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Research article

STRUCTURAL DIVERSITY OF STOMATA IN SOME MONOCOTYLEDONOUS WEEDS

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ABSTRACT

23 herbaceous taxa distributed in 9 orders and 10 monocotyledonous families were documented on nature of stomata. Only arched epidermal cells were observed. Anomocytic, paracytic, tetracytic and hexacytic and mixed stomata were recorded. Stomata size ranged from 17.47µm ± 0.23 x 16.13µm ± 0.29 in Smilax kraussiana to 58.80µm ± 0.33 x 50.40µm ± 0.39 in Commelina benghalensis and stomata index values varying from 0.57% in Aframomum sceptrum to 14.40% in Rhaphidophora africana were documented in this study.

Keywords: Leaf Epidermis, Stomata Type and Size, Monocotyledonous Weeds.

INTRODUCTION

Weeds are associated with man and his activities, they divert energy from the desired crop production, thriving best in disturbed environments, are able to survive un-favorable ecological conditions by having storage organs and producing abundant seeds (Ogbe and Osawaru, 1988). In Africa, total losses in yield of crop plants due to weeds range from 10 to 50% (Okigbo, 1980), though losses as high as 90% have been recorded in Indian sub-continent (Josh, 1977). Though weeds compete adversely with crop plants, but they also play an important role after crop harvest and subsequent fallow periods in that they protect soils from the erosive action of rainfall and winds with leguminous weedy forms serving as soil binders, nitrogen fixers and soil cover plants (Hill, 1997).

Stomata serve for gaseous communication between the internal and external environment of an higher green plant (Swarthout, 2008). Stomata are minute functional pores on the leaf and stem epidermis (Roberts, 1978). Physiological functions like photosynthesis, respiration and transpiration takes place with the help of stomata as it is through them that inter- change of gases such as oxygen, carbon-dioxide and also water

vapour passes between the inter-cellular space of the internal tissues of the higher green plants and the outer atmosphere (Pandey and Chadha, 2006). Stomata can also be diagnostic as a systematic tool in the classification of problematic higher plant taxa (Ogbe. and Osawaru, 1988). Earlier contributors on phytodermology and stomata studies of monocotyledonous species worldwide includes Metcalfe, 1960, 1969 Stebbins and Khush (1961), Tomlinson (1969), Ayensu (1972) and Fatemeh Zarinkamar (2006). In Nigeria, researchers on stomata of monocotyledonous species include Ekundayo (1962), Olatunji (1980) Gill and Mensah (1983) Green (1987), Nyawuame and Gill (1990), Ogundipe (1991a, 1991b), Ogundipe and Olatunji (1989, 1991), Chinyere Nwokocha (1996), Ajayi and Glory Ogundipe (1997), Uduak and Akpabio (2005). In spite of the importance of the stomata apparatus in plant physiology and taxonomy, information on it's structure and size in Nigerian monocotyledonous taxa is minimal. This study is an additional report on stomata structure and size in Nigerian monocotyledonous species.

MATERIALS AND METHODS

Leaf specimens collected, identified at Forest Herbarium Ibadan (FHI) and later deposited as voucher materials at the University of Benin herbarium were used for the study. The designations HIO and HORW are voucher specimens from Okomu oil palm and lyanomo rubber plantations respectively by Onyibe (1987, 1990). OBM collections were by the present authors, all collections within Edo State, Nigeria.

Abaxial leaf surface records only were taken because of confinement constancy of stomata on lower leaf surface. The leaf portions were de-colourised by immersion in 90% alcohol and were washed in 5 changes of distilled water after which they were kept in a beaker of 5% sodium hydroxide solution immersed in a water bath at 100^0Celsius for ten minutes to further enhance leaf de-colourisation and later washed in 5 changes of distilled water after which they were mounted at uniform magnification of X400.

Terminologies of stomata complex types used after Metcalfe and Chalk, (1960a, b, 1969). Size measurements were carried out on 50 stomata for each taxon investigated with ocular graticule using a Swift collegiate light microscope. Number of stomata per field of view was recorded. Stomata index after Dilcher 1974 were calculated as a percentage of the number of stomata to total number of epidermal cells plus stomata per unit area.

$$\text{S.I} = \frac{S}{E+S} x \frac{100}{1}$$

For statistical analysis, Standard error was determined for all taxa.

RESULTS

Qualitative and Quantitative Stomata Characters of the Monocotyledonous weeds after phylogenetic sequence as reported in Hutchinson and Dalziel (1968) Flora of West Tropical Africa (F.W.T.A) in Tables 1 and 2 respectively.

Table 1: Qualitative Stomata Characters of the Monocotyledonous Weeds.

S/N	Taxon	HABIT	Foliar Material	Epidermal Pattern	Stomata Type
1.	Order Commelinales Family Commelinaceae *Aneilema beniniense* (P. Beauv.,) Kunth.,	Herb	HIO -07	Arched	Paracytic
2.	*Commelina benghalensis* L.,	Herb	HORW-152	Arched	Hexacytic
3.	*Cyanotis ceaspitosa* Kotschy and Peyr.,	Herb	OBM-78	Arched	Anomocytic and Paracytic
4.	*Palisota ambigua* (P. Beauv.,) C. B. CL.,	Herb	HIO-67	Arched	Anomocytic
5.	*P. barteri* Hook.,	Herb	HORW-110	Arched	Anomocytic
6.	*P. hirsuta (*Thunb.,) K. Schum.,	Herb	HORW-181	Arched	Anomocytic and Paracytic
7.	Order Zingiberales Family Zingiberaceae *Aframomum danielli* K. Schum	Herb	HORW-184	Arched	Anomocytic
8.	*A. sceptrum* (Oliv and Hanb.,) K. Schum.,	Herb	HIO-61	Arched	Paracytic
9.	Family Costaceae *Costus afer* Ker, Gawl.	Herb	HORW-185	Arched	Paracytic
10.	Family Cannaceae *Canna indica* L.,	Herb	HORW-149	Arched	Paracytic
11.	Order Liliales Family Liliaceae *Gloriosa superba* L.,	Herb	HORW-059	Arched	Paracytic
12.	Family Smilacaceae *Smilax kraussiana* Meisn	Herb	HIO-140	Arched	Anomocytic
13.	Order Arales Family Araceae *Anchomanes difformis* (BL.,) Engl.,	Herb	HORW-048	Arched	Paracytic
14.	*Culcasia glandulosa* Hepper	Herb	HORW-171	Arched	Tetracytic
15.	*C. scandens* P. Beauv.,	Herb	HORW-056	Arched	Anomocytic
16.	*Rhapidophora africana* N. E. Br.,	Herb	HIO-045	Arched	Anomocytic
17.	*Xanthosoma mafaffa* Schott.,	Herb	HIO-163	Arched	Paracytic
18.	Order Dioscoreales Family Dioscoreaceae *Dioscorea minutiflora* Engl.,	Herb	HORW-121	Arched	Anomocytic
19.	Order Orchidales Family Orchidaceae *Eulophidium maculatum* (Lindl.,) Pftz.	Herb	HORW-059	Arched	Anomocytic
20.	Order Poales Family Poaceae *Brachiaria deflexa* Robyns	Herb	HIO-199	Arched	Paracytic
21.	*Coix lacryma*-jobi L.,	Herb	OBM-80	Arched	Paracytic
22.	*Panicum brevifolium* L.,	Herb	HIO-36	Arched	Anomocytic
23.	*P. maximum* Jacq.,	Herb	OBM-81	Arched	Anomocytic

Table 2: Quantitative Stomata Characters of the Monocotyledonous Weeds.

S/N	Taxon	Stomata Length (µm)± S.E.	Stomata Breadth (µm)± S.E.	Pore Size (µm)± S.E.	Stomata Per Field of View	Stomata Index Percentage
1.	Order Commelinales Family Commelinaceae *Aneilema beniniense* (P. Beauv.,) Kunth.,	38.64±0.65	20.66±0.27	30.24±0.34	3	3.60
2.	*Commelina benghalensis* L.,	58.80±0.33	50.40±0.39	33.60±0.38	8	11.76
3.	*Cyanotis ceaspitosa* Kotschy and Perr.,	42.00±0.39	30.24±0.30	33.60±0.31	5	20
4.	*Palisota ambigua* (P. Beauv.,) C. B. CL.,	29.06±0.30	26.88±0.34	22.85±0.34	4	11.76
5.	*P. barteri* Hook.,	33.60±0.36	21.00±0.27	29.40±0.32	1	4.30
6.	*P. hirsuta* (Thunb.,) K. Schum.,	33.60±0.39	18.48±0.24	25.20±0.33	4	7.40
7.	Order Zingiberales Family Zingiberaceae *Aframomum danielli* K. Schum	27.89±0.35	18.48±0.23	18.48±0.53	8	3.84
8.	*A. sceptrum* (Oliv and Hanb.,) K. Schum.,	31.25±0.29	18.48±0.30	18.98±0.28	2	0.57
9.	Family Costaceae *Costus afer* Ker, Gawl.	28.56±0.32	16.80±0.20	20.10±0.23	2	0.66
10.	Family Cannaceae *Canna indica* L.,	26.88±0.52	19.49±0.22	18.48±0.24	15	9.09
11.	Order Liliales Family Liliaceae *Gloriosa superba* L.,	43.01±0.37	26.88±0.30	31.92±0.32	5	11
12.	Family Smilacaceae *Smilax kraussiana* Meisn	17.47±0.23	16.13±0.29	10.75±0.17	10	6.25
13.	Order Arales Family Araceae *Anchomanes difformis* (BL.,) Engl.,	47.04±0.31	20.50±0.27	32.26±0.28	10	9.09
14.	*Culcasia glandulosa* Hepper	22.85±0.25	15.62±0.24	15.62±0.22	6	2.90
15.	*C. scandens* P. Beauv.,	25.70±0.28	16.80±0.22	22.34±0.32	2	2.77
16.	*Rhapidophora africana* N. E. Br.,	17.81±0.22	9.41±0.16	14.78±0.21	22	14.40
17.	*Xanthosoma mafaffa* Schott.,	32.93±0.33	17.07±0.24	18.48±0.32	10	10
18.	Order Dioscoreales Family Dioscoreaceae *Dioscorea minutiflora* Engl.,	19.49±0.26	7.56±0.11	12.26±0.23	10	3.20
19.	Order Orchidales Family Orchidaceae *Eulophidium maculatum* (Lindl.,) Pftz.	31.25±0.24	22.85±0.28	19.32±0.24	2	3.20
20.	Order Poales Family Poaceae *Brachiaria deflexa* Robyns	19.49±0.25	16.13±0.23	16.80±0.20	3	10.70
21.	*Coix lacryma*-jobi L.,	44.35±0.41	16.80±0.23	22.80±0.20	5	9.04

22.	*Panicum brevifolium* L.,	26.88±0.25	24.36±0.31	23.52±0.20	3	13.04
23.	*P. maximum* Jacq.,	24.53±0.26	18.48±0.28	17.81±0.21	2	1.96

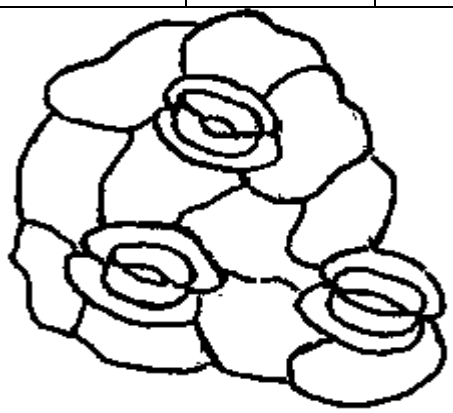

Figure 1: *Aneilema beniniense*: Paracytic Stomata

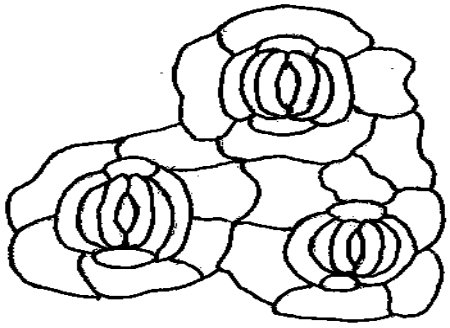

Figure 2: *Commelina benghalensis*: Hexacytic Stomata

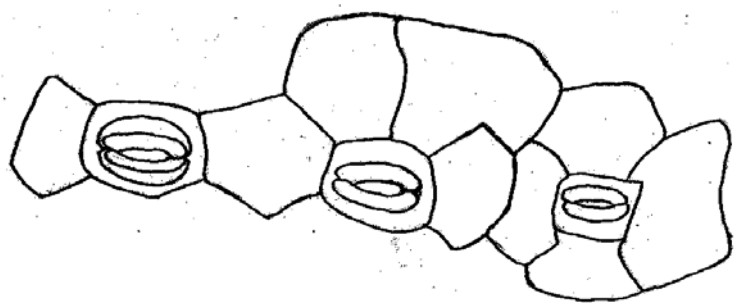

Figure 3: *Cyanotis ceaspitosa*: Anomocytic and Paracytic Stomata

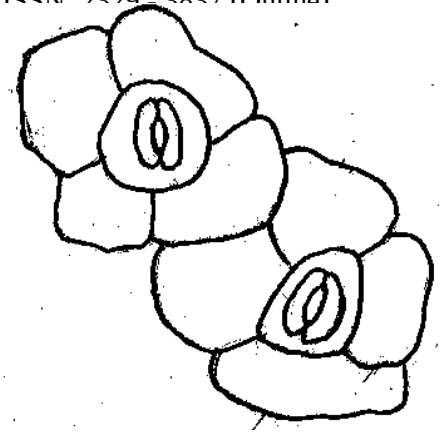

Figure 4: *Palisota ambigua*: Anomocytic Stomata

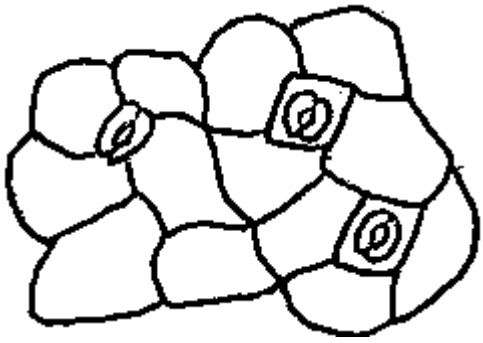

Figure 5: *P. barteri*: Anomocytic Stomata

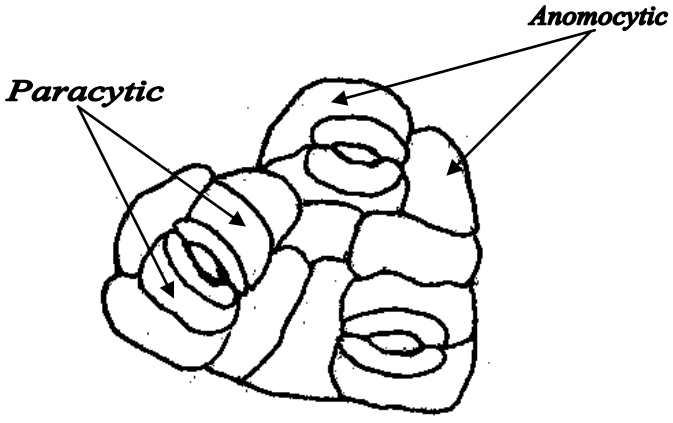

Figure 6: *P. hirsuta*: Anomocytic and Paracytic Stomata

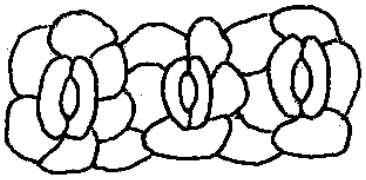

Figure 7: *Aframomum danielli*: Anomocytic Stomata

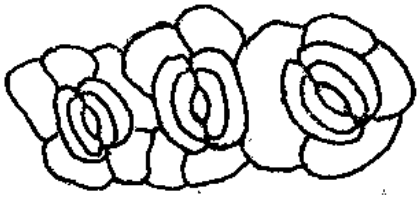

Figure 8: *A. sceptrum*: Paracytic Stomata

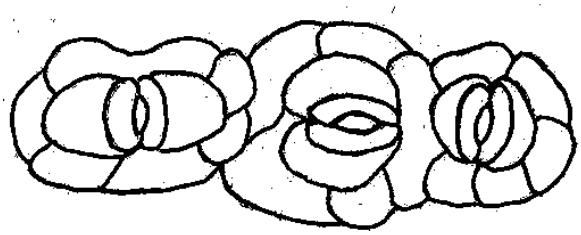

Figure 9: *Costus afer*: Paracytic Stomata

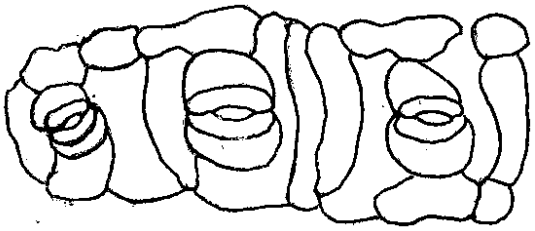

Figure 10: *Canna indica*: Paracytic Stomata

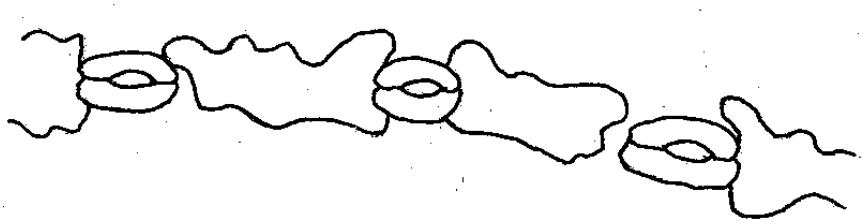

Figure 11: *Gloriosa superba*: Anomocytic Stomata

Figure 12: *Smilax kraussiana*: Anomocytic Stomata

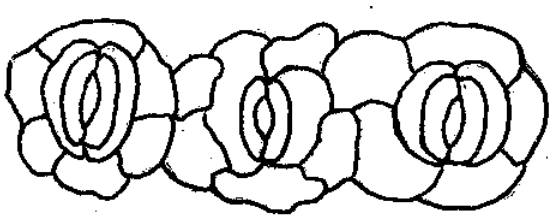

Figure 13: *Anchomanes difformis*: Paracytic Stomata

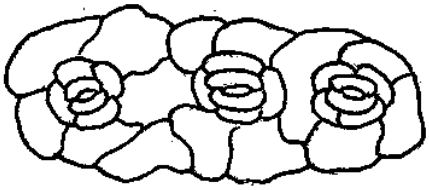

Figure 14: *Culcasia glandulosa*: Tetracytic Stomata

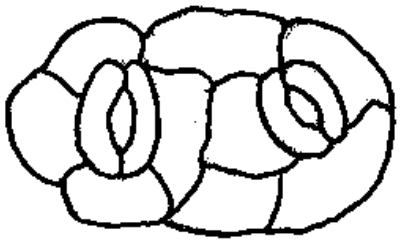

Figure 15: *C. scandens*: Anomocytic Stomata

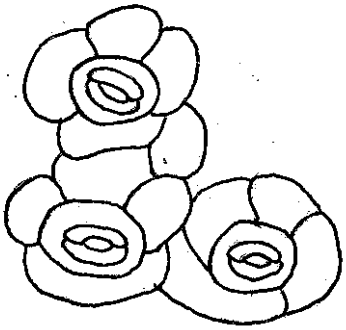

Figure 16: *Rhapidophora africana*: Anomocytic Stomata

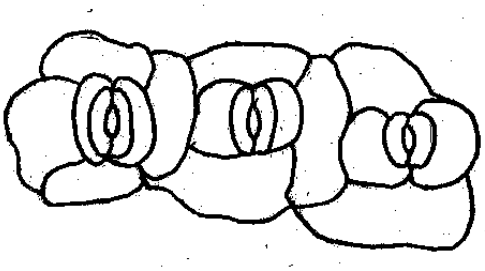

Figure 17: *Xanthosoma mafaffa*: Paracytic Stomata

Figure 18: *Dioscorea minutiflora*: Anomocytic Stomata

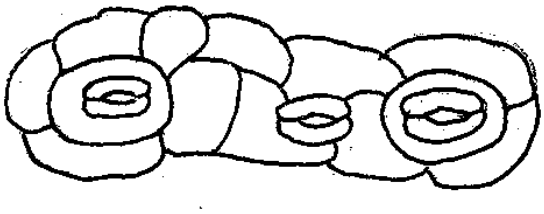

Figure 19: *Eulophidium maculatum*: Anomocytic Stomata

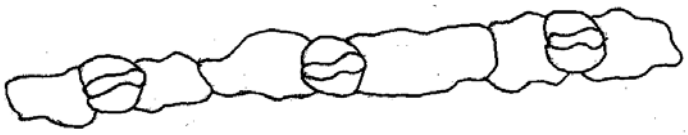

Figure 20: *Brachiaria deflexa*: Anomocytic Stomata

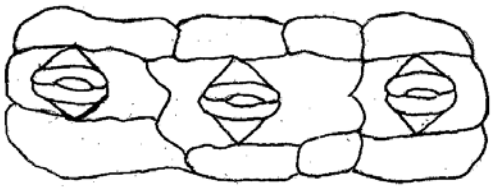

Figure 21: *Coix lacryma-jobi*: Paracytic Stomata

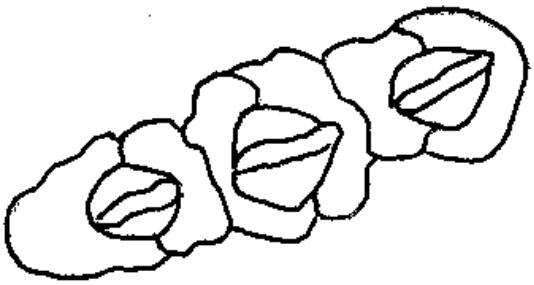

Figure 22: *Panicum brevifolium*: Anomocytic Stomata

Figure 23: *P. maximum*: Anomocytic Stomata

DISCUSSION

Higher plants anatomical characteristics such as stomata complex types, stomata size and stomata index can be used to establish systematic divisions. Stomatal parameters can also be used to suggest phylogenetic relationships within plants generally (Metcalfe and Chalk 1960, 1969). Stace (1965) states that stomata size may vary on the same leaf, but this does not prevent it from being used as a taxonomic character in delimiting species within a genus.

Pataky (1969) suggested stomata size of less than 15μm as small and larger ones those more than 38μm of which four taxa namely *Commelina benghalensis*- 58.80$\mu m\pm$ 50.40$\mu m\pm$0.39, *Coix lacryma-jobi* – 44.35$\mu m\pm$ 0.41 X 16.80$\mu m\pm$ 0.23, *Cyanotis ceaspitosa*- 42.00$\mu m\pm$0.39 X 30.24$\mu m\pm$ 0.30 and *Anchomanes difformis*- 38.64$\mu m\pm$ 0.65 X 20.66$\mu m\pm$0.27 fell into this category.

The role of stomata index in systematic work to delimit species because of it's constancy for any given species has been reported by Cutler (1984), Abdulrahamaan and Oladele (2003), Aworinde et al., (2009). Stomata index values varied from 0.57% in *Aframomum sceptrum* to 14.40% in *Raphidophora africana* were recorded in this study.

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