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Research Article

Species Diversity and Distribution of Orchids along the Sepapah Kiri Waterfall Trail, Kubu Perahu, Bukit Barisan Selatan National Park

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ABSTRACT
Indonesia is known as a country with a high diversity of orchids. Bukit Barisan Selatan National Park (BBSNP) is located along the Bukit Barisan Mountain range in the tropical rainforest heritage of Sumatera, where various natural-growing orchids can be found abundantly. This study aimed to explore and identify the orchids diversity in the Kubu Perahu Forest section of Bukit Barisan Selatan National Park. The observation was conducted along the hiking trails of Sepapah Kiri Waterfall, which has a 2.375 m length and about 568–876 masl. An exploratory method was conducted to collect primary and environmental data. A total of 16 genera were recorded, dominated by epiphytic orchids, with Agrostophyllum and Pinalia as the most abundant genera. Preservation of natural orchid species is needed by cultivation and increasing the exsitu conservation of orchids.

Keywords: *Epiphyte; Ex situ conservation; Orchids; Terrestrial.*

Introduction

Bukit Barisan Selatan National Park is the third largest conservation area in Sumatra. Bukit Barisan Selatan National Park has quite a rich biodiversity. Therefore, UNESCO designated this national park as a Heritage Site of the Tropical Rainforest Mountains Complex of Sumatra (Cluster Mountains Tropical Rainforest Heritage Site of Sumatra) together with the Kerinci Seblat National Park and the Gunung Leuser National Park (Worldwide Fund for Nature, 2014). In general, 154 types of orchids from 58 genera have been identified, with 114 types being epiphytic orchids and the other 40 types being ground orchids in the Bukit Barisan Selatan National Park area [1].

Tropical Forest Conservation Action-Sumatra explains that the Bukit Barisan Selatan National Park (BBSNP) has a land area of 365.000 hectares. The national park area covers two provinces, namely Lampung Province and Bengkulu Province (www.tfcasumatera.org). The diversity of biological resources in the Bukit Barisan Selatan National Park is very high. The results of previous research at the Balik Bukit Resort in the Bukit Barisan Selatan National Park found 10 types of *Eria* spp. such as *Eria iridifolia*, *E. erecta, E. flavescens, E. discolor, E. javanica, E. junghunii, E. mucronata, E. oblitterata, E. retusa,* and *E. robusta* [2].

In Indonesia, there are around 5.000 orchids species that can be found on all the islands in Indonesia [3]. Orchids can be found in the forests of Sumatera, Kalimantan, Papua, and Sulawesi [4]. Sumatera Island is the fifth largest island in the world, and 1118 species of orchids have been identified that grow on the island [5]. Kubu Perahu Resort is part of the Bukit Barisan Selatan National Park. The Kubu

Perahu forest area (800-900 m above sea level) is composed of the lower mountain rainforest ecosystem type.

Most orchids are found living as terrestrial plants, and some types live attached to tree trunks or epiphytes. Terrestrial orchids are often called ground orchids because they live in the soil [6]. Flora exploration activities throughout the BBSNP area are classified as very important. Peviously, the researched orchid types in the BBSNP area, especially the Balik Bukit Resort, with the discovery of 10 types of *Eria* spp [2]. This activity aims to save orchid diversity and inventory orchid species in the area. Due to the lack of a database and specific information regarding natural orchids that still exist and grow in the BBSNP area in other locations, namely on the Sepapah Kiri Waterfall climbing route, especially in Kubu Perahu, it is necessary to collect data as a source of information on preserving orchid species in the area. This research aims to explore orchid diversity in the Kubu Perahu Forest area, Bukit Barisan Selatan National Park.

Materials and Methods

The research was carried out in the utilization zone and rehabilitation zone of the BBSNP area on the Sepapah Kiri waterfall climbing route, Kubu Perahu. The research was conducted in January–April 2023. The research location is presented in Figure 1. The tools used in this research were a digital camera, GPS, lux meter, thermohygrometer, scissors, machete, plastic bags, duct tape, rubber bands, raffia rope, and writing instruments. The materials used in the research were tally sheets to record observation results, hanging labels to record plant specimen labels taken, and types of orchids found at the research location.

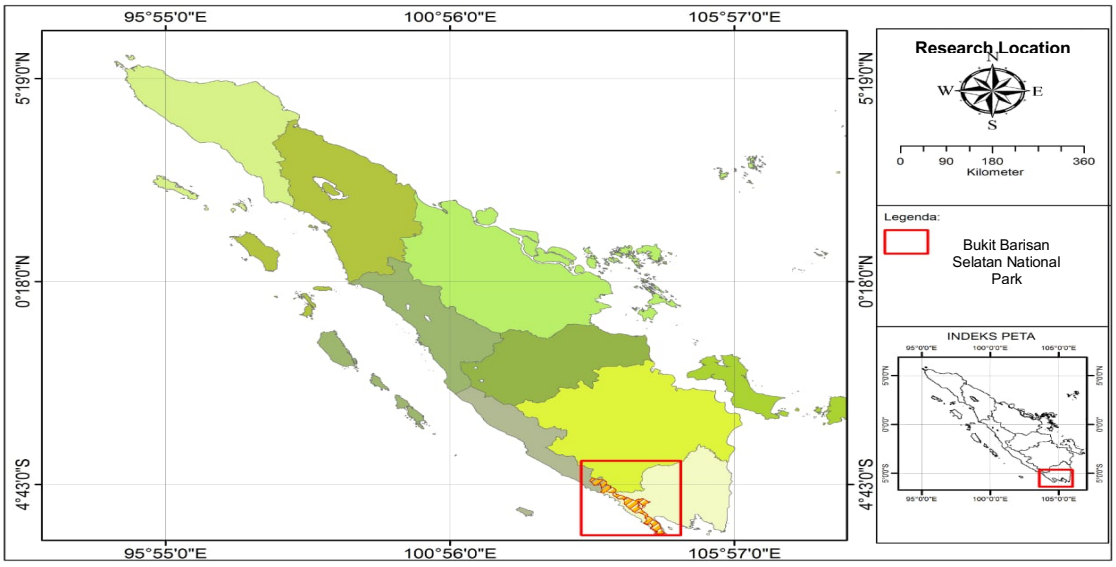


Figure 1. *Map of Research Location.*

The research method uses exploratory or exploratory methods. Along the hiking trail leading to Sepapah Kiri Waterfall, we explored and took inventory of the orchid plants found. Observations were made at each encounter [7], [8]. Data collection was carried out through exploration of orchid plants in the Kubu Perahu Forest area, which is a 2375 m long tourist route. This route was chosen because, as a tourist route, the presence of orchid plants can be an attraction for tourists. Each species found is collected, and all data about the plants collected, along with environmental data, is then recorded in a field book. The data collected includes family names, species names, habitat conditions, and morphological data. Exploration is carried out to determine the type of orchid diversity along the exploration route [9]. Suppose

there is difficulty in determining the name of the type. In that case, the results of the recording in the form of documenting the orchid types will be taken to the demonstration plot location or SPTN Kubu Perahu. Determining the genus and type of orchid is done by matching the characteristics of orchids that have been recorded from field observations [10]. Orchid species whose identities are not yet known are then made into herbarium specimens for further identification. Photographic documentation was also carried out to complement and support the data. Orchid specimen collections were identified based on vegetative morphology and flower and fruit morphology [11].

Data observed while in the field includes primary data and environmental data. Primary data taken is in the form of identification of orchid plant morphology, which consists of the shape and size of the leaves, along with the substrate or host of the orchid plant. Secondary data, which is environmental data, supports primary data obtained from various literature and literature searches as well as several other supporting data from several parties and agencies that are closely related to this research. Secondary data includes the general condition of the research location, area size, and location of the area [12].

Results and Discussion

From the research results, it can be identified that along the Sepapa Kiri waterfall climbing route in the Kubu Perahu Forest area of Bukit Barisan Selatan National Park, 28 orchid species were obtained belonging to 16 genera consisting of 2 terrestrial orchid genera and 14 epiphytic orchid genera. Epiphytic orchids are orchids that live attached to other plants as their hosts [13]. The overall orchid identification results can be seen in Table 1.

Each type of orchid has a different level and distribution pattern, so some forest areas have a diversity of different orchid species [14]. Many orchids were found not in flower, making identification difficult. Figure 1 shows that the most dominant genus is the genus *Eria* which consists of five species, namely *Pinalia erecta, Pinalia* sp.1, *Pinalia* sp.2, *Pinalia* sp.3, and *Pinalia* sp.4. Meanwhile, for the genus, only one species was found, namely *Vanda, Thrixspermum, Trichotosia, Phalaenopsis, Oberonia, Macodes, Flickingeria, Cymbidium, Appendicula,* and *Agrostophyllum*. Photos of orchid species found during the research are presented in Figures 3 to 6.

There were 14 individuals of the *Agrostophyllum bicuspidatum* orchid species, with a stem length of around 20-50 cm (Figure 2). It has a pseudo tuber type with a size of around 13-15 cm with a slightly flat shape, growing close together on a rhizome with 2 or 3 leaves. This orchid species is expected on the Sepapah Kiri waterfall climbing route, a secondary forest, and this species is classified as adaptive in environmental conditions and survives in secondary forests [15]. Trees capable of being hosts and places for orchids to grow are trees with the criteria for a host tree trunk that is flat, rough, and slightly cracked so that much dust sticks to the tree trunk. Over a long time, this dust will accumulate so that it will be splashed by rainwater, and the tree trunk will become damp. This species has terminal flowers or the position of the flower bouquet that appears at the tip of the stem. The labellum has three lobes: the lateral lobes are upright and rounded, and the lobes in the middle are rounded and wavy [16].

The orchid species from the genus *Appendicula* were eight individuals, namely *A. reflexa* This orchid species is an epiphytic orchid characterized by elongated stem size and almost reaching 1 meter, elongated ovoid leaf shape, no flowers were found during observation (Figure 2). This species was found a similar species on the southern slopes of Mount Merapi with the characteristics of flowers emerging from the side of the stem, capitulum, 10-12 flowers, and having tapered lanceolate bracts [6].

Four species were found from the genus *Bulbophyllum* (Figure 2), namely *B. pahudii, B. triflorum, B. violaceum, Bulbophyllum* sp. Nine individuals of the orchid type, *B. pahudii* were characterized by *pseudobulb* that almost resembled stems. *A. pseudobulb* is a secondary stem thickening with one or more segments that some sympodial epiphytic orchids have. This orchid is relatively rare to find in the waterfall climbing route area. At the Cani Sirenreng Nature Tourism Park (TWA) found this orchid species with an H' index of 2.85, which states that the species diversity index is classified as moderate [4].

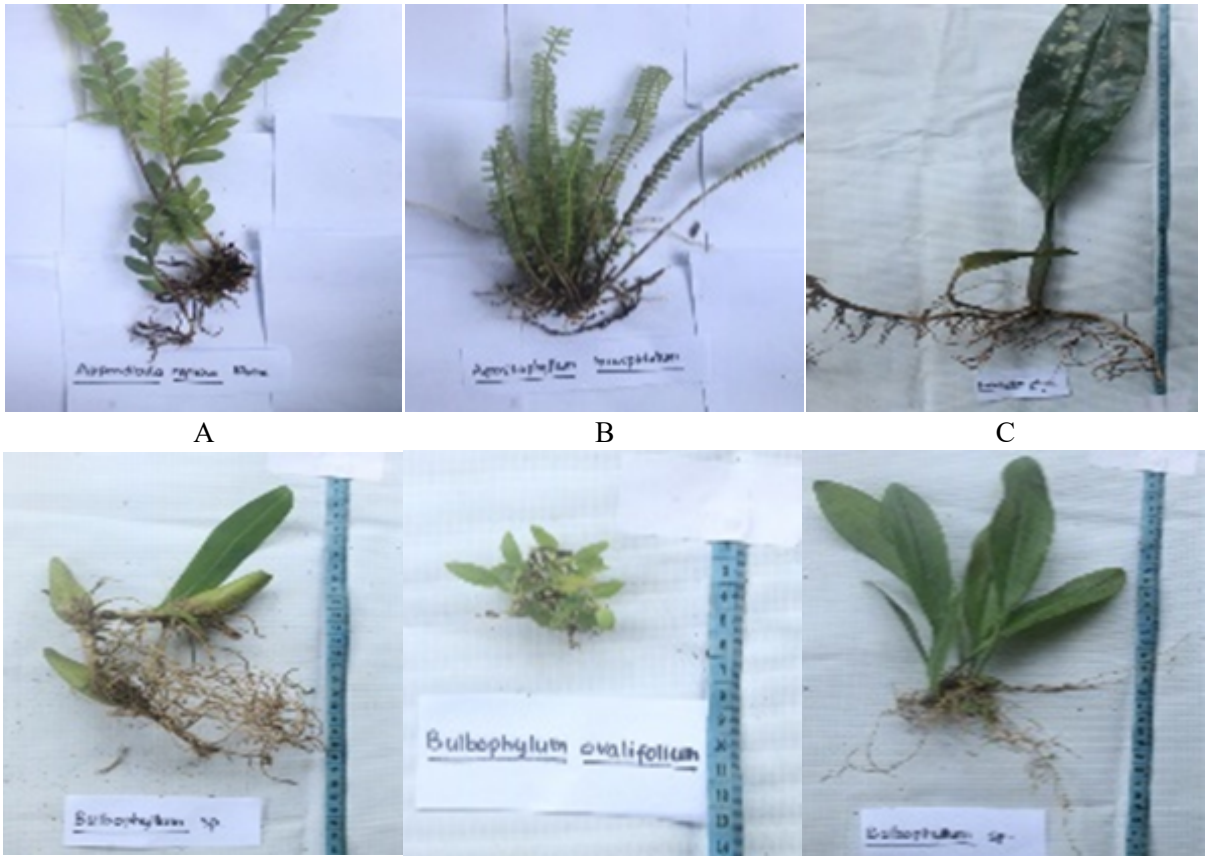


Figure 2. (A) *Agrostophylum bicuspidatum*; (B) *Appendicula reflexa*; (C) *Bulbophyllum pahudii*; (D) *Bulbophyllum triflorum*; (E) *Bulbophyllum violaceum*; and (F) *Bulbophyllum* sp.

Bulbophyllum triflorum is an epiphytic orchid species, with 5 (five) individuals found in the field with hanging or creeping stems. This type characterized by interconnected (sympodial) pseudo-tubers, stem length ranging from 1.2–50 cm with stem colors ranging from dark green, light green, to brownish green [10]. The *Bulbophyllum* genus generally has lanceolate leaves with a green to dark green color. The leaves are 10–25 cm long and 1–7 cm wide. They have a distinctive characteristic, namely that they are located on the flower labellum, which can sway; the surface of the leaves is smooth, but there are also rough edges. The leaves are flat, the leaf tips are pointed, and leaf stalks are about 1-2 cm long, but some do not have stalks [4].

The orchid species *B. violaceum* was found in 5 (five) individuals with the characteristics of the rhizome being close to the pseudobulb, the number of flowers being one or many flowers measuring around 2–8 cm on each stalk, and yellow and this species with almost uniform petal shape characteristics, with a type of size that is larger than the flower crown [4].

Table 1. Species of orchids founds in Kubu Perahu at waterfall trail Sepapa Kiri

Genus	Species	Total	Type	Host plant
Agrostophyllum	*Agrostophyllum stipulatum* subsp. *bicuspidatum* (J.J.Sm.) Schuit.	14	Epiphyte	*Bischofia javanica* Blume
Appendicula	*Appendicula reflexa* Blume	8	-	*Mangifera* sp.
Bulbophyllum	*Bulbophyllum pahudi* (de Vriese) Rchb.f.	9	Epiphyte	*Melaleuca leucadendra* (L.) L.
	Bulbophyllum triflorum (Breda) Blume ex Miq.	5		*Magnolia vrieseana* (Miq.) Baill. Ex Pierre
	Bulbophyllum salaccense Rchb.f.	5		*Buchanania arborescens* (Blume) Blume
	Bulbophyllum sp. 1	4		*Magnolia vrieseana* (Miq.) Baill. Ex Pierre
Calanthe	*Calanthe abbreviata* (Blume) Lindl.	10	Terrestrial	-
	Calanthe sp.	3		
Cymbidium	*Cymbidium* sp.	8	Epiphyte	*Mangifera* sp.
Dendrobium	*Dendrobium lobulatum* Rolfe ax J.J.Sm.	12	Epiphyte	*Tectona grandis* L.f.
	Dendrobium dactyliferum Rchb.f.	7		*Derris canarensis* (Dalzel) Baker
Coelogyne	*Coelogyne similis* (Blume) M.W.Chase & Schuit.	11	Epiphyte	*Syzigium* sp.
	Coelogyne aurantiaca (Blume) M.W.Chase & Schuit.	3		
Pinalia	*Pinalia erecta* (Blume) Kuntze	14	Epiphyte	*Lithocarpus celebicus* (Miq.) Rehder
Flickingeria	*Flickingeria angustifolia* (Blume) A.D.Hawkes	9	Epiphyte	*Popowia pisocarpa* (Blume) Endl. Ex Walp.
Macodes	*Macodes petola* (Blume) Lindl.	11	Terrestrial	-
Oberonia	*Oberonia costeriana* J.J.Sm.	7	Epiphyte	*Lithocarpus* sp.
Phalaenopsis	*Phalaenopsis amabilis* (L.) Blume	13	Epiphyte	*Garcinia* sp.
Coelogyne	*Coelogyne imbricata* (Hook.) Rchb.f.	11	Epiphyte	*Maasia glauca* (Hassk.) Mols, Kessler & Rogstad
Trichotosia	*Trichotosia pauciflora* Blume	9	Epiphyte	*Nephelium* sp.
Thrixspermum	*Thrixspermum tortum* J.J.Sm.	8	Epiphyte	*Borassus* sp.
Vanda	*Vanda tricolor* Lindl.	2	Epiphyte	*Pinus* sp.

Two species of the genus Calanthe were identified at the research location (Figure 3), namely *C. abbreviata* and *Calanthe* sp. The species *C. abbreviata* was found in 10 individuals, and *Calanthe* sp. found three individuals. *C. abbreviata* for which the growth type is found is sympodial; the tip of the stem has limited growth. The habitat of this orchid is terrestrial or an orchid that lives in soil, has thick and fleshy roots, the stem type is small and short, and the stem looks like leaf midribs cover it. The *Calanthe* genus was discovered by other researchers in several orchid farms in Sigi Regency, who stated that this genus has clear or unclear pseudobulbs at the base, covered by leaf midribs, sometimes in clusters. Inflorescences from the leaf axils or the former leaf axils with flower stalks tend to be longer [8].

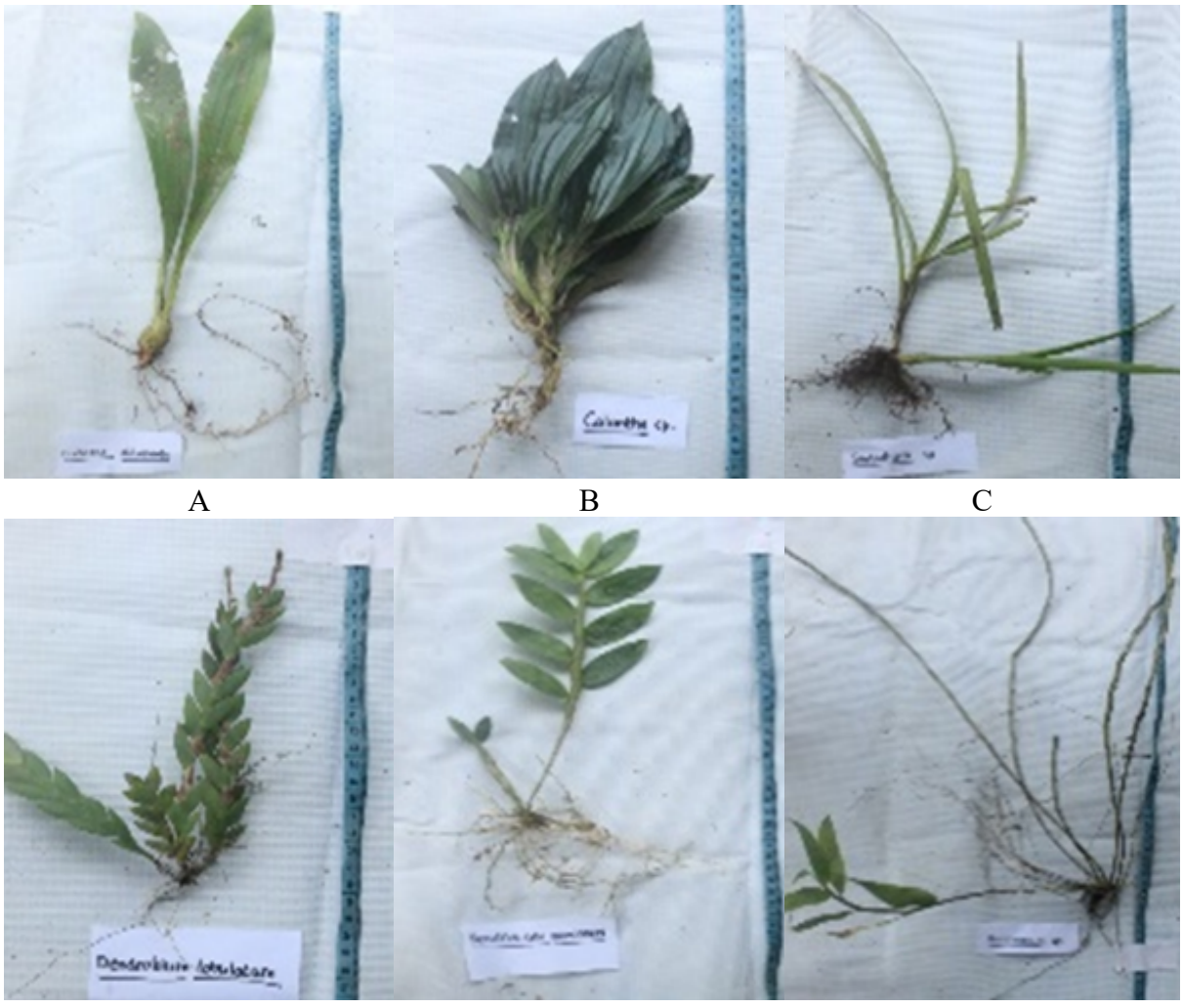


Figure 3. (A) *Calanthe abbreviata*; (B) *Calanthe* sp.; (C) *Cymbidium* sp.; (D) *Dendrobium lobulatum*; (E) *D. dactyliferum*; and (F) *Dendrobium* sp.

The genus *Cymbidium* comes from Greek, which means "boat" because of its lip shape and boat-like characteristics. There were eight orchid species in the genus *Cymbidium* found. This species is included in both epiphytic and terrestrial species. This genus has a sympodial growth characteristic or the tip of the stem has limited growth, the stem looks small and short, the leaf tip is tapered, the leaf edge is flat, has a leaf width of ± 2 cm with a length of ± 38 cm, the surface of the leaf is shiny

with the leaf located opposite, long plants ± 46 cm [17]. The *Cymbidium* sp species has also been discovered by other researchers in the Sigi Regency breeding area, with the characteristics of the flowers being arranged like bunches and hanging down and each bunch containing 15–30 flowers. Species found in the field have ribbon-shaped leaves with tapered leaf tips [8].

The genus *Dendrobium* comes from the Greek words Dendron (tree) and Bios (life); generally, this genus lives on trees or epiphytes. The species *D. lobulatum* was found in 12 individuals with characteristics of sympodial appearance, false tubers segmented stems, and various leaf shapes. Generally, orchids will choose host tree species that can support their survival in obtaining water reserves and are influenced by the bark. If there is a cavity in the bark that is soft with a rough surface and small cracks or cavities, this can allow orchid seeds to get stuck in the cavity [17], [18].

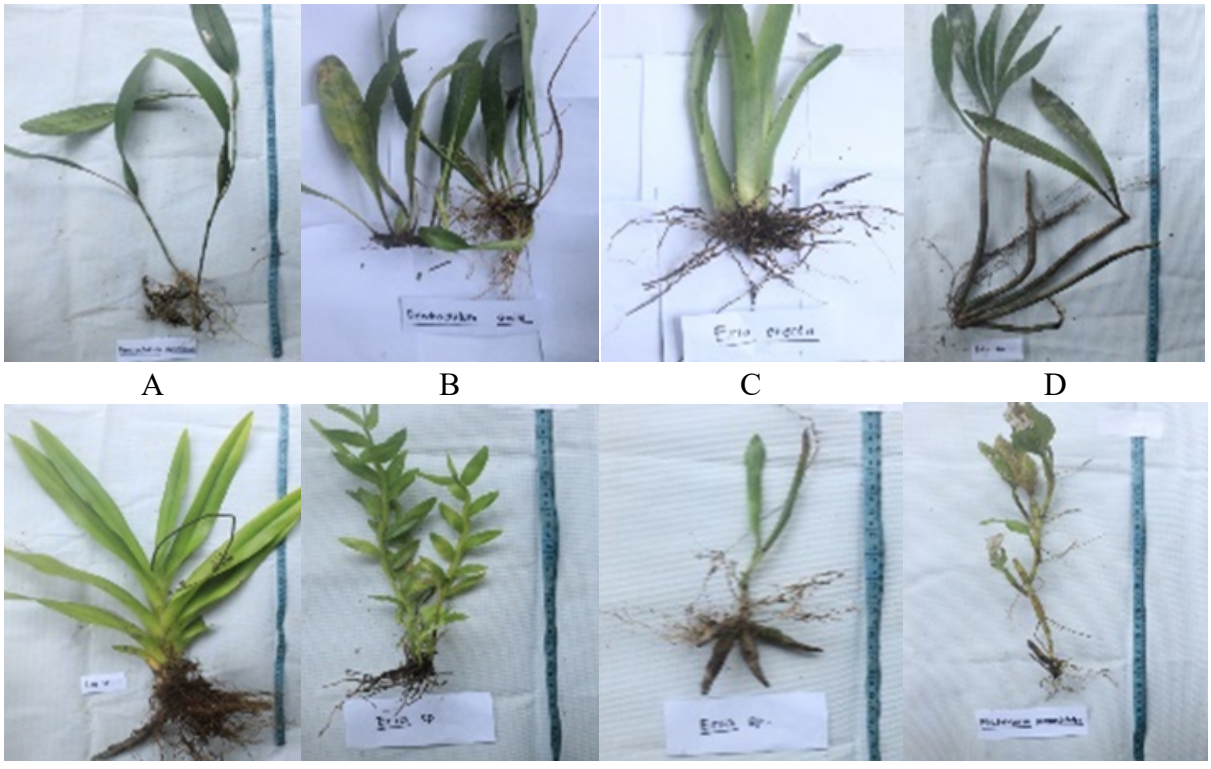


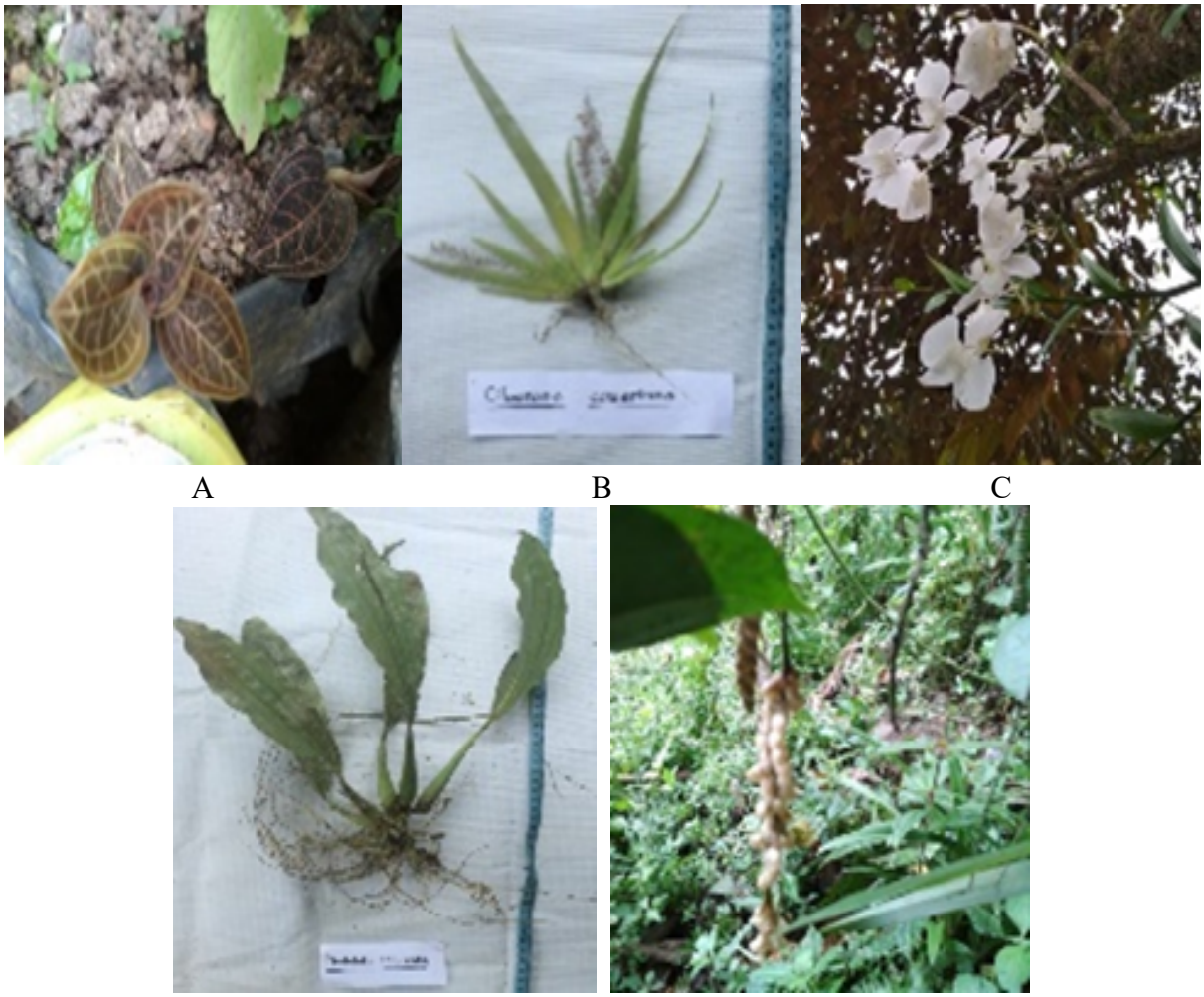
Figure 4. (A) *Coelogyne similis*; (B) *C. aurantiaca*; (C) *Pinalia erecta*; (D) *Pinalia* sp1; (E) *Pinalia* sp2; (F) *Pinalia* sp3; (G) *Pinalia* sp4; and (H) *Flickingeria angustifolia.*

The species *D. lobulatum,* which has the synonym *Aporum lobulatum*, is characterized by very flat stems but is often found shorter. The stem is filled with leaves, except at the base of the stem, which is about 3 cm long. Flat leaves are attached to the stem on both the right and left sides. This species has leaf types that do not overlap but are very close to each other [18]. Flowers usually appear from leafless stems. Characterized by purple striped petals, five lines on the sepals, and lines on the petals. Around the tongue's base is an orange or egg yolk stain. The tongue tip is split in two, thus dividing the tip into two triangular-shaped lobes with a blunt tip [18].

The species *D. dactyliferum* is an orchid species found in 7 individuals and is characterized by sympodial growth, which has a *pseudobulb* with a flat, slightly elongated shape. Several forms of *pseudobulb* have different shape characteristics, such as slender, long, flat,

and shiny; sometimes, there are also white and black hairs [19]. The appearance of *Dendrobium* is a herbaceous plant living as an epiphyte. *Dendrobium* genus generally has a fibrous root system (*radix adventicia*) with rhizomes and contains food reserves [20].

The *Coelogyne* was found in the field with 14 individuals, of which *C. similis* was found in 11 individuals and *C. aurantiaca* was found in 3 individuals (Figure 4). *C. similis* is characterized by sympodial growth; the *pseudobulb* has an egg-shaped shape and feels smooth. Flowers of this orchid species on the northern slopes of Mount Lawu with inflorescences reaching 40 cm, each flower stalk consisting of 35 flowers [21]. Flowers emerge from the stem's tip and flower again from the growing baby plants. The genus *Coelogyne* has a conspicuous labellum. Lives in warm to cold temperatures [21]. For the species *D. aurantiacum,* which has a small stature, this orchid species growing at an altitude of more than 1000 meters. The flowers, although small, are usually produced in large quantities [1].



A B C

D E

Figure 5. (A) *Macodes petola*; (B) *Oberonia costeriana*; (C) *Phalaenopsis amabilis*; (D) *Coelogyne imbricata*; and (E) *Pholidota* sp.

There were 14 individuals of the *Pinalia erecta* species found in the field, characterized by dangling, fleshy stems, 12–14 leaves with an elongated shape, and various flower colors. This species was also found in the BBSNP area with a variety of

flower colors, such as white, pink, and purplish. The leaf shape is rounded, with a leaf length of 5 cm and a leaf width of 1 cm with a pointed tip. *Pinalia* is an epiphytic, sympodial orchid [7]. This genus has short or long pseudo-tubers formed from several segments, growing from spreading rhizome roots. Leaves vary in both shape and size [19].

The *Flickingeria angustifolia* species was found in 9 individuals with clearly visible stem characteristics with many branches, spindle-shaped or round pseudo-tubers, and lanceolate leaves. *Flickngeria* species apart from Sumatra are also spread in Thailand, Vietnam, Peninsular Malaysia and Borneo, while *F. grandiflora* is only found in Sumatra, Java, Flores and Timor [22]. The characteristic of the *Flickingeria* genus is that it has one bulb, one leaf, and one stem for further growth regeneration. This genus of orchids is sympodial and grows epiphytically [23].

The *Macodes petola* species was found in 11 individuals at the observation location (Figure 5), characterized by short stem stature, green color, plant length 10–15 cm and stem diameter ± 0.5 cm, leaf length 7 cm, leaf width ± 4.5 cm, a surface The leaves are smooth and consist of 3–4 leaves. RThis species is a succulent ground orchid with dark green leaves varying in color with golden or silvery yellow stripes, terminal inflorescences with reddish brown petals, and hairy on the outer surface, while the crown is slightly narrower in size [24].

The *Oberonia costeriana* species was found in 7 individuals and had epiphytic characteristics, sympodial growth, and short and flat stems. This species with small flowers measuring 0.4 cm, located slightly apart, pale greenish yellow, triangular petals, oval crown slightly larger than the petals, and green concave lips [18].

A B C

Figure 6. (A) *Trichotosia pauciflora*; (B) *Thirexspermum tortum*; and (C) *Vanda tricolor.*

The *Phalaenopsis amabilis* species was found in 13 individuals and had pure white flowers with slight variations in yellow and reddish spots on the lip of the flower. This species has wide, upright side lobe lips, and the front edge is yellow with a reddish line [8]. The *Phalaenopsis* genus has a group of 60 species that are generally distributed in Asia with a tropical climate type, and sometimes these orchids are found in markets as hybrids; usually, these orchids are used as ornamental plants in home gardens [8], [25].

There were 13 individuals found in the field for the species *Coelogyne imbricata* Which is characterized by a sympodial growth type or an orchid whose stem tip has limited growth; an epiphyte or orchid attached to a tree trunk has strong roots to attach to its host; the roots are

elliptical at the tip and have velamen. This orchid in the Pekalongan forest area, Central Java, with pointed leaf tips [26]. One leaf is found on each pseudo tuber. Grows in slightly shaded places. Pseudo-tubers have four corners with a size of approximately 5x3 cm. Flower bouquets appear on rhizomes, flower bouquets in the form of spikelets, namely several flowers with short flower stalks. The trees that can become hosts for orchids are trees with flat, peeling trunks so that much dust sticks to the host tree [27].

The species *Trichotosia pauciflora* was found in 9 individuals with the characteristics of an epiphytic orchid with sympodial growth, stiff stem type, growing upwards and hanging down, narrowly lanceolate leaves, pointed leaf tips, and rough leaf surfaces (Fugure 6). This species, along the leafy stems on both sides, the flowers are generally medium-sized, the bracts are clearly visible, the outer surface of the petals is always brown or red, the inner surface is brownish white, brown, reddish or greenish [28].

The species *Thrixspermum tortum* was found in 8 individuals in the field as a monopodial orchid type that lives epiphytically, has leaves that grow along the stem, has thick flesh, and has two split ends that are not congruent. The species found in the *Vanda* is *Vanda tricolor,* which has branching characteristics, namely monopodial type, cylindrical roots, tapered tips, fleshy, soft, smooth, and easily broken, and has alternate and opposite leaf arrangements. This species has straight, slender stems and no bulbs; the stems stand upright and are complex [26]. The Vanda orchid species s large and is often seen flowering [5], [6]. *Vanda tricolor* orchid was found on the gintungan tree (*Bischofia javanica*) [10]. However, those found in garden collection trees are limited in number. Most of them were found still in the form of juveniles. The host trees for these *Vanda* saplings are *Cupressus benthamii*, *Cinnamomum camphora*, *Toona sureni*, *Phyllanthus* sp., *Prunus puddum*, *Meliosma ferrugenia*, and *Cordia myxa*. One of the flowering adult *Vanda tricolor* was found growing epiphytically on a *Pinus* sp.

Environmental factors support the orchids found on the research route [27]. The abundance of orchid species is highly dependent on environmental factors. Environmental factors that influence include temperature, sunlight intensity, and humidity [10], [28], [29]. Orchid conservation efforts are essential to maintain the existence of orchids in nature to remain sustainable, both ex-situ and in-situ conservation.

The results of measuring the physical parameters of orchids showed that orchids were found at an altitude of 568 meters above sea level 876 meters above sea level. The measured environmental parameters at the research location showed normal conditions for orchid life seen from the average temperature measured at the time of observation, namely 23˚C. This orchid is a medium-temperature orchid where the orchid grows well at temperatures of 21˚C–30˚C during the day [29]. Observations from the BMKG station in Liwa show that the average temperature that year was 22ºC and the average humidity level was 90% [30]. The light intensity measured during the observation was 1007–6317 lux. Light intensity is one factor in growing orchids; orchids also need sunlight to grow and flower [31], [32]. Humidity measured at the time of observation shows that the area is humid [33], [34]. Humidity measured means that in mountainous areas, the number of orchid species is more significant than in the lowlands because, in mountainous areas, there is high humidity, lots of rainfall, cool air temperatures, and low sunlight intensity [10].

This research can help compile a database of information on orchid populations in the area so that further management can be carried out in efforts to conserve genetic resources by carrying out natural breeding for certain types of orchids so that the results of inventory and

cultivation of natural orchids in the BBSNP area can be helpful. Attract tourists related to ecotourism, which still prioritizes the preservation of orchids as plants typical of the area.

Conclusion

Based on the results of orchid exploration on the Sepapah Kiri waterfall climbing route, it can be concluded that there are a total of 16 genera were recorded, dominated by epiphytic orchids, with *Agrostophyllum* and *Pinalia* as the most abundant genera, namely from the genera *Agrostophyllum, Appendicula, Bulbophyllum, Cymbidium, Denrobium, Coelogyne, Pinalia, Flickingeria, Oberonia, Phalaenopsis, Coelogyne, Trichotosia, Thirexspermum,* and *Vanda*. Several species of epiphytic orchids are often found on the rough texture of host tree trunks and have slightly peeling cracks. The host trees found had large crowns and diameters favorable for epiphytic orchids' growth. Preservation of natural orchid species is needed by cultivation and increasing the captivity exsitu conservation of orchids.

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Conflict of interest

The author declares no potential conflicts of interest regarding the research, authorship, and/or publication of this article.

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