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Phalaenopsis Orchid Hybrid Diversity based on Flower and Leaves Morphology

Sri Hartati [a,b,*], Samanhudi [a,b]

[a] Department of Agrotechnology, Faculty of Agriculture, Universitas Sebelas Maret, Surakarta, Central Java, Indonesia
[b] Center for Research and Development of Biotechnology and Biodiversity, Universitas Sebelas Maret, Surakarta, Central Java, Indonesia
Corresponding author: *tatik_oc@yahoo.com

Abstract— **Identification of orchid species is important in orchid conservation. Diversity in orchids can be studied from morphological and anatomical aspects. Observation of morphological characters is easier because it can be done on all plant parts, including stems, flowers, leaves, roots, seeds, and fruit. This research was conducted to study the morphological diversity quantitatively between hybrid *Phalaenopsis* orchid varieties. The research aims to identify the morphological characteristics of 15 hybrid genotype/accession of *Phalaenopsis* orchids, followed by descriptor for ornamental orchid plants. Observation variables, including 19 quantitative parameters from leaf characterization and flower characterization. Data analysis was performed using the NTYSYS (Numerical Taxonomy and Multivariate Analysis System) version 2.02i to determine genetic distance; Grouping (cluster) using the UPGMA (Unpair Group of Mean Arithmetic) method. The results of the grouping dendrogram showed that based on the quantitative morphological characters of 15 species of *Phalaenopsis* hybrid orchids, there were three major groups at 0.92 Dist, namely group I consist of 8 hybrid *Phalaenopsis* orchids, group II consisted of 6 hybrid *Phalaenopsis* orchids, and group III only had the *P. Shu Long Beauty* orchid. *P. Shu Long Beauty* had the greatest diversity of 1.44 Dist with the other 14 accessions. *Taisuko kaaladian"v3"* and *Dtps. Fullers C-Plus 3790* has a diversity of 0.07. Whereas *Dtps. Fullers Sunset* has a diversity of 0.90 with the accessions *Taisuko kaaladian" v3"*, *Dtps. Fullers C-Plus 3790*, *P. Red Shoe Ox1408*, and *P. Ox Black Face Ox1647*.**

Keywords—**Phalaenopsis hybrid; dendrogram; identification.**

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I. INTRODUCTION

Orchidaceous, the second largest family of flowering plants, is a valuable floricultural plant and an important contributor to the bioeconomy due to its attractive, diverse shapes, sizes and long shelf life [1]. The diversity of orchids identified globally reaches more than 25,000 species, while 5,000 are found in Indonesia. Orchidaceous were considered one of the largest families in the angiosperm group of mostly flowering plants [2]. In 2021, according to [3], orchidaceous is the second largest family of flowering plants, with 29,500 plant species belonging to 870 families, and its members are distributed in several microhabitats of the earth. [4] also explained that regions that have dry or arid tropical environmental conditions would have the least orchid diversity.

The natural orchid species is a genetic resource to hybridize orchids. Identification of orchid species is important in orchid conservation. Diversity in orchids can be studied from morphological and anatomical aspects. As part of the morphological study, all plant parts were thoroughly studied, starting with roots, stems, leaves, flowers, fruits, and seeds, while the anatomical study is limited to vegetative organs such as roots, stems, and leaves [5]. The characterization results can be used as basic information about diversity in vegetative and generative also to produce plant descriptions [6]. Adequate characterization of morphological characters is necessary to facilitate the utilization of germplasm by breeders [7]. In addition, environmental factors also influence morphological markers. According to [8], unbalanced ecosystem can disturbance of orchid habitat and has the potential to reduce the population of orchids in nature.

Characterization can also be used for phylogenetic studies to determine plant diversification patterns [9]. The greater the diversity of character traits orchid flowers exhibit, the higher the aesthetic and economic value associated with the orchid species. Orchids have high aesthetic value, flower shapes diverse, sizes, and colors, which are the main attraction for their fans, and a relatively long shelf life [10]. That makes

orchids have high economic value and good market prospects. The Phalaenopsis genus has been designated as the orchid with the greatest commercial importance in floriculture, the most commercialized cut or potted flowers, and the greatest economic value to the floriculture industry worldwide [11].

Conducting morphological characterization of orchids, is important as a study genetic diversity and population structure, including the shape, development, and external appearance of the plant's body and its various organs [12]. As [13] highlighted, morphological characters serve as crucial tools for plants' taxonomic and systemic foundation, and their identification is essential for supporting successful plant breeding outcomes. Research on the characterization of orchids has been carried out on several orchids types, such as *Dendrobium* spp [13], [14], [15], [16], [17], [18], *Phalaenopsis* spp [19], [20], [21], [22], *Phaius* spp [20], [23], [24], *Vanda* spp [25], *Coelogyne* spp [26], [27], *Anacamptis* [28], and *Paphiopedilium* [29]. According to [30], characterization includes the conservation of germplasm to identify morphological traits that differentiate accessions, evaluate genetic diversity, identify varieties, assess the number of accessions, and so on [29]. The objective of this research was to quantitatively investigate the morphological diversity and determine the degree of similarity among hybrid *Phalaenopsis* orchid varieties.

II. Materials and Methods

A. Genetic Material and Study Area

The genetic materials used were 15 hybrid *Phalaenopsis* orchids, which are PL 43 (*Dtps. Shu Long Purple Queen X Ox King 3545*), PL 48 (*P. Shu Long Beauty*), PHX 41 (*P. Ox1799*), PH 83 (*Dtps. Ben You Firebird X Dtps. Ox Spot Queen "Ox1460"*), PHX 62 (*P. Chain Xen Moment*), PH 546 (*Taisuko kaaladian" v3*"), PHX 09 (*P. Ox Spotqueen Ox Rouge Ox1460*), PHX 15 (*P. Ox Black Face Ox1647*), PH 724 (*P. Fuller's Pink Stripe*), PL 59 (*Dtps. Fullers C-Plus 3790*), PL 65 (*Dtps. Shu Long Jellyfish*), PHX 08 (*P. Red Shoe Ox1408*), PL 08 (*Dtps. Shu Long King X Shu Long's Purple Queen*), PL 42 (*Dtps. Fullers Sunset*), and PL 63 (*P. Shu Long Ts2904*). The research was conducted at screenhouse of the Faculty of Agriculture, Sebelas Maret University Surakarta.

B. Morphological Characterization Method

Morphological characterization was carried out descriptively based on direct observation and documentation of orchid plant parts in 15 hybrid Phalaenopsis species, specifically observing the leaves and flowers. Observation variables, including 19 quantitative parameters from leaf characterization and flower characterization. Leaf characteristics include leaf length, leaf width, and leaf thickness. Meanwhile, flower characteristics include flower length, flower width, dorsal sepal length, dorsal sepal width, dorsal sepal thickness, lateral sepal length, lateral sepal width, lateral sepal thickness, petal length, petal width, petal thickness, number of florets, flower stalk length, length of flower arrangement, diameter of flower stalks, number of flower stalks and numbers of flower buds.

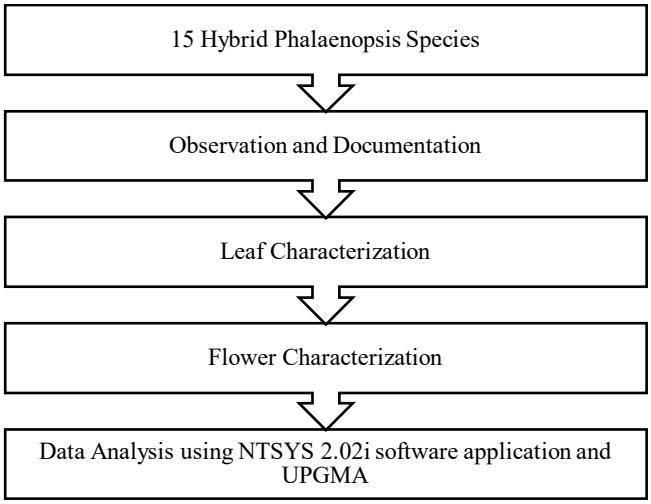

Fig. 1 Block Diagram of Research Flow

C. Data Analysis

The characterization was carried out by observing each species' quantitative morphological characteristics. The data that has been collected is processed using the NTSYS 2.02i software application, Grouping (cluster), using the UPGMA (Unpair Group of Mean Arithmetic) method.

III. Results and Discussion

Characterization is carried out to determine a plant's kinship by identifying plant morphological characteristics [31]. Morphological characterization plays a significant role as each germplasm exhibits distinct characteristics influenced by specific environmental conditions [32].

A. Leaf (Length, Width, and Thickness)

Morphological markers in plants include the roots, stems, leaves, flowers, fruit, and so on, while in orchids, the morphological characteristics of leaves and flowers are used as markers to differentiate between plant groups [33]. Leaf morphological characteristics have been widely used in research to determine kinship between plants [13; 34]. Leaves that have fully opened, even relatively small, and still grow in length, width, and thickness are considered new leaves. Quantitative data on leaf morphology characterization consisted of leaf length, width, and thickness. The average results of leaf length, width, and thickness of 15 hybrid Phalaenopsis orchids are presented in Table 1.

Based on Table 1, the highest leaf length value was obtained from P. Ox Spotqueen Ox Rouge Ox1460 with a leaf length of 29.3 cm, and the lowest value was for the Dtps. Ben You Firebird X Dtps. Ox Spot Queen "Ox1460" orchid with a leaf length of 14.7 cm. The smallest leaf width value is owned by Dtps Ben You Firebird X Dtps Ox Spot Queen "Ox1460" with a value of 5.4 cm, and P. Ox Black Face Ox1647 owns the highest value with a leaf width of 9.6 cm. Leaf thickness at P. Shu Long Beauty is the lowest value with a value of 0.154 cm, while P. Ox Spotqueen Ox Rouge Ox1460 has the highest value of 0.296. According to the research conducted by [35] the findings revealed eight types of hybrid Phalaenopsis have similarities in leaf morphological. In addition, according to [33], leaves are the main organs in absorbing sunlight for photosynthesis, so the larger the leaves will affect plant development.

TABLE I
AVERAGE LEAF LENGTH, LEAF WIDTH, AND LEAF THICKNESS OF 15 HYBRID PHALAENOPSIS ORCHIDS

Species	Length	Width	Thickness
	(cm)		
Dtps. Shu Long Purple Queen X Ox King 3545	20.1	7.9	0.234
P. Shu Long Beauty	19.7	7.5	0.154
P. Ox1799	24.2	7	0.213
Dtps. Ben You Firebird X Dtps. Ox Spot Queen "Ox1460"	14.7	5.4	0.169
P. Chain Xen Moment	22.3	7.6	0.201
Taisuko kaaladian"v3"	17.2	8.1	0.262
P. Ox Spotqueen Ox Rouge Ox1460	29.3	6.2	0.296
P. Ox Black Face Ox1647	25.4	9.6	0.157
P. Fuller's Pink Stripe	19.4	7.9	0.208
Dtps. Fullers C-Plus 3790	20	6.7	0.258
Dtps. Shu Long Jellyfish	22.5	7.6	0.216
P. Red Shoe Ox1408	28.5	8	0.203
Dtps. Shu Long King X Shu Long's Purple Queen	17.3	6.1	0.21
Dtps. Fullers Sunset	19.2	7.9	0.195
P. Shu Long Ts2904	18	7.1	0.243

B. Flower (Length, Width, and Thickness of Flower, Dorsal Sepals, Lateral Sepals, and Petals)

Variation in flower morphology is a natural adaptation in improving the appearance and mechanical adjustment between flowers and pollinators [36]. The quantitative data on flower morphology characteristics consist of flower length and width, petals, dorsal and lateral sepals. Sepals are the outer covering on the orchid flower when the flower is still in the form of a bud or has not yet bloomed and are divided into dorsal and lateral sepals. The dorsal sepals refer to the sepals on the top of the orchid flower. In contrast, the lateral sepals pertain to the sepals at the bottom of the orchid flower. Meanwhile, petals are part of the orchid flower called the corolla. The average length and width of flowers, petals, dorsal sepals, and lateral sepals of 15 hybrid Phalaenopsis orchids are presented in Table 2.

Based on Table 2, the largest flower length and width are owned by Dtps. Fuller C-Plus 3790 with a flower length of 9.3 cm and a flower width of 10.8 cm. While the length and width of the smallest flowers are owned by P. Shu Long Beauty with a length of 6.7 cm and a width of 6.7 cm, and on P. Ox1799 with a length of 6.8 cm and a width of 6.4 cm. The length and width of the petals show the longest and widest petals, namely in the Taisuko kaaladian "v3" type orchid with petals length of 6.4 cm and petals width of 5.1 cm, while the smallest petals are owned by P. Shu Long Beauty has a petals length of 3 cm and a petals width of 3.1 cm.

Dtps. Fuller C-Plus 3790 has the largest dorsal sepal length, which is 4.9 cm, while the widest dorsal sepals are owned by P. Chain Xen Moment, *Taisuko kaaladian* "v3", and Dtps Shu Long Jellyfish with the same width of 3.2 cm. P. Shu Long Beauty has the smallest dorsal sepal length and width, namely dorsal sepals length of 3.1 cm and width of 2 cm. Dtps Shu Long Jellyfish own the largest length of the lateral sepals is 4.7 cm, while the largest lateral sepal width is owned by Dtps Fullers C-Plus 3790 by 3.1 cm. P. Shu Long Beauty and P. Ox1799 have the smallest lateral sepals, with a lateral sepal length of 3.1 cm and a lateral sepal width of 2.1 cm. The largest length and width of the petals are owned by *Taisuko kaaladian*" v3". The results of research by [37] with showed that the length and width of the dorsal sepals were not significantly different.

The characteristics of flower part thickness, including the dorsal, petal, and lateral sepals, were assessed using quantitative data. The average results of the dorsal, petal, and lateral sepal thickness characters of 15 hybrid Phalaenopsis orchids are shown in Table 2. Moreover, Table 2 shows that the thickest dorsal, lateral and petal sepals were found at Dtps. Fullers Sunset with values of 0.081 cm, 0.08 cm, and 0.083 cm, respectively. While the thickness of the dorsal, petal, and lateral sepals is the smallest Dtps. Ox Spot Queen "Ox1460" with respective values of 0.038 cm, 0.028 cm, and 0.022 cm.

TABLE II
AVERAGE LENGTH AND WIDTH OF FLOWERS, PETALS, DORSAL SEPALS, AND LATERAL SEPALS OF 15 HYBRID PHALAENOPSIS ORCHIDS

Species	Flower		Petals			Sepals Dorsal			Sepals Lateral		
	Length	Width	Length	Width	Thickness	Length	Width	Thickness	Length	Width	Thickness
	(cm)										
Dtps. Shu Long Purple Queen X Ox King 3545	8.7	9.6	5.7	4.9	0.070	4.6	3	0.067	4.1	2.9	0.046
P. Shu Long Beauty	6.7	6.7	3	3.1	0.045	3.1	2	0.041	3.1	2.1	0.042
P. Ox1799	6.8	6.4	4.1	3	0.042	3.1	2.2	0.044	3.1	2.1	0.044
Dtps. Ben You Firebird X Dtps. Ox Spot Queen "Ox1460"	7.3	8.6	4.7	4	0.038	3.8	2.8	0.028	3.8	2.7	0.022
P. Chain Xen Moment	8.1	8.7	5.2	4	0.041	4.3	3.2	0.045	4.3	2.8	0.031
Taisuko kaaladian"v3"	9	10.7	6.4	5.1	0.053	4.8	3.2	0.05	4.1	2.9	0.039

P. Ox Spotqueen Ox Rouge Ox1460	8.8	9.2	5.7	4.4	0.065	4.6	3.1	0.046	4.5	3	0.042
P. Ox Black Face Ox1647	8.7	9	4.9	4.2	0.053	4.3	2.8	0.053	4.2	2.1	0.044
P. Fuller's Pink Stripe	7.7	8.1	5.4	3.7	0.04	3.8	2.8	0.042	4.1	2.7	0.044
Dtps. Fullers C-Plus 3790	9.3	10.8	6.3	5.1	0.056	4.9	3	0.055	4.1	3.1	0.047
Dtps. Shu Long Jellyfish	9	9.1	5.8	4.2	0.047	4.2	3.2	0.046	4.7	2.9	0.046
P. Red Shoe Ox1408	7.9	8.4	5.4	3.8	0.054	3.9	3.1	0.049	3.9	2.9	0.048
Dtps. Shu Long King X Shu Long's Purple Queen	8.5	8.6	5.2	4.1	0.051	4.6	2.6	0.048	4.1	2	0.041
Dtps. Fullers Sunset	8	8.1	4.2	3.8	0.083	4.1	2.8	0.081	3.2	2.9	0.08
P. Shu Long Ts2904	7.4	8.3	5.1	3.5	0.064	3.7	2.4	0.053	3.2	2.5	0.055

Based on Table 2, the largest flower length and width are owned by Dtps. Fuller C-Plus 3790 with a flower length of 9.3 cm and a flower width of 10.8 cm. While the length and width of the smallest flowers are owned by P. Shu Long Beauty with a length of 6.7 cm and a width of 6.7 cm, and on P. Ox1799 with a length of 6.8 cm and a width of 6.4 cm. The length and width of the petals show the longest and widest petals, namely in the *Taisuko kaaladian* "v3" type orchid with petals length of 6.4 cm and petals width of 5.1 cm, while the smallest petals are owned by P. Shu Long Beauty has a petals length of 3 cm and a petals width of 3.1 cm.

Dtps. Fuller C-Plus 3790 has the largest dorsal sepal length, which is 4.9 cm, while the widest dorsal sepals are owned by P. Chain Xen Moment, *Taisuko kaaladian* "v3", and Dtps Shu Long Jellyfish with the same width of 3.2 cm. P. Shu Long Beauty has the smallest dorsal sepal length and width, namely dorsal sepals length of 3.1 cm and width of 2 cm. Dtps Shu Long Jellyfish own the largest length of the lateral sepals is 4.7 cm, while the largest lateral sepal width is owned by Dtps Fullers C-Plus 3790 by 3.1 cm. P. Shu Long Beauty and P. Ox1799 have the smallest lateral sepals, with a lateral sepal length of 3.1 cm and a lateral sepal width of 2.1 cm. The largest length and width of the petals are owned by *Taisuko kaaladian*" v3". The results of research by [37] with showed that the length and width of the dorsal sepals were not significantly different.

The characteristics of flower part thickness, including the dorsal, petal, and lateral sepals, were assessed using quantitative data. The average results of the dorsal, petal, and lateral sepal thickness characters of 15 hybrid Phalaenopsis orchids are shown in Table 2. Moreover, Table 2 shows that the thickest dorsal, lateral and petal sepals were found at Dtps. Fullers Sunset with values of 0.081 cm, 0.08 cm, and 0.083 cm, respectively. While the thickness of the dorsal, petal, and lateral sepals is the smallest Dtps. Ox Spot Queen "Ox1460" with respective values of 0.038 cm, 0.028 cm, and 0.022 cm.

C. Quantitative Flower (Length, Diameter, Number of Flower Stalks, and Number of Flower Buds)

Quantitative data on the morphological characters of the flower stalks consist of flower stalk length, flower stalk diameter, and number of flower stalks. The average yields of flower stalk length, flower stalk diameter, number of flower stalks, and number of flower buds on 15 hybrid Phalaenopsis orchids are shown in Table 3.

TABLE III
AVERAGE FLOWER STALK LENGTH, FLOWER STALK DIAMETER, NUMBER OF FLOWER STALKS, AND NUMBER OF FLOWER BUDS ON 15 HYBRID PHALAENOPSIS ORCHIDS

Species	Length of Flower Stalk (cm)	Length of Flower Arrangement (cm)	Diameter of Flower Stalk (cm)	Number of Flower Stalks	Number of Flower Buds
Dtps. Shu Long Purple Queen X Ox King 3545	66.7	41.4	0.38	1	12
P. Shu Long Beauty	66.4	32.8	0.493	1	16
P. Ox1799	48.2	19.17	0.529	3	28
Dtps. Ben You Firebird X Dtps. Ox Spot Queen "Ox1460"	48.8	13.5	0.366	1	5
P. Chain Xen Moment	53.3	19.3	0.568	1	8
Taisuko kaaladian"v3"	60.7	20.7	0.768	1	7
P. Ox Spotqueen Ox Rouge Ox1460	89.4	37.6	0.76	1	9
P. Ox Black Face Ox1647	57.9	26.9	0.497	1	11
P. Fuller's Pink Stripe	54.2	28.2	0.609	1	10
Dtps. Fullers C-Plus 3790	73.1	24.2	0.588	1	8
Dtps. Shu Long Jellyfish	98.1	38.7	0.864	1	15
P. Red Shoe Ox1408	56.1	20.6	0.546	1	7
Dtps. Shu Long King X Shu Long's Purple Queen	46.8	10.1	0.457	1	4
Dtps. Fullers Sunset	33.1	15.7	0.424	1	6
P. Shu Long Ts2904	45.8	23.6	0.548	1	8

Based on Table 3 of 15 accessions of orchids, the longest flower stalk length is owned by Dtps. Shu Long Jellyfish with a length of 98.1 cm. While the shortest flower stalk on Dtps. Fullers Sunset is 33.1 cm. The longest flower arrangement length is owned by Dtps. Shu Long Purple Queen X Ox King 3545 with a value of 41.4 cm. Dtps. Shu Long King X Shu Long's Purple Queen has the shortest flower arrangement length of 10.1 cm. Dtps. Shu Long Jellyfish also owns the largest flower stalk diameter, valued at 0.864 cm. The smallest flower stalk diameter is owned by Dtps. Ox Spot Queen "Ox1460" is 0.37 cm. Meanwhile, the highest number of flowers owned by P. Ox1799, with 28 buds, is in line with the number of stems owned by P. Ox1799, which is 3. Dtps. Shu Long King X Shu Long's Purple Queen has the least flowers, with 4 tuna eyes and only 1 stem.

D. Estimation of Dissimilarity Level Based on Dist Coefficient on Morphological Characteristics Quantitative

The similarity coefficient or similarity value indicates the level of similarity between orchids. Furthermore, according to [38], the higher the similarity value, the higher the orchid similarity. Figure 2 of the dendrogram above shows that the dissimilarities of the 15 hybrid Phalaenopsis orchids are between (0.07-1.44). There were three large groups at 0.92 dist, namely group I consist of 8 hybrid Phalaenopsis orchids, including Dtps. Shu Long Purple Queen X Ox King 3545, P. Ox1799, P. Chain Xen Moment, P. Fuller's Pink Stripe, P. Red Shoe Ox1408, P. Shu Long Ts2904, P. Ox Spotqueen Ox Rouge Ox1460, and Dtps. Shu Long Jellyfish. Group II consisted of 6 hybrid Phalaenopsis orchids, including Dtps. Ben You Firebird X Dtps. Ox Spot Queen "Ox1460", *Taisuko kaaladian*"v3", Dtps. Fullers C-Plus 3790, Dtps. Shu Long King X Shu Long's Purple Queen, P. Ox Black Face Ox1647, and Dtps. Fullers Sunset while group III only P. Shu Long Beauty orchids. *Taisuko kaaladian*"v3" with Dtps. Fullers C-Plus 3790 had a 0.07 diversity. In addition, P. Shu Long Beauty has the greatest dissimilarity of 1.44 Dist with the other 14 accessions. Whereas Dtps. Fullers Sunset has a dissimilarity of 0.90 with accessions *Taisuko kaaladian*" v3", Dtps. Fullers C-Plus 3790, P. Red Shoe Ox1408, and P. Ox Black Face Ox1647. Another study on 10 species and hybrid Phalaenopsis orchids found that they formed two clusters labeled I and II, with a similarity value 0.48 [38].

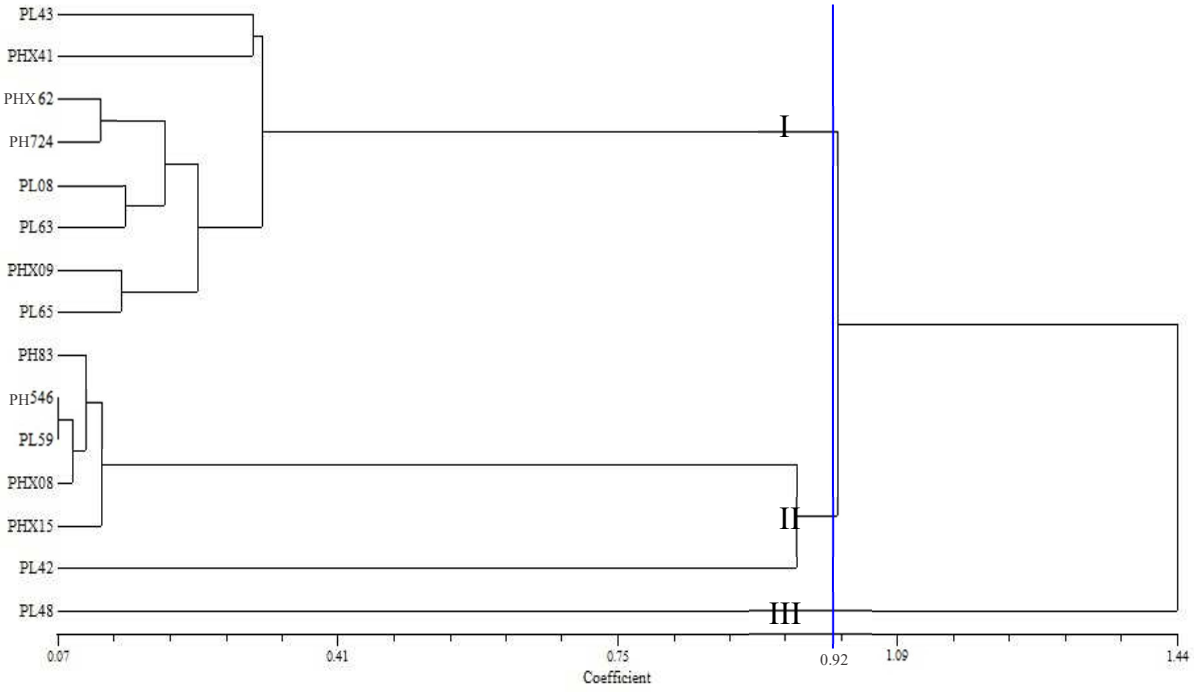

Fig. 2 Dendrogram based on quantitative morphological characters

Information
(1) PL 43 (*Dtps. Shu Long Purple Queen X Ox King 3545*)
(2) PL 48 (*P. Shu Long Beauty*)
(3) PHX 41 (*P. Ox1799*)
(4) PH 83 (*Dtps. Ben You Firebird X Dtps. Ox Spot Queen "Ox1460")*
(5) PHX 62 (*P. Chain Xen Moment*)
(6) PH 546 (*Taisuko kaaladian"v3"*)
(7) PHX 09 (*P. Ox Spotqueen Ox Rouge Ox1460*)
(8) PHX 15 (*P. Ox Black Face Ox1647*)
(9) PH 724 (*P. Fuller's Pink Stripe*)
(10) PL 59 (*Dtps. Fullers C-Plus 3790*)
(11) PL 65 (*Dtps. Shu Long Jellyfish*)
(12) PHX 08 (*P. Red Shoe Ox1408*)
(13) PL 08 (*Dtps. Shu Long King X Shu Long's Purple Queen*)
(14) PL 42 (*Dtps. Fullers Sunset*)
(15) PL 63 (*P. Shu Long Ts2904*)

According to [39], the increasingly big similarity coefficient from something population shows a closer relationship between kinship population and vice versa. The kinship relationship between two individuals can be measured based on the degree of similarity of characters, and it is assumed that a variety of genetic makeup causes differences in characters. The higher similarity coefficient significantly

enhances the success rate of plant breeding programs; [40] stated that a closer genetic relationship plays a crucial role in successful crosses.

IV. Conclusion

The dissimilarities of the 15 hybrid Phalaenopsis orchids are between (0.07-1.44). There were three large groups at 0.92 dist, namely group I consist of 8 hybrid *Phalaenopsis* orchids: *Dtps. Shu Long Purple Queen X Ox King 3545*, *P. Ox1799*, *P. Chain Xen Moment*, *P. Fuller's Pink Stripe*, *P. Red Shoe Ox1408*, *P. Shu Long Ts2904*, *P. Ox Spotqueen Ox Rouge Ox1460*, and *Dtps. Shu Long Jellyfish*. Group II consisted of 6 hybrid *Phalaenopsis* orchids: *Dtps. Ben You Firebird X Dtps. Ox Spot Queen "Ox1460"*, *Taisuko kaaladian"v3"*, *Dtps. Fullers C-Plus 3790*, *Dtps. Shu Long King X Shu Long's Purple Queen*, *P. Ox Black Face Ox1647*, and *Dtps. Fullers Sunset*, while group III only *P. Shu Long Beauty* orchids. *P. Shu Long Beauty* had the greatest diversity of 1.44 Dist with the other 14 accessions. *Taisuko kaaladian"v3"* and *Dtps. Fullers C-Plus 3790* has a diversity of 0.07. Whereas *Dtps. Fullers Sunset* has a diversity of 0.90 with the accessions *Taisuko kaaladian" v3*", *Dtps. Fullers C-Plus 3790*, *P. Red Shoe Ox1408*, and *P. Ox Black Face Ox1647*.

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