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Pada Kam, 1 Des 2016 pada 10:27, Dr. Naqib Ullah KHAN <nukmarwat@yahoo.com> menulis:

> Dear Fitmawati
>
> Dear, you paper is online published in **Vol. 48 ISSUE 4; DECEMBER 2016,** and check the SABRAO website.
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Fw: Genetic Diversity of Bouea from Indonesia

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Fitmawati Sofyan <fitmawati2008@yahoo.com> Rab, 24 Feb 2016 10.24
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Bapak ibu sekalian journal pak tri disubmid ke sabrao.. berikut syaratnya.. termasuk persetujan cooauthor utk diterbitkan.. so akan sy kirimkan alamat authornya

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On Sel, Feb 23, 2016 at 21:25, Dr. Naqib Ullah KHAN <nukmarwat@yahoo.com> wrote:

> **Dear Dr.** Dr. Fitmawati, M. Si
>
> **Your Manuscript:**
> **THE DIVERSITY OF *GANDARIA* (*BOUEA*) IN INDONESIA BASED ON MORPHOLOGICAL CHARACTERISTICS**
>
> My apologies for our late reply. We have had some computer problems in recent weeks.
>
> Please read the following instructions to authors carefully.
>
> Thank you for submitting your article to the *SABRAO Journal of Breeding and Genetics*. Your article is well within the scope of the journal.
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> **Please note that there is a publication fee FOR ALL ARTICLES** - including SABRAO members - which must be paid after publication of the article. This requirement is to cover journal processing costs and to maintain the website. Payment can be made to the Regional Secretary (details available on SABRAO website) in local currency equivalent, or by contacting the Editor-in-Chief.

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From: Fitmawati Sofyan <fitmawati2008@yahoo.com>
To: "sabrao_journal_editor@hotmail.com" <sabrao_journal_editor@hotmail.com>
Cc: Naqib Ullah KHAN <nukmarwat@yahoo.com>
Sent: Tuesday, February 23, 2016 1:20 PM
Subject: Genetic Diversity of Bouea from Indonesia

Dear Editor,

My name is Dr. Fitmawati from Indonesia.
I am a member of SABRAO.
I want to publish journal about Bouea in SABRAO Journal.
I am very glad to know information about the progrss of this paper.
Here I attach the journal to be reviewed.
Thank you.

Best wishes,
Dr. Fitmawati, M. Si
Head of Botany
Department of Biology
Math and Natural Science Faculty
Universitas Riau

IN 12:15

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From: Alex Hartana <ahartana301249@gmail.com>
To: Dr. Naqib Ullah KHAN <nukmarwat@yahoo.com>
Sent: Wednesday, August 24, 2016 12:40 PM
Subject: Re: Reviewing for SABRAO J. Breed. Genet. MS-16-10

Dear Dr. Naqib Ullah Khan

The article titled: **Diversity of Gandaria (Bouea) in Indonesia based on morphological characteristics has been reviewed, with some corections , such as the tables and figures numbers have to synchronize to the text, the quality of the English need to be rewritten as an English sentences, not an Indonesian English. However , the paper useful for breeders and biologists, and acceptable for publication** with minor revisions .

sincerily

Alex Hartana

On Sat, Aug 6, 2016 at 9:13 PM, Dr. Naqib Ullah KHAN <nukmarwat@yahoo.com> wrote:

> Dear Prof. Dr. Alex Hartana
> Bogor Agriculture University
>
> **Re: Reviewing for *SABRAO J. Breed. Genet.* MS-16-10**
>
> The *SABRAO Journal of Breeding and Genetics* has received an article (MS-16-10) titled: **Diversity of Gandaria (Bouea) in Indonesia based on morphological characteristics**

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---------- Forwarded message ----------
From: **Dr. Naqib Ullah KHAN** <nukmarwat@yahoo.com>
Date: Wed, Aug 24, 2016 at 9:55 PM
Subject: Re: Reviewing for SABRAO J. Breed. Genet. MS-16-10
To: Alex Hartana <ahartana301249@gmail.com>

Dear Dr. Prof. Dr. Alex Hartana

Thank you for your time and effort reviewing the manuscript. Your assistance to the *SABRAO Journal of Breeding and Genetics* is greatly appreciated.

An acknowledgment for all reviewers will be listed on the website at the end of each year.

Best wishes,

Sincerely

Prof. (TTS) Naqib Ullah Khan, Ph.D, Post-doc (OSU, USA)
Editor-in-Chief
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Pada Sab, 12 Nov 2016 pada 11:22, Dr. Naqib Ullah KHAN <nukmarwat@yahoo.com> menulis:

Dear Fitmawati

AA

READ WELL MY E-MAIL PLEASE.

I am enclosing the two versions of your manuscripts.

1. DIVERSITY OF GANDARIA (Edited by English Editor)

2. DIVERSITY OF GANDARIA (Edited by Dr. Naqib)

I already made those correction (include deletions and additions) advised by English Editor, However, just for your record i am sending both files.

You kindly only work on the file having name **(2. DIVERSITY OF GANDARIA (Edited by Dr. Naqib)** and add some discussion in each part of the results because there is no discussion in that and not a single reference is use in discussion part please.

After doing above send back to me, as because we wan to put your paper in the current issue of SABRAO please.

If cannot understand my e-mail OR cannot add discussion, then please share with some senior colleague but send the same to in TWO DAYS please.

Sincerely

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Pada Min, 13 Nov 2016 pada 20:35, Dr. Naqib Ullah KHAN <nukmarwat@yahoo.com> menulis:

Dear Fitma

Your manuscript was edited by English Editor from NEPAL, and hope you will pay around $ 20 through Western Union or Money-gram later.

I spend around 2 days on your paper, and I really did not work so much on my own papers. I fixed the Tables design and Figures and also put the Tables and Figures numbers in Paper text also **(but you check also).**

You can see references also which were not according to style of SABRAO, so I manage and change them also, **you can check too.**

Check the authors names, that are correct or not, as you can fix them now please.

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Also check that Title of the paper will be ok with OR without word "**Genetic**"

GENETIC DIVERSITY OF GANDARIA (*BOUEA*) BASED ON MORPHOLOGICAL CHARACTERS IN INDONESIA

But keep me in touch and inform about the whole process of publication.

Final file of the paper attached.

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Fitmawati Sofyan <fitmawati2008@yahoo.com>
ke saya, Nursahara

13 Nov 2016 21.36

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Pada Min, 13 Nov 2016 pada 20:35, Dr. Naqib Ullah KHAN <nukmarwat@yahoo.com> menulis:

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> I spend around 2 days on your paper, and I really did not work so much on my own papers. I fixed the Tables design and Figures and also put the Tables and Figures numbers in Paper text also **(but you check also).**
>
> You can see references also which were not according to style of SABRAO, so I manage and change them also, **you can check too.**
>
> Check the authors names, that are correct or not, as you can fix them now please.
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Fitmawati Sofyan <fitmawati2008@yahoo.com>
ke Nursahara, saya, Sobir

Kam, 1 Des 2016 10.45

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Dikirim dari Yahoo Mail di Android

Pada Kam, 1 Des 2016 pada 10:27, Dr. Naqib Ullah KHAN <nukmarwat@yahoo.com> menulis:

> Dear Fitmawati
>
> Dear, you paper is online published in **Vol. 48 ISSUE 4; DECEMBER 2016,** and check the SABRAO website.
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> Sincerely
> Prof. (TTS) Naqib Ullah Khan, Ph.D, Post-doc (OSU, USA)
> Editor-in-Chief
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> Society for the Advancement of Breeding Research in Asia and Oceania
> Email: nukmarwat@yahoo.com
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IN 13:50

THE DIVERSITY OF *GANDARIA* (*BOUEA*) IN INDONESIA BASED ON MORPHOLOGICAL CHARACTERISTICS

Commented [AH1]: CHARACTERS

SUMMARY

Bouea a member of the family *Anacardiaceae* the major distribution in Malesia region. Genus *Bouea* has three species *B. marcophylla*, *B. oppositifolia*, and *B. poilanei*. Morphological variations found in *Bouea* in various regions of Indonesia. This study aims to review the diversity and grouping *Bouea* in Indonesia using morphological markers. A total 75 accessions of *B. macrophylla* and 30 accessions of *B. oppositifolia* obtained from 13 provinces in Indonesia observed variations using 31 characters 81 characters morphological markers. The result of observation was then cluster analyzed using the program NTSYS version 2.02 and confirmed using Principal Component Analysis (PCA). The results showed that the morphological markers that can distinguish Bouea other plant found on sitting opposite leaves and seeds are purple. Morphological markers that distinguish *B. macrophylla* with *B. oppositifolia* is leaf size, fruit size, fruit shape, fruit color, flesh color, and shape of the leaf axillary bud. The results of cluster analysis showed that *B. macrophylla* has similarity coefficient between 0.77 to 1.00 and is divided in seven groups major on the coefficient of 0.93, while *B. oppositifolia* has similarity coefficient between 0.49 to 1.00 and is divided in five groups major similarity coefficient of 0.85. The results showed that the coefficient of similarity in morphological variation *B. oppositifolia* higher than *B. macrophylla.*

Keyword: Bouea, morphological marker, cluster analysis, coefficient similarity

INTRODUCTION

The genus *Bouea* is a member of the family *Anacardiaceae* (Ghazali & Mohammad, 2014). Most members of the genus still grow wildly and spread across Sumatera, Java, Borneo, Malaysia Peninsula, and Moluccas Island (Rifai, 1992). Hou (1978) reported that the genus *Bouea* includes only two species based on fruit shape, leaf size, and bud size, namely, *Bouea macrophylla* and *Bouea oppositifolia*. The characteristics shared by both species include the opposite leaf base, while the characteristics distinguishing both species are leaf size and shoots growing in leaf base, but Harsono (2013) reported that in some specimens there is a sufficiently wide range of morphological characteristics in view of leaf shape and size, and it still possibly reviews their economic status. Moreover, it is also

reported that there is a number of variations in shape, color, size, and skin spot of *gandaria* fruits that were not reported by Hou (1975). In addition, Rehatta (2005) & Papilaya (2007) reported the presence of *Bouea* in Ambon with the characters of leaves similar to those of *Bouea macrophylla*, but it has fruit shape, size, and color different from those previously reported.

Various shapes, tastes, and local names of *gandaria* fruits were found in several areas in Indonesia. The morphological variety of *gandaria* fruits is from round and elliptical shapes and various weights of fruits. In this country, there are various local names for the *gandaria* fruits such as *merinya* (Aceh), *haramania* (Padangbolak), *raman* fruit (Pekanbaru and Lampung), *kundang* fruits (Bengkalis Island, Riau, Malaysia), *Gondoria* (Batusangkar), *Gondorio* (Palembang), *Jatake* (Banten), *gandaria* (Bogor, Ambon, Karimun Java), and 'Ramania' (Banjar Baru-Borneo) (Heyne, 1927; Hou, 1975; Harsono, 2013). Based on the existing data, it can be known that *gandaria* is only found in Ambon, Bogor and Borneo, while *gandaria* present in other regions has not been documented well. Moreover, in many cases the same names possibly referred to different *gandaria* or, vice versa, the two different names are possibly intended for the same one *gandaria*. For example, *merinya* fruits from Aceh have the same characteristics with *gandaria* in Bogor, *gondoria* in Batusangkar, *jatake* in Banten and *Ramania* in South Borneo. This situation makes difficult in *gandaria* trade because there is no certainty in nomenclature for the management of *gandaria* germ plasm.

Concerning this, it is necessary to review taxonomic species and cultivar status in the genus *Bouea* as there is still a number of confusions in the limitation of species, the use of herbarium specimen, sites of the distribution of specimens, and several morphological characters that were previously not used by researchers due to of the limitation of herbarium used. On the other hand, communities using *gandaria* fruits generally with emphasis on the agronomic characteristics of fruits need clearer classification, so that the species of *gandaria* can be sorted, selected, and given names in a certain manner. The agronomic characters-based certainty is also very important in the management of *gandaria* germ plasm. Therefore, it is

necessary to make a distinct classification system with a result of the clustering of *gandaria* cultivars only based on the agronomic characteristics of fruits.

The objective of the study is to examine the diversity and clustering ~~of~~ the *Bouea* genus in Indonesia using morphological markers. The study was conducted from June 2013 to June 2015.

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MATERIALS AND METHOD

Materials

Materials used in the study were *B. macrophylla* (75 accessions) and *B. oppositifolia* (30 accessions) (Table 1). The samples were collected from regions across Indonesia such as Aceh, North Sumatra, Riau, West Sumatra, Jambi, South Sumatra, Lampung, West Java, Central Java, South Borneo, West Borneo, Ambon and Banten (Figure 1). The materials obtained largely grown wildly and only few were deliberately cultivated.

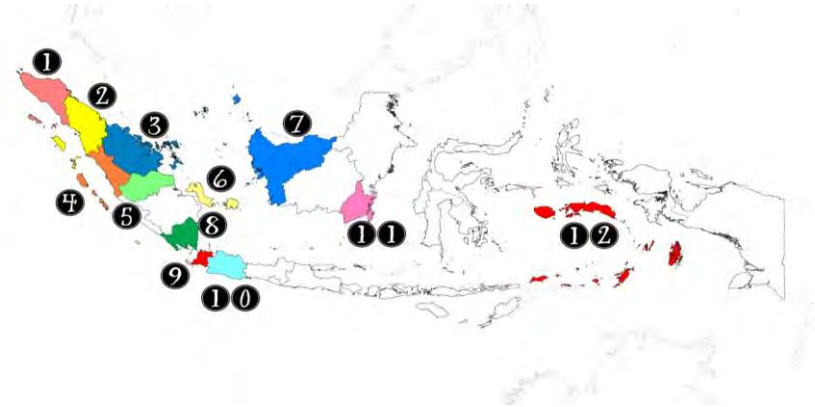

Figure 1. The sites of sampling in the field, (1) Aceh, (2) North Sumatera, (3) Riau, (4) West Sumatera, (5) Jambi, (6) Bangka Belitung, (7) West Borneo, (8) Lampung, (9) Banten, (10) West Java, (11) South Borneo, (12) Ambon, Moluccas

Method

Morphological observations done to determine the species status under the genus *Bouea* referred to the criteria used by Rifai (1976) and Vogel (1987). Some of the main characteristics used were presented in Table 2, while dendogram was

Commented [AH4]: 1992?

generated for the clustering of *Bouea* accessions collected based on morphological character~~istics~~. Documentation was done using digital camera. The clustering was carried out based on the morphological character~~istic~~s, particularly the diagnostic ? features of fruits and leaves as seen in Table 2.

Table 1. List of *Bouea* accessions used in the study

No.	Species	Province	Number
1	*B. oppositifolia* (Roxb.) Adelb.	North Sumatra (SU)	5
2	*B. oppositifolia* (Roxb.) Adelb.	Riau (RI)	1
3	*B. oppositifolia* (Roxb.) Adelb.	Bangka Belitung Islands (BL)	19
4	*B. oppositifolia* (Roxb.) Adelb.	Bogor Botanical Garden (KR)	5
5	*B. macrophylla* Griffit.	Ambon (AM)	14
6	*B. macrophylla* Griffit.	Banten (BA)	8
7	*B. macrophylla* Griffit.	West Sumatera (BS)	5
8	*B. macrophylla* Griffit.	Bogor (BO)	13
9	*B. macrophylla* Griffit.	Jambi (JB)	2
10	*B. macrophylla* Griffit.	West Borneo (KB)	6
11	*B. macrophylla* Griffit.	South Borneo (KS)	18
12	*B. macrophylla* Griffit.	Palembang (PLB)	2
13	*B. macrophylla* Griffit.	Lampung (LP)	1
14	*B. macrophylla* Griffit.	Bangka Belitung (BL)	1
15	*B. macrophylla* Griffit.	Medan (MDN)	1
16	*B. macrophylla* Griffit.	Aceh (SN)	1
17	*B. macrophylla* Griffit.	Great Garden of Bogor (KR)	3
		Total	**105**

Data Analysis

Data on morphological characteristics resulted from the field observation of herbarium specimens were classified and analyzed for similarity and difference to determine their cluster. The results of field observations on *gandaria* specimens from all the sites of the study were classified and arranged in a form of matrix and then analyzed for similarity and difference to determine their cluster.

Commented [AH5]: ????

The analysis of the clustering of inter-accession similarity was carried out using NTSYS ver. 2.02 for the clustering of SAHN by UPGMA (*Unweighted Pair Group Method with Arithmetic Average*). The clustering was carried out based on morphological characteristics, particularly 21 diagnostic features such as leaf, fruit

and seed shapes.

Table 2. Morphological characteristics used in the study

No	Morphological Characteristics	Subcharacters	Number of Characters
1	Trees	Dropping, medium	2
2	Crown	Dense, moderate	2
3	Leaf length	Very long, long, moderate, short	4
4	Leaf size	Very wide, wide, narrow	3
5	Leaf shape	Elliptic, obovate, oblong obovate, elliptic obovate, oblong, lanceolate	6
6	Leaf apex	Acuminate, acuminate obtuse, obtuse	3
7	Leaf base	Acute, acute obtuse, obtuse	3
8	Leaf apex size	Long, short, no leave apex	3
9	Adaxial color	Dark green, green	2
10	Abaxial color	Dark green, green	2
11	Adaxial appearance	Shine, dull	2
12	Abaxial appearance	Shine, dull	2
13	Leaf texture	Dull, fine, rough	3
14	Leaf appearance	Leaves flat, tortuous, convex	3
15	Petiole shape	Thin, round, square	3
16	Petiole size	Very long, long, short	3
17	Bud shape	Acute, round	2
18	Secondary bone	Many, few	2
19	Turpentine stone	No smell, finely smelt, strongly smelt	3
20	Fruit color	Red, yellow	2
21	Fruit shape	Round-oval, round, oval, bell	4
22	Fruit size	Small, big, very big	3
23	Flesh color	Red, yellow	2
24	Fruit taste	Sweet, sweet acid, astringent acid	3
25	Leaf type	Homofili, heterofili	2
26	Bud surface	Hairy, not hairy	2
27	Young stem surface	Hairy, not hairy	2
28	Seed color	Purple, white	2
29	Fruit type	Original, apparent	2
30	Leaf base	Opposite, dispersed	2
31	Flower type	Terminal, axilar	2
Total			81

RESULTS AND DISCUSSION

1. Morphological variation in each of *B. macrophylla* and *B. oppositifolia* accessions

From ~~the analysis of~~ 81 morphological characters, variation in? leaf size,

Commented [AH6]: Based on

shoot at bud, fruit color, and fruit shape can be seen in Table 3.

Table 3. Morphological markers ?variation in *Bouea* fruits, leaves and buds

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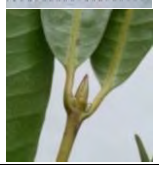
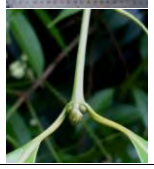
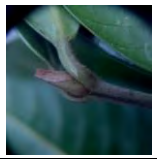
LEAVES					
BUDS					

The data about morphological markers indicate that *B. macrophylla* and *B. oppositifolia* have morphological differences that can be seen in their phenotypic characteristics of leaves, fruits, and stems. All *B. macrophylla* and *B. oppositifolia* accessions have opposite leaf base, pink seed and axial flower. The morphological characteristics of *B. macrophylla* and *B. oppositifolia* based on the characters of leaves were presented in Table 4.

Table 4. The morphological characteristics of *B. macrophylla* and *B. oppositifolia* accessions based on the characters of leaves

No	Characters of Leaves	Sub-characters	*B. macrophylla* (accessions)	*B. oppositifolia* (accessions)
1.	Leaf length	Very long	60	0
		Long	13	5
		Moderate	2	15

	short	0	10
2. Leave size	Very wide	40	0
	Wide	27	8
	Narrow	0	22
3. Leaf shape	Elliptic	0	1
	Obovate	0	1
	Oblong Obovate	0	5
	Elliptic Obovate	2	8
	Oblong	0	15
	Lanceolate	73	0
4. Adaxial leaf color	Dark green	56	23
	Green	19	7
5. Abaxial leaf color	Dark green	10	2
	Green	65	28
6. Adaxial leaf surface	Shine	70	24
	Dull	5	6
7. Abaxial leaf surface	Shine	0	3
	Dull	75	27
8. Leaf surface texture	Fine	0	2
	Rough	75	28
9. Leaf surface shape	Convex	74	4
	Flat	0	26
	Tortuous	1	0
10. Leaf petiole shape	Thin	0	22
	Round	75	8
	Square	0	0
11. Leaf petiole size	Very long	1	0
	Long	75	7
	Short	0	23
12. Secondary bone	Many	0	10
	Few	75	20
13. Leaf landscape	Homofili	75	17
	Heterofili	0	13
14. Leaf position	Opposite	73	30

The leaves of *B. macrophylla* were very long (60 accession), long (13 accessions) and moderate (2 accessions), while those of *B. oppositifolia* were generally moderate (15 accessions), short (10 accessions) and long (5 accessions). The leaves of *B. macrophylla* were very wide (48 accessions) and wide (27 accessions), while those of *B. oppositifolia* were generally narrow (22 accessions) and wide (8 accessions). Most leaves of *B. macrophylla* was lanceolate in shape

(73 accessions) and few was obovate (2 accessions), while *B. oppositifolia* has variation in oval/elliptic shape (1 accession), obovate (1 accession), oblong obovate (5 accessions), elliptic obovate (8 accessions) and oblong (15 accessions).

The upper epidermis surfaces of *B. macrophylla* (56 accessions) and *B. oppositifolia* (23 accessions) were largely dark green in color, while those of *B. macrophylla* (19 accessions) and *B. oppositifolia* (7 accessions) were green. The lower epidemic surfaces of *B. macrophylla* (65 accessions) and *B. oppositifolia* (28 accessions) were mostly green in color, while 10 *B. macrophylla* accessions and 2 *B. oppositifolia* accessions were dark green in color. The apex size of *B. macrophylla* was entirely long, while that of *B. oppositifolia* showed variation, i.e. long (6 accessions), short (23 accessions), and no apex (1 accession).

All *B. macrophylla* accessions had acuminate-shaped leaf apex, while *B. oppositifolia* ones showed variation in shape of leaf apex, i.e. acuminate (17 accessions), acuminate obtuse (12 accessions) and obtuse (1 accession). Rough leaf texture could be seen in all the genus *Bouea*. All *B. macrophylla* accessions had convex leaves, while most leaves of *B. oppositifolia* were flat (26 accessions) and convex (4 accessions). Leaf petiole in *B. macrophylla* accessions had round petiole, while *B. oppositifolia* accessions had thin petiole (22 accessions) and petiole round (8 accessions). All *B. macrophylla* accessions had petiole with long size, while *B. oppositifolia* accessions had short size (23 accessions) and long one (7 accessions). All *B. macrophylla* accessions had homofili leaves, while all *B. oppositifolia* ones had homofili leaves (17 accessions) and heterofili leaves (13 accessions).

The tree characteristics of dropping? could be seen in *B. macrophylla* (64 accessions) and *B. oppositifolia* (KR1, KR2, KR5, and KR6), while medium trees were seen in *B. macrophylla* (11 accessions) and *B. oppositifolia* (26 accessions). Dense crown could be seen in most *B. macrophylla* (67 accessions) and *B. oppositifolia* (9 accessions), while moderate crown could be seen in most *B. oppositifolia* (21 accessions) and *B. macrophylla* (8 accessions). *B. macrophylla* accessions had no hairy young stem, while *B. oppositifolia* had hairy young stem (8 accessions) and no hairy young stem (22 accessions). The morphological

characteristics based on the properties of trees were presented in Table 5.

Table 5. The morphological characters based on the properties of trees

No	Tree characteristics	Subcharacters	*B. macrophylla* (accessions)	*B. oppositifolia* (accessions)
1.	Tree	Dropping	64	4
		Medium	11	26
2.	Crown	Dense	67	9
		Moderate	8	21
3	Young stem surface	Hairy	0	8
		Not hairy	75	22

Most buds in *B. macrophylla* were round (73 accessions) and acumate (2 accessions), while those in *B. oppositifolia* were accumate (28 accessions) and round (2 accessions). All *B. macrophylla* accessions had few secondary bones, while those in *B. oppositifolia* showed variation, i.e. many (10 accessions) and few (20 accessions). All *B. macrophylla* accessions had no hairy bud, while those of *B. oppositifolia* had hairy buds (15 accessions) and no hairy bud (15 accessions).

Terpentine odor was finely smelt in all *B. macrophyla* accessions, while in *B. oppositifolia* terpentine odor was not smelt (22 accessions), finely smelt (6 accessions), and strongly smelt (2 accessions). Fruits in all *B. macrophylla* accessions was yellow in color, while those in *B. oppositifolia* showed variation, i.e. yellow color (8 accessions) and red color (22 accessions). All fruits in *B. macrophylla* were round-shaped, while those in *B. oppositifolia* were round (8 accessions) and oval (22 accessions). All *B. macrophylla* accessions had big fruit size, while those in *B. oppositifolia* had big fruit size (8 accessions) and small fruit size (22 accessions). Fleshes of all *B. macrophylla* accessions were yellow, while those in *B. oppositifolia* were yellow (8 accessions) and red (22 accessions).

Table 6. The morphological characteristics of *B. macrophylla* and *B. oppositifolia* based on the characters of fruits

No	Characteristics of fruits	Subcharacters	*B. macrophylla* (accessions)	*B. oppositifolia* (accessions)
1.	Fruit color	Yellow	75	8
		Red	0	22

2.	Fruit shape	Oval round	0	22
		Round	75	8
		Oval	0	0
		Bell	0	0
3.	Fruit size	Very big	0	0
		Big	75	8
		Small	0	22
4.	Flesh color	Red	0	22
		Yellow	75	8
5.	Fruit taste	Sweet	14	4
		Sweet acid	61	26
		Astringent acid	0	0

2. Cluster Analysis

a. *B. macrophylla*

The data obtained from the morphological markers were used for a cluster analysis using NTSYS program version 2.02. Dendogram was made based on the similarity using a Dice Coefficient method. The cluster analysis was performed by clustering the data obtained into dendogram. Approximately 75 *B. macrophylla* accessions, 30 *B. oppositifolia* accessions, and 2 outgroups (*M. indica* and *A. occidentale*) had similarity coefficient ranging from 0.77 to 1.00 and clustered in 7 main groups at a similarity coefficient of 0.93.

Group 1 consisted of 11 accessions from Ambon. Group 2 consisted of 42 accessions from Banten, Cibinong, South Borneo, Bogor and West Borneo. Group 3 consisted of 8 accessions from Ambon, Bangka Belitung, Banten, Lampung, Palembang, and Bogor. Group 4 consisting of 4 accessions from Jambi, West Borneo, and Bogor Botanical Garden (KR4). Group 5 consisted of 6 accessions from Batu Sangkar, West Sumatera and Ambon (AM14). Group 6 consisted of 2 accessions from Lhoksukon, Aceh and Medan. Group 7 consisted of 2 accessions from Bogor Botanical Garden (KR7 and KR8) (Figue 2).

Group 2 was the largest group, consisting of 42 accessions, so that it can still be divided into 2 groups. Group 1 consisting of 32 accessions from Banten and Cibinong with a similarity coefficient of 0.96, consisted of those from Banten, Bogor, Cibinong, Palembang, South Borneo and West Borneo. Group 2 consisted of 10 accessions from Cibinong, West Borneo, and South Borneo. The highest

similarity coefficient of 0.96 was found in many accessions. Therefore, *B. macrophylla* had sufficiently low diversity based on the morphological markers.

b. *B. oppositifolia*

The cluster analysis of *B. oppositifolia* was carried out by clustering the genotypes obtained into dendogram. Thirty accessions had similarity coefficients ranging from 0.49 to 1.00 and clustered into 5 groups based on the similarity coefficient of 0.84. Group 1 consisted of 6 accessions from North Sumatera and Riau. Group 2 consisted of 2 accessions from Bogor Botanical Garden (KR5 and KR6). Group 3 consisted of 12 accessions from Bogor Botanical Garden (KR2) and Bangka Belitung. Group 4 consisting of 9 accessions from Bogor Botanical Garden (KR3) and Bangka Belitung. Group 5 only had 1 accession from Bogor Botanical Garden (KR1) (Figure 3). The highest similarity coefficient of 0.96 was found in accessions from Bangka Belitung (BL1 and BL13, BL3 and BL13, BL13 and BL20).

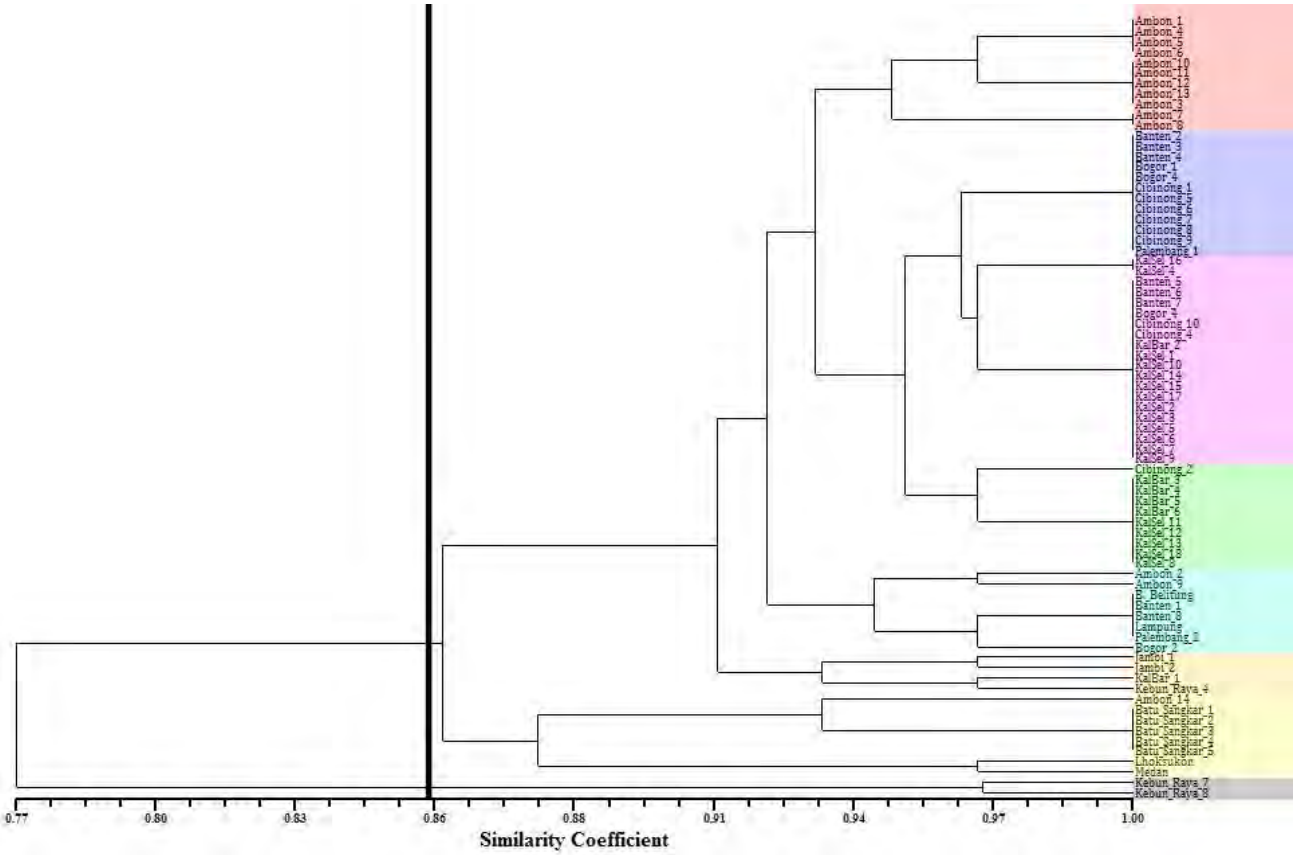


Figure 2. Dendogram based on UPGMA from the morphological characteristics of *B. macrophylla*

Table 7. Similarity coefficient of 36 *B. macrophylla* accessions based on the morphological characteristics

AM1	AM12	AM14	AM3	AM5	AM7	AU	BA1	BA2	BA4	BA5	BL17	BS1	BS3	BS5	JB1	JB2	BO1	KB1	KB4	KB6	KR4	KS1	KS10	KS12	KS14	KS2	KS3	KS4	KS5	KS6	KS8	LP	BO2	PLB	BO3
1,00																																			
0,96	1,00																																		
0,89	0,93	1,00																																	
0,96	1,00	0,93	1,00																																
1,00	0,96	0,89	0,96	1,00																															
0,96	0,93	0,85	0,93	0,96	1,00																														
0,70	0,74	0,81	0,74	0,70	0,74	1,00																													
0,85	0,89	0,81	0,89	0,85	0,89	0,85	1,00																												
0,89	0,93	0,85	0,93	0,89	0,85	0,81	0,96	1,00																											
0,89	0,93	0,85	0,93	0,89	0,85	0,81	0,96	1,00	1,00																										
0,93	0,96	0,89	0,96	0,93	0,89	0,78	0,93	0,96	0,96	1,00																									
0,85	0,89	0,81	0,89	0,85	0,89	0,85	1,00	0,96	0,96	0,93	1,00																								
0,81	0,85	0,93	0,85	0,81	0,78	0,89	0,81	0,85	0,85	0,89	0,81	1,00																							
0,81	0,85	0,93	0,85	0,81	0,78	0,89	0,81	0,85	0,85	0,89	0,81	1,00	1,00																						
0,81	0,85	0,93	0,85	0,81	0,78	0,89	0,81	0,85	0,85	0,89	0,81	1,00	1,00	1,00																					
0,81	0,85	0,78	0,85	0,81	0,78	0,89	0,89	0,93	0,93	0,89	0,89	0,85	0,85	0,85	1,00																				
0,85	0,89	0,81	0,89	0,85	0,81	0,85	0,93	0,96	0,96	0,93	0,93	0,81	0,81	0,81	0,96	1,00																			
0,89	0,93	0,85	0,93	0,89	0,85	0,81	0,96	1,00	1,00	0,96	0,96	0,85	0,85	0,85	0,93	0,96	1,00																		
0,85	0,89	0,81	0,89	0,85	0,81	0,85	0,85	0,89	0,89	0,93	0,85	0,89	0,89	0,89	0,96	0,93	0,89	1,00																	
0,96	0,93	0,85	0,93	0,96	0,93	0,74	0,89	0,93	0,93	0,96	0,89	0,85	0,85	0,85	0,85	0,89	0,93	0,89	1,00																
0,96	0,93	0,85	0,93	0,96	0,93	0,74	0,89	0,93	0,93	0,96	0,89	0,85	0,85	0,85	0,85	0,89	0,93	0,89	1,00	1,00															
0,89	0,93	0,85	0,93	0,89	0,85	0,81	0,89	0,93	0,93	0,96	0,89	0,93	0,93	0,93	0,93	0,89	0,93	0,96	0,93	0,93	1,00														
0,93	0,96	0,89	0,96	0,93	0,89	0,78	0,93	0,96	0,96	1,00	0,93	0,89	0,89	0,89	0,89	0,93	0,96	0,93	0,96	0,96	0,96	1,00													
0,93	0,96	0,89	0,96	0,93	0,89	0,78	0,93	0,96	0,96	1,00	0,93	0,89	0,89	0,89	0,89	0,93	0,96	0,93	0,96	0,96	0,96	1,00	1,00												
0,96	0,93	0,85	0,93	0,96	0,93	0,74	0,89	0,93	0,93	0,96	0,89	0,85	0,85	0,85	0,85	0,89	0,93	0,89	1,00	1,00	0,93	0,96	0,96	1,00											
0,93	0,96	0,89	0,96	0,93	0,89	0,78	0,93	0,96	0,96	1,00	0,93	0,89	0,89	0,89	0,89	0,93	0,96	0,93	0,96	0,96	0,96	1,00	1,00	0,96	1,00										
0,93	0,96	0,89	0,96	0,93	0,89	0,78	0,93	0,96	0,96	1,00	0,93	0,89	0,89	0,89	0,89	0,93	0,96	0,93	0,96	0,96	0,96	1,00	1,00	0,96	1,00	1,00									
0,93	0,96	0,89	0,96	0,93	0,89	0,78	0,93	0,96	0,96	1,00	0,93	0,89	0,89	0,89	0,89	0,93	0,96	0,93	0,96	0,96	0,96	1,00	1,00	0,96	1,00	1,00	1,00								
0,89	0,93	0,85	0,93	0,89	0,93	0,81	0,96	0,93	0,93	0,96	0,96	0,85	0,85	0,85	0,85	0,89	0,93	0,89	0,93	0,93	0,93	0,96	0,96	0,93	0,96	0,96	0,96	1,00							
0,93	0,96	0,89	0,96	0,93	0,89	0,78	0,93	0,96	0,96	1,00	0,93	0,89	0,89	0,89	0,89	0,93	0,96	0,93	0,96	0,96	0,96	1,00	1,00	0,96	1,00	1,00	1,00	0,96	1,00						
0,93	0,96	0,89	0,96	0,93	0,89	0,78	0,93	0,96	0,96	1,00	0,93	0,89	0,89	0,89	0,89	0,93	0,96	0,93	0,96	0,96	0,96	1,00	1,00	0,96	1,00	1,00	1,00	0,96	1,00	1,00					
0,96	0,93	0,85	0,93	0,96	0,93	0,74	0,89	0,93	0,93	0,96	0,89	0,85	0,85	0,85	0,85	0,89	0,93	0,89	1,00	1,00	0,93	0,96	0,96	1,00	0,96	0,96	0,96	0,93	0,96	0,96	1,00				
0,85	0,89	0,81	0,89	0,85	0,89	0,85	1,00	0,96	0,96	0,93	1,00	0,81	0,81	0,81	0,89	0,93	0,96	0,85	0,89	0,89	0,89	0,93	0,93	0,89	0,93	0,93	0,93	0,96	0,93	0,93	0,89	1,00			
0,81	0,85	0,85	0,85	0,81	0,85	0,89	0,96	0,93	0,93	0,89	0,96	0,85	0,85	0,85	0,85	0,89	0,93	0,81	0,85	0,85	0,85	0,89	0,89	0,85	0,89	0,89	0,89	0,93	0,89	0,89	0,85	0,96	1,00		
0,85	0,89	0,81	0,89	0,85	0,89	0,85	1,00	0,96	0,96	0,93	1,00	0,81	0,81	0,81	0,89	0,93	0,96	0,85	0,89	0,89	0,89	0,93	0,93	0,89	0,93	0,93	0,93	0,96	0,93	0,93	0,89	1,00	0,96	1,00	
0,93	0,96	0,89	0,96	0,93	0,89	0,78	0,93	0,96	0,96	1,00	0,93	0,89	0,89	0,89	0,89	0,93	0,96	0,93	0,96	0,96	0,96	1,00	1,00	0,96	1,00	1,00	1,00	0,96	1,00	1,00	0,96	0,93	0,89	0,93	1,00

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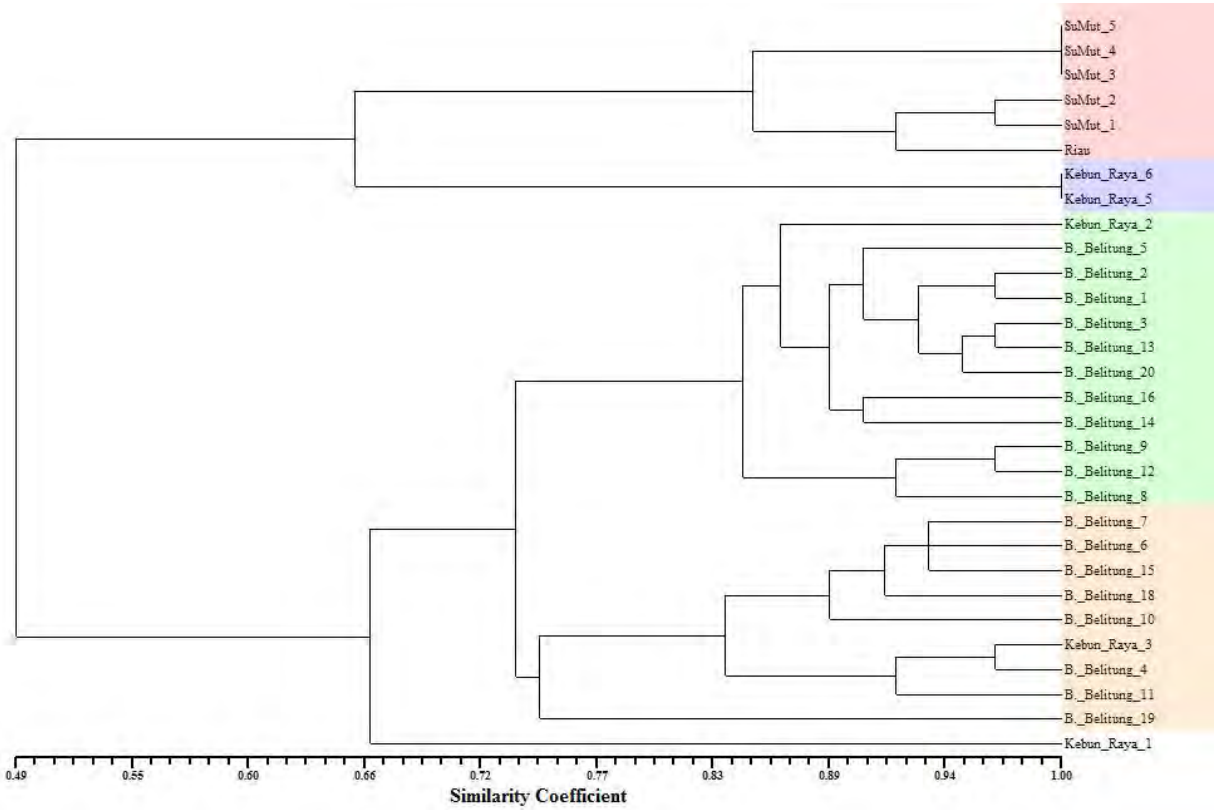

Figure 2. Dendogram based on UPGMA from the morphological characteristics of *B. oppositifolia*

Table 8. Similarity coefficient of 23 *B. oppositifolia* accessions based on the morphological characteristics

Aksesi	SU1	SU2	SU3	SU4	BL1	BL3	BL4	BL5	BL6	BL7	BL8	BL13	BL14	BL15	BL16	BL18	BL20	KR1	KR2	KR3	KR5	KR6	RI
SU1	1,00																						
SU2	1,00	1,00																					
SU3	1,00	1,00	1,00																				
SU4	0,81	0,81	0,81	1,00																			
BL1	0,41	0,41	0,41	0,30	1,00																		
BL3	0,41	0,41	0,41	0,30	0,93	1,00																	
BL4	0,52	0,52	0,52	0,70	0,56	0,56	1,00																
BL5	0,52	0,52	0,52	0,33	0,89	0,89	0,56	1,00															
BL6	0,59	0,59	0,59	0,56	0,74	0,74	0,78	0,78	1,00														
BL7	0,67	0,67	0,67	0,56	0,74	0,74	0,78	0,78	0,93	1,00													
BL8	0,44	0,44	0,44	0,33	0,93	0,85	0,56	0,89	0,78	0,78	1,00												
BL13	0,44	0,44	0,44	0,33	0,96	0,96	0,59	0,93	0,78	0,78	0,89	1,00											
BL14	0,52	0,52	0,52	0,41	0,89	0,89	0,67	0,85	0,70	0,78	0,81	0,93	1,00										
BL15	0,67	0,67	0,67	0,63	0,67	0,67	0,85	0,70	0,93	0,93	0,70	0,70	0,78	1,00									
BL16	0,41	0,41	0,41	0,30	0,85	0,85	0,56	0,81	0,67	0,74	0,78	0,89	0,89	0,67	1,00								
BL18	0,67	0,67	0,67	0,56	0,74	0,74	0,81	0,70	0,85	0,93	0,70	0,78	0,85	0,93	0,74	1,00							
BL20	0,44	0,44	0,44	0,33	0,93	0,93	0,59	0,89	0,78	0,78	0,93	0,96	0,89	0,70	0,85	0,78	1,00						
KR1	0,41	0,41	0,41	0,30	0,59	0,59	0,52	0,56	0,67	0,74	0,63	0,56	0,56	0,67	0,67	0,67	0,56	1,00					
KR2	0,44	0,44	0,44	0,26	0,89	0,81	0,52	0,85	0,63	0,70	0,81	0,85	0,85	0,63	0,81	0,70	0,81	0,63	1,00				
KR3	0,48	0,48	0,48	0,67	0,59	0,59	0,96	0,59	0,81	0,81	0,59	0,63	0,63	0,81	0,59	0,78	0,63	0,56	0,56	1,00			
KR5	0,56	0,56	0,56	0,67	0,19	0,11	0,56	0,19	0,33	0,33	0,19	0,15	0,22	0,41	0,11	0,37	0,15	0,30	0,30	0,52	1,00		
KR6	0,56	0,56	0,56	0,67	0,19	0,11	0,56	0,19	0,33	0,33	0,19	0,15	0,22	0,41	0,11	0,37	0,15	0,30	0,30	0,52	1,00	1,00	
RI	0,78	0,78	0,78	0,81	0,26	0,19	0,52	0,30	0,37	0,44	0,30	0,22	0,30	0,44	0,26	0,44	0,22	0,41	0,37	0,48	0,70	0,70	1,00

The combination of data on the morphological markers of *B. macrophylla* and *B. oppositifolia* were reanalyzed by using NTSYS version 2.0. The results showed that the combined data had similarity coefficients ranging from 0.37 to 1.00 and could be classified into three groups. Group 1 consisted of 75 accessions from *B. macrophylla*, Group 2 consisted of 30 accessions from *B. oppositifolia*, and Group 3 consisted of outgroup including *M. indica* and *A. occidentale.*

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B. oppositifolia from Bogor Botanical Garden (KR2) was included into the group of Bangka Belitung. The group had the morphological characteristics of heterofili leaves (in 1 tree there are two shapes of leaves), i.e. elliptic and obovate, acumate leaf apex, and no leaf apex, hairy bud and young stem, acumate bud apext such as lanceolate, small fruit size (2.1-3.4cm), red ripe fruit color, red ripe flesh color, and sweet acidic taste.

B. oppositifolia from Bogor Botanical Garden (KR3) also was separated from the group of Bogor Botanical Garden together with that of Bangka Belitung.

B. oppositifolia from Bogor Botanical Garden (KR3) was characterized by only-one-leave shape, i.e. oblong, acute leaf apex, very obvious leave bones, dark green leaf color, sufficiently large leaf size (10.1-18.7cm), hairy bud and young stem, acute bud, red ripe fruit color, red ripe flesh color, and sweet acidic taste.

The results indicated by dendogram were reconfirmed using the Principal Component Analysis (PCA) in terms of evaluating the distribution of accessions in a two-dimensional space. PCA clustered the access based on the data obtained from the morphological markers. The results of PCA analysis in Figure 4 showed that there was similarity in clustering in the dendogram of UPGMA (Figure 3). PCA confirmed the profiles of morphological data on similarity at X axis ranging of -0.05 to 0.48% and at Y axis ranging from -0.44 to 0.10. The results of PCA showed that there was a significant relationship between the data obtained using the morphological ones and those observed (*B. macrophylla, B. oppositifolia, M. indica,* and *A. occidentale*). Figure 4 showed that there was a clear clustering in each type. Column 1 was filled by outgroup, i.e. *M. indica* and *A. occidentale,* column 2 was filled by samples of *B. oppositifolie* from Bogor Botanical Garden (KR5), column 3 was filled by samples of *B. macrophylla,* column of 5 was filled by *B. oppositifolia* from North Sumatra, column of 6 was filled by *B. macrophylla* from Great Garden of Bogor (KR7), and column 7 was filled by *B. oppositifolia.* The results were also confirmed by variation appeared in *B. oppositifolia* of three columns in the results of PCA analysis. They showed that morpholigical markers can distinguish the species in the genus *Bouea* and its outgroup.

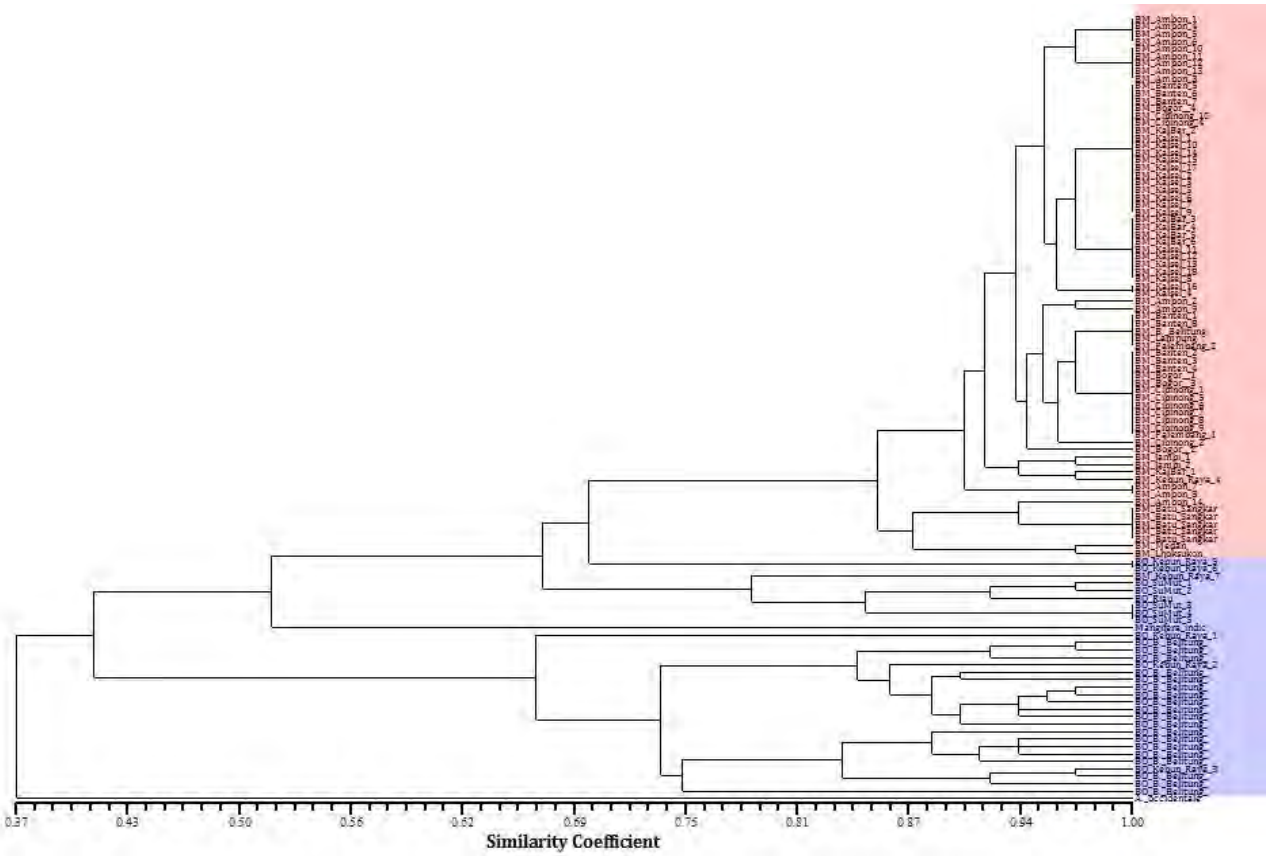

Figure 3. Dendogram based on UPGMA from the morphological markers of *B. oppositifolia* (blue) and *B. macrophylla* (red)

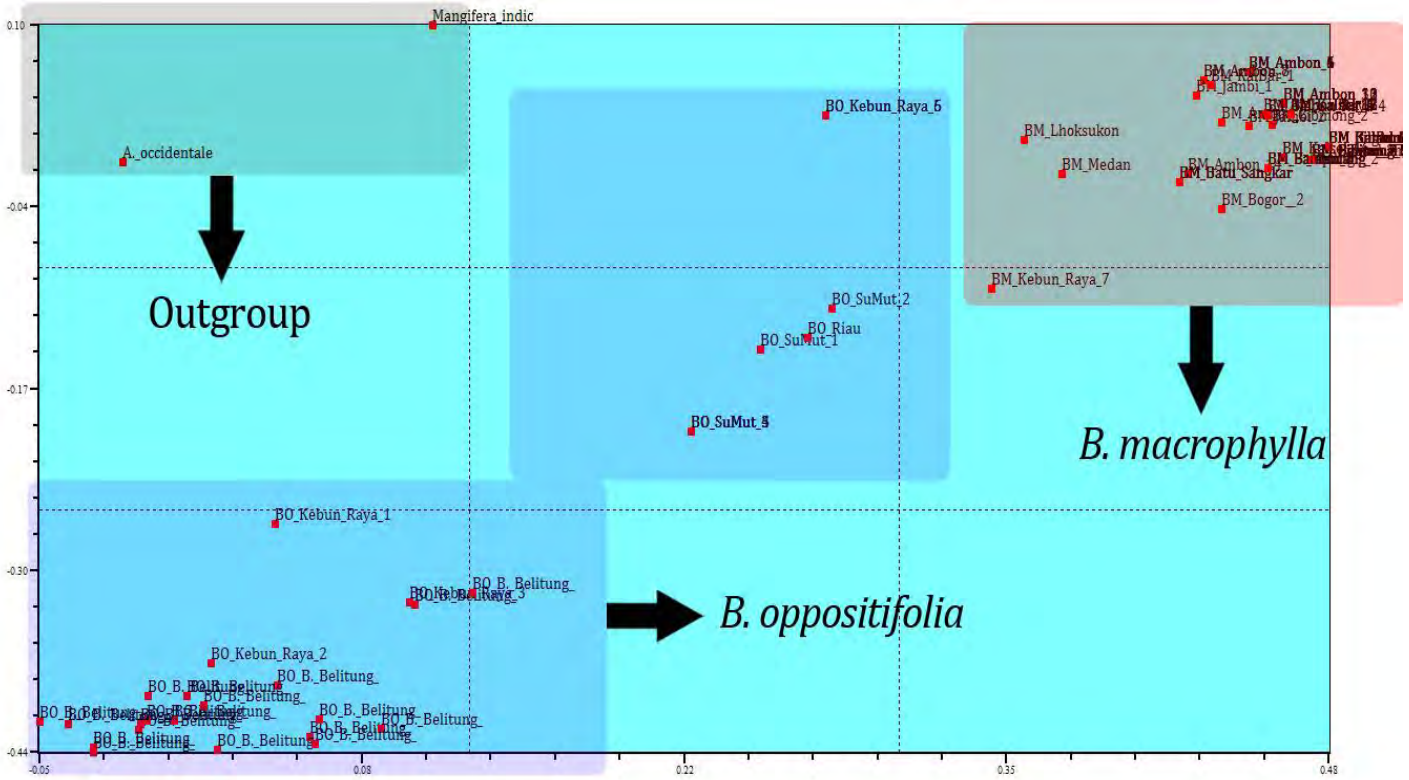

Figure 4. 2D plot of principal component analysis, indicating a relationship between 30 *B. oppositifolia* accessions and 75 *B. macrophylla* accessions as well as 2 outgroup (*M. indica* and *A. occidentale*) based on the morphological markers

2.4. CONCLUSION

Based on the research results obtained that the morphological markers that differentiate *Bouea* from other plants found on sitting opposite leaves and seeds are colored purple. Morphological markers that differentiate *B. macrophylla* and *B. oppositifolia* is the size of the leaf, fruit size, fruit shape, fruit color, the color of the flesh of the fruit, and the shape of the leaf axillary bud. Cluster analysis on *B. Macrophylla* Indonesia yielded similarities of coefficient between 0.77-1.00 and grouped into seven main groups on the similarity coefficient 0.93. Cluster analysis on *B. oppositifolia* Indonesia yielded coefficients of similarity between 0.49-1.00 and grouped into five main groups on the similarity coefficient of 0.84.

2.5. REFERENCES

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DIVERSITY OF *GANDARIA* (*BOUEA*) BASED ON MORPHOLOGICAL CHARACTERS IN INDONESIA

SUMMARY

~~*Bouea* a member of the family *Anacardiaceae* the major distribution in Malesia region.~~ The major distribution of *Bouea* spp from the family *Anacardiaceae* is common in Malaysian region. The g~~G~~enus *Bouea* has three species *B. Marcophylla*, *B. oppositifolia*, and *B. poilanei*. Morphological variations were found in *Bouea* in various regions of Indonesia. This study aims to review the diversity and grouping of *Bouea* spp in Indonesia using morphological markers. A total of 75 accessions of *B. macrophylla* and 30 accessions of *B. oppositifolia* obtained from 13 provinces in Indonesia observed variations using 31 characters and 81 characters morphological markers. The result of observation was then cluster analyzed using the program NTSYS version 2.02 and confirmed using Principal Component Analysis (PCA). The results showed that the morphological markers that can distinguish Bouea from other plant were opposite leaves pattern and purle seeds.~~found on sitting opposite leaves and seeds are purple~~. Morphological markers that distinguished *B. macrophylla* with *B. oppositifolia* ~~is~~ were leaf size, fruit size, fruit shape, fruit color, flesh color, and shape of the leaf axillary bud. ~~The results of cluster~~ Cluster analysis showed that *B. macrophylla* has ~~similarity~~ similarity-coefficient between 0.77 to 1.00 and is divided in seven groups major on the coefficient of 0.93, while *B. oppositifolia* has ~~similarity~~ similarity coefficient between 0.49 to 1.00 and is divided in five groups ~~major similarity coefficient of~~with major coefficient of 0.85 value. ~~.~~*B. oppositifolia* had higher similarity coefficient than *B. macrophylla* with respect to their morphology. ~~The results showed that the coefficient of similarity in morphological variation *B. oppositifolia* higher than *B. macrophylla*.~~

Keyword: Bouea, morphological marker, cluster analysis, coefficient similarity

INTRODUCTION

The genus *Bouea* is a member of the family *Anacardiaceae* (Ghazali & Mohammad, 2014). Most members of the ~~genus~~ *Bouea* still grow wildly and spread across Sumatera, Java, Borneo, Malaysia Peninsula, and Moluccas Island (Rifai, 1992). Hou (1978) reported that ~~the genus~~ *Bouea* includes only two species, namely; *Bouea macrophylla* and *Bouea oppositifolia* based on fruit shape, leaf size, and bud size.~~,~~ ~~namely, *Bouea macrophylla* and *Bouea*~~

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~~*oppositifolia*.~~ The similar characteristics ~~shared by~~between both species ~~include the~~is opposite leaf base, while ~~the~~ distinguished characteristics ~~distinguishing both species~~ are leaf size and shoots growing in leaf base.~~,~~ In some specimens ,~~but~~ Harsono (2013) reported that ~~in some specimens there is a sufficiently~~ wide range of morphological characteristics in ~~view of~~ leaf shape and size and still possibility of reviewing their economic status.~~,~~ ~~and it still possibly reviews their economic status.~~ Moreover, it is also reported that there is a number of variations in shape, color, size, and skin spot of *gandaria* fruits. ~~that were not reported by Hou (1975).~~ In addition, Rehatta (2005) & Papilaya (2007) reported the presence of *Bouea* in Ambon with the characters of leaves similar to those of ~~*Bouea*~~ *B. macrophylla*, but having different ~~it has~~ fruit shape, size, and color. ~~different from those previously reported.~~

In this context, with the objective of diversity study and ~~The objective of the study is to examine the diversity and~~ to cluster the *Bouea* genus in Indonesia using morphological characters~~. The~~, the study was conducted from June 2013 to June 2015.

MATERIALS AND METHOD

~~Materials~~ The germplasms used in the study were *B. macrophylla* (75 accessions) and *B. oppositifolia* (30 accessions) (Table 1). The samples were collected from regions across Indonesia such as Aceh, North Sumatra, Riau, West~~-~~ Sumatra, Jambi, South Sumatra, Lampung, West Java, Central Java, South Borneo, West Borneo, Ambon and Banten (Figure 1). The ~~materials~~ germplasms obtained mostly from wild condition ~~largely grown wildly~~ and only few were deliberately cultivated.

Morphological observations done to determine the species status under the genus *Bouea* referred to the criteria used by Rifai (1992) and Vogel (1987). Some of the main characteristics used were presented in Table 2, while dendogram was generated for the clustering of collected *Bouea* accessions~~ collected based on morphological characters~~. Documentation was done using digital camera. The clustering was carried out based on the ~~morphological characteristics, particularly the~~ diagnostic features of fruits and leaves as seen in Table 2.

Data Analysis

~~Data on morphological characteristics of herbarium specimens obtained from the field observation were classified and analyzed for similarity and difference to determine their~~

~~cluster.~~ The results of field observations on *gandaria* specimens from all the sites of the study classified and arranged in a form of matrix and then analyzed for similarity and difference to determine their cluster.

The analysis of the clustering of inter-accession similarity was carried out using NTSYS ver. 2.02 for the clustering of SAHN by UPGMA (*Unweighted Pair Group Method with Arithmetic Average*). The clustering was carried out based on morphological characteristics~~, particularly~~ with 21 diagnostic features such as leaf, fruit and seed shapes.

RESULTS AND DISCUSSION

Morphological variation in each of *B. macrophylla* and *B. oppositifolia* accessions

Based on the analysis of 81 morphological characters, variation in leaf size, shoot at bud, fruit color, and fruit shape were observed (Table 3). The data about morphological markers indicate that *B. macrophylla* and *B. oppositifolia* have morphological differences ~~that can be seen~~ in their phenotypic characteristics of leaves, fruits, and stems. All *B. macrophylla* and *B. oppositifolia* accessions have opposite leaf base, pink seed and axial flower. The morphological characteristics of *B. macrophylla* and *B. oppositifolia* based on the characters of leaves were presented in Table 4.

The leaves of *B. macrophylla* were very long (60 accession), long (13 accessions) and moderate (2 accessions), while those of *B. oppositifolia* were generally moderate (15 accessions), short (10 accessions) and long (5 accessions). The leaves of *B. macrophylla* were very wide (48 accessions) and wide (27 accessions), while those of *B. oppositifolia* were generally narrow (22 accessions) and wide (8 accessions). Most leaves of *B. macrophylla* was lanceolate in shape (73 accessions) and few was obovate (2 accessions), while *B. oppositifolia* has variation in oval/elliptic shape (1 accession), obovate (1 accession), oblong obovate (5 accessions), elliptic obovate (8 accessions) and oblong (15 accessions).

The upper epidermis surfaces of *B. macrophylla* (56 accessions) and *B. oppositifolia* (23 accessions) were largely dark green in color, while those of *B. macrophylla* (19 accessions) and *B. oppositifolia* (7 accessions) were green. The lower epidemic surfaces of *B. macrophylla* (65 accessions) and *B. oppositifolia* (28 accessions) were mostly green in color, while 10 accessions of *B. macrophylla* ~~accessions~~ and two of~~2~~ *B. oppositifolia* ~~accessions~~ were dark green in color. The apex size ~~of *B. macrophylla*~~ was entirely long for *B.*

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macrophylla , while that of *B. oppositifolia* showed variation, i.e. long (6 accessions), short (23 accessions), and no apex (1 accession).

The leaf apex for all accessions from ~~All~~ *B. macrophylla* ~~accessions~~ had acuminate-shaped ~~leaf apex~~, while *B. oppositifolia* ~~ones~~ showed variation ~~in shape of leaf apex~~, i.e. obtuse (12 accessions) and obtuse (1 accession). Rough leaf texture was noticed for most of the accessions. ~~could be seen in all the genus *Bouea*~~. All *B. macrophylla* accessions had *oppositifolia* were flat (26 accessions) and convex (4 accessions). The l~~L~~eaf petiole in *B. macrophylla* accessions had round and long size ~~petiole~~, while *B. oppositifolia* accessions had short ~~petiole~~ (22 accessions) and ~~petiole~~ round & long (8 accessions). ~~All *B. macrophylla*~~ *oppositifolia and mostly* ~~All~~ all *B. macrophylla* accessions had homofili leaves, while 13 accessions from *B. oppositifolia had* ~~all *B. oppositifolia* ones had homofili leaves (17~~ noticed ~~of dropping could be seen~~ in *B. macrophylla* (64 accessions) and *B. oppositifolia* while medium trees were ~~seen~~ noticed in *B. macrophylla* (11 accessions) and *B. oppositifolia* accessions). ~~Dense crown could be seen in most~~Mostly *B. macrophylla* (67 accessions) and *B. oppositifolia* (9 accessions) were dense crown~~,~~ while moderate crown ~~could be~~ seen in most *B. oppositifolia* (21 accessions) and *B. macrophylla* (8 accessions). Most of the accessions from *B. macrophylla* and 22 accessions from *B. oppositifolia* noticed ~~had~~ no hairy young stem, while 8 accessions from *B. oppositifolia* had hairy young stem .~~(8 accessions) and no hairy young stem (22 accessions).~~ The morphological characteristics based on the properties of trees were presented in Table 5.

Mostly, 73 accessions of *B. macrophylla* and 28 accessions of *B. oppositifolia* had round buds while 2 accessions each from both species were accumate buds. ~~Most buds in *B. macrophylla* were round (73 accessions) and acumate (2 accessions), while those in *B. oppositifolia* were accumate (28 accessions) and round (2 accessions).~~ All *B. macrophylla* accessions and 20 accessions of *B. oppositifolia* had few secondary bones, while 10 accessions of ~~those in~~ *B. oppositifolia* ~~showed~~ noticed ~~variation, i.e.~~ many secondary bones. ~~(10 accessions) and few (20 accessions).~~ All *B. macrophylla* accessions noticed ~~had~~ no hairy buds, while out of 30, 15 accessions had hairy buds and remaining had no hairy buds were noticed in case of ~~those of~~ *B. oppositifolia* .~~had hairy buds (15 accessions) and no hairy bud (15 accessions).~~

Cluster Analysis

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Bouea macrophylla

The data obtained from the morphological markers were used for a cluster analysis using NTSYS program version 2.02. The d~~D~~endogram was made based on the similarity using a Dice Coefficient method. The cluster analysis was performed by clustering the data obtained ~~into~~ from dendogram. Approximately 75 accessions of *B. macrophylla* ~~-~~ ,~~accessions~~, 30 accessions of *B. oppositifolia* ~~accessions,~~ and 2 out-groups (*M. indica* and *A. occidentale*) had similarity coefficient ranging from 0.77 to 1.00 and clustered in 7 main groups at a similarity coefficient of 0.93.

The seven groups i.e. 11 accessions from group 1 (Ambon),42 accessions from group 2 (Banten, Cibinong, South Borneo, Bogor and West Borneo), 8 accessions from group 3 (Ambon, Bangka Belitung, Banten, Lampung, Palembang, and Bogor), 4 accessions from group 4 (Jambi, West Borneo, and Bogor Botanical Garden (KR4)), 6 accessions from group 5 (Batu Sangkar, West Sumatera and Ambon (AM14)), 2 accessions from group 6 (Lhoksukon, Aceh and Medan) and finally 2 accessions from Bogor Botanical Garden(KR7 and KR8) as a group 7 (Figure 2). ~~Group 1 consisted of 11 accessions from Ambon. Group~~ many accessions of *B. macrophylla* showed low diversity based on the morphological markers. Because of 42 accessons, group 2 ~~Group 2 was the largest group, consisting of 42~~ consisting of 32 accessions from Banten and Cibinong with a similarity coefficient of 0.96, consisted of those from Banten, Bogor, Cibinong, Palembang, South Borneo and West Borneo. Group 2 consisted of 10 accessions from Cibinong, West Borneo, and South Borneo.

Bouea oppositifolia

The cluster analysis of *B. oppositifolia* was also carried out by clustering the genotypes obtained in~~to~~ dendogram. Thirty accessions had similarity coefficients ranging from 0.49 to 1.00 and clustered into 5 groups based on the similarity coefficient of 0.84. Six accessions from North Sumatera and Riau (g~~G~~roup 1), 2 accessions from Bogor Botanical Garden (KR5 and KR6) ~~consisted of 6 accessions from North Sumatera and Riau.~~ (g~~G~~roup 2), 12 accessions from Bogor Botanical Garden (KR2) and Bangka Belitung (group 3), 9 accessions from Bogor Botanical Garden (KR3) and Bangka Belitung (group 4) and 1 accession from Bogor Botanical Garden (KR1) consisted as group 5. ~~consisted of 2 accessions from Bogor Botanical Garden (KR5 and KR6). Group 3 consisted of 12 accessions from Bogor Botanical Garden (KR2) and Bangka Belitung. Group 4 consisting of~~

~~9 accessions from Bogor Botanical Garden (KR3) and Bangka Belitung. Group 5 only had 1~~ (BL1 and BL13, BL3 and BL13, BL13 and BL20).

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CONCLUSION

~~Based on the research results obtained that the~~The morphological markers that differentiate *Bouea* from other plants were opposite leaves and purple colored seeds. ~~found on sitting opposite leaves and seeds are colored purple.~~ Similarly, based on the observations, m~~M~~orphological markers like leaf size, fruit size, fruit shape, fruit color, flesh color, leaf axillary buds shape clearly ~~that~~ differentiate *B. macrophylla* and *B. oppositifolia* accessions.~~is the size of the leaf, fruit size, fruit shape, fruit color, the color of the flesh of the fruit, and the shape of the leaf axillary bud.~~ The c~~C~~luster analysis on *B. Macrophylla* from Indonesian origin yielded similarities of coefficient between 0.77-1.00 and grouped into seven main groups on the similarity coefficient 0.93. Similarly, c~~C~~luster analysis on *B.*

oppositifolia Indonesia yielded coefficients of similarity between 0.49-1.00 and grouped into five main groups on the similarity coefficient of 0.84.

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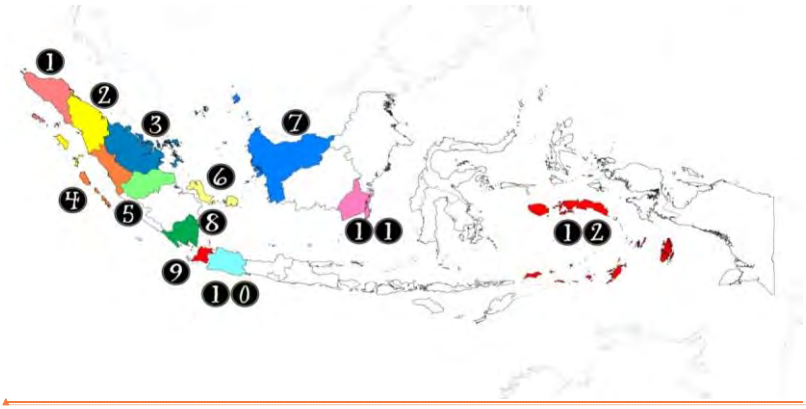

Figure 1. The sites of sampling in the field, (1) Aceh, (2) North Sumatera, (3) Riau, (4) West Sumatera, (5) Jambi, (6) Bangka Belitung, (7) West Borneo, (8) Lampung, (9) Banten, (10) West Java, (11) South Borneo, (12) Ambon, Moluccas

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Table 1. List of *Bouea* accessions used in the study

No.	Species	Province		Number
1	*B. oppositifolia* (Roxb.) Adelb.	North Sumatra	(SU)	5
2	*B. oppositifolia* (Roxb.) Adelb.	Riau	(RI)	1
3	*B. oppositifolia* (Roxb.) Adelb.	Bangka Belitung Islands	(BL)	19
4	*B. oppositifolia* (Roxb.) Adelb.	Bogor Botanical Garden	(KR)	5
5	*B. macrophylla* Griffit.	Ambon	(AM)	14
6	*B. macrophylla* Griffit.	Banten	(BA)	8
7	*B. macrophylla* Griffit.	West Sumatera	(BS)	5
8	*B. macrophylla* Griffit.	Bogor	(BO)	13
9	*B. macrophylla* Griffit.	Jambi	(JB)	2
10	*B. macrophylla* Griffit.	West Borneo	(KB)	6
11	*B. macrophylla* Griffit.	South Borneo	(KS)	18
12	*B. macrophylla* Griffit.	Palembang	(PLB)	2
13	*B. macrophylla* Griffit.	Lampung	(LP)	1
14	*B. macrophylla* Griffit.	Bangka Belitung	(BL)	1
15	*B. macrophylla* Griffit.	Medan	(MDN)	1
16	*B. macrophylla* Griffit.	Aceh	(SN)	1
17	*B. macrophylla* Griffit.	Great Garden of Bogor	(KR)	3
		Total		**105**

Table 2. Morphological characters used in the study

No	Morphological Characters	Sub-characters	Number of Characters
1	Trees	Dropping, medium	2
2	Crown	Dense, moderate	2
3	Leaf length	Very long, long, moderate, short	4
4	Leaf size	Very wide, wide, narrow	3
5	Leaf shape	Elliptic, obovate, oblong obovate, elliptic obovate, oblong, lanceolate	6
6	Leaf apex	Acuminate, acuminate obtuse, obtuse	3
7	Leaf base	Acute, acute obtuse, obtuse	3
8	Leaf apex size	Long, short, no leave apex	3
9	Adaxial color	Dark green, green	2
10	Abaxial color	Dark green, green	2
11	Adaxial appearance	Shine, dull	2
12	Abaxial appearance	Shine, dull	2
13	Leaf texture	Dull, fine, rough	3
14	Leaf appearance	Leaves flat, tortuous, convex	3
15	Petiole shape	Thin, round, square	3
16	Petiole size	Very long, long, short	3
17	Bud shape	Acute, round	2
18	Secondary bone	Many, few	2
19	Turpentine stone	No smell, finely smelt, strongly smelt	3
20	Fruit color	Red, yellow	2
21	Fruit shape	Round-oval, round, oval, bell	4
22	Fruit size	Small, big, very big	3
23	Flesh color	Red, yellow	2
24	Fruit taste	Sweet, sweet acid, astringent acid	3
25	Leaf type	Homofili, heterofili	2
26	Bud surface	Hairy, not hairy	2
27	Young stem surface	Hairy, not hairy	2
28	Seed color	Purple, white	2
29	Fruit type	Original, apparent	2
30	Leaf base	Opposite, dispersed	2
31	Flower type	Terminal, axilar	2
Total			81

Table 3. Morphological markers variation in *Bouea* fruits, leaves and buds

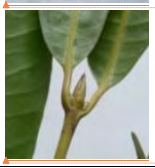
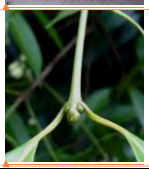
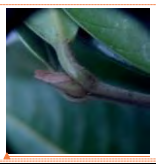
	GROUPS				
	1	**2**	**3**	**4**	**5**
FRUITS					
LEAVES					
BUDS					

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Table 4. The morphological characteristics of *B. macrophylla* and *B. oppositifolia* accessions based on the characters of leaves

S. No.	Characters of Leaves	Sub-characters	*B. macrophylla* Accessions	*B. oppositifolia* Accessions
1	Leaf length	Very long	60	0
		Long	13	5
		Moderate	2	15
		short	0	10
2	Leave size	Very wide	40	0
		Wide	27	8
		Narrow	0	22
3	Leaf shape	Elliptic	0	1
		Obovate	0	1
		Oblong Obovate	0	5
		Elliptic Obovate	2	8
		Oblong	0	15
		Lanceolate	73	0
4	Adaxial leaf color	Dark green	56	23
		Green	19	7
5	Abaxial leaf color	Dark green	10	2
		Green	65	28
6	Adaxial leaf surface	Shine	70	24
		Dull	5	6
7	Abaxial leaf surface	Shine	0	3
		Dull	75	27
8	Leaf surface texture	Fine	0	2
		Rough	75	28
9	Leaf surface shape	Convex	74	4
		Flat	0	26
		Tortuous	1	0
10	Leaf petiole shape	Thin	0	22
		Round	75	8
		Square	0	0
11	Leaf petiole size	Very long	1	0
		Long	75	7
		Short	0	23
12	Secondary bone	Many	0	10
		Few	75	20
13	Leaf landscape	Homofili	75	17
		Heterofili	0	13
14	Leaf position	Opposite	73	30

Table 5. The morphological characters based on the properties of trees

S. No.	Tree characteristics	Sub-characters	*B. macrophylla* Accessions	*B. oppositifolia* Accessions
1	Tree	Dropping	64	4
		Medium	11	26
2	Crown	Dense	67	9
		Moderate	8	21
3	Young stem surface	Hairy	0	8
		Not hairy	75	22

Table 6. Morphological characteristics of *B. macrophylla* and *B. oppositifolia* based on the characters of fruits

S. No.	Characteristics of fruits	Subcharacters	*B. macrophylla* (accessions)	*B. oppositifolia* (accessions)
1	Fruit color	Yellow	75	8
		Red	0	22
2	Fruit shape	Oval round	0	22
		Round	75	8
		Oval	0	0
		Bell	0	0
3	Fruit size	Very big	0	0
		Big	75	8
		Small	0	22
4	Flesh color	Red	0	22
		Yellow	75	8
5	Fruit taste	Sweet	14	4
		Sweet acid	61	26
		Astringent acid	0	0

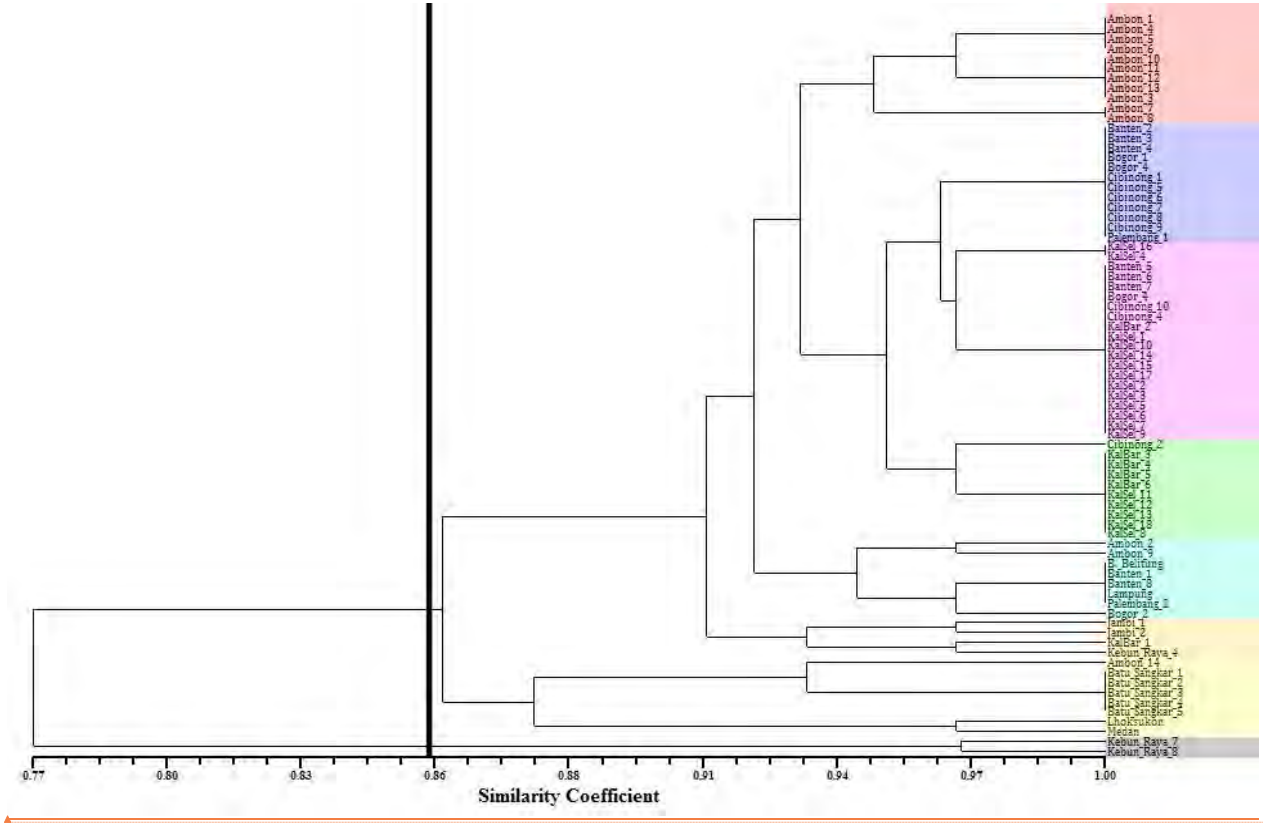

Figure 2. Dendogram based on UPGMA from the morphological characteristics of *B. macrophylla*

Table 7. Similarity coefficient of 36 *B. macrophylla* accessions based on the morphological characteristics

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AM1	AM12	AM14	AM3	AM5	AM7	AU	BA1	BA2	BA4	BA5	BL17	BS1	BS3	BS5	JB1	JB2	BO1	KB1	KB4	KB6	KR4	KS1	KS10	KS12	KS14	KS2	KS3	KS4	KS5	KS6	KS8	LP	BO2	PLB	BO3
1,00																																			
0,96	1,00																																		
0,89	0,93	1,00																																	
0,96	1,00	0,93	1,00																																
1,00	0,96	0,89	0,96	1,00																															
0,96	0,93	0,85	0,93	0,96	1,00																														
0,70	0,74	0,81	0,74	0,70	0,74	1,00																													
0,85	0,89	0,81	0,89	0,85	0,89	0,85	1,00																												
0,89	0,93	0,85	0,93	0,89	0,85	0,81	0,96	1,00																											
0,89	0,93	0,85	0,93	0,89	0,85	0,81	0,96	1,00	1,00																										
0,93	0,96	0,89	0,96	0,93	0,89	0,78	0,93	0,96	0,96	1,00																									
0,85	0,89	0,81	0,89	0,85	0,89	0,85	1,00	0,96	0,96	0,93	1,00																								
0,81	0,85	0,93	0,85	0,81	0,78	0,89	0,81	0,85	0,85	0,89	0,81	1,00																							
0,81	0,85	0,93	0,85	0,81	0,78	0,89	0,81	0,85	0,85	0,89	0,81	1,00	1,00																						
0,81	0,85	0,93	0,85	0,81	0,78	0,89	0,81	0,85	0,85	0,89	0,81	1,00	1,00	1,00																					
0,81	0,85	0,78	0,85	0,81	0,78	0,89	0,89	0,93	0,93	0,89	0,89	0,85	0,85	0,85	1,00																				
0,85	0,89	0,81	0,89	0,85	0,81	0,85	0,93	0,96	0,96	0,93	0,93	0,81	0,81	0,81	0,96	1,00																			
0,89	0,93	0,85	0,93	0,89	0,85	0,81	0,96	1,00	1,00	0,96	0,96	0,85	0,85	0,85	0,93	0,96	1,00																		
0,85	0,89	0,81	0,89	0,85	0,81	0,85	0,85	0,89	0,89	0,93	0,85	0,89	0,89	0,89	0,96	0,93	0,89	1,00																	
0,96	0,93	0,85	0,93	0,96	0,93	0,74	0,89	0,93	0,93	0,96	0,89	0,85	0,85	0,85	0,85	0,89	0,93	0,89	1,00																
0,96	0,93	0,85	0,93	0,96	0,93	0,74	0,89	0,93	0,93	0,96	0,89	0,85	0,85	0,85	0,85	0,89	0,93	0,89	1,00	1,00															
0,89	0,93	0,85	0,93	0,89	0,85	0,81	0,89	0,93	0,93	0,96	0,89	0,93	0,93	0,93	0,93	0,89	0,93	0,96	0,93	0,93	1,00														
0,93	0,96	0,89	0,96	0,93	0,89	0,78	0,93	0,96	0,96	1,00	0,93	0,89	0,89	0,89	0,89	0,93	0,96	0,93	0,96	0,96	0,96	1,00													
0,93	0,96	0,89	0,96	0,93	0,89	0,78	0,93	0,96	0,96	1,00	0,93	0,89	0,89	0,89	0,89	0,93	0,96	0,93	0,96	0,96	0,96	1,00	1,00												
0,96	0,93	0,85	0,93	0,96	0,93	0,74	0,89	0,93	0,93	0,96	0,89	0,85	0,85	0,85	0,85	0,89	0,93	0,89	1,00	1,00	0,93	0,96	0,96	1,00											
0,93	0,96	0,89	0,96	0,93	0,89	0,78	0,93	0,96	0,96	1,00	0,93	0,89	0,89	0,89	0,89	0,93	0,96	0,93	0,96	0,96	0,96	1,00	1,00	0,96	1,00										
0,93	0,96	0,89	0,96	0,93	0,89	0,78	0,93	0,96	0,96	1,00	0,93	0,89	0,89	0,89	0,89	0,93	0,96	0,93	0,96	0,96	0,96	1,00	1,00	0,96	1,00	1,00									
0,93	0,96	0,89	0,96	0,93	0,89	0,78	0,93	0,96	0,96	1,00	0,93	0,89	0,89	0,89	0,89	0,93	0,96	0,93	0,96	0,96	0,96	1,00	1,00	0,96	1,00	1,00	1,00								
0,89	0,93	0,85	0,93	0,89	0,93	0,81	0,96	0,93	0,93	0,96	0,96	0,85	0,85	0,85	0,85	0,89	0,93	0,89	0,93	0,93	0,93	0,96	0,96	0,93	0,96	0,96	0,96	1,00							
0,93	0,96	0,89	0,96	0,93	0,89	0,78	0,93	0,96	0,96	1,00	0,93	0,89	0,89	0,89	0,89	0,93	0,96	0,93	0,96	0,96	0,96	1,00	1,00	0,96	1,00	1,00	1,00	0,96	1,00						
0,93	0,96	0,89	0,96	0,93	0,89	0,78	0,93	0,96	0,96	1,00	0,93	0,89	0,89	0,89	0,89	0,93	0,96	0,93	0,96	0,96	0,96	1,00	1,00	0,96	1,00	1,00	1,00	0,96	1,00	1,00					
0,96	0,93	0,85	0,93	0,96	0,93	0,74	0,89	0,93	0,93	0,96	0,89	0,85	0,85	0,85	0,85	0,89	0,93	0,89	1,00	1,00	0,93	0,96	0,96	1,00	0,96	0,96	0,96	0,93	0,96	0,96	1,00				
0,85	0,89	0,81	0,89	0,85	0,89	0,85	1,00	0,96	0,96	0,93	1,00	0,81	0,81	0,81	0,89	0,93	0,96	0,85	0,89	0,89	0,89	0,93	0,93	0,89	0,93	0,93	0,93	0,96	0,93	0,93	0,89	1,00			
0,81	0,85	0,85	0,85	0,81	0,85	0,89	0,96	0,93	0,93	0,89	0,96	0,85	0,85	0,85	0,85	0,89	0,93	0,81	0,85	0,85	0,85	0,89	0,89	0,85	0,89	0,89	0,89	0,93	0,89	0,89	0,85	0,96	1,00		
0,85	0,89	0,81	0,89	0,85	0,89	0,85	1,00	0,96	0,96	0,93	1,00	0,81	0,81	0,81	0,89	0,93	0,96	0,85	0,89	0,89	0,89	0,93	0,93	0,89	0,93	0,93	0,93	0,96	0,93	0,93	0,89	1,00	0,96	1,00	
0,93	0,96	0,89	0,96	0,93	0,89	0,78	0,93	0,96	0,96	1,00	0,93	0,89	0,89	0,89	0,89	0,93	0,96	0,93	0,96	0,96	0,96	1,00	1,00	0,96	1,00	1,00	1,00	0,96	1,00	1,00	0,96	0,93	0,89	0,93	1,00

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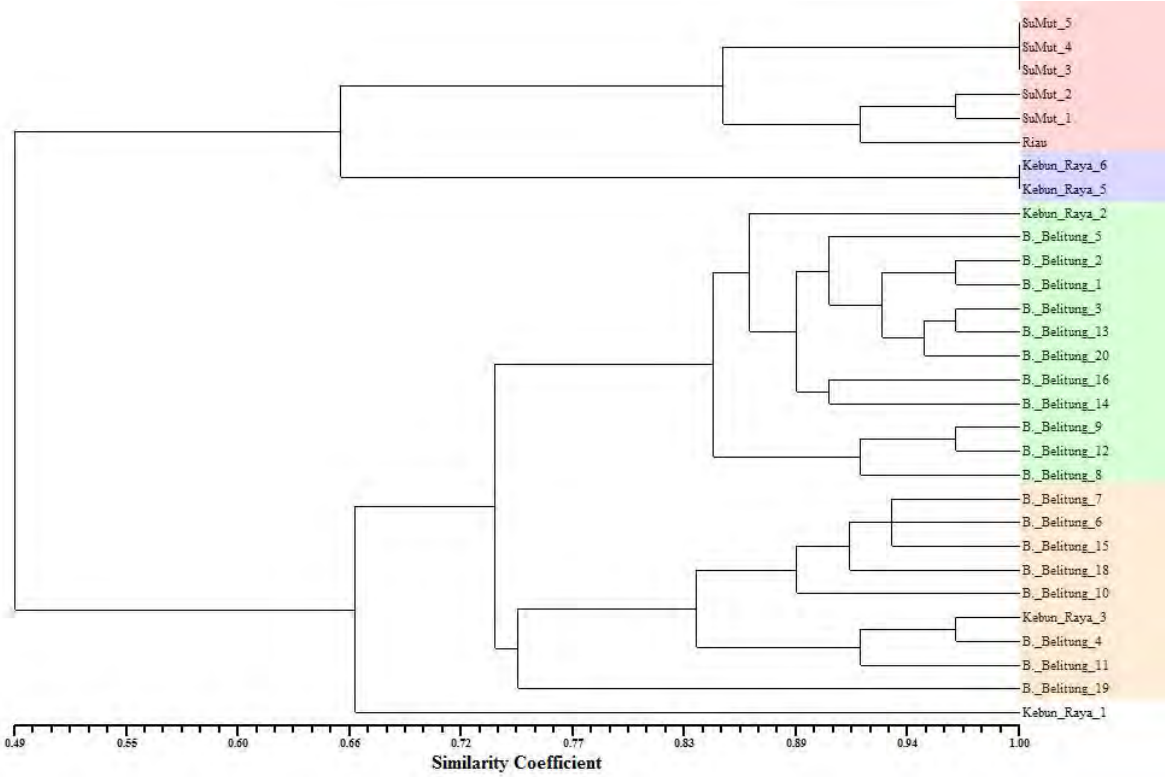

Figure 2. Dendogram based on UPGMA from the morphological characteristics of *B. oppositifolia*

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Table 8. Similarity coefficient of 23 *B. oppositifolia* accessions based on the morphological characteristics

Aksesi	SU1	SU2	SU3	SU4	BL1	BL3	BL4	BL5	BL6	BL7	BL8	BL13	BL14	BL15	BL16	BL18	BL20	KR1	KR2	KR3	KR5	KR6	RI
SU1	1,00																						
SU2	1,00	1,00																					
SU3	1,00	1,00	1,00																				
SU4	0,81	0,81	0,81	1,00																			
BL1	0,41	0,41	0,41	0,30	1,00																		
BL3	0,41	0,41	0,41	0,30	0,93	1,00																	
BL4	0,52	0,52	0,52	0,70	0,56	0,56	1,00																
BL5	0,52	0,52	0,52	0,33	0,89	0,89	0,56	1,00															
BL6	0,59	0,59	0,59	0,56	0,74	0,74	0,78	0,78	1,00														
BL7	0,67	0,67	0,67	0,56	0,74	0,74	0,78	0,78	0,93	1,00													
BL8	0,44	0,44	0,44	0,33	0,93	0,85	0,56	0,89	0,78	0,78	1,00												
BL13	0,44	0,44	0,44	0,33	0,96	0,96	0,59	0,93	0,78	0,78	0,89	1,00											
BL14	0,52	0,52	0,52	0,41	0,89	0,89	0,67	0,85	0,70	0,78	0,81	0,93	1,00										
BL15	0,67	0,67	0,67	0,63	0,67	0,67	0,85	0,70	0,93	0,93	0,70	0,70	0,78	1,00									
BL16	0,41	0,41	0,41	0,30	0,85	0,85	0,56	0,81	0,67	0,74	0,78	0,89	0,89	0,67	1,00								
BL18	0,67	0,67	0,67	0,56	0,74	0,74	0,81	0,70	0,85	0,93	0,70	0,78	0,85	0,93	0,74	1,00							
BL20	0,44	0,44	0,44	0,33	0,93	0,93	0,59	0,89	0,78	0,78	0,93	0,96	0,89	0,70	0,85	0,78	1,00						
KR1	0,41	0,41	0,41	0,30	0,59	0,59	0,52	0,56	0,67	0,74	0,63	0,56	0,56	0,67	0,67	0,67	0,56	1,00					
KR2	0,44	0,44	0,44	0,26	0,89	0,81	0,52	0,85	0,63	0,70	0,81	0,85	0,85	0,63	0,81	0,70	0,81	0,63	1,00				
KR3	0,48	0,48	0,48	0,67	0,59	0,59	0,96	0,59	0,81	0,81	0,59	0,63	0,63	0,81	0,59	0,78	0,63	0,56	0,56	1,00			
KR5	0,56	0,56	0,56	0,67	0,19	0,11	0,56	0,19	0,33	0,33	0,19	0,15	0,22	0,41	0,11	0,37	0,15	0,30	0,30	0,52	1,00		
KR6	0,56	0,56	0,56	0,67	0,19	0,11	0,56	0,19	0,33	0,33	0,19	0,15	0,22	0,41	0,11	0,37	0,15	0,30	0,30	0,52	1,00	1,00	
RI	0,78	0,78	0,78	0,81	0,26	0,19	0,52	0,30	0,37	0,44	0,30	0,22	0,30	0,44	0,26	0,44	0,22	0,41	0,37	0,48	0,70	0,70	1,00

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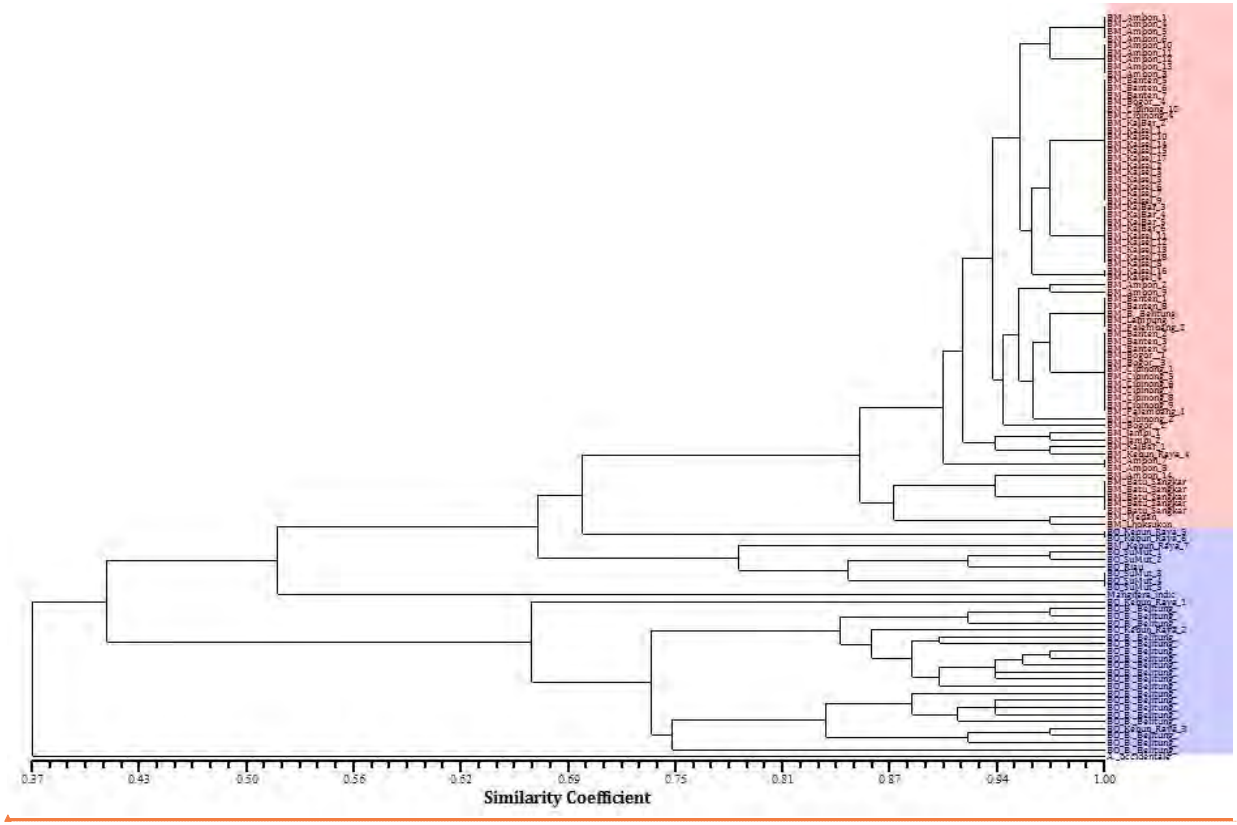

Figure 3. Dendogram based on UPGMA from the morphological markers of *B. oppositifolia* (blue) and *B. macrophylla* (red)

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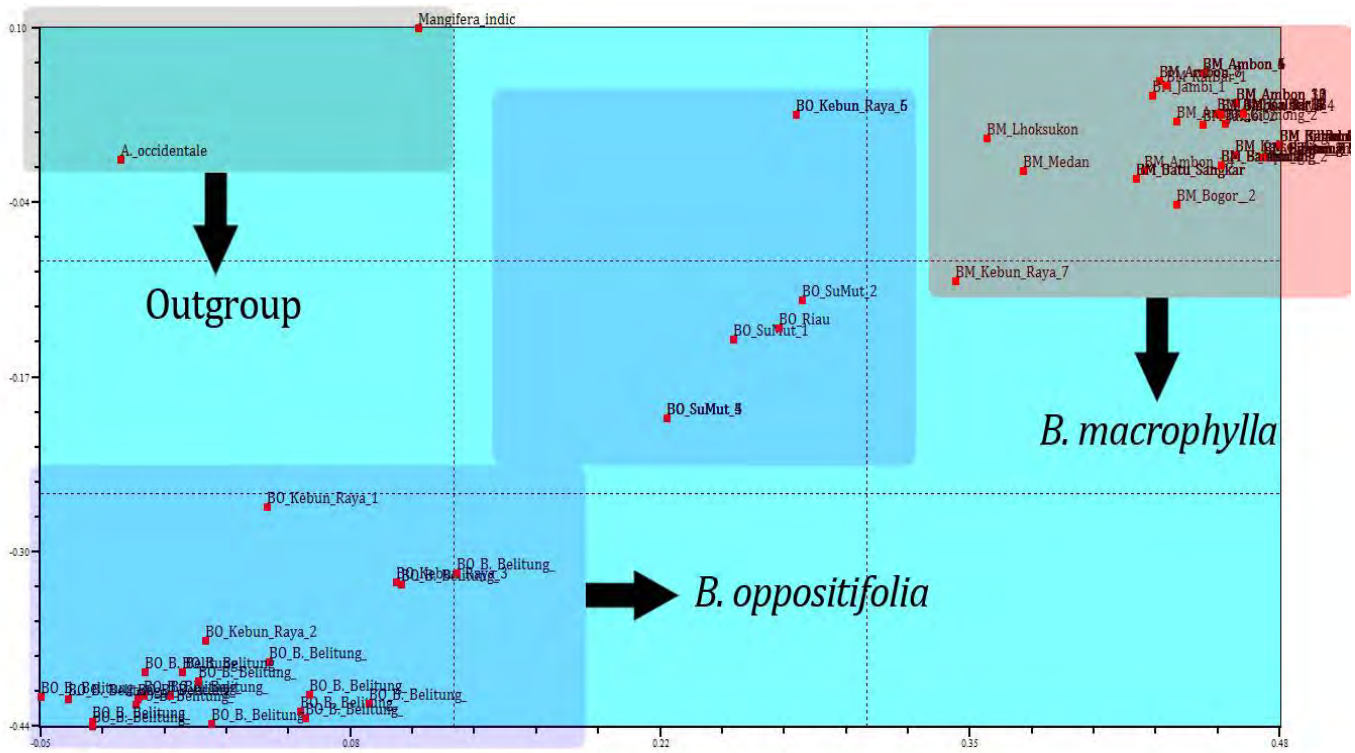

Figure 4. 2D plot of principal component analysis, indicating a relationship between 30 *B. oppositifolia* accessions and 75 *B. macrophylla* accessions as well as 2 outgroup (*M. indica* and *A. occidentale*) based on the morphological markers

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