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Short Communication

Identification of *Dendrobium* (Orchidaceae) in Liwa Botanical Garden Based on Leaf Morphological Characters

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Submitted: 03 September 2020; Accepted: 09 February 2021; Published online: 02 March 2021

ABSTRACT

Orchid is one of the most popular ornamental plants in the world. One of the orchid genera that is collected in a large number and known to have high morphological variations in the Liwa Botanical Garden is *Dendrobium*. However, to date, many *Dendrobium* collections have not been identified. Given the urgency of identification and the limitations of specimens in the field, especially flower organs, this study is important. This study aims to determine variations in morphological characters, phenetic relationships, and to identify *Dendrobium* collections based on leaf morphological characters in the Liwa Botanical Garden. Five accessions of *Dendrobium* were collected, namely CAT140, CAT 144, CAT 271, CAT 274, and IR015. Observation of 11 morphological characters leaves showed that leaf had high variations. The phenetic relationship based on the Gower similarity value and the UPGMA method shows that the *Dendrobium* in the Liwa Botanical Garden can be classified into 2 main groups formed with a similarity index value of 0.813. Based on Principle Component analysis values, it is known that the characters that have a large influence on grouping are the ratio of leaf length and width, leaf cross section, and leaf arrangement. The phenetic dendrogram topology is supported by the morphological character classification. The results of this study are expected to be basic information in the identification of natural orchids and conservation efforts in the Liwa Botanical Garden.

Keywords: orchid, morphological leaf, identification, *Dendrobium*, UPGMA, Liwa Botanical Garden

Orchidaceae (orchids) is one of the biggest plant families that consist of approximately 25,000 species belongs to over 900 genera across the world. Orchids have high variations in the morphology of the flowers, leaves, and stems (pseudobulbs). *Dendrobium* is one of the orchid genera containing a large number of species (approximately 1500 species) widely spread across the world, from Japan, China, India, the Malacca Peninsula, Indonesia, the island of Papua, to Australia. This orchid has a charming flower (Dressler 1993; Kartikaningrum et al. 2004; Kumalawati et al. 2011; Hartati & Darsana 2015).

Dendrobium comes from the words "dendro" (tree) and "bios" (life). *Dendrobium* means orchids that grow on a living tree. *Dendrobium* has various shapes, sizes, and colors of flowers. Flowers that have bloomed can last in

one day to more than 30 days and each stem can have one to more than 20 flowers. Many *Dendrobium* grows at locations with an altitude less than 400 meters above sea level ([Pang et al. 2012](#); [De et al. 2015](#); [Darmawati et al. 2018](#); [Indraloka et al. 2019](#); [Zahara & Win 2019](#); [Yuan et al. 2020](#)).

The Liwa Botanical Garden located in West Lampung Regency (Lampung, Sumatra island) is an institution that performs ex situ conservation of plants including orchids. Orchids have been given high priority in conservation because many orchids are threatened in the wild because of exploitation and overcollection for economic reasons that lead to the population decline and disappearance of many orchid species. Another threatening factor is deforestation causing the loss and damage of orchids, a natural habitat that will lead to the extinction of orchids. Liwa Botanical Garden has an important role in the preservation and conservation of plants including orchids. Many orchid species have been collected from the natural habitats for conservation purposes in the Liwa Botanical Gardens. However, many orchid species have not yet been identified in these gardens ([Solihah 2015](#); [Adi et al. 2019](#); [Mahfut et al. 2019](#)).

Identification of orchid species is important in orchid conservation. The present study focussed on the identification of some specimens of *Dendrobium* (one of the largest orchid genera) that will be based on the morphological characters as one of the important tools in the plant's taxonomic and systemic basis. The morphological characters that will be used in the present study are leaf morphology. Given the urgency of identification and the limitations of specimens in the field, especially flower organs, this study is important. This study aims to determine variations in morphological characters and phenetic relationships for the identification of *Dendrobium* in the Liwa Botanical Garden. The results of this study are expected to serve as basic information in the identification of natural orchids to support conservation in the Liwa Botanical Garden.

Sample collection

Sample collections that were identified based on leaf morphological characters included 5 accessions with sample codes CAT140, CAT 144, CAT 271, CAT 274, and IR015 (Table 1). *Dendrobium* samples were chosen based on orchid data that had not yet been identified. Overall, the sample accessions are native orchids to Lampung.

Table 1. List of accessions of *Dendrobium* samples in the Liwa Botanical Garden.

No. Acc.	Species	Origin Location
CAT140	<i>Dendrobium</i> sp.	Bukit Barisan Selatan National Park
CAT144	<i>Dendrobium</i> sp.	Seminung Forest
CAT271	<i>Dendrobium</i> sp.	Bukit Barisan Selatan National Park
CAT274	<i>Dendrobium</i> sp.	Bukit Barisan Selatan National Park
IR015	<i>Dendrobium</i> sp.	Bukit Barisan Selatan National Park

The morphological identification






The morphological identification was performed by direct observation to the leaf morphology characters including leaf shape, length (L) and width (W) tip shape, cross section, arrangement, edge shape, surface texture, symmetry, and arrangement ([Dressler 1993](#); [Kartikaningrum et al. 2004](#); [Hartati & Darsana 2015](#)).

Based on observations of morphological characters, orchid plants have a high variation. These variations were found in habitus, pseudobulb, leaves, and flowers ([Dressler 1993](#); [Kartikaningrum et al. 2004](#); [Hartati & Darsana](#)

2015). In this research characterization of the flower was not performed because limited specimens were obtained in the field and had not flowered yet.

Based on observations, *Dendrobium* leaves are known as the most varied organs (Table 2). Variations in leaf characters included leaf shape (S), length (L), width (W), tip shape, cross section, arrangement, edge shape, surface texture, and symmetry. Overall, the accession of *Dendrobium* samples at the Liwa Botanical Garden showed different morphological characters of the leaves, namely the cross-section. The leaf cross section of samples with accession numbers CAT 274, CAT 140, and IR 015 are semi terete, whereas that of a sample with accession number CAT 144 is terate and CAT 271 is flat. In addition, leaf arrangement was found in all samples are alternate.

Table 2. Leaf Type of Accession of *Dendrobium* samples in the Liwa Botanical Garden. Bar = 1 cm.

No. Acc	Leaf Shape
CAT140	
CAT144	
CAT271	
CAT274	
IR015	

The ratio difference between leaf length and width between the five accessions show that the shapes of the leaves of the five accessions are different. The complete identification of the morphology of the leaves of the *Dendrobium* accession sample at the Liwa Botanical Garden is presented in Table 3.

Table 3. Variation of morphological characters of the accession of *Dendrobium* samples in the Liwa Botanical Garden.

Morphology Character	CAT 274	CAT 144	CAT 140	IR 015	CAT 271
Leaf Shape (S)	Ovate	Triangular	Oblong	Lanceolate	Llinear
Length (L) and width (W) of leaf	L: 4,5 cm W: 1 cm	L: ±1,7 cm W: 0,5 cm	L: 9,5 cm W: 1,5 cm	L: 8 cm W: 2 cm	L: 8,5 cm W: 1,5 cm
Leaf Tip	Obtuse	Acuminate	Obtuse	Acute	Acuminate
Leaf Cross Section	Semi terete	Terete	Semi terete	Semi terete	Flat
Arrangement of Leaves	Alternate	Alternate	Alternate	Alternate	Alternate
Leaf Edge	Frayed (flat)	Frayed (flat)	Frayed (flat)	Frayed (flat)	Frayed (flat)
Leaf Surface Texture	Hairless (smooth)	Hairless (smooth)	Hairless (smooth)	Hairless (smooth)	Hairless (smooth)
Leaf Symmetry	Symmetry	Symmetry	Symmetry	Symmetry	Symmetry

Based on Table 3, it is known that most of the accessions of *Dendrobium* samples in the Liwa Botanical Garden showed different morphological characters in the leaves.

Phenetic Analysis

The Phenetic analysis is performed through cluster analysis methods and Principal Component Analysis (PCA). Cluster analysis begins with the morphological character scoring, then the Gower (Gower's General Similarity) similarity value is calculated which results in a matrix of similarity between accessions. Data matrix similarity is done by agglomerative hierarchical clustering using the UPGMA method and displayed in the form of a dendrogram.

Phenetic analysis on *Dendrobium* is performed through 2 methods, namely cluster analysis, and PCA. Cluster analysis begins with the morphological character scoring, then the Gower (Gower's General Similarity) similarity value is calculated which results in a matrix of similarities between accessions. Then the similarity matrix data is done by agglomerative hierarchical clustering using the UPGMA method. The results of cluster analysis of 5 *Dendrobium* accessions based on the characters produced by the dendrogram are presented in Figure 1.

Grouping the sample based on the level of similarity between accessions calculated using the gower coefficient formula and UPGMA was chosen for the clustering technique to produce a dendrogram showing 2 main groups formed with a similarity index value of 0.813 marked as group A and group B. Group A consists of CAT 144 which has a distinguishing character that distinguishes from group B, namely the cross section of the double leaf character (Figure CAT 144). Group B consists of CAT 140, CAT 271, IR 015, and CAT 274 which have symmetrical cross-section characters (Figure CAT 140, CAT 271, IR 015, and CAT 274). Group B is divided into 2 sub-groups with a similarity index value of 0.861 marked with B1 and B2

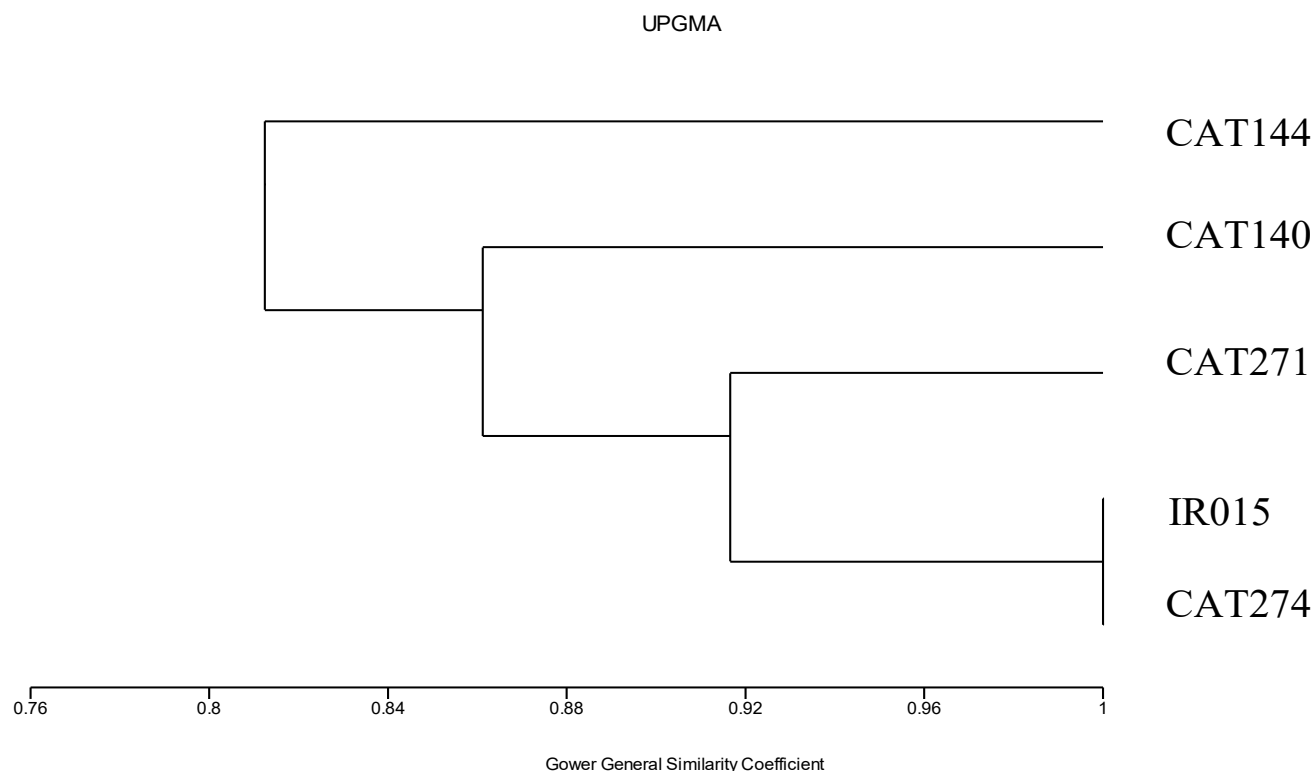


Figure 1. Dendrogram of 5 accessions *Dendrobium* samples from the Liwa Botanical Garden using UPGMA.

on the dendrogram. Characters that show the difference on ratio of the length and width of the leaf and leaf arrangement are same in all samples. Subgroup B1 consists of CAT 140, while subgroup B2 consists of CAT 271, IR 015, and CAT 274. B2 subgroups are divided into 2 namely B2a and B2b based on differences in leaf length and width ratios. The grouping of IR 015 and CAT 274 in one B2b group with a similarity level of 100% indicates that they are the same type. Based on the PCA values, it can be seen that the characters that have a large influence on grouping are the ratio of leaf length and width (PLD), leaf cross section (PMD), and leaf arrangement (DKD).

AUTHOR CONTRIBUTION

M is the main researcher who conceptualized and collected data. He did data analysis and interpretation and drafted and finalized this manuscript. S is the supervisor at Liwa Botanical Garden, he is with TTH and SW are provided the guidance from conceptualization of the research objectives, methodology, data collection, analysis, and interpretation of the results. All were key in the development, drafting later on and finalizing of this manuscript.

ACKNOWLEDGMENTS

This research was funded by Lembaga Penelitian dan Pengabdian Masyarakat (LPPM), Universitas Lampung through the DIPA BLU 2020 Grant with contract number 1492 / UN26.21 / PN / 2020. Thank you to Liwa Botanical Garden who facilitated the research. This activity is a continuation of the collaboration program with Department of Biology, Faculty of Mathematics and Natural Science, Universitas Lampung.

CONFLICT OF INTEREST

The authors report no conflicts of interest regarding the research or the research funding.

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