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Research article

SYSTEMATIC VALUE OF STOMATA IN SOME BICARPELLATAE SERIES – BENTHAM ET HOOKER SENSUS STRICTO

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ABSTRACT

31 taxa comprising of 26 herbs and 5 shrubs distributed in 4 orders and 8 dicotyledonous families of Bicarpellatae series were documented with descriptions on nature of stomata Epidermal cells are generally arched as found in 28 taxa, remaining 3 species with wavy forms. Anomocytic, paracytic, diacytic and mixed stomata were observed. Families Acanthaceae and Lamiaceae are remarkable in this study by exhibiting mostly diacytic stomata. Stomata size range of 17.40µm±0.33 x 8.8µm±025 in *Spigelia anthelmia* to 32.59µm± 0.29 x 21.50µm± 0.33 in *Physalis micrantha* were recorded. Stomata index values varied from 3.84% in *Pergularia daemia* to 16.60% in *Asystasia gangetica*.

Key word: Leaf Epidermis, Stomata Type and Size. Bicarpellatae Series.

Introduction

The series Bicarpellatae has long been recognized by taxonomists such as Bentham and Hooker (1862 – 1883). Major characteristics used in the classification of the bicarpellatae series are a dicotyledonous nature, superior ovary (hypogyny) and possession of two carpels (bi-carpellary ovary).

Bentham and Hooker (1862 – 1883) grouped the series Bicarpellatae into 4 cohorts or orders namely Gentianales, Lamiales, Personales and Polemoniales comprising of 23 families. Gentianales of 6 families namely Apocynaceae, Asclepiadaceae, Gentianaceae, Loganiaceae, Oleaceae and Salvadoraceae. Order Lamiales of 4 families- Lamiaceae (Menthaceae), Myoporineae, Selaginaceae and Verbenaceae. Order Personales of 8 families – Acanthaceae, Bignoniaceae, Collumeliaceae, Gesneriaceae, Lentibulariaceae, Orobanchaceae, Pedaliaceae and

Scrophulariaceae. Order Polemoniales of 5 families namely Boraginaceae, Convolvulaceae, Hydrophyllaceae, Polemoniaceae and Solanaceae.

Hutchinson and Dalziel (1963) did not emphasize the term Bicarpellatae series but taxa with bi-carpellary ovary such as families Loganiaceae and Oleaceae were grouped into order Loganiales, Order Apocynales were constituted as a parallel and separate group from order Gentianales with Apocynales Order of 3 families namely Apocynaceae, Asclepidaceae and Periploceae and Order Gentianales of 2 families – Gentianaceae and Menyanthaceae.

Hutchinson and Dalziel (1963) constituted others with bi-carpellary ovary in Order Polemoniales of only Hydrophyllaceae family, Order Solanales of 2 families Convolvulaceae and Solanaceae. Order Personales of 7 families – Acanthaceae, Bignoniaceae, Gesneriaceae, Lentibulariaceae, Orobanchaceae, Pedaliaceae and Scrophulariaceae. Order Boraginales of only Boraginaceae family and Order Lamiales comprising of 3 families namely Avicenniaceae, Labiateae (Lamiaceae) and Verbenaceae.

Stomata serves for gaseous communication between the internal and external environments of an higher green plant (Swarthout, 2008). Stomata are minute functional pores on the leaf and some stem epidermis (Roberts, 1978). Physiological functions like photosynthesis, respiration and transportion takes place with the help of stomata as it is through them that inter-change of gases such as carbon dioxide and also water vapour passes between the intercellular space of the internal tissues of the higher green plant and the outer atmosphere (Pandey and Chadha, 2006). Stomata can also be diagnostic as a systematic tool in the classification of problematic higher plants taxa (Ogbe and Osawaru, 1988).

Earlier contributors to the phytodermology and stomata studies of series Bicarpellae worldwide include Metcalfe and Chalk, 1950a, b, 1979). In Nigeria, Gill and Nyawuame (1989, 1990), Nyawuame and Gill (1991) reported phylogenetic and systematic value of Bicarpellatae. This study provides additional information on the structure and size of the stomata in some Nigerian Bicarpellatae.

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 H10 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. Leaf portions were de-colourised by immersion in 90% alcohol and were washed in 5 changes of distilled water after which they were mounted at uniform magnification of X400.

Terminologies of stomata complex types used are according to Metcalfe and Chalk, (1950a, b, 1979), Rasmussen (1981). 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.

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

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

RESULTS

Qualitative and Quantitative Stomata Characters of the Bicarpellatae Series reports after Hutchinson and Dalziel (1963) phylogenetic sequence as recorded in the Flora of West Tropical Africa (F. W. T. A.).

Table 1: Qualitative Stomata Characters of the Bicarpellatae

S/N	Taxon	Habit	Foliar Material	Epidermal Pattern	Stomata Type
1.	Order Loganiales Family Loganiaceae *Spigelia anthelmia* L.,	Herb	HIO-125	Arched	Anisocytic
2.	Order Apocynales (Gentianales) Family Apocynaceae *Callichilia stenosepala* Stapf.	Shrub	HORW-064	Arched	Paracytic
3.	*Hedranthera barteri* (Hook. F.) Pichon	Shrub	OBM-43	Arched	Paracytic
4.	*Oncinotis pontyis* Dubbard	Shrub	HORW-173	Arched	Paracytic
5.	Family Asclepiadaceae *Asclepias curassavica* L.,	Herb	OBM-82	Arched	Anomocytic
6.	*Pergularia daemia* (Forsk.,) Chiov.,	Herb	OBM-83	Arched	Anomocytic
7.	Order Solanales Family Solanaceae *Physalis micrantha* Link.	Herb	OBM-58	Arched	Anisocytic
8.	*Solanum nigrum* L.,	Herb	OBM-60	Arched	Anisocytic and Diacytic
9.	Family Convolvulaceae *Hewittia sublobata* (L. F.,) O. Kuntze	Herb	OBN-61	Arched	Anomocytic
10.	*Ipomoea asarifolia* (Dev.,) Roem and Schult.,	Herb	OBM-63	Arched	Paracytic
11.	*I. hederifolia* L.,	Herb	OBM-84	Arched	Paracytic
12.	*I. involucrata* P. Beauv.,	Herb	OBM-018	Arched	Paracytic
13.	*I. nil* (L.,) Roth.,	Herb	OBM-62	Arched	Anomocytic and Paracytic
14.	*I. triloba* L.,	Herb	OBM-64	Arched	Anomocytic
15.	Order Personales Family Acanthaceae *Acanthus montanus* (Nees) T. Anders.,	Herb	OBM-67	Arched	Diacytic
16.	*Asystasia calycina* Benth.,	Herb	OBM-86	Arched	Diacytic
17.	*A. gangetica* (L.,) T. Anders.,	Herb	OBM-67	Arched	Diacytic
18.	*Brillantaisia lamium* (Nees) Benth.,	Herb	HORW-169	Arched	Diacytic
19.	*Dyschoriste perottetii* A.Chev.,	Herb	OBM-81	Arched	Diacytic
20.	*Hypoestes verticillaris* (L.,) ex Roem and Schult.,	Herb	0BM-68	Arched	Diacytic

21.	*Justicia flava* (Forsk.,) Vahl.,	Herb	OBM-69	Arched	Diacytic
22.	*J. insularis* T. Anders.,	Herb	OBM-70	Arched	Diacytic
23.	*Monechma ciliatum* (Jacq.,) Milne-Redh.,	Herb	OBM-71	Arched	Diacytic
24	*Nelsonia canescens* (Lam.,) Spreng	Herb	OBM-87	Arched	Diacytic
25.	*Phaulopsis falcisepala* C. B. CL.,	Herb	OBM-72	Arched	Paracytic and Diacytic
26.	Order Lamiales Family Verbenaceae *Stachytarpheta indica* (L.,) Vahl.,	Herb	OBM-74	Wavy	Diacytic
27.	Family Lamiaceae *Hoslundia opposita* Vahl.,	Shrub	OBM-75	Wavy	Anomocytic
28.	*Hyptis suaveolens* Poit	Herb	OBM-88	Arched	Diacytic
29.	*Ocimum gratissimum* L.,	Shrub	OBM-89	Arched	Diacytic
30.	*Platostoma africanum* P. Beauv.,	Herb	OBM-76	Arched	Diacytic
31.	*Solenostemon rotundifolius* (Poir) J. K. Morton	Herb	OBM-90	Arched	Diacytic

Table 2: Quantitative Stomata Characters of the Bicarpellatae

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 Loganiales Family Loganiaceae *Spigelia anthelmia* L.,	17.40±0.33	8.80±0.25	12.40±0.24	20	9.30
2.	Order Apocynales (Gentianales) Family Apocynaceae *Callichilia stenosepala* Stapf.	27.89±0.33	14.78±0.26	18.48±0.19	12	10.70
3.	*Hedranthera barteri* (Hook. F.) Pichon	28.90±0.17	21.17±0.20	15.46±0.17	14	12.80
4.	*Oncinotis pontyis* Dubbard	32.49±0.29	19.49±0.20	18.98±0.16	10	16.60
5.	Family Asclepiadaceae *Asclepias curassavica* L.,	19.82±0.34	11.76±0.28	12.13±0.28	10	6.25
6.	*Pergularia daemia* (Forsk.,) Chiov.,	27.89±0.33	16.80±0.17	21.17±0.19	10	3.84
7.	Order Solanales Family Solanaceae *Physalis micrantha* Link.	32.59±0.29	21.50±0.33	21.50±0.25	12	10.70
8.	*Solanum nigrum* L.,	25.20±0.36	18.82±0.21	16.13±0.22	12	10.70
9.	Family Convolvulaceae *Hewittia sublobata* (L. F.,) O. Kuntze	26.88±0.27	19.49±0.25	18.98±0.19	20	11.76
10.	*Ipomoea asarifolia* (Dev.,) Roem and Schult.,	25.87±0.25	25.20±0.33	16.80±0.22	20	16.60
11.	*I. hederifolia* L.,	28.56±0.42	22.85±0.38	16.80±0.41	20	14.20
12.	*I. involucrata* P. Beauv.,	26.21±0.26	19.49±0.30	14.78±0.20	22	18
13.	*I. nil* (L.,) Roth.,	25.20±0.27	16.13±0.29	17.81±0.30	10	4.76
14.	*I. triloba* L.,	31.92±0.26	26.54±0.34	20.50±0.41	13	15.60
	Order Personales Family Acanthaceae	19.15±0.21	13.44±0.27	13.44±0.23	13	11.50

15.	*Acanthus montanus* (Nees) T. Anders.,					
16.	*Asystasia calycina* Benth.,	25.20±0.26	16.80±0.22	14.57±0.25	10	10
17.	*A. gangetica* (L.,) T. Anders.,	23.52±0.27	15.62±0.29	16.80±0.21	25	26.30
18.	*Brillantaisia lamium* (Nees) Benth.,	26.88±0.33	17.81±0.26	16.80±0.22	9	15
19.	*Dyschoriste perottetii* A.Chev.,	26.21±0.26	26.88±0.32	18.82±0.26	20	16.66
20.	*Hypoestes verticillaris* (L.,) ex Roem and Schult.,	25.87±0.36	17.14±0.22	18.48±0.27	15	21.40
21.	*Justicia flava* (Forsk.,) Vahl.,	29.67±0.27	22.85±0.37	21.84±0.25	3	4.10
22.	*J. insularis* T. Anders.,	30.74±0.0.47	16.80±0.25	22.34±0.25	20	11.70
23.	*Monechma ciliatum* (Jacq.,) Milne-Redh.,	19.49±0.27	12.77±0.22	16.13±0.23	25	5.26
24	*Nelsonia canescens* (Lam.,) Spreng	24.83±0.32	25.69±0.98	17.27±0.45	15	16.60
25.	*Phaulopsis falcisepala* C. B. CL.,	20.83±0.24	13.10±0.19	11.09±0.22	12	10.70
26.	Order Lamiales Family Verbenaceae *Stachytarpheta indica* (L.,) Vahl.,	30.91±0.21	18.82±0.23	19.82±0.34	13	17.80
27.	Family Lamiaceae *Hoslundia opposita* Vahl.,	21.84±0.27	16.13±0.21	14.45±0.14	15	13
28.	*Hyptis suaveolens* Poit	17.47±0.32	11.42±0.34	13.44±0.28	16	9.60
29.	*Ocimum gratissimum* L.,	26.31±0.46	18.18±0.38	17.47±0.27	14	15
30.	*Platostoma africanum* P. Beauv.,	22.68±0.26	15.96±0.23	15.96±0.0.24	8	18.60
31.	*Solenostemon rotundifolius* (Poir) J. K. Morton	26.23±0.49	15.76±0.50	20.13±0.60	10	18.00

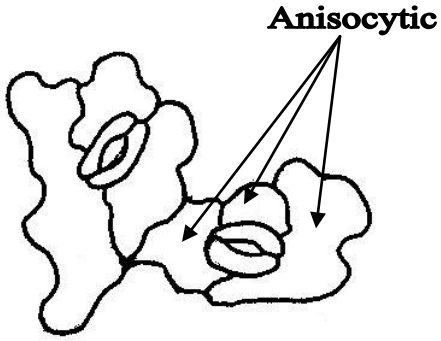

Figure 1: *Spigelia anthelmia*: Anisocytic Stomata

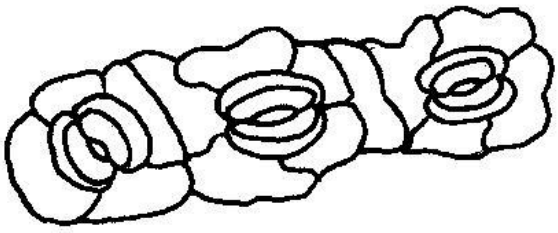

Figure 2: *Callichilia stenosepala*: Paracytic Stomata

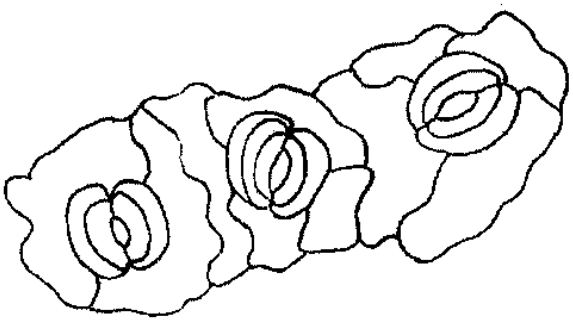

Figure 3: *Hedranthera barteri*: Paracytic Stomata

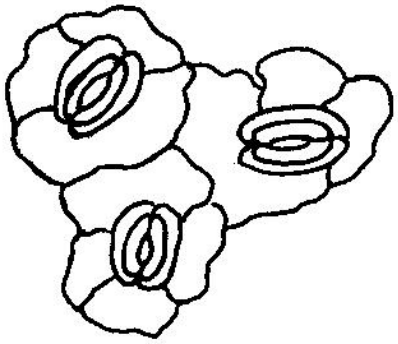

Figure 4: *Oncinotis pontyis*: Paracytic Stomata

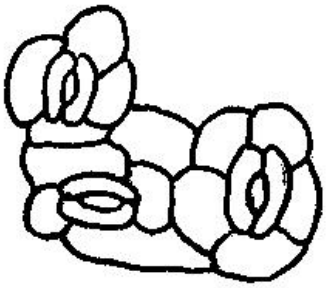

Figure 5: *Asclepias curassavica*: Anomocytic Stomata

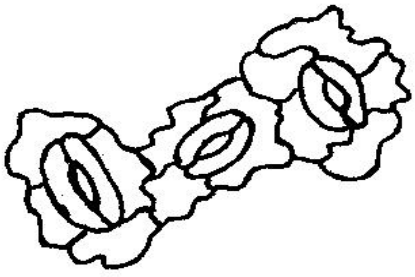

Figure 6: *Pergularia daemia*: Anomocytic stomata

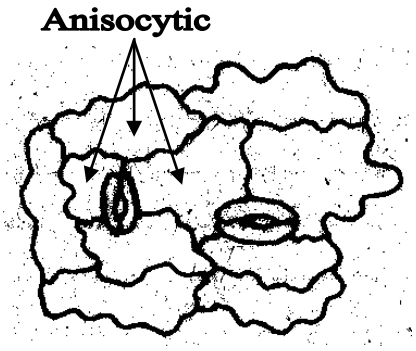

Figure 7: *Physalis micrantha*: Anisocytic Stomata

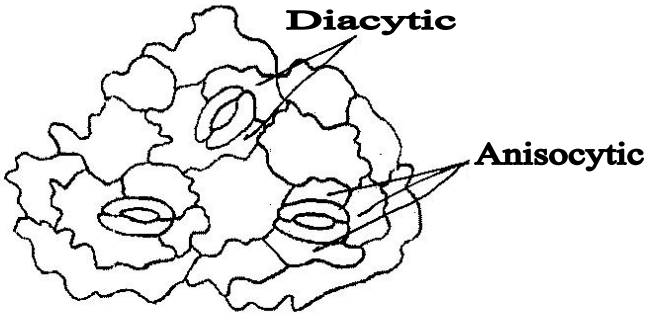

Figure 8: *Solanum nigrum*: Anisocytic and Diacytic Stomata

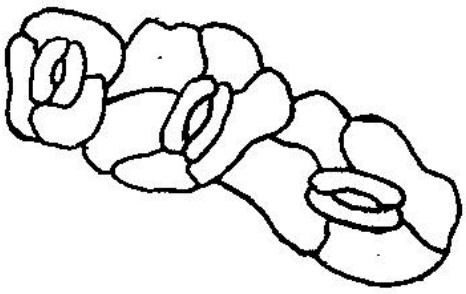

Figure 9: *Hewittia sublobata*: Anomocytic stomata

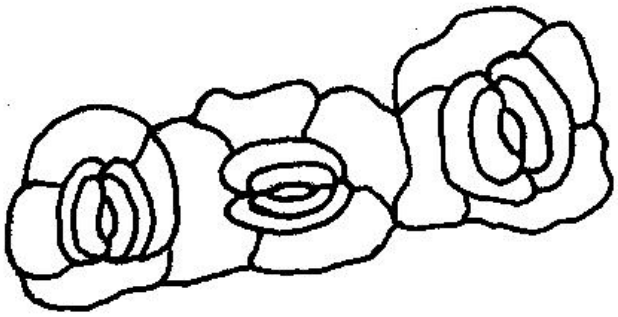

Figure 10: *Ipomoea asarifolia*: Paracytic Stomata

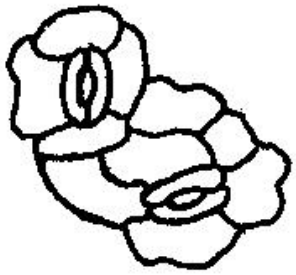

Figure 11: *I. hederifolia*: Anomocytic Stomata

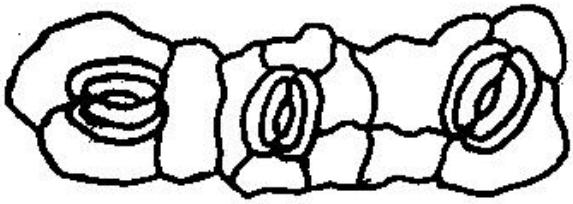

Figure 12: *I. involucrata*: Paracytic Stomata

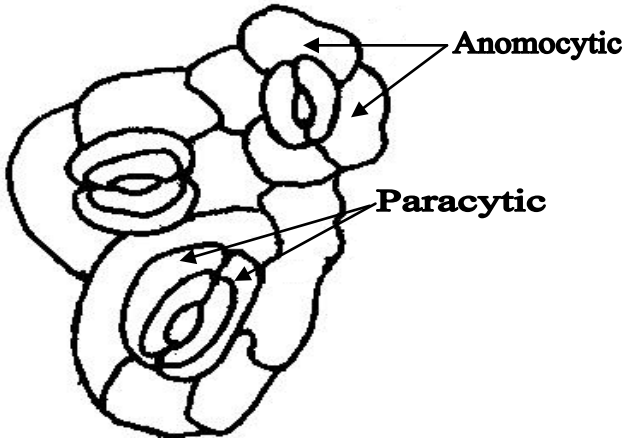

Figure 13: *I. nil*: Anomocytic and Paracytic Stomata

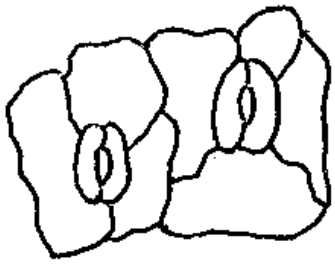

Figure 14: *I. triloba*: Anomocytic Stomata

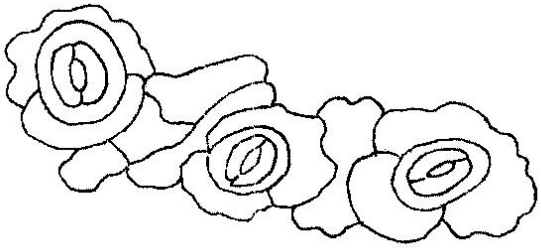

Figure 15: *Acanthus montanus*: Diacytic Stomata

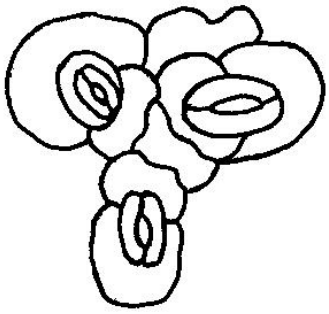

Figure 16: *Asystasia calycina*: Diacytic Stomata

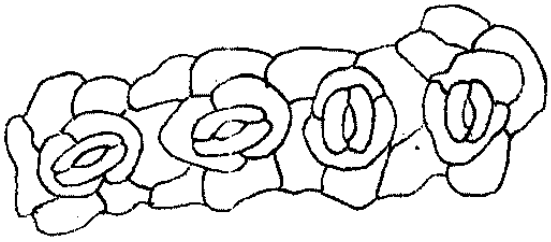

Figure 17: *A. gangetica*: Diacytic Stomata

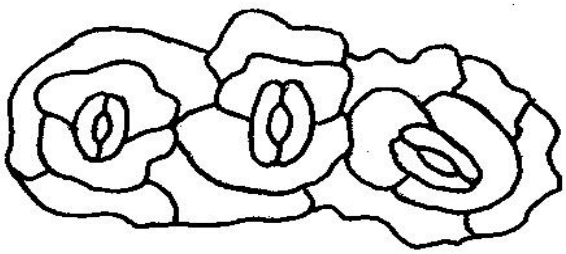

Figure 18: *Brillantaisia lamium*: Diacytic Stomata

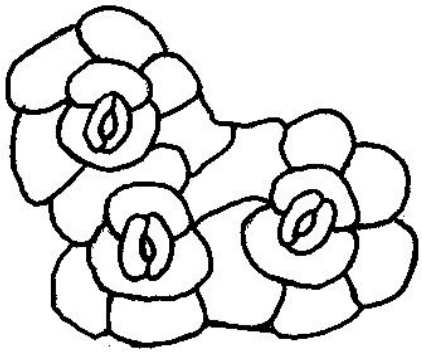

Figure 19: *Dyschoriste perottetii*: Diacytic Stomata

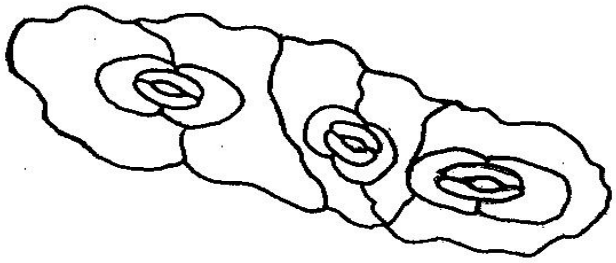

Figure 20: *Hypoestes verticillaris*: Diacytic Stomata

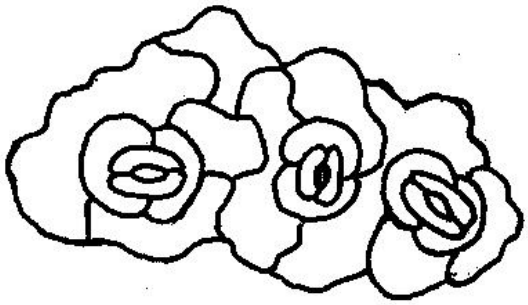

Figure 21: *Justicia flava*: Diacytic Stomata

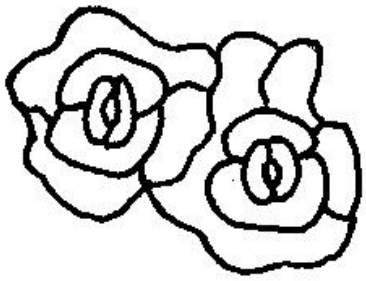

Figure 22: *J. insularis*: Diacytic Stomata

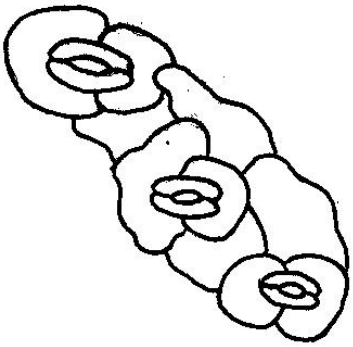

Figure 23: *Monechma ciliatum*: Diacytic Stomata

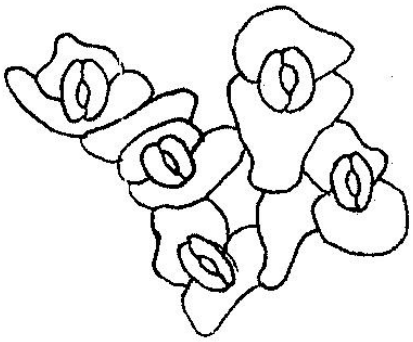

Figure 24: *Nelsonia canescens*: Diacytic stomata

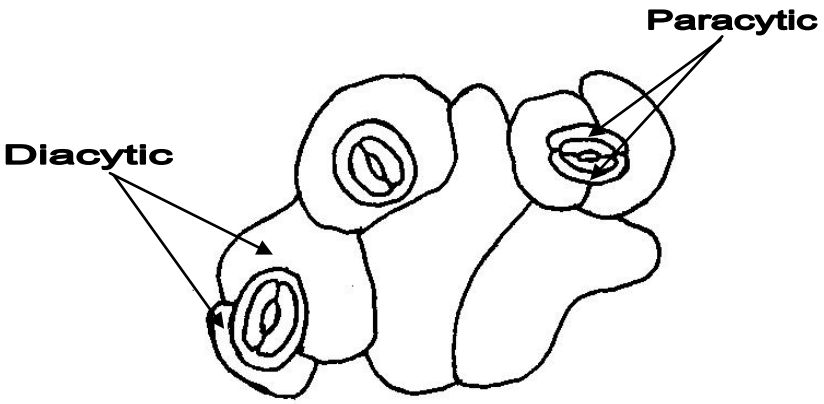

Figure 25: *Phaulopsis falcisepala*: Paracytic and Diacytic Stomata

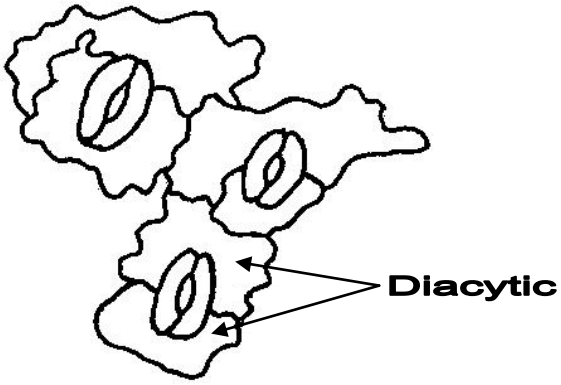

Figure 26: *Stachytarpheta indica*: Diacytic Stomata

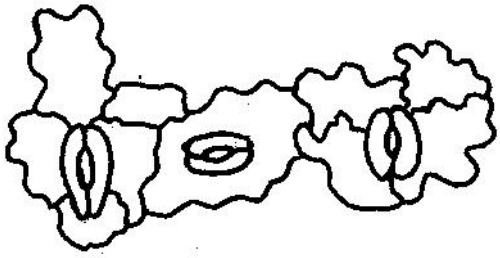

Figure 27: *Hoslundia opposita*: Anomocytic Stomata

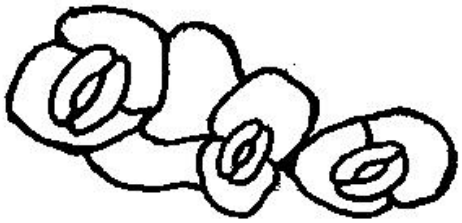

Figure 28: *Hyptis suaveolens*: Diacytic Stomata

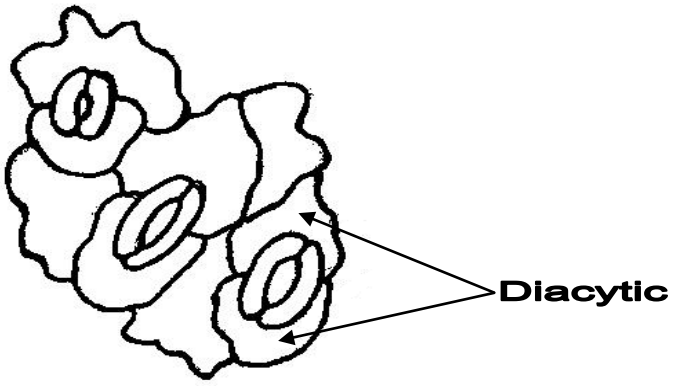

Figure 29: *Ocimum grattisimum*: Diacytic Stomata

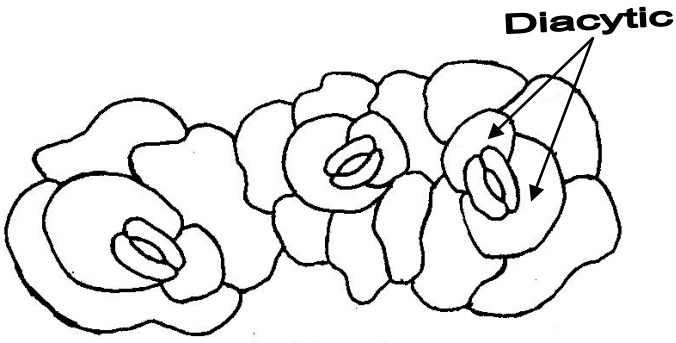

Figure 30: *Platostoma africanum*: Diacytic Stomata

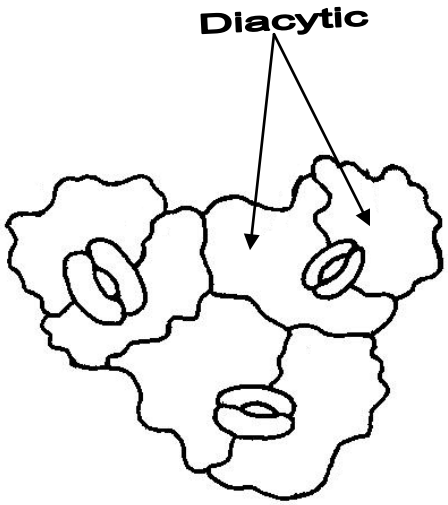

Figure 31: *Solenostemon rotundifolius*: Diacytic Stomata

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 the Bicarpellatae and other higher plant groups. (Metcalfe and Chalk 1950a, b, 1979), 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 different species within a genus. Stomata size range from 17.40µm±0.33 x 8.8µm±0.25 in *Spigelia anthelmia* to 32.59µm±0.29 x 21.50µm±0.33 in *Physalis micrantha*.

The role of stomata index in biosystematics studies to delimit species because of it's near constancy for any given species has been reported by Cutler (1984), Abdulrahamaan and Oladele (2003). Stomata index values varied from 3.84% in *Pergularia daemia* to 16.60% in *Asystasia gangetica* in this study.

REFERENCES

Abdulrahamaan, A. A. and Oladele, F. A. (2003), Stomata Complex Types, Stomata Size, Density and Index in Some Vegetable Species in Nigeria. *Nigerian Journal of Botany*. 16:144-150.

Bentham, G and Hooker, J. D. (1862 – 1883) Genera Plantarum. 3 volumes. London.

Cutler, D. F. (1984) Systematic Anatomy and Embryology. Recent Developments In Heywood, H. H. and Moore, D. M. (Eds.). Current Concepts in Plant Taxonomy, Academic Press, London pp. 108-125.

Dilcher, D. L. (1974) Approaches to the identification of Angiosperm Leaf Remains. *Botanical Review* 4:1-157.

Gill, L. S. and Nyawuame, H. G. K (1989) Epidermal Structure and Ontogeny of Stomata In Some West African Bicarpellatae (Lamiaceae) *Biocosme Mesogeen* 6:49-62.

Gill, L.S. and Nyawuame, H. G. K (1990) Phylogenetic and Systematic Value of Stomata in Bicarpellatae (Bentham et Hooker Sensus Stricto). *Feddes Repertorium,* 104:335 – 360.

Hutchinson, J. and Dalziel, J. M. (1963). Hepper, F. N. (Editor). Flora of West Tropical Africa. Crown Agents of Overseas Governments and Administrations, Millbank, London. Volume 2. 544p.

Metcalfe, C.R. and Chalk, L. (1950a) Anatomy of the Dicotyledons. Volume I. Oxford University Press, London. 724p.

Metcalfe, C.R. and Chalk, L. (1950b) Anatomy of the Dicotyledons. Volume 2. Oxford University Press, London. 1, 500p.

Metcalfe, C. R. and Chalk, L. (1979) (Eds.) Systematic Anatomy of the Leaf and Stem. 2nd Edition. Oxford University Press, London. 294p.

Nyawuame, H.G.K. and Gill, L. S. (1991) Cuticular Studies of Some Tropical Taxa of the Order Gentianales (Bentham and Hooker Sensus Stricto). *Journal Plant Anatomy and Morphology* 5:84-89.

Ogbe, F.M. and Osawaru, M.E. (1988) Structure and Distribution of Stomata Among Some Nigerian Dicotyledonous Weeds. *Feddes Repertorium* 99: 462-466.

Onyibe H. I. (1987). Phytosociological Studies of Weeds of Nine Cohorts of Okomu Oil Palm Plantation, Edo State, Nigeria. University of Benin, M.Sc. Thesis. 272p.

Onyibe H. I. (1990). Ecology of the Weed Flora and Litter Fall in a Mature Rubber Plantation In Edo State, Nigeria. University of Benin. Ph. D. Thesis. 613p.

Pandey, S. N. and Chadha, A. (2008). Plant Anatomy and Embryology. Vikas Publishing House PVT Limited, New Delhi, India. pp 103.

Rasmussen, H. (1981). Terminology and Classification of Stomata and Stomatal Development. A Critical Survey. *Botanical Journal of Linnean Society* 83:199-212.

Roberts, M.B.V. (1978) Biology: A Functional Approach. Thomas Nelson and Sons Limited, London. Pp 152.

Stace, A. C. (1965) Cuticular Studies as an aid To Plant Taxonomy. *Bull. Brit. Mus. (Nat. Hist)* 4:1-78.

Swarthout, D. (2008) Stomata: http://www.eo.earth.org /article/stomata.pp1-3.