

SCANNING ELECTRON MICROSCOPY OF LEAVES IN THE WEST AFRICAN  
POLYGONACEAE

Ayodele, A. E.\* and Zhou, Z.K.

Department of Taxonomy and Ethnobotany, Kunming Institute of Botany, Chinese Academy of Sciences, 650204, Kunming, China

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ABSTRACT

The leaf surfaces of the West African taxa of the Polygonaceae were studied using the Scanning Electron Microscope (SEM). Leaf epidermal cells are polygonal, isodiametric and rarely irregular. Anticlinal walls are straight, curved, undulate or sinuate. Striae are present in a few taxa such as *Polygonum plebeium*, *Rumex abyssinicus*, *R. bequaertii*, *Oxygonum sinuatum*, *Persicaria nepalensis* and *Afrobrunnichia erecta*. The striae may be parallel, radiate, or randomly distributed. Trichomes are unicellular, uniseriate, aggregating together in some species of *Persicaria*, while they may be flagelliform, interwoven and woolly in *Persicaria senegalensis forma albotomentosa* hence diagnostic for the species. Peltate glands are characteristic of *A. erecta*. Stomata are mainly paracytic or anomocytic although diacytic, cyclocytic and anisocytic types may also be found in some taxa sometimes together with the main types. Stomata are sunken in a few species such as *Polygonum plebeium* and *Persicaria attenuata* subsp. *pulchra*, raised or at the same level with epidermal cells in other taxa. Wax deposits are associated with the stomata in *Persicaria attenuata* subsp. *africana*. These characters are discussed in relation to the taxonomy of the family in West Africa.

**Key words:** Taxonomy, SEM, Leaf, Polygonaceae, West Africa.

INTRODUCTION

The Polygonaceae is a cosmopolitan family of herbs, shrubs, small trees or climbers characterized by simple leaves with sheathing ochrea stipules, unilocular ovary and endospermic seed (Hutchinson & Dalziel, 1954; Brummit, 1992; Takhtajan, 1997; Judd *et al.*, 1999). A sole taxon in the monotypic Polyganales, the family is widely distributed especially prevalent in the northern temperate region. It is generally considered to be made up of about 49 genera consisting of close to 1100 species in the world (Heywood, 1978; Brummit, 1992; Judd, *et al.*, 1999). Judd *et al.* (1999) considered the Polygonaceae as a clearly monophyletic family. The family is poorly represented in West Africa.

Recent studies of the family in West Africa showed that it is represented by eight genera and about twenty species (Ayodele, 2000). The species are widely distributed in Nigeria, Ghana, Sierra Leone, Senegal, Liberia, Cote d' Ivoire and Cameroon (Ayodele, 2003). The West African taxa of this family have not yet been fully studied. A revision of the family (Ayodele, 2000) yielded useful data concerning intra and – inter-specific variation patterns as well as geographical relationships of some taxa (Ayodele & Olowokudejo, 2002; Ayodele,

\*Present & Correspondence Address: Department of Botany & Microbiology, University of Ibadan, Ibadan, Nigeria. Email – bayodele@yahoo.com

2005; Ayodele & Olowokudejo, 2006). As part of the multidisciplinary approach to the study of the West African taxa, the search for additional characters of taxonomic value is extended to the leaf surfaces using the Scanning Electron Microscope (SEM). The leaf surfaces of the Polygonaceae render them as excellent materials for SEM work. Leaf, seed and fruit micromorphology can be valuable tools in discerning relationships (Olowokudejo & Nyananyo, 1990). Details of the sculpturing and ornamentation of the wall can be variable and of systematic importance (Barthlott, 1984, 1990; Olowokudejo, 1985; Zhang *et al.*, 2005). These characters are also used in phylogenetic assessment of relationships (Barthlott, 1981; Zhou *et al.*, 1995; Shehata & Loutfy, 2006). The aim of this study is to assess the potential of the characters of the leaves as revealed by SEM in order to further understand the taxonomic relationships of members of the Family Polygonaceae.

#### MATERIALS AND METHODS

Portions of the leaves were taken from specimens studied in the following herbaria: Forestry Research Herbarium (FHI), Ibadan, University of Ibadan Herbarium (UIH), Ibadan, Obafemi Awolowo University Herbarium (OAU), Ile-Ife, and the Herbarium of the University of Lagos (LUH), Lagos, Nigeria. Materials were also obtained from personal field collections. The list of all specimens studied is presented in Table 1.

#### Scanning Electron Microscopy

Three to five specimens of the leaf of each species were examined depending on the distributional range of the taxa. Small pieces (c. 5mm<sup>2</sup>) of each leaf were fixed to labeled stubs with double sided adhesive tape. Each sample was coated with gold in a Polaron E-5000 sputter coating unit, scanned and photographed using the KYKY (Amray) Model 1000B at the Scanning Electron Microscopy Unit of the Kunming Institute of Botany, Chinese Academy of Sciences, Kunming, China.

#### RESULTS

Leaf epidermal cells are isodiametric, polygonal, rarely irregular but sometimes isodiametric to polygonal in a few species (Table 2, Plates 1-4).

Irregular cells were recorded only in *Harpagocarpus snowdenii* Hutch. & Dandy, with undulate to sinuate anticlinal and periclinal walls (Plates 4E&F). The walls of other species are mostly straight or curved and raised or depressed (Table 2). Striae are prominent and parallel in *Polygonum plebeium* R.Br. (Plates 1A&B), and *Rumex abyssinicus* Jacq. (Plate 3D), random in *Oxygonum sinuatum* (Meissn.)Gross (Plate 1C), *R. bequaertii* De Willd. (Plate 3F) and *H. snowdenii* (Plate 4E), radiate in *Afrobrunnichia erecta* Hutch. & Dalz. (Plate 4B). In *Persicaria nepalensis* (Meissn.)Gross, the striae radiate from the stomata outwards (Plate 1D). Striae are absent in other taxa. Trichomes are mostly unicellular and uniseriate, aggregating in most species especially in *Persicaria*, each tapering towards the tip (Plate 1G&H, 2A&G). Peltate glands occur only in *A. erecta*. In *Persicaria senegalensis* (Meissn.) Sojak. *forma albotomentosa* (Graham) K.L.Wilson, the trichomes are long, interwoven threads appearing woolly and obscuring the cells (Plates 2E&F). Trichomes were not observed in other species. Stomata are mainly paracytic or anomocytic. However, anisocytic, cyclocytic and diacytic types occur in some species either wholly or intermixed with the main types (Table 2, Plates 1-4). Stomata are sunken in some species such as *Polygonum plebeium* and *Persicaria attenuata* (R.Br.) Sojak. subsp. *pulchra* (Blume) K.L.Wilson (Plates 1A&B; H&I) but raised or at the same level with epidermal cells in other taxa. Wax deposits are present on the epidermal cells in most taxa (Plates 1B, C, H, and Plate 2A).

Table 1: List of Specimens examined

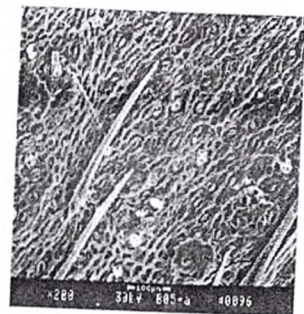
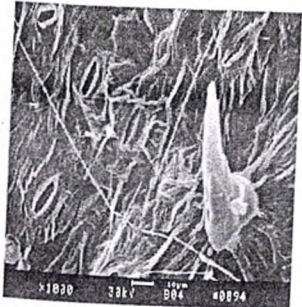
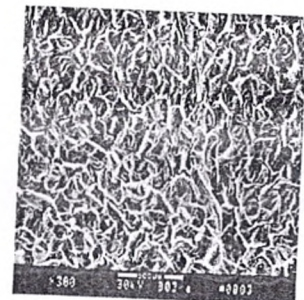
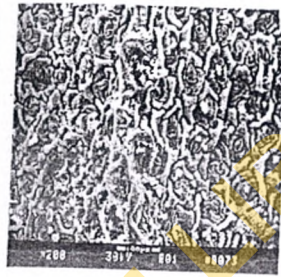
Taxa	Locality	Collector(s)	Herbarium	Date
1 <i>Polygonum plebeium</i> R.Br.	Sokoto, Nigeria,	M.G. Latilo,	FHI 62592	20-7-69
	Bawku, Ghana	J.K. Morton	FHI 53461	25-12-54
	Gombe, Nigeria	Gbile, P. Wit. Daramola	FHI 65466	
	Bawiwi, Ghana	J.K. Morton	FHI 4765	19-4-60
2 <i>Oxygonum sinuatum</i> (MEISSN.) DAMMER	Borno State, Nigeria	Ekwuno & Fagbemi	FHI 94033	30-9-80
3 <i>Persicaria nepalensis</i> (MEISSN.) GROSS	Bamenda, Cameroon	J.K. Morton	FHI 53591	31-4-55
	Bamenda, Cameroon	B.O. Daramola	FHI 40624	23-1-59
	Mambilla, Nigeria	P.O. Ekwuno	FHI 77145	17-11-75
	Obudu, Nigeria	B.O. Daramola	FHI 62401	7-12-68
	Mambilla Plateau, Nigeria	G.W. Ivens	UIH 15096	July 1972
4 <i>Persicaria limbata</i> (MEISSN.) HARA.	Gembu, Nigeria	B.O. Daramola	FHI 86027	17-8-77
	Katagum, Nigeria	Dalziel J.M.	FHI 49877	1907
5 <i>Persicaria attenuata</i> (R.Br.) SOJAK. subsp. <i>pulchra</i> (BLUME) K.L. WILSON	Damaturu, Nigeria	E. Ujor	FHI 23909	16-7-48
	Oguta, Nigeria	Okafor, J.C.	FHI 69335	26-1-74
	Tumu, Ghana	Enwiegbon, J.K. Morton	FHI 52100	30-3-53
	Kaweire, Sierra Leone	J.K. Morton	FHI 21925	24-6-49
	Gongola, Nigeria,	Fagbemi	FHI 89901	12-8-77
6 <i>Persicaria attenuata</i> (R.Br.) SOJAK. subsp. <i>africana</i> K.L. WILSON	Sierra Leone	Morton J.K.	FHI 56739	21-2-64
	Benin, Nigeria	Brenam, J. & E.W. Jones	FHI 39382	25-12-47
	Nagodi, Ghana, Mambilla Plateau, Nigeria, Mubi, Cameroon mt, Cameroon, Zaria, Nigeria	J.K. Morton	FHI 53102	3-4-53
	Benin, Nigeria	G. Ibhanebor	FHI 77873	26-11-75
		P. Wit. & B.O. Daramola	FHI 78216	11-11-73
		Ekwuno, Ike & Odunewu, Fagbemi	FHI 90865	16-6-76
7 <i>Persicaria strigosa</i> (R.Br.) GROSS	Onochie & Ejiofor	Fagbemi	FHI 27146	21-2-53
	Gembu, Nigeria,	M. Reekmans	FHI 98178	Feb. 1979
	Burundi	M. Reekmans	FHI 98629	31-5-79
8 <i>Persicaria senegalensis</i> (MEISSN.) SOJAK <i>f. senegalensis</i>	Mambilla, Nigeria	Mark & de Leeuw.	FHI 58775	16-8-66
	Yola, Nigeria, Bamenda, Cameroon, Akure, Nigeria	Latilo M.G.	FHI 64717	3-12-71
	Lagos, Nigeria,	Hossain M.J.	FHI 43487	20-10-59
	Yola, Nigeria	Ayodele 013	UIH 22223	8-3-95
		Ayodele 007	-	3-7-94
9 <i>Persicaria senegalensis</i> (MEISSN.) SOJAK <i>forma albotomentosa</i> (GRAHAM) K.L. WILSON		Gbile, Wit & Daramola	FHI 65527	6-5-72
	Zaria, Nigeria Yendi, Ghana, Ibadan, Nigeria	A.O. Ohaeri	FHI 102258	31-1-77
	Mambilla Plateau, Nigeria	Adams & Akpabia	FHI 53569	3-12-50
	IITA, Ibadan, Nigeria,	J. Lowe	UIH 20399	3-6-84
	Garshagar	Ayodele	UIH 22221	15-11-95
10 <i>Persicaria salicifolia</i> (BROUSS ex. WILLD.) ASSENOV. subsp. <i>salicifolia</i>	Musa Dagasi	Musa Dagasi	FHI 24868	20-9-49
	Gembu, Nigeria	T.K. Odewo	FHI 87864	23-8-77
	Mambilla, Nigeria	Ekwuno, P.O.	FHI 77271	26-11-75
	Victoria, Cameroon	G. Ogu	FHI 49547	17-8-59
Niger Republic	H.V. Lely	FHI 45270	April 1961	

	Ibadan, Nigeria	Ayodele	UIH 22222	1-4-95
11 <i>Persicaria salicifolia</i> (BROUSS ex. WILLD.) subsp. <i>mambillensis</i>	Badagry, Nigeria	Oyayomi & Osanyinlusi	FHI 78400	21-4-73
	Mambilla Plateau, Nigeria	Ayodele	UIH 22230	22-9-97
12 <i>Persicaria setosula</i> (A. RICH.) K.L. WILSON	Bamenda, Cameroon	Tamajong	FHI 23456	18-8-47
13 <i>Persicaria glomerata</i> S. ORTIZ & J.A.R. PAIVA	Mambilla Plateau, Nigeria	Ayodele	UIH 22233	22-9-97
	Jangla, Cameroon	F.N. Hepper	FHI 54563	5-2-58
	Yelwa, Nigeria	M.G. Latilo	FHI 77449	21-1-76
14 <i>Rumex abyssinicus</i> JACQ.	Gembu, Nigeria	B.O. Daramola	FHI 86014	16-8-77
	Mt. Cameroon, Cameroon	E.W. Jones & Brenam J.P.	FHI 39391	1948
	Mambilla Plateau, Nigeria	T.K. Odewo	FHI 88065	16-8-77
15 <i>Rumex bequaertii</i> DE WILLD.	Oku Bamenda, Cameroon	Hepper F.N. & Bretter F.J.	FHI 53838	17-2-58
	Bamenda, Cameroon	Keay & Ujor Lighthbody, J.S. & Keay RWJ	FHI 30046 FHI 28397	9-4-51 3-1-51
16 <i>Symmeria paniculata</i> BENTH	Njala, Sierra Leone	J.K. Morton	FHI 5317	19-1-54
	Dakar, Senegal	Nonganiema	FHI 17149	18-4-66
17 <i>Afrobrunnichia erecta</i> HUTCH. & DALZ	Eket, Akwa Ibom State, Nigeria	Ayodele/Ariwaodo 004	-	20-4-96
	Kumba, Cameroon	A. Binuyo & B.O. Daramola	FHI 35096	7-1-56
18 <i>Antigonon leptopus</i> HOOK. & ARN.	Ibadan, Nigeria	Alasoadura	UHI 11013	5-2-56
	Ibadan, Nigeria	Ayodele 005	-	11-3-94
	Ago-Iwoye, Nigeria	Ayodele 003	-	18-1-94
19 <i>Harpogocarpus snowdenii</i> HUTCH. & DANDY	Bamenda, Cameroon	Edwin Ujor	FHI 30360	18-5-51
	Bamenda, Cameroon	Brenam	FHI 1712	April 1931
	Bamenda, Cameroon	F.N. Hepper	FHI 53839	7-2-58
	Bamenda, Cameroon	T.A. Russel	FHI 28441	5-1-51

Table 2: Features of the Leaf in West African Polygonaceae

Taxa	Cell Shape	Anticlinal wall	Periclinal wall	Cuticular striation	Trichomes	Stomata
1 <i>Polygonum plebeium</i> R. Br.	Isodiametric	Straight	Straight/Curved	Prominent, parallel	Uniseriate	Anisocytic
2 <i>Oxygonum sinuatum</i> (Meissn.) Dammer	Polygonal	Straight/Curved	Straight/Curved	Random	Absent	Anisocytic
3 <i>Persicaria nepalensis</i> (Meissn.) Gross	Polygonal	Curved/Straight	Straight/Curved	Radiating from stomata	Absent	Cyclocytic/Anomocytic
4 <i>Persicaria limbata</i> (Meissn.) Hara.	Polygonal	Straight/Curved	Straight/Curved	Absent	Aggregated Uniseriate, Tapering	Paracytic
5 <i>Persicaria attenuata</i> (R. Br.) Sojak subsp. <i>pulchra</i> (Blume) K.L. Wilson	Polygonal	Straight	Straight	Absent	Unicellular Uniseriate Tapering	Paracytic
6 <i>Persicaria attenuata</i> (R. Br.) Sojak subsp. <i>africana</i> K.L. Wilson	Polygonal	Straight	Straight	Absent	Unicellular Uniseriate, Tapering, one bifurcating	Paracytic
7 <i>Persicaria strigosa</i> (R. Br.) Gross	Isodiametric to Polygonal	Curved	Curved	Absent	Absent	Paracytic/Anomocytic
8 <i>Persicaria senegalensis</i> (Meissn.) Sojak f. <i>senegalensis</i>	Polygonal	Straight	Straight	Absent	Absent	Paracytic
9 <i>Persicaria senegalensis</i> (Meissn.) Sojak f. <i>albotomentosa</i> (Graham) K.L. Wilson	Obscured by wooly trichomes & wax deposits	Straight	Straight	Absent	Wooly and interwoven	Paracytic
10 <i>Persicaria salicifolia</i> (Brouss. ex. Wild.) Assenov. subsp. <i>salicifolia</i>	Isodiametric to Polygonal with wax deposits	Straight	Straight	Absent	Tapering & spreading	Paracytic
11 <i>Persicaria salicifolia</i> (Brouss. ex. Wild.) Assenov subsp. <i>mambillensis</i> Ayodele	Polygonal	Straight	Straight	Absent	Absent	Paracytic
12 <i>Persicaria setosula</i> (A. Rich.) K.L. Wilson	Polygonal with wax deposits	Straight	Straight	Absent	Absent	Paracytic
13 <i>Persicaria glomerata</i> S. Ortiz and J.A.R. Paiva	Isodiametric	Straight	Straight	Absent	Absent	Paracytic/Diacytic
14 <i>Rumex abyssinicus</i> Jacq.	Polygonal	Straight	Straight depressed	Parallel	Absent	Diacytic
15 <i>Rumex bequaertii</i> De Willd.	Polygonal	Straight	Straight	Random	Absent	Anomocytic

16	<i>Symmeria paniculata</i> Benth.	Isodiametric	Straight	Straight	Absent	Absent	Cyclocyctic
17	<i>Afrobrunnichia erecta</i> Hutch. and Dalz.	Isodiametric	Straight to Curved	Straight to Curved	Radiate	Peltate glands	Anomocytic
18	<i>Antigonon leptopus</i> Hook. and Arn.	Polygonal	Curved	Curved	Absent	Unicellular/ uniseriate, tapering	Anomocytic
19	<i>Harpagocarpus snowdenii</i> Hutch. and Dandy	Irregular	Undulate to sinuate	Undulate to sinuate	Random	Absent	Anomocytic



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Plate 1

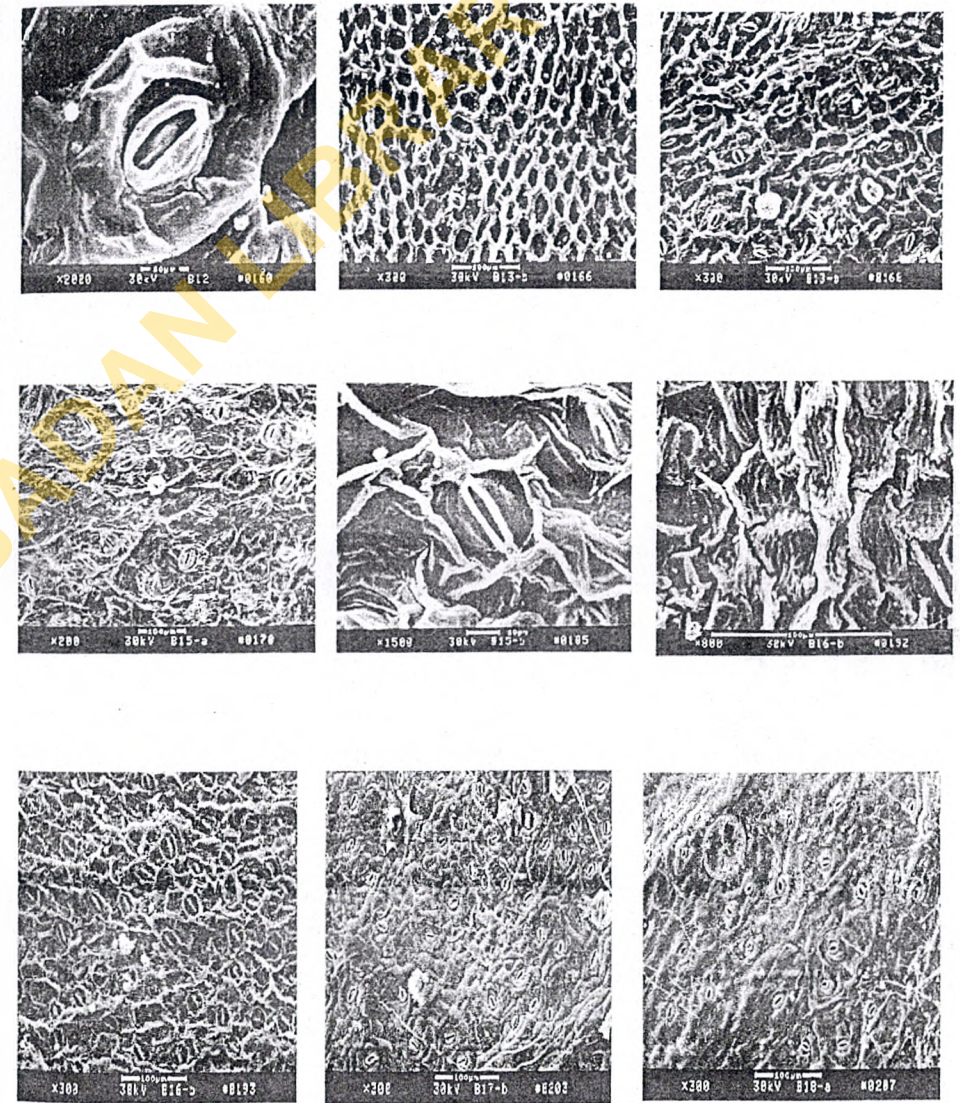
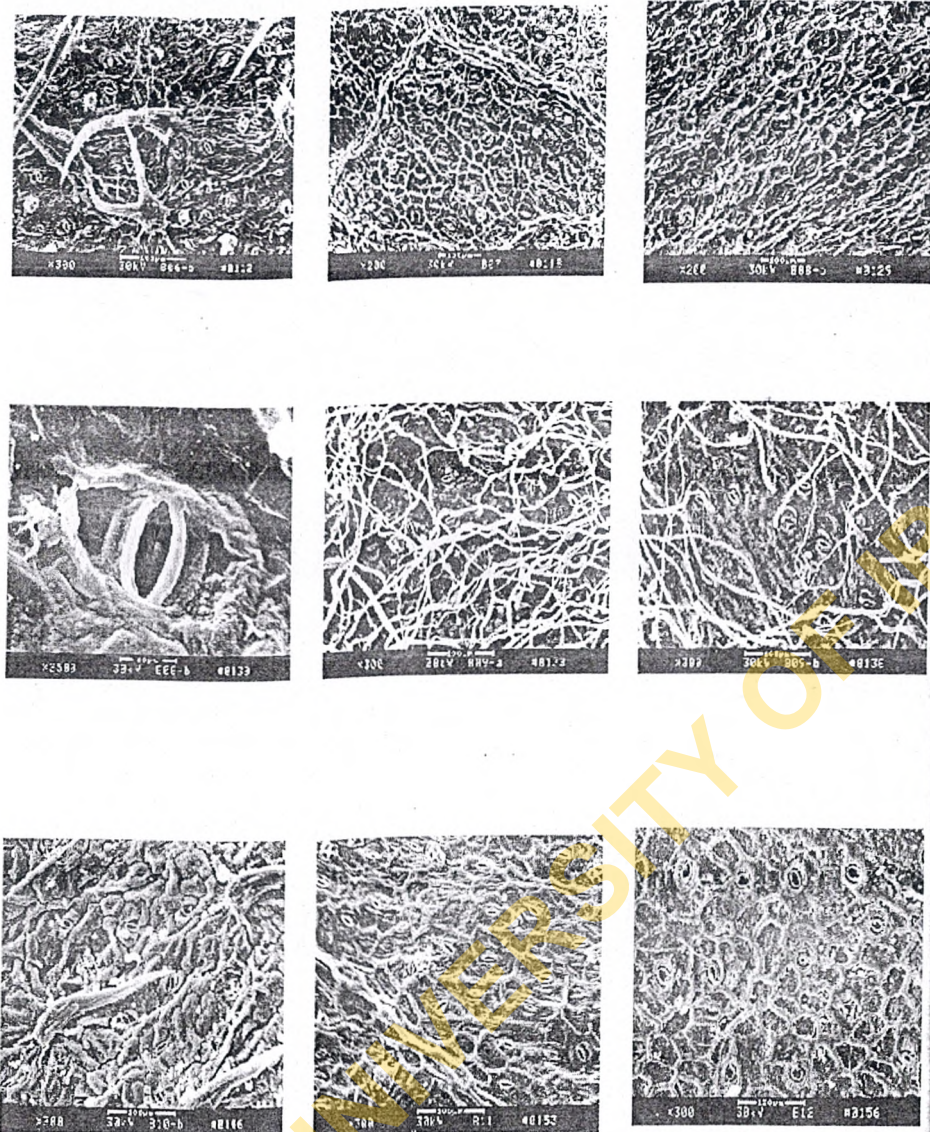
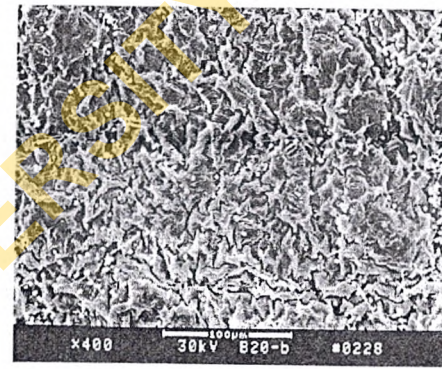
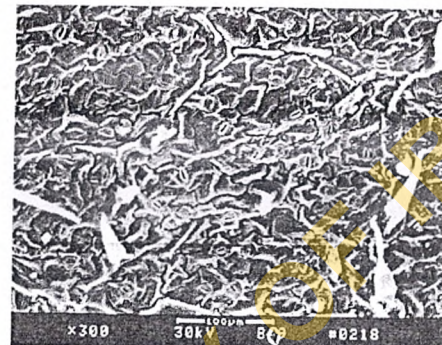
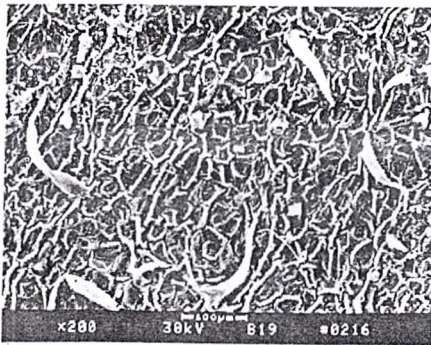
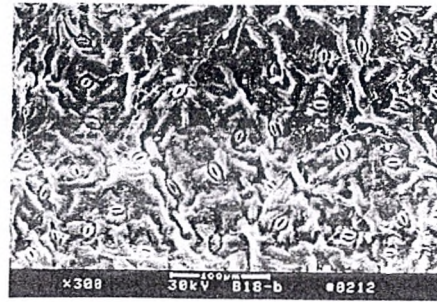


Plate 2

Plate 3



**Legend to Plates**

Plate 1: Photomicrographs of the leaves in the West African Polygonaceae

A&B: *Polygonum plebeium* showing parallel striae, sunken stomata and wax deposits(x200 and x1000)

C: *Oxygonum sinuatum* showing random striae and wax Deposits(x2000)

D, E &F: *Persicaria nepalensis* showing radiating striae from a stoma in D. (x1000, x300 and x2000)

G: *Persicaria limbata* showing a trichome (x1000)

H&I: *Persicaria attenuata* subsp. *pulchra* showing trichomes, sunken stomata and wax deposits (x200 and x2000)

Plate 2: Photomicrographs of the leaves in the West African Polygonaceae

A: *Persicaria attenuata* subsp. *africana* showing wax deposits and Trichomes (x300)

B: *Persicaria strigosa*(x200)

C&D: *Persicaria senegalensis* forma. *senegalensis*(x200 and x2500)

E&F: *Persicaria senegalensis* forma. *albotomentosa* showing interwoven trichomes (x300)

G: *Persicaria salicifolia* subsp. *salicifolia* showing trichomes(x300)

H: *Persicaria salicifolia* subsp. *mambillensis*(x300)

I: *Persicaria setosula*(x300)

Plate 3: Photomicrographs of the leaves in the West African Polygonaceae

A: *Persicaria setosula*(x2000)

B&C: *Persicaria glomerata*(x300)

D&E: *Rumex abyssinicus* showing parallel striae in D. (x200 and x1500)

F&G: *Rumex bequaertii* showing random striae in F. (x800 and x300)

H: *Symmeria paniculata* showing wax deposits on cells. (X300)

I: *Afrobrunnichia erecta*(X300)

Plate 4: Photomicrographs of the leaves in the West African Polygonaceae

A&B: *Afrobrunnichia erecta* showing radiate striae in B. (x300 and x600)

C&D: *Antigonon leptopus* showing trichomes(x200 and x300)

E&F: *Harpogocarpus snowdenii* showing irregular cells with sinuate anticlinal walls and random striae in E.(x800 and x400)

## DISCUSSION

The isodiametric cells are peculiar to *Polygonum plebeium*, *Persicaria glomerata* S. Ortiz & J.A.R. Paiva, *Symmeria paniculata* Benth., and *Afrobrunnichia erecta* HUTCH AND DALZ while they are intermixed with polygonal cells in *Persicaria strigosa* (R.Br.) Gross and *Persicaria salicifolia* (Brouss ex Willd.) Assenov. subsp. *salicifolia* (Table 2, Plates 1-4). *Symmeria paniculata* and *A. erecta* are predominantly high forest species while others are found at different elevations in open habitats (Ayodele, 2003). Thus, cell types are subject to variations at different habitats. Most species in *Persicaria* have polygonal cells. All taxa investigated except *Harpagocarpus snowdenii* HUTCH and DANDY with irregular cells and undulate to sinuate anticlinal and periclinal walls, have straight and rarely curved walls. In most species irregular cells with undulate to sinuate cells were restricted to abaxial surfaces of the leaves except in *H. snowdenii* where they occur on both surfaces (Ayodele & Olowokudejo, 2006). It is known that undulation of the cell wall is a mesomorphic character and that environmental conditions such as humidity play a significant role in determining the pattern of anticlinal cell walls (Stace, 1965). Nevertheless, Sheteolu and Ayodele (1997) and Ayodele and Olowokudejo (2006) have noted that it is not always true that straight to curved walls are characteristic of species growing in drier conditions while undulate walls are found mostly in species growing in areas of high humidity.

Cuticular striation is a common feature of the cells of *Polygonum plebeium*, *Persicaria nepalensis*, *Oxygonum sinuatum* (MEISSN) DAMMER and *H. snowdenii*. However, the present study revealed radiate to parallel and random striae in *A. erecta*, *Rumex abyssinicus* and *R. bequaertii* respectively. Peltate glands have been recorded only in *A. erecta* while most of the trichome types recorded for *O. sinuatum*, *Persicaria nepalensis*, *P. strigosa*, *P. setosula* (A. Rich.) K.L. Wilson, and *H. snowdenii* (Ayodele & Olowokudejo, 2006) were not observed in the present study. This is probably due to the age of the specimens, method of preparation or the extent of the surface examined. Stomata are mainly paracytic or anomocytic although other types such as cyclocytic, diacytic, and anisocytic have been recorded. Most authors (Metcalfe & Chalk, 1950, 1979; Mitchell, 1971 and Ayodele & Olowokudejo, 2006) have shown that the paracytic type is the most common in the family, hence the basic type in the taxon. Stomata may be sunken in *Polygonum plebeium*, *Persicaria attenuata* (R.Br.) Sojak. subsp. *africana* or at the same level with the epidermal cells in other taxa but rarely raised.

Although leaf surface characters show some interesting differences within and among species, the Scanning Electron Microscopy used in the present study provide only a few taxonomically useful characters within the family. The long interwoven threads of *P. senegalensis* forma *albotomentosa* are indeed a reliable criterion for identifying this taxon from the related *Persicaria senegalensis* (Meissn) Sojak. forma *senegalensis* and all other taxa in the family. The same holds for *A. erecta* which has peltate scales only. Furthermore, the peculiar radiating striae from the stomata in *P. nepalensis* differentiate it from all other *Persicaria* in the family where striae are totally absent and from a sister taxon, *Polygonum plebeium* where the striae are parallel and do not emanate from the stomata. The anisocytic stomata type is characteristic of *Polygonum plebeium* and *O. sinuatum* which are the only members of the tribe Polygoneae in West Africa. Both taxa can easily be separated by the cell shape and the orientation of the cuticular striations.

## CONCLUSION

Although the pattern of some of the features in this study may not be consistent enough to be used in identification, they contribute to systematic evidence and are of value in recognizing closely related taxa. Ayodele and Olowokudejo (2006) have noted their values when used in conjunction with macro-morphological characters in the family Polygonaceae.

## ACKNOWLEDGEMENT

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