2	Roadside Forest	*Vanda tessellata*	Epiphytic	~1-2m	*Fibus benghalensis (Banyan)*		Frequent
64	Kadamjhor	22.906029	86.175983	446.2	Mixed forest	*Habenaria furcifera & Vanda tessellata*	Terrestrial & Epiphytic	~1-2m	*Terminalia elliptica (Aasan)*		Frequent
65	Saat Bharia, Teesri	22.902055	86.182779	552	Mixed forest	*Vanda tessellata*	Epiphytic	1	*Dried trunk of Terminalia elliptica (Aasan)*		Occasional
66	Ranga Jal	22.901843	86.209588	561.37	Mixed forest	*Aerides odorata*	Epiphytic	2	*Terminalia elliptica (Aasan)*		Rare
67	Makar Jal	22.902853	86.215223	496.5	Mixed forest	*Aerides odorata*	Epiphytic	Upto 1.5m	*Terminalia bellirica (Bahera)*		Rare

68		22.903208	86.214926	478.9	Dense Mixed forest	*Rhynchostylis retusa*	Epiphytic	Upto 1.5m	Careya arborea & Bauhinia vahlii		Occasional
69					Dense Mixed forest	*Vanda tessellata*	Epiphytic	1m	*Terminalia elliptica (Aasan)*		Occasional
70		22.903488	86.215261	494.3	Dense Mixed forest	*Vanda tessellata*	Epiphytic	Upto 2m	*Terminalia bellirica (Bahera)*		Occasional
71		22.90302	86.216023	496.2	Dense Mixed forest	*Vanda tessellata*	Epiphytic	Upto 1.5-2m	*Terminalia elliptica (Aasan) & Bauhinia vahlii*		Frequent
72		22.903067	86.216792	473.1	Dense Mixed forest	*Luisia zeylanica*	Epiphytic	2m			Rare
73		22.904332	86.218969	493.4	Dense Mixed forest	*Luisia zeylanica*	Epiphytic	2m	*Palash/Buchananania lanzan*		Rare
74		22.90856	86.219701	456.3	Mixed forest	*Nervillea concolor*	Terrestrial	<10cm, 5cm dia	*Shrubs, herbs & grasses*		Rare
75		22.908616	86.21972	467.1	Mixed forest	*Nervillea concolor*	Terrestrial	<10cm, 5cm dia			Rare



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