

LEAF ARCHITECTURE OF SELECTED SPECIES OF MALVACEAE *sensu* APG AND ITS TAXONOMIC SIGNIFICANCE

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ABSTRACT

The leaf architecture of Malvaceae *sensu* APG was examined and characterized to determine if it can be used in classification of the family and the identification of its species. Forty species were observed, measured and described. A dichotomous key was constructed based solely on leaf architecture characters.

The dichotomous key indicated that leaf architecture characters can be used in distinguishing some species of Malvaceae *sensu* APG. Some basic leaf architectural characters can also be used in describing certain clades within the family.

It is recommended that specimens are collected personally instead on relying on available specimens in the herbarium. Preparation of leaf skeletons through clearing method can also be done in future studies. Increase of sample size is also recommended.

KEYWORDS: leaf architecture, APG, classification

INTRODUCTION

Malvaceae Jussieu, *nom. cons* is a newly circumscribed family of the Angiosperm Phylogeny Group (APG, 2003). This family now comprises 243 genera and 4225 species which are mainly tropical in distribution. In the APG system, member families of Malvales like Sterculiaceae, Bombacaceae, Tiliaceae and Malvaceae *sensu strictu* were merged to become Malvaceae *sensu* APG (or *lato*). This lumping of families became controversial and gained criticism from some taxonomists. Cheek (2006, see also Cheek in Heywood *et. al.*, 2007, Stevens, 2010) opts for a full dismemberment of the super family into ten separate families (Bombacaceae, Malvaceae, Sterculiaceae, Tiliaceae, Durionaceae, Brownlowiaceae Byttneriaceae, Helicteraceae, Pentapetaceae, and Sparrmanniaceae).

Members of the family generally have a shrub to tree habit, are polypetalous with valvate sepals (epicalyx present) often having monodelphous or polydelphous filaments, stigmas usually dry, and the fruits

usually a capsule. Its foliar morphology is characterized by spiral or 2-ranked leaves, blades with entire and toothed margin, single vein running to the glandular apex and palmate secondary venation (Stevens, 2010).

Taxonomists often neglect leaf characters and other vegetative characters in the identification and classification of plant taxa due to their belief that these characters have high phenotypic plasticity. However, it can be pointed out that leaf characters, particularly venation patterns are, in general, genetically fixed and can be used as a taxonomic tool. Its two main functions, transport of substances where it supplies water, solutes and hormones via the xylem and exports carbohydrates via the phloem and mechanical stabilization based on the lignified xylem and sclerified elements, are expected to influence the structure of leaf venation. Thus, the form-function relationship of the leaf venations provides the basis for its taxonomic utility (Roth-Nebelsick *et. al.*, 2001). Additionally, in some instances, leaf characters prove useful in taxonomic studies particularly in tropical plants that rarely flower and plant fossils where reproductive organs are absent for study (Dilcher 1974, Hickey 1973, Hickey and Taylor 1991).

Contrary to the belief about leaf characters, most dicotyledonous leaves show consistent leaf architectural features. In fact, the angiosperms are plants that have the most distinct and pronounced hierarchical network of vein pattern. Thus, it has a considerable value in both phylogenetic and ecological study of extant and fossil plants (Hickey, 1973). Moreover, Hickey (1973) forwarded that the high degree of interspecific variation on the entire venation pattern will provide a wealth of useful characters for distinguishing plant species from each other. The full value of leaf characters in taxonomy can only be realized if they are studied in all possible means for the determination of their true identity. Thus only the homologous data should be compared. This is equally important for taxonomic studies and investigations of phylogenetic relationships. A widely accepted, precise but flexible terminology is of great aid when doing taxonomic work on leaf surface characters (Stace, 1984).

Systematics, as a holistic field of biology, needs to acquire all kinds of evidences from other fields for the characterization, identification and classification of organisms. In the case of Malvaceae *sensu* APG, more taxonomic evidences must be presented in order to become a universally accepted circumscription. Leaf architecture, as one of the least explored taxonomic tools, can help in contributing more knowledge that will lead to holistic understanding of this family of angiosperms with a high industrial, medicinal and economic importance. The study generally aims to determine the leaf architecture of some species of Malvaceae *sensu* APG. The specific objectives are to describe the leaf architecture of some species of Malvaceae *sensu* APG; to attempt to use leaf architectural characters to distinguish some species of Family Malvaceae from each other; and to investigate the significance of leaf architecture in the classification of Malvaceae *sensu* APG

MATERIALS AND METHODS

Selection of Herbarium Specimens

A total of forty species were selected from the member species of Malvaceae *sensu* APG, ten from each of the four traditional families. At least three herbarium specimens were examined per species depending on the availability of well-suited specimens deposited in the herbarium. The representative samples are deposited in the College of Agriculture Herbarium University of the Philippines (CAHUP) and Plant Biology Division Herbarium (PBDH) both located at Biological Sciences Bldg., University of the Philippines Los Baños.

Examination of Leaf Architecture

All mature, fully expanded leaves of each sample were examined using a dissecting microscope. Their leaf architecture was described based on leaf architecture characters and terminologies of Hickey (1973) and the Leaf Architecture Working Group (1999). Large measurements such as leaf length, leaf width etc. were measured using a ruler, while minute ones such as vein width were measured using a dial caliper. Angles of divergence were measured using a protractor.

Construction of Dichotomous key

A dichotomous key to the species of Malvaceae *sensu* APG studied was constructed. Descriptions were based solely on leaf architecture characters employed in this study

RESULTS AND DISCUSSION

General Characteristics of Malvaceae *sensu* APG

Some families and genera contain several basic patterns of leaf architecture (Hickey, 1973). Generally, the leaf architectural features of Malvaceae *sensu* APG are as follows: Margin entire or toothed; Primary vein category pinnate or actinodromous; secondary vein category, camptodromous (brochidodromous or eucamptodromous) or craspedodromous (simple, semi- or mixed); angle of divergence usually moderate acute; tertiary vein category percurrent or reticulate, rarely ramified; Marginal ultimate venation looped or incomplete; Veinlets none to 2-branched and; Areolation usually well developed and oriented.

A dichotomous key, solely using leaf architecture characters, was constructed based on the descriptions for each species examined in the study. Based on the descriptions as well as the key, it is evident that leaf architecture characters can separate genera and species from one another. This has been

also shown by Buot and Banaticla (2004) in Rubiaceae and Obico *et. al* (2007) in Araceae. It was also illustrated in several studies made using leaf architecture in recognizing taxonomic relationships of angiosperms leaf remains such as Amentiferae (Wolfe, 1973), Hamamelidae (Wolfe, 1989) and Betulaceae (Liu, 1995). Furthermore, it was proved useful in the documentation of woody dicotyledons in tropical and subtropical China (Cheng-Hong and Za-Lian, 1991).

Leaf Architecture of Some Subfamilies and Tribes of Malvaceae *sensu* APG

Some genera can be grouped into subfamilies and/or tribes that fit to the classification of Malvaceae *sensu* APG through several basic leaf architectural characters. These include: Genera belonging to Bombacoideae (*Adansonia*, *Ceiba*, *Cavanillesia*, *Ochroma* and *Pachira*) with entire margin, actinodromous or palmately compound leaves and brochidodromous secondary vein; genera from Helicterioideae specifically Durioneae (*Durio* and *Neesia*) with entire margin, pinnate primary vein, brochidodromous secondary vein pattern; genera from Sterculioideae (*Sterculia* and *Heritiera*) with entire margin, pinnate primary vein, eucamptodromous secondary vein pattern; genera from Byttenerioideae specifically Theobromeae (*Theobroma glauca* and *T. cacao*) with entire margin, pinnate primary vein, brochidodromous secondary vein pattern; genera from Gossypiae (*Gossypium*, *Hampea* and *Thespesia*) with entire margin, actinodromous primary vein pattern, weak primary vein size, and brochidodromous secondary vein, genera from Hibisceae (*Hibiscus*, *Talipariti*, *Malvaviscus*, *Malachra* and *Urena*) with serrate margin, actinodromous primary vein pattern, weak primary vein size and craspedodromous secondary vein pattern, capsular fruit genera (*Hibiscus* and *Talipariti*) have percurrent tertiary vein while schizocarpous fruit genera (*Malvaviscus*, *Malachra* and *Urena*) have reticulate tertiary vein and; genera from Grewioideae (*Colona*, *Corchorus*, *Grewia*, *Luehea* and *Trichospermum*) with serrate margin, no lobation, actinodromous primary vein pattern and craspedodromous secondary vein pattern (Bayer *et. al* , 2003). Although character sets of subfamilies and tribes sometimes overlap, it will not diminish its usefulness in describing the clades within the family (Hickey, 1973).

Descriptions of Selected Species Examined through Leaf Architecture

BOMBACACEAE

***Adansonia digitata* L.**

Blade narrow obovate with acuminate apex and cuneate base, symmetrical, 95-115 mm long, 40-60 mm wide, 2.1-2.2 : 1 ratio, notophyll, entire, unlobed, palmately compound.

Venation camptodromous, pinnate. **1°** weak; straight. **2°** moderate; angle of divergence wide and uniform; loop-forming branches joining superadjacent **2°** at acute and obtuse angles; abruptly curved; inter-**2°** composite. **3°** opposite percurrent; simple and forked; angle with respect to midvein oblique and decreases upward. **Higher vein order** distinct; **4°** alternate percurrent; **5°** orthogonal; **4°** and **5°** anastomosing to form imperfect and random areolas. **Marginal ultimate venation** looped. **Veinlets** branches once to twice.

Exsiccatae: *Merino 3359 (CAHUP)*, *Merino 12416A (CAHUP)*, *Merino 12418B (CAHUP)*, *Hernaez 57913 (CAHUP)*

Cavanillesia hylogeiton Ulbr.

Blade very wide ovate with odd-lobed acute apex and cordate base, symmetrical, 163-260 mm long, 90-312 mm wide, 1.81:1 ratio, mesophyll to macrophyll, entire, palmately lobed, simple.

Venation camptodromous, perfect actinodromous, basal. **1°** moderate; straight and branched. **2°** brochidodromous; thick; angle of divergence moderately acute to right angles, upper **2°** more acute than lower **2°**; loop-forming branches joining superadjacent **2°** at obtuse angles; abruptly curved. **3°** mixed opposite and alternate percurrent; forked and straight; angle with respect to midvein constant oblique. **Higher vein order** distinct; **4°** alternately percurrent; **5°** orthogonal; highest vein order **5°**; **4°** and **5°** anastomosing to form well developed and oriented areolas. **Marginal ultimate venation** looped. **Veinlets** unbranched and 1-branched.

Exsiccatae: *Pancho and Payson 3356, 3357 (CAHUP)*

Ceiba pentandra (L.) Gaertn.

Blade narrow elliptic with acuminate or attenuate apex and cuneate base, symmetrical, 101-200 mm long, 31-45 mm wide, 3.43-4.56:1 ratio, notophyll, entire, unlobed, palmately compound.

Venation camptodromous, pinnate. **1°** moderate; straight. **2°** brochidodromous; moderate; angle of divergence moderate acute and uniform; abruptly curved; loop-forming branches joining superadjacent **2°** at acute angles; inter-**2°** composite. **3°** random reticulate. **Higher vein order** distinct, **4°** orthogonal, **5°** orthogonal; **4°** and **5°** anastomosing to form well developed and random areolas. **Marginal ultimate venation** looped. **Veinlets** 1-branched.

Exsiccatae: *Bulalacao 1821 (CAHUP)*, *Hernaez 17738 (CAHUP)*, *Gruezo 23956 (CAHUP)*

Durio kutejensis (Hassk.) Becc.

Blade narrow elliptic with acuminate or acute apex and obtuse base, symmetrical, 155- 200 mm long, 55-62 mm wide, 3-3.32:1 ratio, mesophyll, entire, unlobed, simple.

Venation camptodromous, pinnate. **1°** moderate; straight. **2°** brochidodromous; moderate; angle of divergence moderate acute and uniform; abruptly curved; loop-forming branches joining superadjacent **2°** at obtuse angles; inter-**2°** composite. **3°** orthogonal reticulate. **Higher venation order** distinct, **4°** orthogonal; **5°** orthogonal; **4°** and **5°** anastomosing to form well developed and random areolas. **Marginal ultimate venation** looped. **Veinlets** 1-branched.

Exsiccata: *Gruezo 23970 (CAHUP)*

Durio macrophyllus Ridl.

Blade narrow oblong with attenuate or acute apex and cuneate base, symmetrical, 179-236 mm long, 52-60.5 mm wide, 3.37-4.98: 1 ratio, mesophyll, entire, unlobed, simple.

Venation camptodromous, pinnate **1°** moderate; straight. **2°** brochidodromous, moderate; angle of divergence moderate acute and uniform; abruptly curved; loop-forming branches joining superadjacent **2°** at obtuse angles; inter-**2°** composite. **3°** orthogonal reticulate. **Higher venation order** distinct, **4°** orthogonal reticulate; **5°** orthogonal reticulate; **4°** and **5°** anastomosing to form well developed and random areolas. highest vein order up to **5°**. **Marginal ultimate venation** looped. **Veinlets** 1-branched.

Exsiccata: *Hernaez 40781 (CAHUP)*

Durio zibethinus Murr.

Blade oblong or elliptic with acute or acuminate apex and obtuse base, symmetrical, 140-160 mm long, 50-63 mm wide, 2.38-2.83 : 1 ratio, mesophyll, entire, unlobed, simple.

Venation camptodromous, pinnate. **1°** moderate; straight. **2°** brochidodromous; moderate; angle of divergence moderate acute and nearly uniform; abruptly curved; loop-forming branches joining superadjacent **2°** at acute angles; inter-**2°** simple and composite. **3°** orthogonal reticulate. **Higher venation order** distinct; **4°** reticulate; **5°** reticulate; **4°** and **5°** anastomosing to form well developed and oriented areolas; highest vein order up to **5°**. **Marginal ultimate venation** looped. **Veinlets** 1-branched.

Exsiccatae: *Pancho 20207 (CAHUP)*, *Pancho 20342 (CAHUP)*, *Gruezo 23968 (CAHUP)*, *Gruezo 23969 (CAHUP)*, *Gruezo 23972 (CAHUP)*

Neesia altissima Blume

Blade narrow obovate with retuse apex and obtuse base, symmetrical, 269-435 mm long, 110- 190 mm wide, 2.15-2.68:1 ratio, macrophyll, entire, unlobed, simple.

Venation camptodromous, pinnate. **1°** stout; straight. **2°** brochidodromous; thick; angle of divergence moderate acute; loop-forming branches joining superadjacent **2°** at acute angles; abruptly curved. **3°** alternate percurrent; forked; angle with respect to midvein constant oblique. **Higher vein order** distinct **4°** alternate percurrent; **5°** orthogonal; **5°** anastomosing to form well developed and oriented areolas. **Marginal ultimate venation** looped. **Veinlets** none.

Exsiccatae: *Gruezo 23953 (CAHUP)*, *Gruezo 23963 (CAHUP)*, *Gruezo 23964, (CAHUP)*, *Gruezo 23966 (CAHUP)*, *Gruezo 23967 (CAHUP)*

Ochroma lagopus Sw.

Blade very wide ovate with acuminate apex and cordate base, symmetrical, 100-250 mm long, 85-265 mm wide, 0.96-1.21:1 ratio, mesophyll to macrophyll, entire, unlobed, simple.

Venation camptodromous, perfect actinodromous, 3-5 basal. **1°** weak to moderate; straight and branched. **2°** brochidodromous; moderate; angle of divergence moderately acute; loop-forming branches joining superadjacent **2°** at obtuse angles; abruptly curved. **3°** opposite percurrent; convex at the base with forked, retroflexed, straight in the rest of the blade; angle with respect to midvein constant oblique. **Higher vein order** distinct; **4°** alternate percurrent; **5°** orthogonal; **5°** anastomosing to form well developed and oriented areolas. **Marginal ultimate venation** looped. **Veinlets** simple and 1-branched.

Exsiccata: *Gruezo 23970 (CAHUP)*

Pachira sessiles Benth.

Blade oblanceolate with retuse apex and cuneate base, symmetrical, 85-111 mm long, 44.5-49 mm wide, 2.2-2.5:1 ratio, notophyll, entire, unlobed, palmately compound.

Venation camptodromous, pinnate. **1°** stout; straight. **2°** brochidodromous; fine; angle of divergence wide; abruptly curved; loop-forming branches enclosed by **3°** and **4°** arches; inter-**2°** veins composite. **3°** obmedially ramified. **Higher vein order** distinct, **4°** orthogonal reticulate; **5°** orthogonal reticulate; **4°** and **5°** anastomosing to form incomplete areolas with random arrangement; highest vein order up to **5°**. **Marginal ultimate venation** looped. **Veinlets** unbranched and 1-branched.

Exsiccata: *Nee 24481 (CAHUP)*

Pachira aquatica Aubl.

Blade elliptic with convex apex and cuneate base, symmetrical, 98-208 mm long, 45-70 mm wide, 2.17-2.46:1 ratio, notophyll to mesophyll class, entire, unlobed, palmately compound.

Venation camptodromous, pinnate. **1°** moderate; straight **2°** brochidodromous; thick; angle of divergence wide acute and uniform; abruptly curved; loop-forming branches joining superadjacent **2°** at right angles and enclosed by **3°** and **4°** arches; inter-**2°** simple and composite. **3°** obmedially ramified. **Higher vein order** distinct; **4°** and **5°** orthogonal reticulate, **4°** and **5°** anastomosing to form incomplete and random areolas. **Marginal ultimate venation** looped. **Veinlets** none.

Exsiccata: *Hernaez 1159 (PBDH)*

MALVACEAE

Abutilon indicum (L.) Sweet

Blade very wide ovate with acuminate apex and cordate base, symmetrical, 67-76 mm long, 73-89 mm wide, 0.8-0.9:1 ratio, notophyll class, serrate, unlobed, simple.

Venation craspedodromous, imperfect actinodromous, 5 basal. **1°** massive; straight or markedly curved. **2°** simple craspedodromous; thick; angle of divergence acute and uniform; uniformly curved and provided with outer **2°** veins; inter-**2°** veins weak. **3°** alternate percurrent; forked, convex; angle with respect to midvein constant oblique. **Higher vein order** distinct; **4°** orthogonal; **5°** orthogonal; **5°** anastomosing to form well developed and oriented areolas. **Marginal ultimate venation** incomplete **Veinlets** unbranched and 1-branched.

Exsiccatae: *Velasco 10155 (CAHUP)*, *Orlido 10645 (CAHUP)*, *Orlido 10646 (CAHUP)*

Bombycidendron vidalianum Merr. & Rolfe

Blade narrow elliptic or narrow oblong with acute apex and rounded base, symmetrical, 145-166 mm long, 49—57 mm wide, 3.2-3.6:1 ratio, mesophyll, entire, unlobed, simple.

Venation camptodromous, pinnate. **1°** moderate; straight. **2°** brochidodromous; thin; angle of divergence moderately acute and nearly uniform; abruptly curved; loop-forming branches joining superadjacent **2°** at right angles; inter-**2°** composite. **3°** alternate percurrent; forked; angle with respect to midvein oblique and decreases upward. **Higher vein order** **4°** and

5° orthogonal; 5° anastomosing to form well developed and oriented areolas. **Marginal ultimate venation** looped. **Veinlets** unbranched and 1-branched.

Exsiccatae: *Villarill and Gates 1789 (CAHUP)*, *Reyes 8902 (CAHUP)*, *Hernaez 17840 (CAHUP)*, *Velasco 2360 (CAHUP)*

Gossypium hirsutum L.

Blade orbiculate with odd-lobed acute apex and cordate base, symmetrical, 120-135 mm long, 125-162 wide, 1.0-1.1:1 ratio, mesophyll class, entire, palmately lobed, simple.

Venation camptodromous, perfect actinodromous, 5-7 basal. **1°** weak; straight and branched. **2°** brochidodromous; moderate to thin; angle of divergence moderate acute and nearly uniform; abruptly curved; loop-forming branches joining superadjacent **2°** at right angles. **3°** opposite percurrent; convex, angle with respect to midvein constant oblique. **Higher vein order** distinct; **4°** opposite percurrent; **5°** orthogonal; **5°** anastomosing to form well developed and oriented areolas. **Marginal ultimate venation** looped. **Veinlets** simple, 1-branched, 2-branched.

Exsiccatae: *Pancho 20356 (CAHUP)*, *Pancho 20429 (CAHUP)*

Hampea trilobata Standl.

Blade orbiculate with short acuminate apex and rounded or obtuse base, symmetrical, 90-125 mm long, 85-100 mm wide, 1.1-1.25:1 ratio, mesophyll class, entire, unlobed to 3-lobed, simple.

Venation camptodromous, perfect actinodromous, 7 basal. **1°** weak; straight to markedly curved. **2°** bronchidodromous; moderate to thick; angle of divergence moderate acute; loop-forming branches joining superadjacent at obtuse angles. **3°** mixed opposite alternate percurrent; straight or convex; angle with respect to midvein oblique and decreases upward. **Higher vein order** distinct; **4°** and **5°** orthogonal reticulate, **5°** anastomosing to form well developed and oriented areolas. **Marginal ultimate venation** looped. **Veinlets** unbranched.

Exsiccata: *Croat 26980 (CAHUP)*

Hibiscus rosa-sinensis L.

Blade ovate with cuneate or acuminate apex and convex or rounded base, symmetrical, 73-90 mm long, 45-68 mm wide, 1.3-1.6 ratio, notophyll class, serrate, unlobed.

Venation camptodromous, imperfect actinodromous, 5-7 basal. **1°** weak; straight or markedly curved. **2°** simple craspedodromous; moderate;

angle of divergence moderately acute and nearly uniform; inter-2° void. 3° opposite percurrent; forked, sinuous; angle with respect to midvein oblique and decreases upward. **Higher vein order** distinct; 4° and 5° random reticulate; 4° and 5° anastomosing to form imperfect and random areolas. **Marginal ultimate venation** looped. **Veinlets** unbranched.

Exsiccatae: *Manimbo and Tenorio 10014 (CAHUP)*, *Manimbo and Tenorio 55317 (CAHUP)*

Malachra capitata L.

Blade orbiculate or suborbiculate with convex or obtuse apex and convex or truncate, symmetrical, 69-90 mm long, 75-85 mm wide, 0.95-1.2:1 ratio, notophyll to mesophyll class, serrate, unlobed, simple.

Venation craspedodromous, imperfect actinododromous 5-7 basal. 1° weak; straight. 2° simple craspedodromous; moderate to thick; angle of divergence moderate acute and uniform; uniformly curved. 3° orthogonal reticulate. **Higher vein order** distinct; 4° and 5° random reticulation; 4° and 5° anastomosing to form well developed and random areoles. **Veinlets** none.

Exsiccatae: *Cajano 32119 (CAHUP)*, *Cajano 63220 (CAHUP)*, *Cajano 63221 (CAHUP)*

Malvaviscus arboreus Cav.

Blade orbiculate or wide narrow ovate with cuneate apex and convex base, symmetrical, 89-115 mm long, 40-54 mm wide, 2.13-2.25:1 ratio, notophyll class, serrate, unlobed or 3-lobed, simple.

Venation craspedodromous, perfect actinododromous, 5-7 basal. 1° moderate; straight and branched or markedly curved. 2° semicraspedodromous; moderate to thick; angle of divergence moderately acute and nearly uniform; abruptly curved at the apex and straight at the rest of the lamina; loop-forming branches joining superadjacent at obtuse angles; inter-2° void. 3° orthogonal reticulate. **Higher vein order** distinct; 4° and 5° orthogonal reticulate; 5° anastomosing to form well developed and oriented areolas. **Marginal ultimate venation** looped. **Veinlets** none.

Exsiccatae: *Orlido 4715 (CAHUP)*, *Hernaez 12387 (CAHUP)*, *Lugod 8231 (CAHUP)*

Talipariti tiliaceum (L.) Fryxell

Blade orbiculate with odd-lobed apex and cordate base, symmetrical, 87-120 mm long, 70-110 mm wide, 1-1.1:1 ratio, mesophyll class, dentate, palmately lobed, simple.

Venation craspedodromous, perfect actinodromous, 7 basal. **1°** weak; straight and branched. **2°** mixed craspedodromous; thin; angle of divergence moderately acute and nearly uniform; straight and provided with outer **2°** veins; loop-forming branches joining superadjacent **2°** at right angles; inter **2°** void. **3°** opposite percurrent; convex angle with respect to midvein constant oblique. **Higher venation order distinct**; **4°** and **5°** random reticulate; **5°** anastomosing to form imperfect and random areolas. **Marginal ultimate venation** looped. **Veinlets** simple or branched.

Exsiccatae: *Hernaez 52590 (CAHUP)*, *Hernaez 52591 (CAHUP)*, *Hernaez 52592, Picarque and Cajano 1373 (CAHUP)*

Thespesia populnea (L.) Soland ex Correa

Blade wide ovate with long acuminate apex and cordate base, symmetrical, 93-160 mm long, 81-113 mm wide, 1.16-1.39:1 ratio, mesophyll class, entire, unlobed, simple.

Venation camptodromous, perfect actinodromous, 7 basal. **1°** weak, straight and branched. **2°** bronchidodromous; moderate; angle of divergence moderately acute; abruptly curved; loop-forming branches joining superadjacent at right and acute angles; inter-**2°** simple. **3°** random reticulate. **Higher venation order** distinct; **4°** and **5°** random reticulate, **5°** anastomosing to form imperfect and random areolas. **Marginal ultimate venation** looped. **Veinlets** simple or 1-branched.

Exsiccatae: *Leesner and Dwyer 24355 (CAHUP)*, *Fernando 41421 (CAHUP)*, *Casimero 62743 (CAHUP)*, *Hernaez 25077 (CAHUP)*

Urena lobata L.

Blade orbiculate with acute apex and lobate base, symmetrical, 67-81 mm long, 65-99 mm wide, 0.97-1.22:1 ratio, notophyll to mesophyll class, serrate, palmately lobed, simple.

Venation craspedodromous, perfect actinodromous, 7 basal. **1°** weak; straight and branched. **2°** mixed craspedodromous; moderately acute and nearly uniform; abruptly curved at the apex and uniformly curved at the rest of the lamina; loop forming branches joining superadjacent at right angles; inter-**2°** simple. **3°** random reticulate. **Higher vein order** distinct; **4°** and **5°** random reticulate; **5°** anastomosing to form well developed and random areolas. **Marginal ultimate venation** incomplete. **Veinlets** none.

Exsiccatae: *Agne 1818 (CAHUP)*, *Stern 12092 (CAHUP)*, *Quisumbing 18019 (CAHUP)*, *Escobin 41742 (CAHUP)*

STERCULIACEAE

Abroma augusta L.f.

Blade ovate with acute to acuminate apex and cordate base, mostly asymmetrical at base, 55-195 mm long, 99-183 mm wide, 1.2-1.14:1 ratio, mesophyll class, serrate, unlobed to 3-lobed, simple.

Venation craspedodromous, perfect actinodromous, 5-7 basal 1° stout, straight and branched 2° craspedodromous; thick; angle of divergence moderate acute and uniform; abruptly curved; loop-forming branches joining superadjacent 2° at obtuse angles; inte-2° simple. 3° opposite percurrent; straight and forked; angle with respect to midvein constant oblique. **Higher vein order** 4° and 5° orthogonal reticulate, 4° and 5° anastomosing to form well developed and oriented areolas. **Marginal ultimate venation** incomplete. **Veinlets** unbranched.

Exsiccatae: *Orlido 5015 (CAHUP)*, *Hernaez 1161 (CAHUP)*, *Estioko 1830 (CAHUP)*

Heriteria javanica (Blume) Kosterm.

Blade narrow elliptic with cuneate or acute apex and cuneate base, symmetrical, 187-239 mm long, 50-70 mm wide, 3.1-3.4:1 ratio, mesophyll class, entire, unlobed, simple.

Venation camptodromous, pinnate. 1° weak to moderate; straight 2° eucamptodromous; moderate; angle of divergence moderate acute with upper 2° more obtuse than lower 2°; abruptly curved; loop-forming branches joining superadjacent 2° at right and obtuse angles. 3° mixed alternate opposite percurrent; forked, retroflexed, convex; angle with respect with midvein constant oblique. **Higher vein order** distinct; 4° weakly percurrent; 5° orthogonal reticulate; 4° and 5° anastomosing to form well developed and random areolas. **Marginal ultimate venation** looped. **Veinlets** unbranched and 1-branched.

Exsiccata: *Tandang 501 (PBDH)*

Kleinhovia hospita L.

Blade wide ovate with acuminate apex and slightly to nearly truncate base, symmetrical, 64-78 mm long, 51-77 mm wide, 1-1.2:1 ratio, notophyll to mesophyll class, entire, unlobed, simple.

Venation camptodromous, perfect actinodromous, 7 basal. 1° weak; straight and branched. 2° brochidodromous; thick; angle of divergence narrow acute and nearly uniform, abruptly curved; loop-forming branches joining superadjacent 2° at right angles and enclosed by 3° and 4° arches. 3° opposite

percurrent; mostly straight with forked and convex; angle with respect to midvein oblique and decreases upward. **Higher vein order** distinct; 4° and 5° orthogonal reticulate; 5° anastomosing to form well developed and oriented areolas. **Marginal ultimate venation** looped. **Veinlets** unbranched and branched.

Exsiccata: *Hernaez and Cajano 1163 (PBDH)*

Melochia concatenata L.

Blade narrow ovate with acute apex and cordate or truncate base, symmetrical, 30-49 mm long, 20-30 mm wide, 1.2-1.41:1 ratio, nanophyll class, serrate, unlobed, simple.

Venation craspedodromous, imperfect actinododromous, 5 basal. **1°** weak; straight and branched. **2°** simple craspedodromous; thick; angle of divergence narrow acute, uniformly curved; inter-2° simple. **3°** orthogonal reticulate. **Higher vein order** distinct; 4° orthogonal reticulate, 4° anastomosing to form well developed and oriented areolas; highest venation up to 4°. **Marginal ultimate venation** incomplete. **Veinlets** unbranched and 1-branched.

Exsiccatae: *Belonias 1164 (PBDH)*, *Pancho 1165 (PBDH)*

Pterocymbium tinctorium Merr.

Blade orbiculate with long acuminate apex and cordate base, symmetrical, 122-144 mm long, 113-145 mm wide, 1-1.1:1 ratio, mesophyll class, entire, palmately lobed.

Venation camptodromous, perfect actinododromous, 7 basal. **1°** weak; straight and branched. **2°** brochidodromous; thick; angle of divergence moderately acute and nearly uniform; abruptly curved; loop forming branches joining superadjacent 2° at right and obtuse angles; inter-2° void. **3°** alternate percurrent; mostly forked with straight and convex; angle with respect to the midvein oblique and decreases upward. **Higher vein order** distinct; 4° and 5° orthogonal reticulate; 5° anastomosing to form well developed and random areolas. **Marginal ultimate venation** looped. **Veinlets** unbranched.

Exsiccata: *Tandang 506 (PBDH)*

Sterculia montana Merr.

Blade wide elliptic with short acuminate apex and cordate base, symmetrical or asymmetrical at base only, 131-186 mm long, 70-126 mm wide, 1.2-1.8:1 ratio, mesophyll class, entire, unlobed.

Venation camptodromous, pinnate. **1°** moderate to weak; straight to markedly curved. **2°** eucamptodromous; thick, angle of divergence moderately acute and upper **2°** more acute than lower **2°**; abruptly curved; loop-forming branches joining superadjacent **2°** at obtuse angles and enclosed by **3°** and **4°** arches. **3°** opposite percurrent; convex, sinuous, or forked; angle with respect to midvein constant oblique. **Higher venation order** distinct; **4°** alternate percurrent; **5°** orthogonal reticulate; **5°** and **6°** anastomosing to form well developed and oriented areolas. **Veinlets** none

Exsiccata: *Lumain 10413 (CAHUP)*

Sterculia oblongata R. Br.

Blade elliptic with acute apex and convex base, symmetrical, 138-190 mm long, 70-80 mm wide, 2.0-2.4:1 ratio, mesophyll class, entire, unlobed, simple.

Venation camptodromous, pinnate. **1°** moderate, straight. **2°** eucamptodromous; moderate; angle of divergence moderately acute and uniform; abruptly curved; loop-forming branches joining superadjacent **2°** at obtuse angles; inter-**2°** void. **3°** alternate percurrent; forked, straight and convex; angle with respect to midvein constant oblique. **Higher vein order** **4°** and **5°** orthogonal reticulate, **4°** and **5°** anastomosing to form well developed and oriented areolas. **Marginal ultimate venation** looped. **Veinlets** none.

Exsiccata: *Tandang 507 (PBDH)*

Sterculia stipularis R. Br.

Blade elliptic with acute apex and cordate base, symmetrical, 155-175 mm long, 68-93 mm wide, 2.0-2.4:1 ratio, mesophyll class, entire, unlobed, simple.

Venation camptodromous, pinnate. **1°** moderate; straight. **2°** eucamptodromous; moderate; angle of divergence narrow acute and uniform, abruptly curved; loop-forming branches joining superadjacent at right angles. **3°** alternate percurrent; sinuous, angle with respect to midvein oblique and decreases upward. **Higher vein order** distinct; **4°** alternate percurrent; **5°** orthogonal reticulate; **5°** and **6°** anastomosing to form well developed and oriented areolas. **Marginal ultimate venation** looped **Veinlets** none

Exsiccata: *Hernaez 40616 (CAHUP)*

Theobroma cacao L.

Blade elliptic with acuminate apex and cuneate base, symmetrical, 144-208 mm long, 64-74 mm wide, 2.5-2.8:1 ratio, mesophyll, entire, unlobed, simple.

Venation camptodromous, pinnate 1° weak, straight. 2° eucamptodromous; moderate, angle of divergence wide acute and uniform; abruptly curved; loop-forming branches joining superadjacent 2° at obtuse angles near the apex and right angles near the base. 3° alternate percurrent; forked; angle with respect to midvein constant oblique. **Higher vein order** distinct; 4° random reticulation; 5° orthogonal reticulation; 5° and 6° anastomosing to form well developed and oriented areolas. **Marginal ultimate venation** looped. **Veinlets** none.

Exsiccata: *Pancho 20204 (CAHUP)*

Theobroma glauca Karst.

Blade elliptic with acuminate apex and cuneate base, symmetrical, 261-300 mm long, 82-155 mm wide, 1.95-3.5:1 ratio, mesophyll to macrophyll class, entire, unlobed.

Venation camptodromous, pinnate. 1° moderate; straight. 2° eucamptodromous; moderate; angle of divergence moderately acute and uniform; abruptly curved; loop forming branches joining super adjacent 2° at obtuse and right angles. 3° opposite percurrent; convex; angle with respect to midvein perpendicular. **Higher vein order** distinct; 4° and 5° orthogonal; 5° and 6° anastomosing to form well developed and oriented areolas. **Marginal ultimate venation** looped. **Veinlets** branched once.

Exsiccata: *Croat 24460 (CAHUP)*

TILIACEAE

Berrya cordifolia (Willd.) Burret

Blade ovate with acute apex and cordate base, symmetrical, 147-235 mm long, 87-120 mm wide, 1.7-1.9:1 ratio, mesophyll, entire, unlobed, simple.

Venation camptodromous, imperfect actinodromous. 1° weak; straight. 2° eucamptodromous at midrib with brochidodromous laterals; thick; angle of divergence narrowly acute; abruptly curved. 3° opposite percurrent; straight, forked; angle with respect to midvein constant oblique. **Higher vein order** distinct; 4° orthogonal reticulate; 5° orthogonal reticulate highest vein order up to 6°; 6° anastomosing to form well developed and oriented areolas. **Marginal ultimate venation** looped. **Veinlets** none

Exsiccata: *Hernaes 28197 (CAHUP)*

Colona serratifolia Cav.

Blade narrow ovate with straight or long acuminate and obtuse base, asymmetrical to base or whole lamina, 130-180 mm long, 49-66 mm wide, 2.6-2.7:1 ratio, mesophyll, serrate, unlobed, simple.

Venation craspedodromous, imperfect actinodromous, 3-5 basal. **1°** moderate; straight and branched. **2°** craspedodromous; thick; angle of divergence moderately acute, uniformly curved. **3°** opposite percurrent; forked, straight or convex; angle with respect to midvein perpendicular. **Higher vein order** distinct; 4° and 5° random to orthogonal reticulate; 4° and 5° anastomosing to form well developed, random to oriented areolas. **Marginal ultimate venation** incomplete. **Veinlets** unbranched

Exsiccatae: *Domingo 2597 (PBDH)*, *Reyes and Apolinario 26742 (CAHUP)*

Corchorus acutangulus Lam.

Blade narrow ovate with acute apex and obtuse base, symmetrical, 30-48 mm long, 16-23 mm wide, 2-2.4:1 ratio, microphyll, serrate, unlobed, simple.

Venation craspedodromous, perfect actinodromous, 3-5 basal. **1°** weak; straight and branched. **2°** simple craspedodromous; moderate; angle of divergence narrow acute, upper 2° more acute than lower 2°; straight to uniformly curved; inter-2° simple. **3°** alternate percurrent; straight, forked or sinuous; angle with respect to midvein oblique and decreases upward. **Higher vein order distinct**; 4° random reticulate; 4° anastomosing to form imperfect and random areolas; highest vein order up to 4°. **Marginal ultimate venation** incomplete. **Veinlets** unbranched and branched.

Exsiccatae: *Hernaez and Cajano 1960 (PBDH)*, *Hernaez and Cajano 1961 (PBDH)*, *Hernaez and Cajano 1962 (PBDH)*

Diplodiscus paniculatus Turcz.

Blade narrow elliptic with acute apex and cuneate base, symmetrical, 125-137 mm long, 44-55 mm wide, 2.97-3.26:1 ratio, notophyll or mesophyll, entire, unlobed, simple.

Venation camptodromous, imperfect actinodromous. **1°** moderate; straight. **2°** eucamptodromous at midrib with brochidodromous laterals; thick; angle of divergence moderately acute and uniform; loop-forming branches joining superadjacent 2° at obtuse angles; uniformly curved. **3°** mixed alternate and opposite percurrent; mostly convex with straight and convex; angle with respect to midvein perpendicular. **Higher vein order** distinct; 4° and 5° orthogonal reticulation; 4° and 5° anastomosing to form well developed and random areolas. **Marginal ultimate venation** incomplete. **Veinlets** none

Exsiccata: *Manimbo 50839 (CAHUP)*

Grewia multiflora Blanco

Blade narrow elliptic with acuminate apex and cuneate base, symmetrical, 96-114 mm long, 34-36 mm wide, 3.0-3.3:1 ratio, notophyll, serrate, unlobed, simple.

Venation craspedodromous, imperfect actinodromous, 3 basal 1° weak; straight. 2° mixed craspedodromous; thick; angle of divergence narrowly acute; abruptly to uniformly curved; loop-forming branches joining superadjacent 2° at obtuse angles. 3° opposite percurrent; forked and straight; angle with respect to midvein nearly perpendicular. **Higher vein order** distinct; 4° and 5° orthogonal; 5° anastomosing to forming well developed and oriented areolas. **Marginal ultimate venation** incomplete **Veinlets** unbranched or 1-branched.

Exsiccatae: *Tandang 508 (PBDH), Hernaez and Cajano 1969 (PBDH), Baker 1771 (CAHUP)*

Grewia rhombifolia Kaneh. & Sasaki

Blade very wide ovate with acute apex and cordate base, symmetrical, 160-169 mm long, 162-165 wide, 1:1 ratio, mesophyll, serrate, unlobed.

Venation craspedodromous, perfect actinodromous, 5-7 basal. 1° weak; straight to markedly curved, branched. 2° mixed craspedodromous; moderate to thick; angle of divergence moderately acute, angle increasing toward base; loop-forming branches joining superadjacent 2° at obtuse angles; abruptly curved. 3° opposite percurrent; mostly straight, some forked; angle with respect to midvein constant oblique. **Higher vein order** distinct; alternate percurrent; 5° orthogonal; 5° anastomosing to form well developed and oriented areolas. **Marginal ultimate venation** incomplete. **Veinlets** simple.

Exsiccatae: *Resurrecion 6043, 6044 (CAHUP)*

Luehea seemannii Planch. & Triana

Blade elliptic with acute apex and rounded base, symmetrical at base only, 90-110 mm long, 39-50 mm wide, 2-2.6:1 ratio, notophyll class, serrate, unlobed, simple.

Venation craspedodromous, imperfect actinodromous, 5 basal. 1° moderate, straight, branched. 2° simple craspedodromous; thick; angle of divergence moderately acute. 3° percurrent; straight or convex; angle with respect to midvein oblique and decreases upward. **Higher venation order**

distinct; 4° percurrent; 5° orthogonal reticulate. **Marginal ultimate venation** looped. **Veinlets** none

Exsiccata: *Nee 23460 (CAHUP)*

Microcos stylocarpa Burret

Blade narrow elliptic with acute apex and cuneate base, symmetrical, 110-182 mm long, 41-54 mm wide, 3.1-4.1:1 ratio, notophyll to mesophyll, entire, unlobed, simple.

Venation camptodromous, imperfect actinodromous. 1° stout; straight. 2° eucamptodromous at midrib with brochidodromous laterals; thin to moderate; angle of divergence moderately acute with upper 2° more obtuse than lower; uniformly curved; loop-forming branches joining superadjacent 2° at right angles, 3° and 4° arches at lower 2°. 3° alternate percurrent; forked; angle with respect to midvein perpendicular. **Higher venation order** distinct; 4° and 5° orthogonal reticulation; 4° and 5° anastomosing to form well developed and oriented areolas. **Marginal ultimate venation** looped. **Veinlets** unbranched and 1-branched.

Exsiccatae: *Hernaez and Cajano (CAHUP)*, *Co 49488 (CAHUP)*, *Baquiran and Ridsdale 60903 (CAHUP)*

Tilia americana L.

Blade suborbiculate with acuminate apex and cordate base, asymmetrical at base only, 91-120 mm long, 80-105 mm wide, 1.2-1.3:1 ratio, mesophyll class, serrate, unlobed, simple.

Venation craspedodromous, imperfect actinodromous. 1° weak; straight. 2° simple craspedodromous; moderate; angle of divergence moderate acute; provided with outer secondary vein. 3° mixed alternate and opposite percurrent; convex, angle with respect to midvein constant oblique. **Higher venation order** distinct; 4° alternate percurrent; 5° reticulate; 5° and 6° anastomosing to form well developed and oriented areolas. **Veinlets** unbranched and 1-branched.

Exsiccatae: *Velasco 1767 (CAHUP)*, *Pancho 8733 (CAHUP)*, *Fortich 3831 (CAHUP)*

Trichospermum discolor Elmer.

Blade narrow oblong with attenuate or acute apex and cordate base, asymmetrical at base, 170-195 mm long, 67-69 mm wide, 3.14-3.20:1 ratio, mesophyll, serrate, unlobed, simple.

Venation craspedodromous, imperfect actinodromous, 3-5 basal. 1° moderate; straight and branched. 2° mixed craspedodromous; moderate; angle of divergence moderately acute and uniform; abruptly curved; loop-forming branches joining superadjacent 2° at right and obtuse angles. 3° alternate percurrent; forked, recurved, straight; angle with respect to midvein oblique and decreases upward. **Higher vein order** distinct; 4° alternate percurrent; 5° orthogonal; 5° and 6° anastomosing to form well developed and oriented areolas. **Marginal ultimate venation** looped. **Veinlets** unbranched or 1-branched.

Exsiccatae: *Hernaez 41959 (CAHUP)*, *Hernaez 41920 (CAHUP)*

DICHOTOMOUS KEY OF SELECTED TAXA OF MALVACEAE SENSU APG

1. Single 1° vein 2
 2. 2° vein brochidodromous..... 3
 3. Leaf organization simple..... 4
 5. 1° vein size stout, macrophyll, inter-2° vein void.....*Neesia altissima*
 - 5'. 1° vein size moderate, mesophyll, inter-2° common..... 6
 6. 2° vein size thin, 4° and 5° vein percurrent *Bombycidendron vidalianum*
 - 6'. 2° vein moderate, 4° and 5° vein reticulate..... 7
 7. Apex cuneate..... *Durio macrophyllus*
 - 7'. Apex obtuse..... 8
 8. Areolas oriented..... *Durio zibethinus*
 - 8'. Areolas random..... *Durio kutejensis*
 - 3'. Leaf organization palmately compound..... 9
 10. 3° vein reticulate..... *Ceiba pentandra*
 - 10'. 3° vein not reticulate..... 11
 11. 3° vein percurrent..... *Adansonia digitata*
 - 11'. 3° vein ramified..... 12
 12. Blade obovate, apex retuse..... *Pachira sessilis*
 - 12'. Blade elliptic, apex obtuse..... *Pachira aquatica*
 - 2'. 2° veins eucamptodromous 13
 13. Upper lamina brochidodromous..... 14
 14. Inter 2° vein void..... *Heritiera javanica*
 - 14'. Inter 2° vein common..... 15
 15. 3° vein opposite percurrent *Sterculia montana*
 - 15'. 3° vein alternate percurrent 16

16. Base shape cordate, angle of divergence narrow acute..... *Sterculia stipularis*
- 16'. Base shape obtuse, angle of divergence moderate acute.... *Sterculia oblongata*
- 13'. Upper lamina not brochidromous..... 17
17. 1° vein size moderate, 2° vein size, thick, 3° opposite percurrent.....
Theobroma glauca
- 17'. 1° size weak, 2° vein size, moderate, 3° alternate percurrent.....
Theobroma cacao
- 1'. 2 or more 1° veins radial joined at single point..... 18
18. 2° vein terminating at margin..... 19
19. Simple craspedodromous..... 20
20. Angle of divergence narrow acute..... 21
21. Blade class microphyll, 3° vein random reticulate..... *Corchorus acutangulus*
- 21'. Blade class nanophyll, 3° vein orthogonal reticulate..... *Melochia concatenate*
- 20'. Angle of divergence moderate acute 22
22. 3° vein mixed alternate/opposite percurrent 23
23. 1° vein size weak, 2° moderate, outer 2° present *Tilia Americana*
- 23'. 1° vein size moderate, 2° thick, outer 2° absent 24
24. Blade shape lorate, apex acuminate 3° mixed percurrent
Colona serratifolia
- 24'. Blade shape ovate, apex acute 3° opposite percurrent
Luehea seemannii
- 22'. 3° vein not alternate/opposite percurrent 25
25. Blade class mesophyll, asymmetrical at base *Abroma augusta*
- 25'. Blade class notophyll, symmetrical 26
26. 1° vein size massive, inter 2° vein present... *Abutilon indicum*
- 26'. 1° vein size weak, inter 2° vein absent *Hibiscus rosa-sinensis*
- 19'. Not simple craspedodromous 27
27. Semi-craspedodromous 28
28. Apex convex or obtuse, lobed, areolas random *Malachra capitata*
- 28'. Apex cuneate, unlobed, areolas oriented *Malvaviscus arboreus*
- 27'. Mixed craspedodromous 29
29. Unlobed 30

30. 1° vein moderate, asymmetrical at base...	<i>Trichospermum discolor</i>
30'. 1° vein weak, symmetrical	31
31. Blade elliptic, apex acuminate, base rounded, alternate percurrent	<i>Grewia multiflora</i>
31'. Blade ovate, apex acute, base cordate, opposite percurrent	<i>Grewia rhombifolia</i>
29. Palmately lobed	32
32. Tooth type, serrate	<i>Urena lobata</i>
32. Tooth type, dentate	<i>Talipariti tiliaceum</i>
17'. 2° vein not terminating at margin	33
33. Brochidodromous	34
34. 1° vein size weak	35
35. imperfect actinodromous	<i>Berrya cordifolia</i>
35'. perfect actinodromous	36
36. 2° vein thickness weak	37
37. Blade shape ovate	<i>Kleinhovia hospita</i>
37'. Blade shape elliptic	<i>Pterocymbium tinctorium</i>
36'. 2° vein thickness not weak	38
38. Palmately lobed	39
39. Apex acute, base cordate	<i>Gossypium hirsutum</i>
39'. Apex acuminate, base rounded or obtuse	<i>Hampea trilobata</i>
38'. Unlobed	<i>Thespesia populnea</i>
34'. 1° vein size moderate	40
40. Apex acuminate, blade class mesophyll-macrophyll, 3° vein mixed percurrent	<i>Cavanillesia hylogeiton</i>
40'. Apex shape acute, blade class mesophyll, 3° vein opposite percurrent	<i>Ochroma lagopus</i>
33'. Eucamptodromous	41
41. Base shape cuneate, 3° mixed percurrent	<i>Diplodiscus paniculatus</i>
41'. Base shape acute, 3° alternate percurrent	<i>Microcos stylocarpa</i>



Fig. 1 Leaf blade of *Durio zibethinus* (Bombacaceae) Gruezo 23968 (CAHUP).



Fig. 2 Leaf blade of *Pachira aquatica* (Bombacaceae) Hernaez 1159 (PBDH)



Fig 3. Leaf blade of *Ceiba pentandra* Gruezo 23956 (CAHUP).



Fig 4. Leaf blade of *Hibiscus-rosa sinensis* (Malvaceae) Manimbo and Tenorio 55318 (CAHUP).



Fig 5. Leaf blade of *Urena lobata* (Malvaceae) Escobin 41742 (CAHUP).



Fig 6. Leaf blade of *Hampea trilobata* (Malvaceae) Croat 26980 (CAHUP).



Fig. 7. Leaf blade of *Theobroma cacao* (Sterculiaceae) *Pancho 20204* (CAHUP).



Fig. 8. Leaf blade of *Heritiera javanica* (Sterculiaceae) *Tandang 501* (PBDH).



Fig. 9. Leaf blade of *Theobroma glauca* (Sterculiaceae) *Croat 24460* (CAHUP).



Fig 10. Leaf blade of *Grewia multiflora* (Tiliaceae) Baker 1771 (CAHUP).



Fig 11. Leaf blade of *Grewia rhombifolia* (Tiliaceae) Resurrecion 6043 (CAHUP).



Fig 12. Leaf blade of *Berrya cordifolia* (Tiliaceae) Hernaez 28197 (CAHUP).

Table 1. Some Leaf Architecture Characters of Ten Selected Species of Traditional Family Bombacaceae

<i>Characters</i>	<i>Adansonia digitata</i>	<i>Cavanillesia hylogeiton</i>	<i>Ceiba pentandra</i>	<i>Durio kutejensis</i>	<i>Durio macrophyllus</i>	<i>Durio zibethinus</i>	<i>Neesia altissima</i>	<i>Ochroma lagopus</i>	<i>Pachira aquatica</i>	<i>Pachira sessiles</i>
Blade class	notophyll	macrophyll	notophyll	mesophyll	mesophyll	mesophyll	macrophyll	mesophyll	notophyll	notophyll
Margin	entire	entire	entire	entire	entire	entire	Entire	entire	Entire	entire
Lobation	unlobed	palmately lobed	unlobed	unlobed	unlobed	unlobed	unlobed	palmately lobed	unlobed	unlobed
1° vein category	pinnate	actinodromous	pinnate	pinnate	pinnate	pinnate	pinnate	Action-dromous	pinnate	pinnate
L:W Ratio	2:1-3:1	1:1-2:1	3:1-6:1	3:1-6:1	3:1-6:1	2:1-3:1	2:1	1:1-2:1	2:1-3:1	2:1-3:1
1° vein size	weak	moderate	moderate	moderate	moderate	moderate	Stout	moderate	moderate	stout
2° vein category	brochidodromous	brochidodromous	brochidodromous	brochidodromous	brochidodromous	brochidodromous	brochidodromous	brochidodromous	brochidodromous	brochidodromous
2° vein size	moderate	thick	moderate	moderate	moderate	moderate	Thick	moderate	thick	moderate
Angle of divergence	wide acute	moderate acute	moderate acute	moderate acute	moderate acute	moderate acute	moderate acute	moderate acute	wide acute	wide acute
Inter-2° veins	present	void	present	present	present	present	Void	void	present	present
3° vein category	opposite percurrent	mixed percurrent	random reticulate	orthogonal reticulate	orthogonal reticulate	orthogonal reticulate	alternate percurrent	opposite percurrent	ramified	ramified
4° vein category	alternate percurrent	alternate percurrent	orthogonal reticulate	orthogonal reticulate	orthogonal reticulate	orthogonal reticulate	alternate percurrent	alternate percurrent	orthogonal reticulate	orthogonal reticulate
Veinlets	none	1-branched	1-branched	1-branched	1-branched	1-branched	1-branched	1-branched	1-branched	1-branched
Areole Dev't	well-developed	well-developed	well-developed	well-developed	well-developed	well-developed	well-developed	well-developed	incomplete	well-developed
Areole Arrangement	random	oriented	random	random	oriented	oriented	random	oriented	random	oriented

Table 2. Leaf Architecture Characters of Ten Selected Species of Traditional Family Malvaceae

<i>Characters</i>	<i>Abutilon indicum</i>	<i>Bombyci-dendron vidalianum</i>	<i>Gossypium hirsutum</i>	<i>Hampea trilobata</i>	<i>Hibiscus rosa-sinensis</i>	<i>Malachra capitata</i>	<i>Malvaviscus arboreus</i>	<i>Talipariti tiliaceum</i>	<i>Thespesia populnea</i>	<i>Urena lobata</i>
Blade class	notophyll	mesophyll	mesophyll	mesophyll	notophyll	notophyll	notophyll	mesophyll	mesophyll	mesophyll
Margin	serrate	entire	entire	entire	serrate	serrate	Serrate	serrate	entire	serrate
Lobation	unlobed	unlobed	palmately lobed	palmately lobed	unlobed	unlobed	Unlobed	palmately lobed	unlobed	palmately lobed
L:W Ratio	1:1-2:1	3:1-6:1	1:1-2:1	1:1-2:1	1:1-2:1	1:1-2:1	2:1-3:1	1:1-2:1	1:1-2:1	1:1-2:1
1° vein category	actinodromous	pinnate	actinodromous	actinodromous	actinodromous	actinodromous	Actinodromous	actinodromous	actinodromous	actinodromous
1° vein size	massive	moderate	weak	weak	weak	weak	Weak	weak	weak	weak
2° vein category	craspedodromous	brochidodromous	brochidodromous	brochidodromous	craspedodromous	semi-craspedodromous	semi-craspedodromous	mixed craspedodromous	brochidodromous	mixed craspedodromous

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2° vein size	thick	thin	moderate	thick	moderate	thick	Thick	thin	moderate	moderate
Angle of divergence	moderate acute	moderate acute	moderate acute	moderate acute	moderate acute	moderate acute	moderate acute	moderate acute	moderate acute	moderate acute
Inter-2° veins	void	present	void	void	void	void	Void	void	present	present
3° vein category	alternate percurrent	alternate percurrent	opposite percurrent	mixed percurrent	opposite percurrent	orthogonal reticulate	orthogonal reticulate	opposite percurrent	random reticulate	random reticulate
4° vein category	opposite percurrent	opposite percurrent	random reticulate	orthogonal reticulate	orthogonal reticulate	random reticulate	orthogonal reticulate	orthogonal reticulate	random reticulate	orthogonal reticulate
Veinlets	1-branched	1-branched	2-branched	unbranched	unbranched	none	None	1-branched	1-branched	none
Areole Dev't	well - developed	well- developed	well- developed	well - developed	well- developed	well - developed	well - developed	well - developed	imperfect	well - developed
Areole Arrangement	oriented	oriented	oriented	oriented	oriented	random	Oriented	random	random	random

Table 3. Leaf Architecture Characters of Ten Selected Species of Traditional Family Sterculiaceae

<i>Characters</i>	<i>Abroma augusta</i>	<i>Heritiera javanica</i>	<i>Kleinhovia hospita</i>	<i>Melochia concatenata</i>	<i>Pterocymbium tinctorium</i>	<i>Sterculia montana</i>	<i>Sterculia oblongata</i>	<i>Sterculia stipularis</i>	<i>Theobroma cacao</i>	<i>Theobroma glauca</i>
Blade class	mesophyll	mesohyll	mesophyll	nanophyll	mesophyll	mesophyll	mesophyll	mesophyll	mesophyll	macrophyll
Margin	serrate	entire	entire	serrate	entire	entire	entire	entire	entire	entire
Lobation	palmately lobed	unlobed	unlobed	unlobed	palmately lobed	unlobed	unlobed	unlobed	unlobed	unlobed
L:W Ratio	1:1-2:1	3:1-6:1	1:1-2:1	1:1-2:1	2:1-3:1	2:1-3:1	2:1-3:1	2:1-3:1	2:1-3:1	2:1-3:1
1° vein category	actinodromous	pinnate	actinodromous	actinodromous	actinodromous	pinnate	pinnate	pinnate	pinnate	pinnate
1° vein size	stout	weak	weak	weak	weak	moderate	moderate	moderate	weak	moderate
2° vein category	craspedodromous	eucamptodromous	brochidodromous	craspedodromous	brochidodromous	eucamptodromous	eucamptodromous	eucamptodromous	eucamptodromous	eucamptodromous
2° vein size	thick	weak	weak	weak	weak	moderate	moderate	moderate	weak	thick
Angle of divergence	moderate acute	moderate acute	narrow acute	narrow acute	moderate acute	moderate acute	moderate acute	narrow acute	moderate acute	moderate acute
Inter-2° veins	void	void	void	present	void	void	void	void	void	void
3° vein category	opposite percurrent	mixed percurrent	opposite percurrent	orthogonal reticulate	alternate percurrent	opposite percurrent	alternate percurrent	alternate percurrent	alternate percurrent	opposite percurrent
4° vein category	orthogonal reticulate	alternate percurrent	orthogonal reticulate	orthogonal reticulate	orthogonal reticulate	alternate percurrent	orthogonal reticulate	alternate percurrent	random reticulate	orthogonal reticulate

Veinlets	2-branched	unbranched 1-branched	unbranched 1-branched	unbranched 1-branched	unbranched	none	none	none	none	1-branched
Areole Dev't	well - developed	well- developed	well- developed	well - developed	well - developed	well- developed	well- developed	well- developed	well- developed	well- developed
Areole Arrangement	oriented	oriented	oriented	oriented	oriented	oriented	oriented	oriented	oriented	oriented

Table 4. Leaf Architecture Characters of Ten Selected Species of Traditional Family Tiliaceae

Characters	<i>Berrya cordifolia</i>	<i>Colona serratifolia</i>	<i>Corchorus acutangulus</i>	<i>Diplodiscus paniculatus</i>	<i>Grewia multiflora</i>	<i>Grewia rhombifolia</i>	<i>Luehea seemanni</i>	<i>Microcos stylocarpa</i>	<i>Tilia americana</i>	<i>Trichospermum discolor</i>
Blade class	mesophyll	mesophyll	microphyll	mesophyll	notophyll	mesophyll	notophyll	mesophyll	mesophyll	mesophyll
Margin	entire	serrate	serrate	entire	serrate	serrate	Serrate	entire	serrate	serrate
Lobation	unlobed	unlobed	unlobed	unlobed	unlobed	unlobed	unlobed	unlobed	unlobed	unlobed
L:W Ratio	1:1-2:1	2:1-3:1	2:1-3:1	3:1-6:1	3:1-6:1	1:1-2:1	2:1-3:1	3:1-6:1	2:1-3:1	3:1-6:1
1° vein category	actino- dromous	actino- dromous	action- dromous	actino- dromous	actino- dromous	actino- dromous	actino- dromous	actino- dromous	actino- dromous	actino- dromous
1° vein size	weak	moderate	weak	moderate	weak	weak	moderate	stout	weak	Moderate

2° vein category	brochido-dromous	craspedo-dromous	craspedo-dromous	eucampto-dromous	mixed craspedo-dromous	mixed craspedo-dromous	craspedo-dromous	eucampto-dromous	craspedo-dromous	mixed craspedo-dromous
2° vein size	thick	thick	moderate	thick	thick	thick	Thick	moderate	moderate	moderate
Angle of divergence	narrow acute	moderate acute	narrow acute	moderate acute	moderate acute	moderate acute	moderate acute	moderate acute	moderate acute	moderate acute
Inter-2° veins	void	void	present	void	void	void	Void	void	void	void
3° vein category	alternate percurrent	mixed percurrent	random reticulate	mixed percurrent	alternate percurrent	opposite percurrent	mixed percurrent	alternate percurrent	mixed percurrent	alternate percurrent
4° vein category	orthogonal reticulate	orthogonal reticulate	random reticulate	orthogonal reticulate	orthogonal reticulate	alternate percurrent	opposite percurrent	orthogonal reticulate	alternate percurrent	alternate percurrent
Veinlets	none	unbranched	1-branched	1-branched	1-branched	unbranched	None	none	1-branched	1-branched
Areole Dev't	well - developed	well - developed	imperfect	well - developed	well - developed	well - developed	well - developed	well - developed	well - developed	well - developed
Areole Arrangement	oriented	oriented	random	random	oriented	oriented	oriented	oriented	oriented	oriented

CONCLUSION AND RECOMMENDATION

Forty species classified under Malvaceae *sensu* APG were observed, measured and characterized using leaf architecture characters of herbarium specimens at PBDH and CAHUP. Descriptions of the leaf architecture characters were made for each species. It was found that leaf architecture characters can separate taxa such as species and genera from each other as shown by the dichotomous key constructed. Some of the examined species can be grouped into subfamilies and/or tribes of Malvaceae *sensu* APG with the use of basic leaf architectural characters like margin, primary, secondary and tertiary vein patterns.

Leaf characters, especially the venation patterns, are good taxonomic markers either in identification or classification of plant taxa. As leaves are widespread plant organs, these elements are of great utility for taxonomists and ecologists, either in field or laboratory work.

It is recommended that specimens are collected personally instead on relying on available specimens in the herbarium. Preparation of leaf skeletons through clearing method can also be done in future studies in order to see the vein patterns that are not clear in the herbarium specimens. Increase of sample size is also recommended

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