

Orchid Inventory along The Wongaya Gede Trekking Route of Mount Batukaru, Tabanan, Bali - Indonesia

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Abstract. Orchids are among the most diverse groups of flowering plants, with a wide distribution. However, updated information on their distribution in Mount Batukaru, Bali, remains limited. The mountain was designated as a Cagar Alam (nature reserve) in 2020, highlighting the need for baseline data to support conservation. This study aimed to document orchid species along the western slope through exploration surveys conducted from November 2024 to May 2025 across an elevation gradient from 831 to 2,276 m asl. Data were collected through direct field observations and photographic documentation, while species identification was verified using standard taxonomic references. A total of 25 species were recorded, representing two subfamilies, Epidendroideae (24 species) and Orchidoideae (one species, *Corymborkis veratrifolia*). Several species not reported in the previous study, including *Arundina graminifolia*, *Calanthe zollingeri*, *Coelogyne speciosa*, and *Dendrobium spathilingue*, were identified. Notably, *Bulbophyllum ovalifolium* corresponded to the MB2 (Mount Batukaru 2) variant previously reported from Mount Batukaru. The updated data can be used to evaluate the effectiveness of nature reserve designation and guide future conservation strategies.

Keywords: Conservation; Epidendroideae; Mount Batukaru; Orchid diversity; Orchidoideae

I. INTRODUCTION

Orchids are cosmopolitan plants found across the globe, except in Antarctica and the Arctic regions [1]. According to O'Bryne (1994) [2], the number of orchid species worldwide is estimated at 17,000–35,000, belonging to 750-850 genera. Indonesia has approximately 5,000 species [3], of which have been identified [4]. The high level of orchid endemism in Indonesia is attributed to the archipelagic structure and elevational variation, which act as natural barriers [5]. These geographical conditions promote diverse forms of orchid adaptation to their growing environments [6].

Orchids can grow in almost all habitats, supported by various adaptation mechanisms [7]. Mardiyana et al. (2019) [8], grouped orchids into two most common categories, terrestrial and epiphytic orchids. Both terrestrial and epiphytic orchids are also most widely cultivated to meet market demands [9]. Economically,

orchids are an important ornamental plant commodity with high commercial value and relatively stable prices [10]. Their unique floral forms, colors, and characteristics contribute to their popularity as ornamentals [11]. However, the increasing market demand for orchids has led to intensified exploitation of wild orchids from their natural habitats [12]. Excessive exploitation combined with habitat degradation has pushed many orchid species towards extinction. However, conservation efforts are often constrained by limited baseline data on orchid diversity and distribution, particularly in protected areas [13].

Research on orchid diversity in the Mount Batukaru area was previously conducted by Wibowo et al. [14]. Their exploration was carried out along two routes: Wongaya Gede on the western slope and Jatiluwih on the eastern slope of Mount Batukaru. The study recorded a total of 81 species belonging to 32 genera, comprising 67 epiphytic species, dominated by *Bulbophyllum*, and 16

terrestrial species. Given this background, further research on orchid diversity in Mount Batukaru is necessary, as the area was designated a conservation site with CA/Cagar Alam status in 2020 under Bali Provincial Regulation No. 3 of 2020 [15]. This designation was established through the Decree of the Minister of Forestry Num. SK2847/Menhut-VII/KUH/2014 [16]. Updated data on orchids may provide insights into the effectiveness of nature reserve designation in sustaining orchid diversity and serve as a reference for future conservation strategies.

II. METHODS

Study Site

This research was conducted in November 2024 to July 2025, with field data collection taking place between November 2024 and May 2025. The study site was located on the western ridges of Mt. Batukaru within Wongaya Gede village, Penebel district, Tabanan, Bali. The elevation ranges from 800 to 2,276 m asl, with the starting point at Pura Luhur Batukaru (831 m asl).

Data collection using an explorative method based on Rugayah et al. [17] along the western routes of Mountain Batukaru. The species name and pictures were recorded. The identification was conducted in the field and continued in the Laboratory of Plant Systematics, Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Udayana.

Research Tools and Materials

Tools and materials used in this research include a Canon 2400D DSLR camera and a Sony A7IV, a mobile phone camera, plain black fabric as a photo background, a field board, a ruler, a monocular telescope, a Global Positioning System (GPS) Garmin, and sketching supplies (A4 HVS paper, eraser, pencil). Identification was carried out using Orchids of Java [18], Orchids of Indonesia [19], and Orchids of Sulawesi [20].

Research Procedure

Data were collected through direct observation of orchid individuals encountered, including epiphytic orchids observed with the monocular telescope. Each sample was documented in photographs, particularly of orchid flowers showing the type of inflorescence and its parts. Photographs were taken using a mobile phone camera as well as Canon 2400D and Sony A7IV DSLR cameras. Morphological details that could not be documented, such as the labellum or spur, were recorded

in descriptive notes. In several cases, flowers were collected for closer examination and documentation; however, no wet or dry herbaria were prepared in this study. In addition, the altitude at which the samples were found was recorded using a Garmin GPS. The photographs and descriptions obtained were then cross-checked with identification books.

III. RESULTS AND DISCUSSION

The exploration yielded 25 orchid species belonging to two subfamilies, as shown in Table 1 and documented in Figure 1. The Epidendroideae has the most species (24), while the Orchidoideae has only one. Among 25 orchid species, one species was identified in the genus, and the rest were identified to species. Based on the lifeform, 20 species were epiphytes, and five were terrestrials.

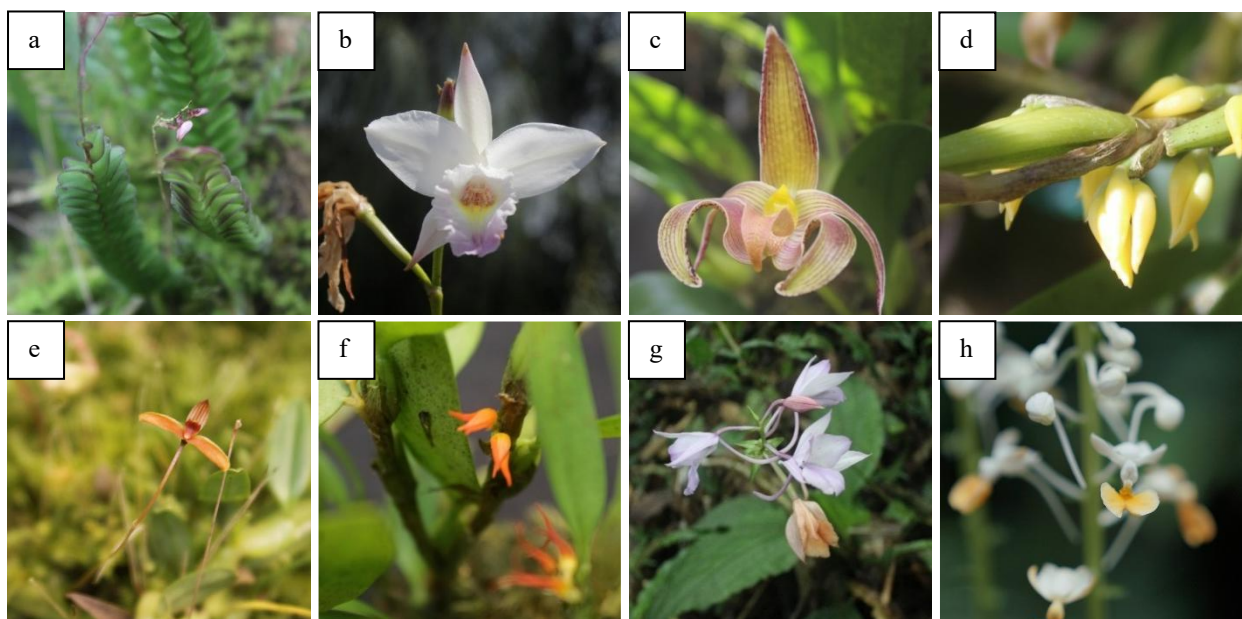
The results of this study differ from those of a previous study by Wibowo et al. [14], which reported 81 orchid species across 32 genera. This difference is most likely due to variations in exploration periods and seasonal dynamics. Data collection in the study by Wibowo et al. was conducted from August to September 2014, during the peak of the dry season, whereas data collection in this study took place from November 2014 to April 2025, during the peak of the rainy season. Prolonged and intense rainfall during this period increases excessive humidity, which may trigger tissue decay and shorten the lifespan of the orchid flowers.

In addition, differences in the scope of the exploration areas also contributed to the discrepancy between the results of this study and those of Wibowo et al. [14]. The research conducted by Wibowo et al. covered both slopes of Mount Batukaru, namely the western slope in Wongaya Gede village and the eastern slope in Jatiluwih village, thereby encompassing a wider, more ecologically diverse area. In contrast, the present study was limited to only one slope, namely the western slope in Wongaya Gede village, with the exploration route following an elevation gradient from bottom to top. This coverage limitation limited the representation of detected orchid diversity, as it did not include potential habitat variation on the other slope.

Nevertheless, this study recorded several species that were not reported by Wibowo et al. [14], namely *Arundina graminifolia*, *Bulbophyllum lobbii*, *Bulbophyllum modestum*, *Calanthe zollingeri*, *Coelogyne speciosa*, *Dendrobium aloifolium*, *Dendrobium inflatum*, *Dendrobium spathilingue*, *Liparis caesoitosa*, *Podochilus gracilis*, *Robiquetia ligulate*, *Schoenorchis juncifolia*, and *Tuberolabium zollingeri*.

Table 1.
 The diversity of orchids and their altitude in the western trekking route of the Mountain Batukaru

Num.	Subfamily	Species	Altitude (m asl)
1.	Epidendroideae	<i>Appendicula elegans</i> Rchb.f.	1,389
2.	Epidendroideae	<i>Arundina graminifolia</i> (D. Don) Hochr.	955
3.	Epidendroideae	<i>Bulbophyllum lobbii</i> Lindl.	1,576
4.	Epidendroideae	<i>Bulbophyllum modestum</i> Hook.f.	1,360
5.	Epidendroideae	<i>Bulbophyllum ovalifolium</i> (Blume) Lindl.	1,005
6.	Epidendroideae	<i>Bulbophyllum triflorum</i> (Breda) Blume	1,195
7.	Epidendroideae	<i>Calanthe sylvatica</i> (Thou.) Lindl.1833	859
8.	Epidendroideae	<i>Calanthe zollingeri</i> Rchb.f.	834
9.	Epidendroideae	<i>Coelogyne miniata</i> (Blume) Lindl.	2,201
10.	Epidendroideae	<i>Coelogyne speciosa</i> (Blume) Lindl.	1,240
11.	Epidendroideae	<i>Dendrobium aloifolium</i> (Blume) Rchb.f.	879
12.	Epidendroideae	<i>Dendrobium inflatum</i> Rolfe	1,333
13.	Epidendroideae	<i>Dendrobium linearifolium</i> Teijsm. & Binn.	870
14.	Epidendroideae	<i>Dendrobium spathilingue</i> J.J. Sm.	1,202
15.	Epidendroideae	<i>Dendrochilum</i> sp.	1,777
16.	Epidendroideae	<i>Eria lamonganensis</i> Rchb.f.	1,464
17.	Epidendroideae	<i>Eria multiflora</i> (Blume) Lindl.	2,178
18.	Epidendroideae	<i>Liparis caespitosa</i> (Thou.) Lindl.	880
19.	Epidendroideae	<i>Phreatia plantaginifolia</i> (J.J Koenig) Ormerod	840
20.	Epidendroideae	<i>Plocoglottis plicata</i> (Roxb.) Ormerod	980
21.	Epidendroideae	<i>Podochilus gracilis</i> (Blume.) Lindl.	1,480
22.	Epidendroideae	<i>Robiquetia ligulata</i> (J.J.Sm.) Kocyan & Schuit.	1,345
23.	Epidendroideae	<i>Schoenorsis juncifolia</i> Blume ex Reinw.	971
24.	Epidendroideae	<i>Tuberolabium zollingeri</i> (Rchb.f.) Ormerod & Juswara	990
25.	Orchidoideae	<i>Corymborkis veratrifolia</i> (Reinw.) Blume	865



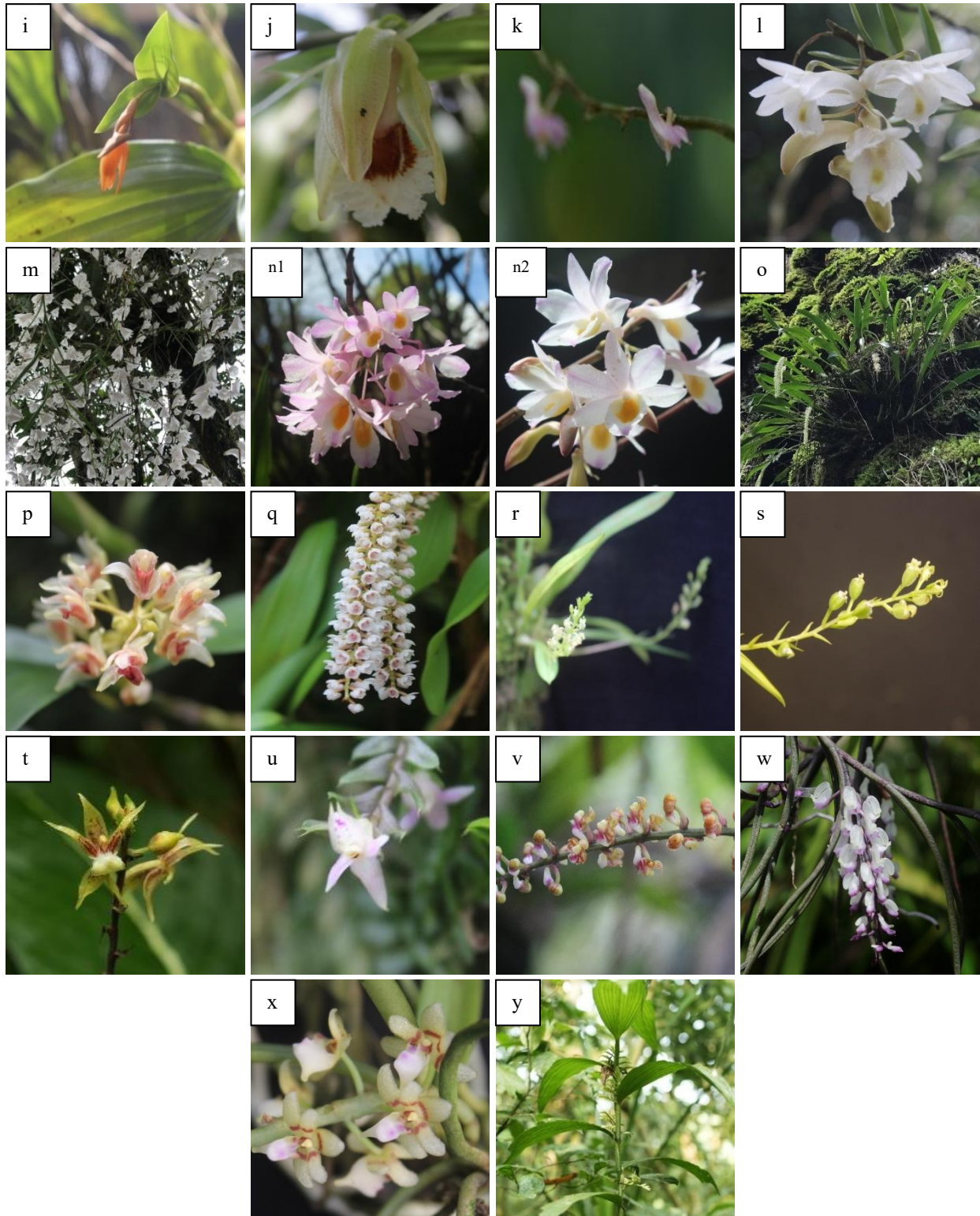


Figure 1. Documentation of orchids found in Mountain Batukaru (a) *Appendicula elegans*; (b) *Arundina graminifolia*; (c) *Bulbophyllum lobbii*; (d) *Bulbophyllum modestum*; (e) *Bulbophyllum ovalifolium*; (f) *Bulbophyllum triflorum*; (g) *Calanthe sylvatica*; (h) *Calanthe zollingeri*; (i) *Coelogyne miniata*; (j) *Coelogyne speciosa*; (k) *Dendrobium aloifolium*; (l) *Dendrobium inflatum*; (m) *Dendrobium inflatum*; (n1) *Dendrobium spathilingue* - variant with more purple-colored flowers; (n2) *Dendrobium spathilingue* - variant with predominantly white flowers with a tinge of purple; (o) *Dendrochilum* sp.; (p) *Eria lamonganensis*; (q) *Eria multiflora*; (r) *Liparis caespitosa*; (s) *Phreatia plantaginifolia*; (t) *Plocoglottis plicata*; (u) *Podochilus gracilis*; (v) *Robiquetia ligulata*; (w) *Schoenorsis juncifolia*; (x) *Tuberolabium zollingeri*; (y) *Corymborkis veratrifolia*

Arundina graminifolia, commonly known as the bamboo orchid due to its reed-like stems [21], is one of the terrestrial orchids that was not reported in the previous study by Wibowo et al. [14]. In the present study, this species was found at an elevation of 955 m asl in an open canopy habitat. This finding is consistent with the statement by Purba and Chasani [22] that most terrestrial orchids typically grow under low light intensity and shaded conditions. Although a few species, such as *Spathoglottis plicata* and *Arundina graminifolia*, require full light exposure.

Calanthe zollingeri was recorded in the present study but was not reported by Wibowo et al. [14]. Nevertheless, this species has previously been documented in Bali by Sulistiarini et al. [23], who reported its occurrence on Mount Mesehe and Mount Merbuk in Jembrana Regency, western Bali. It was found in lowland riverine forests as well as in primary forests at elevations of 200-550 m asl. This orchid exhibits a unique characteristic in its labellum, which initially appears white with a slight yellow at the base, then changes to yellow, and finally turns orange [18].

Bulbophyllum ovalifolium was recorded in this study at an elevation of 1,005 m asl. A previous study by Atmaja et al. [24] reported three variants of *B. ovalifolium* in Bali, consisting of the BT type with a coarsely verrucose lip, the MB1 type with scattered verrucose lip, and the MB 2 type with a glabrous lip. This specimen observed in the present study corresponds to the MB2 variant from Mount Batukaru. Morphologically, this variant is characterized by a relatively small flower (approximately 2,5 cm in diameter), red coloration, and a glabrous lip with reflexed margins, while the petals contain only a single vein. The occurrence of this variant in Mount Batukaru supports the findings of Atmaja et al. [24] and further confirms the presence of the MB2 type in this region.

Two *Dendrobium* individuals in this study were identified as *Dendrobium spathilingue* (Figures 1n1 and 1n2) and showed very high morphological similarity in both flower structure and vegetative characters. The difference between the two was only observed in the color pattern. *D. spathilingue* var. 1 (Figure 1n1) had a light purple color pattern on the edges and center of the dorsal sepal, lateral petal, and lateral sepal, while the color pattern in *D. spathilingue* var. 2 (Figure 1n2) was darker purple in the same parts, with the flower being predominantly white. Both *D. spathilingue* individuals were found growing close to each other on a log at the same site, making it unlikely that the morphological variation was caused by environmental differences. This color variation is most likely the result of generative reproduction from the same parent, producing offspring with differences in flower color. This aligns with Purwantoro et al. (2023) [25], who stated that offspring of crosses between species within the

genus *Dendrobium* may exhibit striking morphological variation in flowers, even when derived from the same parental combination.

Coelogyne speciosa was also recorded in this study as an epiphytic orchid inhabiting large trees in moist forest conditions. This species is notable for its large, attractive flowers, which are highly valued in horticulture and are therefore often subject to collection pressure [18]. Its presence in Mount Batukaru indicates that suitable habitats with mature host trees are still available. Moreover, the occurrence of *C. speciosa* highlights the importance of conserving epiphytic niches, as species with high ornamental value are particularly vulnerable to overexploitation.

The results of this study revealed a dominance of species from the subfamily Epidendroideae, while only one species from the subfamily Orchidoideae was recorded, namely *Corymborkis veratrifolia*. In general, species diversity within Orchidoideae is lower compared to Epidendroideae [26]. Research conducted by Okinomidis and Thanos [27] on embryo to seed ratios and orchid germination behavior indicated that Orchidoideae exhibit distinct growth patterns from those of Epidendroideae. This difference implies that Orchidoideae orchids are not always readily detectable in natural habitats. Furthermore, Orchidoideae tend to exhibit germination patterns highly dependent on specific environmental conditions, particularly when soil moisture increases during the rainy season.

IV. CONCLUSION

A total of 25 orchid species belonging to two subfamilies, Epidendroideae (24 species) and Orchidoideae (one species), were recorded along the Wongaya Gede trekking route on the western slope of Mount Batukaru. Several species, including *A. graminifolia*, *C. zollingeri*, *C. speciosa*, and *D. spathilingue*, were not reported in the previous study but were recorded in the present study. Further research with broader sampling coverage is needed to provide more comprehensive baseline data for future conservation planning and management in Mount Batukaru.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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