academicJournals

Vol. 8(10), pp. 462-472, October 2014
DOI: 10.5897/AJPS2014.1219
Article Number: 1B57E3E48465
ISSN 1996-0824
Copyright © 2014
Author(s) retain the copyright of this article
http://www.academicjournals.org/AJPS

African Journal of Plant Science

Full Length Research Paper

Taxonomic significance of foliar epidermal characters in the Caesalpinoideae

Aworinde David Olaniran[1]* and Fawibe Oluwasegun Olamide[2]

[1]Department of Biological Sciences, Ondo State University of Science and Technology, Okitipupa, Ondo State, Nigeria.
[2]Department of Biological Sciences, Federal University of Agriculture Abeokuta, Ogun State, Nigeria.

Received 31 July 2014; Accepted 21 October 2014

A detailed morphological study of the leaf epidermis of some species in the genera *Bauhinia* Linn., *Caesalpinia* Linn. *Daniellia* Hutch. & Dalz. and *Senna* Linn in Nigeria was undertaken in search of useful and stable taxonomic characters. The study reveals several interesting epidermal features some of which are novel in the genera. Leaf epidermal characters such as epidermal cell types, stomata types and the presence of trichomes were constant in some species and variable in others, making them to be of great significance in determining the relationships among and within species. Stomata were amphistomatic in all the species except in *Senna alata, Senna siamea* and *Senna siberiana* which are epistomatic. The species showed variability in their stomata length, width, density and index, which was reflected in their taxonomic delimitations.

Key words: Taxonomy, Leaf epidermis, *Bauhinia, Caesalpinia, Daniellia, Senna.*

INTRODUCTION

Caesalpinoideae is a large sub-family of about 150 genera with 2200 to 3000 species of flowering plants in the order Fabales (Eddy, 1997). The genus *Senna* is native throughout the tropics, with a few species extending into the temperate region. Some *Senna* species, especially *Senna alata*, have been reported to be used in the treatment of skin infections. Species of *Senna* were formerly included among the approximately 600 species of *Cassia* (Irwin and Turner, 1960). Shifting taxonomic boundaries mark the history of traditional systematic treatments of *Senna.* These shifts are best explained by the difficult taxonomic interpretation of morphological variations in *Senna. Bauhinia* species are commonly found at lowland and medium altitudes in most woodland types and on anthills 150 to 1800 m high; their seeds serve as food and their shoot as vegetables. The roots and leaves of *Bauhinia* species are used for medicine, fodder, shade, firewood, tannin, fibres and rope; they also serve aesthetic purposes (FAO, 1983). The members of the genus *Caesalpinia* are planted as an ornamental as is common in gardens on the coast of East and West Africa. Some species of *Caesalpinia* also have extra floral nectars on their leaves or flower stalks, which attract ants (Marazzi, 2006). The species in the genus *Daniellia* have been reported to have medicinal properties. A decoction of leaves and bark of *Daniellia oliveri* is used as a refreshing lotion of bath, internally against colic and as a mouth-wash against toothache

*Corresponding author. E-mail: daveaworinde@yahoo.com

Author(s) agree that this article remain permanently open access under the terms of the Creative Commons Attribution License 4.0International License

Table 1. Leaf morphological features of some species of sub-family Caesalpinoideae.

Taxa	Apex	Shape	Trichome	Base	Leaf Length/Width ratio
B. rufescens	Em	R	-	Co	1:1
B. tomentosa	Em	Co	-	Co	1:1
C. bonduc	Ac	La	-	Obl	2:1
C. pulcherima	Re	O	-	Ob	2:1
D. ogea	Ac	La	-	Ac	2:1
D. oliveri	A	La	-	Ac	2:1
S. acutifolia	Ac	La	-	Obl	5:1
S. alata	Re	Ob	++	Obl	2:1
S. fistula	Ac	La	-	Obt	2:1
S. hirsuta	A	La	++	Obl	2:1
S. obtusifolia	Re	O	-	Obl	1:1
S. occidentalis	A	La	-	Obl	2:1
S. podocarpa	Ap	Ob	-	Obl	2:1
S. siamea	Ap	L	-	Obt	3:1
S. siberiana	Ac	La	-	Obt	2:1

Em = Emarginate; Ac = Acute; Re = Retuse; A = Acuminate; Ap = Apiculate; R = Reniform; Co = Cordate; La = Lanceolate; Ob = Oblong; O = Obovate; L = Linear; Obl = Oblique; Obt = Obtuse; ++ = presence of trichomes; - = absence of trichomes.

(Irvine, 1961).

According to Stace (1965), the leaf is perhaps the most anatomically varied organ in angiosperms and it provides a variety of anatomical features that can be employed as useful taxonomic characters. Many research works have been done on the physiology, chemotaxonomy and medicinal use of the species of these genera and other genera in the family but information on the anatomy and taxonomy is still fragmentary. Therefore the aim of this work was to determine the taxonomic significance of leaf epidermis and other anatomical features with a view to further establishing a stable taxonomic character among the selected genera.

MATERIALS AND METHODS

Plant specimens used were collected in different ecological areas in Abeokuta (Ogun State), Ibadan, Sepeteri and Iseyin (Oyo State) South-western Nigeria. The collected specimens are: *Bauhinia rufescens, B. tomentosa, Caesalpinia bonduc, C. pulcherima, Danielia ogea, D. oliveri, Senna acutifolia, S. alata, S. fistula, S. hirsuta, S. obtusifolia, S. occidentalis,* S. *podocarpa, S. siamea* and *S. siberiana.* Identification was done at Forestry Herbarium Ibadan (FHI) and University of Ibadan Herbarium (UIH). Voucher specimens were deposited in the two herbaria. Quantitative characters assessed include leaf length and width (taken at the widest point) while qualitative characters such as leaf shape, margin, base and apex were also assessed *in situ.* Micro-characters such as cell wall thickness, size of epidermal cell, stomata size and index were also measured.

Preparation of leaf epidermal surfaces

Leaf epidermal morphology was studied using fresh specimens. About 5 mm^2 to 1 cm^2 leaf portions were obtained from the standard median portion of the leaves. Three to five specimens of each species were used depending on geographical spread of the species except for those known from only one or two localities. Epidermal peeling was carried out according to the procedure of Johansen (1940) as modified by Jayeola and Thorpe (2000). The peeled specimens were later stained with Safranin and counter stained with Fast green and then cleared in clove oil and mounted with DPX®. The slides were appropriately labeled and examined under a light microscope Olympus BX51 while photomicrographs of the micro-morphological features were taken at a magnification of X400 using a photomicrograph Olympus BX 51with installed digital camera optics.

For statistical analysis, 10 epidermal cells and 10 stomata were chosen randomly for each species and measured using a micrometer eyepiece. For each quantitative character, the mean and standard error were determined for all the taxa. The stomata index (SI) was calculated based on the formula derived by Metcalfe and Chalk (1979).

$$SI = \frac{S}{S+E} \times 100$$

Where, SI = Stomata index, S = Number of stomata per unit area, E = Number of epidermal cells in the same unit area.

RESULTS

Tables 1 and 2 and Figures 1 to 4 show the results obtained from this study while Plates 1-30 show photomicrographs of the abaxial and adaxial surfaces of the plant specimens. Generally, the leaves of the genera (*Bauhinia, Ceasalpinia, Daniellia, Senna*) were alternate, rarely opposite and mostly entire (Table 1). Leaves were mostly glabrous in all species except in *S. hirsuta* and *S. alata* which were pubescent. The apices were emarginate,

Table 2. Epidermal characters of some species of sub-family Caesalpinoideae.

Taxa	Cell shape		Anticlinal wall pattern		Stomata type	
	Adaxial	Abaxial	Adaxial	Abaxial	Adaxial	Abaxial
B. rufescens	Irr	Irr	C	S/S	Par	Par
B. tomentosa	Irr	Irr	C	C	An	An
C. bonduc	P	P	S/S	S/S	An	An
C. pulcherima	Irr	P	C	S/S	An	An
D. ogea	P	Irr	S/S	C	An	An
D. oliveri	Irr	P	S/S	S/S	De	--
S. acutifolia	Irr	Irr	C	C	Par	An
S. alata	P	Irr	S/S	C	--	Par
S. fistula	P	P	S	S	--	An
S. hirsuta	P	P	S/S	C	Ani	Par
S. obtusifolia	P	P	S/S	S/S	Ani	--
S. occidentalis	Irr	Irr	C	C	Par	Par
S. podocarpa	Irr	P	C	S/S	Par	--
S. siamea	P	P	S/S	S/S	--	An
S. siberiana	Irr	Irr	C	C	--	An

Irr = Irregular; P = polygonal; C = curved; S = straight; An = Anomocytic; Ani = anisocytic; Par = paracytic; De = Desmocytic; S/S= straight/slightly curved; - = Absent/not present.

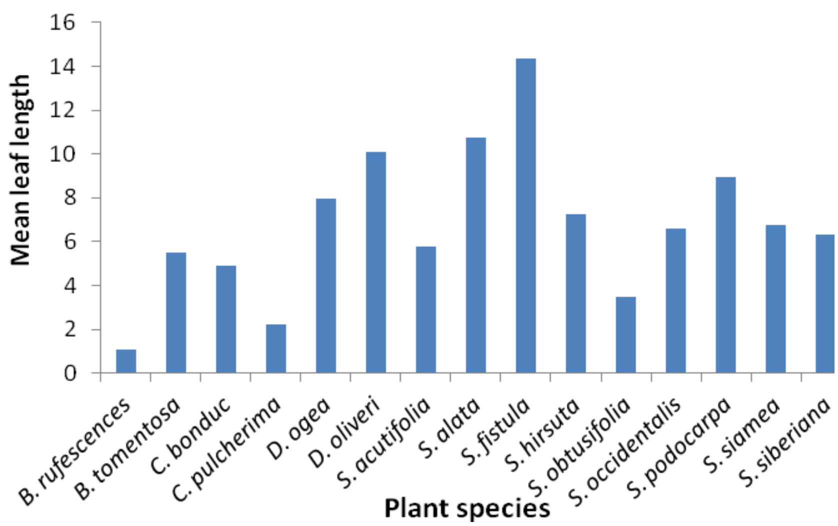

Figure 1. Mean leaf length of some species of sub-family Caesalpinoideae.

acute, acuminate, retuse, or apiculate. The leaflet sizes showed considerable variations within and among the genera with the largest recorded in *S. fistula* (14.8 cm) and the smallest in *B. rufescens* (0.8 cm) (Figure 1). The lowest leaf length/width ratio 1:1 was recorded in *B. rufescens, B. tomentosa* and *S. obtusifolia* (Table 1), while the highest was recorded in *S. acutifolia.* Trichome bases were, however, noticed in some species occurring on their adaxial or abaxial surface. The leaf epidermal cells were more often polygonal (Table 2) but sometimes irregular. Polygonal cells occurred most often on the abaxial surfaces but were also noticed on the adaxial surfaces of *C. bonduc, D. ogea, S. alata, S. fistula, S. obtusifolia, S. hirsuta* and *S. siamea* (Plates 1-30). Sometimes, polygonal cells were seen interspersed with irregular cells as seen in *C. pulcherima, D. ogea, D. oliveri, S. alata* and *S. podocarpa.* Stomata were amphistomatic in all the species and have commonly anomocytic, anisocytic and paracytic types apart from the rare to occasional occurrence of other stomata types and

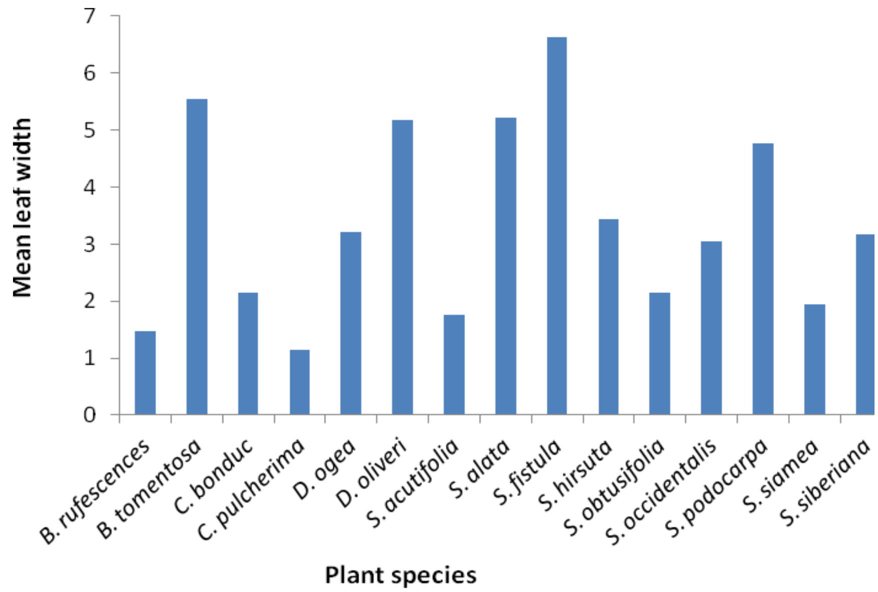

Figure 2. Mean leaf width of some species of sub-family Caesalpinoideae.

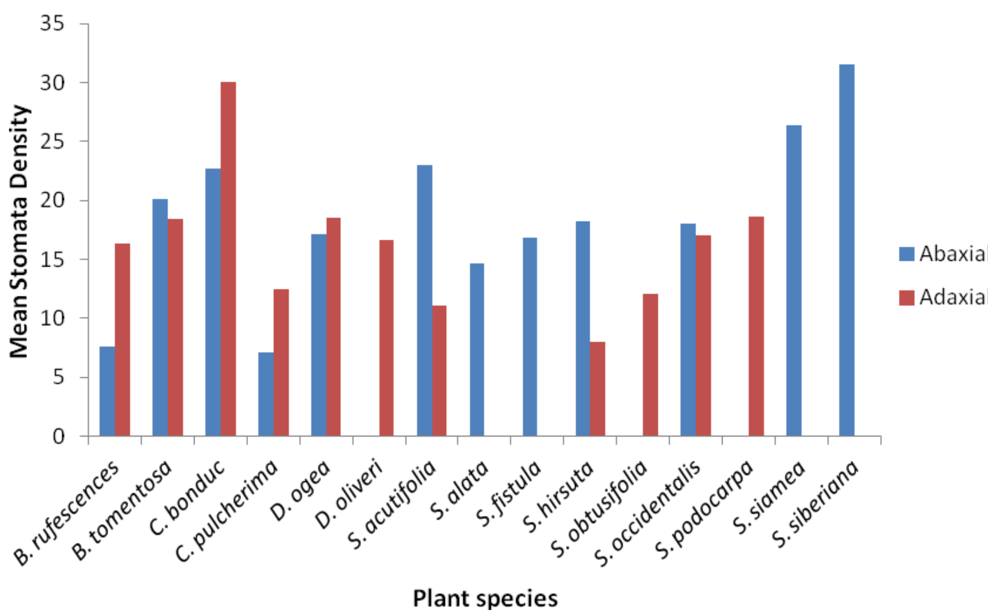

Figure 3. Mean stomata density of some species of sub-family Caesalpinoideae.

abnormalities found on the adaxial surface of *D. oliveri.* Trichomes were absent in most of the species except for the presence of whip-like and non-glandular trichomes found on both surfaces of *S. hirsuta* and *S. alata.*

DISCUSSION

There was a wide variation in the number and distribution of stomata found in all the species. Classification of different types of stomata complexes was based on the number and position of the subsidiary cells and the ontogeny of the cell types. According to Richard et al. (2007), stomata comprise two elongated guard cells bracketing a stomatal pore, and often but not always, surrounded by one to many subsidiary cells. The presence of desmocytic stomata in *D. oliveri* distinguished it from other species. This was corroborated

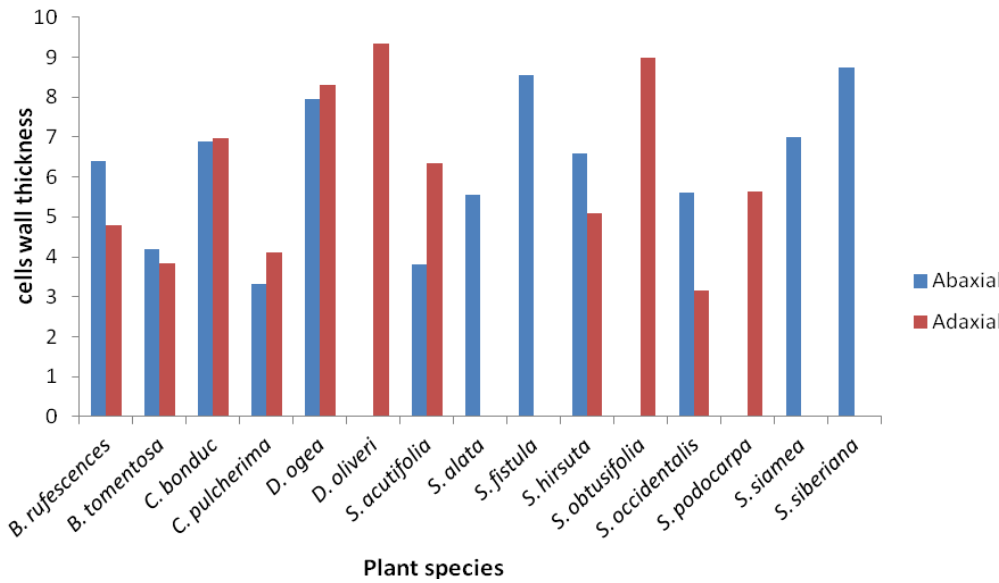

Figure 4. Cell wall thickness (µm) of some species of sub-family Caesalpinoideae.

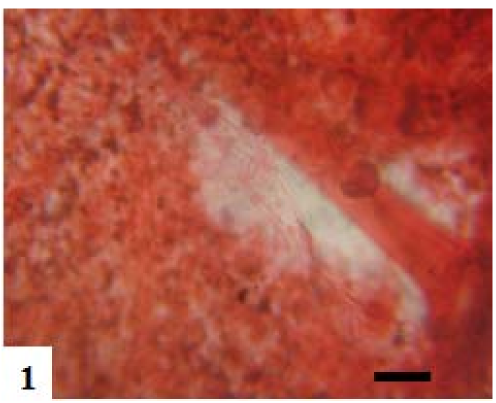

Plate 1. The adaxial surface of *B. rufescence* showing paracytic stomata and irregular epidermal cells.

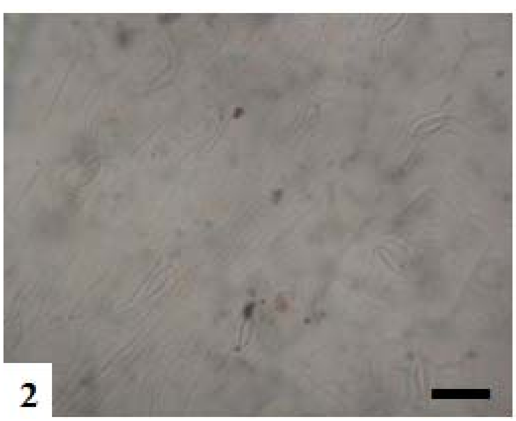

Plate 2. The abaxial surface of *B. rufescence* showing paracytic stomata and irregular epidermal cells.

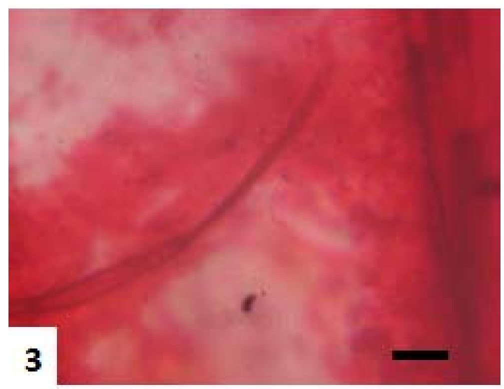

Plate 3. The adaxial surface of *B. tomentosa* showing anomocytic stomata and irregular epidermal cells.

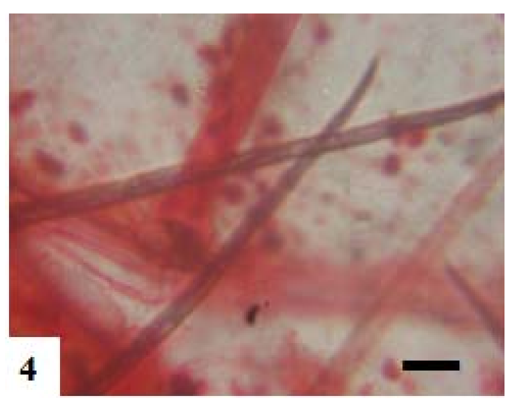

Plate 4. The abaxial surface of *B. tomentosa* showing anomocytic stomata and irregular epidermal cells.

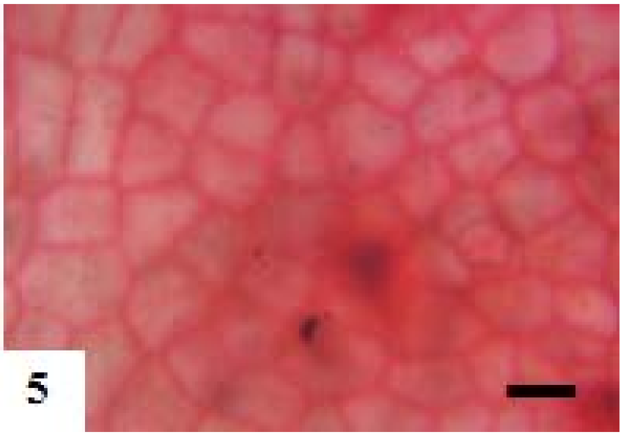

Plate 5. The adaxial surface of *C. bonduc* showing anomocytic stomata and polygonal epidermal cells.

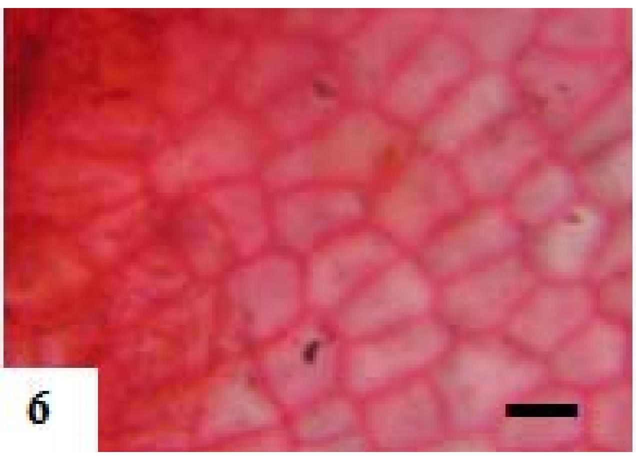

Plate 6. The abaxial surface of *C. bonduc* showing anomocytic stomata and polygonal epidermal cells.

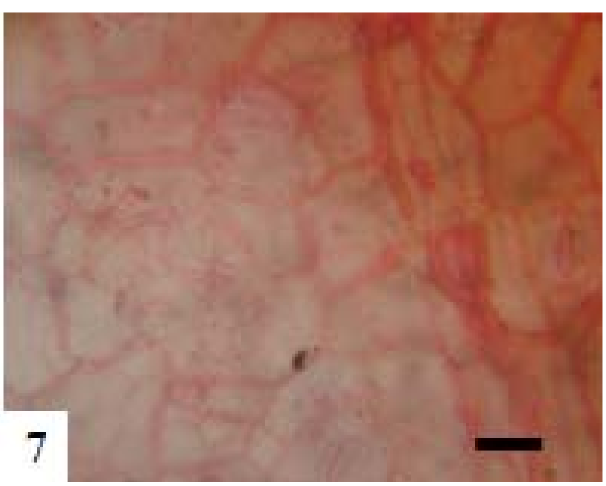

Plate 7. The adaxial surface of *C. pulcherima* showing anomocytic stomata and irregular epidermal cells.

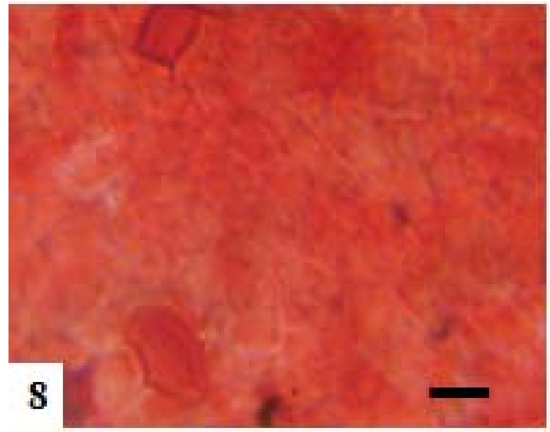

Plate 8. The abaxial surface of *C. pulcherima* showing anomocytic stomata and polygonal epidermal cells.

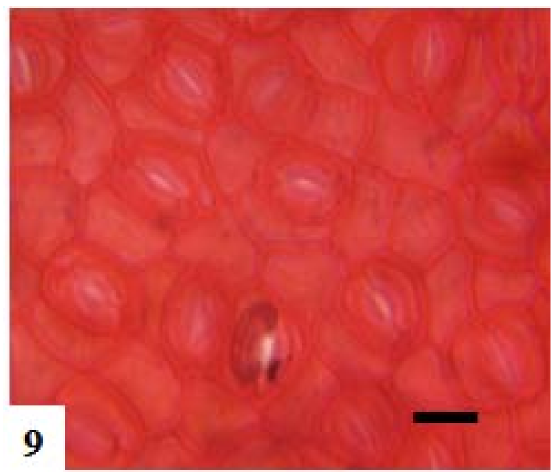

Plate 9. The adaxial surface of *D. ogea* showing anomocytic stomata and polygonal epidermal cells.

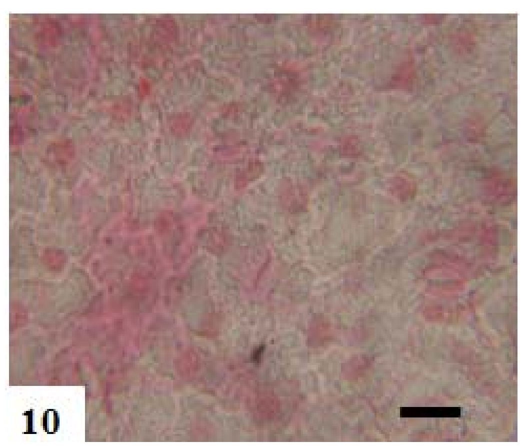

Plate 10. The abaxial surface of *D. ogea* showing anomocytic stomata and irregular epidermal cells.

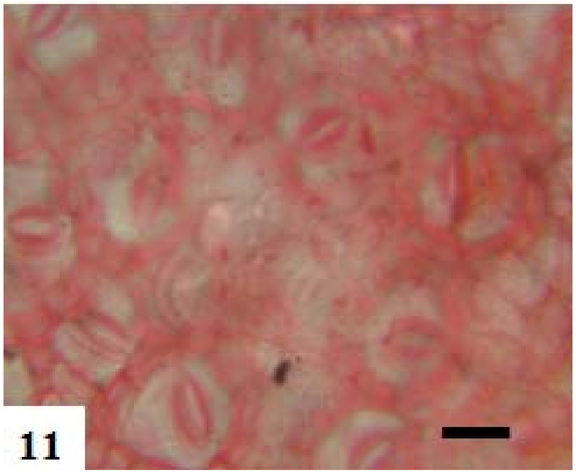

Plate 11. The adaxial surface of *D. oliveri* showing desmocytic stomata and irregular epidermal cells.

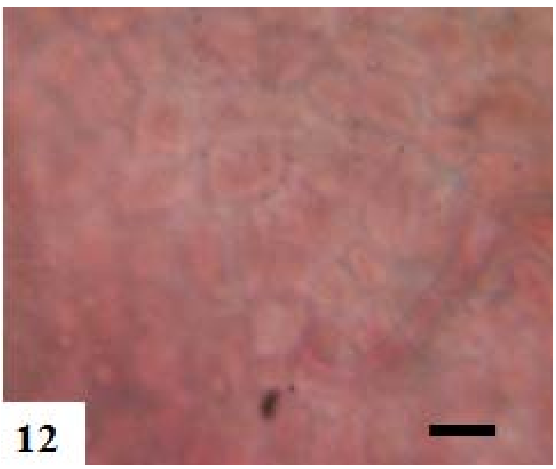

Plate 12. The abaxial surface of *D. oliveri* showing no stomata and polygonal epidermal cells.

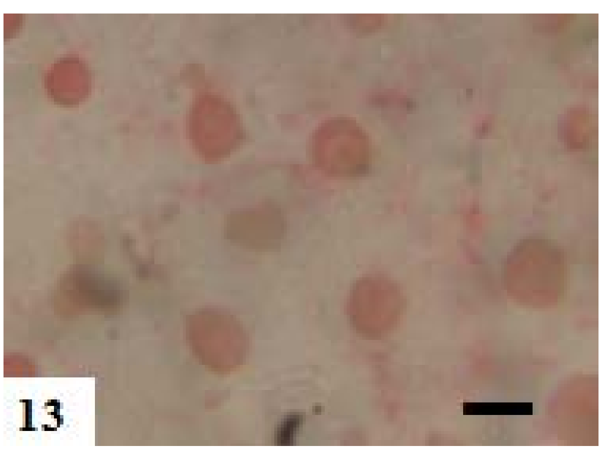

Plate 13. The adaxial surface of *S. acutifolia* showing paracytic stomata and irregular epidermal cells.

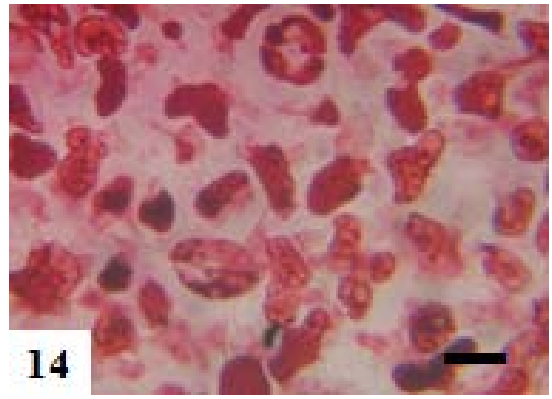

Plate 14. The abaxial surface of *S. acutifolia* showing anomocytic stomata and irregular epidermal cells.

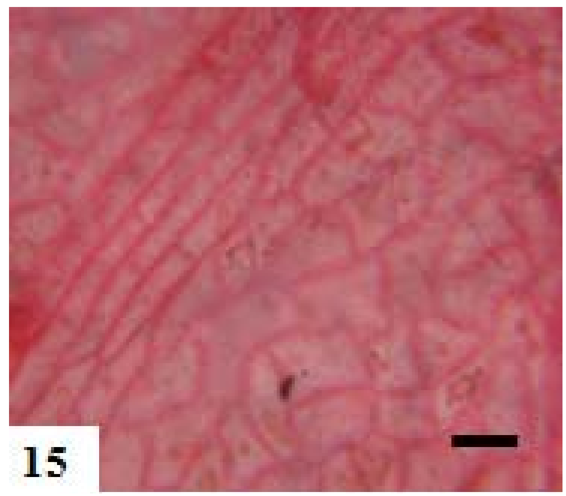

Plate 15. The adaxial surface of *S. alata* showing no stomata and polygonal epidermal cells.

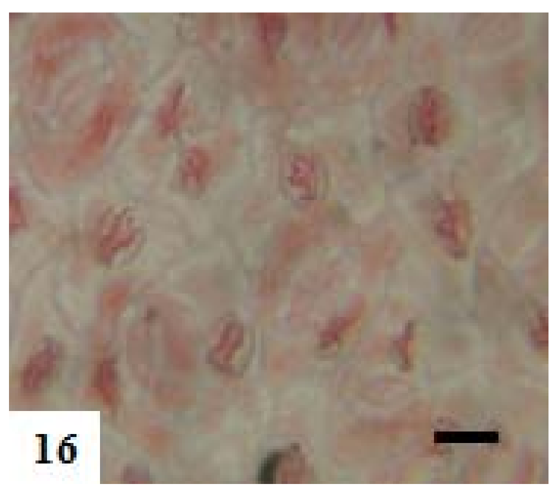

Plate 16. The abaxial surface of *S. alata* showing paracytic stomata and irregular epidermal cells.

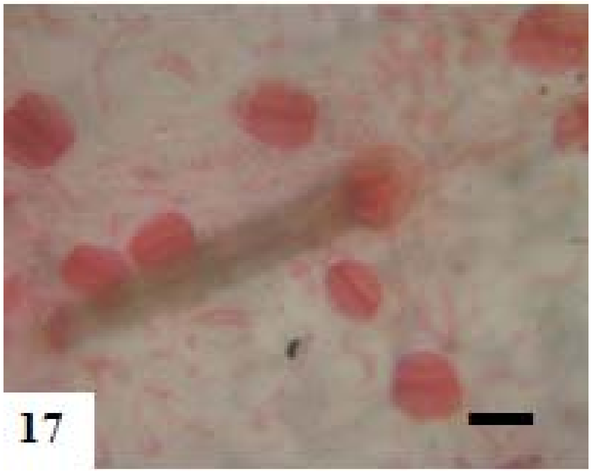

Plate 17. The adaxial surface of *S. fistula* showing no stomata and polygonal epidermal cells.

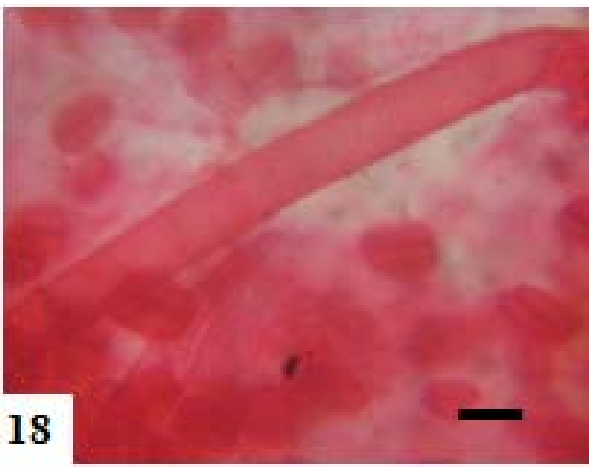

Plate 18. The abaxial surface of *S. fistula* showing anomocytic and polygonal epidermal cells.

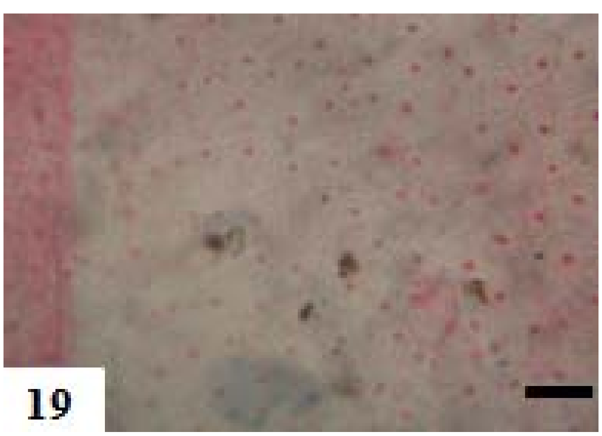

Plate 19. The adaxial surface of *S. hirsuta* showing anisocytic stomata and polygonal epidermal cells.

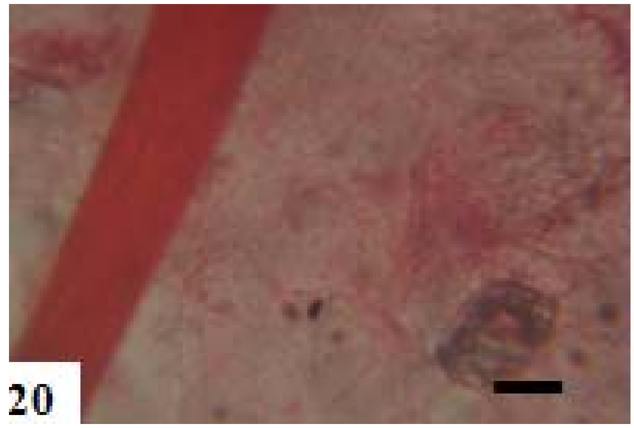

Plate 20. The abaxial surface of *S. hirsuta* showing paracytic stomata and polygonal epidermal cells.

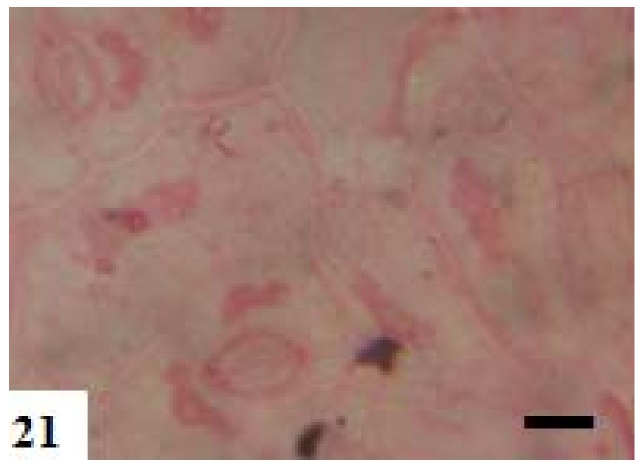

Plate 21. The adaxial surface of *S. obtusifolia* showing anisocytic stomata and polygonal epidermal cells.

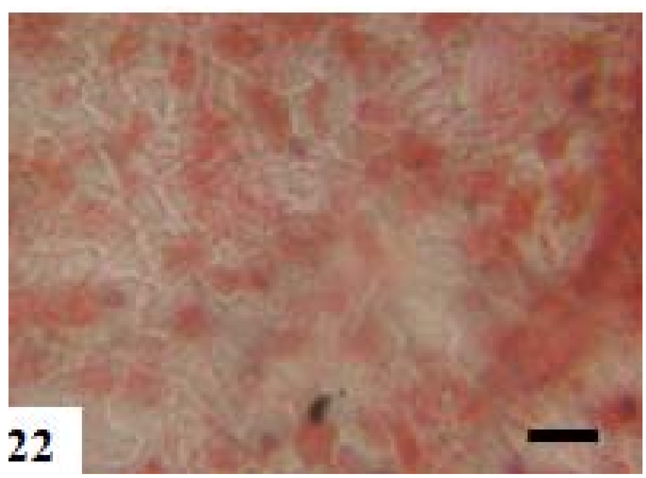

Plate 22. The abaxial surface of *S. obtusifolia* showing no stomata and polygonal epidermal cells.

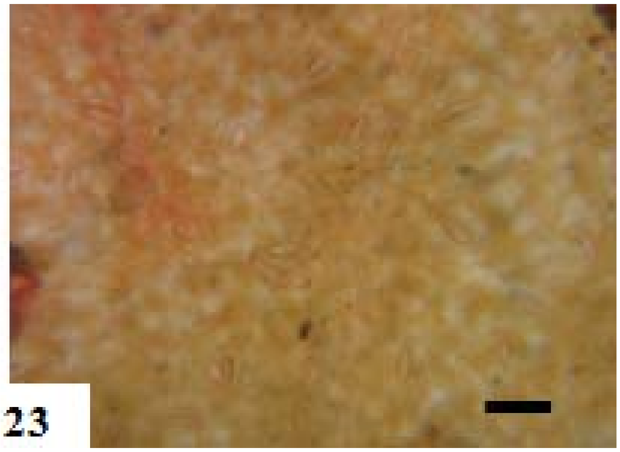

Plate 23. The adaxial surface of *S. occidentalis* showing paracytic stomata and irregular epidermal cells.

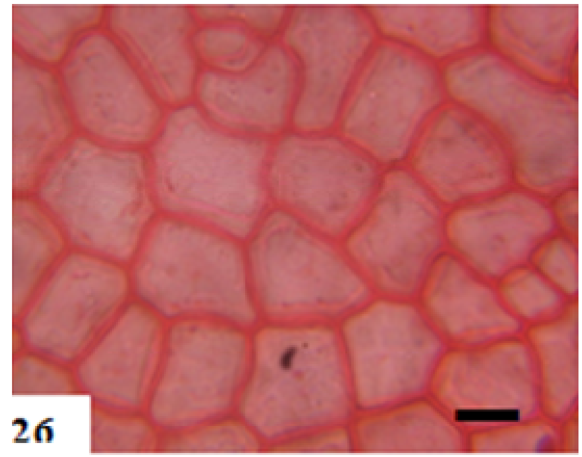

Plate 26. The abaxial surface of *S. podocarpa* showing no stomata and polygonal epidermal cells.

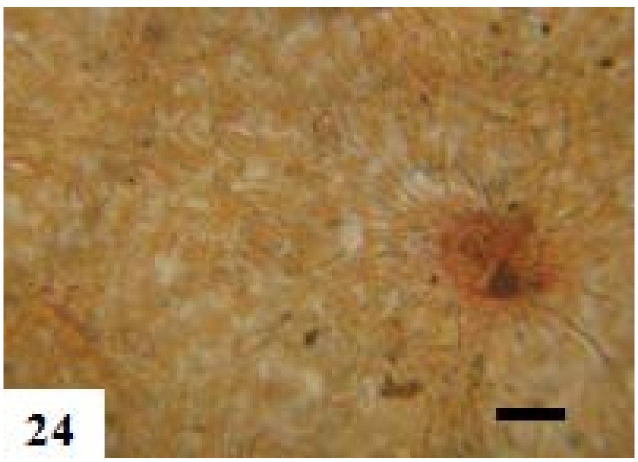

Plate 24. The abaxial surface of *S. occidentalis* showing paracytic stomata and irregular epidermal cells.

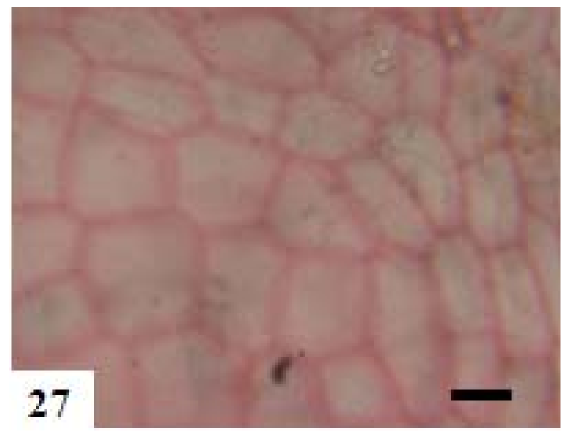

Plate 27. The adaxial surface of *S. siamea* showing no stomata and polygonal epidermal cells.

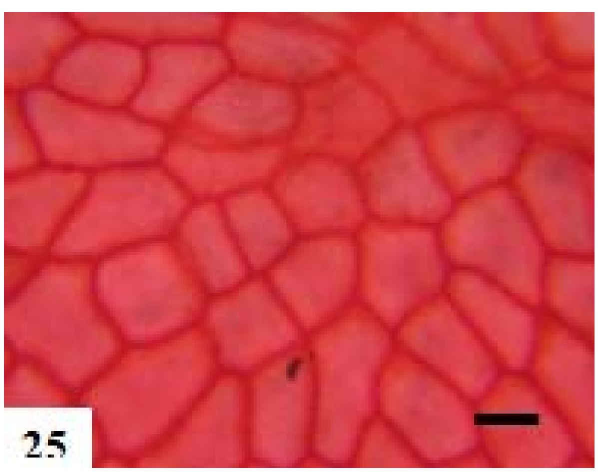

Plate 25. The adaxial surface of *S. podocarpa* showing paracytic stomata and irregular epidermal cells.

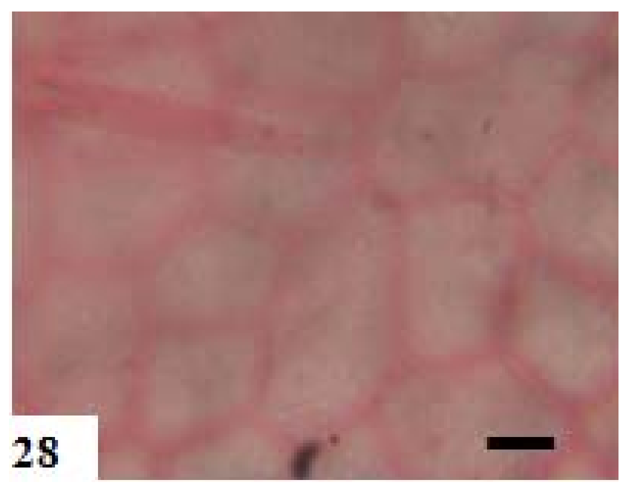

Plate 28. The abaxial surface of *S. siamea* showing anomocytic stomata and polygonal epidermal cells.

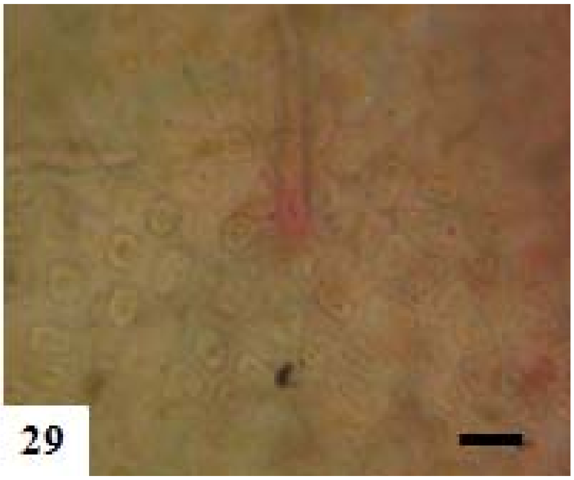

Plate 29. The adaxial surface of *S. siberiana* showing no stomata and irregular epidermal cells.

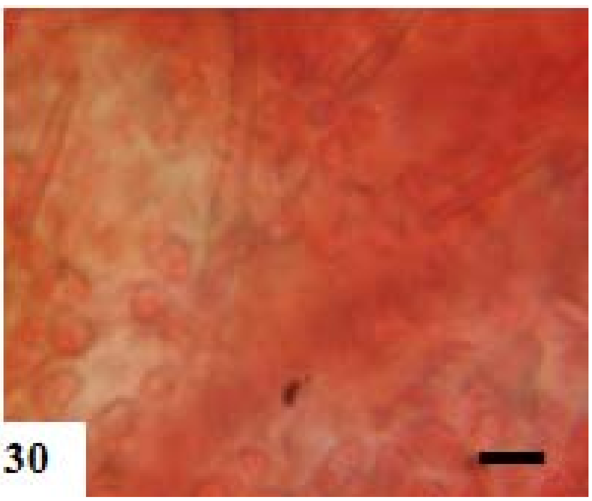

Plate 30. The abaxial surface of *S. siberiana* showing anomocytic stomata and irregular epidermal cells.

by the findings of Metcalfe and Chalk (1979). Also, absence of stomata on the adaxial surfaces of *S. alata*, *S. fistula, S. siamea,* and *S. siberiana* made them distinct from other species in the genus. The cell shape and cell wall patterns vary considerably among these genera and based on these two characters, the species of the genera was divided into groups of five; those with curved anticlinal wall, straight anticlinal wall, curved and straight anticlinal wall, irregular and polygonal cell shapes.

The occurrence of curved walls in most of the species agreed with the suggestion of Stace (1965) and Richard et al*.* (2007) that curved wall was a mesomorphic character and that environmental conditions such as humidity play a significant role in determining the pattern of anticlinal wall. The relative abundance and variation of the trichomes was of taxonomic importance in the genera. Almost all the species in these genera were glabrous which distinguished them from other species which were pubescent. However, the presence of simple, long, interwoven trichomes which covers the epidermal cells and stomata in *S. alata* and *S. hirsuta* distinguished them from other species in the same genus. The presence of many short non-glandular trichomes in *B. tomentosa* and *S. siberiana* makes it easy to be separated from other species. Metcalfe and Chalk (1979) opined that trichomes frequency and size are environmentally controlled while Stace (1965) reported that hairs are constant in species, and when present showed a constant range of form and distribution useful in diagnosis. Some overlap features noted in some species and genera within the sub-family perhaps still explain the affinity in their relationship despite the recent taxonomic divergence.

Preponderance of stomata on the abaxial surfaces than adaxial surfaces is a mechanism to reduce water loss through transpiration (Adegbite*,* 2008). The foliar epidermal features of some members of the genera of the sub-family Caesalpinoideae is of taxonomic importance since they can be separated and classified according to their stomata and cell wall shape. Based on the striking similarities and differences noted in the morphological and anatomical features, it is hereby suggested that further research such as phytochemical analysis and molecular studies be carried out to further delimit the species, as this work serves as baseline upon which other research could stand.

Conflict of Interest

The author(s) have not declared any conflict of interests.

ACKNOWLEDGEMENT

The effort of Mrs. Olanloye Oluwafunmilayo Adebimpe of the Department of Biological Sciences, Federal University of Agriculture, Abeokuta, Ogun State on the photomicrographs is greatly acknowledged.

REFERENCES

Adegbite AE (2008). Leaf anatomical studies in some species of the tribe *Cichorieae* (Asteraceae) in Nigeria. Comp. Newsl*.* 46: 49-58.

Eddy MQ (1997). Taxonomic significance of foliar epidermal dermotypes and floral trichomes in some Cuban taxa of *Indigofera* L. (Fabaceae - Faboideae). Polibotanica 6:1-8.

FAO (1983). “Food and fruit-bearing forest species: Examples form East Africa” Forestry Paper 44/1, FAO, Rome.

Irvine FR (1961). Woody plants of Ghana. Oxford University Press, Amen House, London p.296.

Irwin HS, Turner BL (1960). Chromosomal relationship and taxonomic consideration in the genus *Cassia*. Am. J. Bot. 47: 309-318.

Jayeola AA, Thorpe JR (2000). A scanning electron microscope study of the genus *Calyptrochilum* Kraenzl. (Orchidaceae) in West Africa.

Feddes Repert. 111: 315-320.
Johansen EV (1940). Plant Microtechnique. McGraw Hill Company Inc., New York, London.
Marazzi B (2006). Phylogenetic relationships within *Senna* (Leguminosae - Cassiinae) based on three chloroplast DNA regions: Patterns in the evolution of floral symmetry and extra floral nectarines. Am. J. Bot. 20(2):12-20.
Metcalfe CR, Chalk L (1979). Anatomy of the Dicotyledons (2nd Edition). Volume 1. Oxford University Press, Oxford. p. 276.
Richard J, Jennifer M, David D, Bradley S (2007). The cuticle database: Developing an interactive tool for taxonomic and paleo-environmental study of the fossil cuticle record. Cour. Forsch. Inst. Senckenberg. 258:39-55.
Stace CA (1965). Cuticular studies as an aid to plant taxonomy. Bull. Br. Mus. Nat. Hist. Bot. 4:1-78.