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The morphology and taxonomic significance of pollen in the West-African Polygonaceae

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Abstract: The pollen of Polygonaceae in West Africa was studied by light microscopy. Three pollen types are recognized. **Type A** is typical of *Polygonum* represented by *P. plebeium*. These pollen grains are small, 17.5 x 12.5 µm to 22.5 x 15 µm, quadrangular and prolate with thin exine walls (1.5 – 2.5 µm). The Pollen **type B** is restricted to the *Persicaria* group. The pollen is of medium size, 34.3 – 45.5 µm polypantoporate, spheroidal with germ pores on the entire surface. **Type C** pollen is possessed by other genera studied. The grains range from small to large, 19.2 x 19.9 µm in *Symmeria paniculata* to 51.6 x 44 µm in *Antigonon leptopus.* They are subprolate, prolate-spheroidal to oblate-spheroidal, triangulate in polar view and oblong, elliptic to round in equatorial view. Palynological evidence supports the segregation of *Persicaria* from *Polygonum* as well as revealed that *Harpagocarpus* is better placed in the tribe Coccolobeae than in the tribe Persicareae.

Keywords: Taxonomy, pollen morphology, Polygonaceae, West-Africa.

Introduction

The Polygonaceae JUSS. is a cosmopolitan family of herbs, shrubs, small trees or climbers characterized by simple leaves with sheathing ochrear stipules, one cell, one ovuled ovary and endospermic seeds (HUTCHINSON & DALZIEL 1954, BRUMMIT 1992). The family is generally considered to be made up of 30 to 49 genera embracing about 750 species (HEYWOOD 1978, BRUMMIT 1992). Most genera are restricted to the

Northern temperate regions while others are tropical or subtropical (HEYWOOD 1978). The species of this family are widely distributed in Nigeria, Ghana, Sierra – Leone, Senegal, Liberia, Cote D 'voire and Cameroon (AYODELE 2003).

The dearth of knowledge on the tropical taxa of the Polygonaceae has made identification of taxa difficult and has contributed to the lack of understanding of the intricate patterns of character variation within the group. Recent studies on the family (AYODELE 2000) have yielded useful data concerning intra and – inter – specific variation patterns as well as geographical relationship of some taxa (AYODELE & OLOWOKUDEJO 2002). The value of pollen morphology in the Polygonaceae has much been realized by several workers who have used it in their taxonomic treatment of the family (GROSS 1913, WODEHOUSE 1931, HEDBERG 1946, NOWICKE & SKVARLA 1977). WODEHOUSE (1931) pointed out that the pollen grains in the family are many without any universal similarities, thus difficult to define. With regard to the morphology of the grains, he considered the family as a transitional one standing at the parting of ways. Remarkable variations of great and obvious taxonomic value are said to occur among species of *Polygonum* LINN. (STUESSY 1990, NOWICKE & SKVARLA 1979) based on pollen morphology. These have been used in the taxonomic division of the genus into seven genera – *Koenigia* LINN., *Persicaria* MILL., *Polygonum* s.s., *Pleuropteropyrum* JAUB. & SPACH., *Bistorta* MILL., *Tiniaria* MEISSN., and *Fagopyrum* GAERTN. by HEDBERG (1946), an arrangement which according to DAVIS & HEYWOOD (1963) is accepted by a number of workers. DEN-NIJS et al. (1980) found pollen diameter and sculptural characteristics of no diagnostic value in *Rumex acetosella* LINN. due to their high degree of homogeneity at every ploidy level though a progressive increase in diameter from 2x to the 4x and to the 6x was observed.

Pollen grains of different species of *Polygonum* have certain amounts of morphogenetic affinity and some of them, according to NANDI et al. (1984) have similarities with the pollen grains of families such as Amaranthaceae, Chenopodiaceae, Nyctaginaceae and Caryophyllaceae. Such similarities are evident from the shape, appertural, configurations and surface ornamentations of the pollens.

The present paper describes the pollen types and shows the significance of this character in the taxonomy of the family in West Tropical Africa.

Material and methods

Specimens of the family Polygonaceae were studied in the following herbaria: Forestry Research Herbarium (FHI), Ibadan, University of Lagos Herbarium (LUH), Herbarium of the Department of Botany and Microbiology, University of Ibadan (UIH) and Herbarium of the Department of Botany, Obafemi Awolowo University (IFE). Field studies and collections were made during trips to various parts of the country including Lagos, Ibadan, Ago-Iwoye, Ijebu-Igbo and Akure, all in the southwest and Kakara, Kusuku and Tapari in the Mambilla Plateau, Northeastern Nigeria. The list of all specimens studied is shown in Table 1.

Tab. 1. List of Specimens of Polygonaceae examined.

	Taxa	Locality	Collection(s)	Herbarium	Date
1	*Polygonum plebeium* R.BR.	Sokoto, Nigeria Bawku, Ghana	M.G. Latilo,	FHI 62592	20-7-69
			J.K. Morton	FHI 53461	25-12-54
2	*Oxygonum sinuatum* (MEISSN.) DAMMER	Borno State, Nigeria	Ekwuno & Fagbemi	FHI 94033	30-9-80
3	*Persicaria nepalensis*	Bamenda, Cameroon.	J.K. Morton	FHI 53591	31-4-55
	(MEISSN.) GROSS	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
4	*Persicaria limbata*	Katagun, Nigeria	Dalziel, J.M	FHI 49877	1907
	(Meissn.) HARA.	Damaturu, Nigeria	E. Ujor	FHI 23909	16-7-48
5	*P. attenuata*	Oguta, Nigeria.	Okafor		
	(R.BR) SOJAK.		Enwiogbon,	FHI 69335	26-1-74
	subsp. *pulchra* (BLUME) K.L.	Tumu, Ghana	J.K. Morton	FHI 52100	30-3-53
	WILSON	Kaweire, Siera Leone	J.K. Morton	FHI 21928	24-6-49
6	*P. attenuata*	Nagodi, Ghana	J.K. Morton	FHI 53102	3-4-53
	(R.BR) SOJAK.	Mambilla, Nigeria	G. Ibhanesebor	FHI 77873	26-11-75
	subsp *africana*	Mubi, Cameroon	P. Wit. & B.O.		
	K.L. WILSON		Daramola	FHI 78216	11-11-73
7	*P. strigosa* (R.BR) GROSS	Gembu, Nigeria	M. Reekmans	FHI 98178	Feb. 1979
8	*P. senegalensis* (MEISSN.) SOJAK	Yola, Nigeria, Bamenda,	Latilo M.G.	FHI 64717	3-12-71
	f. senegalensis	Cameroon,	Hossain M.J.	FHI 43487	20-10-59
		Akure, Nigeria	Ayodele 013	UIH 22223	8-3-95
9	*P. senegalensis*	Zaria, Nigeria	A.O. Ohaeri	FHI 102258	31-1-77
	(MEISSN.) SOJAK	Yendi, Ghana	Adams &Akpabla	FHI 53569	3-12-50
	f. albotomentosa (GRAHAM) K.L.	Ibadan, Nigeria Mambilla,	J. Lowe	UIH 20399	3-6-84
	WILSON	Nigeria	Ayodele	UIH 22221	15-11-95
10	*P. salicifolia*	Gembu, Nigeria	T.K. Odewo	FHI 87864	23-8-77

	(BROUSS ex. WILLD.) ASSENOV. subsp. *salicifolia*	Mambilla, Nigeria	Ekwuno, P.O.	FHI 77271	26-11-75
		Victoria, Cameroon	G. Ogu	FHI 49547	17-8-59
11	*P. salicifolia* (BROUSS ex. WILLD.)	Badagry, Nigeria	Oyayomi & Osanyinlusi Ayodele	FHI 78400	21-4-73
	subsp. Mambillensis AYODELE	Mambilla, Nigeria		UIH 22230	22-9-97
12	*P. setosula* (A. RICH.) K.L. WILSON	Bamenda Cameroon,	Tamajong	FHI 23456	18-8-47
13	*P. glomerata* S. ORTIZ & J.A.R. PAIVA	Mambilla, Nigeria	Ayodele	UIH 22232	21-9-97
		Jangla, Cameroon	F.N. Hepper	FHI 54563	5-2-58
14	*Rumex abyssinicus* JACQ.	Gembu, Nigeria	B.O. Daramola	FHI 86014	16-8-77
15	Rumex *bequaertii* DE WILLD.	Fon	Hepper F.N.	FHI 53838	17-2-58
16	*Symmeria paniculata* BENTH.	Njala, Sierra Leone	J.K. Morton	FHI 5317	19-1-54
		Dakar, Senegal	Nonganiema	FHI 17149	18-4-66
17	*Afrobrunnichia erecta* HUTCH. & DALZ.	Eket, C.R.S,Nigeria	Ayodele / Ariwaodo 004.	-	20-4-96
		Kumba, Cameroun	A. Binuyo & B.O. Daramola.	FHI 35096	7-1-56
18	*Antigonon leptopus* HOOK. & ARN.	Ibadan, Nigeria.	Nasoadura,	UHI 11013	5-2-56
		Ibadan, Nigeria	Ayodele 005	-	11-3-94
		Ago- Iwoye, Nigeria	Ayodele 003	-	18-1-94
19	*Harpagocarpus snowdenii* 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

Pollen Morphology

Pollen morphology was studied using the acetolysis method (ERDTMAN 1960). Dried herbarium specimens and dried buds of field collections were used for the study. The flower buds were crushed with a glass rod in centrifuge tubes. About 3ml of the freshly prepared acetolysis mixture (9 part acetic anhydride to 1 part concentrated Tetraoxosulphate VI acid) was added to the content in the tubes and heated in water bath at 70^{0}C to boiling point, stirring the tubes occasionally. The tubes were left in the water bath for about three minutes after which the mixture was centrifuged at 4000 r.p.m. for about five minutes. The supernatant was decanted into specially labelled bottles (acetolysis waste bottles) leaving the sediments in the tubes. Water was added to the sediment in the tubes and shaken vigorously until it foamed. Drops of ethanol were added to remove the foam and the suspension was centrifuged and the supernatant decanted. The washing with water and centrifuging was repeated four times. Fifty percent aqueous glycerine was added to the sediments and left for two hours. The tubes were shaken vigorously and centrifuged for ten minutes at 4000 r.p.m., decanted and inverted over filter paper to drain. The tubes were left in this position for three hours after which 100% glycerine was added to each tube and shaken vigorously. The mixture was then transferred into appropriately labelled storage vials. Slides of the pollen grains were prepared by placing a drop of each content in the storage vial, after shaking, on to a slide and covered with the cover slip. These were sealed using paraffin wax.

The pollen grains were observed and studied using the Kyowa Medilux 12 Microscope. Photomicrographs were taken using the Reichert Microstar IV Microscope with a camera attachment. Descriptive statistics of mean value and standard deviation were calculated for all variables based on twenty measurements. Descriptive terminology is based on MOORE et al. (1991) and ERDTMAN (1952). All slides and storage vials are deposited in the herbarium of the Botany and Microbiology, University of Ibadan, Ibadan.

Results

Three pollen types are recognized for the West African taxa of the Polygonaceae based on light microscopy. These are described below:

Type A

This is the typical *Polygonum plebeium* R.BR. type, the taxon being the only representative in the tribe Polygoneae of the Polygonaceae in West Africa.

The pollen grains are small, 17.5 x 12.5 µm to 22.5 x 15 µm, quadrangular and prolate with thin exine which may be about 1.5 to 2.5 µm thick, tetracolpate with the ectocolpi running meridionally and one continuous endocolpus running equatorially and forming a complete girdle to the grain (Tab. 2, Fig. 1A & B).

Type B

This is *Persicaria* type. All *Persicaria* species investigated have this type of grains. The pollen grains are of medium size 34.3 – 45.5 µm in diameter. All the

grains are polypantoporate, spheroidal with germ pores distributed throughout the entire surface of the grains, furrows are absent and the pores are usually 20-30 in number (Tab. 2, Fig. 1E &F).

Type C

All the grains of other genera fall into this type. They range from small to large, subprolate, prolate spheroidal to oblate spheriodal, triangulate in polar view and oblong, elliptic to rounded in equatorial view. The grains range from 19.2 x 19.9 µm in *Symmeria paniculata* BENTH. to 51.6 x 44 µm in *Antigonon leptopus* HOOK & ARN. and are either dicopate or mainly tricolpate (Tab. 2, Fig. 1 G-S).

Discussion

Palynological evidence obtained from this study shows the naturalness of the *Persicaria* species with their spheroidal and polypantoporate grains (Type B, Fig. 1E & F). The pollen type is common to all *Persicaria* species (HEDBERG 1946, WODEHOUSE 1931) and it further justifies the segregation of this group from *Polygonum* s. lat.

The only representative taxon of *Polygonum* s.s., *P. plebeium* has the type A grain which is quadrangular and prolate (Fig. 1A & B). This type was recognized as the *Avicularia* LINN. type by HEDBERG (1946).

Based on pollen morphology, *Harpagocarpus snowdenii* HUTCH. & DANDY is best placed in the tribe Coccolobeae than in the tribe Persicareae. This taxon has very similar pollen (type C, Fig. 1G – S) with *Afrobrunnichia erecta* HUTCH. & DALZ. and *Antigonon leptopus*.

WODEHOUSE (1931) considered the tricolpate grain to be the basic type in the family although according to him, more furrowed grains are encountered.

Data from pollen are known to be useful at all levels of the taxonomic hierarchy. Pollen can help in suggesting relationships as in *Sonneratia* LINN. f. (MUELLER 1978) at the specific level or to determine variation within a species or even below the species level (STUESSY 1990). Pollen data have been used at generic and sub-generic levels to a good effect (BLACKMORE 1981). TRYTON (1986) examined 250 genera of the Pteridophyta and was able to divide them into five main spore types based on shape, aperture, surface ornamentation and wall structure. The groups correspond well with classifications of their genera on whole plant morphological characters. The same results have been obtained by GUINET (1986) on the taxonomically complex genus *Acacia* MILL. in Australia.

However, it has been noted that of all morphological characters of the pollen grain, the shape is less useful taxonomically (DAVIS & HEYWOOD 1963, MOORE et al. 1991) because it can vary considerably within one grain type or even within one species and the variation can be caused by the choice of extraction methods and embedding media (MOORE et al. 1991). The pollen types obtained for the West African taxa are taxonomically useful in the recognition of the taxa as well as support the morphological delimitation of the genera in the family Polygonaceae.

Tab. 2. Pollen grains morphology of selected taxa of family Polygonaceae.
[All measurements in microns (Range / Mean ± standard error).]

Taxa	Polar axis (P)	Equatorial diameter (E)	Exine thickness	Amb	Shape class	P/E (%)	Pollen size
Tribe *Polygoneae*							
1. Polygonum plebeium	17.5-22.5 20.3±0.4	12.5-15.0 14.3±0.3	1.5-2.5 1.9±0.1	Quadra	Prolate	141.3	Small
2. Oxygonum sinuatum	45.0-55.0 50.8±1.2	30.0-40.0 35.5±1.1	2.5-5.0 4.5±0.2	P-Triangular E-Oblong / Circular	Prolate	143.1	Large
Tribe *Persicarieae*							
3. Persicaria nepalensis	40.0-60.0 45.5±1.5	N. A	Indistinct	Circular	Sphero	N. A	Medium
4. P. limbata	30.0-45.0 36.8±1.5	N. A	Indistinct	Circular	Sphero	N. A	Medium
5. P.attenuata subsp. pulchra	35.0-50.0 42.5±1.3	N. A	Indistinct	Circular	Sphero	N. A	Medium
6. P.attenuata subsp.africana	26.0-45.0 36.2±1.8	N. A	Indistinct	Circular	Sphero	N. A	Medium
7. P. strigosa	20.0-40.0 34.3±1.9	N. A	Indistinct	Circular	Sphero	N. A	Medium
8. P. senegalensis f. senegalensis	35.0-50.0 43.8±1.1	N. A	Indistinct	Circular	Sphero	N. A	Medium

9. P.senegalensis f. albotomentosa	35.0-50.0 41.4±0.7	N. A	Indistinct	Circular	Sphero	N. A	Medium
10. P. salicifolia subsp. salicifolia	35.0-50.0 41.0±0.4	N. A	Indistinct	Circular	Sphero	N. A	Medium
11. P.salicifolia subsp. mambillensis	35.0 – 45.0 42.2±0.6	N. A	Indistinct	Circular	Sphero	N. A	Medium
12. P. setosula	33.0-45.0 38.5±1.2	N. A	Indistinct	Circular	Sphero	N. A	Medium
13. P. glomerata	25.0-50.0 40.5±2.1	N. A	Indistinct	Circular	Sphero	N. A	Medium
Tribe *Rumiceae*							
14. Rumex abyssinicus	20.0-25.0 23.6±0.7	16.0-25.0 20.6±0.7	1.5-2.1 2.0±0.1	Elliptic / Round	Prolate/ Sphero to Sub-p	114.1	Small
15. R. bequaertii	25.0-30.0 26.4±0.7	25.0-27.0 25.3±0.20	2.0-2.5 2.2±0.1	P- Triangular E-Elliptic / Round	Prolate Sphero	104.3	Medium
Tribe *Triplareae*							
16. Symmeria paniculata	15.0-20.0 19.2±0.5	17.5-22.5 19.9±0.4	2.5-4.0 3.0±0.2	P- Triangular E-Elliptic / Round	Oblate Sphero	96.6	Small

Tribe *Coccolobeae*							
17. Afrobrunnichia erecta	40.0-50.0 44.3±1.0	35.0-45.0 39.6±1.0	2.5-5.0 3.1±0.3	Elliptic / Round	Prolate Sphero	111.9	Medium
18. Antigonon leptopus	40.0-60.0 51.6±1.5	30.0-50.0 44.0±1.6	4.0-5.0 4.62±0.1	P-Triangular E-Oblong	Sub-p	117.2	Large
19. Harpagocarpus snowdenii	25.0-35.0 28.6±1.0	22.5-30.0 27.3±0.8	2.3-2.8 2.5±0.1	P-Triangular E-Round	Prolate Sphero	105.0	Medium

Sphero = Spheroidal
Sub-p = Sub-prolate
N. A = Not applicable
Quadra =Quadrangular
P = Polar axis
E = Equatorial plane

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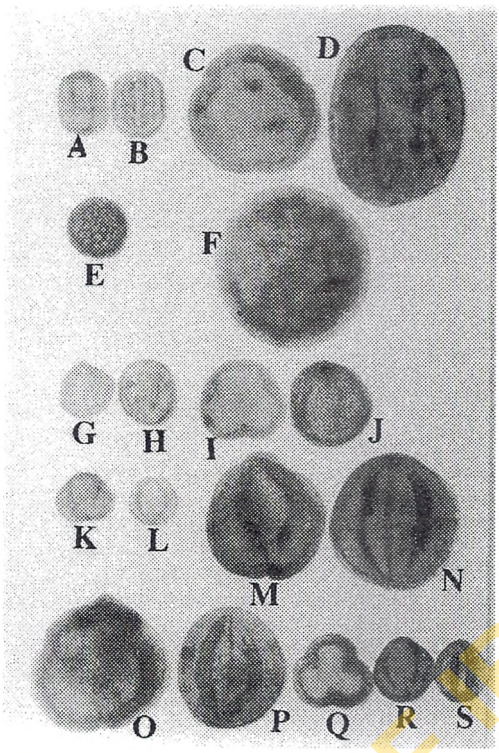

Fig. 1. Photomicrographs of pollen grains of Polygonaceae.

A - D: Tribe Polygoneae

A & B. *Polygonum plebeium* (Sokoto, Latilo, 62592, FHI).

C. Polar view, *Oxygonum sinuatum* (Borno, Ekwuno & Fagbemi; 94033, FHI)

D. Equatorial view, *O. sinuatum* (Borno, Ekwuno & Fagbemi; 94033, FHI)

E & F: Tribe Persicarieae

E. *Persicaria attenuata subsp.africana* (Ibadan, Ayodele, 22234, UIH). Typical for all *Persicaria* species.

F. *P. setosula* (Bamenda, Tamajong, 23456, FHI). Typical for all *Persicaria* species.

G - J: Tribe Rumiceae

G. Polar view, *Rumex abyssinicus* (Gongola, Daramola, 86014, FHI).

H. Equatorial view, *R. abyssinicus* (Gongola, Daramola, 86014, FHI).

I. Polar view, *R. bequaerti* (Hepper, 53838, FHI).

J. Equatorial view, *R. bequaerti* (Hepper, 53838, FHI).

K - L: Tribe Triplareae

K. Polar view, *Symmeria paniculata* (Njala, Morton, 5317, FHI).

L. Equatorial view, *S. paniculata* (Njala, Morton, 5317, FHI).

M - S: Tribe Coccolobeae

M. Polar view, *Afrobrunnichia erecta* (Eket, Ayodele/Ariwaodo, 004).

N. Equatorial view, *A. erecta* (Eket, Ayodele/Ariwaodo, 004).

O. Polar view, *Antigonon leptopus* (Ibadan, Ayodele, 005).

P. Equatorial view, *A. leptopus* (Ibadan, Ayodele, 005).

Q. Polar view, *Harpagocarpus snowdenii* (Bamenda, Hepper, 53839, FHI).

R. Equatorial view, *H. snowdenii* (Bamenda, Hepper, 53839, FHI).

S. Equatorial view, *H. snowdenii* (Bamenda, Hepper, 53839, FHI).

Scale bar = 14µm except 'E' = 56µm

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