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Diversity of Orchids under Teak (*Tectona grandis* Linn. F) Stands in Magelang Regency, Central Java: Initial Effort for Conservation

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Abstrak

Keanekaragaman anggrek terus mengalami penurunan akibat degradasi habitat dan perubahan penggunaan lahan, sehingga diperlukan identifikasi habitat alternatif yang mampu mendukung konservasi jangka panjang. Tegakan jati (*Tectona grandis* Linn. f.) berpotensi menjadi habitat sekunder bagi anggrek epifit, namun informasi mengenai nilai ekologisnya masih terbatas. Penelitian ini bertujuan menginventarisasi keanekaragaman anggrek di bawah tegakan jati di Kabupaten Magelang, Jawa Tengah, serta mengevaluasi variasi morfologi antarspesies sebagai dasar penyusunan strategi konservasi. Penelitian dilakukan secara deskriptif-eksploratif pada tiga plot melalui inventarisasi spesies, pengukuran faktor lingkungan, dan karakterisasi morfologi. Keanekaragaman dianalisis menggunakan indeks Margalef (DMg), Shannon–Wiener (H′), kemerataan Pielou (E), dan Sorensen (IS), sedangkan variasi morfologi dianalisis berdasarkan 36 karakter vegetatif dan generatif menggunakan metode UPGMA. Sebanyak 12 spesies anggrek epifit dari sembilan genus berhasil diidentifikasi. Nilai kekayaan spesies tergolong rendah hingga sedang (DMg = 1,838), sedangkan indeks keanekaragaman (H′ = 1,690) dan kemerataan (E = 0,680) menunjukkan komunitas dengan keanekaragaman sedang dan distribusi individu yang relatif merata. Karakterisasi morfologi menunjukkan variasi yang tinggi (rata-rata H′ = 0,893) dengan koefisien kemiripan 0,14–0,92. Hasil penelitian menegaskan bahwa tegakan jati merupakan habitat potensial bagi konservasi In Situ anggrek epifit serta menyediakan informasi dasar yang penting untuk pengelolaan plasma nutfah, konservasi keanekaragaman hayati, dan program pemuliaan tanaman.

Kata kunci: Anggrek Epifit, Keanekaragaman Hayati, Konservasi, Morfologi, Tegakan Jati

Abstract

Orchid diversity is increasingly threatened by habitat degradation and land-use change, highlighting the need to identify alternative habitats capable of supporting long-term conservation. Teak (Tectona grandis Linn. f.*) plantations have the potential to serve as secondary habitats for epiphytic orchids; however, their ecological significance remains insufficiently documented. This study aimed to inventory orchid diversity under teak stands in Magelang Regency, Central Java, and evaluate interspecific morphological variation as baseline information for conservation planning. A descriptive-exploratory survey was conducted across three sampling plots through orchid inventories, environmental measurements, and morphological characterization. Biodiversity was assessed using the Margalef richness index (DMg), Shannon–Wiener diversity index (H'), Pielou evenness index (E), and Sorensen similarity index (IS), while morphological variation was evaluated using 36 vegetative and generative characters followed by UPGMA cluster analysis. A total of 12 epiphytic orchid species representing nine genera were recorded. Species richness was classified as low to moderate (DMg = 1.838), whereas Shannon–Wiener diversity (H' = 1.690) and Pielou evenness (E = 0.680) indicated a moderately diverse orchid community with a relatively balanced species distribution. Morphological characterization revealed high variation (mean H' = 0.893), with similarity coefficients ranging from 0.14 to 0.92. These findings demonstrate that teak stands provide suitable habitats for the In Situ conservation of epiphytic orchids and offer valuable baseline information for germplasm management, biodiversity conservation, and future orchid breeding programs.*

Keywords: Biodiversity, Conservation, Epiphytic Orchid, Morphological Variation, Teak Stands

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INTRODUCTION

Orchids (*Orchidaceae*) are one of the largest families of flowering plants in the world, with a very high level of species diversity thus contributing to global biodiversity (Zhao et al., 2023). The widespread use of orchid species includes ornamental/aesthetic plants, traditional medicine, ecological functions, and others (Yadav et al., 2024). Ecologically, orchids play an important role in maintaining ecosystem balance through their interactions with host trees, mycorrhizal fungi, and pollinating insects (Waterman & Bidartondo, 2008). However, most orchid species have specific habitat requirements, making them highly vulnerable to habitat degradation, forest fragmentation, and land-use change (Ye et al., 2025). This makes inventorying and documenting orchid diversity become a crucial first step in supporting biodiversity conservation and management efforts.

Indonesia is one of the world's centers of tropical orchid diversity, with thousands of species spread across various ecosystems (Prapitasari et al., 2024). Besides their ecological value, orchids also possess high economic and horticultural value (Li et al., 2021). Overexploitation and the loss of natural habitats, such as those caused by the conversion of forest to agricultural land, have led to the decline and even extinction of many orchid populations (Yudaputra et al., 2024). Therefore, identifying habitats that can still support orchids, including in planted forest areas, is increasingly important. Field observations indicated that local communities have limited knowledge of orchids and their ecological importance. This low level of awareness is reflected in the limited support for orchid conservation, and some human activities may accelerate the decline of orchid populations in the study area.

One of the habitats that has the potential to support the existence of orchids is teak stands. Teak stands (*Tectona grandis* Linn. f.) are a type of planted forest that have the potential to provide habitat for orchids, particularly epiphytic species (Harikrishnan et al., 2012), through their canopy characteristics, microhumidity, and the presence of tree bark as a substrate. However, research on orchid diversity in teak stands is still relatively limited. Although orchid diversity has been documented in natural forests and protected areas, the ecological capacity of managed teak plantation forests to function as surrogate habitats for orchid conservation remains poorly understood. Moreover, previous studies have largely emphasized species inventories, while comprehensive integration of biodiversity assessment with morphological characterization to evaluate germplasm potential has rarely

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been undertaken. Consequently, baseline information linking ecological diversity and morphological variation in plantation ecosystems is still lacking.

Magelang Regency is one of the areas in Central Java province which has an altitude ranging from 153-3,065 masl. Several conditions for growing teak are met in this place, especially at an altitude of 200-800 masl (Pumijumnong et al., 2020). Although Magelang Regency is not considered as a major teak producing area, like Blora Regency, this region still has a potential distribution of teak plantations. In fact, semi-natural habitats such as teak stands have the potential to become important in situ conservation sites (Didas et al., 2022), especially in areas with increasing pressure for land use/vegetation change.

Based on these conditions, research on orchid diversity in teak stands in Magelang Regency is important to conduct as an initial effort to document and overview species richness, understand habitat characteristics that support orchids, and provide baseline data for developing conservation strategies. The resulting information is expected not only to enrich the database of orchid diversity in Indonesia, but also to provide a scientific basis for teak stand management that pays more attention to aspects of orchid biodiversity conservation. Thus, this study aims to inventory and analyze the diversity of orchids growing under teak stands in Magelang Regency, Central Java, as an initial step in supporting orchid conservation efforts outside formal conservation areas.

RESEARCH METHODS

The research was conducted from April to May 2026, located in Bandongan District, Magelang Regency, Central Java, primarily in three different observation plots or teak stands (Figure 1). This research is a descriptive exploratory study with direct observations at the observation location. Observation data were obtained by exploring the species and number of orchids found in the plots/teak stands to conduct diversity analysis and morphological characterization to conduct cluster analysis. The tools used in this research include a digital camera, ruler, magnifying glass, thermohygrometer, luxmeter, portable canopy analyzer, GPS (Global Positioning System), dagger, and a guidebook/descriptor for orchid morphology observations published by Ornamental Plant Research Center (BALITHI), Agricultural Research and Development Agency, Indonesian Ministry of Agriculture, 2007. The materials or orchid species found/used in this study are shown in Table 1.

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Table 1. Orchid Species Observed

Orchid Species	Type/Habitat	Growth Type
Luisia javanica	Epiphytes	Monopodial
Rhynchostylis retusa	Epiphytes	Monopodial
Dendrobium crumenatum Sw.	Epiphytes	Sympodial
Oberonia similis	Epiphytes	Sympodial
Acriopsis lilifolia	Epiphytes	Sympodial
Thrixspermum centipeda	Epiphytes	Monopodial
Taeniophyllum pusillum	Epiphytes	Monopodial
Aerides odorata	Epiphytes	Monopodial
Dendrobium secundum	Epiphytes	Sympodial
Dendrobium stuartii	Epiphytes	Sympodial
Liparis eliptica	Epiphytes	Sympodial
Taeniophyllum obtusum	Epiphytes	Monopodial

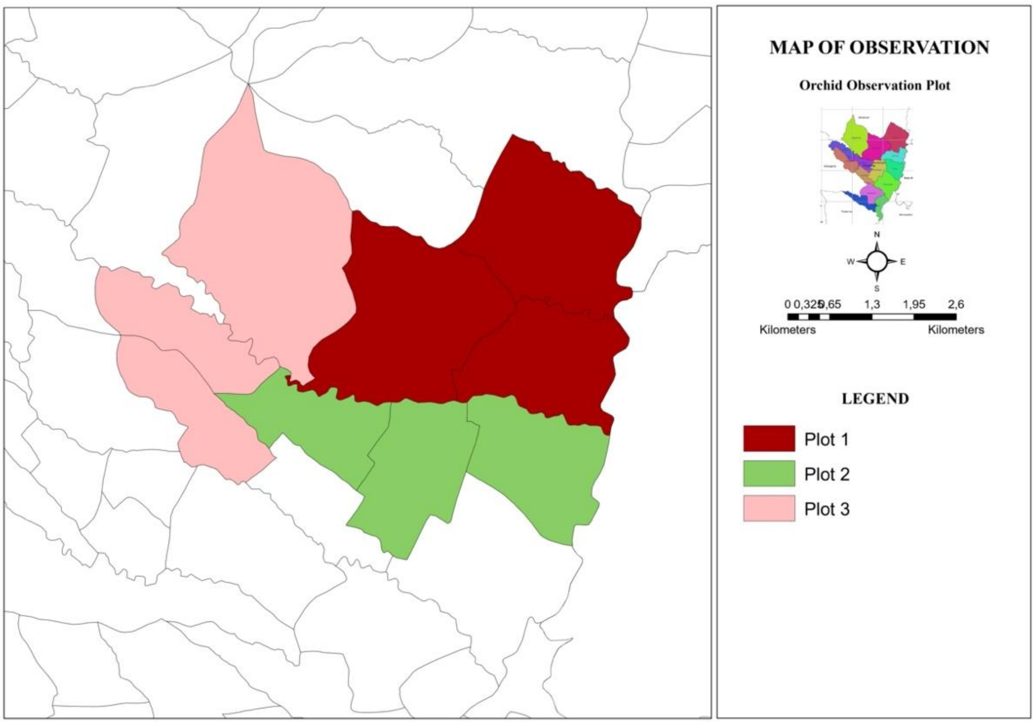

Figure 1. Map of observation locations and the each plot

The research stages include location surveys, observation of growing environment/plot conditions, exploration of orchid species (including observing numbers, morphological characters, and documentation), and data analysis. Observations of orchids in teak stands were carried out by exploring the entire area in the three observed plots so that all orchids found under the teak stands could be properly inventoried. Observations of abiotic environmental conditions, especially maximum temperature, minimum

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temperature, and air humidity were carried out for 7 consecutive days with a frequency of 4 times each day at 06:00-07:00 (morning), 11:00-12:00 (noon), 16:00-17:00 (evening), and 20:00-21:00 (night) then the observation data for 7 days were averaged, other parameters also were also observed for 7 days.

The Margalef index is used to determine species richness at an observation location (Ludwig, 1988), with the following formula:

$$\mathrm{DMg} = \frac{\mathrm{S} - 1}{\ln(\mathrm{N})}$$

where :

S	: total species
N	: total individual
ln	: natural logarithm

Diversity at the species level can be analyzed using Shannon-Wiener analysis. which is expressed by the following formula

$$\mathrm{H}' = -\sum_{i=1}^{R} P\mathrm{i} \ln P\mathrm{i}$$

where :

R	: Margalef index
Pi	: individual proportions (against the amount of sample)

with the commonly used general standards, the results of the H' analysis can be interpreted that if H' < 1 then the diversity is low, 1 ≤ H' ≤ 3 then the diversity is moderate, and H' > 3 then the diversity is high (Magurran, 1988), H' was also used to determine the variation in morphological sub-characters in the orchid species observed. The evenness of species can be determined using the Pielou species evenness (Mulder et al., 2004) which is stated in

$$E = \frac{\mathrm{H}'}{\ln(S) \text{ or } \mathrm{H}'\mathrm{max}}$$

Where :

H'max	: derived from the pervious H' calculation
S	: number of total species found

if the value of E < 0.3 is low, 0.3 < E < 0.6 is medium, and E > 0.6 is classified as high. The level of relative similarity based on the composition and structure of orchid

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species in the observation plot can be analyzed using the Sorensen index (Soerianegara and Indrawan, 2015), the equation is as follows

$$(IS) = \frac{2\mathrm{W}}{\mathrm{x} + \mathrm{y}}$$

where :

W	: the same or lowest total quantitative value of two species in different groups
x	: total quantitative value of all species in the 1st group that being compared
y	: total quantitative value of all species in the 2nd group that being compared

Morphological characterization refers to the orchid morphology descriptor guidelines (BALITHI, 2007), there are 36 morphological characters were evaluated. The morphological characters observed along with the number of sub-characters: habitat type (3), growth type (2), root type (4), presence of pseudobulb (2), longitudinal shape of pseudobulb (6), transverse shape of pseudobulb (2), size of pseudobulb (5), leaf shape (14), leaf apex (12), leaf margin (12), leaf surface texture (8), leaf arrangement (2), leaf symmetry (2), trichomes (2), pseudobulb length (5), pseudobulb width (5), pseudobulb thickness (5), leaf length (5), leaf width (5), leaf thickness (5), inflorescence type (7), inflorescence position (3), resupination (2), flower shape (4), sepal shape (9), petal shape (8), sepal and petal apex shape (12), cross and longitudinal section of sepal and petal (3), callus/protrusion (3), spur (2), number of pollinia (3), flower fragrance (5), flower length (5), flower width (5), L x W dorsal sepal (5), and L x W lateral sepal (5).

Observations of morphological characters will be converted into scoring form based on sub-characters and used as the main data in cluster analysis to construct a phenogram and similarity matrix. The algorithm used in performing hierarchical clustering (phylogenetic tree) refers to a genetic distance matrix based on morphological characters using UPGMA (Unweighted Pair Group Method with Arithmetic Mean) and proccessed with the SimQual procedure. Cluster analysis was performed using the NTSYSpc (Numerical Taxonmy and Multivariate Analysis System) application series 2.02i. (Rohlf, 1988).

RESULTS AND DISCUSSIONS

Exploration carried out on 3 plots, obtained 12 species of orchids from various different genera (9 genus) and also with different numbers/compositions, showing that teak stands are capable of being one of the substrates for epiphytic orchids. Teak bark substrate is not the only main factor that supports the growth of wild orchid populations, but the environment also influences the growth and generative phase of orchids (Lopez & Runkle,

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2005), it indirectly influences population dynamics and species distribution. Under the teak tree, epiphytic orchids will certainly get natural shade from the teak canopy, although in certain conditions and weather in tropical climates, teak can shed its leaves (Hlaing et al., 2014), so there is a period where the orchids will get full sunlight. Sunlight that reaches under the canopy will affect the microclimate and productivity of the plants below (Jin et al., 2024), so that it will affect the dynamics of orchid growth conditions, especially abiotic factors, as can be observed in Table 2.

Table 2. Abiotic Environmental Conditions of the Observation Plot

Environmental Variables	Teak Stand Plot		
	Plot I	Plot II	Plot III
Light Intensity (lux)	16.357 ± 311.57	18.503 ± 285.60	19.711 ± 231.55
Canopy Index (%)	27.29 ± 3.51	18.44 ± 2.84	16.58 ± 2.22
Canopy Density (%)	68.90 ± 4.55	54.21 ± 2.67	46.14 ± 4.15
Altitude (masl)	393.61 ± 23.50	403.13 ± 12.45	404.52 ± 12.18
Max. Temperature (°C)	24.21 ± 3.00	24.94 ± 2.78	26.20 ± 2.53
Min. Temperature (°C)	19.26 ± 1.54	20.41 ± 2.44	19.32 ± 1.80
Air Humidity (%)	87.5 ± 8.74	82.3 ± 10.55	84.8 ± 8.33

Referring to Table 2, each plot shows the variation in light intensity received under the canopy, teak stands with a less dense canopy will transmit more solar radiation (Sonohat et al., 2004), The larger canopy index, the greater canopy density. Although the altitude of the 3 observation plots does not have a large difference, the maximum, minimum temperature and average air humidity show different averages, so that the abiotic environmental conditions in the three plots are relatively different. In general, if we look at the implications for the number of orchid populations and species (Table 3), plot 1 is the plot with the largest number of orchid populations and species, so it is predicted to be the most suitable habitat to support most of the species found. Light is a crucial factor in the growth and development of epiphytic orchids, especially in terms of the intensity (Stancato et al., 2002), Moreover, orchids are CAM (Crassulacean Acid Metabolism) plants, too much light intensity and heat will cause stress (Tay et al., 2019), so they need shade.

Table 3. Orchid Species Population/Found per Plot

Orchid Species	Teak Stand Plot		
	Plot I	Plot II	Plot III
L. javanica	2	0	0
R. retusa	9	1	0
D. crumenatum Sw.	105	16	47
O. similis	1	0	0
A. lilifolia	2	0	0

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Orchid Species	Teak Stand Plot		
	Plot I	Plot II	Plot III
T. centipeda	65	1	0
T. pusillum	51	4	15
A. odorata	12	0	24
D. secundum	0	0	4
D. stuartii	0	0	1
L. eliptica	2	0	11
T. obtusum	13	3	8
Total	262	25	110

In general, epiphytic orchids are ideal at light intensities of around 10,000-20,000 lux, but *Dendrobium* has the ability to tolerate lower levels at 2000-3000 lux (Prapitasari & Kurniawan, 2022). In the research conducted, 3 observation plots were still in the range of 10,000-20,000 lux, however, in plot 1 with the largest number of populations and species, the average light intensity is 16,357 lux, although several species such as *D. secundum* and *D. stuartii* are not found in this plot but in plot 3 with a higher light intensity. Some wild orchid species have specific growing requirements but some species also have good tolerance of environmental dynamics, as evidenced by several orchid species present in the three plots such as *D. crumenatum Sw*., it has good environmental adaptation and has invasive potential (Duenas-Lopez, 2022). In this study, differences in environmental conditions of the plots influenced the diversity of orchid species found, as can be seen in Table 4.

Table 4. Orchid Biodiversity Index under Teak Stands

Plot	Total Species	Biodiversity Index				H' Category
		DMg	E	IS	H'	
All Plot	12	1.838	0.680	-	1.69	Moderate
Plot I	10	1.616	0.682	I-II : (5)/0.667 (66.7%)	1.57	Moderate
Plot II	5	1.243	0.678	I-III : (5)/0.588 (58.8%)	1.09	Moderate
Plot III	7	1.276	0.797	II-III : (3)/0.500 (50%)	1.55	Moderate

Note: DMg: Margalef Index (species richness), E: Pielou index (eveness of species) , IS: Sorensen index (similarity index), and H': Shannon-Wiener diversity index

All orchid species obtained are epiphytic orchid types, as can be seen in Figure 2, with 6 of them having a monopodial growth type and the remaining 6 being sympodial. Overall (all plots) the DMg index shows a figure of 1.838 which means low to moderate (Hussain et al., 2012), which mean species richness (the number of different species present) is low to moderate, This can be influenced by environmental disturbances, dominance by some species, and sample size. Pielou index shows an index of 0.680, which

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means that the evenness is quite high in the 3 plots combined, although some species dominate, when combined with the three plots, the evenness index increases, when compared with each plot. The entire plot and each plot show the Shannon-Wiener diversity index in the same category, namely moderate ($1 \leq H' \leq 3$), the implication is that all plots are predicted to still show a relatively healthy ecosystem and relatively small interventions on the ecosystem/plot (Soetignya et al., 2021).

The plot with the highest DMg index is plot 1, this is due to the number of species in plot 1, namely 10 species, when compared with plots 2 and 3 which are much lower, respectively 1,243 (5 species) and 1,276 (7 species). The level of species richness in an ecosystem indicates favorable environmental conditions (McGill et al., 2015) and the availability of adequate resources, thus supporting the growth and distribution of orchid populations. The highest species evenness index was in plot 3 at 0.797 (high), so that in the plot the number of individuals in each species is distributed evenly and there are no species that dominate (Herrmann et al., 2022).

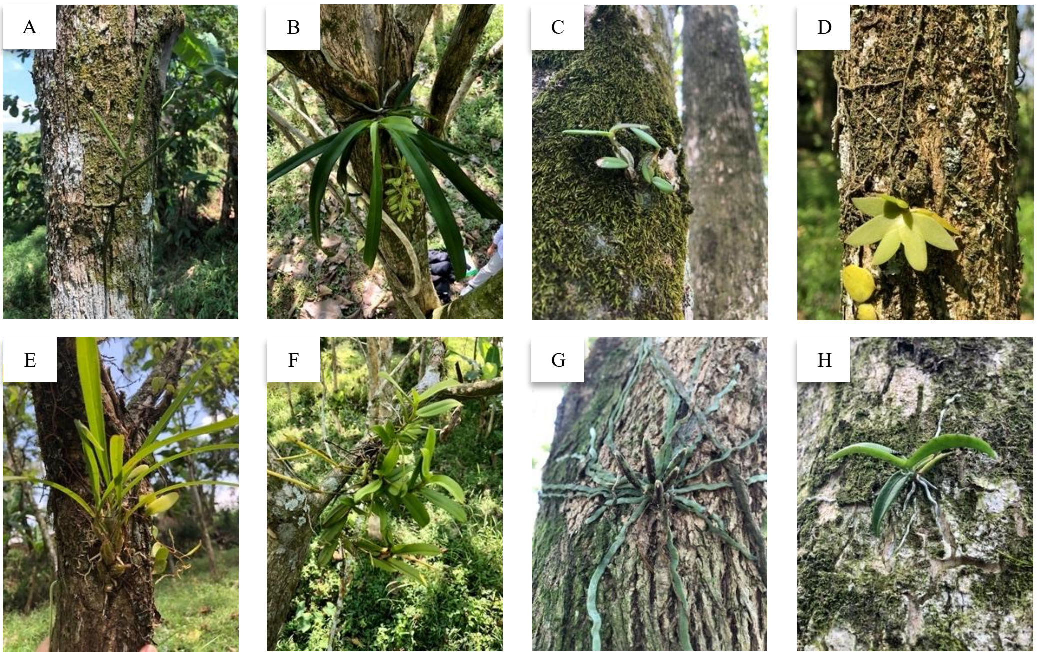

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Figure 2. 12 Species of orchids discovered: A: *L. javanica*, B: *R. retusa*, C: *D. crumenatum* Sw., D: *O. similis*, E: *A. lilifolia*, F: *T. centipeda*, G: *T. pusilum*, H: *A. odorata*, I: *D. secundum*, J: *D. stuartii*, K: *L. eliptica*, and M: *T. obtusum*

When comparing between plots, refer to the Sorensen index, the highest similarity based on species composition was in plot 1 with 2 (66.7%) and the lowest was in plot 2 with 3 (50%), indirectly means that each plot has approximately ±50% similarity in environmental conditions. The changes in environmental conditions can be monitored based on the dynamics of the species found and the decrease in the similarity index. The Sorensen Similarity Index is used to assess whether a protected area contributes unique biodiversity or overlaps with existing reserves. High similarity values indicate redundant habitats, whereas lower values suggest that both areas are important for conserving regional biodiversity (Patanduk et al., 2025).

Morphological variation among species was assessed based on similarities in their sub-characters, this analysis is essential for understanding the genetic distance and relationships among species. Referring to Table 5, 12 orchid species found in 3 plots of teak stands were evaluated using 36 morphological characters, and showed that 2 characters have no sub-character variation (monomorphism), 2 characters have low variation, 11 characters have moderate variation, and 21 characters have high variation. However, the average shows H' of 0.893 with a high (H’ for sub-character variation > 0.75) category (Azam et al., 2023). The high variation in morphological characters in wild orchid species indicates the existence of a high source of germplasm (Ganefianti, 2025). Morphological characterization and exploration of wild orchid germplasm are important for formulating future conservation policies and becoming an important genetic resource for plant breeding purposes, so it must be preserved.

Table 5. Morphological Characters and Sub-Characters of 12 Orchid Species

Plant Part	Character	Sub-Character	N	H’	Criteria
vegetative	Habitat Type	[2] Epiphytes	12	0	None
	Growth Type	[1] Monopodial	6	0.693	Moderate

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Plant Part	Character	Sub-Character	N	H'	Criteria
	Rooting Type	[2] Sympodial	6		
		[3] Clinging (adhesive)	7	0.679	Moderate
		[4] Combined type	5		
	Presence of Pseudobulb	[0] Absent	7	0.679	Moderate
		[1] Present	5		
	Longitudinal Shape of Pseudobulb	[0] Absent	7	1.119	High
		[2] Lanceolate	2		
		[3] Oblong	2		
		[6] Ovate	1		
	Transverse Shape of Pseudobulb	[0] Absent	7	0.960	High
		[1] Elliptic	3		
		[2] Circular	2		
	Size of Pseudobulb	[0] Absent	7	1.119	High
		[2] Small	1		
		[3] Medium	2		
		[4] Large	2		
	Leaf Shape	[0] Not observed	2	1.199	High
		[1] Subulate	1		
		[3] Oblong	6		
		[6] Lanceolate	3		
	Leaf apex	[0] Not observed	2	1.468	High
		[1] Acute	5		
		[5] Obtuse	2		
		[7] Retuse	2		
		[9] Tridentate	1		
	Leaf margin	[0] Not observed	2	0.451	Low
		[1] Entire	10		
	Leaf surface texture	[0] Not observed	2	0.451	Low
		[1] Glabrous	10		
	Leaf arrangement / vernation	[0] Not observed	2	0.721	Moderate
		[1] Convolute	1		
		[2] Duplicate	9		
	Leaf symmetry	[0] Not observed	2	0.960	High
		[1] Symmetric	7		
		[2] Asymmetric	3		
	Trichomes	[0] Absent	12	0	None
	Pseudobulb length	[0] Absent	7	1.119	High
		[1] Very small	2		
		[2] Small	1		
		[4] Large	2		
	Pseudobulb width	[0] Absent	7	0.960	High
		[1] Very small	3		
		[2] Small	2		
	Pseudobulb thickness	[0] Absent	7	0.960	High
		[1] Very small	2		
		[2] Small	3		
	Leaf length	[0] Not observed	2	1.358	High
		[1] Very small	6		
		[2] Small	2		

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Plant Part	Character	Sub-Character	N	H’	Criteria
		[3] Medium	1		
		[4] Large	1		
	Leaf width	[0] Not observed	2	1.468	High
		[1] Very small	2		
		[2] Small	5		
		[3] Medium	2		
		[5] Very large	1		
	Leaf thickness	[0] Not observed	2	1.445	High
		[1] Very small	1		
		[2] Small	4		
		[3] Medium	1		
		[5] Very large	4		
generative	Inflorescence type	[3] Spicate	5	0.918	High
		[4] Racemose	6		
		[5] Paniculate	1		
	Inflorescence position	[1] Base/side of pseudobulb	5	1.028	High
		[2] Lateral/axillary	5		
		[3] Apical	2		
	Resupination	[1] Non-resupinate	3	0.562	Moderate
		[2] Resupinate	9		
	Flower shape	[1] Round	3	0.824	High
		[2] Star	8		
		[3] Curly	1		
	Sepal shape	[1] Lanceolate	4	1.474	High
		[3] Oblong	3		
		[4] Elliptic	1		
		[7] Obovate	1		
		[8] Ovate	3		
	Petal shape	[1] Linear	1	1.234	High
		[2] Oblong	7		
		[3] Elliptic	1		
		[7] Ovate	2		
		[9] Circular	1		
	Sepal & petal apex shape	[1] Acute	3	0.562	Moderate
		[5] Obtuse	9		
	S. sepal and petal	[1] Concave	6	0.693	Moderate
		[2] Straight	6		
	Callus	[1] Lamellate	1	0.721	Moderate
		[2] Complex	2		
		[3] Simple	9		
	Spur	[0] Absent	7	0.679	Moderate
		[1] Present	5		
	N.of Pollinia	[1] Two	8	0.637	Moderate
		[2] Four	4		
	Flower fragrance	[0] Absent	7	0.679	Moderate
		[1] Present	5		
	Flower length	[1] Very small	6	1.040	High
		[2] Small	3		

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Plant Part	Character	Sub-Character	N	H’	Criteria
		[5] Very large	3		
	Flower width	[1] Very small	6	1.040	High
		[2] Small	3		
		[5] Very large	3		
	L × W Dorsal Sepal	[1] Very small	7	1.075	High
		[2] Small	1		
		[4] Large	1		
		[5] Very large	3		
	L × W Lateral Sepal	[1] Very small	6	1.199	High
		[2] Small	2		
		[4] Large	1		
		[5] Very large	3		

By grouping orchid species based on similarities in morphological characteristics, predictions and analyses of genetic proximity can be made based on morphological characteristics. Through characterization of morphological characters, it is possible to identify the important and beneficial traits of orchid (Hossain & Islam, 2026), such as flower characters and leaf shapes that have aesthetic value. This will be very useful in efforts to increase genetic diversity through selection, breeding, and biotechnology. Although identification of diversity in species is only done based on morphological characters, for initial studies in conservation, it is sufficient. Previous studies stated that variations in morphological sub-characters also produce diverse patterns in DNA fragments (Khasim & Ramesh, 2010), confirming that grouping orchid species based on morphology is an important step for genetic resource management and conservation purposes.

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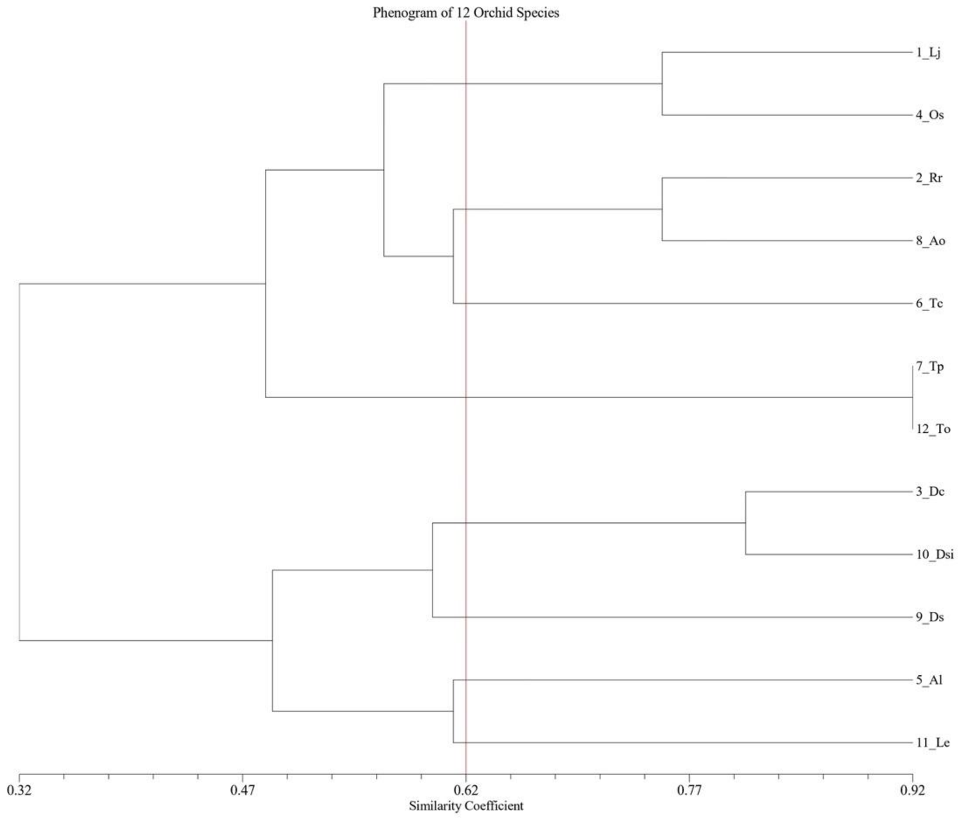

Figure 3. Phenogram of 12 orchid species

The phenogram constructed based on the similarity of morphological characters (Figure 3) shows the presence of 2 large clusters and 4 sub-clusters. Cluster 1 consists of 7 species and cluster 2 consists of 5 species, while the sub-clusters respectively consist of 5, 2, 3, and 2 species. Clusters formed on a phenogram, grouping species based on appropriate characteristics and levels of similarity. The species with the highest similarity is *T. pusilum* with *T. obtusum*, with a similarity index of 0.92, which means that the two species only have a dissimilarity coefficient of 0.08, These two species are separated into their own sub-cluster based on their high similarity, namely sub-cluster 2. 3 species of *Dendrobium* are also grouped into a separate sub-cluster, namely sub-cluster 3, which *D. Crumenatum* Sw. is more similar or closer to *D. stuartii* than *D. secundum*. Through phenograms, species can be identified that have certain unique characteristics based on the evaluated characteristics, so they are important in conservation (Palsson et al., 2024).

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Species	1_LJ	2_Rr	3_Dc	4_Os	5_Al	6_Tc	7_Tp	8_Ao	9_Ds	10_Dsi	11_Le	12_To
1_LJ	1,00											
2_Rr	0,56	1,00										
3_Dc	0,39	0,28	1,00									
4_Os	0,75	0,53	0,31	1,00								
5_Al	0,50	0,22	0,53	0,47	1,00							
6_Tc	0,67	0,67	0,39	0,53	0,44	1,00						
7_Tp	0,56	0,42	0,22	0,50	0,33	0,47	1,00					
8_Ao	0,61	0,75	0,42	0,50	0,22	0,56	0,39	1,00				
9_Ds	0,28	0,36	0,56	0,36	0,42	0,39	0,14	0,33	1,00			
10_Dsi	0,39	0,22	0,81	0,39	0,53	0,33	0,25	0,36	0,64	1,00		
11_Le	0,42	0,28	0,50	0,50	0,61	0,31	0,19	0,31	0,53	0,44	1,00	
12_To	0,56	0,47	0,19	0,56	0,36	0,50	0,92	0,44	0,22	0,22	0,28	1,00

Figure 4. Similarity matrix of 12 orchid species

Referring to the similarity matrix (Figure 4), it can be observed that the range of similarity coefficients in 12 orchid species based on morphological characters is a wide range of similarity, ranges from 0.14-0.92, so that the smallest level of similarity is at 0.14 (as in 7_Tp with 9_Ds) and the largest at 0.92. The level of similarity between species based on morphological characters is important information in genetic studies, especially in the applied context of plant breeding. Orchid with high morphological similarity (close genetic distance) such as *T. pusilum* and *T. obtusum*, if cross-breeding is carried out, the success rate will be high because the genetic distance is close, but the variation in traits in the offspring will be low, because both parents have high similarities.

Several possible conditions such as microclimate changes due to climate change, the reduction of some teak populations, agriculture under stands, and several human activities are capable of reducing orchid populations both directly and indirectly, such as unsuitable environmental conditions for growth, so that conservation needs to be carried out by considering valid data in the field. Referring to the biodiversity data obtained from this study, it can certainly be used in developing a conservation plan framework for wild orchids growing under teak stands. In Situ conservation can still be carried out and combined with strategies aimed at minimizing human intervention on orchid sustainability. However, for some species that are not found or are unable to grow in some plots, this can be done by carrying out Ex Situ conservation, by planting and propagating them outside their original habitat with effective methods, so that replanting can be carried out in all plots periodically while improving the habitat and providing a suitable growing environment.

Wild orchid diversity plays an important role in ecosystem health (as an indicator), genetic discovery, and climate resilience (Rabeya et al., 2026). Functioning as important

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ecological indicators, wild orchids contribute to the maintenance of complex food webs (Ticktin et al., 2023). Their highly specialized life cycles, which depend on specific mycorrhizal fungi and specialized pollinators, make wild orchids particularly vulnerable to environmental changes. Consequently, their presence reflects a healthy and biodiverse ecosystem, whereas population declines may indicate broader ecosystem degradation. The occurrence of 12 orchid species indicates that teak trees provide suitable phorophytes. Besides light availability, bark texture, branch architecture, moisture retention, and epiphytic bryophyte development are likely to facilitate orchid seed germination and establishment. Based on this condition, the conservation of wild orchids in teak stands is not only aimed at the orchid population, but also at the natural vegetation that provides a substrate for the growth of epiphytic orchids and local biodiversity that interacts with orchids.

CONCLUSION AND SUGGESTIONS

Teak stands in Magelang Regency provide suitable habitats for epiphytic wild orchids, supporting 12 species from nine genera with moderate species diversity and relatively high species evenness. Morphological characterization revealed substantial interspecific variation, highlighting the importance of these orchid populations as valuable germplasm resources for future conservation and breeding programs. These findings demonstrate that teak stands can contribute to biodiversity conservation outside formal protected areas. Future studies should integrate molecular analyses with morphological characterization to better resolve genetic relationships among species, while long-term monitoring and habitat management are recommended to maintain orchid populations and minimize the impacts of environmental change and human disturbance.

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