

Systematic value of foliar epidermal morphology in some taxa of the tribes: Urticeae and Parietariae of the West African Urticaceae

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Abstract: The foliar epidermal characteristics of all West African species of the tribe Parietarieae and some taxa in the tribe Urticeae were investigated by the means of light microscopy for the purposes of easy identification and justification of recent taxonomic merging of *Fleurya* with *Laportea*. In the tribes, cell number is higher on the adaxial surface (52 to 110) than on the abaxial surface (19 to 96), stomata number varies from 31 to 42 per mm² while cell size ranged from 60.8 - 70.4 µm x 22.4 - 32.0 µm on the adaxial surface and 32.0 - 40.0 µm x 16.0 - 22.4 µm on the abaxial surface. Generally, all the species have hypostomatic leaves and anomocytic stomatal type but paracytic and anisocytic types are diagnostic for *Laportea aestuans*, *Laportea ovalifolia*, *Parietaria laxiflora*, and *Laportea alatipes*. Glandular and simple trichomes of different sizes were observed in all the taxa except in *Girardinia heterophylla* and *L. ovalifolia*. The cell shape, anticlinal wall pattern, and stomatal type which correlate to a reasonable extent have supported the amalgamation of *Laportea* and *Fleurya*. Crystal sands of calcium oxalate were found in *L. ovalifolia*, *Girardinia condensata*, and *Parietaria laxiflora* while peltate scales distinguished *P. laxiflora* from other species. The species have medicinal and economic values. An artificial indented dichotomous taxonomic key for separating the taxa is presented.

Keywords: Urticaceae, Urticeae, Parietariaeae, leaf epidermis, morphology, West Africa.

Introduction

Urticaceae, the nettle plant, is a family of flowering plants consisting of herbs, shrubs and trees (HUTCHINSON & DALZIEL 1963; HUTCHINSON 1967; HEYWOOD 1978). The family has 45 genera with about 700 species (HEYWOOD 1978). There are eleven genera in West Africa and four of these which are grouped in two tribes (Urticeae and Parietarieae) were selected for the present study. The taxa were specifically selected for study because of the recent taxonomic change, lack of sufficient information on leaf endo-morphological characteristics and synonymy problem. *Fleurya* Gaud. has been merged with *Laportea* Gaud. (LOWE & SOLADOYE 1990). There is a very thin line of distinction between Parietarieae and Boehmerieae (HEYWOOD 1978) and perhaps because of the ecological preference (montane areas) of Parietarieae, taxonomic information about it is scanty in West Africa; furthermore, the two species of *Girardinia* are often regarded as synonyms and *Droguetia* is poorly represented in and taxonomic information about it is almost lacking (HUTCHINSON & DALZIEL 1963). The following taxa were investigated, Urticeae: *Droguetia iners* (Forsk.) Schweinf., *Laportea aestuans* (Linn.) Chew., syn. *Fleurya aestuans* (Linn.) Miq., *Laportea ovalifolia* (Schumach.) Chew., syn. *Fleurya ovalifolia* (Schum. & Thonn.) Dandy, *Laportea alatipes* Hook f., *Laportea mooreana* (Hiern.) Chew., *Girardinia heterophylla* (Vahl.) Decne, *Girardinia condensata* (Hochst. ex Steud.) Wedd., syn. *Girardinia diversifolia* (Link.) Friis, and Parietarieae: *Parietaria debilis* Forst. f. and *Parietaria laxiflora* Engl. were studied. These species have culinary, clothing and aesthetic uses (BURKILL 1997; HUTCHINSON & DALZIEL 1963). Based on exo-morphology, BENTHAM & HOOKER (1965) grouped all taxa in the family in one tribe Urereae while HEYWOOD (1978) subdivided the family into six tribes and our genera were grouped into two tribes Urticeae and Parietarieae. In the later account documented by LOWE & SOLADOYE (1990), the genus *Fleurya* Gaud. was changed to *Laportea* Gaud. and all the species were transferred based on exo-morphological traits. The present investigation therefore aims at justifying the merging of *Fleurya* with *Laportea* using endo-morphological features of the leaf and also to document the leaf epidermal features of other species in order to facilitate their delimitation and ease their recognition even if leaf samples are available in fragments. The only existing report on leaf endo-morphology in the group is the general family account by METCALFE & CHALK (1950, 1979) with scanty information on few taxa of the tribes: Urticeae and Parietarieae, which are the major focus of the present work; however, other taxa in family are not also sufficiently accounted for. The present study will therefore contribute more taxonomic data that will enhance taxonomic understanding of the group. In order to facilitate this, an artificial indented dichotomous taxonomic key is therefore presented to assist in taxa delimitation.

Material and methods

Preserved specimens obtained from the herbarium of the Forestry Research Institute of Nigeria, Ibadan (FHI) and fresh specimens collected from field trips

were used for the study. Specimens deposited in the herbarium of the University of Lagos (LUH) were visited for authentication and study. Herbarium abbreviations follow HOLMGREN et al. (1990). The herbarium indices of the investigated species are given as follow: *D. iners* (FHI 8889), *F. eastuans* (FHI 33365), *F. ovalifolia* (FHI 51098), *L. alatipes* (FHI 29958), *L. mooreana* (LUH 3163), *L. ovalifolia* (FHI 101554), *G. heterophylla* (FHI 97877), *G. condensata* (FHI 42715), *P. debilis* (FHI 97893) and *P. laxiflora* (FHI 39217). Specimens of synonymous taxa were compared.

Methods follow ADEDEJI (2004), AKHIL & SUBHAN (1997), KADIRI et al. (2007), KOTRESHA & SEETHARAM (2000), OGUNDIPE & WUJEK (2004), REJDALI (1991). Portions of 2–5 cm² were cut from the standard median part of the leaf lamina near the mid-rib, or the whole leaf was used. Dried leaves were boiled in water for thirty minutes and subsequently soaked in either concentrated trioxonitrate (v) acid (HNO₃) in capped specimen bottles for about 8–24 hrs to macerate the mesophyll, or irrigated in sodium hypochlorite solution (commercial bleach) for 30–120 minutes to bleach the leaf portions. Tissue disintegration was indicated by bubbles and the epidermal layers were separated and transferred into Petri dishes containing water for cleansing. In case of fresh materials, the leaves were scraped with razor blade to separate epidermis. Tissue debris was cleared off the epidermis with fine-hair brush and washed in several changes of water. Drops of different grades of ethanol, 50 % – 100 %, were added in turn to dehydrate the cells. The preparations were later stained with Safranin O in 50 % alcohol for about five minutes before being mounted in glycerine on glass slides. The epidermal layers were mounted on glass slides with the uppermost surfaces facing up, covered with cover-slips and ringed with nail varnish to prevent dehydration. Photographs of epidermal features of the leaf were obtained with the aid of digital Motic camera attached to a microscope and Pentium IV computer while line diagrams of structures were made with camera lucida.

Results

D. iners has the highest number of trichomes on the adaxial surface. Trichomes occur on both surfaces of the leaves of *D. iners*, *L. aestuans*, *L. alatipes*, *G. condensata* and *Parietaria* spp. while *L. ovalifolia* and *G. heterophylla* are glabrous (Plates 1 and 2, Tab. 1). The epidermal cell shape is polygonal on both surfaces of *D. iners*, *G. condensata* and *Parietaria* spp., but it is irregular on both surfaces of *L. ovalifolia* and *L. aestuans*. It is polygonal/irregular on the surfaces of *L. alatipes*, *L. mooreana* and specimens of *L. ovalifolia* (Fig. 1, Plate 1, Tab. 1). The two species of *Parietaria* showed limited variations in their foliar epidermal features. The leaf is pubescent on both surfaces; the anticlinal wall is undulate while the cell shape is also uniform on both surfaces (Fig. 1, Plates 1 and 2, Tab. 1). Mean cell size is 45.2 - 107.8µm x 20.5 -40.6µm and stomatal size is 18.9 µm x 7.7 - 10.6 µm. Cell wall thickness varies from 4.3 – 8.8 µm on both surfaces (Tab. 2). The species grouped under the tribe: Urticeae are more variable in their foliar epidermis than the species of Parietarieae. The leaf is either glabrous on both surfaces in *G. heterophylla* and

L. ovalifolia or pubescent on both surfaces in *D. iners*, *G. condensata*, *L. aestuans*, *L. alatipes*, *L. mooreana* and *Parietaria* spp. (Tab. 1). Intra-generic differences in these features were also recorded. Mean cell size is 27.0 - 57.8 μm x 10.5 - 27.2 μm and stomatal size is 13.4 - 20.8 μm x 6.7 - 11.9 μm . Cell wall thickness varies from 3.1 - 4.8 μm on both surfaces (Tab. 2). Stomatal types recorded included the anomocytic type which is present in all species (Plate 1), anisocytic which is restricted to *Laportea* species: *L. alatipes*, *L. aestuans* and *L. ovalifolia* and paracytic type which occurred only in *P. laxiflora* (Tab. 1). Cystoliths filled the cell lumen in all *Laportea* species including specimens regarded as *Fleurya* (Fig. 1 D, E, F, H, K).

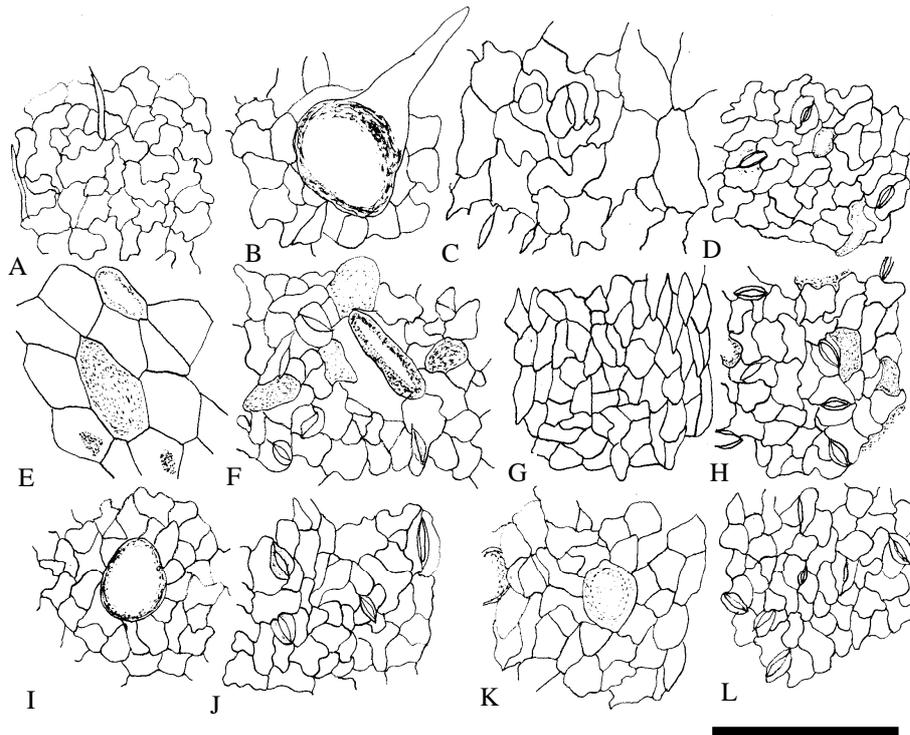


Fig. 1: Line drawings of some taxonomically useful foliar epidermal features of some members of West African Urticaceae. A: *D. iners* (short conical trichomes), B: *P. debilis* (bulbous base glandular trichome), C: *P. laxiflora* (large cell size in *Parietaria* spp.), D, E (*L. aestuans*), F (*L. ovalifolia*), G, H (specimen designated as *Fleurya ovalifolia* at FHI) and K (*L. alatipes*) have cystoliths within cell lumen; C, D (*L. aestuans*); F, H, J (*G. heterophylla*) and L (*L. alatipes*): show anomocytic stomata, the common stomatal type in the two tribes. The leaf is hypostomatic. I: *P. laxiflora* (scar of bulbous base glandular trichome). Adaxial surface: A, B, E, G, I and K; abaxial surface: C, D, F, H, J, and L. Scale is 50 μm .

Tab. 1: Relative quantitative and qualitative characteristics of foliar epidermis of the species of the tribes: Urticeae and Parietarieae of the West African Urticaceae.

Species	Surface	Cell shape	Wall pattern	Stomatal type	Trichome type	Cell no. (x) per mm ²	Stomatal no. (x) per mm ²	Trichome no. (x) per mm ²
Tribe: Urticeae								
<i>Droguetia iners</i>	adaxial	polygonal	curved	absent	present	110	absent	16
	abaxial	polygonal	curved	anomocytic	present	62	3	3
<i>Laportea aestuans</i> syn. <i>Fleurya aestuans</i>	adaxial	irregular	curved	absent	present	41	absent	1
	abaxial	irregular	curved	anomocytic, anisocytic	present	33	15	8
<i>Laportea alatipes</i>	adaxial	polygonal/irregular	straight/curved	absent	present	39	absent	7
	abaxial	polygonal/irregular	straight/curved	anomocytic, anisocytic	present	27	14	7
<i>Laportea mooreana</i> syn. <i>Fleurya mooreana</i>	adaxial	polygonal/irregular	straight/curved	absent	present	30	absent	7
	abaxial	irregular	straight/curved	anomocytic	present	26	10	6
<i>Laportea ovalifolia</i> syn. <i>Fleurya ovalifolia</i>	adaxial	irregular	curved	absent	absent	46	absent	absent
	abaxial	irregular	curved	anomocytic, anisocytic	absent	19	32	absent
<i>Girardinia heterophylla</i>	adaxial	irregular	straight/curved	absent	absent	34	absent	absent
	abaxial	polygonal/irregular	straight/curved	anomocytic	absent	49	42	absent
<i>Girardinia condensata</i>	adaxial	polygonal	straight	absent	present	45	absent	14
	abaxial	polygonal	straight	anomocytic	present	97	10	55
Tribe: Parietarieae								
<i>Parietaria debilis</i>	adaxial	polygonal	undulate	absent	present	64	absent	1
	abaxial	polygonal	undulate	anomocytic	present	24	12	75
<i>Parietaria laxiflora</i>	adaxial	polygonal	undulate	absent	present	16	absent	7
	abaxial	polygonal	undulate	anomocytic, paracytic	present	20	5	6

Tab. 2: Relative quantitative characteristics of foliar epidermis of the species of the tribes: Urticeae and Parietarieae of the West African Urticaceae.

Species	Surface	Epidermal cell length		Epidermal cell width		Epidermal cell thickness		Stomatal length		Stomatal width	
		Min(Mean±S.E)	Max (µm)	Min(Mean±S.E)	Max (µm)	Min(Mean±S.E)	Max (µm)	Min(Mean±S.E)	Max (µm)	Min(Mean±S.E)	Max (µm)
Tribe: Urticeae											
<i>Droguetia iners</i>	adaxial	32.0(36.6±4.12)	48.0	16.0(17.6±0.8)	19.0	4.0(4.7±0.2)	5.1	absent		absent	
	abaxial	32.0(35.5±1.72)	40.0	21.0(10.5±0.5)	13.0	4.0(4.6±0.2)	4.8	12.8(15.3±1.0)	16	6.4(6.7±0.1)	8
<i>Laportea aestuans</i> syn. <i>Fleurya aestuans</i>	adaxial	29.0(36.1±4.0)	48.0	8.0(11.2±1.1)	13.0	1.6(3.4±0.8)	4.8	absent		absent	
	abaxial	32.0(39.6±4.4)	52.0	10(11.8±1.1)	14.4	3.2(3.6±0.2)	4.8	12.8(15.4±1.0)	16.0	8.0(9.3±0.7)	9.6
<i>Laportea alatipes</i>	adaxial	29.0(37.7±4.2)	48.0	13.0(17.9±2.3)	24.0	3.2(3.5±0.7)	4.4	absent		absent	
	abaxial	19.2(27.0±5.3)	42.0	10.0(13.4±2.3)	19.0	2.9(3.3±0.2)	4.0	11.2(13.4±0.7)	14.0	6.2(8.3±0.8)	9.6
<i>Laportea mooreana</i> syn. <i>Fleurya mooreana</i>	adaxial	27.0(35.7±4.1)	45.0	11.0(16.9±2.2)	22.0	3.0(2.9±0.6)	4.0	absent		absent	
	adaxial	16.2(25.0±5.0)	40	8.0(10.2±2.1)	16.0	2.4(3.0±0.3)	4.0	10.2(11.4±0.8)	13.0	5.2(6.3±0.7)	7.8
<i>Laportea ovalifolia</i> syn. <i>Fleurya ovalifolia</i>	adaxial	48.0(50.9±2.2)	56.0	22.4(25.6±2.1)	32.0	3.2(4.3±0.7)	6.0	absent		absent	
	abaxial	35.0(41.9±3.4)	48.0	16.0(17.9±2.4)	26.0	3.2(3.7±0.8)	4.0	16(16.6±1.2)	18.0	8.0(9.3±0.8)	11.0
<i>Girardinia heterophylla</i>	adaxial	38.0(43.5±7.1)	64.0	16.0(21.7±2.3)	25.6	3.7(4.3±0.8)	4.8	absent		absent	
	abaxial	38.0(45.1±3.1)	51.0	14.0(18.5±1.6)	22.4	4.0(4.6±0.2)	4.8	16.0(17.9±1.2)	21.0	8.0(11.5±1.7)	16.0
<i>Girardinia condensata</i>	adaxial	22.0(29.1±4.1)	42.0	8.0(10.6±1.2)	12.8	3.2(3.5±0.1)	3.8	absent		absent	
	abaxial	22.0(31.3±1.3)	32.0	13.0(17.6±2.4)	24	2.4(3.4±0.5)	4.8	11.0(16±3.0)	24.0	6.4(8.6±0.9)	11.2
Tribe: Parietarieae											
<i>Parietaria debilis</i>	adaxial	37.0(45.2±3.2)	51.0	19.2(20.5±2.8)	29	4.8(5.2±0.3)	5.6	absent		absent	
	abaxial	35.0(40.3±3.2)	48.0	16(21.1±4.5)	25	3.2(4.3±0.8)	4.8	11.2(18.9±1.1)	16.0	6.4(7.7±0.7)	8.0
<i>Parietaria laxiflora</i>	adaxial	69.0(91.9±8.7)	112.0	32(40.6±6.1)	56.0	6.4(8.8±1.4)	12.8	absent		absent	
	abaxial	96.0(107.8±9.0)	136.0	32(40.0±4.6)	51.0	4.8(7.2±1.3)	9.6	14.4(18.9±2.1)	22.4	8.0(10.6±1.1)	13.0

S.E= Standard error

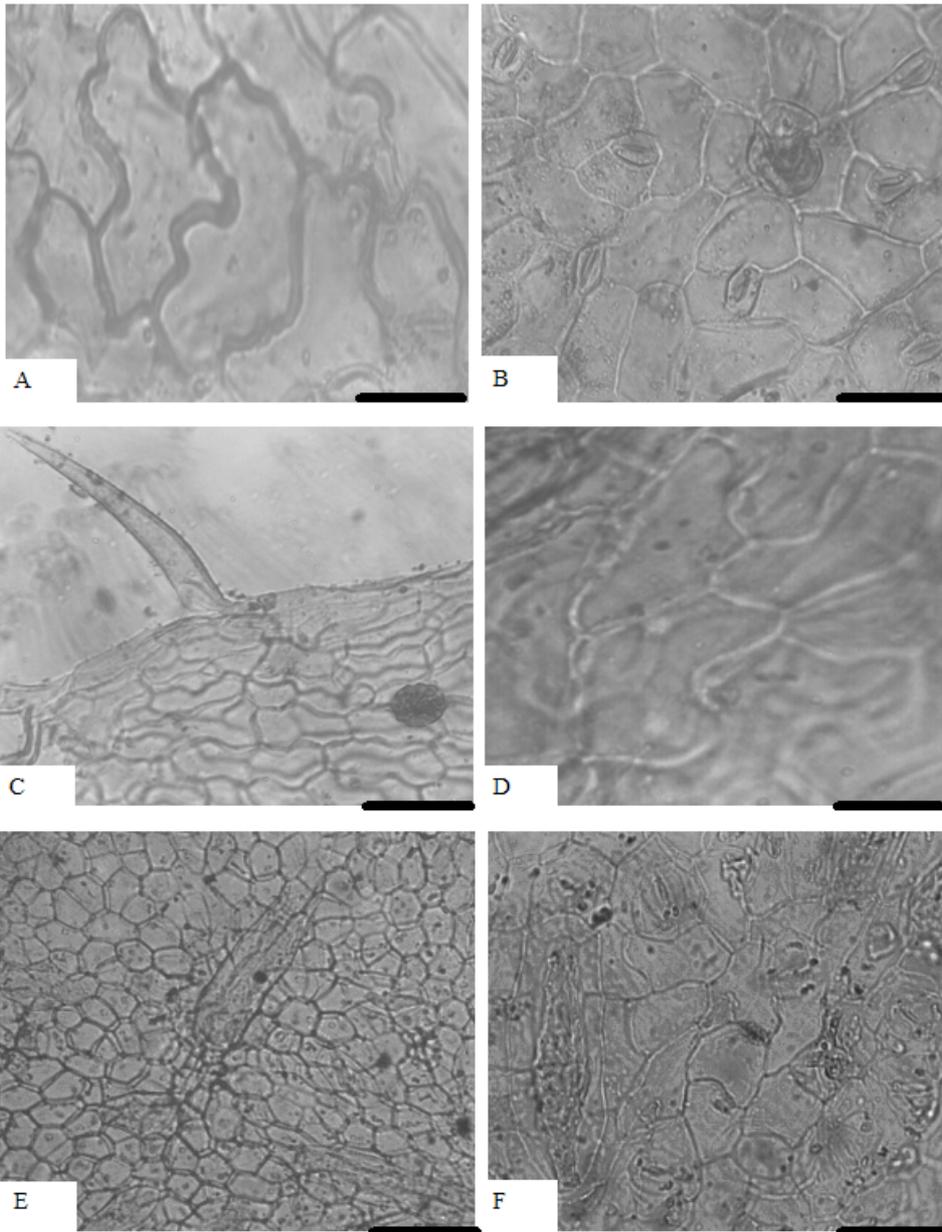


Plate1: Foliar epidermal surfaces of some species of Urticaceae. A, B: *Girardinia heterophylla*; C, D: *Droguetia iners*; E, F: *Laportea mooreana*. A, C, and E: adaxial surface, B, D, F: abaxial surface. Scale bar is 25 μ m.

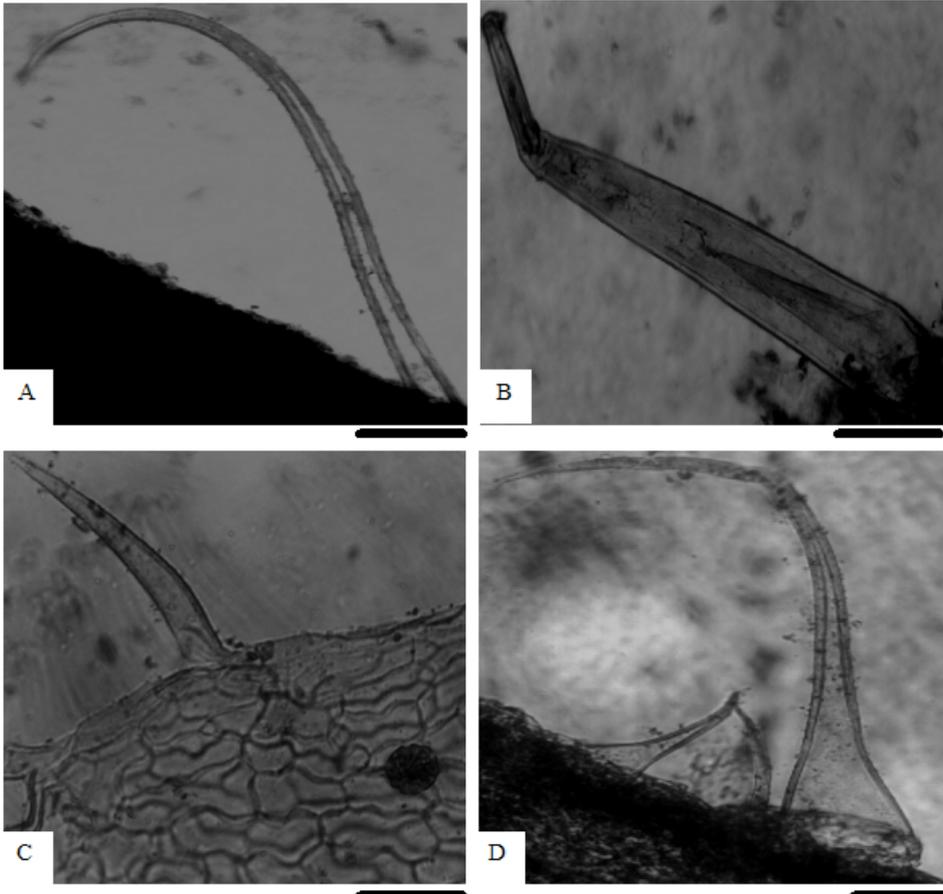


Plate 2: Trichome types recorded within the tribes: Urticeae and Parietarieae. A: Simple multiseriate acicular trichome found in *Girardinia condesata*, B: Multicellular glandular trichome reported in *Laportea* spp., C: Unicellular non-glandular acicular type recorded in *Drougetia iners*, D: Unicellular tip-bent glandular trichome found in *Parietaria* spp.. Scale is 75 μ m.

Discussion

In the general anatomical account of Urticaceae, METCALFE & CHALK (1950, 1979) reported the occurrence of laticiferous elements, glandular, non glandular and stinging hair types, hypostomata, presence of hydathodes, fluid-loaded epidermis, silicified and calcified cell walls which occur as cystoliths of different forms. Lumen-filled cystoliths were encountered in all the *Laportea* species. There were variations in the length and type of trichomes observed among these species; simple multiseriate acicular trichomes were found in *Girardinia*,

multicellular glandular type was recorded in *Laportea* spp., simple non-glandular long acicular type was found in *D. iners* and multicellular tip-bent glandular type was recorded in *Parietaria* spp. and *L. alatipes* has the longest trichomes of 60.1µm. These features were found to have reliable systematic value. The amalgamation of *Laportea* and *Fleurya* is supported by the foliar epidermal characteristics especially all the qualitative features as these features correlate to a large extent. DAVIS & HEYWOOD (1963) have described qualitative features as those characters which are limitedly influenced by environmental factors as they are under strict genetic control. However, DAVIS & HEYWOOD (1963); HEYWOOD (1973) and DILCHER (1947) cautioned the application of trichomes in making taxonomic decisions as its expression can be influenced by environmental factors. In the quantitative characters, there was a considerable overlap in all measurements; the mean values of epidermal cell and stomatal size are reasonably close; therefore, the merging of these species as documented by LOWE & SOLADOYE (1990) is strongly supported. Generally, all the species have hypostomatic leaves and anomocytic stomatal type but paracytic and anisocytic types were also recorded in *L. aestuans*, *L. alatipes*, *L. ovalifolia* and *P. laxiflora*. The taxonomic relevance of trichomes in Urticaceae and the systematic relevance of epidermal features has been articulated in angiosperms (AKHIL & SUBHAN 1997, KADIRI et al. 2007, KOTRESHA & SEETHARAM 2000, METCALFE & CHALK 1950 1979, OGUNDIPE & WUJEK 2004 and REJDALI 1991). Crystal sands of Calcium oxalate was found in *L. ovalifolia*, *G. condensata*, *L. ovalifolia*, and *P. laxiflora* while peltate scales distinguish *P. laxiflora* from other species. However, the variations recorded in these features have pointed to the fact that these species cannot be lumped together in a single tribe as done by BENTHAM & HOOKER (1965). The species of *Parietaria* share many features in common; therefore their grouping in the same tribe Parietariaeae is supported. An artificial indented dichotomous taxonomic key for separating the taxa is presented as follows:

Artificial intended dichotomous key for separating the species of the two West African tribes: Urticeae and Parietariae of the family Urticaceae

- 1. Cell shape polygonal/irregular, anticlinal wall pattern straight/curved. Stomatal types anomocytic, anisocytic and paracytic. Leaf pubescent on either surface, mean cell size 27.0 - 57.8 µm x 10.5 - 27.2 µm, stomatal size 13.4 - 20.8 µm x 6.7 – 11.9µm. Cell wall thickness varies from 3.1 – 4.8 µm, cystoliths present.....Tribe Urticeae
- 1. Cell shape polygonal, anticlinal wall pattern undulate, stomatal types anomocytic and paracytic. Leaf pubescent on both surfaces, Mean cell size 45.2 - 107.8µm x 20.5 - 40.6µm and stomatal size is 18.9 µm x 7.7 - 10.6 µm. Cell wall thickness varies from 4.3 – 8.8 µm on both surfaces, cystoliths absent.....Tribe Parietariae

Tribe Urticeae:

- 1. Epidermal cell shape undulate, leaf surface glabrous....*Girardinia heterophylla*
- 1. Epidermal cell shape polygonal/ irregular , leaf surface pubescent

2. Stoma more than twice as long as wide, mean trichome number on the abaxial surface 55 per mm².....*Girardinia condesata*
2. Stoma twice as long as wide, mean trichome number on the abaxial surface 3 per mm².....*Droguetia iners*
3. Cell shape irregular on both surfaces,
 4. Trichome present.....*Laportea aestuans*
 4. Trichome absent.....*Laportea ovalifolia*
3. Cell shape irregular/polygonal on both surfaces
 5. Anisocytic stomata present.....*Laportea alatipes*
 5. Anisocytic stomata absent.....*Laportea mooreana*

Tribe Parietariaeae:

1. Paracytic stomata absent, trichome number greater than 50, mean cell length almost uniform on both surfaces.....*Parietaria debilis*
1. Paracytic stomata present, trichome number less than 10, mean cell length longer on the adaxial than abaxial surface.....*Parietaria laxiflora*

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