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Cover: A mesmerising Indian Luna moth *Actias selene* is dancing through the starry night (by Vincent van Gogh) moonlit sky, displaying its ballistic display of feather tail. Digital artwork by Vyshnavee Sneha Jaijar.

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COMMUNICATION

A pioneer study of orchids on Nusa Barung Island of Indonesia

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Abstract: This is the first study specifically on orchids in the Nusa Barung Island Wildlife Reserve. Nusa Barung Island has restricted access. We conducted a 14-day exploration across seven transects, covering a total distance of 12 km. Previous research only recorded five species of orchids, whereas our findings identified 17 species, of which 80 % were new records for this island. Three species of terrestrial orchids were found, namely *Eulophia picta, Nervilia plicata,* and *N. simplex*, while the other 14 species were epiphytes/ lithophytes. *Vanda limbata* is abundant and can be found growing on cliffs, while other epiphytes can be found on tree trunks & branches in Jeruk Bay, and Kandangan Bay.

Keywords: Epiphytes, Orchidaceae, small island, transects, terrestrial orchids, *Vanda limbata*, wildlife reserve.

Abstrak: Ini adalah studi pertama yang secara khusus meneliti anggrek di Suaka Margasatwa Pulau Nusa Barung. Akses ke Pulau Nusa Barung sulit dan terbatas. Kami melakukan eksplorasi selama 14 hari menyusuri tujuh transek, dengan total jarak 12 km. Penelitian sebelumnya hanya mencatat lima jenis anggrek, sedangkan temuan kami mengidentifikasi 17 jenis, di mana 80% adalah catatan baru untuk pulau ini. Tiga jenis anggrek tanah ditemukan, yaitu *Eulophia picta*, *Nervilia plicata*, dan *N. simplex*, sementara 14 jenis lainnya adalah epifit/litofit. *Vanda limbata* ditemukan melimpah dan dapat ditemukan tumbuh di tebing, sementara epifit lainnya dapat ditemukan di batang dan cabang pohon yang tumbuh di Teluk Jeruk dan Teluk Kandangan.

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Author details: Toni Artaka: Forest Ecosystem Controller (PEH) for wild flora and breeder manager of in situ orchids for ex-situ conservation in Bromo Tengger Semeru National Park. Bina Swasta Sitepu: Botanist and junior researcher for forest ecology at the National Research and Innovation Agency of Indonesia. Fajar Dwi Nur Aji: Forest Ecosystem Controller (PEH) for wild flora and fauna at Division of Natural Resources Conservation (BBKSDA) Jawa Timur. Suryadi: Nature enthusiasts are interested in orchids and other ornamental plants at Yayasan Pakarti. Tri Atmoko: Principal researcher of wildlife bio-ecology and nature conservation at the National Research and Innovation Agency of Indonesia.

Author contributions: Toni Artaka conceptualised research, methodology, data curation, and writing. Tri Atmoko was a principal investigator, conceptualised the methodology, served as supervisor, data curation, writing lead, and funding recipient. Bina SS, Suryadi, and Fajar DNA were involved in data curation and writing.

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INTRODUCTION

Indonesia is an archipelagic country with more than 17 thousand islands (Indonesian Government 2024). Of that number, 111 are the outermost small islands, one of which is Nusa Barung Island (Presidential Decree of Indonesia 2017). The uninhabited Nusa Barung Island is a wildlife reserve that humans rarely visit due to its relatively difficult accessibility. To reach it, one must cross the Indian Ocean, which is known for its large waves, unpredictable weather, and the island itself has limited freshwater sources. These are the limiting factor for biodiversity research activities on this island, resulting in a lack of data on its flora and fauna, including the orchid species (Orchidaceae).

Indonesia is one of the World's orchid biodiversity centers (Vitt et al. 2023). The country has a natural distribution of more than 5,500 orchid species or about one-fifth of the species in the world (Chase et al. 2017; Wati et al. 2023). Of these, 731 species are found on the island of Java, and 231 are endemic (Comber 1990). Orchids are an important part of the ecosystem and have high economic and conservation appeal with their morphological, ecological, and adaptation to various environmental conditions (Sharma et al. 2024). Orchids are able to survive and thrive in various habitats on Earth (Ziegler 2011).

Much research on orchid diversity on the island of Java has been conducted in past (Comber 1990; Nurfadilah et al. 2016; Rindyastuti et al. 2018; Sadili 2019), but these surveys were not conducted specifically on Nusa Barung Island. General information on plant diversity in Nusa Barung was collected by Jacobs (1958) and Partomihardjo & Ismail (2005). Both provided basic knowledge of the plant species in Nusa Barung Island, although their exploration area was limited. The previous study (Partomihardjo & Ismail 2005), only explored the coastal areas at limited locations. The present study included several inland areas that had not been visited before. This information is essential considering the unique ecosystem on Nusa Barung Island, which is a small island dominated by karst.

This biodiversity database provides invaluable information that will serve as a foundation for managing conservation areas. This study is hence, a valuable first step in gathering biodiversity data on Nusa Barung Island for managers. This paper is the result of the first study aimed at identifying and documenting orchid species on Nusa Barung Island.

STUDY SITE AND METHODS

The study was conducted for two weeks in July 2024 on Nusa Barung Island, a 76.4 km² wildlife reserve located in the Indian Ocean. Administratively, it is located in Puger District, Jember Regency, East Java (Figure 1). Based on DEM SRTM data (https://earthexplorer.usgs.gov/), this island has an altitude ranging 0–279 m with flat as well as undulating topography. Based on our general observations, forest types include coastal, lowland, karst, and mangrove forests. Based on NASA POWER data (https://power.larc.nasa.gov/) for the past 10 years, the weather patterns are as follows: annual rainfall ranging 1,129–2,421 mm/ year, an average air temperature of 26.9 ^{0}C (min-max: 24.1–28.8 ^{0}C), and an average air humidity of 81.1 % (min-max: 77.3–85.1 %).

Exploration was carried out following a standard methodology, for example, in field tracking was conducted on the observation transects and its surroundings with a width of approximately 15 m from the transect. Fourteen days were spent to cover seven routes with a total distance of approximately 12 km, in Plirik-Monyetan (2,083 m), Kedok Watu (2,508 m), Kandangan Bay (1,530 m), Jeruk Bay (2,549 m), Ketimo (715 m), Pucung Prau (1,140 m), and Cambah Bay-Sumber Gempol (1,544 m). Observations were made on terrestrial and epiphytic orchids. The epiphytic orchids on the high branches were observed with a binocular and documented with DSLR digital camera with tele lens. This study was mostly limited to the observation of individual orchids on high branches more than 20 m from the ground. The orchids found were identified and documented; the number of individuals/clumps was counted, and certain individuals were collected for further identification in Herbarium Wanariset (WAN). We identified the species by referring to the field guide provided by Comber (1990) and Artaka (2019).

RESULTS AND DISCUSSION

During the survey, 17 species of orchids of 13 genera were found (Table 1; Image 1). Three species found were terrestrial orchids, namely, *Eulophia picta* (Image 1F), *Nervilia plicata* (Image 1I), and *N. simplex* (Image 1J). The other species include the epiphyte and lithophyte groups. *Vanda tricolor* in Kandangan Bay uses the Bayur Tree *Pterospermum javanicum* as its host, while *Luisia zollingeri* (Image 1H), found around Kandangan Bay, attaches to the trunk of the *Dysoxylum* sp. The presence of *Vanda limbata* (Image 1P), is abundant, growing

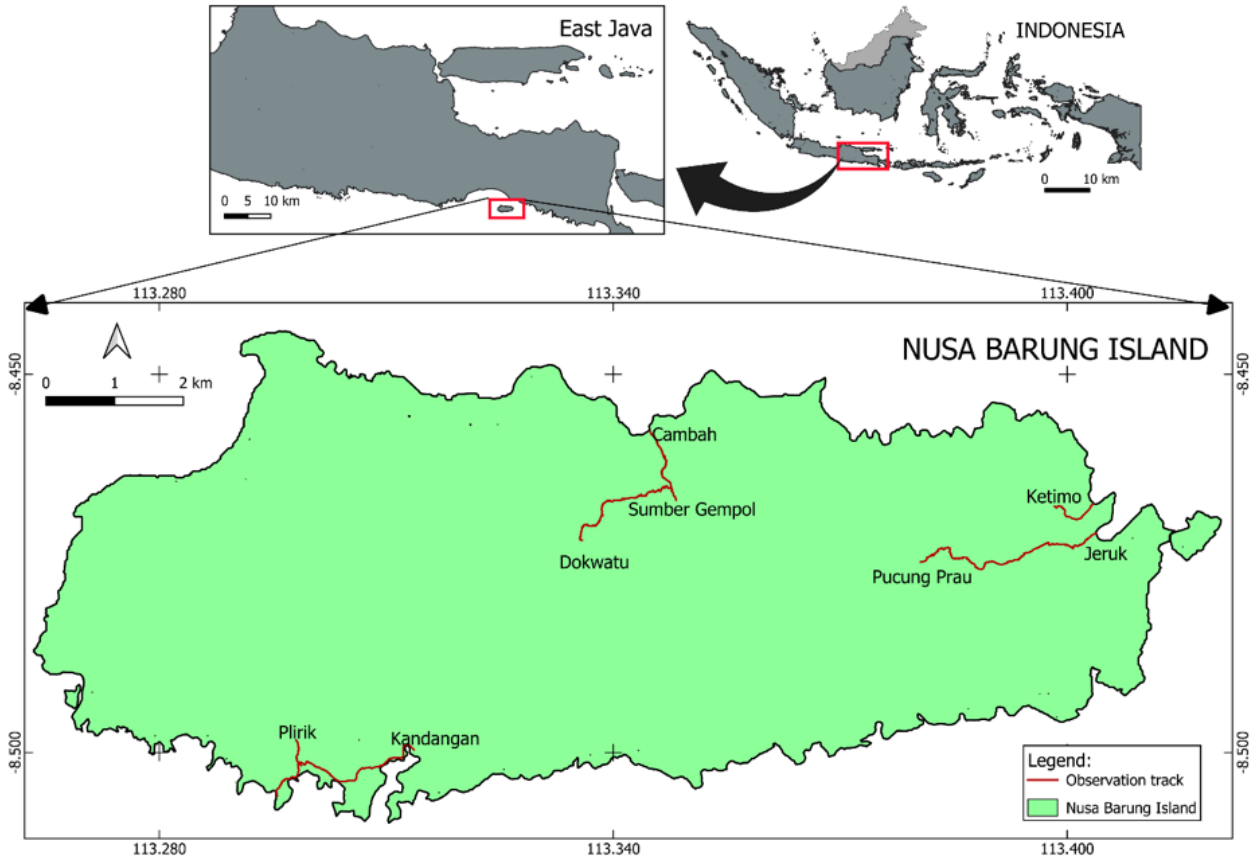

Figure 1. The study site, Nusa Barung Island in Indonesia.

on cliffs and rocks around Jeruk Bay. Meanwhile, those around Kandangan Bay grow as epiphytes with *Rhynchostylis retusa* (Image 1L), on the Syzygium sp. as a host.

Although we did not create a permanent plot to calculate abundance, based on individual/clump counting, several orchid species were found in small numbers, such as *Cymbidium* sp., *Dendrobium crumenatum*, *Liparis parviflora*, and *Polystachya concreta* (Table 1). Protection and prevention of illegal harvesting of this species needs to be done more because it has high vulnerability and potential for local extinction.

Vanda limbata was most commonly found in this study mainly in Kandangan Bay and Jeruk Bay. That is in line with the results of previous studies. During the exploration activities, Jacobs (1958) also reported the discovery of *V. limbata* in Nusa Barung, alongside species such as *Taeniophyllum* sp. and *Aerides* sp. Partomihardjo & Ismail (2005) conducted a survey and found *V. limbata*, *Dendrobium crumenatum*, *Phaius flavus*, and *Taeniophyllum* sp. among a total of 282 flora species. We were unable to find *Phaius flavus* in this survey.

Indonesia has a high diversity of Vanda. Out of 90 species of *Vanda* in the world (POWO 2025), 20 species grow naturally in Indonesia (Metusala 2011). This is a species that was initially known to be endemic to the island of Java until it was later found in Bali, the Nusa Tenggara Islands, Sulawesi, and Maluku (Metusala 2011). This species exhibits a relatively diverse habitat distribution, ranging from karst cliffs and seashores to attaching itself as an epiphyte on large tree trunks at altitudes exceeding 500 m (Yulia & Budiharta 2011). Setiawan (2018) also noted the presence of *V. limbata* as an epiphyte on tamarind trees *Tamarindus indica* planted as shade trees in Bangkalan, Madura Islands (East Java).

Sempu Island, a small island also located south of Java Island, has at least seven orchid species, one of which is also found on Nusa Barung Island, namely *Dendrobium crumenatum* (Sadili 2019); other species are *Ascochilus emarginatus*, *D. subulatum*, *Thrixspermum subulatum*, *T. acuminatissimum* (Rindyastuti et al. 2018), *Taeniophyllum biocellatum* (Nurfadilah et al. 2016), and

Table 1. Species and distribution of orchids in the Nusa Barung Island Wildlife Reserve, Indonesia.

	Species	Habitus	Individuals/ Clump					
			A	B	C	D	E	F
1	*Aerides odorata* Lour. (Image 1A)	Epiphytic	6	40	18			
2	*Arachnis sulingi* (Blume) Rchb.f. (Image 1B)	Lithophytic			18			
3	*Cymbidium* sp. (Image 1C)	Epiphytic				1		
4	*Dendrobium crumenatum* Sw. (Image 1D)	Epiphytic				1		
5	*Dendrobium macrostachyum* Lindl. (Image 1E)	Epiphytic			4			
6	*Eulophia picta* (R.Br.) Ormerod (Image 1F)	Terrestrial					8	
7	*Liparis parviflora* (Blume) Lindl. (Image 1G)	Epiphytic				2		
8	*Luisia zollingeri* Rchb.f. (Image 1H)	Epiphytic	7		1			
9	*Nervilia plicata* (Andrews) Schltr. (Image 1I)	Terrestrial			23			
10	*Nervilia simplex* (Thouars) Schltr. (Image 1J)	Terrestrial		8		4		
11	*Polystachya concreta* (Jacq.) Garay & H.R.Sweet (Image 1K)	Epiphytic			2			
12	*Rhynchostylis retusa* (L.) Blume (Image 1L)	Epiphytic	4		26			
13	*Taeniophyllum hasseltii* Rchb.f. (Image 1M)	Epiphytic	18		3			
14	*Taeniophyllum* sp. (Image 1N)	Epiphytic			6			2
15	*Thrixspermumra ciborskii* J.J.Sm. (Image 1O)	Epiphytic					2	8
16	*Vanda limbata* Bl. (Image 1P)	Lithophytic, Epiphytic	66				abundant	
17	*Vanda tricolor* Lindl. (Image 1Q)	Epiphytic	4	15	2			

A—Kandangan Bay | B—Plirik-Monyetan | C—Cambah Bay-Sumber Gempol | D—Kedok Watu | E—Jeruk Bay | F—Pucung Prau.

Grosourdya appendiculata (Sadili 2019). When compared to the closest location on the mainland of Java Island, as many as five species of orchids in Nusa Barung are the same as those found in Bromo Tengger Semeru National Park (Artaka 2019), and three species are the same as in Meru Betiri National Park (Puspitaningtyas 2007). This phenomenon shows that distribution of propagules from the main island affects the biodiversity of Nusa Barung Island as a result of the dispersion by biotic and abiotic agents, as well as native species that already existed in this area when the island was separated from it due to rising sea levels (Schrader et al. 2020).

This survey only covered a small part of Nusa Barung Island, hence it is assumed that more orchid species may still exist on the island, waiting to be discovered. Several obstacles during the survey included the limitation in collecting epiphytic orchid species that grow attached to the crown of large trees at a height of more than 20 m. Another obstacle was that only a few orchid species were found flowering during the survey, which coincided with the dry season in Indonesia (April–September) without flowers, which is a problem for further identification at the species level. The specimens without flower were identified only at the genus level, except for the species that have important identification character on their vegetative organs (e.g., leaf, bulb and root).

Several species, although not with generative organs, can still be identified at the species level based on the special vegetative characteristics they have, such as the *Eulophia picta* species. That species is easily recognized even when it is not flowering because it has a distinctive habitus and tubers (pseudobulbs). The *E. picta* was only found with as many as eight individuals growing on sandy coastal soil media shaded by the canopy of the *Hibiscus tiliaceus* tree in Jeruk Bay. The tubers have a depth of 5–7 cm in the sandy soil and are characterized by fine-haired roots.

Dendrobium macrostachyum is commonly found attached to trees around the rain-fed lake (Sumber Gempol). This species is recognized because of its distinctive habitat, and it always grows hanging. Preferring shady and windy habitats, it grows together with *Polystachya concreta*, *Luisia zollingeri*, and *Taeniophyllum hasseltii*.

The Cymbidium species was found dead on the forest floor. The genus *Cymbidium* is recognized from its oval pseudobulbs covered by leaf sheaths. It is very difficult to determine the species without a flower. Same is the case with *Taeniophyllum* sp., which was also found in vegetative phase.

Image 1. Orchid species found on Nusa Barung Island: A—*Aerides odorata* | B—*Arachnis sulingi* | C—*Cymbidium* sp. | D—*Dendrobium crumenatum* | E—*Dendrobium macrostachyum* | F—*Eulophia picta* | G—*Liparis parviflora* | H—*Luisia zollingeri* | I—*Nervilia plicata* | J—*Nervilia simplex* | K—*Polystachya concreta.* © Toni Artaka.

Further surveys are recommended during the transition from the rainy to the dry season (October–March) to obtain more complete information on orchid species with possibly different phenological times. Several terrestrial orchids typical of the lowlands primarily grow with completed generative parts during these seasons (Artaka 2019). Expansion of the exploration area is also needed to reach the inland forest areas that have not been visited yet. This study also supports area managers for an updated biodiversity database, primarily as a source of natural orchid germplasm to support cultivation.

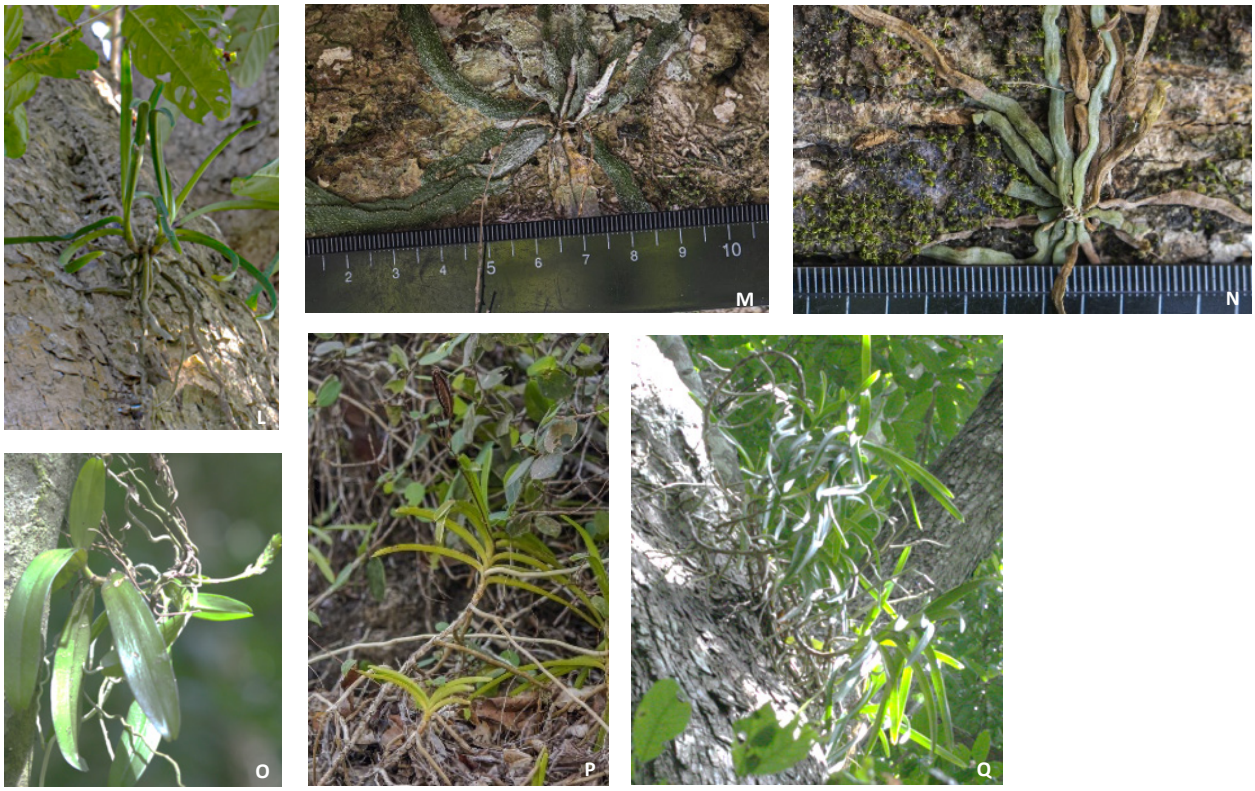

Image 1 cont. The orchid species found on Nusa Barung Island: L—*Rhynchostylis retusa* | M—*Taeniophyllum hasseltii* | N—*Taeniophyllum* sp. | O—*Thrixspermum raciborskii* | P—*Vanda limbata* | Q—*Vanda tricolor* © Toni Artaka.

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