

MORPHOLOGICAL VARIATION IN *ASPENIUM TRUNCATUM* BLUME (ASPENIACEAE)**Winda Nurul Fajriah¹, Agung Sedayu¹, Wenni Setyo Lestari², Wita Wardani²**¹Biology Study Programme, Faculty of Mathematics and Natural Sciences,
Universitas Negeri Jakarta, Jakarta, 16112, Indonesia²Research Center for Biosystematics and Evolution, BRIN, Cibinong, 16911, Indonesia

Correspondence: wita002@brin.go.id

ABSTRAK

Winda Nurul Fajriah, Agung Sedayu, Wenni Setyo Lestari, Wita Wardani 2025. Variasi morfologi pada *Asplenium truncatum* (Aspleniaceae). *Floribunda* 8(2) 74 – 83 — *Asplenium truncatum* Blume menunjukkan variasi morfologi yang cukup besar di seluruh wilayah persebarannya di Malesia, sehingga nama ini sering digunakan secara bergantian dengan taksa yang berkerabat dekat dengannya yaitu *A. caudatum*. Penelitian ini dilakukan untuk mengkaji rentang karakter morfologi di dalam *A. truncatum* dan mengevaluasi kekuatannya dalam pengelompokan. Sejumlah 91 spesimen herbarium digunakan dalam analisis morfometrik dengan data pengukuran 12 karakter kuantitatif dan tiga karakter kualitatif. Variasi ditemukan pada bentuk daun, bentuk pinna, dan karakter sisik yang mengarah pada perbedaan morfotipe atau varietas, termasuk var. *lobulatum* dan var. *crenulatum*. Principal Component Analysis (PCA) menunjukkan bahwa variasi di antara morfotipe tersebut tidak menghasilkan batas morfologi yang jelas, dan diduga bahwa keanekaragaman yang diamati merepresentasikan adanya plastisitas fenotipik dalam satu spesies dan bukan taksa yang berbeda.

Kata kunci: Aspleniaceae, *Asplenium truncatum*, morfologi, plastisitas fenotipe, variasi morfotipe.

Winda Nurul Fajriah, Agung Sedayu, Wenni Setyo Lestari, Wita Wardani 2025. Morphological Variation in *Asplenium truncatum* Blume (Aspleniaceae). *Floribunda* 8(2) 74 – 83 — *Asplenium truncatum* Blume exhibits considerable morphological variation across its distribution in Malesia, which cause the name is used interchangeably with closely related taxa i.e. *A. caudatum*. This study examines the range of morphological characters within populations of *A. truncatum* specimens and evaluates diagnostic value of them. We used 91 herbarium specimens for 12 quantitative character measurements and three qualitative characters scoring that included in the morphometric analyses. Variations were found in frond architecture, pinna shape, and scale characters, which historically led to the recognition of morphotypes or varieties, including var. *lobulatum* and var. *crenulatum*. Principal Component Analysis (PCA) revealed that the variation among these morphotypes forms a continuous spectrum without clear morphological boundaries. These results indicate that the observed diversity represents phenotypic plasticity within a single species rather than distinct taxonomic entities.

Keywords: Aspleniaceae, *Asplenium truncatum*, morphology, morphotype variation, phenotypic plasticity.

INTRODUCTION

Asplenium truncatum Blume is a fern species of the family Aspleniaceae, distributed throughout the Malesian region, including Sumatra, Java, Sulawesi, and the Lesser Sunda Islands. Historically, this species has been considered taxonomically complex due to its high morphological variability. Blume (1827) originally described two morphotypes—*A. truncatum* var. *lobulatum* and var. *crenulatum*—based mainly on the differences in pinna incision (lobe shape). Subsequent researchers frequently misidentified specimens as *A. caudatum* for its overlapping morphological features. Salgado (2020) differentiate *A. truncatum* from *A. caudatum* based on the truncated lamina base and proliferation on the rachis. This study focuses exclusively on morphological variation within *A. truncatum* to clarify the range and diagnostic value of its vegetative and reproductive characters.

MATERIALS AND METHODS

The morphological characters of *Asplenium truncatum* were examined through direct field observations and analysis of herbarium specimens, including both newly collected materials (from Bali Botanical Gardens living collections and field explorations) and older specimens deposited in the Herbarium

Bogoriense (BO). A total of 12 quantitative and 3 qualitative characters were selected for morphological measurement (Table 1). The selection of characters was based on a modification of the multivariate numerical taxonomy method in phenetic studies proposed by Wei and Zhang (2013). The observations were compared with previous descriptions by Blume (1827) and Salgado (2020) and described following the morphological guidelines provided by PROSEA (De Winter & Amoruso, 2003) and Tjitrosoepomo (2018). Marginal sinuses of pinnae were defined in three major types: 'truncatum', 'lobulatum', 'crenulatum' (Figure 1). There are specimens originating from Maluku which exhibited distinctive various morphological patterns compared to other morphotypes. It was initially included in the analysis but we provisionally treat it as a separate and omitted from discussion.

All morphological characters were compiled into a data matrix (see supplement) and analyzed using a non-parametric approach through Principal Component Analysis (PCA) to determine the characters that contributed most strongly to the morphological variation among specimens (Barathi et al., 2023; Danong et al., 2024; Mishra et al., 2017; Rachmah et al., 2023). This approach is commonly used to simplify analysis and visualization of data set that contain many continuous variables.

Table 1. Quantitative and qualitative morphological characters used in the analysis

Quantitative characters
1. Stipe length
2. Lamina length
3. Lamina width
4. Frond length
5. Rhizome scales
6. Distance of middle pinnae
7. Pinnae length
8. Pinnae width
9. Distance of basal pinnae
10. Number of pinnae
11. Ultimate pinnae length
12. Indusium length

Qualitative characters

1. Indumentum cover on rachis: sparse (0) or dense (1)
 2. Color of rhizome scales: dark (0) or light (1) brown
 3. Pinnae lobes: truncatum (0) lobulatum (1) crenulatum (2)
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RESULTS AND DISCUSSION

General Morphological Characters

Asplenium truncatum is a terrestrial to epiphytic fern with an erect to short-creeping rhizome covered by dense, clathrate scales of varying color (light to dark brown). Fronds are simple to bipinnatifid, ranging from 9–150 cm in length and 18–113 cm in lamina length. The stipe is slender and woody (6–49 cm long) with sparse to dense indumentum. Rachises

may bear proliferous buds either at the middle or tip of the frond. Pinnae are alternate to subopposite, 2.5–14 × 0.5–2 cm, with entire to deeply lobed margins. Sori are linear, parallel along the costa, and protected by thin indusia. Fertile and sterile fronds are morphologically similar except for the presence of sori. The two varieties (Figure 1) differ in the lacinate pinnae for being more crenulate in var. *crenulatum*, and lobate in var. *lobulatum*.



Figure 1. *Asplenium truncatum* (A) and its varieties, i.e. var. *crenulatum* (B) and var. *lobulatum* (C)

Morphological Variation

Morphological observations of *Asplenium truncatum* were conducted on selected herbarium specimens housed in the Herbarium Bogoriense (BO) collection, as well as on dried specimens collected from botanical gardens living collections and field explorations. Several specimens previously identified as *A. caudatum* were revised to *A. truncatum* based on morphological comparisons with relevant taxonomic literature. A total of 91 specimens were examined, consisting of 68

fertile, 16 sterile, and 7 juvenile individuals. We eventually exclude measurement of sterile and juvenile individuals from the analysis as those do not contain “indusium length” variable.

The Principal Component Analysis (PCA) produced six components explaining 80.78% of the total variation (Table 2). The first component (PC1) accounted for 37.989% of the variation, while the remaining components (PC2–PC6) explained 11.267%, 8.75%, 8.269%, 7.675%, and 6.829%, respectively. The highest

eigenvalue was recorded for PC1 (5.698), indicating that most morphological variation could be represented by the first principal component. The loading factors further

supported this, as characters with the highest loadings (approaching 1) were all concentrated in PC1.

Table 2. Principal Component Analysis (PCA) matrix of 15 characters from 68 samples of *A. truncatum*

	Component					
	1	2	3	4	5	6
Stipe length	0,608	-0,481	0,204	0,104	0,377	0,034
Lamina length	0,884*	-0,106	-0,16	0,151	-0,162	0,209
Lamina width	0,847*	0,192	-0,099	-0,205	-0,167	-0,005
Fronde length	0,908*	-0,241	-0,046	0,185	-0,006	0,164
Rachis indumentum cover	-0,324	0,316	-0,592	0,134	0,433	0,269
Marginal sinuses pinnae	-0,318	-0,229	0,343	0,114	-0,344	0,642
Rhizome scales	-0,014	0,165	0,519	0,077	0,686	0,33
Rhizome scales color	0,152	0,127	0,255	-0,831	-0,137	0,245
Middle pinnae distance	0,676	0,085	0,33	0,192	-0,024	-0,214
Pinnae length	0,853*	0,342	0,043	-0,104	0,036	0,009
Pinnae width	0,752*	0,32	-0,017	-0,033	0,113	-0,19
Basal pinnae distance	0,529	-0,559	0,118	-0,107	0,132	-0,256
Total pinnae on lamina	0,679	-0,238	-0,417	0,121	-0,113	0,357
Ultimate pinnae	0,082	0,533	0,361	0,556	-0,322	-0,019
Indusium sorus length	0,528	0,526	-0,051	-0,136	0,105	0,158
Eigenvalue	5,698	1,690	1,313	1,240	1,151	1,024
% of Variance	37,989	11,267	8,75	8,269	7,675	6,829
Cumulative %	37,989	49,256	58,006	66,275	73,95	80,78

Note:

Component value close to 1 indicate higher influence in the analysis

Bold numbers (*) indicate the top strongest values in the analysis

The (+) dan (-) indicate direction of the relationship

The most important characters based on PC1 were lamina length, lamina width, frond length, pinnae length, and pinnae width. Basal pinnae distance and rachis indumentum cover were the main contributors in PC2 and PC3, respectively. The factor scores of PC1 and PC2 were plotted in a scatter diagram (Figure 2), which displayed four overlapping

morphotypes, indicating the absence of distinct morphological groupings among specimens. The same morphological characters remained significant across both PCA models, differing only in loading values. Scatter plots showed that all four morphotypes overlapped, with no visible clustering pattern.

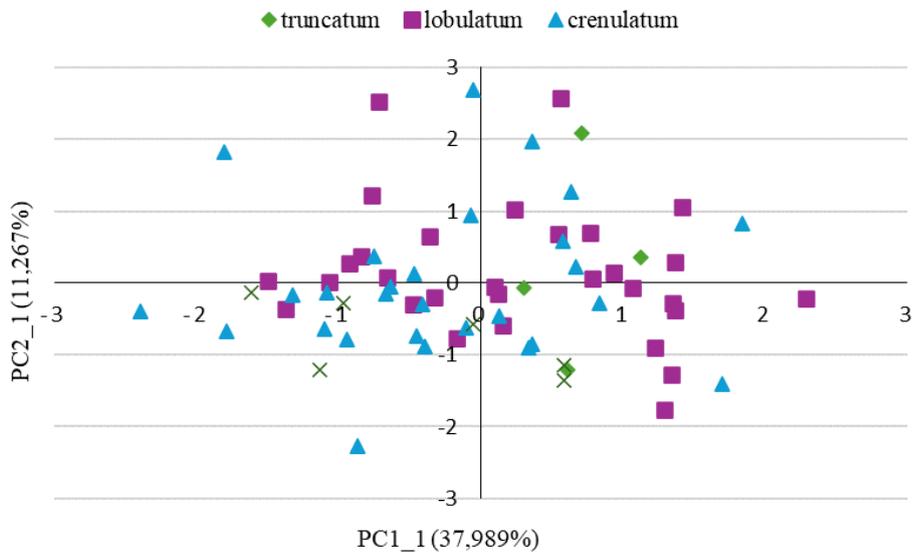


Figure 2. Scatter plot based on PC-1 and PC-2 value of the *Principal Component Analysis* with 15 observed characters.

Geographical distribution patterns were also evaluated based on specimen origins. Specimens from Java were the most numerous and occupied a wide area across all quadrants of the scatter plot, overlapping with specimens from other islands (Figure 3). Maluku specimens were mostly distributed in quadrant III, those from Lombok (Nusa Tenggara

Barat (NTB)) aligned near the X-axis, Bali specimens were found in quadrants I and III, Sulawesi specimens were absent from quadrant I, and Nusa Tenggara Timur (NTT) specimens were absent from quadrant IV. No consistent geographical clustering pattern was observed among *A. truncatum* populations.

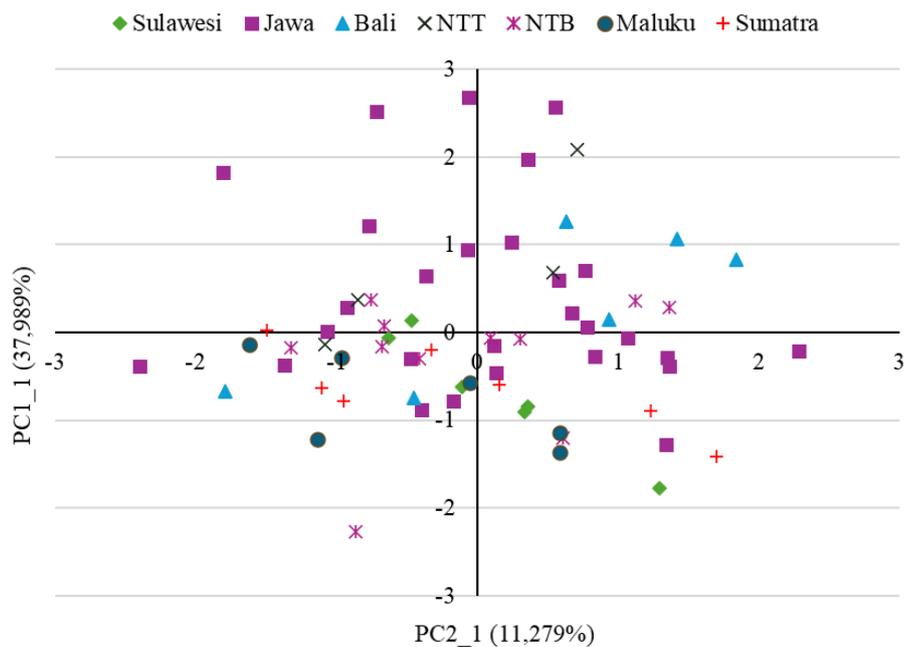


Figure 3. Scatter plot based on PC-1 and PC-2 value of the *Principal Component Analysis* with geographical categories.

Specimens were categorized according to the shape of the pinnae incisions. The morphometric analysis revealed lamina length, frond length, and pinnae length as the most influential traits, with lamina length being the strongest discriminant character. Although frond and pinnae length also contributed, their effects were inconsistent, making them less reliable for distinguishing among morphotypes.

Field and herbarium observations showed that the lamina of fertile and sterile fronds shared identical shape and size, differing only in the presence or absence of indusium and sori. This uniformity indicates that *A. truncatum* is a monomorphic species (Vasco et al., 2013). Variation in pinnae margin shape, from sharply crenate (var. *crenulatum*) to shallowly lobed (var. *lobulatum*), is likely related to phenotypic plasticity (Grašič et al., 2020) and may result from combinations of environmental factors and genetic variability (Vasco et al., 2013). Morphological differentiation may also be derived from hybridization or polyploidization (Vicent et al., 2014).

Overall, the measured morphological characters were insufficient to segregate morphotypes within *A. truncatum*. The results are consistent with the findings of Salgado (2020), strengthened here by multivariate data, that the morphotypes of *A. truncatum* represent unstable phenotypic variations rather than taxonomically distinct forms. Therefore, the distinction of the two morphotypes, i.e., var. *lobulatum* and var. *crenulatum*, is not supported statistically in this study. Future study might explore other less prominent characters and expand the survey into closely related species, i.e., *A. caudatum*.

CONCLUSION

The morphometric analysis using 15 characters of 91 specimens did not separate the three morphotypes within the species *A. truncatum*. There was also no distinct segregation between different geographical areas. Lamina length, lamina width, frond length, pinnae

length, and pinnae width were the top characters explaining variation observed in the pool of specimens. Different lobe shape that was referred for distinguishing the three variations was not among the top five characters. Therefore, the separation of morphotypes into infraspecific variation is not supported in this study.

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Supplement. Matrix of measurement data included in the Principal Component Analysis

Island	Coll. Num.	Stipe length	Lamina length	Lamina width	Fronde length	Indument covering	Lobe type	Rhizome scale	Color of rhizome scale	Distance of middle pinnae	Pinnae length	Pinnae width	Distance of basal pinnae	Number of pinnae	Ultimate pinnae length	Indusium length
Celebes	11081	42	56	13	98	sparse	crenulatatum	0.5	dark	2.5	7	1	2.5	56	3	1
Celebes	5133	39	99	15	138	sparse	lobulatatum	1	dark	2.5	10	1	3	86	2.5	0.5
Celebes	7099	25	45	14	70	sparse	crenulatatum	1	light	1.5	7.5	1	2	52	2.5	0.8
Celebes	11003	31	69	13	100	sparse	crenulatatum	0.5	dark	2	9	1	2.5	84	4.5	0.5
Celebes	Dm 933	28	52	15	80	sparse	crenulatatum	0.5	dark	1.5	8	1	3	62	5	0.6
Celebes	2502	25	35	14	60	sparse	crenulatatum	0.5	light	1.5	7	1	2	56	3	0.7
Java	5516	10	48	17	58	dense	lobulatatum	0.5	light	1	9	1	1.5	40	4.5	1.1
Java	533	6.5	42	14	48.5	sparse	lobulatatum	0.5	dark	2	7.5	0.8	2	46	4.5	0.8
Java	66	28	52	15	80	dense	lobulatatum	1	light	1.5	8.4	0.9	1.5	64	2.5	0.7
Java	499	32	55	14	87	dense	crenulatatum	1	dark	2.5	13	1.2	1.5	54	5	1
Java	25032	12	25	5	37	dense	crenulatatum	1	dark	1	6	0.8	1.5	48	6	0.8
Java	31315	17	73	18	90	dense	lobulatatum	0.5	dark	2	10.5	2	1	74	5	0.8
Java	3665	42	73	20	115	sparse	lobulatatum	1	dark	2	11	1.5	3	94	2.5	0.5
Java	12720	6	57	18	63	sparse	crenulatatum	0.5	dark	2.5	10.5	1	1.5	52	7	1
Java	145	10	91	12	101	dense	crenulatatum	0.5	dark	2	8	1	1.5	72	3.5	0.9
Java	16588	14	18	5	32	dense	crenulatatum	0.5	dark	0.8	2.5	0.5	1.5	52	2.2	0.5
Java	11413	27	62.5	14	89.5	dense	crenulatatum	0.5	light	2	7	0.8	3	78	3.5	0.9
Java	206	29	44	13	73	dense	lobulatatum	1	light	2	10	1	2.5	86	4.5	1
Java	19829	28	40	13	68	sparse	crenulatatum	0.5	dark	1.5	7.5	1	2.5	64	2	0.8
Java	470	25	41	7.5	66	dense	lobulatatum	1	dark	1.5	6	0.7	2	66	3.5	0.8
Java	241	22	47	7	69	dense	lobulatatum	0.5	dark	1	4.5	0.6	1.5	70	3	0.5
Java	213	27	93.5	15.5	120.5	sparse	lobulatatum	0.5	dark	2	9	1	2.5	102	5	1
Java	111	27	41	8	35	dense	lobulatatum	0.5	light	1.5	5.5	0.5	2	66	2	1
Java	95	20	64.5	12	84.5	dense	lobulatatum	0.5	light	1	6	0.8	2	92	2.5	0.7
Java	337	24	84	16	108	sparse	crenulatatum	0.5	light	2	10	1	2.5	90	3	1
Java	31	28	95	21	123	sparse	lobulatatum	0.5	dark	2	9.5	1	2.5	110	4	1
Java	57	18	68	23	86	dense	crenulatatum	0.5	dark	2	9	1	2.5	100	4	1

Java	521	24	68	12	92	sparse	lobulatum	0.4	dark	1.5	7	1	2	82	3.5	0.43
Java	60	33	66	17	99	sparse	lobulatum	1	light	2	9	1.5	2.5	62	5	0.8
Java	65	28	82	18	110	dense	lobulatum	0.5	dark	2	10	1	2.5	90	4	0.8
Java	40	33	68	14	101	sparse	crenulatum	1	light	2	10	1.3	2.5	64	3.5	1
Java	664	37	113	25	150	sparse	lobulatum	0.5	dark	2	12	1.5	2.5	116	4	1
Java	sn (Racib.)	40	102	15	142	dense	lobulatum	0.7	dark	1.5	9	1.5	2.5	106	3.5	1
Java	WNF6	25	55	14	80	dense	lobulatum	0.5	dark	2	9	1	3	60	2	1
LSI (Bali)	4870	33	66	20	99	dense	crenulatum	1	light	1.5	14	1	2	68	4	1
LSI (Bali)	182	27	48	11	75	sparse	crenulatum	1	dark	1.5	5.5	0.7	3	66	4	0.9
LSI (Bali)	1961	19	30	7.5	49	dense	crenulatum	0.3	dark	1.2	3.5	0.5	2	52	3	0.5
LSI (Bali)	Mr 128	30	82	24	112	sparse	crenulatum	0.5	light	2	14	1.5	2.5	94	2.5	1.5
LSI (Bali)	FK 109	35	75	22	110	sparse	lobulatum	0.5	dark	1.5	10	1	2.5	80	5	1
LSI (Bali)	kp 252*	28	80	27	108	dense	lobulatum	0.7	light	1.5	14	1.5	2	98	2	1
LSI (Flores)	3058	21.5	40	11	61.5	dense	crenulatum	0.4	dark	1.5	7	0.7	2	52	3	0.6
LSI (Flores)	1732	14	42	11	56	dense	lobulatum	1	dark	1.5	7	0.7	2.5	68	3	0.8
LSI (Flores)	1503	24	70	15	94	sparse	lobulatum	0.3	light	1.5	12	1	2	82	4	1
LSI (Flores)	1159	10	66	22	76	sparse	truncatum	0.3	light	1.5	11	1.5	2	84	5	1
LSI (Lombok)	6	35	42	9	77	sparse	crenulatum	0.5	dark	1	6.5	0.7	2.5	68	2	0.3
LSI (Lombok)	1182	22	36	10	58	sparse	crenulatum	1	dark	1	5.5	0.7	1.8	50	3.5	0.6
LSI (Lombok)	SH 1101	26	78	23	104	sparse	lobulatum	0.5	light	2	12	1.5	2.5	84	2	1
LSI (Lombok)	WAR 683	20	67	15	87	dense	lobulatum	0.5	dark	1.5	8	1	2.5	84	2	1
LSI (Lombok)	SH 11154	14	47	15	61	dense	crenulatum	0.5	dark	1.5	8	1	2	80	2	0.5
LSI (Sumbawa)	12606	25	42	11.5	67	dense	crenulatum	1	dark	1.5	7	1	2	60	3.5	0.7
LSI (Sumbawa)	248	23	38	11	61	sparse	lobulatum	0.5	dark	2	6.5	1	2.5	40	5	0.5
LSI (Sumbawa)	18504	25	55	12	80	dense	crenulatum	0.5	dark	1.5	7	1	2.5	64	3	0.8
LSI (Sumbawa)	Pen 549	27	43	15	70	sparse	truncatum	0.5	dark	2	10	1.5	3	52	3	0.5
LSI (Sumbawa)	Pen 544	33	62	20	95	sparse	truncatum	0.5	light	2	11	1.5	3	58	3	1
LSI (Sumbawa)	WN 82	25	75	18	100	sparse	truncatum	0.5	light	2	9	0.8	3	80	2	0.5
Maluku	5696	13	37	8	50	sparse	truncatum	1	light	1	4	0.7	1.5	68	3.5	0.5
Maluku	1016	28	69	14	97	sparse	truncatum	0.5	light	1.5	7.5	0.8	2.5	68	5	0.7

Maluku	12415	28	90	14	118	sparse	truncatum	0.5	light	2	8.5	0.8	2.5	102	5	0.5
Maluku	12094	20	43	11	63	sparse	truncatum	0.5	light	1.5	5.5	0.5	2	62	2	0.5
Maluku	1741	23	85	21	108	sparse	truncatum	0.5	light	1.5	8	1	3	86	2.5	0.7
Maluku	2211	14	49	13	53	sparse	truncatum	0.5	light	1.5	7	0.5	2	64	3	0.7
Sumatra	5932	40	86	15	126	sparse	lobulatum	0.5	dark	2	11	1	3	80	3.5	1
Sumatra	1015	27	61	15.5	88	sparse	lobulatum	0.5	light	2	8	1	2.5	56	2	0.7
Sumatra	15119	49	84	22	133	sparse	crenulatum	0.5	dark	2	11	1.5	3	90	3	0.8
Sumatra	15826	15	32	9.5	47	sparse	lobulatum	0.5	dark	1	5	0.7	1.5	60	3.5	0.5
Sumatra	10385	30	48	10	78	dense	crenulatum	0.2	dark	1.2	6	0.8	1.5	80	3.5	0.35
Sumatra	5947	15	38	14	53	dense	crenulatum	0.2	dark	1.3	7	0.8	2.4	62	2.5	0.37
Sumatra	53	18	53	13	71	dense	lobulatum	0.5	dark	1	7	1	3	80	2.5	1