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Exploration, Morphological Characterization, and Phenetic Relationship Analysis of Eria Orchids in Pancasari Forest, Bali

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ABSTRACT

Orchids (*Orchidaceae*) are among the most diverse and economically important ornamental plants in Indonesia. The genus *Eria* comprises epiphytic orchids with ecological, conservation, breeding, and potential pharmacological value; however, its local diversity remains insufficiently documented in several forest habitats. This study aimed to explore, identify, and characterize *Eria* orchids in Pancasari Forest, Bali, and to assess their morphology-based phenetic relationships. Field exploration was conducted from June to December 2024. Species identification was performed using literature-based morphological comparison and interviews with local orchid collectors, whereas characterization included vegetative and reproductive characters of stems, leaves, flowers, and pseudobulbs. Qualitative and quantitative morphological data were analyzed descriptively and subjected to cluster analysis using the UPGMA (Unweighted Pair Group Method with Arithmetic Mean) method in Minitab 19. Four *Eria* species were recorded and characterized: *Eria hyacinthoides*, *Eria iridifolia*, *Eria multiflora*, and *Eria verruculosa*. The species differed in leaf shape, leaf margin, leaf apex, leaf surface texture, flower type, flowering position, aroma, sepal and petal morphology, and several quantitative characters such as stem or pseudobulb length, leaf size, flower diameter, and pseudobulb diameter. Cluster analysis indicated that the recorded taxa/accessions were separated into distinct phenetic groups with low similarity, suggesting considerable morphological divergence. The results provide baseline information for local orchid conservation and may support future breeding programs, although molecular validation is recommended to confirm taxonomic and phylogenetic relationships.

Keywords: *Eria*, exploration, morphological characterization, orchid conservation, phenetic relationship

INTRODUCTION

Orchids (*Orchidaceae*) are among the most admired flowering plants worldwide, and Indonesia is recognized as one of the major centers of orchid diversity. Flower color, size, number of florets per inflorescence, floral arrangement, number of flower stalks, and flower longevity are important attributes that determine the ornamental value of orchid plants (Banu et al., 2023).

Indonesia ranks second after Brazil in orchid germplasm richness. Approximately 5,000-6,000 orchid species have been reported from Indonesian forests, and the number continues to increase as new species and endemic taxa are discovered (Djufri et al.,

2015). Orchid cultivation also has economic potential because it can increase community income through ornamental plant production and ecotourism-related activities (Semiarti et al., 2020).

Eria is one of the diverse genera within *Orchidaceae*. Members of this genus are mostly epiphytic and have been reported to possess potential uses as medicinal plants (Nurfadilah, 2023). More than 800 *Eria* species have been described, with a distribution that includes tropical regions, Polynesia, Australia, and islands in the Pacific region (Wololi et al., 2021). Despite their diversity, *Eria* orchids are less popular commercially than several other orchid genera because of their relatively small flowers and short floral longevity. Nevertheless, their environmental adaptability and unique morphological traits make them important for conservation, germplasm documentation, and breeding studies.

Exploration and morphological characterization are essential for documenting local orchid germplasm, particularly in natural habitats such as Pancasari Forest, Bali. Exploration involves searching, collecting, documenting, and characterizing available germplasm (Asril et al., 2022). Morphological characterization remains a simple, efficient, and widely used approach for orchid studies (Baldi et al., 2017; Fatimah, 2013). Morphological data can also be used to analyze phenetic relationships among species through similarity-based clustering (Kundariati et al., 2021).

Because *Eria* orchids show high morphological diversity, characterization is necessary to identify distinctive traits and understand relationships among species (Kartikaningrum et al., 2004). Therefore, this study focused on the exploration, morphological characterization, and phenetic relationship analysis of *Eria* orchids found in Pancasari Forest, Bali.

MATERIALS AND METHODS

Study site and period

The study was conducted in the Pancasari area, Bali, which is considered a suitable habitat for natural *Eria* orchids. Field exploration was carried out from June to December 2024. The research location was selected based on preliminary information obtained through direct interviews with natural orchid collectors in the Baturiti area.

Tools and materials

The tools used for characterization included a Global Positioning System (GPS), ruler, caliper, digital camera, pruning scissors, black cloth background, laptop, and stationery. Orchid specimens encountered during exploration were documented and characterized in the field.

Identification procedure

Identification was conducted to determine the scientific names and origin of the samples used in the study. The identification process was based on literature review, online reference sources, and interviews with orchid growers or collectors. For publication-quality taxonomic validation, future versions should include explicit identification keys, herbarium voucher numbers, accession codes, and confirmation against accepted taxonomic databases.

Morphological characterization

Morphological characterization was performed through field surveys and direct documentation of vegetative and reproductive plant parts. The main observed characters included stem, leaf, flower, and pseudobulb traits. Stem growth habit was recorded as monopodial or sympodial. Leaf characters included shape, margin, apex, surface texture, and symmetry. Flower characters included flower shape, type and position of inflorescence, aroma, sepal and petal shape,

color pattern, and labellum morphology. Pseudobulb characters were recorded based on shape and size.

Data analysis

Morphological variation was analyzed descriptively based on direct observations and photographic documentation. Qualitative and quantitative morphological characters were further analyzed using cluster analysis. The UPGMA (Unweighted Pair Group Method with Arithmetic Mean) method was applied using Minitab Statistical Software 19. Quantitative data were standardized before cluster analysis, and the resulting dendrogram was interpreted to describe phenetic relationships among the recorded species or accessions. Because the analysis was based only on morphology, the term phenetic relationship is more appropriate than phylogenetic relationship unless molecular data are added.

RESULTS AND DISCUSSION

Eria species recorded during exploration

Four *Eria* species were recorded during exploration in Pancasari Forest: *Eria multiflora*, *Eria iridifolia*, *Eria hyacinthoides*, and *Eria verruculosa*. Representative images of the recorded species are shown in Figure 1.

Eria multiflora

Eria iridifolia

Eria hyacinthoides

Eria verruculosa

Figure 1. Eria orchids recorded during exploration in Pancasari Forest, Bali

Eria multiflora

Eria multiflora was recorded as an epiphytic orchid with sympodial growth through lateral shoots. It had needle-shaped leaves, serrated margins, sharply pointed apices, glabrous surfaces, and symmetrical leaf form. The flowers were star-shaped, arranged in racemose inflorescences emerging from the shoot apex, and produced a distinctive aroma that may function as a pollinator attractant. The obovate sepals and elliptic petals, together with a centrally notched labellum, provide useful diagnostic traits for this species.

Eria iridifolia

Eria iridifolia showed sympodial epiphytic growth. The leaves were lanceolate, entire-margined, tapered at the apex, glabrous, and asymmetrical, which distinguished this species from the other observed taxa. Its star-shaped flowers were arranged in racemose inflorescences arising from the shoot apex. The flowers were aromatic, with oblong sepals and rhomboid petals bearing patterned coloration. The apically notched labellum is a taxonomically important structure that may guide visiting pollinators.

Eria hyacinthoides

Eria hyacinthoides was characterized by sympodial epiphytic growth, lanceolate leaves, entire margins, pointed apices, wrinkled leaf surfaces, and symmetrical leaf form. The flowers were star-shaped and arranged in racemose inflorescences arising from the shoot apex. Unlike several other recorded taxa, the flowers did not have a distinct aroma. The elliptic sepals and oblong petals had relatively uniform coloration, while the centrally notched labellum represented a key morphological feature.

Eria verruculosa

Eria verruculosa was observed as a sympodial epiphytic orchid with narrow needle-like leaves, entire margins, torn apices, glabrous surfaces, and asymmetrical leaf form. Its flowers were star-shaped and solitary, arising from the side of the stem, and lacked a distinct aroma. The oblong sepals and rhomboid petals showed differential coloration, with more uniform sepals and patterned petals. The centrally notched labellum differentiates this species from taxa with an apically notched labellum.

Qualitative morphological characters

The qualitative morphological characters of the four *Eria* species are summarized in Table 1. The four species shared sympodial growth and star-shaped flowers, but differed in leaf shape, leaf margin, leaf apex, leaf texture, leaf symmetry, flowering type, flowering position, flower aroma, and sepal-petal morphology.

Quantitative morphological characters

Quantitative characters also varied among the four *Eria* species (Table 2). *Eria iridifolia* had the longest stem or pseudobulb (8.3 cm), whereas *Eria multiflora* had the shortest (7.3 cm). *Eria hyacinthoides* showed the largest stem diameter (2.7 cm), longest leaves (27.3 cm), widest leaves (5.0 cm), and the largest flower diameter (1.5 cm), indicating strong vegetative and floral development. *Eria iridifolia* had the largest pseudobulb diameter (2.4 cm), which may be associated with water and nutrient storage capacity in epiphytic habitats.

Phenetic relationship among Eria species/accessions

Phenetic relationship analysis was performed using 19 morphological characters, including qualitative characters (leaf shape, flower morphology, color pattern, and flowering position) and quantitative characters (stem, leaf, flower, and pseudobulb dimensions). UPGMA clustering using squared Euclidean distance grouped the

recorded taxa/accessions according to morphological similarity. The low similarity among groups indicates marked morphological divergence among the observed *Eria* taxa. In breeding programs, morphologically divergent parents may provide wider variation; however, breeding recommendations should be supported by reproductive compatibility tests and molecular data.

Table 1. Qualitative morphological characters of four Eria species recorded in Pancasari Forest

Character	E. hyacinthoides	E. iridifolia	E. multiflora	E. verruculosa
Growth habit	Sympodial	Sympodial	Sympodial	Sympodial
Leaf shape	Lanceolate	Lanceolate	Needle-shaped	Needle-shaped
Leaf margin	Entire	Entire	Serrated	Entire
Leaf apex	Pointed	Tapered and pointed	Sharply pointed	Torn
Leaf surface texture	Wrinkled	Glabrous	Glabrous	Glabrous
Leaf symmetry	Symmetrical	Asymmetrical	Symmetrical	Asymmetrical
Flower shape	Star-shaped	Star-shaped	Star-shaped	Star-shaped
Inflorescence type	Raceme	Raceme	Raceme	Solitary flower
Flowering position	Shoot apex	Shoot apex	Shoot apex	Lateral side of stem
Flower stalk posture	Erect	Erect	Erect	Erect
Flower aroma	Non-aromatic	Aromatic	Aromatic	Non-aromatic
Sepal shape	Elliptic	Oblong	Obovate	Elliptic
Dorsal sepal color pattern	Uniform	Patterned	Uniform	Uniform
Lateral sepal color pattern	Uniform	Patterned	Uniform	Uniform
Petal shape	Oblong	Rhomboid	Elliptic	Rhomboid
Petal color pattern	Uniform	Patterned	Uniform	Patterned/lineated
Sepal and petal apex	Pointed	Pointed	Pointed	Pointed

Table 2. Quantitative morphological characters of four Eria species recorded in Pancasari Forest

Character	E. hyacinthoides	E. iridifolia	E. multiflora	E. verruculosa
Stem/pseudobulb length (cm)	8.2	8.3	7.3	8.1
Stem diameter (cm)	2.7	2.2	2.2	2.5
Leaf length (cm)	27.3	26.4	26.2	26.4
Leaf width (cm)	5.0	4.8	4.7	5.0
Flower diameter (cm)	1.5	1.2	1.2	1.2
Flower stalk diameter (cm)	0.3	0.3	0.3	0.3
Flower stalk length (cm)	22.6	22.2	22.9	21.1
Pseudobulb diameter (cm)	2.1	2.4	2.2	2.1

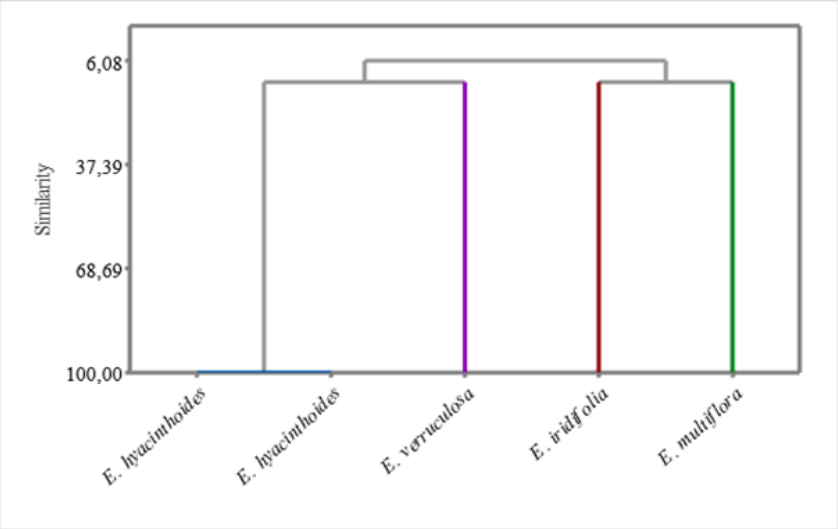

Figure 2. UPGMA dendrogram of Eria orchids based on morphological characters. Note: the source figure contains two terminal labels for E. hyacinthoides; accession codes should be clarified before journal submission

The dendrogram indicates that the observed materials formed distinct groups. Because the analysis was based on morphological characters only, the results should be interpreted as phenetic similarity rather than phylogenetic relationship. The repeated *E. hyacinthoides* label in the source dendrogram should be clarified by adding accession numbers or regenerating the dendrogram from the final character matrix. This clarification is important because the text reports four species, whereas the dendrogram appears to contain five terminal entries representing four species or accessions.

CONCLUSION

Four *Eria* species from Pancasari Forest, Bali, were morphologically characterized: *Eria hyacinthoides*, *Eria iridifolia*, *Eria multiflora*, and *Eria verruculosa*. The species differed in leaf apex, leaf margin, leaf texture, flower aroma, flowering type, flowering position, sepal and petal morphology, and several quantitative traits. The recorded *Eria* species showed qualitative and quantitative morphological variation, particularly in inflorescence type, flowering position, flower aroma, sepal and petal shape, and sepal-petal color pattern. Morphology-based UPGMA analysis indicated low similarity among the observed taxa/accessions, suggesting wide phenetic divergence. This information may support germplasm documentation and preliminary parent selection in breeding programs, although molecular analysis is required to verify phylogenetic relationships more accurately. Further research should include molecular markers, herbarium voucher deposition, GPS-based habitat documentation, population size estimation, and clear accession coding to strengthen taxonomic validity and conservation value.

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