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Exploration and Reintroduction of Orchid on the West Slope of Mount Lawu: Conservation Studies PT Pertamina Aviation Fuel Terminal Adi Sumarmo

Nova Dewi Soraya[1*], Bagas Cesar Bastomi[1], Julia Rizki Jumas[1], Zaenal Abidin[2], Harya Ramadanu[2]

Article Info

**Correspondence Author*
(1) PT Cipta Inovasi Berkelanjutan (Ailesh)
(2) PT Pertamina Aviation Fuel Terminal Adi Sumarmo

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Correspondence E-Mail: soraya@ailesh.id

Abstract

This study aimed to inventory the taxonomic diversity of Orchidaceae on the western slopes of Mount Lawu, a conservation area managed by PT Pertamina Aviation Fuel Terminal Adi Sumarmo. Through exploratory methods, 51 orchid taxa were identified with a total of 230 individuals. The Eria, Dendrobium, and Liparis genera dominated the species composition, with their distribution influenced by microhabitat characteristics. The significant presence of epiphytic species suggests a healthy forest canopy. Vegetative propagation efforts through tissue culture were successfully conducted on five selected species: Eria sp, Liparis sp, Dendrobium sp, Malaxidinae sp, and Vanda tricolor, with Dendrobium sp demonstrating the highest potential for vegetative propagation (26%). These findings open avenues for reintroduction programs of rare species into their natural habitats.

A conservation status assessment revealed that most species are not yet listed in the IUCN Red List, emphasizing the urgent need for further research and more intensive conservation efforts. Therefore, this study recommends the implementation of integrated in-situ and ex-situ conservation strategies to ensure the sustainability of orchid diversity within the Mount Lawu conservation area.

***Keywords*: Biodiversity; Exploration; Mount Lawu Slopes; Orchidaceae; Reintroduction**

Introduction

Orchids are one of the most diverse flowering plant families globally, ranking second only to Asteraceae with over 29,000 identified species (Willis, 2017; Zhao *et al.*, 2021). As a result, orchids have been a significant focus of botanists and conservationists. The high diversity of orchids, particularly in tropical regions like Indonesia and reflects their remarkable evolutionary adaptation to various habitats. With its diverse topography and supportive climate, Java Island is one of the centers of orchid diversity in Indonesia. Mount Lawu, an active volcano in Java, possesses a high potential for biodiversity, including orchids.

Previous studies have demonstrated the significant economic and ecological value of orchids. In addition to their aesthetic appeal, many orchid species contain bioactive compounds that have potential as sources of new medicines (Hinsley *et al.*, 2018). However, the natural habitats of orchids are increasingly threatened by climate change, land conversion, and excessive exploitation. Orchids are vulnerable to extinction due to their specific ecological requirements, including narrow habitat preferences, small populations, and high dependence on biological interactions with other organisms. This multitrophic dependence makes orchids highly susceptible to environmental disturbances, even on a small scale (Gale *et al.,* 2018). Consequently, orchid conservation efforts have become crucial for maintaining biodiversity sustainability and ecological balance.

This study aims to inventory the taxonomic diversity of Orchidaceae on Mount Lawu, a conservation area managed by PT Pertamina Patra Niaga AFT Adi Sumarmo. Through exploratory activities, the study will identify orchid species, analyze their distribution and habitat preferences, and assess their conservation status based on the IUCN Red List. The International Union for Conservation of Nature (IUCN) Red List is a global database that evaluates the conservation status of plant, animal, and fungi species. This identification will serve as the foundation for orchid reproduction in vitro. Tissue culture techniques are selected due to their potential for producing large quantities of orchids in a relatively short time. This reintroduction activity is expected to contribute to increasing orchid populations in the wild and ensuring their sustainability.

Method

Exploration of Orchid

This research was conducted in the Natural Forest Area and along the Mount Lawu climbing path via Tambak, within the Tahura KGPAA Mangkunagoro I, Karanganyar, Central Java, in June 2024. Data were collected using the transect method, with observation paths selected based on accessibility. All individual orchids encountered were visually documented using cameras and morphologically identified with the aid of literature. The collected diversity data were analyzed quantitatively to determine species composition, species richness, and diversity index. Additionally, a conservation status assessment was conducted based on the IUCN Red List to identify endangered species.

Multiplication of Orchid

The techniques and methods employed for orchid reproduction include tissue culture or in vitro culture. Orchid reproductions using in vitro culture are highly recommended because in vitro cultured plants possess the same characteristics as their parent plants. Tissue culture is a technique involving the isolation of tissues, organs, cells, or plant protoplasm for use as explants. The resulting explants are then cultivated on sterile growth media, allowing for growth, development, organogenesis, and ultimately the production of complete plants (Mattjik, 2005). Tissue culture or in vitro culture techniques encompass seed culture, organ culture, callus culture, cell suspension culture, protoplasmic culture, and haploid culture. The

orchid reproduction process includes explant selection, explant sterilization, culture media preparation, and planting and incubation. Prior to in vitro culture, it is essential to understand laboratory procedures. Laboratory procedures involve the proper use of tools and materials to ensure hygiene, health, and safety during laboratory work aimed at orchid reproduction through in vitro culture methods (LAF).

Reintroduction to Nature

Orchid reintroduction is an attempt to establish an endangered orchid population within its original habitat. Reintroduction can be an effective strategy for restoring biodiversity and protecting endangered orchid species. Successful orchid reintroduction requires careful consideration of several factors essential for orchid growth, including environmental conditions, habitat compatibility, and the availability of necessary natural resources (Dixon *et al.,* 2003). Reintroduction is an innovative program that bridges the gap between in-situ and ex-situ conservation efforts. The steps involved in orchid reintroduction include proper species selection, preparation of orchids prior to planting in a new habitat, selection of a suitable location that closely resembles the original orchid habitat, and intensive monitoring of the reintroduced orchids (Newell, 2004). The conservation flow, encompassing in-situ, ex-situ, and reintroduction efforts, is illustrated in the figure below:

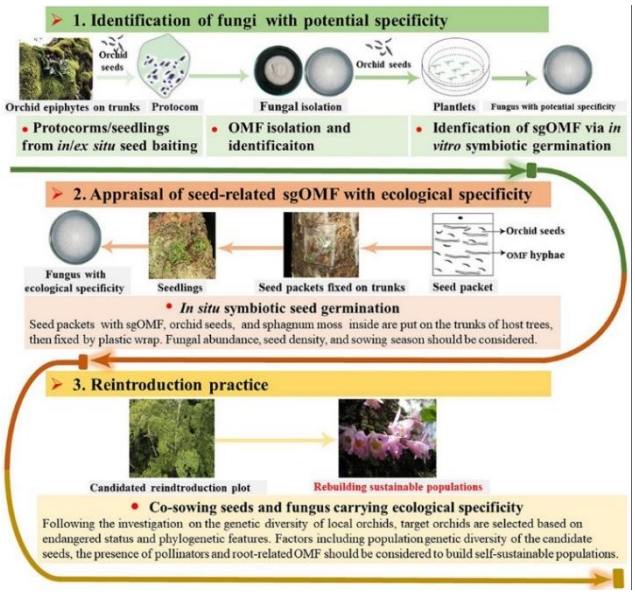

Figure 1. Conservation Flow In/Ex Situ and Reintroduction

Sources: Zhao D-K *et al.,* 2021

Plot sampling is a commonly used method in ecological studies to monitor the success of orchid and other vegetation reintroductions. The plot is located within Tahura KGPAA Mangkunagoro I, with coordinates 7° 37' 22" S 111° 08' 09" E, and has a monitoring area of 20 meters by 20 meters. The plot is marked with a rope to facilitate orchid monitoring.

Discussion

Exploration Findings

An exploration of orchid diversity on the western slopes of Mount Lawu in Karanganyar, Central Java, along the Mount Lawu hiking trail via Tambak up to an altitude of 1,840 meters above sea level successfully identified 51 orchid species with a total of 230 individuals, indicating significant species richness in this area. The identified orchid species are listed in the table below.

Table 1. Types of orchids on the West slopes of Mount Lawu

No	Orchid Species	Local Name	Individual Count	Habitus	IUCN Status
1	*Aerides javanica*	Anggrek javan	5	Epifit	-
2	*Aerides odorata*	Anggrek larat	1	Epifit	-
3	*Agrostophyllum* sp.	Anggrek daun rumput	4	Epifit	-
4	*Anoectochilus flavescens*	Anggrek daun polka	1	Terestrial	-
5	*Appendiculate* sp.	Anggrek dagu	1	Epifit	-
6	*Appendicula angustifolium*	Anggrek pita	11	Epifit	-
7	*Appendicula ramosa*	Anggrek berantai	1	Epifit	-
8	*Appendicula* sp.	Anggrek ranting	2	Epifit	-
9	*Arachnis flos-aeris*	Anggrek kalajengking,	1	Epifit	LC
10	*Arundina graminifolia*	Anggrek buluh/bambu	1	Terestrial	LC
11	*Bulbophyllum longerepens*	Anggrek kelopak panjang	1	Epifit	-
12	*Calathea flava*	Calathea kuning	1	Terestrial	-
13	*Calathea* sp.	Calathea, kembang setaman	8	Terestrial	-
14	*Coelogyne miniata*	Anggrek batu	1	Epifit	-
15	*Corybas umbrosus*	Anggrek helm	8	Terestrial	-
16	*Cryptostylis arachnites*	Anggrek manis	7	Terestrial	-
17	*Cymbidium lancifolium*	Anggrek lanset, pedang	4	Epifit	-
18	*Dendrobium* sp.	Anggrek dendrobium, Anggrek sekrop	17	Epifit	-
19	*Eria multiflora*	Anggrek eria	1	Epifit	-
20	*Eria* sp.	Anggrek eria	19	Epifit	-
21	*Flickingeria grandiflora*	Anggrek sabun, Anggrek rumbai	2	Epifit	-
22	*Godera viridiflava*	Anggrek pelakat	4	Terestrial	-
23	*Goodyera viridiflora*	Anggrek tali ayam	9	Epifit	-
24	*Habenaria* sp.	Anggrek bintang, Anggrek star	9	Terestrial	-
25	*Liparis pallida*	Anggrek liparis pucat	9	Terestrial	-
26	*Liparis sp.*	Anggrek liparis	16	Epifit	-
27	*Macodes petola*	Anggrek petola, Anggrek batik	2	Terestrial	-
28	*Malaxidinae* sp.	Anggrek bayangan	15	Terestrial	-
29	*Oberonia* sp.	Anggrek	4	Epifit	-
30	*Hetaeria oblongiofolia*	Anggrek	3	Terestrial	-
31	*Nervilia punctata*	Anggrek tahi cicak, Anggrek titik	4	Terestrial	-
32	*Nervilia* sp.	Anggrek nervilia	2	Terestrial	-

No	Orchid Species	Local Name	Individual Count	Habitus	IUCN Status
33	*Oberonia*	Anggrek kuku macan, Anggrek angin	1	Terestrial	-
34	*Oberonia similis*	Anggrek mirip oberonia	4	Terestrial	-
35	*Pholidota* sp.	Anggrek batang	14	Epifit	-
36	*Phreatia sp*	Anggrek tanah	2	Epifit	-
37	*Dendrochilum sp*	Anggrek dendro	12	Epifit	-
38	*Rhomboda cristata*	Anggrek kristal, Anggrek rhomboda	1	Terestrial	-
39	*Rhyneostilis retusa*	Anggrek siger	1	Terestrial	-
40	*Schoenorchis juncifolia*	Anggrek juncus, Anggrek anyelir	1	Terestrial	-
41	*Spathoglottis* sp.	Anggrek tanah, Anggrek bumi	1	Terestrial	-
42	*Taeniophyllum glandulosum*	Anggrek taeniophyllum	1	Terestrial	-
43	*Taeniophyllum* sp.	Anggrek kecil	1	Terestrial	-
44	*Thelymitra javanica*	Anggrek telymitra, Anggrek cendrawasih	1	Terestrial	-
45	*Thricotosia ferox*	Anggrek serigala	1	Terestrial	-
46	*Pinalia* sp.	Anggrek	7	Epifit	-
47	*Trichoglottis* sp.	Anggrek trichoglottis	1	Terestrial	-
48	*Trixspermum* sp.	Anggrek trixspermum	3	Terestrial	-
49	*Vrydagzynea albida*	Anggrek	1	Terestrial	-
50	*Vanda tricolor*	Anggrek vanda, Anggrek berwarna	2	Epifit	-
51	*Vanda limbata*	Anggrek vanda, Anggrek ekor	1	Epifit	-
Total number of Individual Counts			**230**		
Total Species			**51**		

Sources: Primary Research Data, 2024

Table 1 shows that the orchid species with the highest abundance is *Eria* sp. with a total of 19 individuals out of all species. *Eria* sp. is an epiphytic orchid associated with trees as a support or place to grow. Additionally, the orchid species with the second-highest abundance is *Dendrobium* sp. with 17 individuals. This is followed by *Liparis sp* with 16 individuals. The dominance of the *Eria*, *Dendrobium*, and *Liparis* genera indicates their good adaptation to local environmental conditions. Previous studies by Solvia (2005) suggested a certain altitude preference for several genera, such as *Phalaenopsis*, *Oncidium*, and *Dendrobium*, which are dominant at elevations between 500 and 700 meters above sea level. The results of this study align with the finding that *Dendrobium* is the most commonly found genus. Furthermore, *Liparis* sp. was found abundantly at an altitude of 1,400 meters above sea level, suggesting the existence of an altitudinal distribution pattern.

The presence of a large number of orchid species in this area indicates that Mount Lawu possesses unique ecological characteristics that support the growth and development of orchids. Most orchid species found are terrestrial, but significant epiphytic species suggest that the forest canopy remains in good condition. This uniqueness is influenced by factors

such as altitude, rainfall, and vegetation type. Anthropogenic disturbances, such as deforestation and the collection of wild orchids, have a significant impact on the distribution and diversity of orchids on Mount Lawu. This finding reinforces the claim that Mount Lawu is one of the centers of orchid diversity in Java.

Conservation status analysis reveals that most species are not yet listed in the IUCN Red List, indicating a lack of research data but also suggesting the potential for very high orchid diversity. Only a few species, such as *Arachnis flos-aeris* and *Arundina graminifolia*, are classified as Least Concern, which can serve as early indicators of the potential on Mount Lawu. This underscores the urgent need for further research to assess the conservation status of all species and develop effective conservation strategies.

Multiplication of Orchid

Orchid reproduction was conducted using in vitro culture. The orchid explants that **have** been cultivated in vitro produced 95 orchid seedlings. The number of orchid explants that survived in each growing medium varied. The orchid with the most surviving explants was the *Dendrobium sp.* orchid species. The results of orchid propagation through in vitro culture can be seen in the figure below.

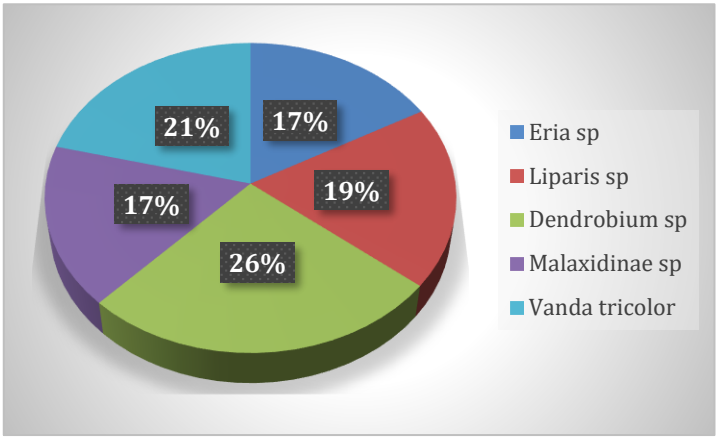

Figure 2. Percentage of Orchid Seeds that Grow

Sources: Primary Research Data, 2024

The results of in vitro culture demonstrated that *Dendrobium sp* orchids exhibited the highest percentage of explant growth at 26%, or approximately 25 seedlings out of all orchids cultured in vitro. Dendrobium orchids are a genus of orchids native to Halmahera (Maluku), Sulawesi, and Sunda. According to the Royal Horticultural Society (RHS), Dendrobium orchids have 169 types of crosses utilizing *Dendrobium stratiotes Rchb.f.* as a cross parent, 104 as a male parent, and 65 as a female parent, resulting from interspecific and intersectional crosses (Orchidroots, 2022). Several types of *Dendrobium* sp. orchids can thrive at elevations between 500 and 700 meters above sea level, while the *Dendrobium jacobsoni* orchid species grows in groups at elevations ranging from 2,200 to 3,000 meters above sea level. The *Vandatricolor* orchid exhibited the second-highest percentage of explant growth after *Dendrobium* sp., with a percentage of 21%, or approximately 20 seedlings.

Reintroduction and Monitoring

Reintroduction is an innovative conservation strategy aimed at preserving biodiversity in nature. Orchid reintroduction is implemented following the completion of in vitro culture reproduction. Orchids produced through in vitro cultivation are returned to their native habitats, considering factors that support their growth and development. Orchids from in vitro culture were reintroduced at a location with coordinates 7° 37'22" S 111° 08'09" E,

adjacent to the Tahura KGPAA Mangkunagoro I office. The location of the orchid reintroduction can be seen in the figure below.

Figure 3. Orchid Reintroduction Monitoring Sampling Plot Area

Sources: Primary Research Data, 2024

During the monitoring process, a 20-meter by 20-meter plot was established. A total of 95 orchid seedlings from in vitro culture were planted at the designated reintroduction location. The orchid monitoring process was conducted for 30 days to observe the growth and development of the orchids. Orchids thrive in environments with temperatures ranging from 20°C to 30°C, humidity levels between 60% and 80%, and altitudes of 700 to 1,400 meters above sea level (Gunawan, 2019).

Conclusion

This study successfully inventoried 51 species of orchids, comprising a total of 230 individuals, on the western slopes of Mount Lawu, demonstrating significant species richness in the area. The dominance of the *Eria*, *Dendrobium*, and *Liparis* genera suggests specific morphological and physiological adaptations to local environmental conditions. The tissue culture results indicated the potential of *Dendrobium* sp. as a promising candidate for in vitro vegetative reproduction efforts, with a growth rate of 26%, making it suitable for reintroduction. These findings underscore the importance of Mount Lawu as one of the centers of orchid diversity in Java. However, further research is necessary to comprehensively understand the conservation status of each species, as well as the environmental factors that influence its distribution and abundance. This information is vital for developing effective conservation strategies, including reintroduction activities. This study recommends the implementation of integrated in-situ and ex-situ conservation strategies to ensure the sustainability of orchid diversity within the Mount Lawu conservation area.

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