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Exploration and Characterization of Host Trees and Orchid Epiphyte Zones in Lore Lindu National Park, Central Sulawesi

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ABSTRACT

Host trees are vital for the survival of epiphytic orchids, providing necessary light and air circulation for optimal growth. Large trees with tall canopies contribute to the broader distribution of epiphytic orchids in forest areas. This research aimed to identify the characteristics of orchid host tree species in Lore Lindu National Park, considering both elevation zones and orchid growth zones. The research was conducted at various locations within the park, employing the field exploration survey method (cruise method). This method involved comprehensive exploration at each research site and establishing observation paths along pioneer lines, mainly where orchid host trees were found. The findings indicate the presence of 20 types of orchid host trees and 35 species of epiphytic orchids. The basal branching zone (Zone 3) was the most populated by epiphytic orchids on host trees, and the lowland forest was the elevation zone where most orchid host trees were found in Lore Lindu National Park, Central Sulawesi.

1. Introduction

Central Sulawesi, a province in Indonesia located on the island of Sulawesi, is renowned for its rich biodiversity within the Wallacea bioregion, an area unique for its endemic flora and fauna (Lohman et al. 2011; Munawir et al. 2022). This region has also been recognized as one of the global biodiversity hotspots (Shahabuddin et al. 2005). Notably, the island of Sulawesi has been the site for the discovery of numerous new plant species, as evidenced by various studies (Ardi et al. 2019; Atkins and Kartonegoro 2021; Brambach et al. 2016; Henderson et al. 2018; Kartonegoro and Potter 2014). Additionally, active research has focused on the Zingiberaceae taxon in Sulawesi, including aspects of its utilization (Ardiyani et al. 2017; Pitopang et al. 2019; Poulsen and Docot 2019; Ramadanil et al. 2019).

Lore Lindu National Park (LLNP), situated in the heart of Wallacea, is a conservation area in Central Sulawesi with a high level of biodiversity (Munawir et al. 2022). However, the diversity of epiphytic orchid species in this area has not been fully revealed. Some reports, as described by Pitopang (2012), indicate the presence of various epiphytic orchid species and their unique habitats. Human activities, such as forest conversion to plantation areas and encroachment, pose a severe threat to the sustainability of these habitats and the native orchid populations (Assédé et al. 2018; Pitopang and Ramawangsa 2016; Tang et al. 2023). Approximately 25,000 epiphytic orchid species, with 70% residing on host trees (phorophytes), require specific conditions for survival,

such as optimal light and air circulation (Wagner et al. 2015). Wagner et al. (2015) found that epiphytic orchids are often found on host trees with uneven, rough, and cracked bark textures and added that the forest's physical characteristics and microclimatic conditions influence the presence and distribution of epiphytic orchids.

Knowledge about the dominant orchid species in Lore Lindu National Park has been studied through previous research identifying the diversity of epiphytic flora in the area. The study by Fahlil et al. (2018) on the Inventory of Orchid Species Around Lake Kalimpaa in the Central Sulawesi Lore Lindu National Park area did not delve deeply into the ecological interactions between orchids and their surrounding environment, including the distribution patterns of orchids and environmental factors affecting their presence. This research identified 21 orchid species in Sedoa Village, Lake Kalimpaa area of Lore Lindu National Park, with 15 epiphytic species and six terrestrial genera covering Agrostophyllum to Rhomboda.

Another study by Pemba et al. (2015) on the diversity of orchid species in the Lore Lindu National Park, Mataue Village, successfully identified 17 epiphytic orchid species and four terrestrial orchid species, with *Cymbidium ensifolium* dominating the orchid population found. This research discusses the diversity of orchid species in the Protected Forest Area of Lake Lindu, Central Sulawesi, focusing on distribution, uniformity, species diversity, endemic species, dominance, and abundance of orchid species as well as the potential of orchids as a source of biodiversity. The research method involved vegetation analysis using the transect method to observe the orchid species. The results showed 40 orchid species from 577 identified individuals, with *Spathoglottis plicata* and *Arundina bambusifolia* being the dominant species (Nasrun et al. 2019).

While this research provides valuable insights into the diversity of orchids in the area, several shortcomings need to be addressed for future research development. One is the lack of detailed information on the ecological interactions between orchids and their surrounding environment, such as the distribution patterns of orchids and the environmental factors affecting their presence. Additionally, comparisons of each elevation zone where orchids grow, measurements of environmental factors supporting the growth of host trees and orchid species, and visualization through images of host trees and orchids should also be considered to strengthen research analysis.

Subsequent studies on the relationship between epiphytic orchids and their host trees in the Sulawesi region have provided critical insights into biodiversity and unique ecological interactions among these species. Febriliani et al. (2013) aimed to analyze the vegetation habitat of orchids around Lake Tambing in Lore Lindu National Park, covering orchid vegetation from seedling to tree level but not comparing elevation zones, environmental factors, orchid types, or displaying host tree and orchid images. Mariyanti et al. (2015) studied the characteristics of orchid host trees in the Pangi Binangga Nature Reserve, aiming to identify host tree and orchid types and their growth zoning. While sharing a focus on orchid host trees, differences lie in the research locations and the inability to compare elevation zones, environmental factors, and orchid types. Additionally, Murtiningsih et al. (2016) sought to identify natural orchid species and their diversity in Lore Lindu National Park, documenting 18 orchid species and measuring the importance value index (IVI) to determine orchid diversity, focusing only on sunlight intensity without specific percentages.

One recommended approach to preserve and prevent the extinction of orchids is documenting various types of orchid host trees, as proposed by (Brundrett 2020). This step is crucial before the orchids and their host trees disappear entirely from their natural habitats, as highlighted by (Swarts and Dixon 2009).

Based on previous research, this study aims to identify and explore the characteristics of orchid host trees in Lore Lindu National Park, focusing on host tree species, habitat, and orchid distribution. The research provides insights into natural orchid host trees and their relationship with the surrounding environment to support conservation efforts. This study adds to previous research by detailing the distribution of orchid host trees based on elevation zones, the distribution of epiphytic orchids relative to their hosts based on growth zones in the host trees, and identifying environmental factors such as temperature, light intensity, and humidity. Additionally, this study presents an inventory of host trees and orchids as part of conservation efforts, aiming to prevent extinction and provide information on orchid species in Lore Lindu National Park, significantly contributing to the understanding and preserving of biodiversity.

2. Materials and Methods

2.1. Research Location

This research was conducted in Lore Lindu National Park, located in the region Sigi Regency and Poso Regency, Central Sulawesi Province. The research location map can be seen in **Fig. 1**. The research sites were spread across different altitudinal zones: lowland forest, lower mountain forest, mountain forest, and upper mountain forest. The elevation information for each altitude in Lore Lindu National Park refers to the study by Pitopang (2012). Details of the altitude zones at the research site can be seen in **Table 1**.

Table 1. Distribution of elevation zones in Lore Lindu National Park

No	Elevation Zone	Elevation (masl)
1	Lowland forest	200–900
2	Lower montane forest	1,000–1,500
3	Montane forest	1,500–2,000
4	Upper montane forest	2,000–2,600

2.1.1. Research methodology

This study used a field exploration survey (cruise method), where the research team systematically explored and documented each area under study (Tapilatu et al. 2021). This was done by creating observation lanes 1,500 m long and 10 m wide, divided into two sides, left and right, each 5 m wide. The total observation area for each path is 15,000 m^2 or 1.5 ha. This method is called the transect method, one of the sampling methods for plant community analysis (Indriyanto 2006). Four plots were created in each elevation zone, each representing a different type of orchid host tree. This resulted in a total observation area of 60,000 m^2 or 6 ha for the entire research location. The observation trails were positioned along pioneer lines, mainly where orchid host trees were found. The map of the area and layout of the observation plots can be seen in **Fig. 1**. Additionally, the map and layout of the research observation plots are illustrated in **Fig. 2**.

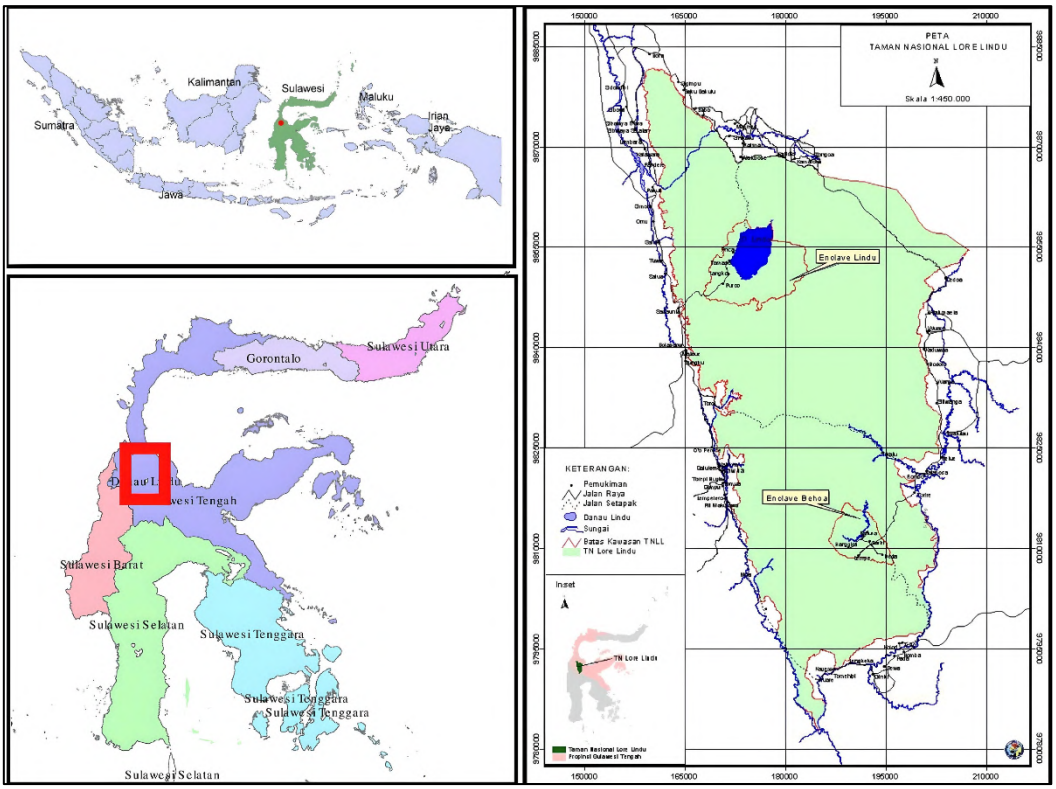


Fig. 1. Research and observation locations in Lore Lindu National Park.

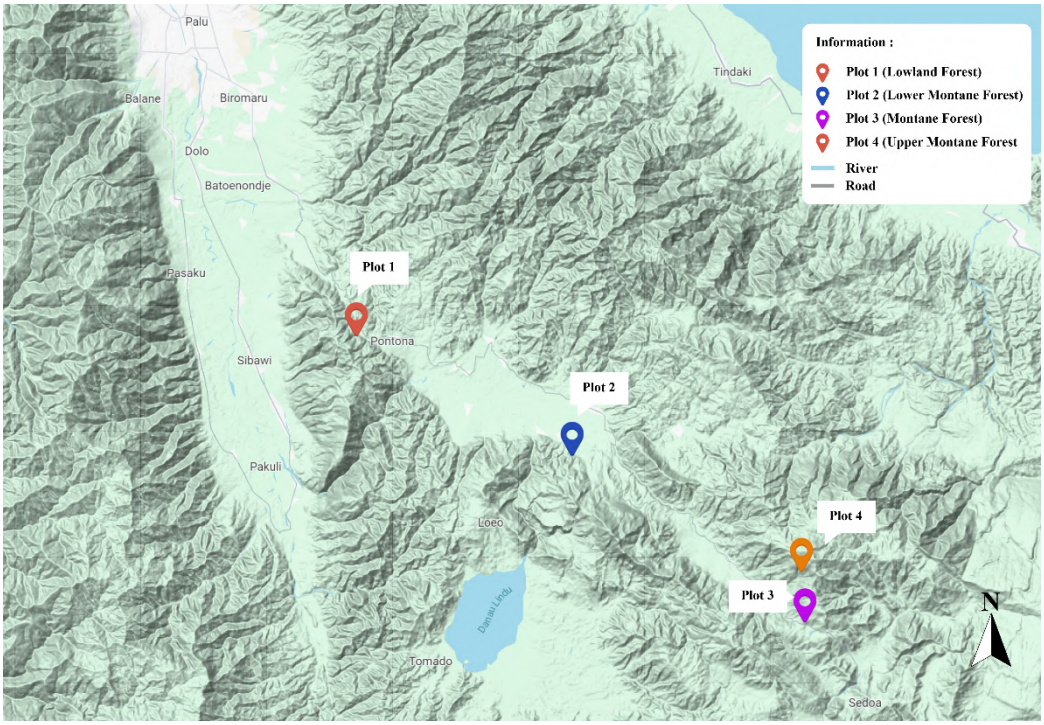


Fig. 2. Map and layout of research observation plots.

Observation plot coordinates provided precise geographic locations for the study sites. These coordinates are critical to accurately identify the specific environmental context of our observation plots in different elevation zones. For more detailed information regarding the coordinates of each research observation plot (**Table 2**).

Table 2. Observation plots coordinate

Plot No.	Observation Plot (Elevation Zone)	UTM Coordinates		Geographic Coordinates (DMS)	
		S	E	S	E
1	Lowland forest	832730 m	9875833 m	01°07'18.6"	119°59'21.7"
2	Lower montane forest	181807 m	9866682 m	01°12'16.8"	119°08'27.8"
3	Montane forest	200109 m	9853613 m	01°19'22.6"	120°18'18.9"
4	Upper montane forest	199813 m	9857742 m	01°17'08.2"	120°18'09.4"

Epiphytic orchids grow on host trees that are divided into different zones. Based on the specific characteristics and conditions of each part of the host tree, the growing area of this orchid is divided into five different zones (Trimanto and Danarto 2020). The illustration of the division of altitude zones for orchid host trees can be seen in **Fig. 3**.

- Zone 1: the area covering the tree's base, ranging from 0 to 3 m (adjusted according to the tree's proportions)
- Zone 2: the area including the tree's main trunk up to the first branching
- Zone 3: the area covering the basal part of the branching (or 1/3 of the total length of the branch)
- Zone 4 covers the middle part of the branching (or the next 1/3 of the branch)
- Zone 5: the outermost part of the branching (or the outermost 1/3 of the branch).

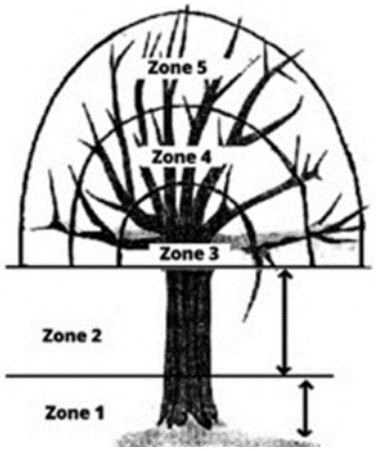


Fig. 3. Division of orchid host zones (Cahyanto et al. 2018).

The researchers compared the classification of each orchid species using images and references from previous research (Murtiningsih et al. 2016; Pemba et al. 2015). Additionally, researchers utilize several books to compare the pictures of orchids found (Puspitaningtyas 2003). Moreover, findings from this study are compared with reference specimens available at the Herbarium Celebense (CEB) at Tadulako University (Pitopang et al. 2011). The division of elevation zones, tree height, and growth zones is based on the study by (Pitopang 2012). For environmental data collection, direct habitat-based data collection was conducted using measurement and recording techniques, including humidity, temperature, sunlight intensity, altitude, latitude, and longitude. Humidity and temperature were measured using a thermohygrometer. Sunlight intensity was measured using a lux meter. A Global Positioning System (GPS) device measured altitude, latitude, and longitude.

3. Results and Discussion

This research successfully identified 20 types of orchid host trees across various elevation zones and 35 species of epiphytic orchids across host trees in Lore Lindu National Park. The findings of this study will be discussed in three subsections: firstly, the characteristics of epiphytic orchid host trees based on the growth zones on the host trees; secondly, the characteristics of epiphytic orchid host trees based on elevation zones, including lowland forest, lower montane forest, montane forest, and upper montane forest and lastly, a database catalog of epiphytic orchid host trees found in Lore Lindu National Park.

3.1. Orchid Host Tree Characteristics Based on Orchid Growth Zones

This section focuses on the characteristics of epiphytic orchid host trees and the distribution of different orchid types in each host tree zone (**Table 3**).

Table 3. Relationship between host trees, orchid species, and growth zonation

No.	Host tree		Family	Orchid species name	Host tree zone	Temp. (°C)	LI (%)	RH (%)
	Species name	Local name						
1	*Palaquium quercifolium* (de Vriese) Burck	Kume batu, wana	Sapotaceae	*Appendiculata congenera* BL	Zone 2	23	30.2	91
				Coelogyne asperata Lindl	Zone 3			
				Dendrobium fibriatum Hook	Zone 3			
				Lipais latifolia	Zone 1			
				Podochillus microphyllum	Zone 2			
2	*Castanopsis acuminatissima* (Blume) Rehder	Haleka	Fagaceae	*Bulbophyllum echinolabium*	Zone 3	19	10	85
				Aerides odoratum Lour	Zone 2			
				Eria hyacinthoides	Zone 1			
				Eria retusa	Zone 1			
				Lipais pallida Blume Lindl	Zone 1			
3	*Artocarpus teysmannii* Miq	Teturu	Moraceae	*L. latifolia* Blume Lindl	Zone 1	14	10	83
4	*Podocarpus neriifolius* D.Don	Korongia	Podocarpaceae	*Eria floribunda*	Zone 2	14.1	10	88
				Eria hyacinthoides Lindl	Zone 2			
				Eria multiflora Lindl	Zone 3			
				Trichotosia velutina Lodd Ex Lindl	Zone 3			
5	*Pandanus sarasinorum* Warb	Pandan hutan	Pandanaceae	*Cymbidium lancifolium* Hook	Zone 1	18.6	29.7	92
				Cymbidium finlaysonianum Lindl	Zone 3			
				E. Bogorensis J.J.Sm	Zone 3			
6	*Syzygium acuminatissimum* (Blume) DC	Tombe	Myrtaceae	*B. lobbii Lindl*	Zone 1	22.6	36	86
				D. Staratiotes Rchb.f	Zone 3			
				Cymbidium roseum L.SW	Zone 3			

7	*Melicope latifolia* (DC) T.G. Hartle	Korio	Rutaceae	*Liparis viridiflora* Bl. Lindl	Zone 3	14	10	90
8	*Agathis dammara* (Lamb.) Rich.& A. Rich	Damar	Araucariaceae	*D. platygastrum* Rchb.f *Pholidota imbricate* W.J	Zone 3 Zone 2	24	10	93
9	*Alsophila celebica* (Blume) Mett.	Pakis	Cyatheaceae	*Agrostophyllum majus* J.J.Sm *D. Secundum* (Bl.)Lindl	Zone 2 Zone 1	23	22	84
10	*Neonauclea intercontinentalis* Bakh.f. Ridsdale	Lebanu	Rubiaceae	*Agrostophyllum majus* J.J.Sm	Zone 2	19	22	92
11	*Homalanthus populneus* (Geissler) Pax	Belanti	Euphorbiaceae	*Bulbophyllum biflorum* Teijsm	Zone 3	15	10	91
12	*Aleurites moluccana* (L.) Willd	Kemiri	Euphorbiaceae	*Lusia* sp.	Zone 3	23	10	84
13	*Phoebe grandis* (Nees) Merr.	Pasabo	Lauraceae	*D. reflexitepalum* J.J.Sm	Zone 3	25	29.7	78
14	*Gomphandra mappioides* Valeton	Lowaq	Stemonuraceae	*D. reflexitepalum* J.J.Sm	Zone 3	25	29.7	78
15	*Schefflera nodosa* F.M. Mull	Birako	Araliaceae	*D. crumenatumm* SW	Zone 3	23	22.1	78
16	*Antidesma montanum* Blume	Pampawu	Euphorbiaceae	*Eria retusa* B.L.	Zone 2	23.2	22.1	74
17	*Elaeocarpus celebicus* Koord.	Ame	Elaeocarpaceae	*Grammathophyllum stapelliflorum* J.J.S	Zone 3	18.6	10	84
18	*Eryhrina subumbrans* (Hasskrl) Merr	Kamurogo	Fabaceae	*Phalaenopsis celebiensis* B.L	Zone 3	26	45	78
19	*Lithocarpus celebicus* (Miq.) Rehder	Palili	Fagaceae	*Dendrobium macrophyllum* A.Rich	Zone 3	25	29.7	78
20	*Carallia brachiata* (Lour.) Merr.	Parapa	Rhizophoraceae	*D. luteocilium* Rupp	Zone 3	29.7	25	78

Notes: Temp.= temperature, LI = light intensity, RH = relative humidity.

Based on **Fig. 4**, the growth zonation of epiphytic orchids on the host tree illustrates that zone 3 is the dominant growth site for orchids. Zone 3 covers the basal part of the branching. Twenty orchid species grew on host trees in zone 3 (**Table 3**). Sixteen types of host trees were found (**Table 3**). The basal part of the branching is a cell located on the outermost part of the skin (epidermis), which is peeled off the horizontal shape to facilitate the growth of orchids. Tree branches are more in shade zone 3 it is not too high up, so they are not exposed to direct sunlight (moderate light intensity) and are sufficiently exposed to the wind so that moisture is maintained, with the horizontal shape of the branch allowing it to maintain more water capacity.

Zone 2 is the area of the tree's main trunk up to the first branching. Nine species of host trees were overgrown with nine epiphytic orchids (**Table 3**). Likewise, in zone 2, the physical condition of the bark is generally a large diameter tree, hollow bark, rough and fissured bark surface that can retain water and allow orchid seeds to proliferate. The rough, scaly texture of the bark can affect the attachment of seeds and the ability to retain water that can support seed germination.

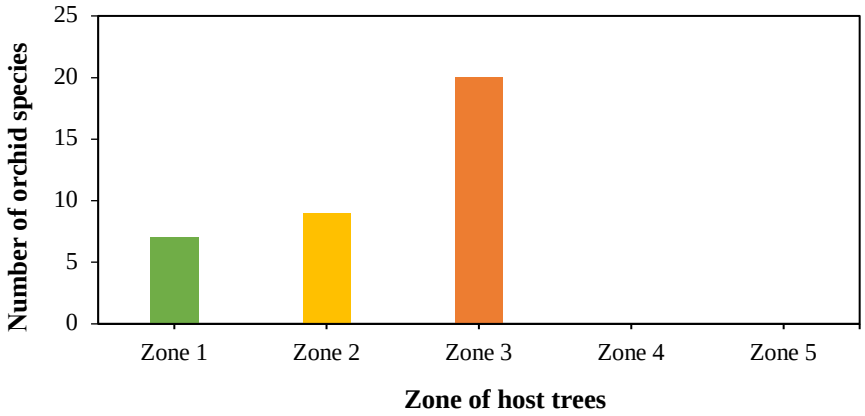


Fig. 4. Diagram zonation of orchids on host trees.

Zone 1 is an area that covers the base of the tree. Seven epiphytic orchid species grew on seven host tree species in host zone 1 (**Table 3**). Tree characteristics in zone 1 are generally similar to those in zone 2. Trees with relatively large diameters tend to be more overgrown with epiphytic orchids because of their ability to hold litter, ability to store rainwater in more significant quantities, more excellent nutrients, and more shaded by tree branches, allowing the decomposition of various types of litter and dust that can provide benefits for epiphytic orchid growth.

Based on **Table 3**, the average temperature for orchid host trees is 21.36°C, reflecting the predominantly warm conditions of their habitats. The lowest recorded temperature is 14°C for *Artocarpus teysmanii* Miq and *Melicope latifolia* (DC) T.G. Hartle, indicating that some orchid species can survive in more relaxed environments. Conversely, the highest temperature recorded is 29.7°C for *Carallia brachiata* (Lour.) Merr suggests that some host trees reside in areas with higher temperatures, possibly at lower elevations or locations receiving direct sunlight.

The average light intensity is 17.69%, highlighting the varied lighting conditions in these orchid habitats, with some areas under dense canopies receiving less light. The lowest value for light intensity is 10%, found in multiple host tree species, which suggests orchids are adapting to low-light conditions. Meanwhile, the highest light intensity is 45% for *Eryhrina subumbran* (Hasskrl) Merr, indicating that orchids on this host tree are exposed to more light, possibly due to more open positioning or less dense canopies.

The average humidity in these environments is 84.25%, confirming that orchid host trees generally exist in moist conditions, preferred by epiphytic orchids. The lowest humidity is 74% for *Antidesma montanum* Blume, which is still above the threshold supportive for most orchids. The highest recorded humidity is 93% for *Agathis dammara* (Lamb.) Rich. & A. Rich, indicating a very supportive microclimate with high moisture levels for epiphytic orchids.

Based on the conducted research on Host Trees and Growth Zonation, it has been observed that orchids are capable of living and adapting from lowlands, lower montane forests to upper montane forest areas (at elevations of 824 to 2,300 meters above sea level (masl), with temperatures ranging from 14 to 33°C, sunlight intensity between 10 to 36%, and humidity ranging from 82 to 93%). Lore Lindu National Park, across four observation areas, including lowland areas, lower montane forests, montane forests, and upper montane forests, exhibits high humidity ranging from 73 to 94% with relatively low temperatures of 14 to 33°C. These conditions allow orchids and their host trees to thrive and develop excellently.

Host tree is one of the basic needs of epiphytic orchids to get light and good air circulation, retain water, and allow orchid seeds to be easily stuck (Prapitasari and Kurniawan 2021; Wagner et al. 2015; Zarate-García et al. 2020). Host tree species can influence the vital rates and long-term population dynamics of orchids (Ramírez-Martínez et al. 2022). However, due to differences in host traits, not all trees offer the same conditions for establishing and developing epiphytic orchids (Wagner et al. 2015). Rough bark texture can affect seed capture; rough and scaly bark can favor seed adherence compared to smooth bark (Gowland et al. 2013; Hernández-Pérez et al. 2018; Timsina et al. 2016), as well as the ability to retain and release water that can favor seed germination, bark with higher water retention capacity and slower release rate strongly favors seed germination (Einzmann et al. 2015). Similarly, allelopathic compounds in the bark can limit seed germination and epiphyte establishment (Harshani et al. 2014).

The four regions observed showed that the host tree species *Palaquium quercifolium* (de Vriese) Burck family *Sapotaceae* and *Castanopsis acuminatissima* (Blume) Rheder. Family Fagaceae is a host tree species mainly occupied by epiphytic orchid species. Epiphytic orchids were generally found in zones 3, 2, and 1 (**Table 3**). This is because the physical condition of the bark is usually hollow bark soft, rough, and slit surfaces so that it can hold water and allow orchid seeds to easily (Martiansyah et al. 2022; Trimanto and Danarto 2020). Furthermore, individual orchid trees are phorophytes or trees that can be used as hosts to accommodate the most significant number of individual orchids. The most considerable abundance of epiphytic orchids is found in the basal and middle branches of the host tree, namely in zone 3 (Martiansyah et al. 2022).

Host trees with relatively large diameters tend to harbor more epiphytic orchids (Zotarelli et al. 2019), attributed to their capacity to retain leaf litter, store a more significant amount of rainwater, provide more nutrients, and offer more shade due to their extensive branching. These conditions facilitate the decomposition of various types of leaf litter and dust, which benefits the growth of epiphytic orchids. Studies indicate that the bark of phorophytes (host trees), predominantly found in subtropical and tropical regions, contributes to the unique characteristics of host tree bark, especially in adapting to complex terrestrial ecosystems (Borrero et al. 2022). In the microenvironment of epiphytes, interacted opportunities (tree bark containing cellulose) are utilized by most trees as epiphytic hosts, showing that epiphytes are more commonly found on trees with denser bark. Variations in environmental factors within the tree canopy reflect the microclimatic conditions necessary for epiphytes in specific situations (Rosa-Manzano et al. 2014). At least two characteristics of host trees contribute to the habitats of epiphytic orchids: first, the height of certain host trees, which can serve as shelters for numerous epiphytic orchids, and second, the diameter (DBH) of the host trees (Cedric et al. 2021).

Previous research has revealed similarities and differences in orchid species and their hosts across various study locations within Central Sulawesi and beyond (Murtiningsih et al. 2016). Common host trees include Palili (*Lithocarpus* sp.). Conversely, distinct host trees, such as Enau, Bula, Hulata, Wukeimbu, Butohuloku, tree ferns, Banyan, Belobo, and Pomaria, have been identified. For orchids, the same species found were *Dendrobium Crumenatum* Sw., *Eria* sp., *Coelogyne asperata* Lindl., *Agrostophyllum majus* J.J.Sm., *Podochilus microphyllus* Lind., *Grammatophyllum stepeliiflorum* J.J.S., *Aerides odorata*, and *Dendrobium macrophyllum*. Different species included *Liparis lacerata*, *Vanda* sp., *Vanda arculata*, *Bulbophyllum* sp., *Dendrochyllum* sp., and *Coelogyne foerstermanni* Rchb.f.

Similar orchid species to this research were found: *Cymbidium finlaysonianum* Wall. ex Lindl., *Luisia* sp., *Bulbophyllum* sp., *Liparis* sp., *Pholidota*, *Phalaenopsis* sp., *Eria* sp., and the

differing ones were *Abdominea minimiflora* (Hook.f), *Aerides inflexa* Teijsm. & Binn, and *Apendicula* sp. (Nirwana et al. 2017).

3.2. Distribution of Host Tree Species by Elevation

This sub-chapter will discuss the distribution of orchid host tree species in various altitude zones in Lore Lindu National Park. Details of host tree characteristics based on altitude zones in Lore Lindu National Park (**Table 4**).

Table 4. Distribution of host tree species by elevation

No	Species of host tree		Family	Elevation (m asl)	Elevation Zone
	Species name	Local name			
1	*Palaquium quercifolium* (de Vriese) Burck	Kume batu, wana	Sapotaceae	895.11	LF
				1,014.60	LMF
				1,760.22	MF
				2,061.19	UMF
2	*Castanopsis acuminatissima* (Blume) Rehder	Haleka	Fagaceae	1,660.25	MF
				1,847.19	UMF
3	*Artocarpus teysmannii* Miq	Teturu	Moraceae	1,788.83	MF
				2,061.19–2,158.04	UMF
4	*Podocarpus neriifolius* D.Don	Korongia	Podocarpaceae	1,652.36–1,674.34	MF
				2,010.92	UMF
5	*Pandanus sarasinorum* Warb	Pandan hutan	Pandanaceae	895.11	LF
				1,760.22	MF
				2,061.19	UMF
6	*Syzygium acuminatissimum* (Blume) DC	Tombe/gora hutam	Myrtaceae	836.69–990.09	LF
7	*Melicope latifolia* (DC) T.G. Hartley	Korio	Rutaceae	2,061.19–2,300.56	UMF
8	*Agathis dammara* (Lamb.) Rich.& A. Rich.	Damar	Araucariaceae.	2,061.19	UMF
9	*Alsophila celebica* (Blume) Mett	Pakis	Cyatheaceae	857.08–986.46	LF
				1,652.38–1,668.99	MF
10	*Neonauclea intercontinentalis* Bakh.f. Ridsdale	Lebanu	Rubiaceae	823.64–824.98	LF
				832.49–1,668.99	MF
11	*Homalanthus populneus* (Geissler) Pax	Belanti	Euphorbiaceae	852.00	LF
				1,014.60	LMF
				2,010.58–2,010.92	UMF
12	*Aleurites molucana* (L.) Willd	Kemiri	Euphorbiaceae	1,014.60	MF
13	*Phoebe grandis* (Nees) Merr	Pasabo	Lauraceae	1,666.29–1,760.22	MF
14	*Gomphandra mappioides* Valeton	Lowaq	Stemonuraceae	895.11	LF
15	*Schefflera nodosa* F.M. Mull	Birako	Araliaceae	823.64	LF
16	*Antidesma montanum* Blume	Pampawu	Euphorbiaceae	964.09	LF
17	*Elaeocarpus celebicus* Koord	Ame	Elaeocarpaceae	895.11	LF
18	*Eryhrina subumbrans* (Hasskrl) Merr	Kamurogo	Fabaceae.	986.40	LF
19	*Lithocarpus celebicus* (Miq.) Rehder	Palili	Fagaceae	858.08–986.46	LF
20	*Carallia brachiata* (Lour.) Merr	Parapa	Rhizophoraceae	858.08	LF

Notes: LF = lowland forest, LMF = lower montane forest, MF = montane forest, UMF= = upper montane forest.

Based on (**Fig. 5**), the distribution of orchid host trees is widespread in the lowland forest area at elevations ranging from 823.64 to 895.11 masl. Thirteen types of host trees were identified in this area (**Table 4**). *Palaquium quercifolium* (de Vriese) is a species that spreads and grows well

in entire elevation zones. It is typically found in lowland forests. *P. quercifolium*is a cosmopolitan tree species capable of living in various regions under diverse environmental conditions.

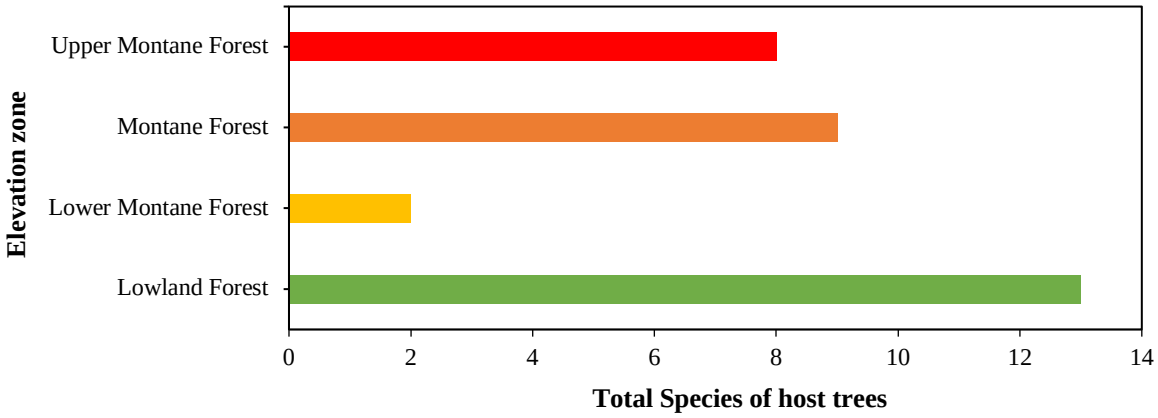


Fig. 5. Distribution of host tree species by elevation.

Two host tree species were found in the lower montane forest area at 1,014.60 masl (**Table 4**). *P. quercifoliumis* and *Homalanthus populous* (Geissler) Pax. *H. populous* is a plant in lowland to high montane forest regions. Its distribution includes Thailand, the Malaysian Peninsula (Sarawak, Sabah), Indonesia (Sumatra, Java, Lesser Sunda Islands, West Kalimantan, East Kalimantan, South Kalimantan, Sulawesi, Maluku, Papua), and Brunei (Culmsee et al. 2011; Hiratsuka et al. 2006).

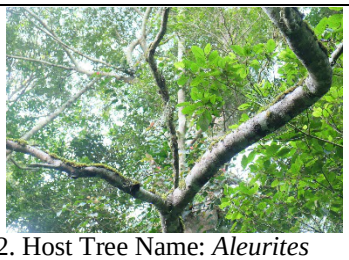
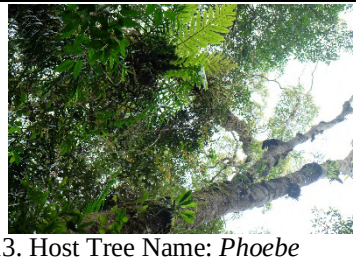
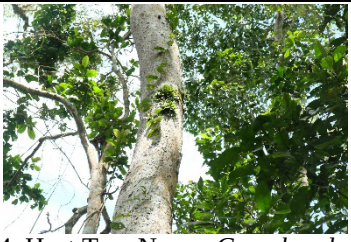
Nine host trees were found in the montane forest area (**Table 4**) at 1,014.60–1,788.83 masl. *P. quercifoliumis* and *Podocarpus neriifolius* D.Don are two host tree species that can adapt across four elevations. *H. populous* and *Pandanus sarasinorum* Warb are also adaptable, up to 2,010.92–2,061.19 masl (upper montane forest). These host trees are distributed in areas such as Kalimantan, Java, Lesser Sunda Islands, Malaysia, Maluku, the Philippines, Sulawesi, Sumatra, and Thailand (Hiratsuka et al. 2006; Wirasisya and Hohmann 2023).

Castanopsis accuminatisima (Blume) Rehder is growing at 1,660.25–1,847.19 masl. This species typically grows in montane forests at elevations 300–2,500 masl (Robiansyah 2018). In Sulawesi, it predominantly grows in montane forests around 1,100 masl, and it is also prevalent in northern Thailand at 1,300–1,450 masl (Marod et al. 2022). In the upper montane forest, eight types of host trees were found (**Table 4**) at 1,847.19–2,300.56 masl. Seven host tree species were found in habitats at elevations above 2,010.58–2,300.56 masl, and one host tree species, *C. accuminatisima* was found at an elevation of 1,847.19 masl.

3.3. *Database Catalog of Epiphytic Orchid Host Trees*

To support conservation efforts and prevent the extinction of orchids, one initiative undertaken is the creation of a visual catalog (**Table 5**) that displays various images of host trees along with their names, specifically for epiphytic orchids found in Lore Lindu National Park. This catalog provides a visual overview and information about the host tree and orchid species, which is highly beneficial for orchid conservation activities in the region. It offers a visual and informational perspective on host tree species, significantly aiding the conservation efforts for orchids in the area.

Table 5. Catalog database of epiphytic orchid species and host trees in Lore Lindu National Park

 1. Host Tree Name: *Palaquium quercifolium* (de Vriese) Burck; Orchid Name: *Dendrobium fibriatum* Hook; Zone: 3	 2. Host Tree Name: *Castanopsis acuminatissima* (Blume) Rehder; Orchid Name: *Liparis pallida* Blume Lindl; Zone: 1	 3. Host Tree Name: *Artocarpus teysmannii* Miq; Orchid Name: *Liparis latifolia* Blume Lindl; Zone: 1
 4. Host Tree Name: *Podocarpus neriifolius* D.Don; Orchid Name: *Trichotosia velutina* Lodd Ex Lindl; Zone: 2	 5. Host Tree Name: *Pandanus sarasinorum* Warb; Orchid Name: *Cymbidium lancifolium* Hook. E; Zone: 1	 6. Host Tree Name: *Syzygium acuminatissimum* (Blume) DC; Orchid Name: *Bulbophyllum lobbii* Lindl; Zone: 1
 7. Host Tree Name: *Melicope latifolia* (DC.) T.G. Hartley; Orchid Name: *Liparis viridiflora* Bl. Lindl; Zone: 3	 8. Host Tree Name: *Agathis dammara* (Lamb.) Rich. & A. Rich; Orchid Name: *Pholidota imbricata* W.J; Zone: 2	 9. Host Tree Name: *Alsophila celebica* (Blume) Mett; Orchid Name: *Dendrobium scundum* (Bl.) Lindl; Zone: 1
 10. Host Tree Name: *Neonauclea intercontinentalis* Bakh.f. Ridsdale; Orchid Name: *Agrostophyllum majus* J.J.Sm; Zone: 2	 11. Host Tree Name: *Homalanthus populneus* (Geissler) Pax; Orchid Name: *Bulbophyllum biflorum* Teijsm. ex Lindl; Zone: 3	 12. Host Tree Name: *Aleurites mollucana* (L.) Willd; Orchid Name: *Lusia* sp.; Zone: 3
 13. Host Tree Name: *Phoebe grandis* (Nees) Merr.; Orchid Name: *D. reflexitepalum* J.J.Sm; Zone: 3	 14. Host Tree Name: *Gomphandra mappioides* Valeton; Orchid Name: *D. reflexitepalum* J.J.Sm; Zone: 3	 15. Host Tree Name: *Schefflera nodosa* F.M. Mull; Orchid Name: *D. crumenatumm* SW; Zone: 3

 16. Host Tree Name: *Antidesma montanum* Blume; Orchid Name: *Eria retusa* B.L. D.usa B.L. D; Zone: 2	 17. Host Tree Name: *Elaeocarpus celebicus* Koord; Orchid Name: *Grammathophyllum stapelliflorum* J.J.S; Zone: 3	 18. Host Tree Name: *Eryhrina subumbrans* (Hasskrl) Merr; Orchid Name: *Phalaenopsis celebiensis* B.L; Zone: 3
 19. Host Tree Name: *Lithocarpus celebicus* (Miq.) Rehder; Orchid Name: *Dendrobium luteocilium* Rupp; Zone: 3	 20. Host Tree Name: *Carallia brachiata (Lour.)* Merr.; Orchid Name: *Coelogyne speciosa* Lindl; Zone: 3	

4. Conclusions

The study identified 20 types of orchid host trees and 35 epiphytic orchid species in Lore Lindu National Park. The results revealed the crucial role of host trees in the existence and growth of epiphytic orchids, considering environmental factors such as temperature, light intensity, and humidity. The findings also indicated differences in orchid host types and orchid species in this area compared to others, including regions outside Central Sulawesi, providing valuable insights for conservation and further study. These results emphasized the need to protect the diversity of host trees as key to preserving the diversity of epiphytic orchids, making the data on host trees, elevation zones, and orchid distribution vital for effective conservation planning. This research is valuable for both the academic field and practical applications by park managers and stakeholders. Additionally, it is suggested that future research should focus on the potential use of epiphytic orchids as traditional medicine.

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