Asian Journal of Plant Sciences

ISSN 1682-3974

science alert

ANSInet
an open access publisher
http://ansinet.com

Asian Journal of Plant Science 5 (1): 41-49, 2006
ISSN 1682-3974

Leaf Epidermal Micromorphology in the Systematics of *Abrus* (Papilionaceae) in Parts of Tropical West Africa

Ikechukwu O. Agbagwa and Bosa E. Okoli
Department of Plant Science and Biotechnology, Faculty of Sciences,
University of Port Harcourt, P.M.B. 5323, Port Harcourt, Rivers State, Nigeria

Abstract: Comparison of the leaf epidermis of three species (*A. canescens* Welw. ex Bak., *A. precatorius* L. and *A. pulchellus* Wall. ex Thw.) and a new collection of *Abrus* adanson (simply referred to as *Abrus* sp.) found in tropical West Africa was undertaken by simple microscopy. The epidermal cells are irregular with wavy, sinuous or arcuate anticlinal walls, while the coastal cells are parallel, elongated and rectangular, terminating obliquely. Six types of stomata: paracytic (laterocyclic), diacytic, anomocytic, anisocytic, staurocytic and contiguous, were observed in the species. Anomocytic stomata are absent in *A. canescens*. The new collection *Abrus* sp., is distinguished from the other three species by its amphistomatic nature and possession of stomata in-groups of two or three bordered by six continuous subsidiary cells on its abaxial surface. It also has a Stomatal Index (SI) of 18.19, the highest in the genus. The other species are hypostomatic. Simple unbranched trichomes (long and short category) occur on both leaf surfaces of the species except in the new collection *Abrus* sp. where trichomes are confined to the abaxial surface. Trichome Index (TI) of 3.79 on the abaxial surface of *A. canescens* was observed to be the highest in the genus. Venation is of the camptodromous-brochidodromous type. Crystals are of common occurrence in the species. The study was aimed at improving systematic information on the tropical West African species of *Abrus,* which is hitherto lacking and with the collection of a new species, stimulate interest on *Abrus* taxonomy and conservation in the region.

Key words: *Abrus*, amphistomatic, crystals, hypostomatic, microscopy, stomata, trichome

INTRODUCTION

Abrus Adanson is of the family Papilionaceae. In tropical West Africa, Dalziel[1], Hutchinson and Dalziel[2] and Burkill[3] briefly described three members of this genus. These are *A. canescens* Welw. ex Bak., *A. pulchellus* Wall. ex Thw. and the widespread *A. precatorius* L. The species are among the lesser known and utilized legumes although great potentials for exploitation abound for the genus[4]. Several medicinal, pharmacological and toxicological uses are ascribed to the species especially *A. precatorius*[1,3], including the preparation of liquorice from leaves and leafy twigs[5,6]. Despite the enormous uses of *Abrus* species in tropical West Africa as reported by Burkill[3], information on their taxonomy is almost lacking. Efforts to make fresh collections of *A. canescens* in the course of this study within Nigeria where it was reported to occur[2,3] were not successful; hence only herbarium samples were used. This may imply gradual extinction of the species without proper taxonomic documentation. There is also the problem of variability of the vegetative features and the conflicting reports of the exact number of species in the genus. The need therefore arises to commence detailed systematic studies on the species in tropical West Africa to provide factual taxonomic information based on fresh field investigations complemented by herbarium data to resolve some of these taxonomic controversies. A good taxonomic documentation of members of this genus will unarguably help in conserving their biodiversity.

The usefulness of epidermal characteristics in comparative anatomy and taxonomy in some members of the *Leguminosae* has been highlighted[7-11]. These reports utilized information from the structure, development and types of stomata, trichome and trichome types and various other quantitative and qualitative leaf epidermal characters to achieve taxa elucidation. Cutler[12] reported that apart from the usefulness of these characters in taxonomy, they are also effectively used in the identification of fossil leaf impressions in paleobotany and authentication of foliar drugs in pharmacognosy. Though *Abrus* species have found enormous use in ethnomedical practices in Tropical West Africa[1,3], information on the systematics of the genus is scanty

Corresponding Author: Ikechukwu O. Agbagwa, Department of Plant Science and Biotechnology, Faculty of Sciences, University of Port Harcourt, P.M.B. 5323, Port Harcourt, Rivers State, Nigeria

amidst extinction treat to some species. Even where taxonomic information exists, there is need to resolves controversies associated with variability and overlaps in vegetative features, which creates difficulty in species identification. The detailed descriptive qualitative and quantitative epidermal data amassed herein together with a diagnostic key based on the epidermal features provides good taxonomic guide to the species. Also described are the epidermal characteristics of a new collection in this genus whose identity is undergoing confirmation. We hope that findings will be invaluable for conservation and biotechnological exploitation of this plant.

MATERIALS AND METHODS

Fresh and herbarium specimens were used in this study (Table 1). Herbarium specimens were obtained from Forestry Herbarium Ibadan (FHI) and University of Ibadan Herbarium (UIH). Voucher specimens of all the living materials studied were collected between 1998 and 2000 and are deposited in the University of Port Harcourt Herbarium (UPH).

The leaf epidermis of *Abrus* species were studied from either fresh samples (*A. precatorius*, *A. pulchellus* and the new collection *Abrus* sp.), fixed directly into the fixative formol acetic alcohol i.e., FAA (1 part formaldehyde, 1 part glacial acetic acid, 18 parts 70% ethanol v/v), or from herbarium materials (*A. precatorius*, *A. pulchellus* and *A. canescens*) using the scraping method[12], with modifications[13]. Initial soaking in water for 8-12 h first revived the herbarium samples. The surface to be examined was placed on a glass slide or tile while the other surface was carefully cleared by flooding with 5% sodium hypochlorite (domestic bleach) for about 2 min. Scraping was achieved with razor blade. The clear epidermal layers obtained were subsequently washed in several changes of distilled water, stained in 1% safranin for 1 min and temporarily mounted in glycerin. The preparations were observed and studied with a LEITZ microscope at objective lens 10 and 40 microscope magnification. Twenty microscope field views chosen at random were used to enumerate and study the number and types of stomata, trichomes and other epidermal cells. Stomatal indices were computed according to Stace[14],

Table 1: Examined sources of plant materials

Taxa	Serial number of species studied	Collector and accession/ herbarium number	Collection date	Locality	Remarks
Abrus precatorius	001	Agbagwa 001 UPH*	17/5/98	Emeabiam, Owerri West L. G. A., Imo State	
	002	Agbagwa 002 UPH*	15/8/98	Orazi road, Port Harcourt. Climbing on a barbed fence	
	003	Agbagwa 010 UPH*	2/8/99	Forestry Research Institute of Nigeria (FRIN), Ibadan	
	004	Agbagwa 005 UPH*	16/1/99	69 Independence Layout, Enugu	In private compound
	005	Agbagwa 011 UPH*	12/12/99	Ibiono Ibom, Akwa Ibom State	
	006	E. Bernays UIH 16216	8/4/75	Iwo Road, Ibadan (½ mile from New Ife road)	
	007	Williamson, R. UIH 15402	14/12/73	Kaiama, Kolokuma Area Yenegoa Division	
	008	D. Vermeer. UIH 16712	1975	W. of J. W. Donga, Benue Province, 7o15'N 9o40'E	
	09	Olurunfemi FHI 57085	26/9/66	Kabama forest reserve, Zaria	
	010	Magaji FHI 17962	15/9/67	Seven Miles on 6/7 range Runka Forest Reserve, Katsina. On savanna woodland	
	011	C. Onochie FHI 7194	22/4/44	Umuikem, Onitsha	
	012	FHI 98709	17/9/77	Northern Province, Karonga District, Mali Vinthukhutu 2 miles North of Chilumba 1800ft	Republic of Mali
	013	Adam (377) FHI 84029	21/1/48	M'Bao, Rufisque District, Senegal. Rep	Republic of Senegal
	014	Daramola FHI 78539	20/9/75	Creek edge near New Prisons Calabar, S.E.	
Abrus pulchellus	015	Agbagwa 003 UPH*	21/12/98	Emeabiam, Owerri-West L. G. A., Imo State	
	016	Agbagwa 004 UPH*	6/01/99	Behind Chemical Engineering Dept. Choba, Uniport	
	017	Agbagwa 006 UPH*	12/2/99	After the Mosque, University of Ibadan Nigeria	
	018	Agbagwa 007 UPH*	1/3/99	Botanical Garden University of Calabar, Nigeria	
	019	Agbagwa 009 UPH*	3/5/99	KM 4, along Kolo-Creek/Rumuekpe Pipeline, Imiringi, Bayelsa State	
	020	Agbagwa 012 UPH*	29/11/2000	High Secondary forest, opposite IITA office, Onne Station	
	021	Latilo FHI. Bret 1961	1/3/61	Acharane F. R., Idah District, Kabba	
	022	Ujor E. FHI 29395	22/11/51	Gambari South F.R. Ibadan.	
	023	Gbile, Olorunfemi, Binuyo FHI 20588	7/2/69	Ogbesse River Bank Ogbesse-Owo Rd; Owo Ondo. Det. as *A. pulchellus* Wall 6/3/69, *A. fruticulosus* Wall Ex. W. And A. 1/11/61; *A. pulchellus* Thro. sp. 1/4/71	Det. as *fruiticulosus* wall. Ex wight et Arn. and *A. pulchellus* wall, respectively at Kew

Table 1: Continue

Taxa	Serial number of species studied	Collector and accession/ herbarium number	Collection date	Locality	Remarks
	024	Onochie PSP 132 FHI 43187	16/11/58	Akpaka F. R. Onitsha Det. As *A. fruticulosus* Wall. Ex wight et Arn. and *A. pallchellus* Wall. Respectively at Kew	
	025	Jones FHI 6359	11/10/43	Oyo	Seen for revised edition of F.W. T.A.
	026	Emwiogbon FHI 43539	14/11/61	Shasha F.R, Oyo, Ife District	
Abrus canescens	027	Meikle (1089) UIH 2098	21/1/50	Kontagora Division by roadside, about 4k from Kontagora	
	028	Olurunfemi Binuyo, Babagbemi FHI 96811	23/11/81	Iyere-Ogura Road, Owo District, Ondo State.	Cited specimen F. W. T. A. Ed. 2, 1958
	029	Latilo FHI 62268	14/11/68	Egbe, Yagba District of Kabba, Kwara State.	
	030	Latilo FHI 64726	3/12/71	North East, Bauchi about 10 miles east of Aliya village in Ngeji village	
	031	Eimunjeze and Oguntayo FHI 71358	8/10/74	Savanna-woodland, beside a stream, Omu-Aran, Kwara State	
	032			Omu-Aran, Kwara State	
	033	Ohaeri (1037) FHI 78891	20/10/75	Shika farm, Zaria	
	034	Daramola and Adebisiyi FHI 38433	14/10/58	On the line 15, Savanna woodland area, Bunu District, Kabba	
	035	Opayemi (095) FHI 68859	18/11/72	5 miles after Oyo on Iseyin Road; savanna near a stream	
	036	FHI 77678 Photo No. 1723	1855	Angola No. 2249	Type specimen: type of british museum herbarium
	037	Olurunfemi Oguntayo, Ihe FHI 88335	20/9/78	Savanna: Ogamnana-Lokoja Road, Okene, Kwara State	as *A. frutensis*
	038	Latilo FHI 73554	10/11/75	Baissa-Mararraba Road, North Eastern State	Savanna area
	039	Mullenders (248) FHI 42593	1/4/47	Kaniama-Haut Lomani (Congo Belge)	Specimen from Ex Herbario Horti Botanici Yangambiensis. (Congo Belge)
	040	Amshoff FHI 31707	1972	Near Sindou, 5 11Wo, 10 49No, Upper Volta	Presently Burkina Faso Specimen from Plantae Upper Volta. exsiccatae Herbarium vadense
	041	Rwaburindore (1141) FHI 104671	20/1/83	Kanyanya Valley, W. Mengo District Kyadondo District of Uganda. Lat Oo23N long. 32o 36'E. Altitude 1200M	Uganda Flora of Uganda
	042	Adams and Akpabla (4394) FHI 53186	18/12/50	Climbing on shrubs near swamps: from Ghana Herbarium	Cited F. W. T.A. ed. 2, 1.574
	043	Morton (2482) FHI 14626	14/11/65	Kameron to Kuruboula, about 2 miles from Kameron	In damp savanna in Kameron
Abrus sp.	044	Agbagwa 013 UPH*	1/12/2000	Taylor Greek area, Biseni, Bayelsa State	High tropical rainforest area

UPH*: Fresh specimens deposited at the University of Port Harcourt Herbarium

stomatal type according to Metcalfe and Chalk[7], Stace[14] and Dilcher[15], trichome morphology and venation description according to Metcalfe and Chalk[7], Sasikala and Narayanan[16], trichome density and distribution according to Olowokudejo[17]. Photomicrographs were taken with a LEITZ DIAPLAN (Photomicroscope) fitted with LEICA WILD MPS 52 camera at objective lens of 10 and 40 magnification.

RESULTS

Results showed that the epidermis on both leaf surfaces of the species have one type of cell shape, i.e. irregular. The anticlinal wall of the leaf surfaces may be wavy, sinous or arcuate (Fig. 1-4 and Table 2). The adaxial anticlinal wall in *A. precatorius* and *A. pulchellus* is wavy and in *Abrus* sp. and *A. canescens*, they are sinuate and arcuate, respectively. Except in *A. precatorius* where the abaxial anticlinal wall is wavy, the other species show sinuate to arcuate anticlinal wall patterns. On the adaxial surface epidermal cell size varied from 42.20±17.31 x 15.06±5.06 μm in *A. canescens* to 73.80±47.68 x 12.04±3.44 μm in *A. pulchellus*. On the abaxial surface, the average size of cells of *A. pulchellus* and *A. precatorius* are 76.18±40.31 x 13.50±3.60 μm and 51.30±8.25x15.37±2.55 μm, respectively, while 31.86±16.83 x 16.61±6.11 μm for *A. canescens*. For the new collection *Abrus* sp., the epidermal cell sizes on both surfaces are the same (Table 2). *A. pulchellus* had the highest cell length while the new collection *Abrus* sp. scored the highest cell width. Values for epidermal cell size in *A. canescens* are more on the adaxial surface.

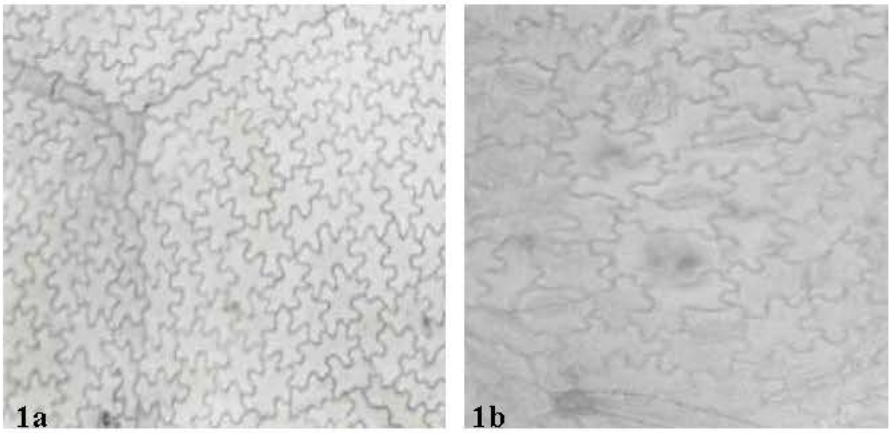

Fig. 1: a: (x 560)-showing adaxial leaf epidermis of *A. precatorius*, b: (x 875)- showing abaxial leaf epidermis of *A. precatorius*

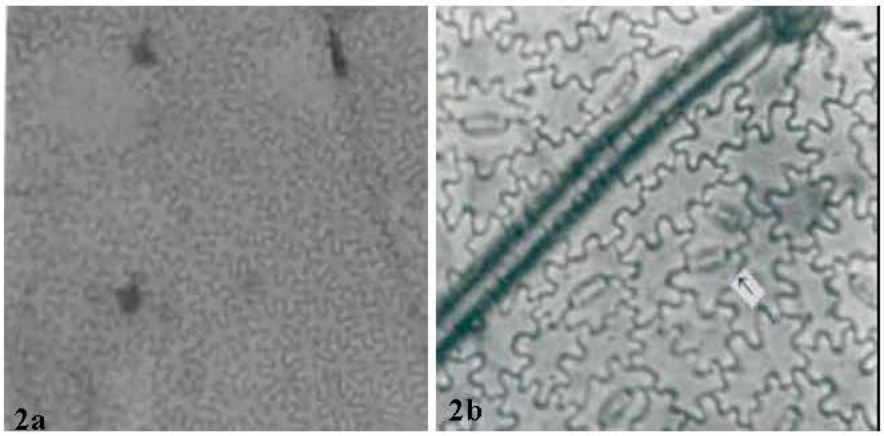

Fig. 2: a: (x 560)-adaxial leaf epidermis of *A. pulchellus*, b: (x 875)-abaxial leaf epidermis of *A. pulchellus*. Arrow shows contiguous stomata

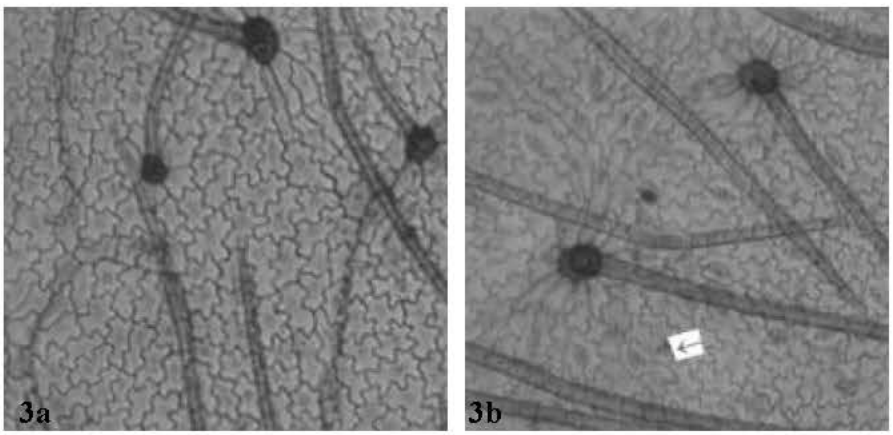

Fig. 3: a: (x 560) Showing adaxial leaf epidermis of *A. canescens*, b: (x 560)-showing abaxial leaf epidermis of *A. canescens* with several paracytic stomata. Arrow shows staurocytic stomata with four subsidiary cells

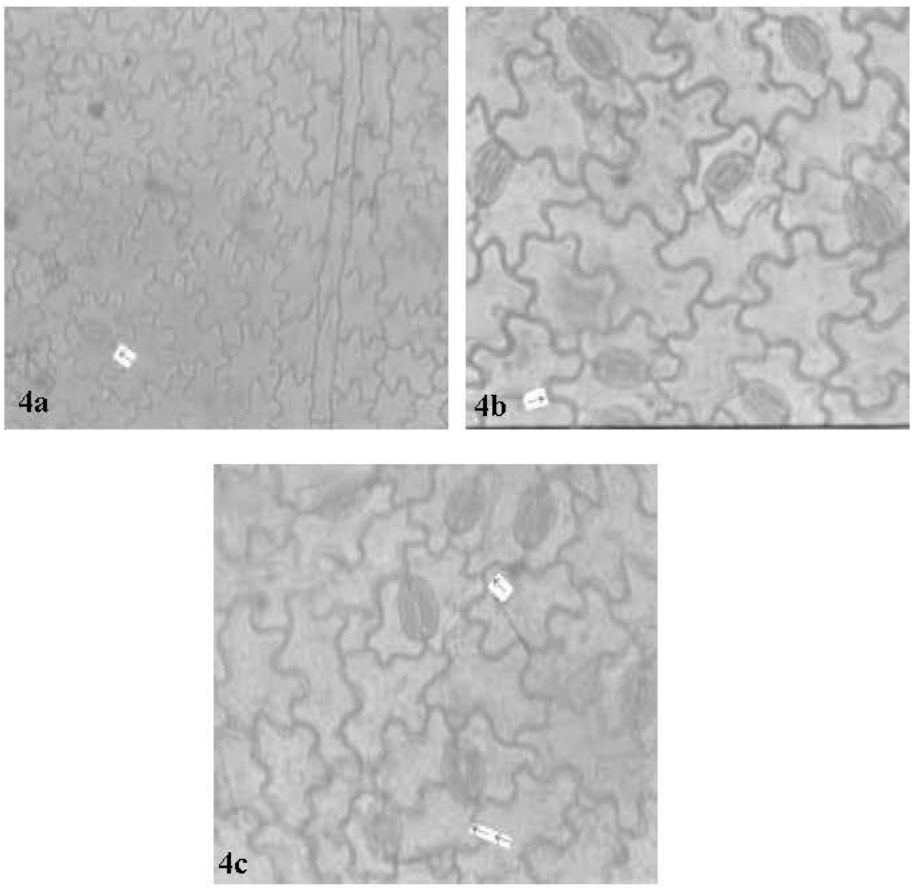

Fig. 4: a: (x 560)-Adaxial leaf epidermis of *Abrus* sp. Arrow points to a single stoma in the field view. Species is hypostomatic, b: (x 875)-Abaxial epidermis of *Abrus* sp. Arrow shows contiguous stomata. c (x 875)-Arrow shows three stomata joined by 6 paracytic cells. Double arrow shows semi-contiguous stoma

Table 2: Epidermal cell characteristics of the leaf of *Abrus* species studied

Taxa	Leaf surface	Epidermal cell shape	Anticlinal cell wall pattern	Epidermal cell length range (μm)	Epidermal cell length (μm)	Epidermal cell width range (μm)	Epidermal cells width (μm)	No. of epidermal cell per field view	Epidermal cell wall thickness range (μm)	Epidermal cell wall thickness (μm)
A. precatorius	Adaxial	Irregular	Wavy, sinuate	14.00-68.00	48.70±19.58	8.00-24.00	14.20±4.19	171	1.35-2.20	1.54±0.24
	Abaxial	Irregular	Sinuate, wavy	40.50-67.50	51.30±8.25	13.50-18.90	15.37±2.55	122	1.35-2.70	2.30±0.65
A. pulchellus	Adaxial	Irregular	Sinuate, wavy	16.00-154.00	73.80±47.68	5.40-16.00	12.04±3.44	164	1.35-2.70	2.17±0.68
	Abaxial	Irregular	Sinuate, slightly wavy	22.00-143.10	76.18±40.31	8.10-18.90	13.50±3.60	158	1.35-2.70	2.16±0.69
A. canescens	Adaxial	Irregular	Sinuate, slightly arcuate wavy	22.00-78.00	42.20±17.31	8.10-27.00	15.06±5.06	256	1.35-1.90	1.52±0.22
	Abaxial	Irregular	Arcuate, slightly wavy	16.20-62.10	31.86±16.83	8.10-29.70	16.61±6.11	244	1.35-2.70	2.43±0.75
Abrus sp.	Adaxial	Irregular	Slightly wavy, sinuate	37.00-103.00	64±21.23	10.80-24.0	16.20±4.02	129	2.70-5.40	3.51±1.30
	Abaxial	Irregular	Sinuate, slightly sinuate, arcuate, wavy	37.00-103.00	64±21.23	10.80-24.30	16.20±4.02	129	2.70-5.40	3.51±1.30

The cell wall thickness varies generally from 1.35 to 5.40 μm on the adaxial and abaxial leaf surfaces of the species. *A. precatorius, A. pulchellus* and *A. canescens* have closely related cell wall thickness on their leaf. The new collection *Abrus* sp. has thicker epidermal cell wall. The costal cells are parallel, elongated and rectangular shaped, with long arms straight, arcuate or wavy and having straight to oblique end walls. The average epidermal cell number per field view varied from 129 in *Abrus* sp. to 256 in *A. canescens* on the adaxial surface and from 122 in *A. precatorius* to 244 in *A. canescens* on the abaxial surface.

Table 3: Stomatal and Cuticular features of the leaf of *Abrus* species studied

Taxa	Leaf surface	Stomata type(s)	Length width (μm) Stomatal dimension		Stomatal length/ stomatal width	Stomatal Index (SI)	Epidermal cell size/ stomatal complex length	Trichome type	No. of trichome foot cells	Trichome length (μm)	Trichome width (μm)	Trichome Thickness (μm)	Trichome Index (TI)
A. precatorius	Adaxial	Absent	.....	.....	.....	.....	.....	Simple unbranched	5-7	244.50± 50.87	8.91±1.44	2.49± 0.26	0.93
	Abaxial	Paracytic (Laterocyclic), diacytic, anomocytic, anisocytic	22.41± 2.22	13.91± 1.27	1.6	14.41	2.30	Simple unbranched	6-8	195± 49.38	13.10±2.21	3.11± 0.09	2.33
A. pulchellus	Adaxial	Absent	.....	.....	.....	.....	.....	Simple unbrached	6-8	274.90± 59.33	10.41±2.71	2.49± 0.53	1.00
	Abaxial	Paracytic, diacytic, anomocytic, anisocytic, contiguous	24.57± 2.36	14.72± 1.34	1.7 1.7	15.57	3.10	Simple, unbranched	5-12	365.50± 128.87	17.50±4.46	3.92± 1.34	1.73
A. canescens	Adaxial	Absent	.....	.....	.....	.....	.....	Simple, unbranched	7-11	392.1± 114.14	10.63±2.17	2.99± 0.64	2. 03
	Abaxial	Paracytic, anisocytic, diacytic, staurocytic.	19.17± 3.23	10.53± 1.99	1.8 1.8	13.19	1.70	Simple unbranched	7-12	495.2± 190.11	12.69±1.30	2.57± 0.42	3.79
Abrus sp.	Adaxial	Paracytic only	30.30± 1.80	23.23± 1.77	1.30	1.30	2.10	No trichome	-	-	-	-	
	Abaxial	Paracytic,. anomocytic with 5, 6, 7 surrounding cells; anisocytic, staurocytic, contiguous, 3 paracytic with 6 sub. cells	31.05± 1.91	24.71± 2.20	1.30	18.19	2.10	Simple unbranched	6-8	324.80± 110.34	23.00±3.62	4.86± 0.70	1.64

All the species except the new collection of *Abrus* sp. have stomata on the abaxial epidermis (hypostomatic) only; *Abrus* sp. has stomata on both surfaces (amphistomatic) with stomata index of 1.30 on the adaxial surface. Six types of stomata were observed on the leaf surfaces: paracytic (laterocyclic), diacytic, anomocytic, anisocytic, staurocytic and contiguous (Table 3). Staurocytic stomata occurred only in *A. canescens* and *Abrus* sp. and anomocytic was absent in *A. canescens*. Contiguous stomata were observed in *A. pulchellus* and *Abrus* sp. Stomata in-groups of 3 bordered by 6 continuous subsidiary cells (Fig. 4c) were observed in the new collection of *Abrus* sp. *Abrus* sp. had the highest SI of 18.19. The stomatal sizes of the species ranged from 19.17±3.23 x 10.53±1.20 μm in *A. canescens* to 31.05±1.91 x 24.71±2.20 μm in the new collection *Abrus* sp. On the average, the stomatal sizes and indices of *Abrus* sp. are the highest followed by those of *A. pulchellus* (Table 3). Prismatic crystals were observed in the leaf surfaces of the species. They are sparingly distributed in few cells of *A. precatorius*, *A. pulchellus* and *A. canescens*, but occur ranging from cluster of four to several chains linked together in *Abrus* sp.

One type of trichome, the simple unbranched (long and short categories) was observed on the leaf surfaces of the four species. The adaxial surface of *Abrus* sp. has no trichome. The trichome or hair-base cells are polygonal, isodiametric or wavy on the leaf surfaces. The number of cells at the foot of the trichomes (trichome-base cells) varied from species to species (Table 3). These cells are highest in *A. canescens* with 7-11 and 7-12 cells on the adaxial and abaxial surfaces, respectively. The longest trichomes were observed on the abaxial surface of *A. canescens* i.e., 495.20±190.11 μm, while the least was recorded on the abaxial surface of *A. precatorius* i.e., 195±49.38 μm. Apart from the situation in *A. precatorius* where the average trichome length was higher on the adaxial surface, all other species had longer trichomes on their abaxial surfaces. Trichome index was highest on the abaxial surface of *A. canescens* (3.79) and least on the adaxial surface of *A. precatorius* (0.93).

In all the species, the venation is pinnate, camptodromous-brochidodromous. Primary vein is of moderate size, straight and unbranched with secondary veins diverging at 45°-60°; divergent angle almost uniform. Secondary veins branched, loop joining superadjacent secondaries at obtuse angle, enclosed by 2° or 3° arches. Intersecondary veins are composite, traversing the intercostal areas. Tertiary veins are percurrent, forked and more or less at right angles to the primary vein; a ratio of 1:1 alternate to opposite. Veinlet endings range from zero through linear to branched; branching up to twice. Areole well developed and oriented; mostly pentagonal with few guadangular.

DISCUSSION

The observed epidermal characters are of taxonomic relevance in the study of *Abrus* species. While the cell shape on the leaf surfaces of these species are generally irregular, the anticlinal wall pattern may be wavy, sinus or arcuate (Table 2), with wavy and sinuate pattern dominating. These similarities, which were also observed in the ranges and mean values of the epidermal cell

wall thickness on the adaxial and abaxial surfaces of *A. precatorius, A. pulchellus* and *A. canescens* (Table 2 and 3), indicate relatedness and generic affinity. Similar findings have been made on other leguminous genera and used in taxa elucidation[9-11]. Epidermal cell numbers were more on the abaxial surfaces with species to species differences. Apart from the systematic importance of the occurrence of more epidermal cells on the upper surface of these species, a situation previously reported in another leguminous genus[11], this condition could be related to their hypostomatic nature. Thus, the stomata and its subsidiary or adjoining cells may have taken over positions initially occupied by epidermal cells on the lower surface.

Micromorphological studies of another leguminous genus revealed high variability in the dimensions of epidermal cells of the species[11]. Thus it was difficult to make clear distinction between the species using such character. This study shows that though variability in dimensions in epidermal cells of *Abrus* species occur, the final values over a range of samples are diagnostic at the species level (Table 2). *Abrus pulchellus,* a polyploid[18], is close in epidermal size with the new collection, *Abrus* sp. Since increased or large somatic cells has been reported as providing preliminary lead to the detection or confirmation of polyploids[19-22], it is likely that the new collection, *Abrus* sp. is a polyploid. The values of the epidermal size seem to be fairly but constantly high on the abaxial as against the adaxial surface. This may be connected with light related stimuli, as the species may have to guide against excessive loss of water.

The incidence of hypostomatic stomatal distribution in three species, *A. precatorius, A. pulchellus* and *A. canescens* shows the relatedness of these species despite other differences. However, the occurrence in the new *Abrus* sp. collection of amphistomatic condition is species diagnostic and further distinguishes it from the other ones. A similar but opposite situation was observed by Abubakar and Yunusa[10] who reported among four species of another legume *Acacia,* one hypostamotic and three hypoamphistomatic species. They concluded that the hypostomatic species, *Acacia macrostachya*, could be distinguished from the other three based on stomatal distribution. Some of the stomatal types observed in this genus have been previously reported in some other leguminous genera[9-11,23]. The similarities in stomata types among these species as in Table 3 support their inclusion in the same genus. However, the observed differences like the occurrence of contiguous stomata in *A. pulchellus* and *Abrus* sp., the discovery of staurocytic stomata and lack of anomocytic type in *A. canescens* all serve diagnostic purposes at the species level. It is important to note that the occurrence of contiguous stomata is a feature associated with polyploidy. A special type of stomatal complex was observed in the new collection *Abrus* sp. (Fig 4c and d) in which 3 stomata occurs in group and is bordered continuously by 6 subsidiary cells. The occurrence of stomata in groups is a useful generic diagnostic character in some families, which in the Papilionaceae has only been reported in *Euchestra*[7]. This advanced contiguous situation is thus important in the taxonomy of this new collection and the genus. Significant taxonomic variation on stomatal size and index useful in distinguishing species were observed on the leaf surfaces (Table 3). Carlquist[24] emphasized the contributions of the variation in stomatal size and index in delimiting species within a genus. Gill and Nyawuame[25] used similar characters in the systematics and phylogeny of the members of Bicarpillatae. It is noteworthy that the reduced stomatal index and dimensions in *A. canescens* could be more of an adaptation to functional since evidence from distribution proved that it exists in the xerophytic savanna areas. Thus the species has to device mechanisms to check water loss.

Ogundipe and Akinrinlade[11] have recently reported the occurrence of crystal sand and prismatic crystals in foliar epidermis of a leguminous genus *Albizia.* These were of common occurrence on the leaf surfaces of the *Abrus* species studied. Of particular note is the distribution of this crystal in the new collection *Abrus* sp. where they occur ranging from four to several chains linked together. The role of these crystals is not yet known.

The taxonomic value of trichomes has long been documented[7]. The presence of one type of trichome (Table 4), the simple unbranched type on the leaf surfaces

Table 4: Morphology, density and distribution of trichomes in *Abrus* species studied

Taxa	Leaf surface	Type of trichome	Density in (%)	Description
A. precatorius	Adaxial	Simple, unicellular	1-10	Glabrescent
	Abaxial	Simple unicellular	1-10	Glabrescent
A. pulchellus	Adaxial	Simple unicellular	1-10	Glabrescent
	Abaxial	Simple unicellular	1-10	Glabrescent
A. canescens	Adaxial	Simple unicellular	>50	Very densely hairy
	Abaxial	Simple unicellular	>50	Very densely hairy
Abrus sp.	Adaxial	……		
	Abaxial	Simple unicellular	1-10	Glabrescent

of the species except the adaxial surface of the new collection *Abrus* sp. is an indication of affinity. The trichome index and mean length observed on the abaxial surface of *A. canescens*, which is the highest in the genus, is an indication of high pubescence. This is probably an adaptation to savanna/xerophytic conditions. Foliar venation pattern as a diagnostic tool in taxonomy has been highlighted[7,26,27]. In the four *Abrus* sp. the venation pattern is generally pinnate, comptodromous-brochidodromous. Seetharam and Kotresha[28] recently employed foliar venation patterns to separate 12 species of the genus *Bauhinia*. into three groups. They further stated that this character could be used to identify the litter and fossil impressions of leaves of *Bauhinia*. Thus an insight into the leaf venation pattern as provided through this study not only supports the taxonomy of these species but also provides a lead to paleobotanical studies of the genus. A diagnostic key based on foliar epidermal characteristics of the *Abrus* species is presented below:

1. *Abrus* species with contiguous stomata …….. 2
1[1]. *Abrus* species without contiguous stomata ……. 3
2. Species amphistomatic, with stomata in-groups and cluster of crystals ……. *Abrus* sp.
2[1]. Species not amphistomatic and without stomata in-groups ……. *A. pulchellus*
3. Stomata staurocytic, anomocytic type completely absent.. ….. *A. canescens*
3[1]. Stomata not staurocytic, predominantly anomocytic, paracytic (Laterocyclic) and diacytic… *A. precatorius*

REFERENCES

1. Dalziel, J.M., 1937. The Useful Plants of West Tropical Africa. 1st Edn., Crown Agents for the Colonies, London, pp: 224-226.
2. Hutchinson, J. and J.M. Dalziel, 1958. Flora of West Tropical Africa, Part 2. Crown Agents for Oversea Governments and Administrations, London, 1: 574-575.
3. Burkill, H.M., 1995. The Useful Plants of West Tropical Africa. Vol. 3. Families J-L. Royal Botanic Gardens Kew, pp: 267-271.
4. Anonymous, 1979. Tropical Legumes: Resources for the Future. Washington D.C., pp: 1-4.
5. Choi, Y.H., R.A. Hussain, J.M. Pezzuto, A.D. Kinghorn and J.F. Morton, 1989. Abrusosides A-D, four novel sweet-tasting triterpene glycosides from the leaves of *Abrus precatorius*. J. Natl. Products, 52: 1118-1127.
6. Jakinovich, W., C. Moon, Y.H. Choi and A.D. Kinghorn, 1990. Evaluation of Plant extracts for sweetness using the Mongolian gerbil. J. Natl. Products, 53: 190-195.
7. Metcalfe, C.R. and L. Chalk, 1979. Anatomy of the Dicotyledons. 2nd Edn., Systematic Anatomy of the Leaf and Stem, with a Brief History of the Subject. Clarendon Press, Oxford, 1: 40-62, 97-117, 201-204.
8. Gill, L.S. and Y.Y. Karatela, 1985. Structure and Ontogeny of stomata in the foliar organs of some Nigerian *Cassia* species (Leguminosae). Iselya, 2: 121-127.
9. Edeoga, H.O. and P.I. Osawe, 1996. Cuticular studies of some Nigeiran species of *Senna* Tourn. ex Mill. (Syn. *Cassia* Tourn. ex L.): Leguminosae-caesalpinioideae. Acta Phytotax. Geobot., 47: 41-46
10. Abubakar, B.Y. and A.I Yunusa, 1998. Epidermal structure and stomatal ontogeny of some species of *Acacia* (Leguminosae-Mimosoidieae) from Nigeria. Nig. J. Bot., 11: 117-123.
11. Ogundipe, O.T. and O.O. Akinrinlade, 1999. Epidermal micromorphology of some species of *Albizia* Durazz. (Mimosaceae). Phytomorphology, 48: 325-333.
12. Cutler, D.F., 1978. Applied Plant Anatomy. Longman Inc. New York, pp: 103.
13. Okoli, B.E., 1992. Field, Herbarium and Laboratory Techniques. Mbeyi and Associates (Nig.) Ltd., Port Harcourt, pp: 239
14. Stace, C.A., 1980. Plant Taxonomy and Biosystematics. Edward Arnold Publishers Limited. London, pp: 81-84.
15. Dilcher, D.L., 1974. Approaches to the identification of angiosperm leaf remains. Bot. Rev., 40: 1-157.
16. Sasikala, K. and R. Narayanan, 1998. Numerical evaluation of trichome characters in certain members of Asteraceae. Phytomorphology, 480: 67-81.
17. Olowokudejo, J.D., 1990. Comparative morphology of leaf epidermis in the genus *Annona* (Annonaceae) in West Africa. Phytomorphology, 40: 407-422.
18. Agbagwa, I.O. and B.E. Okoli, 2005. Chromosome number and cytomorphological characterization of a polyploidy *Abrus*, Afr. J. Biotechnol., 4: 607-610.
19. Stebbins, G.L. Jr., 1940. The significance of Polyploidy in Plant Evolution. The Am. Natl., 74: 54-66.
20. Stebbins, G.L. Jr., 1950. Variation and Evolution in Plants. Columbia Univ. Press, New York, pp: 643.
21. Allard, R.W., 1960. Principles of Plant Breeding. John Wiley and Sons, Inc. New York, pp: 485.
22. Swanson, C.P., 1968. Cytology and Cytogenetics. 2nd Edn., Prentice-Hall Inc. New Jersey, pp: 596.

23. Gill, L.S., G.O. Olabanji and S.W.H. Hussaine, 1982. Studies on the structural variation and distribution of stomata in some Nigerian legumes. Willdenowia, 12: 87-94.
24. Carlquist, S., 1961. Comparative Plant Anatomy. Holt, Rinehart and Winston, New York and London.
25. Gill, L.S. and H.G.K. Nyawaume, 1990. Phylogenetic and Systematic Value of Stomata in Bicarpellatae. Feddes Repertorium, 101: 453-498.
26. Hickey, L.F., 1973. Classification of the architecture of dicotyledonous leaves. Am. J. Bot., 60: 17-33.
27. Melville, R., 1976. The terminology of leaf architecture. Taxon, 25: 549-561.
28. Seetharam, Y.N. and K. Kotresha, 1998. Folia venation of some species of *Bauhinia* L. and *Hardwickia binata* Roxb. (Caesalpinioideae). Phytomorphology, 48: 51-59.