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GENETIC RELATIONSHIPS AMONG 81 *Dendrobium* ACCESSIONS FROM MALAYSIA

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ABSTRACT

In breeding programs, the information on the relationships among the species and hybrids is important to make the correct choice of parents for hybrid production. In this study we addressed the relationship among 81 *Dendrobium* accessions (13 *Dendrobium* species, 8 commercial hybrids and 17 interspecific hybrid progenies) with 16 morphological traits. Data was analyzed using unweighted pair group method with arithmetic averages (UPGMA) cluster analysis. The results of characterization analysis revealed a high diversity between the *Dendrobium* accessions. *Dendrobium* accessions were grouped into three well-defined clusters. The first cluster consisted of 4 species, 8 commercial hybrids and 17 interspecific hybrid progenies. The second cluster consisted of 8 *Dendrobium* species. The third cluster comprised 1 *Dendrobium* species. These results indicated that the morphological characters were adequate in distinguishing between the species, commercial hybrids and interspecific hybrid progenies according to the species section and geographic origin.

Key words: *Dendrobium*, genetic relationships, morphological analysis

INTRODUCTION

The orchid industry in Malaysia has kept on increasing over the years and expected to increase further with greater consumer affluence and growing appreciation for fresh cut flowers. The prospects for the cut flower industry in Malaysia are very bright because of wider product range, longer shelf-life, species diversity and ability to export flowers year round.

Xiaohua (2008) presented taxonomic revision for some *Dendrobium* species. Among various orchid categories in the family, *Dendrobium* have become increasingly popular due to its flower sprays, wide range of colors, sizes and shapes, year round availability, and long flowering life in several weeks to months (Kuehnle, 2007). A detailed study of part of the Asian clade, with emphasis on representatives of the morphologically based *Dendrobium* section has been studied (Clements, 2003).

Orchid belongs to the Orchidaceae family and is one of the largest groups of flowering plants in the world. The family is subdivided in several subfamilies and over 800 genera. According to Dressler (1993), there are 5 subfamilies and 20000 species in 850 genera reported for this family.

According to Holttum (1964) there are nearly 3000 species found in Malaysia. Nearly 886 species from139 genera have been recorded in peninsula Malaysia (Seidenfaden & Wood, 1992).

In Malaysia, orchid species are collected from various zones and assembled at the MARDI orchid germplasm, mainly for research and breeding purposes. Correct classification and identification of accessions in a germplasm collection provides a handle for germplasm managers to avoid duplication in the germplasm collection, detect mislabeled accessions, certify propagated materials and infer genetic variability of accessions. Intensive orchid breeding activities over many years have given rise to many cut flower hybrids with good combination of appreciable flower colour and shape, vase life and yield. Commercial orchid breeders generally choose parents for breeding based on favorable characteristics and experience. Furthermore, accurate genetic relationship information is essential for designing efficient and imaginative breeding programmes.

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Despite the diversity of orchids in nature, only a small number of genera are cultivated in large quantities as commercial ornamental crops e.g. *Cymbidium*, *Dendrobium*, *Oncidium*, and *Phalaenopsis* (Blanchard & Runkle, 2006).

Dendrobium is an enormous orchid genus of more than 1000 species native to south Asia, Australia, New Zealand, and Oceania. They are highly popular among orchid growers for their beauty and diversity (Lavarack *et al.*, 2000). The *Dendrobium* species are broadly categorised into horticultural, agricultural, medicinal or dual purpose species depending upon their utility *per se.* (Chattopadhyay *et al.*, 2012).

Morphological characters have commonly been used to assess genetic diversity. Comparative vegetative anatomy and plant systematics were common strategies to understand the relationships among *Dendrobium* species (Morris *et al.*, 1996).

The objective of this study was to determine the genetic relatedness of *Dendrobium* accessions, including *Dendrobium* spp. and its hybrids cultivated in MARDI orchid germplasm using morphological characters.

MATERIALS AND METHODS

Plant materials

A total of 81 *Dendrobium* accessions were used in this study including 13 *Dendrobium* species, 8 commercial hybrids and 17 interspecific hybrid progenies. Cultivars were collected from MARDI Orchid Collection Centre. Figure 1 shows the geographical distribution of the species in Malaysia (one species Dendrobium bigibbum is from Australian origin). A list of the *Dendrobium* accessions, their corresponding accession numbers and classification is provided in Table 1.

Morphological analysis

Sixteen morphological characters were evaluated from leaves, flowers and plants (Data matrix for morphological characters analysis of 81 *Dendrobium* accessions are presented in supplementary data). Eighty one taxa were analyzed for 16 characters; plant habit, growth performance, leafy, leaf structure, leaf structure of cross section, hairy leaf, leaf surface, pseudobulb, flower, pedisel, hairy pedisel, labellum character, hairy lip, column foot, column wing and fragrance. The morphological character states were referred to that of Sheehan and Sheehan (1994). All measurements were made using digital caliper and flower colour was standardized using the Royal Horticultural Society colour Chart (R.H.S. Colour Chart). Morphological character data were standardized to minimize the effects of different scales of measurements. Measurements for each sample were averaged and were used to regenerate similarity coefficients, according to Jaccard (1908). The similarity coefficients were used to construct dendogram, using the unweighted pair group method with arithmetic averages (UPGMA) using PAST version 1.92 software (Hammer *et al.*, 2001).

RESULTS AND DISCUSSION

The data from morphological characters revealed that the simple matching coefficient, ranged from 0.33 to 1.0, suggesting a broad genetic base for the *Dendrobium* accessions investigated in this study. Figure 2 represents the dendrogram for the 81 *Dendrobium* accessions generated by UPGMA analysis using 16 morphological characters. The results of this cluster analysis revealed a high diversity between the *Dendrobium* accessions. *Dendrobium* accessions were grouped into three well-defined clusters; the first cluster consisted of

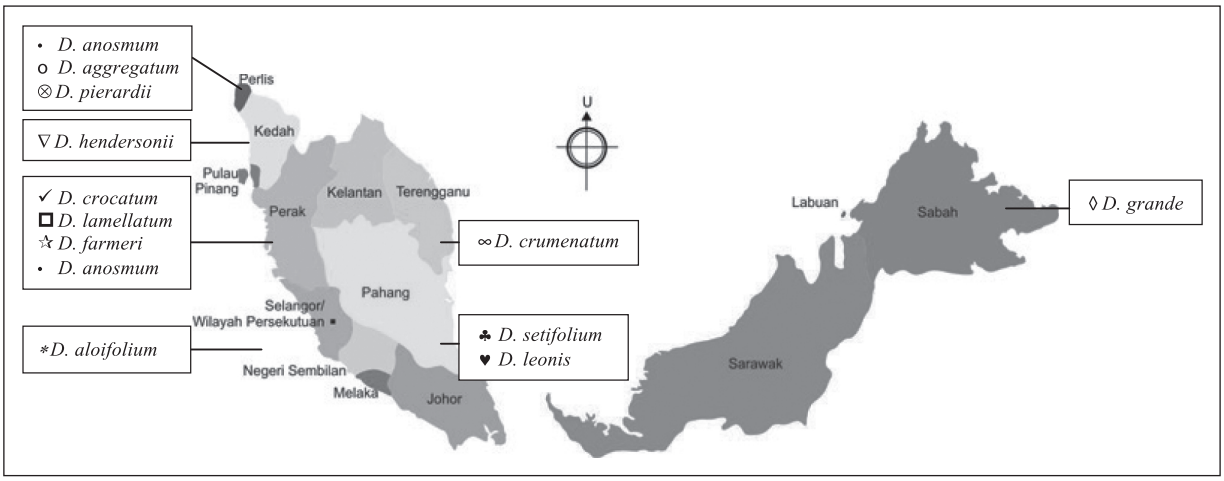

Fig. 1. Geographical origin of the twelve *Dendrobium* species origin in Malaysia
(•) *D. anosmum*; (o) *D. aggregatum*; (⊗) *D. pierardii*; (▽) *D. hendersonii*; (√) *D. crocatum*; (□) *D. lamellatum*; (☆) *D. farmerii*; (*) *D. aloifolium*; (♣) *D. setifolium*; (∞) *D. crumenatum*; (♥) *D. leonis*; (◊) *D. grande*

Table 1. List of *Dendrobium* accessions, their corresponding accession numbers and classification

Accessions No.	Species or cultivar	Section
Aloi1	*Dendrobium aloifolium*	*Aporum*
Aloi2	*Dendrobium aloifolium*	*Aporum*
Aloi3	*Dendrobium aloifolium*	*Aporum*
Aloi4	*Dendrobium aloifolium*	*Aporum*
Grand1	*Dendrobium grande*	*Aporum*
Grand2	*Dendrobium grande*	*Aporum*
Grand3	*Dendrobium grande*	*Aporum*
Croc1	*Dendrobium crocatum*	*Pedilonum*
Croc2	*Dendrobium crocatum*	*Pedilonum*
Croc3	*Dendrobium crocatum*	*Pedilonum*
Croc4	*Dendrobium crocatum*	*Pedilonum*
Lamel1	*Dendrobium lamellatum*	*Pedilonum*
Lamel2	*Dendrobium lamellatum*	*Pedilonum*
Lamel3	*Dendrobium lamellatum*	*Pedilonum*
Hend1	*Dendrobium hendersonii*	*Rhopalanthe*
Hend2	*Dendrobium hendersonii*	*Rhopalanthe*
Hend3	*Dendrobium hendersonii*	*Rhopalanthe*
Hend4	*Dendrobium hendersonii*	*Rhopalanthe*
Crum1	*Dendrobium crumenatum*	*Rhopalanthe*
Crum2	*Dendrobium crumenatum*	*Rhopalanthe*
Crum3	*Dendrobium crumenatum*	*Rhopalanthe*
Seti1	*Dendrobium setifolium*	*Rhopalanthe*
Seti2	*Dendrobium setifolium*	*Rhopalanthe*
Seti3	*Dendrobium setifolium*	*Rhopalanthe*
Seti4	*Dendrobium setifolium*	*Rhopalanthe*
Seti5	*Dendrobium setifolium*	*Rhopalanthe*
Leon1	*Dendrobium leonis*	*Aporum*
Leon2	*Dendrobium leonis*	*Aporum*
Leon3	*Dendrobium leonis*	*Aporum*
Leon4	*Dendrobium leonis*	*Aporum*
Leon5	*Dendrobium leonis*	*Aporum*
Fram1	*Dendrobium farmerii*	*Callista*
Fram2	*Dendrobium farmerii*	*Callista*
Fram3	*Dendrobium farmerii*	*Callista*
Fram4	*Dendrobium farmerii*	*Callista*
Fram5	*Dendrobium farmerii*	*Callista*
Anos1	*Dendrobium anosmum*	*Dendobium*
Anos2	*Dendrobium anosmum*	*Dendobium*
Anos3	*Dendrobium anosmum*	*Dendobium*
Anos4	*Dendrobium anosmum*	*Dendobium*
Anos5	*Dendrobium anosmum*	*Dendobium*
Anos6	*Dendrobium anosmum*	*Dendobium*
Aggr1	*Dendrobium aggregatum*	*Callista*
Aggr2	*Dendrobium aggregatum*	*Callista*
Aggr3	*Dendrobium aggregatum*	*Callista*
Aggr4	*Dendrobium aggregatum*	*Callista*
Pier1	*Dendrobium pierardii*	*Dendobium*
Pier2	*Dendrobium pierardii*	*Dendobium*
Pier3	*Dendrobium pierardii*	*Dendobium*
Pier4	*Dendrobium pierardii*	*Dendobium*
Pier5	*Dendrobium pierardii*	*Dendobium*
Bigi1	*Dendrobium bigibbum*	*Phalaenanthe*
Bigi2	*Dendrobium bigibbum*	*Phalaenanthe*
Bigi3	*Dendrobium bigibbum*	*Phalaenanthe*
Bigi4	*Dendrobium bigibbum*	*Phalaenanthe*
Bigi5	*Dendrobium bigibbum*	*Phalaenanthe*
Soni1	*Dendrobium Sonia*	*D. Ceasar* X *Tomie Drake* Commercial hybrid
Soni2	*Dendrobium Sonia*	*D. Ceasar* X *Tomie Drake* Commercial hybrid
Caes1	*Dendrobium Caeser*	*D. phalaenantbe* X *D. stratiotes* Commercial hybrid
Caes2	*Dendrobium Caeser*	*D. phalaenantbe* X *D.stratiots* Commercial hybrid

Caes3	*Dendrobium Caeser*	*D. phalaenantbe* X *D. stratiots* Commercial hybrid
Chao1	*Dendrobium Chao Praya Gem*	*D. Madame Thong-In* X *D. Pinky* Commercial hybrid
Chao2	*Dendrobium Chao Praya Gem*	*D. Madame Thong-In* X *D. Pinky* Commercial hybrid
Chao3	*Dendrobium Chao Praya Gem*	*D. Madame Thong-In* X *D. Pinky* Commercial hybrid
TN1	*Dendrobium Tuanku Najihah*	*D. Caesar 'Giant'* X *D. Sonia* interspecific hybrid
TN2	*Dendrobium Tuanku Najihah*	*D. Caesar 'Giant'* X *D. Sonia* interspecific hybrid
TN3	*Dendrobium Tuanku Najihah*	*D. Caesar 'Giant'* X *D. Sonia* interspecific hybrid
TN4	*Dendrobium Tuanku Najihah*	*D. Caesar 'Giant'* X *D. Sonia* interspecific hybrid
TN5	*Dendrobium Tuanku Najihah*	*D. Caesar 'Giant'* X *D. Sonia* interspecific hybrid
DS1	*Dendrobium Doctor Sharif*	*D. biggidum* X *D. Chao Praya Gem* interspecific hybrid
DS2	*Dendrobium Doctor Sharif*	*D. biggidum* X *D. Chao Praya Gem* interspecific hybrid
DS3	*Dendrobium Doctor Sharif*	*D. biggidum* X *D. Chao Praya Gem* interspecific hybrid
DS4	*Dendrobium Doctor Sharif*	*D. biggidum* X *D. Chao Praya Gem* interspecific hybrid
DS5	*Dendrobium Doctor Sharif*	*D. biggidum* X *D. Chao Praya Gem* interspecific hybrid
TF1	*Dendrobium Tunanku Fauziah*	*D. peeweewas* X *D. Chao Praya Gem* interspecific hybrid
TF2	*Dendrobium Tunanku Fauziah*	*D. peeweewas* X *D. Chao Praya Gem* interspecific hybrid
TF3	*Dendrobium Tunanku Fauziah*	*D. peeweewas* X *D. Chao Praya Gem* interspecific hybrid
TF4	*Dendrobium Tunanku Fauziah*	*D. peeweewas* X *D. Chao Praya Gem* interspecific hybrid
TF5	*Dendrobium Tunanku Fauziah*	*D. peeweewas* X *D. Chao Praya Gem* interspecific hybrid
TF6	*Dendrobium Tunanku Fauziah*	*D. peeweewas* X *D. Chao Praya Gem* interspecific hybrid
TF7	*Dendrobium Tunanku Fauziah*	*D. peeweewas* X *D. Chao Praya Gem* interspecific hybrid

42 accessions and was further divided to two sub-clusters (Figure 2): sub-cluster 1a representing 8 accessions belonged to two species (Lamel1, Lamel2, Lamel3, Fram1, Fram2, Fram3, Fram4 and Fram5) belonging to section *Pedilonum* and section *Callista*, all species in sub-cluster 1a are from Perak, sub-cluster Ib contained 34 accessions representing 9 accessions (Aggr1, Aggr2, Aggr3, Aggr4 belonging to sections *Callista* from Perlis, and Bigi1, Bigi2, Bigi3, Bigi4 and Bigi5 belonging to *Phalaenanthe* and 25 commercial hybrid and interspecific hybrid progenies: 8 commercial hybrids (Chao1, Chao2 and Chao3 belonging to *Dendrobium chao praya gem*, Soni1 and Soni2 belonging to *Dendrobium sonia* and Caes1, Caes2 and Caes3 belonging to *Dendrobium caeser*), 17 interspecific hybrid progenies (DS1, DS2, DS3, DS4 and DS5 belonging to *Dendrobium Doctor Sharif*, TF1, TF2, TF3, TF4, TF5, TF and TF7 belonging to *Dendrobium Tuanku Fauziah*, TN1, TN2, TN3, TN4 and TN5 belonging to *Dendrobium Tuanku Najihah*. This result is acceptable since the interspecific hybrid DS is a progeny of *Dendrobium chao praya gem and Dendrobium bigibbum*. *Dendrobium chao praya gem* is a parent of TF interspecific hybrid and TN parents are *Dendrobium ceasar* and *Dendrobium sonia.* The second cluster consisted of 35 accessions and was further divided to two sub-clusters: sub-cluster 2a with 30 accessions belonging to sections *Rhopalanthe*, *Aporum* and *Dendrobium* from Kedah, Terenganu, Pahang, Perlis and Selangor. Sub-cluster 2b contained 5 accessions for *Dendrobium setifolium* species (Seti1, Seti2, Seti3, Seti4 and Seti5) belonging to section *Rhopalanthe* and from Pahang, the third cluster comprised 4 accessions all belonging to the *Pedilonum* section and from Perak.

According to Tsi *et al.* (1999) morphological classification for 74 *Dendrobium* species and two varieties were grouped into 12 sections. In the present study cluster analysis for 81 *Dendrobium* accessions based on 16 morphological characters revealed three clusters (Figure 2). Wang *et al.* (2009) reported that 28 morphological traits for 31 *Dendrobium* species were grouped into three major clusters with multiple species and three minor clusters with only single species.

Our results in agreement with previous studies, (Adams *et al.*, 2006) reported that the morphological characters have proved informative in the cladistic analysis to determine relationships of twelve *Dendrobium* taxa, which share an eastern Australian biogeography. (Schuiteman, 2011) found that in Australasian clade the sectional classification based on morphology is largely supported by the molecular phylogenies. The relationships between the clades are largely unresolved and the Asian clade contains several well-supported subclades, but these are much less congruent with morphology than in the Australasian clade, and the relations between the subclades are, in many cases, still unclear.

Our results indicated that the morphological characters utilized in the cluster analysis were adequate in distinguishing between the species, commercial hybrids and interspecific hybrid progenies according to the species section and geographic origin.

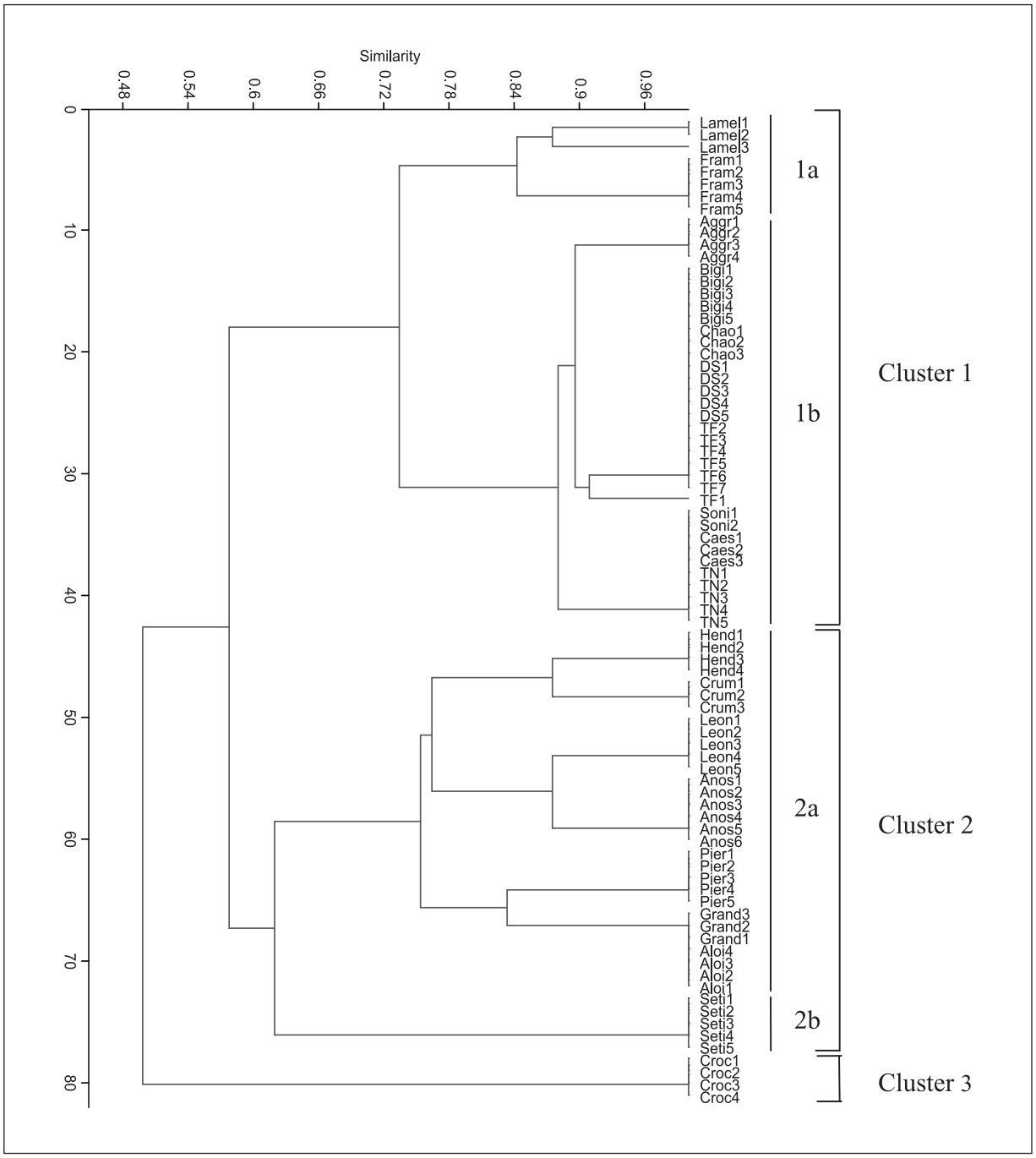

Fig. 2. Dendrogram for 81 *Dendrobium* accessions, commercial hybrids, interspecific hybrid progenies generated by unweighted pair group method based on morphological characters using Jaccard coefficient of genetic similarity estimates

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