Short Communication

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

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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 focused 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 6 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  | Dendrobium sp.    | Bukit Barisan Selatan National Park      |
| CAT144  | Dendrobium sp.    | Seminung Forest                          |
| CAT271  | Dendrobium sp.    | Bukit Barisan Selatan National Park      |
| CAT274  | Dendrobium sp.    | Bukit Barisan Selatan National Park      |
| IR015   | Dendrobium 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
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  | ![Leaf Image](CAT140.png) |
| CAT144  | ![Leaf Image](CAT144.png) |
| CAT271  | ![Leaf Image](CAT271.png) |
| CAT274  | ![Leaf Image](CAT274.png) |
| IR015   | ![Leaf Image](IR015.png)  |
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 | Linear |
| 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  | Acuminete | Obtuse | Acute   | Acuminete |
| 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.
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.

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**CONFLICT OF INTEREST**
The authors report no conflicts of interest regarding the research or the research funding.
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