

LEAF ARCHITECTURAL STUDIES ON SIX SPECIES OF ANGIOSPERMS FROM MOHNYIN TOWNSHIP, KACHIN STATE

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Abstract

The present paper deals with leaf architectural study on 6 species belonging to 6 genera and 6 families of Angiosperms from Mohnyin Township, Kachin State. The characters studied include leaf attachment, leaf arrangement, leaf organization, laminar shape, base and apex shape, base and apex angle, margin type, leaf texture, petiole features, laminar size classes, 1°, 2°, 3°, 4° and 5° vein category, spacing, angle and areolation. In this study, the leaves were compound in 2 species and simple in 4 species. Symmetrical leaf base and petiole base pulvinate was the characteristic of *Phyllodium vestitum* Benth. Leaf margin of all species were entire, sinuous, erose and dentate. The texture of leaf was coriaceous in 5 species and membranous in 1 species. In the present research work, three types of laminar size classes (mesophyll in 3 species, macrophyll in 1 species, and notophyll in 2 species) were recorded. Primary vein category were pinnate in 4 species and palmate in 2 species. Secondary vein category were hemieucamptodromous in 1 species, cladodromous in 1 species, brochidodromous in 1 species, festooned semicraspedodromous in 1 species, and eucamptodromous becoming brochidodromous in 2 species. Intersecondary vein was present in 3 species and absent in 3 species. Tertiary vein category were irregular reticulate anastomose in 2 species, transverse freely ramified in 1 species, composite admedial reticulate in 1 species, mixed alternate and opposite percurrent in 1 species, and opposite percurrent in 1 species. Marginal ultimate venation were looped in 5 species and spiked in 1 species. A dichotomous key for the species were constructed. These resulting data showed unifying and distinguishing diagnostic characters that are good taxonomic markers for the identification and classification of flowering plants, especially in dealing with sterile plant specimens.

Keywords: Leaf Architectural, Angiosperms, Mohnyin Township, Kachin State.

Introduction

The Kachin State in Myanmar is famous for its invaluable natural resources and its rich biodiversity. Kachin State has four districts namely Myitkyina districts in the centre, Putao districts in the north, Bamaw districts in the south and Mohnyin districts in the west.

Mohnyin township is bounded by Moegaung township in the east, Homalin township in the west, Indaw township in the south and Phakant township in the north. This area lies between 24° 46' North Latitudes and 96° 22' East Longitude. The total area is 2578, 46 square miles. The elevation of Mohnyin is 333.33 meter above sea level. Indawgyi lake is one of the famous place in Mohnyin township. It has 16 miles in length and 7 miles in width. Indawgyi pagoda festival is annually held in March.

Leaf architecture was first used and described by Hickey (1973) to represent the placement and form of those elements constituting the outward expression of leaf structure, including venation pattern, marginal configuration, leaf shape and gland position (Jessica and Buof 2014).

This is aimed to study and record the leaf architecture of 6 species of Angiosperms from Mohnyin Township, Kachin state. The main objectives are to describe the leaf architecture of Angiosperms, to provide the usefulness of leaf architectural characters distinguishable in various species of Angiosperms from each other and then these valuable leaf architectural data to

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practically use in plant taxonomy and systematics, mostly especially in dealing with sterile plant specimens.

Materials and Methods

Angiosperms leaves of 6 different species belonging to 6 genera and 6 families were collected from Mohnyin Township, Kachin State. Ten mature leaf samples of each species were randomly taken from different branches of the identified plants. Plant collection was carried out during June 2022 to December 2023. Taxonomic identification of the collected specimens were determined by referring to Backer & Brink (1964-1968), Brandis (1971), Dassanayake (1980-2001), and Qi-ming & De-lin (2007-2009). All of the nomenclatural studies were checked in the websites of International Plant Names Index (IPNI) and online Botanical Database of Tropical Plants (TROPICOS). Myanmar names of collected species were referred to Hundley and Chit Ko Ko (1987) and Kress *et al.* (2003).

Fresh leaves of each species were examined under a stereomicroscope. Photographs were taking by using electric light box and stereomicroscope. For the measurement, a ruler was used in width, length and etc. while a protractor measuring angle of divergence. The laminar size class (Blade class) was measured and classified base on the result of laminar size followed by Ellis *et al.* (2009). Then the leaf architecture of these studied species were described by using the established leaf architecture characters and terminologies defined by Hickey (1973) and that of the leaf Architecture Working Group (1999). The terms massive, stout and moderate used for describing the size of the primary vein are based upon the formula suggested by Dilcher (1974).

The studied species were systematically arranged into families according to Angiosperm Phylogeny Group (APG IV) system of Byny *et.al* (2016). The arrangement of genera and species under the families were placed alphabetically. The collected leaf samples were pressed and sun dried. Then the dried leaf specimens were mounted on a herbarium sheet together with label of field data.

Results

The collected specimens 6 species belong to 6 genera 6 families were presented.

Table 1. List of the collected species from Mohnyin Township, Kachin State

Family		Species	Myanmar name
1. Fabaceae	1.	<i>Phyllodium vestitum</i> Benth.	Taw pe
2. Combretaceae	2.	<i>Getonia floribunda</i> Roxb.	Bu nwe
3. Anacardiaceae	3.	<i>Rhus semialata</i> Murr.	Chying ma
4. Polygonaceae	4.	<i>Antigonon leptopus</i> Hook&Arn	Taik- pan
5. Loganiaceae	5.	<i>Strychnos nux-blanda</i> A.W.Hill,	Khabaung gyi
6. Lamiaceae	6.	<i>Callicarpa tomentosa</i> (L.) L.	Kyun nalin

1. *Phyllodium vestitum* Benth. F.A.W.Miquel, Pl. Jungh: 217 1852. (Figure 1)

Leaflet attachment petiolulate, compound leaf arrangement alternate, leaf organization odd-pinnately compound. Blade attachment marginal. Laminar size mesophyll, 100-156 mm long and 48-77 mm wide. Laminar L:W ratio 1.8:1, leaf area 6435.56 mm². Laminar shape oblong-

lanceolate with medial symmetry and basal symmetry. Margin unlobed, sinuous with acute apex angle and acuminate apex-shape, obtuse base angle and rounded base shape, terminal apex features mucronate. Leaf texture coriaceous. Surface texture rugose. Gland absent. Petioles features canaliculate, 1.0-3.0 cm long, petiolule base pulvinulate, 1.4-2.3 cm long. Primary vein (1°) venation palmate basal actinodromous with five basal vein and compound agrophic veins, naked basal veins absent; primary vein (1°) size moderate; primary vein (1°) course slightly curved. Major secondary vein (2°) hemieucamptodromous with regular spacing; secondary vein (2°) uniform angle and decurrent attachment to midvein; secondary vein (2°) size moderate; secondary vein (2°) course abruptly upward curved; number of secondary vein along one side of 1°vein 7-10; angle between 1° and 2° vein 40°-50°; narrowly acute. Minor secondary vein (2°) simple brochidodromous. Intersecondary veins absent. Intercostal tertiary vein (3°) fabric mixed opposite and alternate percurrent, tertiary vein course sinuous; angle to primary vein obtuse; increasing exmedially angle variability. Quaternary vein (4°) fabric irregular reticulate. Quinternary vein (5°) fabric irregular reticulate. Areoles moderately developed, variable size and shape. Freely ending veinlets dichotomous branched. Marginal ultimate venation looped.

2. *Getonia floribunda* Roxb. Pl. Coromandel 1:61.1795. (Figure 2)

Leaf attachment petiolate, leaf arrangement opposite, leaf organization simple. Blade attachment marginal. Laminar size mesophyll, 136-224 mm long and 77-134 mm wide. Lamina L: W ratio 1.7 :1, leaf area 13192.2 mm². Laminar shape broadly ovate with medial symmetry and basal symmetry. Margin unlobed, entire with obtuse apex angle and acuminate apex shape, obtuse base angle and rounded base shape. Leaf texture coriaceous. Surface textures pubescent. Gland absent. Petiole features canaliculate, 0.7-1.5 cm long. Primary vein (1°) venation pinnate with one basal vein; primary vein (1°) size stout, primary vein (1°) course sinuous. Naked basal veins and agrophic veins absent. Secondary vein (2°) eucamptodromous becoming brochidodromous distally with irregular spacing; secondary vein (2°) abruptly increasing proximally angle and excurrent attachment to midvein; secondary vein (2°) size weak; secondary vein (2°) course abruptly upward curved; number of secondary vein along one side of 1°vein 7-11; angle between 1° and 2° vein 40°-60°; moderately acute. Intersecondary veins present, parallel to major secondary proximal course. Intercostal tertiary vein (3°) fabric irregular reticulate anastomose; tertiary vein course sinuous, angle to primary vein acute, angle variability inconsistent. Quaternary vein (4°) fabric irregular reticulate. Quinternary vein (5°) fabric irregular reticulate. Areoles poorly developed, random, irregular size and shape. Freely ending veinlets linear, dendritic branched. Marginal ultimate venation looped.

3. *Rhus semialata* Murr. Comm. Soc. Regiae Sci. Gott.6: 27. 1784. (Figure 3)

Leaflets attachment sessile, compound leaf arrangement opposite, leaf organization odd-pinnately compound. Blade attachment marginal. Laminar size notophyll, 66-110 mm long and 45-69 mm wide. Laminar L:W ratio 1.6:1, leaf area 3818.79 mm². Laminar shape ovate-lanceolate with medial symmetry and basal symmetry. Margin unlobed, dentate with acute apex angle and acuminate apex shape, obtuse base angle and rounded base shape. Leaf texture coriaceous. Surface texture pubescent. Gland absent. Petioles features pulvinae, 10.5-15.6 cm long. Primary vein (1°) venation pinnate with one basal vein, primary vein (1°) size stout, primary vein course straight. Naked basal veins and agrophic veins absent. Secondary vein (2°) cladodromous with regular spacing, secondary vein (2°) smoothly increasing proximally angle and deflected attachment to midvein; secondary vein (2°) size moderate, Secondary vein (2°)

course uniformly curved; number of secondary vein along one side of 1° vein 9-16; angle between 1° and 2° vein 50°-60°; moderately acute. Intersecondary veins present, distal course. Intercostal tertiary vein (3°) fabric transverse freely ramified, angle variability inconsistent. Quaternary vein (4°) fabric freely ramifying. Quinary vein (5°) fabric freely ramifying. Areoles lacking. Freely ending veinlets dendritic. Marginal ultimate venation spiked.

4. *Antigonon leptopus* Hook & Arn. Bot. Beech. Voy 208.69. 1841. (Figure 4)

Leaflet attachment petiolulate, leaf arrangement alternate, leaf organization simple. Blade attachment marginal. Laminar size notophyll, 76-99 mm long and 55-80 mm wide. Laminar L:W ratio 1.2:1, leaf area 4492.98 mm². Laminar shape ovate with medial symmetry and basal symmetry. Margin unlobed, erose with acute apex angle and acuminate apex-shape, reflex base angle and cordate base shape, terminal apex features mucronate. Leaf texture membranous. Surface texture pubescent. Gland absent. Petioles features canaliculate, 1.0-1.7 cm long. Primary vein (1°) venation pinnate with one basal vein; primary vein (1°) size stout; primary vein (1°) course straight. Naked basal veins and agrophic veins absent. Secondary vein (2°) festooned brochidodromous with decreasing proximally spacing; abruptly increasing proximally angle and excurrent attachment to midvein; secondary vein (2°) size stout; secondary vein (2°) course abruptly upward curved; number of secondary vein along one side of 1° vein 8-10; angle between 1° and 2° vein 60°-65°; moderately acute. Intersecondary veins present. Intercostal tertiary vein (3°) fabric irregular reticulate anastomose. Quaternary vein (4°) fabric irregular reticulate. Quinary vein (5°) fabric irregular reticulate. Areoles poorly developed, random, irregular size and shape. Freely ending veinlets dendritic branched. Marginal ultimate venation looped.

5. *Strychnos nux-blanda* A.W.Hill, Bull. Misc. Inform. Kew 1917.189.1917. (Figure 5)

Leaf attachment petiolate, leaf arrangement opposite, leaf organization simple. Blade attachment marginal. Laminar size mesophyll 112-211 mm long and 60-127 mm wide. Laminar L:W ratio 1.6:1; leaf area 13794.37 mm². Laminar shape ovate with medial symmetry and basal symmetry. Margin unlobed, entire with acute apex angle and acuminate apex shape, obtuse base angle and rounded base shape. Leaf texture coriaceous. Surface texture rugose. Gland absent. Petioles features canaliculate at the adaxial sides. Primary vein (1°) venation palmate; imperfect basal acrodromous with 5 basal veins. Primary vein (1°) size moderate; primary vein (1°) course markedly curved. Naked basal veins and agrophic veins absent. Secondary vein (2°) brochidodromous with irregular spacing and excurrent attachment to midvein; interior secondary veins present; major secondary vein (2°) size weak; secondary vein (2°) course sinuous; number of secondary vein along one side of 1° vein 4-11; angle between 1° and 2° vein 50°-70°; moderately acute. Minor secondary vein (2°) course simple brochidodromous. Intersecondary veins absent. Intercostal tertiary vein (3°) fabric composite admedial reticulate; tertiary vein course sinuous, angle variability inconsistent. Quaternary vein (4°) fabric irregular reticulate. Quinary vein (5°) fabric freely ramifying. Areoles poorly developed, random, irregular size and shape. Freely ending veinlets dendritic. Marginal ultimate venation looped.

6. *Callicarpa tomentosa* L. J.A.Murr. Syst. Veg. ed. 13: 153. 1774. (Figure 6)

Leaf attachment petiolate, leaf arrangement opposite, leaf organization simple. Blade attachment marginal; laminar size macrophyll, 214-360 mm long and 103-165 mm wide. Laminar L:W ratio 2.2:1; leaf area 31478.50 mm². Laminar shape ovate with medial symmetry and basal symmetry. Margin unlobed, undulate with acute apex angle and acuminate apex shape, obtuse base angle and cuneate base shape. Leaf texture coriaceous. Surface texture rugose. Gland absent. Petioles features canaliculate, 3.8-5.8 cm long. Primary vein (1°) venation pinnate with one basal vein; primary vein (1°) size stout; primary vein (1°) course straight. Naked basal veins and agrophic veins absent. Secondary vein (2°) eucamptodromous becoming brochidodromous distally with decreasing proximally spacing; uniform angle and excurrent attachment to midvein; secondary vein (2°) size moderate; secondary vein (2°) course abruptly upward curved; number of secondary vein along one side of 1° vein 10-16; angle between 1° and 2° vein 60°-70°; wide acute. Intersecondary veins absent. Intercostal tertiary vein (3°) fabric opposite percurrent, tertiary vein (3°) course straight, angle to primary vein obtuse; angle variability increasing proximally. Quaternary vein (4°) fabric mixed percurrent. Quinary vein (5°) fabric irregular polygonal reticulate. Areoles paxillate developed, distinct oriented fields. Freely ending veinlets linear, dendritic branched. Marginal ultimate venation looped.



Figure 1. Laminar and leaf venation patterns of *Phyllodium vestitum* Benth.

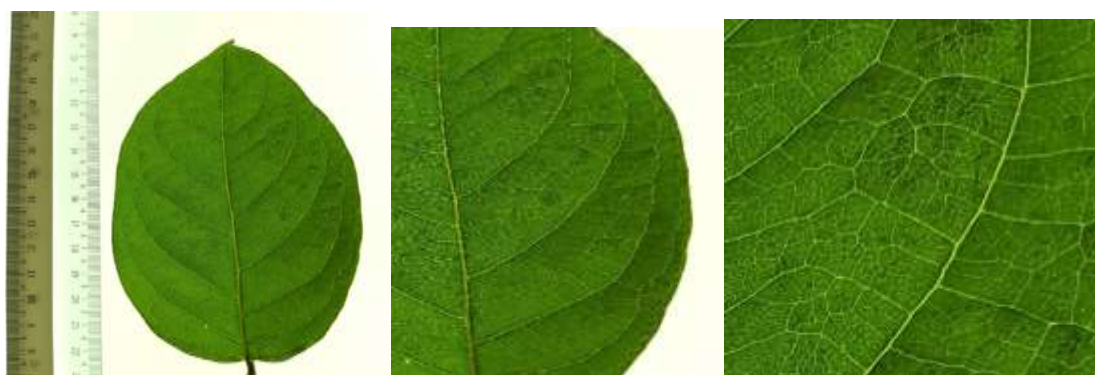


Figure 2. Laminar and leaf venation patterns of *Getonia floribunda* Roxb.



Figure 3. Laminar and leaf venation patterns of *Rhus semialata* Murr.



Figure 4. Laminar and leaf venation patterns of *Antigonon leptopus* Hook&Arn.



Figure 5. Laminar and leaf venation patterns of *Strychnos nux-blanda* A.W.Hill,



Figure 6. Laminar and leaf venation patterns of *Callicarpa tomentosa* (L.) L.

An Artificial Key to the Studied Species

1. Leaf organization compound-----2
1. Leaf organization simple -----4
 2. Laminar size class notophyll -----3. *Rhus semialata*
 2. Laminar size class macrophyll-----3
3. Primary venation palmate; primary vein size moderate; 2° vein hemieucamptodromous becoming brchdodromous-----1. *Phyllodium vestitum*
3. Primary venation pinnate; primary vein size stout; 2° vein eucamptodromous becoming brchdodromous distally ----- 6. *Callicarpa tomentosa*

4. Leaf margin erose; leaf texture membranous -----

----- 4. *Antigonon leptopus*

4. Leaf margin entire; leaf texture coriaceous -----

----- 2. *Getonia floribunda*

5. Leaf arrangement opposite; 2° vein brochidodromous with irregular spacing -----

----- 5. *Strychnos nux-blanda*
5. Leaf arrangement alternate; 2° vein craspedodromous with irregular spacing -----

Discussion and Conclusion

The present research work deals with the leaf architectural characteristics of Angiosperms found in Mohnyin Township, Kachin State. A total of 6 species belonging to 6 genera of 6 families were collected, examined, measured and characterized based on the leaf architectural characters. The leaf architectural characters of each species were described based on the terminologies of leaf Architecture Working Group (LAWG 1999). The characters described were leaf attachment, leaf arrangement, leaf organization, leaf texture, petiole features, laminar area, laminar size class, laminar shape and symmetry, laminar ratio, base and apex angle, base and apex shape, position of petiolar attachment, margin type, lobation and vein orders.

In this study, collected species were varying characteristics of blade shape, base, apex, margin and texture. The venation patterns are also variable from species to species. Most of the studied species possess compound leaves and simple leaves. Symmetrical leaf base and petiole base pulvinate was the characteristics of *Phyllodium vestitum* Benth. The shape of leaf blade was also key characters in determining the species of flowering plant. In this research, two different lamina shape were observed and recorded. The apex shape was acuminate in all species. The base shape of the leaves were convex in *Phyllodium vestitum* Benth, cordate in *Antigonon leptopus* Hook&Arn, rounded in *Getonia floribunda* (Lam.) Roxb. and *Rhus semialata* Murr.; concave in *Strychnos nux-blanda* A.W.Hill.; cuneate in *Callicarpa tomentosa* (L.). These findings were in accordance with Backer (1964-1968), Hooker (1875-1879), Dassanayake (1980-2001) and Qi min & De-lin (2007-2009).

In the present study, most of the leaf margin were entire in 2 species; sinuous in *Phyllodium vestitum* Benth., dentate in *Rhus semialata* Murr; undulate in *Callicarpa tomentosa* (L.) L., and erose in *Antigonon leptopus* Hook&Arn. The texture of leaves were membranous in *Antigonon leptopus* Hook&Arn and coriaceous in 5 species. These findings were in agreement with Hooker (1875-1879) and Dassanayake (1980-2001).

Elis *et al.* (2009) stated that the laminar size was determined by measuring the area of the leaf. The laminar size classes were leptophyll, nanophyll, microphyll, notophyll, mesophyll, macrophyll, and megaphyll. In the present study, laminar size classes of leaf samples examined for 6 species were notophyll in 2 species, mesophyll in 3 species and macrophyll in only one.

According to Elis *et al.* (2009), the leaf venation were classified into two fundamental types namely pinnate and palmate. In this study, most of the leaves samples were pinnate venation pattern except in *Phyllodium vestitum* Benth., and *Strychnos nux-blanda* A.W.Hill.. The primary vein size was moderate in 2 species and stout in 4 species.

In the present study, major secondary vein were hemieucamptodromous in 1 species, cladodromous in 1 species, festooned semicraspedodromous in 1 species, brochidodromous in 1 species, and eucamptodromous becoming brochidodromous in 2 species. These finding were in agreement with the statements presented by Elis *et al.* (2009) and Hickey (1973).

Most of the leaves are regular secondary vein spacing in *Phyllodium vestitum* Benth.,; irregular secondary vein spacing in 3 species and decreasing proximally spacing in *Antigonon leptopus* Hook & Arn and *Callicarpa tomentosa* (L.) L. Hickey (1973) stated that angle of 2° vein divergence were narrowly acute (< 45°), moderately acute (45°-65°), wide acute (65°-80°), right angle (80-100°) and obtuse (>100°). In the present investigation, moderately acute occurred

in 4 species; narrowly acute angle observed in *Phyllodium vestitum* Benth. and wide acute in *Callicarpa tomentosa* (L.).

The tertiary vein category in the studied species have been found to be irregular reticulate anastomose in 2 species transverse freely ramified in *Rhus semialata* Murr.; mixed alternate and opposite percurrent in *Phyllodium vestitum* Benth. composite admedial reticulate in *Strychnos nux-blanda* A.W.Hill. and opposite percurrent in *Callicarpa tomentosa* (L.) species. These finding were in agreement with the statements reported by Elis *et al.* (2009) and Hickey (1973). During the present study, quaternary vein and quinary vein categories were freely ramifying, irregular reticulate and mixed percurrent. Areoles are the smallest areas of leaf tissues surrounded by veins. Paxillate developed areolation was observed in 1 species; poorly developed areolation was observed in 3 species and moderately developed areolation was found in 1 species and lacking in 1 species. Hickey (1973) reported that the veinlets into none, simple or branch. In the present study, simple or branched veinlets were observed. Hickey (1973) classified the marginal ultimate venation into looped, fimbriate and incomplete patterns. In the present investigation marginal ultimate venation exhibit great uniformity in majority of the plants. Looped marginal venation occurs in 5 species and spiked in *Rhus semialata* Murr.

Based on the resulting data, it was proved that the leaf architecture characters are good taxonomic markers in plant identification and classification. Moreover, leaf architecture has been an important topic in taxonomy, especially encountering flowering periodization, and leaves as identification tools in the flowering plants were bound to be very useful in the future.

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