FLORAL STRUCTURE OF FOUR SPECIES OF *Senna*: Sub-family Caesalpinoideae

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ABSTRACT: The floral structure in four species of *Senna* are described. Petals are hypostomatic except *Senna alata* which had no stomata. The mature stomata are paracytic, anomocytic, staurocytic, brachyparacytic, anisocytic and laterocytic, but laterocytic stomata was more frequent. Brachyparacytic stomata was restricted to the abaxial surface of *S. occidentialis* and *S. hirsuta.* Abnormality noticed in *S. obtusifolia* are parallelcontiguous stomata and unopened stomata. Crystal Druses was present in *S. hirsuta.* Simple long trichomes are restricted to *S. obtusifolia* in vein cells of the abaxial surface. These differences are of taxonomic importance and can be used to delimit each species and thus enhance precision in the taxonomy of the genus *Senna.*

INTRODUCTION

The genus *Senna L. Cassia* Linn. belongs to the sub-family Caesalpinoideae which includes 171 genera and about 2250 species family Fabaceae. It is commonly found in the tropical and sub-tropical regions of the world comprising of trees, shrubs, vines and herbs with numerous representatives growing in the South America rainforest where the species spread out to the tropical Africa and other tropical regions of the world (Lewis *et al*., 2005).

Prior to the work of (Irwin and Barneby, 1981), the genus *Senna* used to be a very large genus that comprises of about 500 to 600 species (Airy-Shaw, 1973). The genus ranks among the 25 largest genera of the dicotyledonous plants. (Irwin and Turner, 1960).

The genus contains about 22 indigenous species apart from those introduced or cultivated (Hutchinson and Dalziel, 1958). Anatomical data have been used to good effect at all levels of the taxonomic hierarchy, as well as for identification and assessment of the taxonomic relationships among taxa of the flowering plants (Stuessy, 1990). Although taxonomists lately realized the importance of microscopic features of the epidermis, taxonomic monographs are now considered in complete without them (Rejdalimoh, 1991). Floral anatomy helped resolve the delimitation of the Bignoniaceae and Scrophulariaceae (Armstrong, 1985). Stomatal ontogeny was studied on the vegetative and floral organs of *Vigna unguiculata*, *Phaseolus radiatus* and *P. aconitifolius* (Shah and Gopal, 1969) belonging to Papilionaceae. Shah and Gopal (1969) reported the ontogeny of stomata on the foliar and floral organs of some species of *Crotalaria* L. Epidermal structure and ontogeny of stomata in vegetative and floral organs of *Hibiscus rosa-sinensis* L. have been reported by Inamdar and Chohan (1969a).

The roasted seeds of *Senna occidentalis* can be used to substitute coffee (Burkill, 1994, Elliot, 1979). *S. occidentalis* to cure herpes, chest pains and elephantiasis (Burkill, 1995). *Senna hirsuta* has many therapeutic properties used for stomach troubles, dysentery, abscesses combined with much nutritive value (Oladunmoye *et al*., 2009). *Senna obtusifolia* leaves, seeds and root are used in medicine, primarily in Asia, possess laxative effects and beneficial to eyes (Burkill, 2002). The seeds are often roasted, then boiled in water to produce a tea (Burkill, 2002). The flowers of *S. obtusifolia* have odour and used as national flower of Thailand, where the yellow coloured flower symbolized the royalty (Oliver, 2005). *S. alata* can be used as insect

repellant, for regulating menstrual flow, treating dermal related infections and gonorrhea (Burkill, 1995).

From the available literature, studies on the floral epidermal morphology of the species of *Senna* seems not to be recorded. This study also attempted to reveal additional characteristics for *S. occidentalis*, *S. hirsuta*, *S. obtusifolia* and *S. alata* flowers which might be useful for identification and assessment of the taxonomic relationships among species as well as for assessing their phylogenetic relationships.

MATERIALS AND METHODS

The fresh flowers of *S. occidentalis* (L.) *S. hirsuta* (L.) *S. obtusifolia* and *S. alata* were collected on October, 2011, from a medicinal farm in the Department of Pharmacognosy and Traditional Medicine, Faculty of Pharmacy, University of Uyo, Uyo. Anatomical Studies were carried out using the methods below:

Microscopic Examination

For the purpose of anatomical studies small sizeable portion of the species were obtained from the standard median flowers of mature, well expanded flower. Sizeable portion of the flowers were also cut between inflorescence of mature flower in the species. Epidermal peel of both abaxial and adaxial surface was made by placing the flower taken from standard median portion of the flowers on a clean glass slide. The specimen surface was irrigated with water holding the specimen from one end. The epidermis above the desired surface was scrapped off carefully with a sharp razor blade.

Loose cells were washed away from the epidermal peel with the aid of soft camel hairbrush and water until the desired epidermis below was reached. The epidermal peels were stained with 1% aqueous solution of Safranin for 4-8 minutes, then rinsed carefully in water to removed excess stain and mounted in 10% glycerol.

Guard cell area was calculated by Franco's constant method 0.7854 (Guard cells area = length x width x 0.7854). The stomatal index was determined according to Metcalfe and Chalk, (1979) using the formula:

$$\frac{S}{E+s} \times \frac{100}{1} = \text{Stomatal index (SI)}$$

Where S = number of stomata per unit area
E = number of epidermal cell in same area.

All measurements were made with the aid of an ocular micrometer and finally converted by the ocular constant with respect to the power under which they were taken. Images were computerized digitally with a motic image plus version 2.0ml mounted on Zeiss light microscope.

RESULTS

Morphological features of the epidermis of the taxa are summarized in (Table 1). Descriptive terminology is based primarily on Dilchar (1974). Metcalfe and Chalk (1979) and Dehgan (1980). It is important to explain the term paracytic stomata as used by Dilchar (1974) and Irina (2011) for the purpose clarity in this paper. A paracytic occur with two subsidiary cells parallel to the guard cells. A distinction is made between paracytic stomata in which the guard cells are completely enclosed by the subsidiary cells and brachyparacytic stomata, in which enclosed of guard cells is not complete and a gap exists at least at one end.

Shape and Sizes
Epidermal cell show wide variation in shape and size. The abaxial surfaces of the epidermal cell are polygonal and irregular in all the species. The largest cells were recorded in *S. occidentalis* (Table 1) while *S. obtusifolia* showed the smallest cells. Anticlinal cell walls on *S. obtusifolia, S. occidentalis, S. hirsuta* were straight to curved while it is straight to slightly curved in *S. alata* (Plate 2a and b).

Stomata
Stomata are absent in all the adaxial surfaces but present in the abaxial surfaces of *S. occidentalis, S. hirsuta* and *S. obtusifolia* (hypostomatic) and are characteristically recorded while absent on both surfaces of *S. alata* (Table 1). The smallest stomata (17.9μm) (Table 1) was recorded on the abaxial surface of *S. occidentalis* while the largest stomata (38.3μm) were recorded in abaxial surface *S. hirsuta.* The mature stomata types were paracytic, laterocytic, staurocytic, brachyparacytic, anisocytic, and anomocytic. Paracytic stomata are recorded in abaxial surface of *S. occidentalis* only while few brachyparacytic occurred in *S. hirsuta S. occidentalis* and abaxial surfaces but anonocytic stomata are recorded on *S. occidentalis* and *S. obtusifolia* in abaxial surface and anisocytic stomata are recorded in all the three species but laterocytic stomata are more frequent in *S. occidentalis, S. hirsuta* and *S. obtusifolia* in abaxial surface while no stomata was recorded in *S. alata* (Table 1).

Stomata index varied between three species on the abaxial surfaces only (Table 1). The highest stomatal index was recorded on the abaxial surface of *S. occidentalis* (21.7μm) and the lowest stomatal index was recorded on the abaxial surface of *S. obtusifolia* (10.7μm).

Abnormal Stomata
Abnormal stomata structures were absent only on abaxial surface of *S. obtusifolia* and they are parallel contiguous stomata (which is two guard cells of separate stamata connected by a common neighbouring cell) (Plate 4e).

Hairs
The morphology of trichomes including shape, size and frequency is characteristic of the different species studied and hence of great diagnostic interest. Most of the species are glabrous except *S. obtusifolia* with long and short unicellular, acicular trichomes which are non-glandular and usually with surrounding basal cell were recorded in *S. obtusifolia* but absent in *S. hirsuta, S. obtusifolia* and *S. alata.* They may have pointed curved or tapering apices (Table 1).

DISCUSSION

The morphological observations made in the study have been considered diagnostic and indispensable for the identification of these floral species (Singh, Pande and Jain (1998). Anatomical features are widely used in systematic for identification and for placing anomalous group in a satisfactory position in classification of species (Essiett, 2004). The epidermal cell size varies significantly and can be fairly used for the separation of the species in the group. *S. alata* has the largest epidermal cell size in the abaxial Surface while *S. hirsuta* has the smallest epidermal cell size (Table 1).

The presence and combination of different types of stomata on the surfaces of the flowers can be useful in easy identification and classification of the species. It is possible for most of the species to have more than one type of stomata in some Polemoniales (Patel and Inamdar, 1971). The species studied are hypostomatic (stomata absent in adaxial Surface and present in abaxial surface). The presence of various stomata types can be used to distinguish *S. occidentalis*) in having paracytic stomata in abaxial surface while laterocytic are abundant than brachyparacytic on abaxial surface of *S. hirsuta* and *S. occidentalis*.

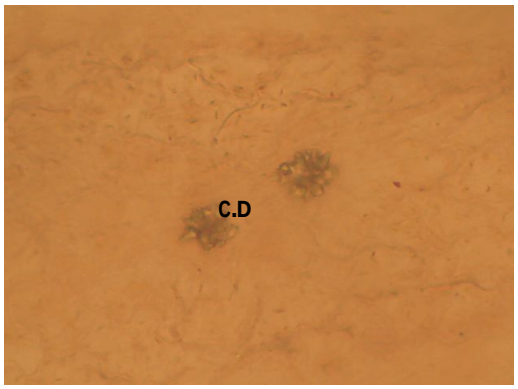
Table 1: Epidermal Feature of the flowers of *S. occidentalis*, *S. hirsuta, S. obtusifolia* and *S. alata*

Species	Stomatal size (µm)		Epidermal cell (µm)		Trichomes (µm)		Stomata Index (%)		Guard cell area (μm^2)	Stomatal Distribution	Cell shape	Epidermal cell wall	
	Ab	Ad	Ab	Ad	Ab	Ad	Ab	Ad				Ab	Ad
S. occidentalis	26.8x17.9	- -	71.5x49.9	7.6x 6.9	-	- - -	21.7	- -	19.9	hypostomatic	P, I	Undulating	Undulating
S. hirsuta	38.3x20.8	- -	65.5x18.7	8.7x6.0	-	- - -	17.7	- -	17.8	hypostomatic	P, I	Sinous	Slightly sinous
S. obtusifolia	25.5x20.3	- -	65x38.7	9.2x6.3	17.8x14.0	- -	10.7	- -	12.4	hypostomatic	P, I	Sinous	Sinous
S. alata	-	- - -	72.3x45.2	6.2x7.0	-	- - -	-	- --	- -	- -		Undulating	more undulating

Key: P = Polygonal
I = Irregular
Na - Nonglandular

Epidermal Cells

Senna occidentalis was characterized by epidermal cells with high undulation on both abaxial and adaxial surface (Plate 3e) *S. hirsuta* could be delimited by straight to undulate on both abaxial and adaxial surface (Plate 1b) whereas in *S. alata* the epidermal cells on abaxial flower surface were straight to undulate while cells with straight to slightly undulate were found on adaxial surface (Plate 2a-b).



C.D: Crystal Druses on *Senna hirsuta* (lower surface)x400

Plate 1A

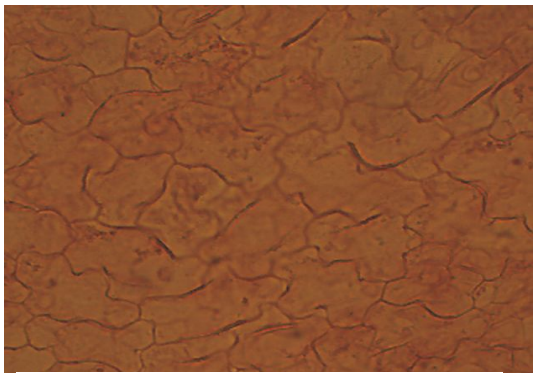
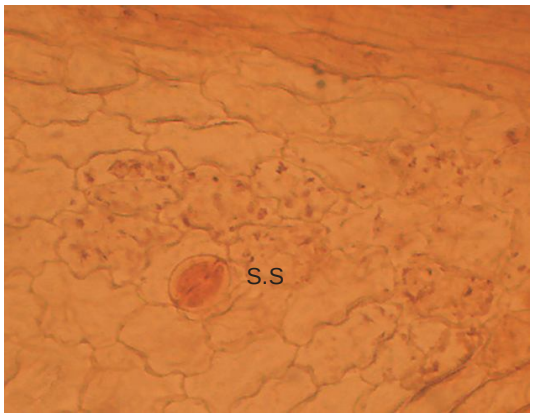


Plate 1B: Epidermal Cell on *Senna hirsuta* (upper surface) x400



S.S: Staurocytic Stomata on*Senna hirsuta* (lower surface)x400

Plate 1C

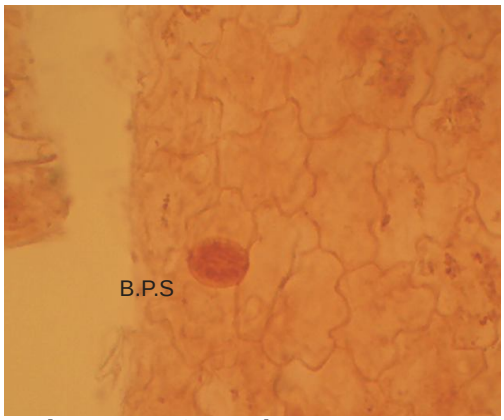
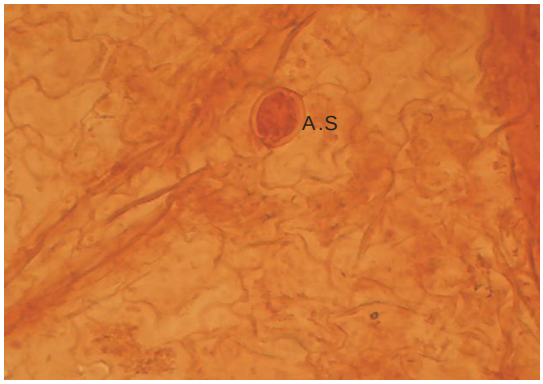


Plate 1D, B.PS: Brachy Paracytic Stomata on *Senna hirsuta* (lower surface)x400



A.S: Anisocytic Stomata on *Senna hirsuta* (lower surface)x400

Plate 1E

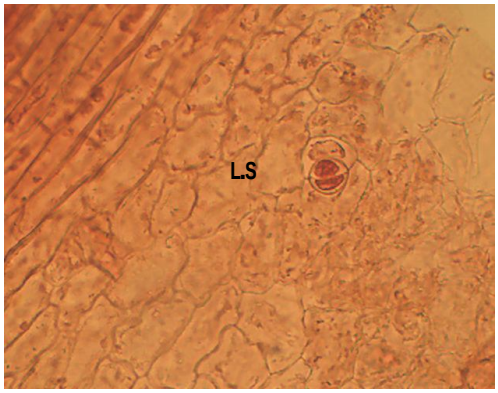
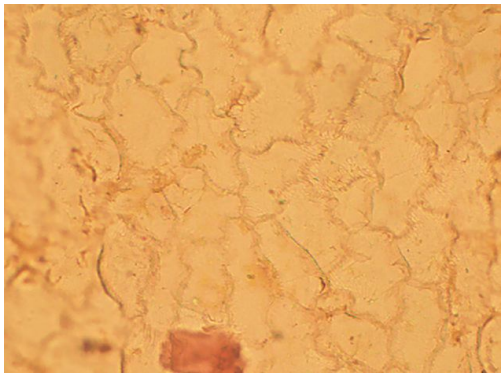


Plate 1 F: L.S: Laterocytic Stomata on *Senna hirsuta* (lower surface)x400



Epidermal Cell on *Senna alata* (lower surface)x400

Plate 2A: L.S:

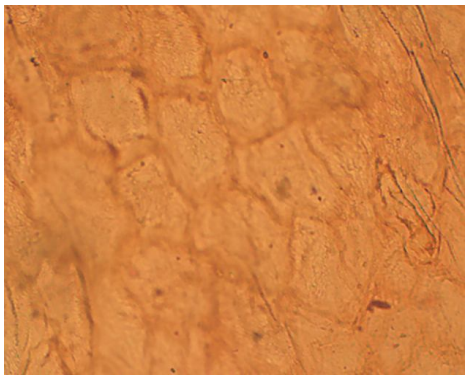


Plate 2B: Epidermal Cell on
Senna alata (upper surface)x400

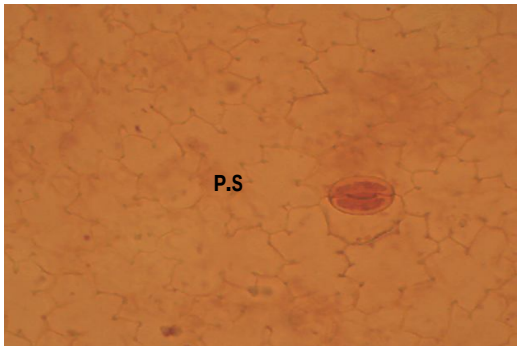


Plate 3A, P.S: Paracytic Stomata on
Senna occidentalis (lower surface)x400

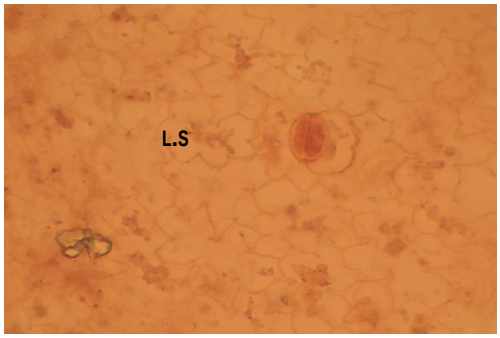
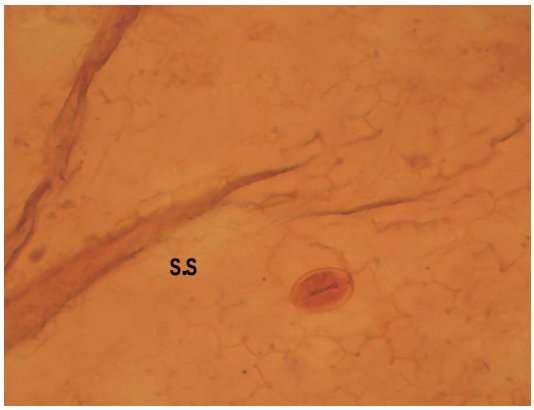


Plate 3B P.S: Laterocytic Stomata on
Senna occidentalis (lower surface) x400



S.S: Staurocytic Stomata on *Senna occidentalis* (lower surface) x400

Plate 3C

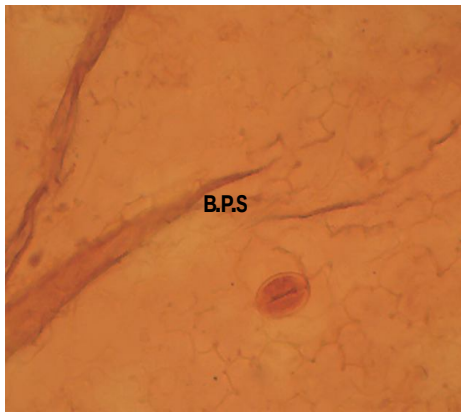
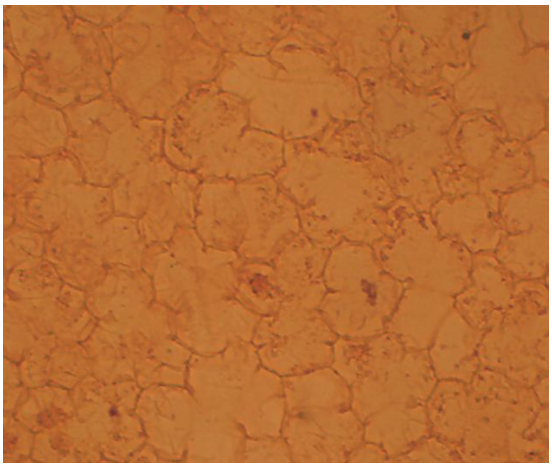
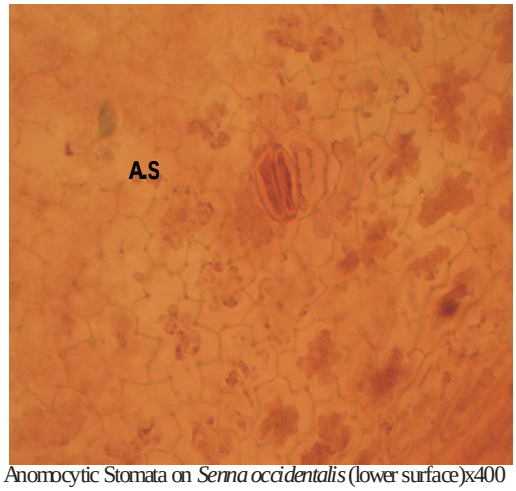


Plate 3D B.P.S: Brachy-paracytic Stomata
On *Senna occidentalis* (lower surface)x400



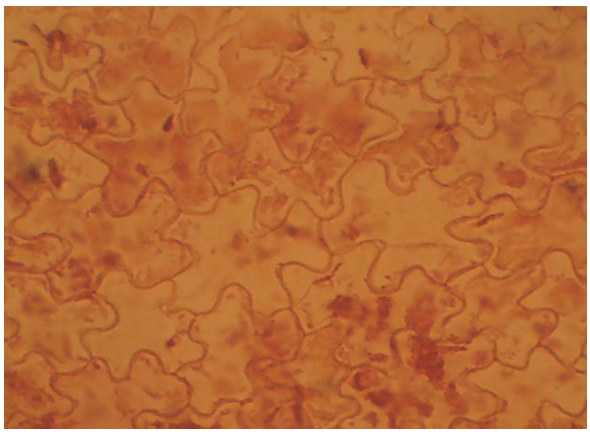
Epidermal Cell on *Senna occidentalis* (upper surface)x400

Plate 3E:



Anomocytic Stomata on *Senna occidentalis* (lower surface)x400

Plate 3F A.S:



Epidermal Cell on *Senna obtusifolia* (upper surface)x400

Plate 4A

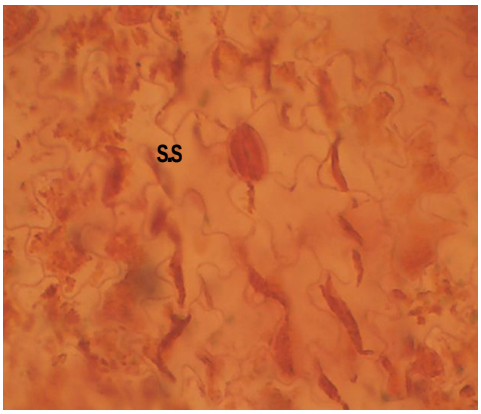
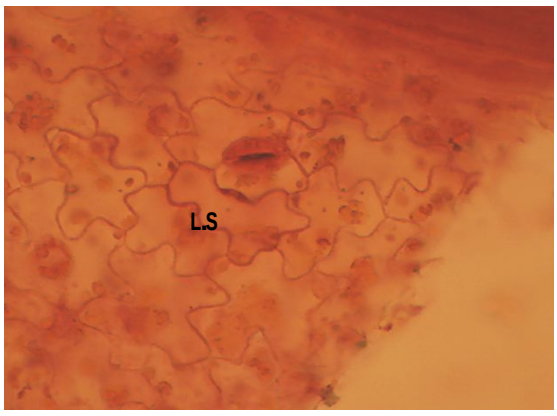


Plate 4B, S.S: Staurocytic Stomata on *Senna obtusifolia* (lower surface)x400



Laterocytic Stomata on *Senna obtusifolia* (lower surface)x400

Plate 4C L.S:

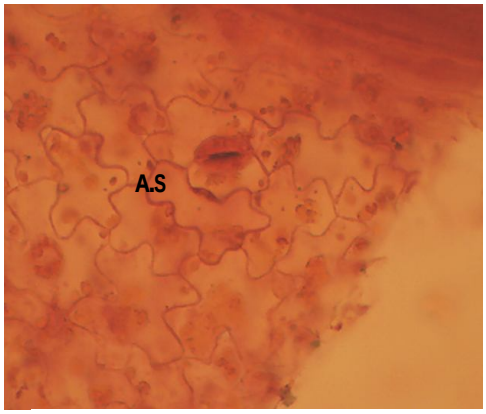


Plate 4D A.S: Anisocytic Stomata on *Senna obtusifolia* (lower surface)x400

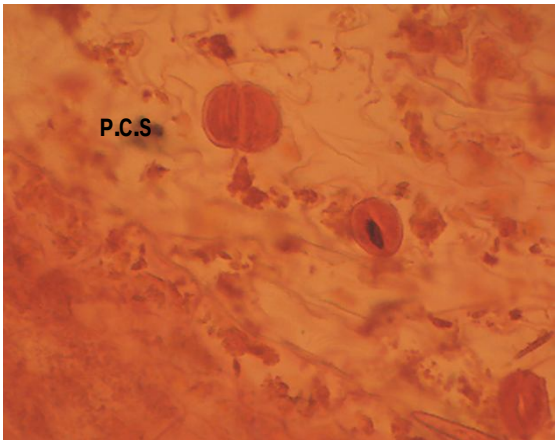


Plate 4E P.C.S: Parallel contiguous Stomata on *Senna obtusifolia* (lower surface)x400

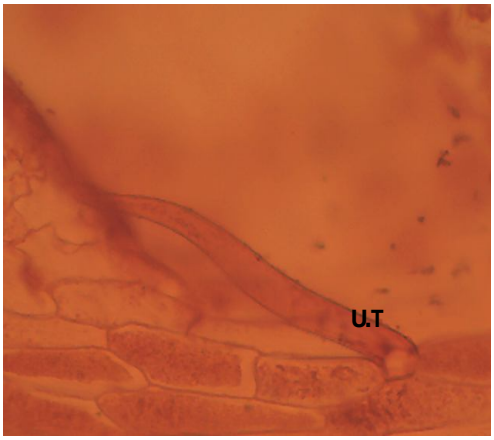


Plate 4F U.T: Unicellular Trichome on *Senna obtusifolia* (lower surface)x400

On abaxial surfaces of three species out of four studied, the highest stomatal index was found on abaxial surface of *S. occidentalis* while the lowest are found on abaxial surface of *S. occidentalis* (Table 1) in agreement with the findings of (Isawumi, 1989). The main function of stomata is associated with various physiological processes and with the survival or success of each individual plant. It is expected, therefore that stomata structure would be under strong and highly integrated genetic control and their modification of stomata during evolution would reflect both general relationship and evolutional trend.

The guard cell area, stomata index provide values that would serve as parameter for comparison among the taxa. The stomata index is independent of the environment, size or portion of the flower surface size of intervening epidermal cells (Metcalfe and Chalk, 1979, Essiett and Akpabio, 2005) and so it is a reliable factor for identification. Thus, the low stomatal index values observed on the abaxial surface of *S. obtusifolia* appear to be adaptive responses of their natural environments to reduce the rate of water loss. The presence of abnormal stomata with parallel contiguous stomata i.e. one lateral subsidiary cell shared between two stomata have been described by Greens (1987) in some *Dioscorea* species in *S. obtusifolia.*

The occurrence of curved walls in some of the species agreed with the suggestion of Stace (1984) that curved wall is a mesomorphic characters and that environmental conditions such as humidity play a significant role in determining the pattern of anticlinal cell walls.

The importance of crystals in taxonomy as diagnostic tools was emphasized by Amos (1951) and Roe (1971). The presence of crystals druses and their flower distribution in all the species studied Dehnel (1960) and Singh, Pande and Jain (1998). Druses of Crystals present and other features appear to be of good diagnostic value for Identification and classification of *Sanna* species studied.

Trichomes were present on the vein cells of *S. obtusifolia* as a result of high density of the hairs in them which also serves to reduce the rate of transpiration in the plants. The importance of trichomes in taxonomy has been highlighted by Stace (1980) in the family of Combretaceae.

Metcalfe and Chalk (1979) hold that trichome frequency and size are environmentally controlled, while Stace believes that hairs are constant in a species when present and showed a

constant range of form and distribution useful in diagnosis. Trichomes also contribute to longitivity of leaves more trichomes on the adaxial surface than abaxial is to prevent water loss through the transpiration since the adaxial surfaces are exposed to direct sunlight. This therefore suggests that occurrence of trichome on the flower discouraged high rate of transpiration in plants.

CONCLUSION

In conclusion, observations made from the study shows that the four species are quite distinct. The present study shows the significance of the floral characters in identification and collection of these species easily.

REFERENCES

Airy-shaw, H. K. (1973). *A Dictionary of the Flowering Plants* 8th Edition, Cambridge University press, London. 48-94 pp.

Amos, G. I. (1951). Some siliceous timbers of British Guyana. *Caribb For.,* 12:133-137.

Armstrong, J. E. (1985). The delimitation of Bignoniaceae and Scrophuloriaceae based on floral anatomy and the placement of problem genera. *Arm. J. Bot.,* 72: 755 – 766.

Burkill, H. M. (1994). The *Useful plants of West Tropical Africa,* Second Edition. Vol. 2, Addenda Royal Botanic Gardens, Kew, Richmond, United Kingdom. pp. 21 – 25.

Burkill, H. M. (1995). The *Useful Plants of West Tropical Africa,* Second Edition, Vol. 3, Families J – L, Royal Botanic Gardens, Kew, United Kingdom, 857p.

Burkill, H. M. (2002). *The Useful of Plants of West Tropical Africa,* Second Edition, Vol. 4. Families S-Z, Addenda Royal Botanic Gardens, Knew Richmond. United Kingdom, 689 p.

Dehgan, B. (1980). Application of epidermal morphology to taxonomic delimitations in the genus *Jatropha* L. (Euphorbiaceae). *Bot. J. Linnaean.* Soc., 257-278.

Dehnel, G. S. (1960). Response of stomata wounding. *Botanical Gazzette* 122:124-130.

Dilchar, K. L. (1974). Approaches to the identification of Angiosperm leaf remains. *Botanical Reviews,* 40:2-157.

Elliot, J. H. (1979). *Herbal medicine,* 6th Edition, Germany Publishing Company, New York. 124-130 pp.

Essiett, U. A. and Akpabio, K. E. (2005). Some observations on the diversity of staomata and trichomes in seven species and two varieties of *Dioscorea* in Nigeria. *Nigerian Journal of Botany,* 18:118-127.

Essiett, U. A. (2004). *Biosystematic Studies of Some Nigeria Dioscorea Species.* Ph.D. Thesis, Department of Botany and Microbiology, University of Uyo, Uyo, Nigeria.

Greens, B. O. (1987). *Application of Epidermal Characteristics and Certain Ergastic Substances to Taxonomic delimilation in the Genus. Dioscorea* L. (Dioscoreaceae). M. Sc. (Botany) Thesis submitted to University of Port-Harcourt.

Hutchinson, J. and Dalziel, J. M. (1958). *Floral of West Tropical Africa*, Vol. 1, Part 2. The Whitefairs Press Ltd., London.

Inamdar, J. A. and Chohan, A. J. (1969a). Epidermal structure and ontogeny of stomata in vegetative and floral organs of *Hibiscus rosa-sinensis* L. *Australian J. Bot.*, 17: 89 – 95.

Irina, N. G. (2011). Anatomical and micro-morphological peculiarities of *Adonis vernalis* L (Ranunculaceae). *Pak. J. Bot*., 43(2): 811-820.

Irwin, H. S. and Barneby, R. C. (1981). Cassieae. *In*: *Advances in Legume Systematics* (R. M. Polhill and P. H. Raven (Eds.). Royal Botanical Gardens, Kew Part I: 97 – 106.

Irwin, H. S. and Turner, B. L. (1960). Chromosomal relationship and taxonomic consideration in the genus *Cassia. American Journal of Botany,* 47: 309 – 318.

Isawumi, M. A. (1989). Epidermal studies in the species of *Jatropha L*. (Euphorbiacease) Found in *Nigeria. Journal of Botany,* 23:94-100.

Lewis, G. P. Schrire, B. Mackinder and Lock, M (2005) Legumes of the World Royal Botanical Garden *Knew. U. K*. 591 pp.

Metcalfe, C. R. and Chalk, L. (1979). *Anatomy of Dicotyledons,* Second Edition, Vol. 1, Clarendon Press, Oxford, 275 pp.

Oladunmoye, M. K. Adefuyi, F. C and Akinyosoye F. A. (2009). Effect of *Cassia hirsuta* (L.) extract on DNA profile of some micro-organisms. *African Journal of Biotechnolgy* (3): 447-450.

Oliver, B. (2005). *Medicinal Plants in Nigeria.* Nigerian College of Arts. In linking-hub Elsevier.com/retrieve pi. February 23rd 2005 121 pp.

Patel, R. C. and Inamdar, J. A. (1971). Structure Ontongeny of Stomata in some Polemoniales. *Ann. Bot*. 35:389-409.

Rejdalimoh, F. L. S. (1991). Leaf micromorphology and taxonomy of North African species of *Sideritis* L. (Lamiaceae). *Bot. J. Linnean Soc*., 107: 67 – 77.

Roe, K. E. (1971). Terminology of hairs in the Genus *Solanum. Taxon* 2 (4): 501-508.

Shah, G. L. and Gopal, V. (1969). Ontogeny of stomata on the foliar and floral organs of some species of Crotalaria L. Ann. Bot. 33: 553 - 560

Singh, V., Pande, P. C. and Jain, D. E. (1998). Anatomy of *S*eed plants first Edition. By Rakesh Kuman Rastogi pp 68-69.

Stace, C. A. (1980). *Plant Taxonomy and Biosystematic*. Contemporary Biology. 1st Edition. Edward Arnold Limited, London WCIB-3DQ. Pp.79-83.

Stace, C. A. (1984). The taxonomic importance of the leaf surface, In: Heywood V. H. and Moore D. M. (Eds). *Current Concepts in Plant Taxonomy*. Academic Press. London pp. 67-94.

Stuessy, F. T. (1990). *Plant Taxonomy: The Systematic Evolution of Comparative Data*. Columbia University Press, New York.