

Morphological characteristics of *Phaius* spp. orchids from Indonesia

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Abstract. Hartati S, Samanhudi, Manurung IR, Cahyono O. 2021. Morphological characteristics of *Phaius* spp. orchids from Indonesia. *Biodiversitas* 22: 1991-1995. Orchid is one of the ornamental plants with great economic value in various communities. Characterization and grouping of several orchid species can be used in breeding efforts to obtain hybrid with the desired traits. This study is aimed to characterize the morphological appearance of *Phaius* orchids and to cluster the species based on their similarity in morphological characteristics. Five species of *Phaius* (*P. tankervilleae*, *P. indigoferus*, *P. montanus*, *P. amboinensis*, and *P. callosus*) of the collection of the Bogor Botanical Garden were observed based on 30 morphological characters including the characters of stems, pseudobulbs, leaves and flowers. The data obtained were converted into binary data and computed using the Numerical Taxonomy and Multivariate Analysis System (NTSYS) Spc 2.02 program to produce dendrogram. The results show that based on the morphological characterization of the five species of *Phaius* spp., they have similarities from 63% to 80%. Among the five *Phaius* species, *P. amboinensis*, *P. tankervilleae*, and *P. montanus* had 80% similarity and can be used as parents for crossing.

Keywords: Characterization, morphological, *Phaius*, orchids, similarity

INTRODUCTION

Orchids is a group of cosmopolitan plants that is widely distributed across the world, especially in the tropical region. Orchids are characterized with their distinctive features of unique flowering morphology with blooms that are often colorful and fragrant. They are diverse and widespread family of flowering plants. One of the genus of orchids is *Phaius*. This genus is characterized by the presence of bulbs and lanceolate types of leaves with pointed tips (Kurniawan et al. 2020).

There are about 20 species within the genus *Phaius*, which are widely distributed across India, China, Malaysia, Indonesia, Papua New Guinea, some Pacific Islands, and Australia (Simmons et al. 2018). Several species from *Phaius* genus are known as decorative plants which are noticeable through their color, size, shape, number of flower buds, stem length, and durable freshness (Devadas et al. 2019). Based on the stock within the Sicikeh-cikeh timberland, it is known that there are at slightest 102 species from 30 genera of orchids. The differing qualities of earthbound orchids are less than that of epiphytic orchids (Hartini, 2019).

Several studies recorded *Phaius* occurrence in Indonesia with each species requires specific habitat characteristics. For example, in Gunung Simpang, West Java, there were three species of *Phaius*, namely *P. pauciflorus*, *P. callosus* and *P. tankervilleae*. Both *P. callosus* and *P. pauciflorus* preferred to grow in shady habitats, meanwhile, *P. tankervilleae* lived in open and exposed areas with direct sunlight. Among them, *P.*

pauciflorus was the most abundant in Mount Simpang (Puspitaningtyas 2005).

Taxonomical characterization is the first step for the sustainable utilization and conservation of biodiversity including for orchids. This characterization is fundamental to determine the variations in morphological features, either in the vegetative or generative organs. Viewed from utilization perspective, characterization can be used as a basis for phylogenetic studies to determine crop diversification patterns (Freudenstein et al. 2015). Morphological characterization in orchids is also very important in breeding efforts for conservation and agribusiness purposes (Kasutjianingati and Firgiyanto 2018). The characterization result of 10 native *Dendrobium* orchids having a place to spatulata segment in Indonesia can be utilized as logical data for many requirements in cross-breeding movement, propagation, conservation of germplasm and hereditary change (Indraloka et al. 2019).

All orchid species depend on other plants and their living biological system to survive. In the period of climate alter, seriously observing work on the differences of this range is still critically required for detecting changes to this important woodland in terms of status security and utilization of its plant differing qualities. Thus providing pattern data on plant and orchid diversity information could be a fundamental step to be modified and should be prioritized by Indonesian preservation specialists (Hartini, 2019).

Several studies have investigated the morphological characteristics of orchids, including in *Vanda* spp. (De et al. 2015a), *Phalaenopsis* (Jang, 2015; Deng et al. 2015), *Dendrobium* spp. (De et al. 2015b; Darmawati et al.

2018; Indraloka et al. 2019), *Coelogyne* spp. (Hartati et al. 2019a); *Phaius* spp. (Devadas et al, 2019; Hartati et al. 2021). The objective of this study is to determine the similarity of five natural *Phaius* species based on qualitative morphological characters to select the prospective parents for crossing efforts.

MATERIALS AND METHODS

The morphological characterization of orchids was carried out at the Bogor Botanical Gardens, Research Center for Plant Conservation and Botanic Gardens, Indonesian Institute of Sciences (LIPI). The morphological characterization of orchids was carried out at the Bogor Botanical Gardens Conservation Center. The materials used were five *Phaius* spp. species, namely *P. amboinensis*, *P. callosus*, *P. tankervilleae*, *P. montanus*, and *P. indigoferus* which were the collection of the Bogor Botanical Garden (Figure 1).

This study used descriptive method by direct observation. The documentation and characterization of the morphology of species based on the guide from the Indonesian Ornamental Plants Research Institute (Balithi 2007).

The qualitative observation of *Phaius* spp. consisted of 30 characters, namely growth type, leaf shape, leaf cross-section, tip leaf shape, leaf arrangement, leaf edge shape, leaf surface texture, symmetry leaf, leaf color, type of flowering, resupinate flower's shape, dorsal and lateral sepal shape, transverse and longitudinal shapes of dorsal and petal, petal shape, sepal petal tip shape, type of callus, lip curvature, murmur in the labellum (to attract insects), cross-section of the lip, spurs, flowering position, amount of pollinia, dorsal sepal color pattern, lateral sepal color pattern, petal collar pattern, floral aroma, pseudobulb longitude section, pseudobulb cross-section shape, rooting type and pseudobulb size.

Data analysis was performed by scoring the morphological features into binary data, i.e. (1) if the morphological character was present; or (0) if the character was absent. Based on the morphological data, a similarity index was calculated to cluster the species using the Unweighted Pair Group Methods using Arithmetic averages (UPGMA) software functional SIMQUAL (Qualitative Similarity). The data obtained were also analyzed using the NTSYS-PC (Numerical Taxonomy and Multivariate Analysis System) version 2:02.

RESULTS AND DISCUSSION

Morphological characterization of *Phaius* orchids

The determination of morphological characters was carried out on plant parts, namely stems, flowers, leaves, roots, seeds, and fruit, which were identified and documented (Indraloka et al. 2019). Leaves on orchids have several variations from elongated round to rounded-like in general, lacked leaf bones that form a spread mesh, however parallel to the blade.



Figure 1. The Morphological of *Phaius* spp. from Bogor Botanical Garden, Indonesia. A. *P. amboinensis* (Bali); B. *P. callosus* (Jawa); C. *P. tankervilleae* (Sulawesi); D. *P. montanus* (Papua); E. *P. indigoferus* (Sulawesi)

The leaf bones also vary from thin to thick fleshy (Lokho and Kumar 2012). The relationship between plants was determined through the leaf's anatomical characteristics (Darmawati et al. 2018). The presence of pseudobulb will reduce the loss of water content in leaves during drought by proper channeling (Tay et al. 2015).

Table 1 shows that there are similarities in many morphological characters of the five *Phaius* spp., including growth type, leaf shape, leaf cross-section, tip leaf shape, leaf edge shape, leaf surface texture, symmetry leaf, leaf color, flower's shape, resupinate, petal shape, sepal petal tip shape, type of callus, pseudobulb longitude shape, pseudobulb cross-section shape, root type. On the other hand, there are some differences among the five species.

For example, *P. amboinensis* has morphological differences with the other four *Phaius* spp. in terms of the absence of spur, flowering position, pollinia, and sepal dorsal collar pattern. Based on the observation, the shape of *Phaius* spp. leaves were lanceolate (elongated flat). Meanwhile, *P. callosus* has morphological differences from

the other four *Phaius* spp. in characters of transverse and longitudinal shape of dorsal and petal, dorsal sepal collar pattern, lateral sepal color pattern, petal color pattern, floral aroma, and pseudobulb size. The ground orchid *Phaius callosus* (Blume) is synonymous with *Limodorum callosum* Blume and *Phaius kuhlii* Rchb.f. has a large and sturdy stature, up to 1 m high. The leaves are elongated, fleshy and up to 70 cm long. Inflorescences emerge from the tips of the stems, towering over the length of the leaves. One inflorescence supports 5-12 flowers that are reddish-brown in color. The lips are funnel-shaped, white with purple stripes on the inside. Meanwhile, *P. tankervilleae* has differences from the other four *Phaius* in terms of location of labellum curve, cross-section of the labellum and sepal lateral color pattern. *P. montanus* differs from the other four *Phaius* spp. in terms of lateral sepal color pattern and petal color pattern. *P. indigoferus* has differences in its carcinoma with the other four *Phaius* spp. in the flowering position, pollinia, dorsal collar pattern, sepal lateral color pattern and petal color pattern.

Table 1. Morphological characters of five *Phaius* spp.

Character morphology	Species				
	<i>P. amboinensis</i>	<i>P. callosus</i>	<i>P. tankervilleae</i>	<i>P. montanus</i>	<i>P. indigoferus</i>
Growth type	Sympodial	Sympodial	Sympodial	Sympodial	Sympodial
Leaf shape	Lanceolate	Lanceolate	Lanceolate	Lanceolate	Lanceolate
Leaf cross-section	Plicate	Plicate	Plicate	Plicate	Plicate
Tip leaf shape	Acuminate	Acuminate	Acuminate	Acuminate	Acuminate
Leaf arrangement	Convolute	Convolute	Convolute	Convolute	Rolled leaves
Leaf edge shape	Curse	Curse	Curse	Curse	Curse
Leaf surface texture	Glabrous	Glabrous	Glabrous	Glabrous	Glabrous
Symmetry leaf	Symmetry	Symmetry	Symmetry	Symmetry	Symmetry
Leaf color	Light green	Light green	Light green	Light green	Light green
Flower's shape	Star	Star	Star	Star	Star
Resupinate	Resupinate	Resupinate	Resupinate	Resupinate	Resupinate
Dorsal & lateral sepal shape	Oval	Ovoid	Oval	Oval	Oval
Transverse & longitudinal shape of dorsal and petal	Concave	Sunken	Concave	Concave	Convex
Petal shape	Straight	Straight	Oval	Straight	Oval
Sepal petal tip shape	Taper	Taper	Taper	Taper	Taper
Type of callus	Simple	Simple	Simple	Simple	Simple
Lip curvature	At the tip	At the tip	At the middle	At the tip	At the tip
Murmur in the labellum	Murmur	Murmur	Murmur	Murmur	Murmur
Cross-section of lip	Curved slightly inward	Flipped out	Flat	Curved slightly inward	Flipped out
Spur	No spur	Spur	Spur	Spur	Spur
Flowering position	Next to or between armpits	At the base	At the base	At the base	At the top
Amount of Pollinia	2	8	4	8	8
Dorsal sepal color pattern	Equally	Edge and striped	Edge	Edge	Striped
Lateral sepal color pattern	Equally	Edge and striped	Equally	Patterned and striped	Edge
Petal color pattern	Equally	Pattern	Equally	Patterned and striped	Edge
Floral aroma	No aroma	Smelling	Smelling	No aroma	No aroma
Pseudobulb longitude section	Ovate	Ovate	Ovate	Ovate	Ovate
Pseudobulb cross-section shape	Round	Round	Round	Round	Round
Rooting type	Fiber	Fiber	Fiber	Fiber	Fiber
Pseudobulb size	Large	Medium	Large	Large	Medium

The orchids are called androgynous plants (hermaphrodites), their pollen and pistil are contained in one flower, while the sex characteristics are monoandre (male and female genitalia were located in one place). Therefore, they are easily pollinating. Plants like orchids have structures that consist of roots, stems, leaves and flowers. The main plant characteristic can be identified from roots, stems, leaves, flowers, fruits and seeds, with a wide variety of colors and shapes. The structure mainly were petal, sepal, pollinia, column, and labellum (Castro and Singer 2019). The root types in orchids are divided into 3, namely ground, air, and sticky, and were for attachment to the plant growing media. In terrestrial orchids, the roots have long and dense hairs which function as absorbing water and organic matter in the soil. Khairiah et al (2012) stated that orchids have rhizome roots-like tubers. Puspitaningtyas (2005) states *P. pauciflorus* and *P. callosus* prefer to grow in shady habitats, while *P. tankervilleae* live in open, direct sunlight, among grasses and Andam ferns (*Gleichenia linearis*). *Phaius tankervilleae* is a beautiful, highly ornamental and valuable ethnobotanical orchid. (Kanwal 2014). Several species of the genus *Phaius* are known as ornamental plants which can be seen from their color, size, shape, number of flower buds, stem length and long-lasting freshness (Ackerman 2012).

The dendrogram of *Phaius* spp. based on morphological characters is presented in Figure 2. The dendrogram shows that morphological similarity among the five orchids is between 63%-80%. Using threshold of 0.79, the five *Phaius* can be clustered into three groups, i.e., the first group consists of *P. amboinensis*, *P. tankervilleae* and *P. montanus*, the second group is *P. callosus* and the third is *P. indigoferus*. Morphological characters are used to identify and analyze the diversity of close relationships between species in orchids (Kasutjaningati and Firgiyanto 2018).

The study showed that based on qualitative characters, the genotypes of *P. amboinensis*, *P. tankervilleae* and *P. montanus* show high similarity (80%) compared to the other genotypes (Figure 2). On the other study based on quantitative identification, Hartati et al (2021) found that other *Phaius* spp., *P. amboinensis* and *P. indigoferus* showed morphological similarity of 87%. The results of quantitative identification, the number of flowers of 5 *Phaius* spp., *P. indigoferus* had 22 flowers, *P. tankervilleae* had 18 flowers, *P. amboinensis* had 15 flowers, *P. montanus* had 13 flowers and *P. collasus* had 10 flowers. The study showed length of the flower stalk was directly proportional to the number of flower buds. The longer the flower stalk the greater the number of flowers. *P. indigoferus* has the longest flower stalk, and therefore a greater flower number than the other species.

The other study reported that based on qualitative identification among six orchid species of *Coelogyne*, two species that had high similarity (i.e. 87%) were *C. pandurata* and *C. rumphi* (Hartati et al. 2019a). Identification of character similarity can also be done by the molecular characteristics using ISSR (Inter Simple Sequence Repeats). Hartati (2017) showed that the genetic similarity of *C. pandurata* with *C. rumphi* was 51%.

Furthermore, the crosses of *C. pandurata* and *C. rumphi* are 100% successful using selfing, crossing, and reciprocal methods (Hartati et al. 2019b). Further research to determine the molecular characteristics using RAPD (Random Amplified Polymorphic DNA) showed that analysis has successfully detected genetic variation of ♀ *C. rumphi*, ♂ *C. pandurata*, and their F1 hybrids. The orchid parents and their F1 hybrid have a similarity range of 16-100% (Hartati and Muliawati 2020).

The results of the research on the clustering of five species of *Phaius* spp. can be used as selection of parental candidates of crossing in order to create more potential orchids. According to Lokho and Kumar (2012), the morphological character of orchids is useful for resource management, conservation of individual species, and hybridization, cultivation and germplasm conservation as well as genetic improvement. all contradiction with other orchid genera shows limit hereditary base, but found to be consistent inside genera conjointly self-consistent. The new essential crossbreed from inborn species created can serve as perfect reference fabric for taxonomical studies and can be valuable as hereditary stock for development as terrestrial plants with great versatility sub-tropical conditions. Population improvement in the F2 era may disentangle the genetic control of different characteristics and help develop the classical hereditary outline in *Phaius*. Assist change can be done through markers, change breeding and hybridization with its close relatives like *Calanthe*, etc. (Devadas et al. 2019). De et al. (2015b) conducted research on morphological characterization of *Dendrobium* species to determine the morphological development of descriptors based on the International Union for the Protection of New Varieties of Plants (UPOV) guidelines and a total of 62 morphological descriptors of *Dendrobium* were developed.

In conclusion, based on the morphological characterization of the five species of *Phaius* spp., they have similarities from 63% to 80%. Among the five of *Phaius* spp. being morphologically tested showed that *P. amboinensis*, *P. tankervilleae*, and *P. montanus* had 80% similarity and could be used as parents for crossing to obtain the desired hybrid.

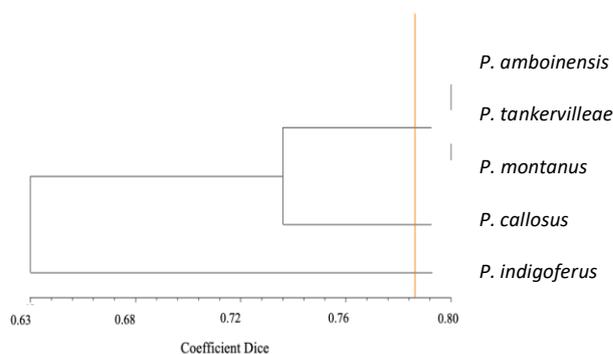


Figure 2. Dendrogram of *Phaius* spp. based on qualitative morphological characters

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