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Simplifying complexity: using leaves rather than flowers to identify *Xylopia* species in Liberia

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Abstract

Five species of Xylopia Linn. were appropriated and examined in the study. Botany and dendrology lecturers at the Department of Forestry, University of Liberia, generally experienced difficulties in delimiting Xylopia species because their floral characteristics are similar and arduous to delineate. Ten leaves of each species were borrowed from ArcelorMittal Iron Ore Mining Company (AML) mini-herbarium. Lamina physical characters were examined using one-foot graduated ruler, hand lens of 10X and 20X magnification, and canon camera (EOS 1100). Results showed that laminar size, auxiliary veins and third vein angle inconsistency proved most useful. The study was important in that it provided appreciable understanding of selected Xylopia species for teachers, students and most local users. Hence! The use of leaf architecture as identification tool for plants continues to gain further eminence.

Keywords: Identification, Leaf Architecture, Country Spice, Taxonomy, Liberia.

Introduction

Global attention in plant identification was once weighted on the use of floral parts[1]. Following Linnaeus era, scientists have derived many approaches to identifying plants[2-9]. Some plants are quite similar in their floral structures; some multifaceted, and others hardly flower; thus require advanced methods in delineating them. Others can be distinguished from using manuals.

The genus Xylopia Linn. belongs to the family Annonaceae, and is widely distributed in parts of West Africa[10]. To date, there are about 14 Xylopia species identified in western African Forests; of which five of the eight widely distributed in Liberia were studied[11]. Because the floral characteristics of these species are similar and arduous to delineate, botany and dendrology lecturers at the Department of Forestry, the University of Liberia generally experienced difficulties in delimiting Xylopia species. Another reason was owed to the fact that majority of rafters used for construction purposes in local communities are from the genus Xylopia for which locals needed to know the differences beyond their usual "male and female distinctions", as they are referred to. Besides, their fruits are important forest products sold on the Liberian and neighboring countries' markets; something that required proper identification particularly on the Liberian market. For instance, the dried fruits are called "country spice" in Liberia, and referred to as "Malian pepper" when under export to neighboring countries. The need to use alternative means by which teachers and students in separate case, and locals on the other hand could easily understand and identify delimitations in these plants became apparent. This study, owing to their identification complexities, employed the use of leaf characters especially venation following Hickey's manual; a simplified technique for identifying key differences in plants[12]. It is interesting to note that leaf architectural approach continues to provide formidable information especially in the case where the usual flora parts are lacking to formulate existing differences between plant species[13-24]. Hence! Ten Philippine *Psychotria* species of the Rubiaceae family were separated using leaf venation as distinguishing characters[25]. In their book, Yu and Chen used leaf morphology to describe 720 species found in South and Southeast Asia[26]. In early October 2014, Kpadehyea and Buot Jr. distinguished two species and nine infra-specific taxa of Philippine *Mussaenda* (Rubiacae) using leaf characters in agreement with Hickey's[27]. This study was important in that it provided clarity and significant understanding of selected *Xylopia* species using leaf characters only for the first time in Liberia.

Material and methods

Ten leaves for each selected specimens appropriated for this study were borrowed from the Arcelor Mittal Iron Ore Mining Company (AML), and brought in the old boardroom of the Forestry Development Authority (FDA) near Monrovia for establishing their leaf character differences. The study focused on two aspects. The first described leaf characters such as blade (class, size, shape, symmetry); base (angle, and shape); and apex shape. The second considered architectural characters of secondary vein (category, spacing, angle and inter-secondary vein); tertiary vein (category, course, angle, and angle variability); quaternary vein category; 5˚ vein category; areolation; and freely ending ultimate veins of leaf (F.E.V.S.). Length and width of each lamina was measured using graduated one foot ruler. The measurements were in line with the Hickey's guideline for measuring leaf size enshrined in the Manual of Leaf Architecture Working Group (length X width in millimeters X 2/3) to determine leaf precise size. Besides, chosen specimens were examined using hand lens of magnification 10X, and 20X to understand venation pattern and orientation that provided both similarities and dissimilarities between and among *Xylopia* species studied. Photographs of magnified leaf parts were taken using canon camera (EOS 1100D), and hand lens of 20X magnification. The specimens were placed on transparent glass (4 X 6 inches) on top of touch-light (China made) of two batteries set alight. A hand lens was placed on top of each specimen and focused with a canon camera to photograph the specimens exemplified in this study (please see photos of partial specimens).

A key was drawn as a result of the obvious discontinuities identified, which formed clear differences among *Xylopia* species studied; thus providing further evidence of the important use of leaf architecture in the field of global plant taxonomy.

Results and discussion

In general, the five species of the genus Xylopia Linn. had simple, entire, and symmetrical leaf. They were studied using 10 leaves of each selected Xylopia species. The most interesting characters scored were the blade-size, followed by the 2˚vein category, and 3˚vein angle variability. Please see Tables-1 and 2 respectively.

Except for *Xylopia aethiopica* which blade class was identified class was identified to occur under mesophyll (area of leaf in 4,500 – 18,225 mm²), the rest were identified to occur under notophyll (area of leaf 2,025 – 4,500mm²). The category of blade shape identified in the study were elliptic (*Xylopia acutiflora, X. aethiopica, and X. staudtii*), oblong (*X. villosa*) and obovate (*X. quintasii*). All five species have symmetrical blade with acuminate apex shape. In respect to blade angle, only X. villosa had acute to obtuse, and all other four maintained acute angle. X. quintasii was the only species with complex base-shape, while the rest carried cuneate shape. The most outstanding distinction under leaf characters was seen in blade-size. All five lamina size varied.

Table-1: Characters of five (5) Xylopia species leaf blades.

Taxa	Blade class	Blade size	Blade shape	Blade symmetry	Base angle	Base shape	Apex shape
Xylopia acutiflora	Notophyll	1612 - 3761 mm	Elliptic	Symmetrical	Acute	Cuneate	Acuminate
Xylopia aethiopica	Mesophyll	4620 – 7398 mm	Elliptic	Symmetrical	Acute	Cuneate	Acuminate
Xylopia quintasii	Notophyll	2772 – 5831 mm	Obovate	Symmetrical	Acute	Complex	Acuminate
Xylopia staudtii	Notophyll	2112 – 4544 mm	Elliptic	Symmetrical	Acute	Cuneate	Acuminate
Xylopia villosa	Notophyll	1630 – 9384 mm	Oblong	Symmetrical	Acute to Obtuse	Cuneate	Acuminate

Table 2a: Architectural characters of five Xylopia species.

Taxa	2° vein category	Auxiliary vein spacing	Auxiliary vein angle	Inter - auxiliary vein	Third vein group	Third vein course	Third vein angle
Xylopia acutiflora	Weak brochidodro-mous	Narrowing in direction of base	Smoothly decreasing toward base	Weak inter-auxiliaries	Not aligned from base to apex	Straight	Between 90˚and 180˚
Xylopia aethiopica	Brochido-dromous	Irregular	Abruptly decreasing toward base	Strong inter-auxiliaries	Not aligned from base to apex	Exmedial-ly ramified	Between 90˚and 180˚
Xylopia quintasii	Intramargin-alvein	Expanding in the direction of base	Easily narrowing in direction of base	Feeble inter-auxiliary	Usual many-sided networks	Twisting	Forming right angles
Xylopia staudtii	Intramargin-alvein	Narrowing in direction of base	A pair of bottom sharp auxiliaries	Strong inter auxiliaries	Not aligned from base to apex	Twisting	Between 90˚and 180˚
Xylopia villosa	Festooned brochidodro-mous	Irregular	Easily narrowing in direction of base	Strong inter auxiliaries	Usual many-sided networks	Exmedial-ly ramified	Between 90˚and 180˚

Table-2b: Architectural characters of five Xylopia species.

Taxa	Third vein angle unevenness	Fourth vein group	Fifth vein group	Spots between veins	Freely Ending Veins (F.E.V.S)
Xylopia acutiflora	Increasing exmedially	Regular polygonal reticulate	Usual many-sided networks	Moderately improved	Deficient
Xylopia aethiopica	Varied	Not aligned from base to apex	Usual many-sided networks	Pixilate; five or more sided	Deficient
Xylopia quintasii	Uniform	Dichotomizing	Absent	Pixilate; five or more sided	Deficient
Xylopia staudtii	Inconsistent	Usual many-sided networks	Dichotomizing	Moderately improved	Branched
Xylopia villosa	Increasing basally	Not aligned from base to apex	Regular polygonal reticulate	Fully developed	Deficient

Architectural characters showed 2˚vein category in X. quintasii and X. staudtii as intramarginal, and interestingly in X. acutiflora, X. aethiopica, and X. villosa as weak brochidodromous, brochidodromous, and festooned brochidodromous respectively. The respective 2˚vein spacing was irregular for X. aethiopica, and X. villosa; decreasing toward base for X. acutiflora, and X. staudtii; and increasing toward base for X. quintasii. Three species (X. acutiflora, X. quintasii, and X. villosa) had their 2˚vein angle smoothly decreasing toward base; while X. aethiopica had abruptly decreasing toward base and X. staudtii had one pair acute basal secondaries. Both X. quinatsii and X. villosa had irregular polygon reticulate for the 3˚vein category; and the rest had alternate percurrent. Except for X. acutiflora that had its 3˚vein course straight, X. aethiopica, and X. villosa had exmedially ramified, and X. quintasii and X. staudtii had sinuous. Notably, X. quintasii had perpendicular 3˚vein angle, and the others with obtuse angle. Their vein angle variability proved inconsistent for X. aethiopica and X. staudtii; uniform for X. quintasii, increasing basally for X. villosa, and increasing exmedially for X. acutiflora. Architectural characters in the 4˚vein category showed X. acutiflora and X. staudtii orientation in regular polygon reticulate; alternate percurrent in X. aethiopica and X. villosa, and dichotomizing in X. staudtii. In X. quintasii, 5˚vein category was absent. However, the orientation in X. acutiflora, X. aethiopica, and X. villosa were regular polygonal reticulate. Only X. villosa had areolation well developed, followed by X. acutiflora and X. staudtii with areolation moderately developed; and pixillate for X. aethiopica, and X. quintasii. Finally, F.E.V.S for X. staudtii was branched; and absent in the rest.

Distinct leaf architectural characters for 5 Xylopia Linn.: ***Xylopia acutiflora*** (Dunal) A.Rich: Blade class notophyll, blade size 60 – 90 mm long, 18 – 28 mm wide, oval and even; base angle sharp, form cuneate, and highest point acuminate. Secondary veins category weak brochidodromous, spacing decreasing towardbase, and angle smoothly shrinking in the direction of base with feeble inter-auxiliaries.

Tertiary veingrouping alternate percurrent, layer course straight, angle obtuse, and variability increasing exmedially. Forth veingrouping forming net-wise polygon. Fifth veingroupingnet-wise polygon withmoderate and colorful area of freely ending veins (F.E.V.S) absent (Figure-1). Exsiccate: Patrick 4274 (AMLH)

Figure-1: Leaf blade of *Xylopiaacutiflora* (Dunal) A.Rich.

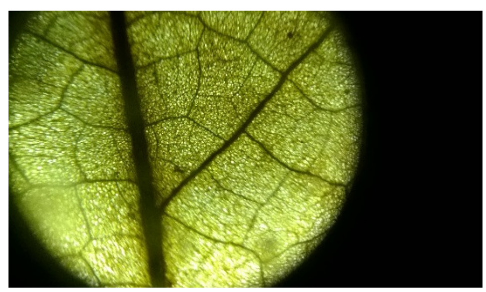

Figure-1a: Venation: 10X magnification.

Xylopia aethiopica (Dunal) A.Rich: Laminar class mesophyll; size 140 – 190mm long, 50 – 59 mm wide, elliptic and symmetrical; base angle acute, shape acute, and apex acuminate. Secondary vein category brochidodromous, spacing irregular, with angle abruptly decreasing toward base and strong inter-secondary veins.

Tertiary veins cartegory alternate percurrent, vein course exmedially ramified in obtuse angle, variability inconsistent. Quaternary veins category alternate percurrent, and fifth veingrouping net-wise reticulate. Colorful area distorted, and freely ending veins absent (Figure-2). Exsiccata: Patrick 1697 (AMLH)

Figure-2: Lamina of *Xylopiaaethiopica* (Dunal) A.Rich.

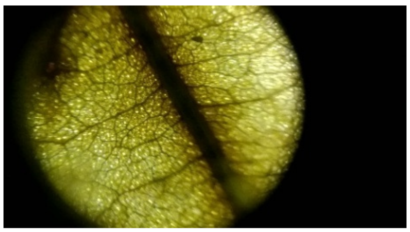

Figure-2a: Venation: 10X magnification.

Xylopia quintasii Pierre ex Engl. and Diels: Blade class notophyll; 105 – 135 mm long, and 37 – 57 mm wide; blade shape obovate and symmetrical. Base angle acutewith cuneate shape, and apex shape acuminate. Auxiliary veins occurring between margins with spacing expanding in the direction of the base, vein angle smoothly narrowing in the direction of the base, showing feeble inter-auxiliaries.

Tertiary vein grouping net-wise formation, vein course twisting, angle perpendicular, and vein angle variability uniform. Forth vein grouping dichotomizing; fifth and freely ending veins absent, and areolation pixilate with five or more sided (Figure-3). Exsiccata: Patrick 1708 (AMLH)

Figure-3: Lamina of *Xylopia quintasii* Pierre ex Engl.

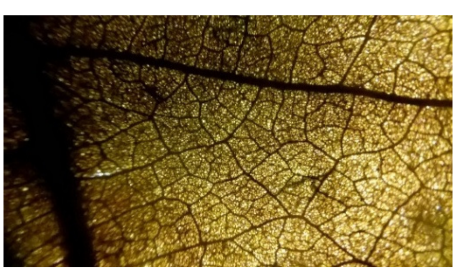

Figure-3a: Venation: 10X magnification.

Xylopia staudtii: Engl. and Diels: Leaf blade class notophyll; 100 – 135 mm long, 32 – 51 mm wide, shape elliptic and symmetrical. Laminar base angle acute and cuneate in shape with apex acuminate. Auxiliary veins between margins, spacing narrowing in the direction of the base, angle one pair sharp basal ancillary, with strong inter-secondary veins.

Tertiary veins category alternate percurrent, course sinuous angled obtuse, and variability inconsistent. Quaternary veins category regular polygon reticulate; fifth veins dichotomizing; areolation moderately developed and F.E.V.S branched (Figure-4). Exsiccate: Patrick 5128 (AMLH)

Figure-4: Leaf blade of *Xylopia staudtii* Engl. and Diels

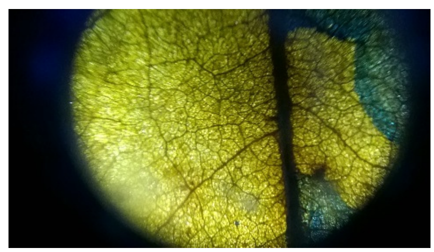

Figure-4a: Venation: 10X magnification

Xylopiavillosa**Chipp**: Laminar class notophyll; 80 – 163 mm long, 26 – 43 mm wide, blade shape oblong and symmetrical. Base angle acute to obtuse, shape cuneate, and apex acuminate.

Secondary veins category festooned brochidodromous, spacing irregular, and angle smoothly decreasing toward base with strong intersecondaries.

Tertiary veins category regular polygon reticulate, vein course exmedially ramified, angle obtuse and variability increasing basally. Quaternary vein category alternate percurrent; fifth veins regular polygon reticulate, areolation well developed, but no F.E.V.S (Figure-5). Exsiccate: Patrick 3572 (AMLH).

Dichotomous key to five *Xylopia* species
1a. Blade size 1612 – 3761 mm …………………………2
2a. Secodary veins weak brochidodromous, decreasing toward base……………….*Xylopia acutiflora*
2a. Secondary veins brochidodromous and spacing irregular…………………….…*Xylopia aethiopica*

1b. Blade size 2772 – 5831 mm………………………..3
3a. Blade shape obovate, and base shape complex……………………………..*Xylopia quintasii*
3b. Blade shape elliptic………………………..4
4a. Secondary vein angle one pair acute basal secondaries…………….*Xylopia staudtii*
E 4b. Secondary vein angle smoothly decreasing toward base, with areolation well developed……………………………………*Xylopia villosa*

Figure-5: Leaf blade of *Xylopia villosa* Chipp**.**

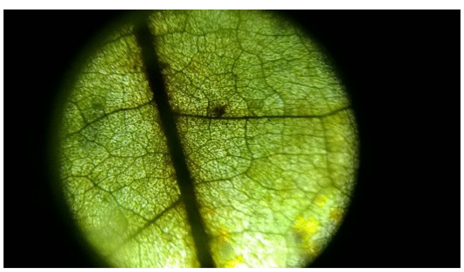

Figure-5a: Venation: 10X magnification

Conclusion

The establishment of differences between selected Xylopia species through this study further expounds how useful leaf architecture is in the field of modern plant taxonomy. Thus, the challenges imposed on the use of flowers as key identification medium are becoming narrower and narrower by the leaf architectural approach in providing accurate similarities and dissimilarities between plants. Leaf architecture is recognized as a major tool for solving complex floral identification problems in the taxonomic world. This study was useful for teachers, students and locals of Liberia.

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