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by Eries Dyah Mustikarini

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Diversity and morphological relationship of orchid species (Orchidaceae) in Bangka Island, Indonesia

GIGIH IBNU PRAYOGA[1,♥], HENRI[2], ERIES DYAH MUSTIKARINI[1], ANGGYANSYAH[1]

[1]Department of Agrotechnology, Universitas Bangka Belitung. Balunijuk, Merawang, Bangka 33172, Bangka-Belitung Island Province, Indonesia
[2]Department of Biology, Universitas Bangka Belitung. Balunijuk, Merawang, Bangka 33172, Bangka-Belitung Island Province, Indonesia.
♥email: gigihibnuprayoga@gmail.com

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Abstract. *Prayoga GI, Henri, Mustikarini ED, Anggyansyah. 2022. Diversity and morphological relationship of orchid species (Orchidaceae) in Bangka Island, Indonesia. Biodiversitas 23: 5323-5332.* The population of orchid plants has suffered extinction due to the conversion of forest land functions. Efforts to preserve orchids can be carried out through exploration, identification and conservation activities. Diversity and morphological information are useful for resource management, conservation, hybridization, and genetic improvement of orchids. This research was to determine the diversity and relationship of orchids on Bangka Island based on morphological characters. This research was conducted in four districts in Bangka Island, namely Central Bangka, West Bangka, Bangka, and South Bangka. The research method used is a survey method with a convenience sampling technique. Observed data were analyzed descriptively and calculated for diversity index, evenness index, species richness index, and morphological relationship. Analysis of morphological relationship was done using UPGMA (Unweighted Pair Group Method with Arithmetic Mean). The results of the study found 17 species of orchids in Bangka Island i.e. *Bulbophyllum subumbellatum, Podochilus microphyllus, Crepidium calophyllum, Phalaenopsis cornu-cervi, Cymbidium finlaysonianum,* and *Malaxix kobi*. Bangka District found 10 species, namely *Phalaenopsis sumatrana, Liparis rhombea, Bulbophyllum* sp., *Robiquieta spathulata, Liparis* sp., *Trichotosia velutina, Micropera collosa, Dendrobium aloifolium, Grammatophyllum speciosium,* and *Adenoncos major*. Exploration in West Bangka District and South Bangka District only found the same orchid species, namely *Acriopsis javanica*. The orchid species on Bangka Island have moderate diversity, high evenness index, and low species richness index. The relationship of orchid species in Bangka Island based on morphological characters has 60% similarities which are divided into 9 clusters. Prevention of orchid population reduction on Bangka Island can be done by using in situ and ex-situ conservation methods. In addition, for the future development of orchids, crosses between orchids that have unique characters and distant morphological relationships can also be carried out to produce orchids for commercial purposes.

Keywords: Diversity, evenness, morphological relationship, orchid, species richness

INTRODUCTION

The orchid plant is a high-value industrial plant in several countries such as Indonesia, Thailand, Australia, Singapore, Taiwan, Brazil, and Malaysia. Orchids are ornamental plants that have an aesthetic appeal to ornamental plant consumers. Orchids flower also called the queen of flowers because of their beauty (Biggs 1987). Orchid flowers have beautiful colors, various shapes and patterns, and can last a long time, so this plant has a high economic value. Indonesia, at its size, has 5,000 species. Of that number, 986 species are found on Java Island, 971 species are found on Sumatra Island, and the rest can be found in Maluku, Sulawesi, Irian Jaya, and Kalimantan (Portal Informasi Indonesia, 2019). Some orchid species are endemic to Indonesia, including *Dendrobium capra*, *Paphiopedilum glaucophyllum*, and *Vanda foetida* (Purba and Chasani 2021).

The population of orchids in their habitat has decreased due to forest conversion for residential, industrial and other purposes, such as illegal harvesting because of great demand for wild orchid species, especially rare species, despite the fact that most orchid products are produced legally (via cultivation, for example) (Broto et al. 2020). These activities threaten their existence in nature. The population of orchids is influenced by two main factors, biological factors and exploitation factors. Biological factors, including pollination, demographics, population genetics, and mycorrhizal associations (Fay 2018). Careless exploitation of forests makes an ecosystem unbalanced and makes some populations decrease and become extinct (Sadili 2013). The diversity of plants is threatened to diminish, even before extinct, due to the high rate of deforestation in Indonesia (Hartini 2019). According to Baucom et al. (2005), extensive logging can alter the level and distribution of genetic variation. About 57.5 percent of the 657,510 hectares of forest area in Bangka Belitung is classified as critical land (Susanto 2015). Deforestation may cause disturbance of orchid habitat and has the potential to reduce the population of orchids in nature.

Bangka Island is part of the Sumatra region, Indonesia. There are 1118 species of orchids found growing in Sumatra; possibly, there are still 10% of other orchid species that have not been identified (Comber 2001; Hartini 2019). The diversity of orchids on Bangka island is currently not widely known because there have not been

many previous studies related to it. According to Destri et al. (2015), currently there are 12 types of orchids in Central Bangka District i.e. *Apostasia wallichii*, *Bromheadia finlaysoniana*, *Claderia viridiflora*, *Bulbophyllum sp. 1*, *Bulbophyllum* sp. 2, *Malaxis* sp, *Cymbidium finlaysonianum*, *Dendrobium aloifolium*, *Dipodium scandens*, *Grammatophyllum speciosum*, *Oberonia* sp, and *Thrixspermum centipeda*.

The high diversity of germplasm can be used as capital to support conservation programs and plant breeding activities. The study of orchids on Bangka Island can only be found in the study by Destri (2015), so the diversity and morphological relationships of orchids on Bangka Island still need to be studied. The purpose of this study was to identify the germplasm of Bangka orchids and their morphological characteristics. Characterization is a method for qualitatively and quantitatively determining plant traits (Hartati et al. 2021). Morphological characterization is important because each germplasm will show different characteristics according to the environment (Prayoga et al. 2020). The morphological or phenetic analysis is the grouping of organisms into taxa groups according to their shared traits. Morphological analysis is useful for resource management, conservation of individual species, and hybridization, cultivation and germplasm conservation as well as genetic improvement (Lokho and Kumar 2012). The information obtained can be used as information for orchid's conservation and plant breeding activities on Bangka Island. This information is also useful in determining whether to protect or use it for commercial orchid production.

MATERIALS AND METHODS

Materials and study area

This research was conducted from December 2019 - April 2020 in four districts of Bangka island, i.e. Central Bangka, West Bangka, Bangka, and South Bangka. The research location was carried out in several forests in four Bangka Island Regencies that have the potential to grow as orchid habitats based on information from the community, plant collectors and sellers, journals and books. The tools used in this research were the orchid description book, Royal Horticultural Society Color Charts, camera, and millimeter block book.

Methods

The research method used is a survey method. The sampling technique uses convenience sampling, which is one of the sampling methods based on the probabilities put forward in several practical criteria such as easy accessibility or geographical proximity, with the research objectives (Etikan et al. 2016). The samples taken were plants that were discovered incidentally during the survey. The morphological part of the orchids found will be observed and identified using a description of orchid plants and an orchid identification book.

Characteristics of orchids from the exploration results were observed using the orchid description book, orchid identification book, and characterization guidelines for ornamental orchids (Balithi 2007; Comber 2001). The characters observed in this research were the orchid growing habitat, pseudobulb form, leaf shape, leaf tip shape, leaf edge shape, leaf size, leaf surface texture, leaf color, growth type, flower number, flower color, flower panicle shape, flower type, flower shape, flower size, dorsal sepals shape, lateral sepals shape, petal shape, the position of flower interest.

Data analysis

The observation results will be analyzed descriptively and calculated for diversity index, evenness index, species richness index, and morphological relationship. Index of diversity was analyzed using the Shannon-Wiener diversity index (Magurran 2004). The Shannon-Wiener diversity index is an analysis used to determine the level of species diversity found with the following formula:

$$H' = -\sum Pi \ln(Pi), \text{ where } Pi = (ni/N)$$

Where:
H' : Shannon-Wienner diversity index
ni : Number of individuals type-i
N : Number of all individuals types

Index of evenness functions to determine the evenness of each type in each community found. This analysis will be carried out for each observed district. The evenness index is calculated using the following formula by Pielou (1969):

$$E = H'/\ln S$$

Where:
E : Index of evenness (value range 0 - 10)
H': index of plant diversity
ln : natural logarithms
S : Number of types

Index of species richness functions to determine the species richness of each species in each community found. This analysis will be carried out for each observed district. The index of species richness was calculated using the following formula by Margalef (1958):

$$Dmg = (S-1) / \ln (N)$$

Where:
Dmg : Index of species richness
S : Number of types
N : Total number of all individu types.

Analysis of morphological relationship using Unweighted Pair Group Method With Aritmatic Mean (UPGMA) method (Mohammadi and Prasanna 2003) that was calculated using Numeric Taxonomy and Multivariate Analysis System (NTSYS-pc) software. The morphological relationship of the 19 characters observed was revealed in

the form of a dendrogram showing the relationship between orchids found.

RESULTS AND DISCUSSION

Exploration was carried out in five villages located in four districts on Bangka Island (Table 1 and Figure 1). The exploration results of forest orchids conducted on the island of Bangka found 17 species of orchids. There are 6 species of orchid found in Central Bangka District, namely *Bulbophyllum subumbellatum, Podochilus microphyllus, Crepidium calophyllum, Phalaenopsis cornu-cervi, C. finlaysonianum,* and *Malaxis kobi*. Bangka District found 10 species, namely *Phalaenopsis sumatrana, Liparis Rhombea, Bulbophyllum* sp., *Robiquieta spathulata, Liparis* sp., *Trichotosia velutina, Micropera collosa, D. aloifolium, Grammatophyllum speciosum,* and *Adenoncos major*. Exploration in West Bangka District and South Bangka District only found the same orchid species, namely *Acriopsis javanica*.

The exploration results of orchids in Bangka Island discovered 17 species of orchid. The initial stage of the germplasm evaluation is characterization (Teixeira and Guimarães 2021), which adds information on the accession of exploration results. Orchids from exploration results are then identified for their morphology to identify the level of diversity in germplasm.

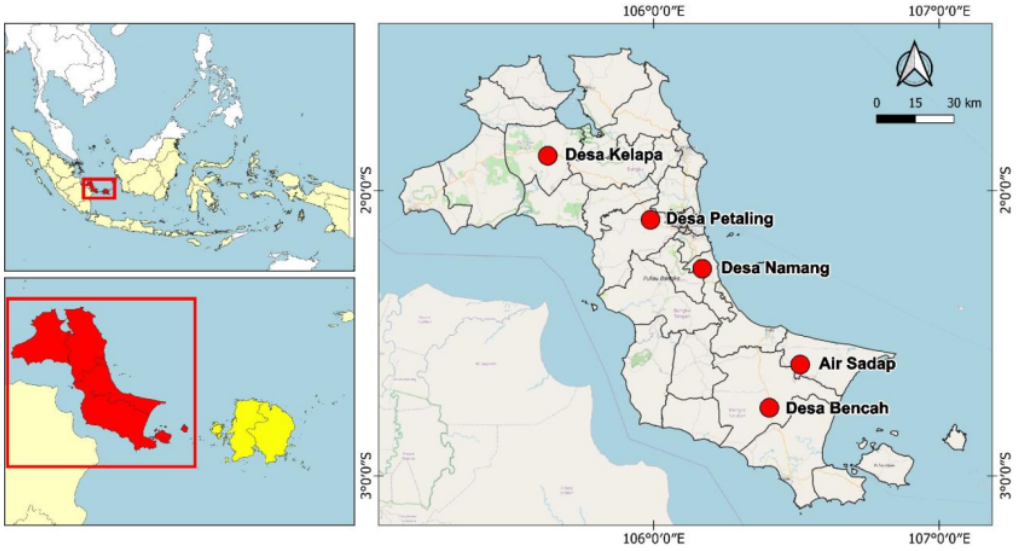

Figure 1. Location of orchids exploration in Bangka Island, Indonesia

Table 1. Orchid germplasm found in Bangka Island, Indonesia

Species	Growing habitat	Location (village-district)
Acriopsis javanica Reinw. ex Blume	Epiphyte	Kelapa, West Bangka and Bencah, South Bangka
Adenoncos major Ridl.	Epiphyte	Petaling, Bangka
Bulbophyllum sp.	Epiphyte	Petaling, Bangka
Bulbophyllum subumbellatum Ridl	Epiphyte	Namang, Central Bangka
Crepidium calophyllum (Rchb.f.) Szlach.	Saprophyte	Sadap, Central Bangka
Cymbidium finlaysonianum Lindl.	Epiphyte	Namang, Central Bangka
Dendrobium aloifolium (Blume) Rchb.f.	Epiphyte	Petaling, Bangka
Grammatophyllum speciosum Blume	Epiphyte	Petaling, Bangka
Liparis sp.	Epiphyte	Petaling, Bangka
Liparis rhombea J.J.Sm.	Epiphyte	Petaling, Bangka
Malaxis kobi (J.J.Sm.) J.B. Comber	Saprophyte	Namang, Central Bangka
Micropera callosa (Blume) Garay	Epiphyte	Petaling, Bangka
Phalaenopsis cornu-cervi (Breda) Blume & Rchb.f	Epiphyte	Namang, Central Bangka
Phalaenopsis sumatrana Korth. & Rchb.f.	Epiphyte	Petaling, Bangka
Podochilus microphyllus Lindl.	Epiphyte	Sadap, Central Bangka
Robiquetia spathulata (Blume) J.J.Sm.	Epiphyte	Petaling, Bangka
Trichotosia velutina (Lodd. ex Lindl.) Kraenzl.	Epiphyte	Petaling, Bangka

Each type of orchid that has been observed has characteristics, especially in flowers. The orchids that were found had striking differences in size, color and pattern (Table 2 and Figure 2). *Phalaenopsis sumatrana* is a protected forest orchid that can be found on Bangka Island. This orchid was first discovered in 1839. The name "Sumatrana" comes from the island where this orchid was found, namely the Sumatra. The distribution of these orchids includes Myanmar, Thailand to Indonesia (Alrich and Higgin 2014). This orchid has white flowers with purple spots. The declining population of *P. sumatrana* in nature has made this orchid endangered and it has become a protected orchid (Khairiah et al. 2012).

Figure 2. Orchid flowers discovered in Bangka Island, Indonesia, Indonesia: A. *B. subumbellatum,* B. *P. microphyllus,* C. *C. calophyllum,* D. *P. cornu-cervi,* E. C. *finlaysonianum,* F. *M. kobi,* G. *P. sumatrana,* H. *L. Rhombea,* I. *Bulbophyllum* sp., J. *R. spathulata,* K. *Liparis* sp., L. *T. velutina,* M. *M. callosa,* N. *D. aloifolium,* O. *G. speciosium*, P. *A. major*, Q. *A. javanica*

Table 2. Morphological characteristics of orchids in Bangka Island, Indonesia

Charactes	*B. subumbellatum*	*P. microphyllus*	*C.calophyllum*	*P. cornu cervi*	*C. finlaysonianum*	*M. kobi*
Growing habitat	E	E	S	E	E	S
Pedobulb shape	1	-	2	-	-	1
Leaf shape	1	6	8	8	3	8
Leaf tip shape	2	2	1	1	5	1
Leaf edges	10	10	2	10	10	3
Leaf size (cm)	L: 11, W: 2.5	L: 0.8, W: 0.5	L: 6, W: 2.8	L: 33, W: 3	L: 77, W: 3	L: 21, W: 6
Leaf surface	1	1	7	1	1	7
Leaf color	Strong Yellow Green A	Strong Yellow Green A	Light yellowish brown	Moderate olive green A	Moderate green olive A	Strong yellow green A
Growth type	1	2	1	2	2	1
Flower number	2	2	31	2	16	95
Flower color	Brillilliant Yellow C	Pale yellow green A	Strong yellow B	Strong greenish yellow	Dark greenish yellowish D	Ligh olive B
Flower panicle shape	1	3	3	3	3	3
Flower type	2	2	2	2	2	2
Flower shape	2	2	2	2	2	2
Flower size (cm)	L: 3, W: 5	L: 0.2, W: 0.1	L: 0.6, W: 0.4	L: 3.5, W: 2.5	L: 5.5, W: 4.1 .	L: 0.4, W: 0.5
Dorsal sepal shape	4	4	2	3	2	6
Literal Sepal shape	1	8	2	4	2	2
Petal shape	3	7	1	2	2	7
Flower potition	1	3	3	2	2	3

Table 2. Morphological characteristics of orchids in Bangka Island, Indonesia (*con't*.)

Characters	*P. sumatrana*	*L. rhombea*	*Bulbophyllum sp.*	*R. spathulata*	*Liparis sp.*	*T. velutina*
Growing habitat	E	E	E	E	E	E
Pedobulb shape	-	6	3	-	2	-
Leaf shape	8	1	8	3	8	6
Leaf tip shape	1	1	1	8	2	3
Leaf edges	10	2	10	10	10	10
Leaf size (cm)	L: 33, W: 5	L: 15, W: 2.5	L: 10,W: 2.5	L: 15, W: 2	L: 15, W: 2.5	L: 6.7, W: 1.8
Leaf surface	1	1	1	1	1	2
Leaf color	Moderate olive green A	Moderate olive green A	Strong yellow green A	Moderate olive green A	Strong yellow green A	Moderate olive green A
Growth type	2	1	1	2	1	2
Flower number	4	8	7	95	65	4
Flower color	Yellowish white A	Pale yellow green A	Light greenish yellow B	Vivid yellow A	Deep purplish pink D	Pink white C
Flower panicle shape	3	8	9	10	11	12
Flower type	2	3	1	2	2	3
Flower shape	2	2	2	2	2	3
Flower size (cm)	L: 5, W: 3.5	L: 1, W: 0.5	L: 1.4, W: 0.5	L: 1, W: 0.5	L: 0.4, W: 0.2	L: 1.5, W: 1.5
Dorsal sepal shape	1	5	3	6	2	4
Literal Sepal shape	4	2	3	3	3	3
Petal shape	2	1	4	3	1	2
Flower potition	2	1	1	2	1	2

Table 2. Morphological characteristics of orchids in Bangka Island, Indonesia (*con't.*)

Characters	*M. collosa*	*D. aloifolium*	*G.speciosium*	*A. major*	*A. javanica*
Growing habitat	E	E	E	E	E
Psedobulb shape	-	-	-	-	6
Leaf shape	8	6	3	6	1
Leaf tip shape	7	1	1	1	1
Leaf edges	10	10	2	10	2
Leaf size (cm)	L: 8.7, W: 1.7	L: 1.5, W: 0.5	L: 67, W: 2.8	L: 4, W: 1	L: 16, W: 1
Leaf surface	10	1	1	1	1
Leaf color	Moderate olive green A	Moderate olive green A	Moderate olive green A	Moderate olive green A	Moderate olive green A
Growth type	2	2	2	2	1
Flower number	14	8	36	1	20
Flower color	Vivid yellow B	Pale yellow green A	Brilliant yellow A	Moderate yellow green C	Brillian greenish yellow D
Flower panicle shape	13	14	3	2	3
Flower type	3	4	2	1	2
Flower shape	2	2	2	2	1
Flower size (cm)	L: 1.5, W: 1	L: 0.4, W: 0.3	L: 9, W: 10	L: 0.7, W: 0.5	L: 1, W: 0.8
Dorsal sepal shape	2	3	3	4	2
Literal Sepal shape	1	2	3	4	2
Petal shape	2	3	8	1	2
Flower potition	2	3	1	2	1

Note:

1. Growing habitat: Epiphyte (E), Saprophyte (S), Terrestrial (T), Lhitofit (L)
2. Psedobulb shape: (1) ribbon, (2) javelin cuff, (3) oblong, (4) oblong, (5) round, (6) ovate
3. Leaf shape: (1) needle, (2) ribbon / straight, (3) oblong, (4) elliptical, and (5) spoon, (6) lanceolate / javelin, (7) breech / reverse lanceolate, (8) ovate, (9) ovoid breech (10) spade, (11) heart, (12) triangle, (13) arrows, (14) spearhead
4. Leaf tip shape: (1) taper / sharp to the tip, (2) tapered with sharp sides, (3) tapered with sharp edges, (4) shallow tapered tip, (5) blunt, (6) shape of a slash / cut, (7) romping / blunt with a little notch, (8) torn, split ends, (9) three toothed, (10) serrated (11) brush-shaped, (12) tail
5. Leaf Edges: (1) curled up, (2) wavy, (3) crooked, (4) angled / sided, (5) edged, (6) crunched, (7) serrated, (8) sawed, (9)) double saws, (10) fraying, (11) tiptoe, like lashes, and (12) curling
6. Leaf Surface: (1) bald, (2) meroma (covered in sparse fine hairs), (3) shielding (covered in long, slightly stiff hairs), (4) wetting, (5) flouring , (6) fringed (irregular surface), (7) wrinkled, and (8) pleated
7. Growth type: (1) Monopodial and (2) Simpodial
8. Flower panicle shape: (1) umbil / umbellate, (2) spike, (3) raceme and (4) panicle
9. Flower Type: single interest (1) and compound interest (2)
10. Flower Shape: (1) round, (2) star, (3) curly, and (4) horned
11. Shape Sepals (1) lanceolate / javelin, (2) ribbon / straight, (3) oblong, (4) oval, (5) ovoid breech, (6) ovoid, (7) round
12. Petal shape: 1) ribbon / straight, (2) oval, (3) oblong, oblong, oval, (4) rhombus, (5) ovoid breech, (6) spoon shape, (7) oval, and (8) slightly rounded
13. Flower Position: (1) base, (2) side / between two axillary leaves and (3) shoots

Some orchids are found in Atok Man botanical garden, Petaling village, Bangka District. About 10 orchids can be identified in Atok Man botanical garden, that are collected from the forest in the Mendo Barat district, Bangka District. Collecting germplasm also serves as a place for conservation and breeding. According to Sujiprihati and Syukur (2012), breeding germplasm is one way to protect germplasm from extinction. In an effort to conserve local orchids, local environmental activists have started two orchid conservation sites in Bangka District, namely the Atok Man Botanical Garden and the Upang River Conservation Center.

Exploration of local orchids is still conducted in most of the natural habitats or forests to collect and conserve the existing diversity of orchid. The need for orchid conservation is critical to leaving a rich and fascinating orchid legacy for future generations (Fay 2018). Pedersen et al. (2018) emphasized the intimate connection between collection-based research and conservation, whereas Swarts and Dixon (2009) concentrated on the importance of botanic gardens in promoting orchid conservation scientifically and horticulturally. Studying the habitat preferences of orchids is important for orchid conservation efforts, because orchids have a wide range of habitats and environmental factors (Irawati 2012). Understanding orchid biology is essential for effective orchid conservation, and this will require more study in areas like pollination, mycorrhizal relationships, population genetics, and demographics (Fay 2018). The use of efficacious mycorrhizal fungi in propagation will increase the value of ex-situ collections and likely increase the success of conservation translocations (Phillips et al. 2020). The conservation of the natural environment of orchids, their pollinators, their genetic variety, and other fauna, such as the birds, frogs, insects, reptiles, and mammals in the forests where they live, are all included in orchid conservation (Orchid Conservation Alliance, 2017).

The results of the diversity index analysis, evenness, and species richness show that Bangka Island has a moderate level of orchid diversity (H '> 1). Bangka District has the highest score compared to other districts, namely, H ': 1.58 (Table 2). H 'value: 1.58 indicates that Bangka district has a moderate level of diversity. The level of diversity in the districts of Central Bangka (H ': 0.89), West Bangka (H': -3.3) and South Bangka (H ': 0) is low because the H value is' less than 1. The H value' in West Bangka (H ': 0.91) and South Bangka (H': 0) are below one because there are few orchids found in that location. The level of species diversity in a place can be influenced by the number of species and populations found.

Diversity index can generally be calculated with several indexes. One of the most frequently used indexes is the Shannon-Wiener index (H'). The Shannon-Wiener Index is used to determine the level of diversity of a species in a place. Bangka Island has moderate diversity of orchid Bangka District has the highest score compared to other districts (Table 3). Bangka District has a moderate level of diversity. This diversity level is influenced by the number of diversity levels in the districts of Central Bangka, West Bangka and South Bangka, including low because the H 'value is less than 1. The H' value in West Bangka and South Bangka is below one due to the small number of orchids found in these locations. The level of species diversity can be influenced by the many species and populations found. According to Pielou (1966), low diversity can occur if the species are separated so that the sub-area is less likely to contain only individuals of a few species.

In general, Bangka District has the highest value of diversity. The value of diversity in West Bangka and South Bangka is low due to forest conversion. The conversion of forest functions makes the population in its habitat decrease. Damaged orchid habitats make orchids difficult to find. In West Bangka, orchids were found around farmland, especially on palm tree plantations. While in South Bangka it was found not far from tin mining land. South Bangka has 24,895.13 hectares of critical land (Susanto 2015).

The evenness index value has a value range of 0-1. A value close to one has a stable evenness index value. The level of evenness on the island of Bangka is even (E: 0.65). South Bangka and West Bangka District have an evenness value of E: 0. Bangka District has a likeness value of E: 0.66. Central Bangka has an evenness level with an E value: 0.5. Species richness in Bangka is low (Dmg <2.5) (Table 2). The highest species richness index on Bangka Island is in Bangka District with a Dmg value: 2.14. South Bangka District has a species richness value of Dmg: 1. Central Bangka District has a diversity value of Dmg: 0.97. West Bangka District has a species richness value of Dmg: 0. Orchid diversity in Bangka District has a moderate level of diversity, but has the highest diversity value compared to other regencies.

Species evenness is a parameter that indicates the relative abundances of the various species in a sample (DeJong 1975). Based on evenness index result, Bangka District has an evenness index close to 1. If the value of the evenness index obtained is close to 1, it means more even distribution of species. Whereas in South and West Bangka District, the value of evenness index is 0. This is because only one species with a low population is found in South dan West Bangka District.

Species richness is usually thought of as the number of species per sample (DeJong 1975). Bangka Island shows low species richness of orchids. This is due to the small number of each species found during exploration. Identification of orchids in the field is not easy because it is difficult to find flowering orchids in their habitat. South Bangka, Bangka, and West Bangka are regions with low species richness index. The species richness value of a place can be influenced by the number of species found. The greater the number of species found in the community, the higher the species richness index value.

The orchid morphological relationship can be seen in the dendogram (Figure 3). Based on the dendogram there are 9 clusters at a coefficient of 0.6 or 60%. Cluster 1 consists of 2 species, namely *P. microphyllus* and *D. aloifolium*. Cluster 2 consists of 2 species, namely *L. rhombea* and *A. javanica*. Cluster 3 consists of 1 species, namely *G. speciosium*. Cluster 4 consists of 3 species,

namely *A. major, T. velutina*, and *R. spathulata*. Cluster 5 consists of 2 species, namely *Bulbophyllum* sp. and *Liparis* sp. Cluster 6 consists of 1 species, namely *M. kobi*. Cluster 7 consists of 4 species, namely *P. cornu-cervi*, *C. finlaysonianum*, *P. sumatrana*, and *M. collosa*. Cluster 8 consists of 1 species, namely *C. calophyllum*. Cluster 9 consists of 1 species, namely *B. subumbellatum*. *P. cornu-cervi* and *P. sumatrana* are closely related species, at a coefficient of 0.89 or 89%.

Table 3. Index of diversity, evenness, and species richness of orchid discovered on Bangka Island, Indonesia

District	Village	Species	Total	H'	E	Dmg
Bangka	Petaling	*P. sumatrana*	34	1.58	0.66	2.14
		L. rhombea	8			
		Bulbophyllum sp.	5			
		R. spathulata	1			
		Liparis sp.	3			
		T. velutina	3			
		M. collosa	2			
		D. aloifolium	4			
		G. speciosium	2			
		A. major	1			
South Bangka	Bencah	*Acriopsis javanica*	1	0	0	1
Central Bangka	Namang	*B. subumbellatum*	3	0.89	0.5	0.97
		P. cornu-cervi	1			
		C. finlaysonianum	1			
		M. kobi	1			
	Sadap	*P. microphyllus*	110			
		C. calophyllum	56			
West Bangka	Kelapa	*A. javanica*	3	0	0	0.91
Bangka Island				1.84	0.65	2.83

Note: H ': Shannon-Wienner Diversity Index, E: Evenness Index, Dmg: Wealth Index, H' <1.5 = Low Diversity, 1.5> H '<3.5 = Moderate versity, H> 3.5 = High Diversity , E <0.3 = Low Evenness, 0.3> E <0.6 = Medium Evenness, E> 0.6 = High / Even Evenness, Dmg <3.5 = Low Species Richness, 3.5> Dmg <5.0 = Medium Species Richness, Dmg> 5.0 = High Species Richness

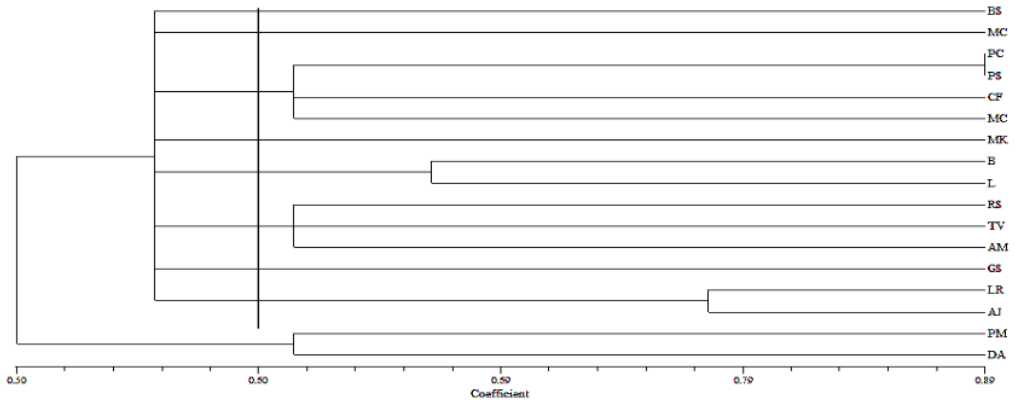

Figure 3. The dendogram of orchids discovered in Bangka Island, Indonesia, based on morphological characteristics

Note:

BS : *Bulbophyllum subumbellatum*
PM : *Podochilus microphyllus*
MC : *Crepidium calophyllum*
PC : *Phalaenopsis cornu cervi*
CF : *Cymbidium finlaysonianum*
GS : *Grammatophyllum speciosium*
MK: *Malaxis kobi*
PS : *Phalaenopsis sumatrana*
LR : *Liparis rhombea*
B : *Bulbophyllum* sp.
RS : *Robiquieta spathulata*
AJ : *Acriopsis javanica*
L : *Liparis* sp,
TV: *Trichotosia velutina*
MC1: *Micropera collosa*
DA : *Dendrobium aloifolium*
AM: *Adenoncos major*

Dendogram analysis was carried out to determine the level of relationship between forest orchids found based on their morphology. Morphological characters were used to analyze the relationships between species in orchids (Kasutjianingati and Firgiyanto 2018; Hartati et al. 2021). The data used in the dendogram analysis include psedobulb habitat, leaf shape, leaf tip shape, leaf edge shape, leaf size, leaf pattern, leaf surface texture, leaf color, type of stem growth, number of stem flowers, flower color, flower panicle shape, literal type, petal shape, and flower position. The results of the dendogram analysis show the results of the analysis, which are divided into 9 large clusters at a similarity coefficient of 60%. In Cluster 1, there are two orchids that are similar to other orchids, namely *P. microphyllus* and *A. javanica*. The two orchids have a similarity level of 61%. *P.microphyllus* and *A. javanica* are closely related. In Cluster 2 there are 2 species of orchids, namely *L. rhombea* and *A. javanica*. Both of these orchids have almost 79%. This is because morphologically, it looks the same and that is what distinguishes the flower. The similarities between these orchids can be found in their small flower size, leaf shape, stem growth type, where the flowers appear and the type of flower stalk. The similarity of the characters possessed by several orchid species can show the close relationship between the orchids being tested.

Bulbophyllum sp. and *Liparis* sp. in cluster 5 are one of the results of dendogram analysis with different genera but on the same line. This is because the two types of orchids have similarities in morphology. The two types of orchids have striking differences in the shape of the psedobulb and the shape of the flower. The psedobulb shape of the two orchids is different, *Bulbophyllum* sp. Has an oval shape and *Liparis* sp. Has a cuff shape. The shape of the *Bulbophyllum* sp. fan and *Liparis* sp. are star-shaped with panicles of spike flowers. The difference between *Bulbophyllum* sp. and *Liparis* sp. causes these two orchids to have a low success rate when crossed. Dendogram results of relationship analysis show that each genus has similar morphology. Genetic characteristics as a marker for each species This diversity causes natural orchids to have similarities between genera, which makes several orchids of different genera appear on the same line.

The results of dendogram analysis in group 7 contained 4 species and 3 groups, namely *C. finlaysonianum*, *Micropera collosa*, *P. cornu-cervi* and *P. sumatrana*. The *P. cornu-cervi* and *P. sumatrana* orchids have the closest relationship (89%). *Phalaenopsis cornu-cervi* and *P. sumatrana* are in the same genus, which makes these orchids have a very high level of relationship compared to other orchids. Both orchids having a superior distinctive character, namely flower color, which makes *P. cornu-cervi* and *P. sumatrana* can be used as parents in crossing.

The knowledge of orchids' morphological diversity is useful to determine the protection or commercial purpose of the orchids hybrid plant (Kasutjianingati and Firgiyanto 2018). The availability of genotypes that have specific characteristics will have a major impact on the effectiveness and acceleration of plant breeding programs in producing superior varieties that have economic value (Prayoga et al. 2020). The development of orchid varieties with unique characteristics, including flower color, morphology, and resistance, using various approaches, including traditional and molecular breeding, can increase market circulation and increase the orchid trade (Li et al. 2021). One of the efforts that will enable the exploitation of the maximum genetic variability and creation of superior recombinant genotypes is the choice of suitable parents to be used in the hybridization process (Bertan et al. 2007). Materials for hybridization derived from germplasm have the advantage of wide genetic diversity. More than 100,000 orchid hybrids are produced by artificial pollination (Cardoso et al. 2020). The result of crossing *Phalaenopsis cornu-cervi* x *Phalaenopsis sumatrana* was the Tiger cub orchid carried out by H. Wallbrunn in 1972 (Alrich and Higgin 2014). The research by Hartati et al. (2021) results in five cluster of *Phaius* spp. that can be used to select parental candidates of crossing to create more potential orchids.

In conclusion, exploration results of orchids in Bangka Island discovered 17 species i.e. *B. subumbellatum, P. microphyllus, C. calophyllum, P. cornu-cervi, C. finlaysonianum,* dan *M. kobi, P. sumatrana, L. rhombea, Bulbophyllum* sp., *R. spathulata, Liparis* sp., *T. velutina, M. collosa, D. aloifolium, G. speciosium, A. major,* and *A. javanica*. The orchids germplasm discovered in Bangka Island has moderate diversity, high evenness index, and low species richness index. The relationship of orchid sp. in Bangka Island based on morphological characters has 60% similarities which are divided into 9 clusters. Prevention of orchid population reduction on Bangka Island can be done by using in situ and ex-situ conservation methods. In addition, for the development of orchids in the future, crosses between orchids that have unique characters and distant morphological relationships can also be carried out to produce orchids for commercial purposes.

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