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Comparative leaf architectural studies of some Vernonia SCHREB (Asteraceae) in Nigeria

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Abstract
Lamina symmetry, leaf shape, margin, texture, petiole, venation and areolation patterns were studied on five species of the genus Vernonia SCHREB (Asteraceae) in Nigeria in search of diagnostic and stable taxonomic characters. The diagnostic feature that clearly distinguished Vernonia galamensis apart from lanceolate leaf shape is the possession of craspedodiomous venation. Notable characters that are of taxonomic value such as wavy anticlinal wall with polygonal cell shape differentiated V. ambigua, while straight anticlinal wall with irregular cell shape was noted in V. amygdalina and V. cinerea. All the leaves are amphistomatic and have commonly paracytic types apart from rare to occasional occurrence of other stomatal types with abnormalities. A taxonomic key based on the characters of the leaves is presented.

Key words: Foliar ,epidermal, anatomy, Vernonia, Nigeria

INTRODUCTION

Asteraceae, alternatively compositae, is a one of the largest dicotyledonous families of flowering plants with about 1600 genera and over 25,000 species with cosmopolitan distribution worldwide (Walters et al. 1996) and is commonly called aster, sunflower, daisy or thistle family. The name compositae was derived from latin word compositus meaning “made up or united in one common whole (Herman 2000). The family is divided into three sub-families; the numerous genera are divided into about 13 tribes. Asteraceae show remarkable variation in growth, form and morphology because they occur in many different localities and habitats. They are annual, biennial or perennial herbs, dwarf shrubs, shrubs, a few tree, some are scramblers and aquatics. Some are succulent while others are spiny and have milky sap. Members of this family have almost all features generally occurring in plants. They have branched tap root system, herbaceous or woody, erect and branched stem with their leaves simple, alternate or opposite, exstipulate, petiolate, pubescent and reticulate in venation. Flowers are the features that distinguish this family from all other plant families. The inflorescence present could be head or capitulum, terminal or axillary. Florets are surrounded by involucre of bracts. Their flowers are bisexual, pentamerous, heterochlamydeous and epigenous. Economic importance of this family includes: food for man and animals, poisonous material and medicinal.

According to Burkill (1996) and Hamowia & Saffaf (1994) all parts of the plant Vernonia amydalina are pharmacologically useful, the roots and the leaves are used in ethnomedicine to treat fever, kidney problems and stomach discomfort. The active components of the plant have been shown to be mainly sesquiterpene lactones like vernodalin and vernoamygdaline and steroid glycosides like vernonioside B1 and vernoniol B1 (Kupcham et al. 1969). Despite the varied uses of members of this family, there has been insufficient information on their toxicological potentials on the animal system. Hence, this study will serve as the basis upon which further scientific researches would be based.

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MATERIALS AND METHODS

Plant specimens used were collected from Botanical Garden of University of Ibadan, University of Agriculture, Abeokuta premises and Old Oyo National Park, Sepeteri, Oyo State all in the Southwestern Nigeria. Identification of specimens was done at the University of Ibadan Herbarium (UIH) and Forestry Herbarium Ibadan (FHI). Voucher specimens deposited in the same herbaria.Ten different fresh leaf materials of each taxon were measured in situ using graduated meter rule.

Macro-character assessment on matured leaves were carried out at comparative position and this includes: leaf length, width at widest point, petiole length, leaf apex, base, margin, shape and derived ratios of length and width were also measured in situ. Micro-characters measured include: number and size of epidermal cells at the widest point, number of stomata, stomata length, width, index and type, order of venation, areolation pattern, shape of epidermal cells, trichome type and anticlinal wall pattern.

Leaf epidermal morphology of Vernonia species were studied using fresh leaves. Sizeable leaf portions of about 1cm were obtained from the midrib with a disposable knife. Epidermal preparation followed the procedure described by Hussin (2000) as modified by Aworinde et al. (2009).

Mature and well expanded fresh leaves were decolourised by soaking in parazone. The cleared leaves were then removed and

rinsed in 2-3 changes of water to remove the bleach solution from the specimens and later stored in 50% ethanol to avert dehydration. Cleared leaves stained faintly with safranin and rinsed thoroughly with water and mounted in 25% glycerol for microscopic examination. Illustrations were made with camera lucida fitted to M20 wild microscope. Further procedures followed Folorunso et al. (2009).

Epidermal cells and stomata were chosen at random from each taxon and measured with a calibrated microscope. For quantitative characters, the mean, standard deviation and standard error were determined, stomata index (SI) calculated using Salisbury (1972) procedure as modified by Hussin (2000).

$$SI = \frac{S}{S + E} \times 100$$

Where SI= stomata index
S= number of stomata per unit area
E= number of epidermal cells of the same area

RESULTS

Epidermal studies

Epidermal cells are more often found on both surfaces of all taxa except *V. ambigua* with few polygonal cells. Straight anticlinal wall patterns were found on irregular cell of *V. amygdalina* and *V. cinerea*. Straight to curved wall characterized the irregular cell of *V. galamensis* and *V. tenoreana.* Wavy walls were found on polygonal cells of *V. ambigua*. Epidermal cells are moderately thick ranging from 10µm in *V. tenoreana* and 20µm in *V. ambigua* on the abaxial and ranges from 10µm in *V. tenoreana* and 20 µm in *V. amygdalina* on the adaxial surface. The number of cells on both surfaces is moderate with lowest of 10µm in *V. tenoreana* and highest of 30µm in *V. ambigua* on the adaxial surface.

Stomata

All the leaves were amphistomatic having stomata on both abaxial and adaxial surfaces. Paracytic stomata type was found prominent in all the species. Stomata density ranges from 6 in *V. tenoreana* to 15 in *V. galamensis* on the abaxial and 3 in *V. tenoreana* to 6 in *V. galamensis* on the adaxial surface. The mean stomata width varied from 20mm in *V. galamensis* to 30mm in *V. cinerea* on the abaxial and 10mm in *V. galamensis* to 20mm in *V. ambigua* on the adaxial while mean length varied from 6.6mm in *V. amygdalina* to 5mm in *V. ambigua* on the abaxial and 7mm in *V. tenoreana* to 5.4mm in *V. ambigua* on the adaxial surface. Stomata index varied from 33% in *V. ambigua* to 10% in *V. galamensis* on the abaxial and 55% in *V. ambigua* to 9% in *V. galamensis* on adaxial surface (Table 1).

Table 1: Abaxial and adaxial epidermal characters of the taxa.

Taxa	Character						
	1	2	3	4	5	6	7
Vernonia ambigua	-	+	-	+	-	+	+
V. amygdalina	+	-	+	-	-	+	+
V. cinerea	+	-	+	-	-	+	+
V. galamensis	+	-	-	-	+	+	+
V. tenoreana	+	-	-	-	+	+	+

Legend to character codes: 1= Irregular cell shape, 2= Polygonal cell shape, 3= Straight anticlinal wall, 4= Curved anticlinal wall, 5= Straight to curved anticlinal wall, 6= Paracytic stomata, 7= Trichomes, + denotes presence, - denotes absence

Trichomes

Generally, the presence of numerous trichomes on both surfaces of *V. ambigua* distinguished it from other species of the genus but trichomes are more prominent on the abaxial surface than the adaxial surface. Veins and veinlets on the abaxial surface of all the species are more pronounced than those on the adaxial surface which is useful in architectural feature diagnosis.

Petiole

Observation of the petiole anatomy of *Vernonia* species revealed different shapes and structures internally. Crescently shaped walls were observed at proximal, median and distal regions in *V. cinerea* and *V. tenoreana*. Slightly raised with annular collenchyma cells, ribs vestigial at the middle and proximal regions are found in *V. galamensis*. Crescent shape, thin walled parenchyma cells were noted on the adaxial surface and annular collenchymas cells of about 5-6 ribs raised on the adaxial surface of *V. ambigua* and *V. amygdalina*.

Leaf architectural features

Vernonia amgdalina:

The lamina is symmetrical, leaf shape is ovate, apex is acuminate and base is acute. The margin is dentate, texture is pubescent, and petiole is long and round. Venation is simple (craspedodiomous), primary vein size is moderate, primary vein course is straight and branched, angle of divergence is acute while variation in angle is nearly uniform. Areolation is random with imperfect pentagonal shape. Veinlets are branched with one or more secondary ramification (Table 2).

V. ambigua: The lamina is symmetrical, leaf shape is ovate, apex is acuminate and base is acute. The margin is dentate, petiole is long, round and pubescent. Venation is simple (craspedodiomous), primary vein size is moderate, primary vein course is straight and branched, angle of divergence is acute while variation in angle of divergence is nearly uniform. Areolation is random with imperfect hexagonal shape. Veinlets are branched with one or more secondary ramification.

V. cinerea: The lamina is symmetrical with ovate leaf shape, apex is acuminate with acute base. The margin is sub-entire, texture slightly pubescent and petiole is short and winged. Venation is craspedodiomous, primary vein size is moderate, primary vein course is straight and branched, angle of divergence is acute while variation in angle of divergence is nearly uniform. Areolation is random with imperfect pentagonal shape. Veinlets are branched with one or more secondary ramification.

V. galamensis: The lamina is symmetrical with lanceolate leaf shape, apex is acuminate and base is acute. The margin is dentate, texture is pubescent and petiole is short and flat. Venation is semi-craspedodiomous, primary vein size is moderate, primary vein course is straight and branched, angle of divergence is acute while variation in angle of divergence is nearly uniform. Areolation is

random with imperfect pentagonal shape. Veinlets are branched with one or more secondary ramification.

V. tenoreana: The lamina is symmetrical with ovate leaf shape, apex acuminate and base acute. Dentate margin with glabrous texture and petiole is long and flat. Venation is craspedodiomous, primary vein size is moderate, primary vein course is straight and branched, angle of divergence is acute while variation in angle of divergence is nearly uniform. Areolation is random with well developed quadrangular shape. Veinlets are branched with one or more secondary ramification.

Table 2: Leaf architectural features of the taxa.

Character	Taxa				
	V. ambigua	**V. amygdalina**	**V. cinerea**	**V.galamensis**	**V. tenoreana**
Lamina symmetry	Symmetrical	Symmetrical	Symmetrical	Symmetrical	Symmetrical
Leaf shape	Ovate	Ovate	Ovate	Lanceolate	Ovate
Leaf apex	Acuminate	Acuminate	Acuminate	Acuminate	Acuminate
Leaf base	Acute	Acute	Acute	Acute	Acute
Margin	Dentate	Dentate	Sub-entire	Dentate	Dentate
Texture	Very pubescent	Slightly pubescent	Pubescent	Pubescent	Glabrous
Petiole	Long round	Long round	Short winged	Short flat	Long flat
Venation	Simple craspedodiomous	Simple craspedodiomous	Simple craspedodiomous	Semi craspedodiomous	Simple craspedodiomous
Primary vein size	Moderate	Moderate	Moderate	Moderate	Moderate
Primary vein course	Straight, branched	Straight, branched	Straight, branched	Straight, branched	Straight, branched
Angle of divergence	Acute	Acute	Acute	Acute	Acute
Variation in angle of divergence	Nearly uniform	Nearly uniform	Nearly uniform	Nearly uniform	Nearly uniform
Veinlets	Branched one or more times	Branched one or more times	Branched one or more times	Branched one or more times	Branched one or more times
Areolation	Randomly oriented	Randomly oriented	Randomly oriented	Randomly oriented	Randomly oriented
Areolation development	Imperfect	Imperfect	Imperfect	Imperfect	Well developed
Areolation Shape	Hexagonal	Pentagonal	Pentagonal	Pentagonal	Quandragular

DISCUSSION

The results of foliar epidermis and petiole anatomical features of *Vernonia* species revealed striking differences and similarities in their epidermal cell wall pattern, epidermal cell shape, stomata types, petiole anatomy and leaf architecture and have been used to distinguish one species from another for taxonomic decision. Morphologically, all the five species have some phenotypic uniformity except *V. galamensis* with lanceolate leaf shape and semi craspedodiomous venation and also the presence of numerous trichomes on abaxial surface of *V. ambigua*. There is little variability and diversity in their internal structures and most of these structures possessed might be as a result of environmental and ecological need. Vegetative features of *Vernonia* species are habitat dependent and this is in agreement with Robinson (1999) who reported that vegetative features and habits of *Vernonia* species are useful in the taxonomic similarities of the genus. Hickey (1972) reported that leaf architectural features can show evolutionary significance in dicotyledonous plants and can also be used to delimit species. Isawunmi (1989) used leaf epidermal characteristic to show some degree of variation in the leaves of the genus *Vernonia.*

Little is known about the taxonomy and anatomy of petiole distribution in this genus, superficial structural designs found on the petiole can be of descriptive and taxonomic value. Leaf architectural and epidermal characters are of taxonomic significance in the genus *Vernonia*. Each taxon showed marked consistency for the anatomical characters examined in leaf epidermal cells, stomata, trichomes and transverse section of petiole which is sufficient enough to delimit them from one another.

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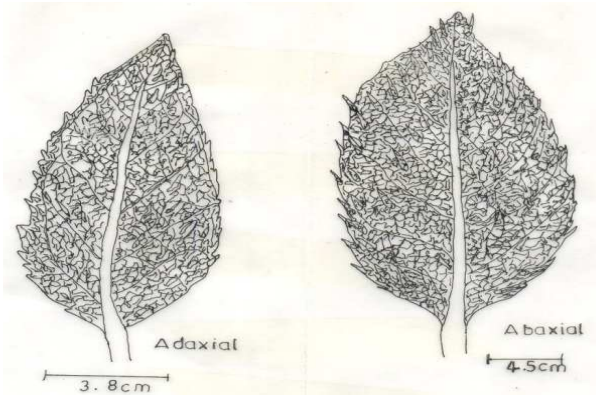

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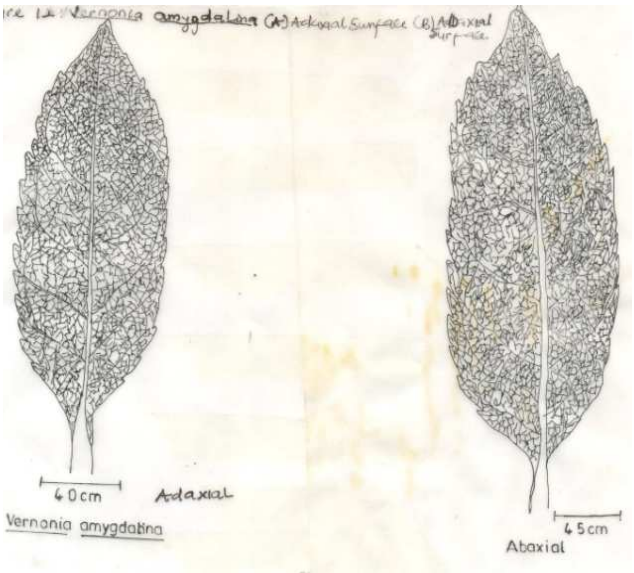

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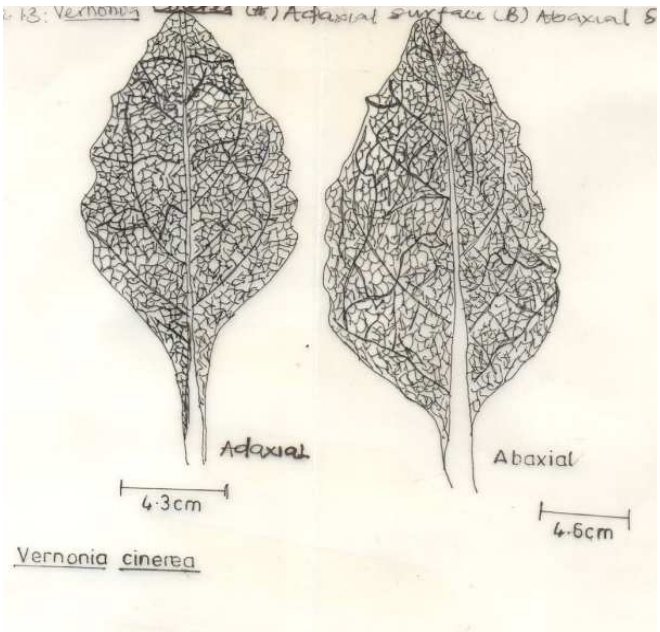

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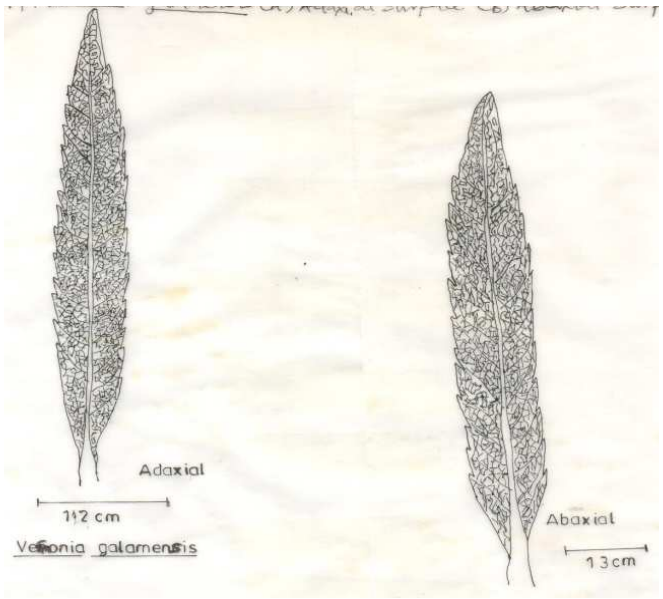

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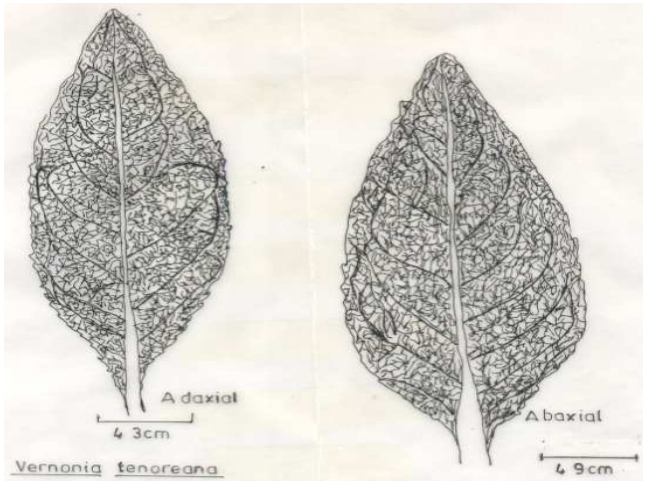

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Figures 1-5 showing the leaf architectures of *Vernonia ambigua, V. amygdalina, V. cinerea, V. galamensis* and *V. tenoreana* respectively.

APPENDIX

Key to the identification of *Vernonia* species in Nigeria

1 a. Leaf shape ovate ---------- *Vernonia amygdalina*
  b. Leaf shape lanceolate ----------
2 a. Petiole long and rounded ----------
  b. Petiole short and winged ---------- *V. cinerea*
3 a. Venation simple craspedodiomous ----------
  b. Venation semi-craspedodiomous ---------- *V. galamensis*
4 a. Areolation shape pentagonal ----------
  b. Areolation shape quadrangular ---------- *V. tenoreana*
5 a. Leaf texture pubescent ---------- *V. ambigua*
  b. Leaf texture glabrous ----------

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