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Leaf Micro- and Macro-Morphological Studies on Some Species in Four Genera of the Family Asteraceae in Nigeria

David Olaniran Aworinde[1]*, Sakiru Morenikeji Erinoso [1], Alimi Adeyemi Ogundele[2] and Emmanuel Chukwuamaka Chidube[1]

[1]Department of Biological Sciences, Ondo State University of Science and Technology, Okitipupa, Nigeria
[2]Department of Biology, Federal College of Education (Special), Oyo, Nigeria

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Abstract

Leaf macro- and micro-morphological investigations were carried out on ten species belonging to four genera in the family Asteraceae in order to evaluate their taxonomic relationships. The epidermal cell shape varied from polygonal to irregular in *Vernonia amygdalina* and *Chromolaena odorata* respectively. Preponderance of epidermal cells on the adaxial surface than on the abaxial surface is indicative of water conservation strategy. The occurrence of anomocytic stomata type in all the species justifies their grouping within the family. The absence of trichomes in *Lactuca taraxacifolia* distinguishes it from all other species and could prove useful as a diagnostic character in delimiting it from the other taxa. Vegetative features of some members in this family are habitat dependent. Variations observed in stomata density, length, width and index and their consequential taxonomic significance are discussed in relation to the family.

Keywords: Morphology, Taxonomy, Asteraceae, Nigeria.

1.0 Introduction

Asteraceae is a cosmopolitan family comprising of over 1,600 genera and 23,000 species, majority of which are shrubs, sub-shrubs or perennial herbs (Kubitzki, 2007). The inflorescence is a capitulum with many flowers. Leaves are alternate or opposite, rarely whorled, usually simple but often lobed (Olorode, 2012; Kubitzki, 2007).

Chromolaena odorata L. is an herbaceous perennial of about 1.5 - 2.0m in height that grows in clusters and forms dense bushes. It is an invasive weed of field crops and poses a great problem in protected plant ecosystems due to its highly competitive nature (Chakraborty *et al*., 2011). *Vernonia amygdalina* Del. is a small shrub (1-3m tall) that grows in tropical Africa. In Nigeria, it is commonly used as a vegetable or as a spice in soup (Igile *et al*., 1995). *V. colorata* (Willd.) Drake is a shrub or small tree with flower heads shorter and broader than those of *V. amygdalina* and is easily identified by the presence of rust coloured fine hairs on its flower heads, leaves and young branches. *V. tenoreana* Oliv. is a savannah shrub characterized by purple markings on the stem and petiole (Olorode, 2012). *V. cinerea* (L.) Less. is an annual erect herb with many of its terminal panicles having many heads and pale purple to purple flowers. *Crassocephalum rubens* (Juss. ex. Jacq.) S. Moore is an erect herb commonly found in disturbed areas. It is characterized by bright purple florets that are occasionally white, pink or blue.

C. crepidioides (Benth.) S. Moore is a stout erect herb with bright brownish-red florets. *C. biafrae* (Oliv. & Hiern.) S. Moore is a glabrous climbing herb with pale yellow flower heads (Hutchinson and Dalziel, 1963). *Lactuca taraxacifolia* (Willd.) Schum. Ex Hornemann is an erect herb with a stem that arises after the formation of a basal rosette of leaves from an underground rhizome (Hutchinson and Dalziel, 1963). *L. sativa* L. is an annual herb that is widely cultivated for its leaves which are edible. Various authors (Metcalfe and Chalk, 1979; Narayana, 1979; Adegbite, 2008; Unamba *et al*., 2008; Essiett and Archibong, 2014; Kolawole *et al*., 2017) have illustrated the usefulness of epidermal characters as a taxonomic tool in the classification of taxa. The studied species which are from four different genera were selected in order to evaluate the intergeneric relationships that exist in the family.

*Corresponding Author's E-mail Address: davidaworinde@yahoo.com

The study also was aimed at providing more taxonomic information on the investigated species so as to justify their taxonomic groupings.

2.0 Materials and Methods

2.1 Source of Plant Materials

The plant materials used were obtained from the Botanical Gardens of University of Ibadan, Oyo State and Ondo State University of Science and Technology, Okitipupa, Ondo State. Collections were also made during periodic field trips. All the plant materials were identified at the Herbarium, University of Ibadan, Nigeria.

2.2 Quantitative and Qualitative Assessment of Leaf Characters

Ten fresh mature leaves of each species were examined. The macro-characters assessed on mature leaves at comparative positions include: leaf length, width (at the widest point), petiole length, and blade. Qualitative characters such as leaf shape, surface, apex, margin, and base were observed *in situ*.

2.3 Epidermal Preparations

Sizeable portions of the mature leaves of about 5mm²-1cm² were obtained from the standard median portion of the leaves. The portions were thereafter soaked in conc. trioxonitrate (v) acid (HNO_3) in Petri dishes for a period of about 15mins - 5hours. The appearance of air bubbles on the surface of the leaf fragments indicated their suitability for separation. Epidermal peeling, staining and mounting were done according to Hussin*et al.* (2000). The epidermal characters were assessed using a light microscope and photomicrographs were taken at a magnification of x400 using an OLYMPUS BX 51 photomicrograph with an installed digital camera optics connected to a computer. Stomata frequency per field of view at x400 magnification was estimated from an average of ten counts. All measurements were carried out using an ocular micrometer. The measurements were later converted to microns using a pre-calibrated stage micrometer. The stomata index was determined according to Metcalfe and Chalk (1979) using the formula:

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

Where **I is** Stomata index, **S** is Number of stomata per unit area and **E** is the Number of ordinary epidermal cells in the same unit area.

3.0 Results

The morphological parameters of the leaf of all the studied taxa are shown in Tables 1 and 2. Photomicrographs of the upper and lower epidermis are shown in Plates A – T. The leaf shape varied from ovate, lanceolate, lyrate, lyrate-pinnatifid, obovate to hastate. The leaves are pubescent in all the species except in *Lactuca taraxacifolia* with glabrous leaves. The apices are mostly acute, with the exception of *Crassocephalum biafrae* and *L. sativa* that are acuminate and truncate respectively. The bases are attenuate, hastate but rarely cuneate and sessile.

The leaf length show considerable variation within the family with the largest in *Vernonia colorata* (27.0cm) and the smallest in *V. cinerea* (5.4cm). The lowest leaf length/width ratio of 2:1 was recorded in *Chromolaena odorata* while the highest of 4:1 was recorded in *V. colorata*. The micromorphological parameters of the adaxial and abaxials ufaces are shown in Table 3 and Table 4 respectively. Epidermal cells on both adaxial and abaxial surfaces were irregular to polygonal in shape. Anticlinal wall patterns range from straight, slightly curved to wavy on both surfaces.

The number of epidermal cells ranges from 15 cells per mm² in *V.colorata* to 200 cells per mm² in *V.cinerea* on the adaxial surface while on the abaxial surface it ranges from 9 cells per mm² in *V. colorata* to 120 cells per mm² in *V. tenoreana*. The leaves of all the plant species are amphistomatic; however, more cells were observed on the adaxial surface than on the abaxial surface. The stomata types are mainly anomocytic and anisocytic but rarely paracytic, laterocytic and staurocytic.

The stomata density ranges from 14 stomata per mm² in *Crassocephalum rubens* to 78 stomata per mm² in *C. biafrae* on the adaxial surface while on the abaxial surface it ranges from 13 to 40 stomata per mm² in *Chromolaena odorata* and *Crassocephalum crepidioides* respectively. The

Table 1: Leaf macro-morphological qualitative parameters

Taxa	Apex	Margin	Shape	Base	Trichomes
Chromolaena odorata	Acute	Serrate	Ovate	Attenuate	++
Vernonia amygdalina	Acute	Serrate	Lanceolate	Attenuate	++
V. cinerea	Acute	Crenate	Ovate	Cuneate	++
V. colorata	Acute	Crenate	Lanceolate	Attenuate	++
V. tenoreana	Acute	Serrate	Lanceolate	Attenuate	++
Crassocephalum crepidioides	Acute	Lancerate	Lyrate	Hastate	++
C. biafrae	Acuminate	Parted	Hastate	Hastate	++
C. rubens	Acute	Parted	Lyrate-pinatifid	Hastate	++
Lactuca sativa	Truncate	Wavy	Obovate	Sessile	++
L. taraxacifolia	Acute	Finely toothed	Lyrate	Hastate	--

++ = trichomes present; — = trichomes absent.

Table 2: Leaf macro-morphological quantitative parameters

Taxa	Length (cm)	Width (cm)	Length/width	Petiole length (cm)
Chromolaena odorata	13(14.59±0.35)16.5	6.90(8.79±0.42)11	2:1	1.8(2.41±0.12)3
Vernonia amygdalina	21(23.62±0.35)25.30	8.5(10.56±0.27)11.5	2:1	3(4.24±0.23)5
V. cinerea	5.4(5.79±0.08)6.0	2.9(3.10±0.05)3.40	2:1	1.6(1.83±0.04)2
V. colorata	16.1(21.49±1.89)27	5.2(5.46±0.05)12.7	4:1	2(3.45±0.57)6
V. tenoreana	22.5(24.38±0.34)25.7	9.8(11.92±0.26)12.7	2:1	4(4.66±0.08)4.8
Crassocephalum crepidioides	16.9(18.29±0.29)19.6	7(8.63±0.43)10.8	2:1	3.8(4.0±0.04)4.2
C. biafrae	16(18.33±0.42)20.6	7.5(9.73±0.48)11.6	2:1	5(7.05±0.31)8
C. rubens	16.9(18.28±0.29)19.6	7(8.63±0.43)10.8	2:1	3.8(4.0±0.04)4.2
Lactuca sativa	18(19.57±0.48)22.0	8.9(9.59±0.18)10.5	2:1	_____
L. taraxacifolia	20.30(22.96±0.68)26.4	7.9(9.03±0.27)10.6	3:1	_____

Values are: min. (mean ± S.E.) max

stomata index ranged from 12.31% in *C. odorata* and *V. amygdalina* to 77.52% in *C. crepidioides* on both surfaces. The highest stomata length on both surfaces was 51.45µm in *C. rubens* (abaxial surface) and the lowest (15.75µm) was in *C. rubens* (adaxial surface). The stomata width had values ranging from 6.3µm to 46.2µm on both adaxial and abaxial surfaces.

Table 3: Micro-morphological parameters of the adaxial surface

Taxa	Epidermal cell shape	Anticlinal wall	Stomata type	Epidermal cell number (per mm²)	Cell wall thickness (µm)	Stomata density (per mm²)	Stomata length (x10.5µm)	Stomata width (x 10.5µm)	Stomata index (%)
Chromolaena odorata	Irregular	Slightly curved, wavy	Anomocytic	119(126.1±1.41)133	0.8(1.43±0.11)1.6	16(17.7±0.21)18	1.8(1.99±0.03)2.1	0.6(0.79±0.03)1.0	12.31
Vernonia amygdalina	Polygonal	Straight	Anomocytic	125(145.3±2.7)150	0.8(1.28±0.13)1.6	18(20.4±0.43)23	2.0(2.12±0.04)2.3	0.6(0.92±0.06)1.2	12.31
V. cinerea	Polygonal	Slightly curved	Anomocytic	156(184.3±5.56)200	0.6(1.82±0.04)1	30(30.1±0.1)31	1.8(2.12±0.05)2.3	0.8(1.04±0.05)1.2	14.04
V. colorata	Irregular	Straight	Anomocytic	15(15.9±0.31)18	0.6(78±0.02)0.8	22(24.1±0.35)25	1.8(1.87±0.03)2.0	0.5(0.61±0.02)0.7	60.25
V. tenoreana	Polygonal	Straight	Anomocytic	148(149.6±0.22)150	0.8(0.88±0.08)1.6	20(23.6±1.33)30	1.8(1.96±0.05)2.2	1(1.12±0.03)1.2	13.63
Crassocephalum crepidioides	Irregular	Slightly curved	Anomocytic, Laterocytic	18(21.6±0.6)24	0.8(0.88±0.8)1.6	70(74.5±0.72)77	2.3(2.61±0.05)2.8	1.2(1.3±0.03)1.4	77.52
C. biafrae	Irregular	Slightly curved, straight	Anomocytic	25(47.5±2.6)56	0.8(0.08±0.08)1.6	70(75.5±1.15)78	2.4(2.9±0.07)3.0	1.4(1.77±0.08)2.4	61.38
C. rubens	Irregular	Slightly curved	Anomocytic	20(24.90±0.31)26	0.8(0.8±0)0.8	14(15.1±0.38)17	1.5(3.45±0.29)4.2	2.2(2.3±0.03)2.4	37.75
Lactuca sativa	Polygonal	Wavy	Anomocytic	28(30.20±0.70)35	0.8(0.88±0.8)1.6	20(27.3±1.17)30	1.6(2.40±0.2)3.4	1.4(1.70±0.05)1.9	47.48
L. taraxacifolia	Polygonal	Wavy	Anomocytic, Anisocytic	20(43.60±2.83)50	0.8(0.88±0.8)1.6	30(33.5±0.7)35	2.3(2.60±0.05)2.8	1.2(1.34±0.03)4.4	43.45

Per mm² denotes per field of view at **x400** magnificaton. All quantitative values are min. (mean ± S.E.) max.

Table 4: Micro-morphological parameters of the abaxial surface

Taxa	Epidermal cell shape	Anticlinal wall	Stomata type	Epidermal cell number (per mm²)	Cell wall thickness (µm)	Stomata density (per mm²)	Stomata length (x 10.5µm)	Stomata width (x 10.5µm)	Stomata index (%)
Chromolaena odorata	Irregular	Wavy	Anomocytic, Anisocytic	44(48.7±0.90)53	1.6(1.7±0.08)2.4	13(14.2±0.2)15	2.0(2.11±0.03)2.3	0.6(0.81±0.04)1.	22.58
Vernonia amygdalina	Irregular	Wavy	Anomocytic, Anisocytic	50(59±2.59)76	0.8(1.24±0.19)2.4	26(26.8±0.13)27	2.2(2.36±0.05)2.8	1.4(0.99±0.05)0.8	31.24
V. cinerea	Irregular	Wavy	Anomocytic, Laterocytic	67(8.25±2.73)92	0.6(0.78±0.02)0.8	30(34.3±0.5)35	2.0(2.24±0.07)2.6	0.60(0.74±0.03)0.8	29.37
V. colorata	Irregular	Wavy, Straight	Anomocytic, Anisocytic	9(10.5±0.31)12	0.8(0.8±0)0.8	18(19.2±0.33)20	1.8(1.95±0.03)2.1	0.8(0.84±0.02)0.9	64.65
V. tenoreana	Polygonal	Wavy	Anomocytic, Paracytic	97(100.8±2.18)120	0.8(1.20±0.13)1.6	28(29.7±0.37)32	1.6(1.76±0.05)2	0.6(0.78±0.04)1.0	22.76
Crassocephalum crepidioides	Polygonal	Wavy, Straight	Anomocytic	23(25.5±0.37)27	0.8(0.8±0)0.8	36(38.3±0.45)40	2.3(2.98±0.1)3.5	1.6(1.82±0.04)2.0	60.03
C. biafrae	Irregular	Wavy, Straight	Anomocytic, Laterocytic	24(28±1.13)35	0.8(0.96±0.11)1.6	38(39.9±0.28)41	2.3(2.64±0.08)3.0	1.2(1.30±0.07)2.0	58.76
C. rubens	Irregular	Wavy, Slightly curved	Anomocytic	10(13.6±1.10)18	0.8(1.04±0.12)1.6	15(17±0.3)18	2.0(3.64±0.27)4.9	1.4(2.78±0.29)3.9	55.65
Lactuca sativa	Polygonal	Wavy	Anomocytic, Anisocytic	22(26.6±0.79)30	0.8(9.6±0.1)1.6	20(25.7±1.25)29	1.7(2.80±0.2)3.5	1.50(2.10±0.1)2.6	49.14
L. taraxacifolia	Irregular	Slightly curved	Anomocytic, Anisocytic, Staurocytic	20(36.8±1.90)42	0.8(0.8±0)0.8	27(27.5±0.17)28	2.3(2.84±0.10)3.2	1.2(1.36±0.05)1.6	42.77

Per mm² denotes per field of view at **x400** magnificaton. All quantitative values are min. (mean ± S.E.) max.

4.0 Discussion

Metcalfe and Chalk (1979) submitted that similarities in stomatal apparatus are often of taxonomic importance and its reliability as a diagnostic character is increased if the stomatal ontogeny is known. Therefore, the presence of anomocytic stomata in all the studied taxa justifies their taxonomic relationship. Some of the studied species possessed other stomata types such as the anisocytic, paracytic, laterocytic and staurocytic stomata types and this is not an uncommon occurrence as observed in similar studies by Baas (1974), and Essiett and Archibong (2014) who noted that different stomata type combinations in a taxon could be used as a diagnostic character in the delimitation of the taxon.

Various physiological and environmental conditions are known to be responsible for variations in epidermal cell size, epidermal cell number, cell wall thickness, stomata density and stomata size. The variations and overlaps of the characters noted in the studied taxa therefore may be of little help in their taxonomic classification. Stomata index on the other hand is assumed to be fairly constant for a given species and is seldom affected by environmental factors (Metcalfe and Chalk, 1979). Unamba *et al.* (2008) determined the stomata index for the abaxial surface of *C. odorata* to be 21.76% which somewhat correlates with the value (22.58

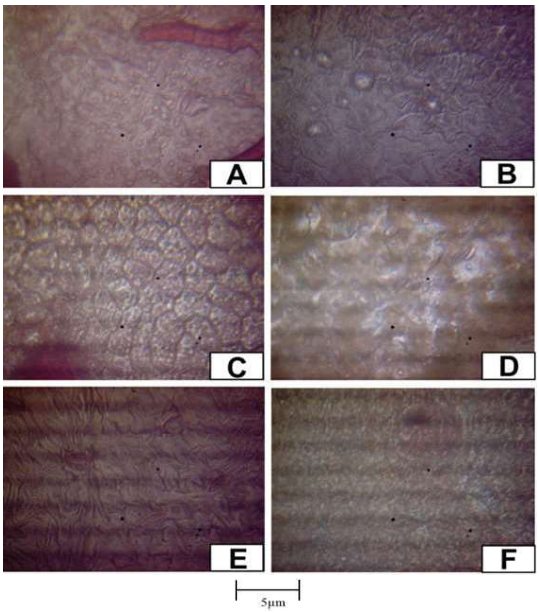

Plate A: The adaxial surface of *Chromolaena odorata* with anomocytic stomata and irregular epidermal cells.
Plate B: The abaxial surface of *C. odorata* with anomocytic stomata and irregular epidermal cells.
Plate C: The adaxial surface of *Vernonia amygdalina* with anomocytic stomata and polygonal epidermal cells.
Plate D: The abaxial surface of *V. amygdalina* with anomocytic stomata and irregular epidermal cells.
Plate E: The adaxial surface of *V. cinerea* with anomocytic stomata and polygonal epidermal cells.
Plate F: The abaxial surface of *V. cinerea* with anomocytic stomata and irregular epidermal cells.

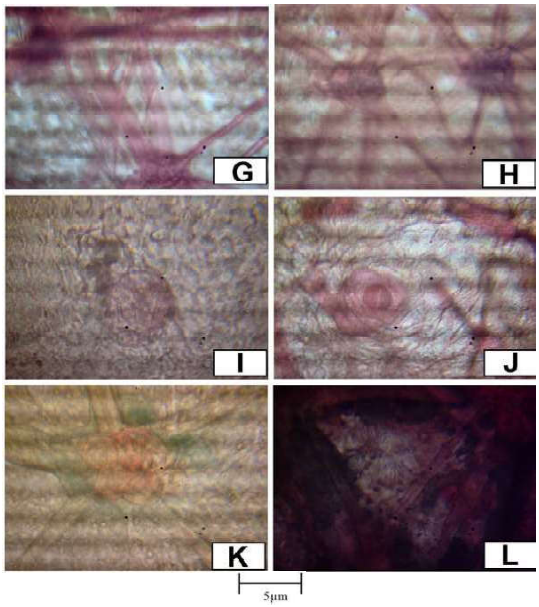

Plate G: The adaxial surface of *V. colorata* with anomocytic stomata and irregular epidermal cells.
Plate H: The abaxial surface of *V. colorata* with anomocytic stomata and irregular epidermal cells.
Plate I: The adaxial surface of *V. tenoreana* with anomocytic stomata and polygonal epidermal cells.
Plate J: The abaxial surface of *V. tenoreana* with anomocytic stomata and polygonal epidermal cells.
Plate K: The adaxial surface of *Crassocephalum crepidioides* with anomocytic stomata and irregular epidermal cells.
Plate L: The abaxial surface of *C. Crepidioides* with anomocytic stomata and polygonal epidermal cells.

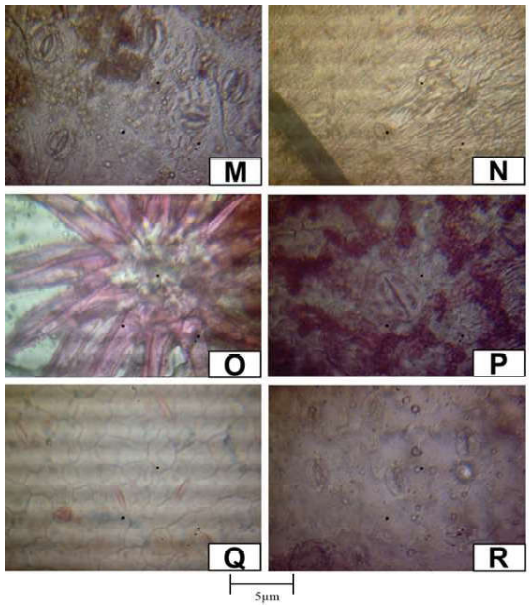

Plate M: The adaxial surface of *Crassocephalum biafrae* with anomocytic stomata and irregular epidermal cells.
Plate N: The abaxial surface of *C. Biafrae* with anomocytic stomata and irregular epidermal cells.
Plate O: The adaxial surface of *C. rubens* with anomocytic stomata and irregular epidermal cells.
Plate P: The abaxial surface of *C. rubens* with anomocytic stomata and irregular epidermal cells.
Plate Q: The adaxial surface of *Lactuca sativa* with anomocytic stomata and irregular epidermal cells.
Plate R: The abaxial surface of *L. sativa* with anomocytic stomata and polygonal epidermal cells.

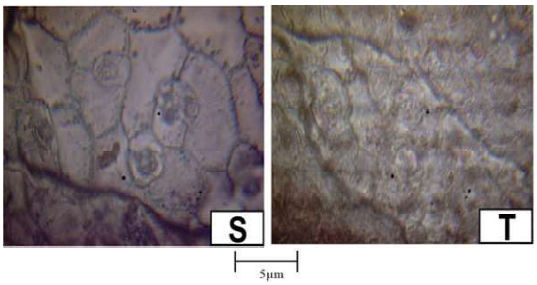

Plate S: The adaxial surface of *Lactuca taraxacifolia* with anomocytic stomata and polygonal cells.
Plate T: The abaxial surface of *L. taraxacifolia* with anomocytic stomata and polygonal cells.

%) determined in this study confirming the aforementioned. This is however contradictory in studies of *Vernonia cineria*, *V. amygdalina* (Eltahir and AbuEReish, 2011; Kemka-Evans *et al*., 2014), *Crassocephalum crepidioides*, *C.biafrae* and *C. rubens* (Kemka and Nwachukwu, 2011), *Lactuca sativa* and *L. taraxacifolia* (Adegbite, 2008) when compared with their respective stomata index values obtained in this study. Therefore, the stomata index may not be of much help in the delimitation of these taxa. Variations in stomata characteristics are not uncommon and the reasons have been extensively discussed by Weyers and Lawson (1997).

Trichomes are known to be of taxonomic importance (Narayana, 1979); trichomes were absent only in *L. taraxacifolia*. This can be a useful diagnostic character in delimiting it from *L. sativa.* The occurrence of T-shaped trichomes observed in *Vernonia amygdalina* corroborates the study of Kemka-Evans *et al*. (2014).

Akinnubi *et al.* (2014) studied characters such as palisade and spongy features, vascular bundle types and venation types in some species of Asteraceae and found these characters to be useful in taxonomic classification. The presence of phytochemicals could also prove supportive in the delimitation of species (Kolawole *et al.*, 2017). More studies that cover the epidermal, phytochemical, petiole, palynological and molecular aspects of plants in order to foster further delimitation of some species especially *L. Taraxacifolia* is suggested.

References

Adegbite, A.E. 2008. Leaf anatomical studies in some species of the tribe Cichorieae (Asteraceae) in Nigeria. Compositae Newsletter, **46**: 49 – 58.

Akinnubi, F.M., Akinloye, A.J., Olaleye-Otunla, O. and Adenegan-Alakinde, T.A. 2014. Foliar anatomy of some species of Asteraceae in South Western Nigeria. African Journal of Plant Science, **8**(9): 426 – 440.

Baas, P. 1974. Stomatal types in Icacinaceae. Additional observations on genera outside Malesia. Acta Botanica Neerlandica, **23**(3): 193 – 200.

Chakraborty, A.K., Rambhade, S. and Patil, U.K. 2011. *Chromolaena odorata* L.: an overview. Journal of Pharmacy Research, **4**(3): 573 – 576.

Eltahir, A.S. and AbuEReish, B.I. 2011. Microscopical studies on the leaf and petiole of *Vernonia amygdalina* Del. .Advances in Applied Science Research, **2**(2): 398 – 406.

Essiett, U.A. and Archibong, B. 2014. The taxonomic significance of certain anatomical variation in four genera of Asteraceae. Bulletin of Environment, Pharmacology and Life Sciences, **3**(5): 150 – 163.

Hussin, K.H., Seng, H., Ibrahim, W.Q., Gen, L.J., Ping, A. and Nian, L. 2000. Comparative leaf anatomy of *Alpinia* Roxb. species (Zingiberaceae) from China. Botanical Journal of the Linnaean Society, **133**: 161 – 180.

Hutchinson, J.J. and Dalziel, J.M. 1963. *Flora of West Tropical Africa.* In: Hepper, F.N. (ed.), Vol. II, 2nd edition. Crown Agents, London.

Igile, G.O., Oleszyek, W., Burda, S. and Jurzysta, N. 1995. Nutritional assessment of *Vernonia amygdalina* leaves in growing mice. Journal of Agricultural and Food Chemistry, **43**: 2126 – 2166.

Kemka, C.I. and Nwachukwu, C.U. 2011. Epidermal micromorphology of species in the genus *Crassocephalum* (Moench) S. Moore (Compositae) in Nigeria. Journal of Pharmacy and Clinical Sciences, **3**: 31 – 41.

Kemk-Evans, C.I., Okoli, B. and Nwachukwu, C.U. 2014. Epidermal studies of three species of *Vernonia* Schreb. in Southern Nigeria. Biodiversitas, **15**(2): 137 – 141.

Kolawole, O.S., Jimoh, M.A., Yakubu, F. and Chukwuma, E.C. 2017. Taxonomic value of the leaf micro-morphology and quantitative phytochemistry of *Jatropha integerrima* Jacq. And *Jatropha podagrica* Hook. (Euphorbiaceae) - known horticultural plants in Nigeria, Anales de Biologia, **39**: 55 – 62.

Kubitzki, K. 2007. *The Families and Genera of Vascular Plants*. In: Kadereit, J.W. and Jeffrey, C. (eds.), Vol. VIII. Springer, Heidelberg, Germany. 635pp.

Metcalfe, C.R. and Chalk, L. 1979. *Anatomy of the Dicotyledons.* Vol I, 2nd edition. Oxford Univesity Press, New York. 276pp.

Narayana, B.M. 1979. Taxonomic value of trichomes in *Vernonia* Schreb. (Asteraceae). Proceedings of the Indian Academy of Sciences Section B, **88a**(5): 347 – 357.

Olorode, O. 2012. *Taxonomy of West African Flowering Plants*. Cedar Productions, Ile-Ife,

Nigeria. 187pp.

Unamba, C.I.N., Inyama, C.N., Okeke, S.E. and Mbagwu, F.N. 2008. Leaf epidermal features of *Ageratum conyzoides*, *Aspilia africana*, *Chromolaena odorata* and *Tridax procumbens* (Asteraceae). International Science Research Journal, **1**(2): 169 – 172.

Weyers, J.D.B. and Lawson, T. 1997. Heterogeneity in stomatal characteristics. Advances in Botanical Research, **26**: 318 – 348.