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LEAF MORPHOLOGICAL VARIATION OF *PISONIA GRANDIS* R.BR. (NYCTAGINACEAE) FROM JAVA, BALI, AND LOMBOK

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ABSTRACT

Indah Anugrah Sari & Himmah Rustiami 2025. Variasi Morfologi Daun *Pisonia grandis* R.Br. (Nyctaginaceae) dari Jawa, Bali, dan Lombok. Floribunda 8(2) 44 – 53 — Suatu penelitian mengenai variasi morfologi daun *Pisonia grandis* R.Br. dari Jawa, Bali, dan Lombok dilakukan untuk mengkaji pola variasi intraspesifik. Sebanyak 16 spesimen telah diteliti, yang seluruhnya menunjukkan tepi daun rata, tekstur daun umumnya kartaseus, serta tulang daun utama yang menonjol pada permukaan abaksial. Variasi ditemukan pada 15 karakter daun. Analisis fenetik mengungkapkan tiga kelompok utama pada koefisien kemiripan 0,45. Kelompok A terdiri atas dua subkelompok (A1 dan A2) pada koefisien kemiripan 0,52. Kelompok B juga terbagi menjadi dua subkelompok (B1 dan B2) pada koefisien kemiripan 0,45, sedangkan Kelompok C terdiri atas dua subkelompok (C1 dan C2) pada koefisien kemiripan 0,59. Analisis klaster tidak mendukung pengakuan taksa infraspesifik, karena variasi morfologi yang diamati tidak berkorelasi dengan distribusi geografis.

Kata kunci: daun, morfologi, analisis fenetik, *Pisonia grandis*

Indah Anugrah Sari & Himmah Rustiami 2025. Leaf Morphological Variation of *Pisonia grandis* R.Br. (Nyctaginaceae) from Java, Bali, and Lombok. Floribunda 8(2) 44 – 53 — A study on leaf morphological variation in *Pisonia grandis* R.Br. from Java, Bali, and Lombok was conducted to assess patterns of intraspecific variation. Sixteen specimens were examined, all of which exhibit entire leaf margins, predominantly chartaceous textures, and a prominent abaxial midrib. Variation was detected across 15 leaf characters. Phenetic analysis revealed three major groups at a similarity coefficient of 0.45. Group A comprises two subgroups (A1 and A2) at a similarity coefficient of 0.52. Group B is also divided into two subgroups (B1 and B2) at a similarity coefficient of 0.45, while Group C consists of two subgroups (C1 and C2) at a similarity coefficient of 0.59. The cluster analysis does not support recognition of any infraspecific taxa, as the observed morphological variation does not correlate with geographic distribution.

Key words: leaf, morphology, phenetic analysis, *Pisonia grandis*

Pisonia grandis R.Br. is a tree species reaching up to 30 m in height and belongs to the family Nyctaginaceae. In Indonesia, its geographic distribution includes Nusakambangan Island, Karimunjawa, and Kangean (Stemmerik 1964). Although natural populations of this species are very limited, its conservation status is currently not protected,

as *P. grandis* has been widely cultivated and planted in various locations (Pratama et al. 2014). Moreover, the species exhibits a broad geographic range extending from southeastern Kenya to northeastern Tanzania and from the Indian Ocean to the Pacific region (Stemmerik 1964).

In its natural habitat along the rocky southern coast of Nusakambangan Island, only two individuals of *P. grandis* were observed during a field survey conducted in 2019. This number is considerably lower than historical records from the same locality approximately 50 years earlier, which reported up to 20 individuals in the area. *Pisonia grandis* grows well on phosphate-rich limestone substrates with acidic conditions formed by accumulations of seabird guano. Such edaphic conditions are typically restricted to small islands, including Nusakambangan (Stemmerik 1964).

Monitoring data from the Cilacap SKW III Natural Resources Conservation Center indicate that *P. grandis* individuals growing on coral rock substrates in Nusakambangan currently exhibit a stunted growth form, in contrast to cultivated plants, which generally show more robust development. Despite this observation, reports addressing morphological variation of *P. grandis* across different regions of Indonesia remain scarce. Prior to this study, variation in this species was primarily noted in leaf morphology. Stemmerik (1964) reported that leaves of *P. grandis* vary in shape from oval to elliptic or rounded, possess thin (membranaceous) leaf blades, and have glabrous surfaces with reddish to dark-colored venation.

Herbarium specimens of *P. grandis* examined in this study, collected from different localities, demonstrate additional morphological variation. From a systematic perspective, species boundaries within *P. grandis* remain ambiguous, particularly in determining whether the observed morphological differences warrant recognition at an infraspecific taxonomic level (*e.g.* subspecies or variety) or merely reflect phenotypic plasticity in response to varying environmental conditions.

This study presents a herbarium-based investigation focusing on leaf morphological variation, with particular emphasis on leaf surface characters, using specimens of *P. grandis* housed at Herbarium Bogoriense (BO). Digital herbarium records from the National Herbarium of the Netherlands (L) were also consulted, particularly for information on type specimens. The aim of this study is to describe and evaluate leaf morphological characters of *P. grandis* specimens collected from Java, Bali, and Lombok. The results are expected to contribute to a clearer delimitation of the species concept of *P. grandis* and to facilitate species identification based on morphological characters.

MATERIALS AND METHODS

A total of 16 specimens of *P. grandis* from Java, Bali, and Lombok deposited at BO were examined for leaf morphological variation, following the methods of Vogel (1987) and Rifai (1976). Fifteen morphological characters were included in the phenetic analysis (Table 1). The scoring data are presented in Table 2, while the examined specimens of *P. grandis* and their provenance are listed in Table 3. Leaf surface features, particularly the presence of freckles, were observed under a trinocular microscope and scored using binary character states (absent = 0; present = 1). Data analysis was conducted using the NTSYSpc program version 2.1 (Rohlf, 1997) to calculate similarity coefficients among samples, followed by cluster analysis using the *Unweighted Pair Group Method with Arithmetic Mean* (UPGMA).

Species descriptions and identification keys for *P. grandis* were constructed based on leaf morphological characters. Information on habitat, ecology, and uses was compiled primarily from Flora Malesiana and supplemented with data from specimen labels.

Table1. Characters used in the phenetic analysis of *P. grandis* from Java, Bali dan Lombok

No	Characters	Variation
1	Leaf blade shape	elliptic (0), ovate (1)
2	Leaf base shape	acute (0), acuminate (1), obtuse (2)
3	Leaf apex shape	acute (0), acuminate (1), obtuse (2)
4	Leaf length	9.9–16.7 cm (0), 16.8–23.6 cm (1), 23.7–30.4 cm (2)
5	Leaf width	4.5–7.8 cm (0), 7.9–11.2 cm (1), 11.3–14.5 cm (2)
6	Petiole length	1–2 cm (0), 2.1–3.1 cm (1), 3.2–4.2 cm (2)
7	Petiole width	0.1 cm (0), 0.2 cm (1), 0.3 cm (2)
8	Midrib width at the base	0.1 cm (0), 0.2 cm (1), 0.3 cm (2)
9	Midrib width at the middle	0.1 cm (0), 0.2 cm (1)
10	Freckles on the adaxial surface of leaf	absent (0), present (1)
11	Freckles on the abaxial surface of leaf	absent (0), present (1)
12	Freckles on the adaxial surface of midrib	absent (0), present (1)
13	Freckles on the abaxial surface of midrib	absent (0), present (1)
14	Density of freckles on adaxial surface of leaf	absent (0), sparsely (1), densely (2)
15	Density of freckels on abaxial surface of leaf	absent (0), sparsely (1), densely (2)

Table 2. Data scoring

Specimens	Characters														
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Variant 1	0	1	0	1	1	2	1	1	0	1	1	1	0	1	2
Variant 2	0	1	0	2	2	2	1	1	0	0	1	0	0	0	2
Variant 3	0	2	2	0	1	0	0	0	0	0	1	0	1	0	1
Variant 4	0	1	0	1	1	1	1	1	1	0	0	0	1	0	0
Variant 5	0	1	0	0	0	0	0	0	0	1	0	1	0	1	0
Variant 6	0	0	0	2	2	2	1	1	0	1	1	1	1	1	1
Variant 7	0	0	0	2	2	2	0	0	0	0	1	0	1	0	1
Variant 8	0	1	1	1	1	1	0	0	0	1	1	1	0	1	1
Variant 9	0	0	1	2	1	1	0	0	0	1	1	1	1	2	2
Variant 10	0	1	0	1	2	2	1	1	0	1	1	1	1	1	2
Variant 11	0	0	0	1	0	1	0	0	0	1	1	1	1	1	1
Variant 12	0	1	0	0	0	0	0	0	0	1	0	1	0	2	0
Variant 13	1	1	0	1	1	0	1	1	0	0	0	0	0	0	0
Variant 14	0	1	1	2	1	1	2	2	1	0	0	0	0	0	0
Variant 15	0	1	0	2	2	1	2	2	1	0	0	0	0	0	0
Variant 16	0	1	0	1	1	1	0	0	0	0	1	0	1	0	1

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RESULT AND DISCUSSIONS

Morphological examination shown that there are some characters that can be found in all leaves of the examined specimens, includingentire leaf margin, chartaceous leaf texture, and prominent abaxial midrib. In this study, leaf surface characteristics were used for phenetic analysis because after observation under a microscope, the leaf surfaces of the *P.grandis* specimens were not all found to be glabrous. There are variations in the characteristics of the adaxial and abaxial surfaces of the leaves as follow:

Figure 1. Occurrence of freckles on the leaf surface. A. Leaf surface without freckles, B. Leaf surface with sparsely distributed freckles, C. Leaf surface with densely distributed freckles. Observed under light microscopy at 4×10 magnification.

According to Radford (1986), leaf surface features such as freckles or spots are referred to as spiculate**.** These freckles or spots represent trichomes, which may occur either sparsely or densely on the leaf surface. Leaf surface characters have rarely been used in phenetic analyses at the species level in *P. grandis*, including in several descriptions provided in *Flora Malesiana* (Stemmer 1964). In that treatment, the leaf surface of *P. grandis* is described as glabrous, without the presence of freckles. Nevertheless, variation in leaf surface characters cannot be reliably used to delimit infraspecific taxa, as these features do not show a consistent correlation with the geographic distribution of the examined specimens.

Figure 2 presents the phenetic analysis of 16 specimens of *P. grandis* collected from the Java–Bali–Lombok region, based on 15 morphological characters. The specimens are separated into three major groups (A, B, and C) at a similarity coefficient of 0.45, indicating that these groups share approximately 45% overall morphological similarity. Group A is further divided into two subgroups (A1 and A2) at a similarity coefficient of 0.52. Group B is also subdivided into two subgroups (B1 and B2) at a similarity coefficient of 0.45, while Group C comprises two subgroups (C1 and C2) with a similarity coefficient of 0.59.

According to Rohlf (1993), similarity indices reflect the degree of difference among selected operational taxonomic units (OTUs). Lower similarity index values indicate greater overall similarity, whereas higher values reflect fewer shared characters. Loveless (1989) further emphasized that classification is based on correlations among a large number of characters; thus, taxa sharing a greater number of characters are considered more closely related than those sharing only a few characters.

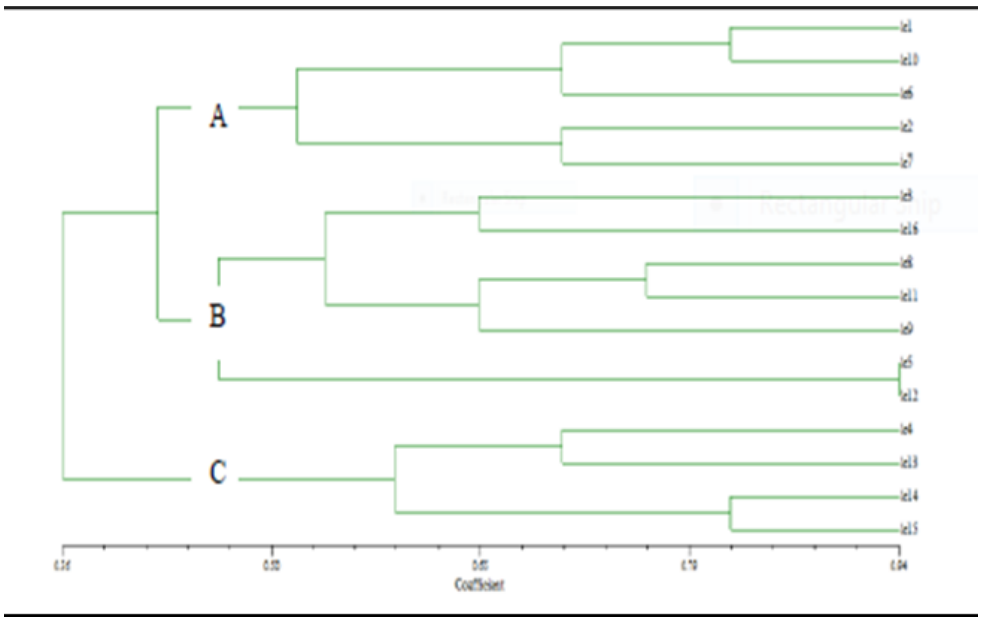

Figure 2. Phenogram of morphological similarity among *Pisonia grandis* from Java, Bali and Lombok.

Table 3. Specimens examined of *Pisonia grandis* and their provenance.

Ntsys Code	Variant designation	Collector names	Collector Number	Herbarium accession number	Localities
K1	*P. grandis* variant 1	SH Koorders	6048	BO1819558	Insula Java
K2	*P. grandis* variant 2	SH Koorders	6047	BO1819552	Insula Java
K3	*P. grandis* variant 3	Docters van Leeuwen Reijnvaan	7010	BO1819519	Batavia
K4	*P. grandis* variant 4	Zippelius	*s.n*	B01787135	Lesser Sunda Island Timor
K5	*P. grandis* variant 5	Valeton	*s.n*	BO1819552	Java
K6	*P. grandis* variant 6	R.C. Bakhuizen v/d Brink	6810	BO1819536	Batavia
K7	*P. grandis* variant 7	D.F van Slooten & C.A. Backer	35061	BO1418818	Batavia
K8	*P. grandis* variant 8	J.G.B Beumee	45	BO1418820	Java Pekalongan
K9	*P. grandis* variant 9	JJ Smith	15	BO1819521	Batavia
K10	*P. grandis* variant 10	SH Koorders	*s.n*	BO1819559	Java
K11	*P. grandis* variant 11	CA Backer	33987	BO1819539	Batavia
K12	*P. grandis* variant 12	Dommers	276	BO1819538	Kangean
K13	*P. grandis* variant 13	CA Backer	20762	BO1418822	Madura
K14	*P. grandis* variant 14	S. Riswan & Ismail *et al.*	*s.n*	BO1475604	Lesser Sunda Island Lombok
K15	*P. grandis* variant 15	Valeton	*s.n*	BO1819544	Lesser Sunda Island Bali
K16	*P. grandis* variant 16	Teysmann	10669	BO1787134	Lesser Sunda Island Timor

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Specimens of *P. grandis* (variants 1, 10, 6, 2, and 7) are grouped within Group A, as these five specimens share several morphological similarities, including an elliptic leaf blade, an acute leaf apex, a long petiole (3.2–4.2 cm), a midrib width of 0.1 cm at the middle portion, and the presence of freckles on the abaxial leaf surface. Group B comprises specimens of *P. grandis* (variants 3, 16, 8, 11, 9, 5, and 12), which cluster together based on shared characters such as an elliptic leaf blade, a petiole width of 0.1 cm, a midrib width of 0.1 cm at the base, and a midrib width of 0.1 cm at the middle. Group C includes specimens of *P. grandis* (variants 4, 13, 14, and 15), which are clustered due to similarities in having an obtuse leaf base, the absence of freckles on both adaxial and abaxial leaf surfaces, the absence of freckles on the adaxial surface of the midrib, and an overall lack of freckle density on the leaf surface.

The phenogram indicates that no infraspecific taxon can be recognized among the examined specimens, as the diagnostic characters defining each group do not correspond consistently with geographic distribution. In other words, the distinguishing morphological traits observed in each group are not geographically structured. For example, specimens of *P. grandis* originating from the same region (Batavia) exhibit variation in leaf apex shape (acute, acuminate, and obtuse) as well as petiole length (short, intermediate, and long categories), resulting in their placement into two different phenetic groups (Groups A and B). A similar pattern is observed in specimens from the Lesser Sunda Islands (Timor), where seven morphological variations are present despite their common geographic origin, leading to their placement in two different groups (Groups B and C).

According to Rifai (2015), biogeographic distribution plays a crucial role in defining species boundaries. Biogeography provides a framework for distinguishing species, subspecies, varieties, and forma, thereby facilitating clearer taxonomic delimitation. Subspecies generally represent populations composed of multiple biotypes with wide geographic distributions, whereas varieties are typically restricted to more limited areas and consist of subsets of populations exhibiting distinct morphological characters. Because the morphological groupings observed in this study do not align with geographic boundaries, they cannot be reliably distinguished as taxa below the species level. This conclusion is consistent with the treatment of *P. grandis* in Flora Malesiana (Stemmerik 1964).

The present results further support the morphological variation reported by Stemmerik (1964), who noted that *P. grandis* exhibits variability in leaf shape (oval, elliptic, or ovoid), leaf apex (acute or acuminate), and leaf base (pointed, rounded, or cordate). Such morphological variation is most plausibly attributable to phenotypic plasticity in response to differing environmental conditions rather than reflecting taxonomically meaningful differentiation.

Taxonomic treatment

Pisonia grandis R.Br., Prod. Fl. Nov. Holl. I (1810), Stemmerick (1964). — Type: *R. Brown s.n.* (Isotype L!-image seen [L0038762]; BM; B) from the North Coast of Australia (Jeer Australiense).

Ceodes grandis (R.Br.) D.Q.Lu, Fl. Reipubl. Popularis Sin. 26: 3 (1996).

Cordia olitoria Blanco, Fl. Filip.: 123 (1837).

Calpidia forsteriana (Endl. ex Walp.) Heimerl, Oesterr. Bot. Z. 63: 284 (1913).

Calpidia macrophylla Bojer, Rapp. Annuel Trav. Soc. Hist. Nat. île Maurice 11: 42 (1841).

Ceodes forsteriana (Endl. ex Walp.) Skottsb., Acta Horti Gothob. 2: 231 (1926).

Pisonia alba Span., Linnaea 15: 342 (1841).

Pisonia forsteriana Endl. ex Walp., Nov. Actorum Acad. Caes. Leop.-Carol. Nat. Cur. 19 (Suppl. 1): 403 (1843).

Pisonia inermis G.Forst., Fl. Ins. Austr.: 75 (1786), *nom. illeg.*

Pisonia macrophylla Link, Enum. Hort. Berol. Alt. 1: 354 (1821).

Pisonia macrophylla Choisy in A.P.de Candolle, Prodr. 13(2): 446 (1849), *nom. illeg.*

Pisonia malabarica Choisy in A.P.de Candolle, Prodr. 13(2): 447 (1849).

Pisonia morindifolia R.Br. in N.Wallich, Numer.

List: n.° 7130 (1832).
Pisonia olitoria (Blanco) Zoll., Natuurk. Tijdschr. Ned.-Indië 14: 154 (1857).
Pisonia procera Bertero ex Guill., Ann. Sci. Nat., Bot., sér. 2, 7: 191 (1837).
Pisonia sylvestris Teijsm. & Binn., Natuurk. Tijdschr. Ned.-Indië 9: 349 (1855).
Pisonia viscosa Balf.f., J. Linn. Soc., Bot. 16: 19 (1877).
Timeroyea canalensis S.Moore, J. Linn. Soc., Bot. 45: 379 (1921).
Plectronia macconnelii Horne ex Baker, J. Linn. Soc., Bot. 20: 363 (1883), *pro syn*.

Distribution. Native to Aldabra; Andaman Islands; Borneo; Caroline Islands; Chagos Archipelago; Christmas Island; Cocos (Keeling) Islands; Comoros; Cook Islands; Fiji; Gilbert Islands; Hawaii; India; Java; Kenya; Laccadive Islands; Lesser Sunda Islands; Line Islands; Madagascar; Malaya; Maldives; Maluku; Marcus Island; Mariana Islands; Marquesas Islands; Marshall Islands; Mozambique Channel Islands; Nauru; New Caledonia; New Guinea; New South Wales; Nicobar Islands; Niue; Philippines; Phoenix Islands; Pitcairn Islands; Queensland; Rodrigues; Samoa; Santa Cruz Islands; Seychelles; Society Islands; Solomon Islands; South China Sea region; Sulawesi; Taiwan; Tanzania; Tokelau–Manihiki; Tonga; Tuamotu Archipelago; Tubuai Islands; Tuvalu; Vanuatu; Wake Island; and Wallis and Futuna Islands (POWO 2024).

Habitat and ecology. Occurring in dry to semi-arid habitats, typically along coastal areas on sandy or rocky substrates, from sea level up to 1200 m elevation. Common on oceanic islets and atolls, where it is often a dominant species (Stemmerik 1964). Frequently cultivated in gardens as an ornamental plant.
Uses. In Bali, *Pisonia grandis* is traditionally used for catching birds. In several regions of Indonesia, the leaves—particularly from cultivated plants—are consumed as vegetables (Stemmerik 1964).

Key to *Pisonia grandis* species from Java, Bali and Lombok

1 a. Leaf blade shape has variations (elliptic or ovate) .....*Pisonia grandis* group C
b. Leaf blade shape has no variations (all elliptic) 2

2 a. Leaf apex shape has no variations (all acute); petiole length in long category (3.2–4.2 cm) ... . *Pisonia grandis* group A
b. Leaf apex shape has variations (acute or acuminate or obtuse); petiole length in short-middle category (1–3.1 cm) .....*Pisonia grandis* group B

Based on the results of the phenetic analysis, there are three groups that can be recognized, which is described below:

1. Group A

This group differs from the other groups seen from the character of the leaf apex shape shows no variations, leaf apex acute, petiole 3.2–4.2 cm long.

Tree. Leaves opposite; petiole 3.2–4.2 cm long; leaf blade elliptic, 16.8–30.4 cm long, margin entire, apex acute, chartaceous, brownish-brown on both surfaces of the leaf, freckles present on the abaxial surface; midrib prominent abaxially, 0.1 cm wide at the middle. Inflorescences terminal, dense corymbose cymes with imperfect flowers (polygamous).

Vernacular names. *Widjojo Kusumo* (in Javanese language).

Specimens examined. INDONESIA: Java: Insula Java, *s.d.*, *SH Koorders 6048* (BO! [BO1819558]); Insula Java, *s.d.*, *SH Koorders 6047* (BO! [BO1819552]); Java, *s.d.*, *SH Kooders s.n* (BO! [BO1819559]); Batavia, July 10 1927, *R.C. Bakhuizen v/d Brink 6810* (BO! [BO1819536]); Batavia, 8 September 1921, *D.F. van Slooten & C.A. Backer* 35061 BO! [BO1418818]).

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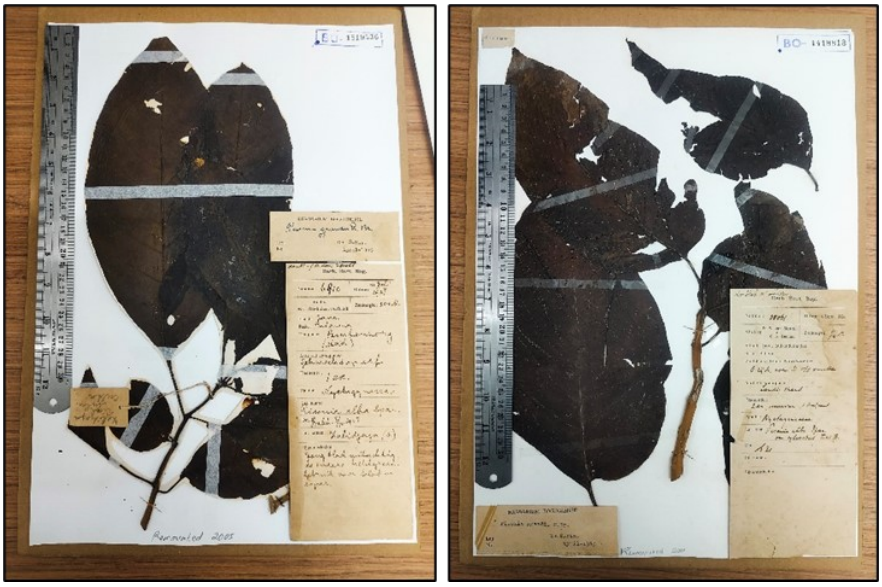

Figure 3. Sample of *Pisonia grandis* group A (Ntsys Code K6 and K7)

2. Group B

Differs from the other groups by various leaf apex shape (acute, acuminate or obtuse); petiole length in middle-short category (1–3.1 cm long).

Tree. Leaf opposite; petiole 1–3.1 cm long; leaf blade shape elliptic, margin entire, chartaceous, brownish-brown on both surfaces of the leaves; midrib prominent abaxially, 1 mm wide at the base and middle. Inflorescences densely corymbose cymes with imperfect flowers (polygamous).

Vernacular names. *Widjojo Kusumo*.

Specimens examined. INDONESIA: Java, *s.d.*, *Valeton s.n.* (BO! [BO1819522]); Batavia, 23 May 1923, *Docters van Leeuwen-Reijnvaan 7010* (BO! [BO1819519]); Batavia, May 1931, *C.A. Backer 33987* (BO! [BO1819539]; Batavia, December 1906, *J.J. Smith 15* (BO! [BO1819521]). Central Java: Pekalongan, April 1920, *J.G.B. Beumee* 45 (BO! [BO1418820]). East Java: Kangean, 10 October 1920, *Dommers 276* (BO! [BO1819538]). Lesser Sunda Island: Timor, *s.d.*, *Teysmann 10669* (BO! [BO1787134]).

Figure 4. Sample of *Pisonia grandis* group B (Ntsys Code K8 and K9)

3. Group C

Differ from other groups by variations of the leaf blade shape (ovate-elliptic).

Tree. Leaf opposite; leaf blade ovate to elliptic, 16.8–30.4 cm long, base obtuse, chartaceous, brownish-brown on both surfaces of the leaf, ofreckles absent; midrib prominent abaxially, Inflorescences densely corymbose cymes with imperfect flowers (polygamous).

Vernacular names. *Widjojo Kusumo*.

Spesimen examined. INDONESIA: Java: Madura, 27 March 1915, *C.A. Backer 20762* (BO! [BO1418822]). Lesser Sunda Island: Bali, *s.d.*, *Valeton s.n.* (BO! [BO1819544]); Lombok, 11, October 2001, *S. Riswan & Ismail s.n*. (BO! [BO1475604]); Timor, *s.d.*, *Zippelieus s.n*. (BO! [BO1787135]).

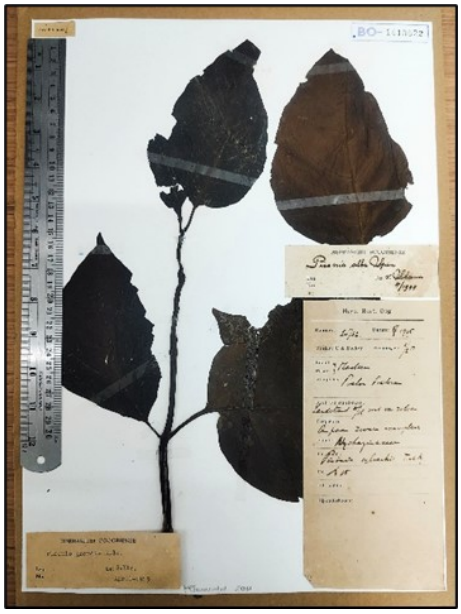

Figure 5. Sample of *Pisonia grandis* group C (Ntsys Code 13)

CONCLUSION

Several morphological characters are consistent across all examined specimens, including entire leaf margins, predominantly chartaceous leaf texture, and a prominent abaxial midrib. However, observations and measurements of 15 leaf morphological characters revealed both qualitative and quantitative variation among the 16 herbarium specimens collected from different regions. Phenetic analysis recognized three major groups, but these groupings do not support the recognition of taxa below the species level, as the distinguishing characters of each group do not show a consistent correlation with geographic distribution. The observed morphological variation is therefore most likely attributable to phenotypic plasticity in response to differing environmental conditions.

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