MORPHOLOGICAL INVESTIGATION ON COTYLEDONS: REVEALING TRIBES WITHIN BIGNONIACEAE

Studi morfologi kotiledon: menyingkap beberapa tribus dalam suku Bignoniaceae

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Abstrak

Morfologi kotiledon dari sebelas jenis tumbuhan suku Bignoniaceae diamati sebagai upaya untuk identifikasi lapangan. Kotiledon pada suku Bignoniaceae memiliki karakter unik dan jarang ditemukan pada suku tumbuhan lain. Ujungnya berbelah dua dan berbentuk hati. Karakter unik ini dapat digunakan untuk identifikasi tumbuhan di lapangan, terutama pada fase semai. Sudut kedua parakotiledon, sudut belahan pada ujung para-kotiledon, dan panjang parakotiledon dapat digunakan untuk membedakan tribus dalam suku Bignoniaceae. Namun demikian, penelitian lanjutan yang menggunakan lebih banyak jenis diperlukan untuk menguatkan hasil awal ini.

Kata kunci: (para-)kotiledon, Bignoniaceae, morfologi, tribus, identifikasi

INTRODUCTION

Seedling stage of plant can be employed for species identification in the field. Knowledge in mature plant morphology should also be complemented by a juvenile phase of the respective species as concurrence with mature plant in the field is not always easy. Furthermore, field studies require more than just the acquaintance of the mature plant when seedling or vegetative populations are encountered. The population in question may be rare or sporadic, restricted or endemic, threatened or endangered an encounter that may never present itself again. Therefore plant identification based on complementary organs apart from the shoot alone and other stages of development other than the matured stage only, is plausible. Seedling features including cotyledon characteristics have been found to exhibit high degree of stability and constancy (Ogunwenmo, 2003). Cotyledons of the Bignoniaceae find their relevance here.

Bignoniaceae refers to trumpet-creeper family consisting of 109 genera (Kirkbride *et al.*, 2006). These are categorized into eight tribes i.e. Bignoniae, Coleeae, Crescentiae, Eccremocarpeae, Oroxyleae, Schlegeliae, Tecomeae, and Tourettieae (USDA, 2003). Based on the Bogor Botanic Garden collection catalogue (2001), Bignoniaceae in the garden consisted of 33 genera which are: *Adenocalymma* Mart. ex Meisn., *Anemopaegma* Mart. ex Meisn.,

Arrabidaea DC., *Bignonia* L., *Campsis* Lour., *Crescentia* L., *Cydista* Miers, *Deplanchea* Vieill., *Dolichandrone* (Fenzl) Seem., *Fernandoa* Welw. ex Seem., *Jacaranda* Juss., *Kigelia* DC., *Macfadyena* A. DC., *Markhamia* Seem. ex Baill., *Millingtonia* L. f., *Newbouldia* Seem. ex Bureau, *Oroxylum* Vent., *Pandorea* (Endl.) Spach, *Parmentiera* DC., *Perichlaena* Baill., *Phyllarthron* DC., *Pithecoctenium* Mart. ex Meisn., *Pseudocalymma* A. Samp. & Kuhlm., *Pyrostegia* C. Presl, *Radermachera* Zoll. & Moritzi, *Saritaea* Dugand, *Spathodea* P. Beauv., *Stenolobium* D. Don, *Stereospermum* Cham., *Tabebuia* Gomes ex DC., *Tanaecium* Sw., *Tecoma* Juss., and *Tecomanthe* Baill.

The objective of the study is to define the correlation between cotyledon characteristics of Bignoniaceae and its phylogeny in order to facilitate identification in the field particularly for seedling stage. Since the observation was confined to eleven species, the categorization cannot encompass species level, but solely to tribe level.

METHODS

The number of species involves was confined by the number of seed availability and plant bearing fruits. Thus, the observation was limited to eleven species, viz.: *Kigelia africana, Tabebuia heterophylla, Dolichandrone spathacea, Parmentiera cerifera, Crescentia cujete, Oroxylum indicum, Tecoma stans, Radermachera elegans, Jacaranda acutifolia,* and *Fernandoa macroloba*. Number of seedling paracotyledons measured varied due to the availability of seeds, viz.: 50, 50, 10, 50, 50, 10, 50, 3, 10, and 50, respectively. The measurement was done for its quantitative and qualitative features. For the former, it included: paracotyledon length, breadth, basal-apical notch, basal paracotyledon- basal notch, notch divergence, divergence of paracotyledon, stalk length, and hypocotyl-radicle length (Figure 1). Qualitative features measured comprised of cotyledon's texture, surface, color, and venation. Measurement was made on seedlings with transparent ruler on mature cotyledons, i.e.: when eophylls emerged from the plumule.

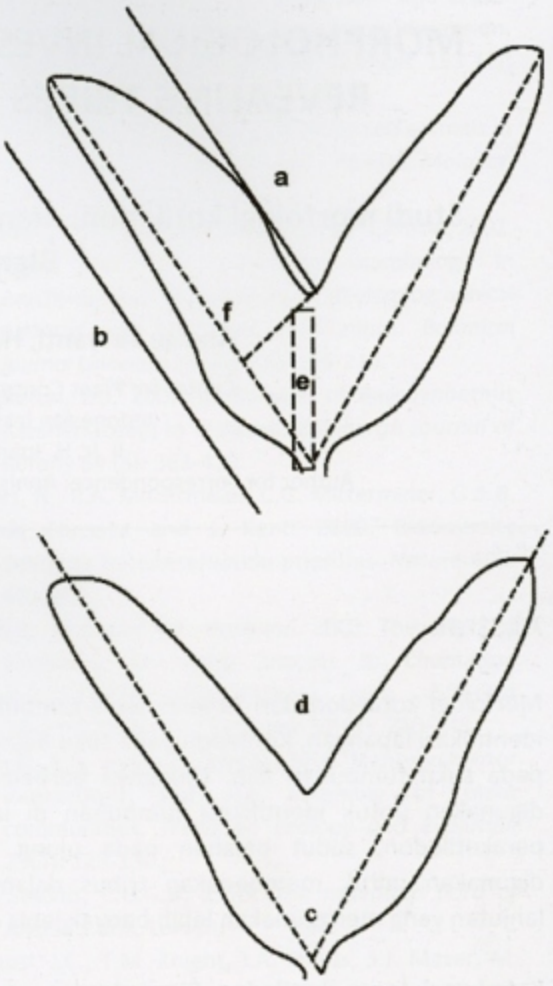

Figure 1. Quantitative measurement for the cotyledons, viz.: basal-apical notch (a), paracotyledon's length (b), divergence of paracotyledon (c), notch divergence (d), basal paracotyledon-basal notch (e), breadth (f), stalk length, and hypocotyl-radicle length.

RESULTS AND DISCUSSION

The cotyledons of Bignoniaceae

The disseminules of Bignoniaceae germinate following epigeal form. The seedlings' cotyledons consist of two paracotyledons with bilobed apices (Figure 2). Lobes in the cotyledons of Bignoniaceae provoked in a notch of V like structure that vary in size and chassis. A specific character for Bignoniaceae cotyledons is its bilobed apices and basal cordate.

Besides its cotyledon prominent character, investigations of Bignoniaceae fruits also have taxonomic value, being important for the definition of tribes and genera of this family for instance a study of the genus *Tabebuia* by Souza *et al.* (2005).

A phanerocotylar cotyledon is a photosynthetic cotyledons providing support for seedling to receive energy. Thus, the cotyledons of Bignoniaceae are green corresponding to its chlorophyll content. However, upon a prolonged soaking in water for a dormancy breaking effort, the cotyledon may turn yellowish (Figure 2a). The colour varies from light green to very dark green. Lighter green cotyledons are represented in *Parmentiera* and *Crescentia*, whereas heavier green cotyledons are shown in *Oroxylum* and *Dolichandrone*. Shape, venation, colour and texture vary in cotyledons (Table 1). Colour hue of cotyledons is not attributed to environmental condition as the sowing condition is kept identical. In addition, phanerocotylar cotyledons contain chlorophyll that facilitates photosynthesis. Difference in cotyledon colour brightness can be embedded mostly to its maternal factor and thus, it may represent differences in species cotyledon character. Larger cotyledons represented by *Kigelia africana* and *Oroxylum indicum*, whereas others showed smaller cotyledons. The texture for former group is leafy, while for the latter is leathery. These can be applied to categorize tribe in Bignoniaceae.

It can be inferred that from the cotyledons of the investigated species, four tribes can be distinguished. Tribe Tecomae constituted by seven genera which are *Dolichandrone*, *Tabebuia*, *Fernandoa*, *Tecoma*, *Jacaranda*, *Radermachera* and *Spathodea* characterized by a narrow notch, deep apex lobe, and wide paracotyledons which appear to be four cotyledons (occupying 360°).

Table 1. Qualitative characters of the Bignoniaceae cotyledons.

Species	Features				Tribes
	texture	surface	colour	venation	
Kigelia africana	leafy	smooth	darker green	obvious	Coleeae
Parmentiera cerifera	leathery	smooth	yellowish green	not apparent	Crescentiae
Crescentia cujete	leathery	smooth	yellowish green	not apparent	Crescentiae
Oroxylum indicum	leafy	smooth	darker green	somewhat obvious	Oroxylae
Dolichandrone spathacea	leathery	smooth	green	not apparent	Tecomae
Tabebuia heterophylla	leathery	smooth	green	not apparent	Tecomae
Spathodea campanulata	leathery	smooth	green	not apparent	Tecomae
Tecoma stans	leathery	smooth	green	not apparent	Tecomae
Fernandoa macroloba	leathery	smooth	green	not apparent	Tecomae
Jacaranda acutifolia	leathery	smooth	light green	not apparent	Tecomae
Radermachera elegans	leathery	smooth	green	not apparent	Tecomae

In the Crescentiae, notch very much alike a proportional V symbol with smaller size of paracotyledon, consist of two species, i.e. Crescentia and Parmentiera. Kigelia, belonging to tribe Coleeae, displayed large and leafy cotyledons with clear venation. Oroxylum, a member of tribe Oroxylae, showed wavy cotyledons in dark green and somewhat obvious venation. All observed cotyledons displayed absence of cotyledons venation except for *Oroxylum* and *Kigelia* (Figure 2). The cotyledons of *Oroxylum* displayed similar shape to some of the Tecomae tribes in a way the paracotyledons overall

seems to be spherical and with a narrow notch. Unfortunately, previous observation was not found of intra-species cotyledon variation within each genus. There were no available seeds of tribe members of Bignoniae, Eccremocarpeae, and Tourettiae. Unfortunately, thus at present the comparison can not be carried out.

Table 2. Quantitative characters of the Bignoniaceae cotyledons.

Species (Tribe)	Features (mm)							
	Basal-apical notch (a)	Length (b)	divergence (c)	notch divergence (d)	length to notch base (e)	½ breadth (f)	Stalk	Hypocotil-radicle
Kigelia africana (Coleeae)	8-10 & 9	20-21& 23-24	60&70	76-92 & 50-92	24-28 & 26	12-15 & 14	2-3 & 4-5	42-56 & 13-20
Parmentiera cerifera (Crescentiae)	2-3	5-6	30-33	42-70	5-6	3.5-4	2-3	9-15
Crescentia cujete (Crescentiae)	2-3	8-9	30-38	33-80	8-9	4-5	2	21-30
Oroxylum indicum (Oroxylae)	11-16	80-88	12-28	4-31	3-5	13-21	3-4	30-46
Dolichandrone spathacea (Tecomae)	3-4	8-10	100-105	87-92	7-9	8-11	2-4	41-49
Tabebuia heterophylla (Tecomae)	4	9-11	87-90	1-2	7-8	9	3-4	31-39
Spathodea campanulata (Tecomae)	3	6-7	60-70	1-2	3-4	4-5	1	16-20
Tecoma stans (Tecomae)	2-3	5-6	50-90	0 (overlap)	2	6-8	2-3	32-40
Fernandoa macroloba (Tecomae)	5-6	6-7	85-90	2-4	3-4	8-9	4-5	40-46
Jacaranda acutifolia (Tecomae)	1-2	4-5	50	0-1	2.5-3	2	1-1.5	25-35
Radermachera elegans (Tecomae)	3-4	7	90	76	3-4	5	1-2	18

Cotyledon Morphology

Regardless the fact that cotyledon is proven to be able to contribute in phylogeny study, a study on cotyledon morphology of Bignoniaceae and its taxonomical relationship can hardly be found. However, some studies indeed described that cotyledon morphology besides providing aid in field identification can also be used to see phylogenic relationship of species within a genus such as for *Ipomoea* and further complemented with identification key (Das and Mukherjee, 1997). More so, the conservative nature of cotyledon characteristics predisposes them to elucidation of phylogenetic relationships among taxa (Duke, 1965, Sampathkumar, 1982). Other study on seedling morphology and its taxonomic implication were done for *Gmelina arborea*, *Mimusops elengi*, *Polyalthia longifolia*, *Putranjiva roxburghii*, and *Terminalia arjuna* (Saha *et al.*, 1998).

Figure 2. Bilobed apices of paracotyledons of species observed: (a) *Kigelia africana*, abnormal (form 1), (b) *Kigelia africana* (form 2), (c) *Crescentia cujete*, (d) *Oroxylum indicum*, (e) *Kigelia africana* (form 1), (f) *Tecoma stans*, (g) *Tabebuia heterophylla*, (h) *Radermachera elegans*, (i) *Fernandoa macroloba*, (j) *Dolichandrone spathacea*, (k) *Jacaranda acutifolia*, (l) *Parmentiera cerifera*, (m) *Spathodea campanulata*.

Studies of cotyledon venation pattern and architecture with regards to its taxonomic importance were also studied for Leguminosae (Smith and Scott, 1995; 1998). Cotyledons provide a complex of interrelated minor characters that correlate with and reinforce taxonomic grouping at several levels in the family (Smith, 1983). Seedling morphology in identification was found to be consistent as well in Genistae of Fabaceae (Lopez *et al.*, 1998). Moreover, cotyledon characters provided ground for taxonomic and evolutionary evaluation of *Ipomoea* species based on interspecific variations and affinities. Discontinuous variations in cotyledon sizes were early identifiable marks separating closely related taxa (Ogunwenmo, 2003). The advantage of using seedling morphology in systematic studies stems from their uniformity at the juvenile stages, before they are subjected to the diversity of factors that prevail in the case of mature plants (de-Vogel, 1980).

CONCLUSION

Paracotyledonary divergence, notch divergence, length and breadth were useful in resolving the tribes in the observed species of Bignoniaceae. Nevertheless, since species involved in the observation is limited, it is too early to conclude that quantitative and qualitative characters of bilobed apices in Bignoniaceae cotyledons revealed the tribes within the family thoroughly.

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