

Research Article

Anatomical Features of the Transverse Sections of the Leaves of Loranthaceae in Nigeria

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ABSTRACT

The anatomical characteristic of the transverse sections of leaves of the Nigerian parasitic family of Loranthaceae were investigated as a contribution to the taxonomy of the family especially in species identification and delimitation. The study revealed presence of palisade tissues for all the species except *Tapinanthus bangwensis* and *T. globiferus*. Second layer of palisade cells of *Englerina gabonensis* and *Phragmanthera capitata* with wavy outline. Prismatic crystals were present in most of the species and they were either associated with sclereids only or with sclerieds and xylem fibers. Acicular crystals were diagnostic to only *Agelanthus bruneus*. The presence of brachysclereids and astrosclereids are diagnostic features in the family. The anatomical features observed from the study could be utilized for taxonomic purposes especially as diagnostic features for easy identification of the species even when leaf material is in fragment. The information could also be used in monograph preparation for these medicinally useful species.

Keywords: Microscopy, Loranthaceae, Nigeria, Monograph

INTRODUCTION

Loranthaceae (mistletoes) is a family of parasitic plants widely known for their destructive nature to the host plants which they parasitized¹⁻⁶. The brightly coloured inflorescence species are well known for their very high medicinal and cultural values⁷⁻¹³. Recent revision of the family in Nigeria documented fifteen species for the region¹⁴.

Information on the anatomy of the Loranthaceae is very meager. Apart from a few anatomical features of *Elytranthe tetrapetala* (Murray) Engl. and *Tupeia* Cham. & Schldl. by Metcalfe and Chalk¹⁵, anatomical description of *Phoradendron liga* (Gill. ex H. et A.) Eichl. and Amazonian mistletoe, *Cladocolea micrantha* (Eichler) Kuijt was also carried out recently by Varela *et al.*¹⁶ and Guimaraes *et al.* (2007) respectively. Patel¹⁸ did a detailed work on the wood anatomy of six New Zealand species and the presence of silica inclusions was recorded in some species, while its absence was recorded in the remaining species. Also, in search of vegetative characters having potential taxonomic value for the mistletoes, Wilson and Calvin¹⁹ undertook a study on cuticular epithelium in the group. Little is known about the comparative anatomical features of the family Loranthaceae in Nigeria except the work of Bako *et al.*²⁰ on the vegetative anatomy of *Tapinanthus dodoneifolius* (DC) Danser and that of Ibrahim *et al.*²¹, who undertook a study to determined the taxonomic significance of epidermal and phytochemical characters of the leaves of *Agelanthus dodoneifolius* in relation to their hosts. The significant of leaf epidermal

characters in taxonomy of Nigerian species have also been documented²².

Cases of misidentification in the family Loranthaceae are common problem to taxonomists and medicinal plants researchers^{23,7,14,21}. The rate at which wrong specific names are applied in many publications in Nigeria is becoming alarming as it can be found in the work of Mbagwu and Onuoha²⁴, Mbagwu *et al.*,²⁵ Iwalokun *et al.*²⁶ and so many others. Many of the species names used do not exist in this part of the world while some put all specimens under *Tapinanthus bangwensis*, (the most known taxon in the Western part of Nigeria) and *Tapinanthus dodoneifolius*, the most known species in the northern part of Nigeria¹⁴. The misidentification is as a result of lack of sufficient information on the taxonomy of the plants and overlapping of delimitation characters either between the genera or among the species as a result of their similarities in appearance and habit^{27,7}. Several workers have employed different parameters in solving taxonomic problems. One of such parameters is anatomical characters from leaves, stem and wood of plants^{28,18,19,29}.

The present study is a part of series of studies aimed at investigating the extent to which leaf anatomical characters could contribute to the elucidation of relationships in the family Loranthaceae for easy identification and delimitation of the taxa. And this particular study focuses on the transverse sections of the leaves.

MATERIALS AND METHODS

Sources of material

Specimens of the mistletoes used for the study were collected during field trips to different parts in Nigeria. Samples of well authenticated Herbarium specimens were also used for taxa not collected during the field trips. List of taxa studied is presented in Table 1.

Leaf sectioning

The leaves were first rehydrated by boiling in water for some minutes. These were then transferred to 50% ethanol ready for sectioning. Unripe pawpaw was used as the embedding material, which was to support leaf tissue during sectioning from damage by the microtome knife. A 3cm by 3cm portion of the leaves was cut at the median position; these were put in between the unripe pawpaw and inserted in the sliding microtome for sectioning. The transverse sections of the leaves were made at the 8µ thickness. The sections were removed from the microtome with the use of camel hair brush into a Petri dish containing

water. The sections were selected from the Petri dish using dissecting needle and camel hair brush and transferred into storage bottles containing 50% ethanol.

Slide preparation

The transverse sections were later removed from the 50% ethanol and washed in water and cleared in 15% Sodium hypochlorite for 10seconds to 1minute. They were later washed in water and stained in Sudan IV for about 3 to 5 minutes. These were mounted in glycerine on a slide with the edges of the cover slip ringed with nail varnish to preserve them from dehydration. The slides were observed and studied using the light microscope. The slides were observed and studied using the light microscope. Photomicrographs were taken using Olympus microscope Hyper Crystal LCD model No E-330 with Olympus camera CX31 RTSF. Tissues and cells identification were done following the procedure of Ghani³⁰, Metcalfe and Chalk³¹ and Fahn³².

Table 1: List of Nigeria Loranthaceae Specimens Studied

Taxa (Parasites)	Taxa (Host)	Locality	Name of Collector	Herbarium number	Date of Collection
<i>Agelanthus dodoneifolius</i> (DC) Polh. & Wiens	- <i>Piliostigma thonningii</i>	Chaza village, Suleija. Niger state	J. A Ibrahim & I. Muazzam/ P002	NIPRD/H/615 9	15/05/07
Synonyms –	- <i>Vitellaria paradoxum</i>	„	J A Ibrahim & I Muazzam/ P004	NIPRD/H/615 8	15/05/07
<i>Tapinanthus dodoneifolius</i> (DC) Danser	- <i>Parkia biglobosa</i>	„	J A Ibrahim & I Muazzam/ P008	NIPRD/H/615 7	„
	- <i>Lannea sp</i>	Jiwa, Abuja	Tanko Garba / P023	NIPRD/H/616 0	17/06/2007
	- <i>Parkia biglobosa</i>	Uni. Jos, Jos	J A Ibrahim & F Tarfa / P065	NIPRD/H/633 9	17/11/2007
<i>Agelanthus braunneus</i> (Engl.) Van Tiegh.	- <i>Ochna sp</i>	Gongoro FR, Muri. Taraba state	J. D Chapman	FHI 106745	22/02/76
	- <i>Kigelia africana</i>	Omo FR, Ijebu-Ode. Ogun	A.P.D. Jones	FHI 16684	12/03/06
	- <i>Alstonia sp</i>	Sapoba FR, Edo	A.E Ross / 208	FHI 8965	21/10/34
<i>Agelanthus heteromorphus</i> (A. Rich.) synonym – <i>T. heteromorphus</i>	- <i>Parkia biglobosa</i>	Naraguta FR, Jos. Plateau	J.D Kennedy	FHI 7234	05/1944
	- <i>Terminalia avicenioides</i>	Kaura Namoda, Sokoto	G.A.E Ogbe & A.K Jaiyesimi	FHI 15893	08/05/46
		Naraguta FR, Jos. Plateau		FHI 55756	
<i>Englerina gabonensis</i> (Engl.) Balle	-	Obudu cattle Ranch	J. B Hall	UIH 17897	08/01/78
	-	Obudu Cattle Ranch, Cross River	J.B Hall / 17897	FHI 88172	08/01/78
	- <i>Ficus sp</i>	Shasha FR, Omo. Ijebu-Ode	A.P.D Jones & C.F Onochie	FHI 17304	09/04/46
<i>Globimetula braunii</i> (Engl.)Danser	- <i>Persea americana</i>	Ikot-Uduak, Calabar	J A Ibrahim & F I Apejoye / P090	NIPRD/H/630 9	18/02/2008
	- <i>Cola sp</i>	Akpabuyo, Calabar	J A Ibrahim & F I Apejoye / P092	NIPRD/H/631 3	19/02/2008
	- <i>Cola sp</i>	Ibuso-Gboro, Ibadan	J A Ibrahim & O M Wahab / P097	UIH 22308 NIPRD/H/635 8	12/04/2008

Table 1: List of Nigeria Loranthaceae Specimens Studied

Taxa (Parasites)	Taxa (Host)	Locality	Name of Collector	Herbarium number	Date of Collection
	<i>-Theobroma cacao</i>	Ibuso-Gboro, Ibadan	J A Ibrahim & O M Wahab / P102	NIPRD/H/6319 UIH 22310	12/04/08
<i>Globimetula oreophila</i> (Oliv.) Danser	<i>Strombosia grandifolia</i>	Obudu cattle ranch, Cross River	J. K. Adebusuyi	FHI 58722	20/5/1966
	-	Ubkpa forest, Nsukka	Emwiogbon & Anyandiegwu	FHI 73130	28/3/1974
<i>Helixanthera mannii</i> (Oliv.) Danser	-	Warwar, Mambilla, Adamawa	S. S.H Wimbush	FHI 48403	02/1959
	-	Mambilla, Adamawa	F.N.Hepper/2803	FHI 56181	14/01/1958
<i>Helixanthera spathulata</i> (Wiens & Polh.)	<i>-Euphorbia sp</i>	Enyong Calabar	FR, C.F.A Onochie	FHI 33216	20/05/1953
<i>Phragmanthera capitata</i> (Sprengel) Balle. Synonym – <i>P. Incana</i> (Schum.) Balle	<i>Persea americana</i>	Ikot-Uduak, MCC Road, Calabar	Pastor Frank & J. A Ibrahim/P089	UI 22309 NIPRD/H/6311	18/02/2008
	RUBBER TREE	Pamol Rubber Plantation, Odukpani LGA, Calabar	Pastor Frank & J. A Ibrahim/P091	NIPRD/H/6310	„
	<i>Persea americana</i>	Esuk Ekpo Eyo, Akpabuyo. Calabar	„	NIPRD/H/6312	19/02/2008
<i>Phragmanthera nigritana</i> (Hook.f. ex Benth) Balle.	<i>Citrus auranthifolia</i> (lime)	Chaza village, Suleija. Niger state	J A Ibrahim & I Muazzam / P010	NIPRD/H/6247	15/5/2007
	<i>Citrus auranthifolia</i>	„	J A Ibrahim & I Muazzam /P078	NIPRD/H/6351 UIH 22317	22/11/2007
<i>Phragmanthera talbotiorum</i> (Sprague) Balle.	-	Obudu Cattle Ranch	J. B. Hall	UIH 17917	07/01/78
<i>Tapinanthus bangwensis</i> (Engl. & K. Krause) Danser	<i>Cola acuminata</i>	Keji village, Idi-Ayunre, Ibadan	J A Ibrahim & K Oyepeju / P038	NIPRD/H/6197	23/08/2007
	<i>Citrus medica</i>	„	J A Ibrahim & K Oyepeju / P040	NIPRD/H/6248	„
	<i>Albizia sp</i>	„	J A Ibrahim & K Oyepeju / P043	NIPRD/H/6370	„
	<i>Newboldia laevis</i>	„	J A Ibrahim & K Oyepeju / P046	NIPRD/H/6329	„
	<i>Thevetia sp</i>	Ibuso-Gboro, Ibadan	J A Ibrahim & O M Wahab / P096	NIPRD/H/6376	12/04/2008
	<i>Cola sp</i>	„	J A Ibrahim & O M Wahab / P100	NIPRD/H/6378	„
<i>Tapinanthus cordifolius</i> Polh. & Wiens Synonym – <i>T. sessilifolius</i> (P. Beauv.) Tieghem	<i>Syzygium eucalyptoides</i>	Dzarma ganda, Jos	J A Ibrahim & F Tarfa / P056	NIPRD/H/6215	17/11/2007
	<i>Psidium guajava</i>	Sch. of forestry, Jos	J A Ibrahim & F Tarfa / P058	NIPRD/H/6354	17/11/2007
	<i>Citrus auranthifolia</i>	Flamingo by-pass, Jos	J A Ibrahim & F Tarfa / P063	NIPRD/H/6338	„
	<i>Citrus sinensis</i>	„	J A Ibrahim & F Tarfa / P064	NIPRD/H/6250	„

Table 1: List of Nigeria Loranthaceae Specimens Studied

Taxa (Parasites)	Taxa (Host)	Locality	Name of Collector	Herbarium number	Date of Collection
	<i>Citrus medica</i>	„	J A Ibrahim & F Tarfa / P066	UIH 22313	„
	<i>Persea americana</i>	Dzarma ganda, Jos	J A Ibrahim & F Tarfa / P068	NIPRD/H/6185	18/11/2007
	<i>Ficus sp</i>	„	J A Ibrahim & F Tarfa / P069	NIPRD/H/6216	„
	<i>Jacaranda sp</i>	„	J A Ibrahim & F Tarfa / P070	NIPRD/H/6251	„
	<i>Jatropha curcus</i>	Ruba Road, Jos	F Tarfa / P083	NIPRD/H/6326	29/11/2007
	<i>Ficus exasperata</i>	Jenta-Apata, Jos	F Tarfa / P084	NIPRD/H/6322	„
<i>Tapinanthus globiferus</i> (A. Rich.) Tieghem	-	Zamfara Sokoto	FR, R.W.J Keay	FHI 18015	22/04/46
	-	Samaru, Zaria	D Clayton / DC1240	FHI 39841	07/1957
	- <i>Ficus sp</i>	Gwari, Niger	C.F.A Onochie	FHI 38458	12/06/58
	- <i>Ficus sp</i>	Zamfara Sokoto	FR, J.M Keay	FHI 16120	09/04/46
	<i>Gmelina arborea</i>	Chaza Village, Suleija	I Muazzam & JA Ibrahim / P006	NIPRD/H/6253	15/05/2007
	<i>Ficus sur</i>	Basa Jiwa, Abuja	Tanko Garba / P016	NIPRD/H/6335	11/06/2007
	<i>Anacardium occidentale</i>	Chaza, Suleija	Auwal & I Muazzam / P018	NIPRD/H/6334	13/06/2007
	<i>Lannea sp</i>	Jiwa, Abuja	Tanko Garba / P024	NIPRD/H/6340	13/07/2007
	<i>Citrus medica</i>	Tudun wada, Kano	I Muazzam / P025	NIPRD/H/6367	01/08/2007
	<i>Gmelina arborea</i>	Chaza village, Suleija. Niger state	J A Ibrahim & I Muazzam / P071	NIPRD/H/6325	22/11/2007
	<i>Anogeisus leiocarpus</i>	Idu Industrial Area, Abuja	J A Ibrahim & Tanko Garba / P087	NIPRD/H/6328	06/12/2007
	<i>Zyzyphus sp</i>	Yola, Adamawa	Coleman / P115	NIPRD/H/6316	12/05/2008
	<i>Azadirachta indica</i>	„	Coleman / P116	NIPRD/H/6315	„
	<i>Zyzyphus sp</i>	„	Coleman / P117	UIH 22314 NIPRD/H/6318	„

Table 2: Anatomical features of transverse sections of the leaves of Loranthaceae species in Nigeria

Taxa	Palisade layer	Presence of hypodermis	Midrib	Trichome	Crystal	Oil globules	Type of pits	Sclereids
<i>Agelanthus brunneus</i>	2 layers	Absent	Protruded	Absent	Prismatic with sclereids; rhafieldes on mesophyll	Absent	Reticulate & scleriform; long fibers	Few brachysclereids

Table 2: Anatomical features of transverse sections of the leaves of Loranthaceae species in Nigeria

Taxa	Palisade layer	Presence of hypodermis	Midrib	Trichome	Crystal	Oil globules	Type of pits	Sclereids
<i>Agelanthus dodoneifolius</i>	2 layers, not elongated like typical palisade cells	Absent	Protruded at abaxial & adaxial	Absent	Prismatic with sclereids	Abundant oil globules	Reticulate vessels	Abundant brachysclereids
<i>Agelanthus heteromorphus</i>	1 layer abaxial, 2 layers adaxial	Single layer on the abaxial surface	Slightly protruded	2 armed & simple trichome	Absent	Absent	Abundant xylem fibers; reticulate & scleriform vessel	Absent
<i>Englerina gabonensis</i>	2 layers, cell wall of 2 nd layer wavy	Absent	Protruded	Absent	Absent	Few oil globules present	Scleriform & reticulate xylem vessel; xylem fibers present	Absent
<i>Globimetula braunii</i>	3 layers	Absent	Highly protruded	Absent	Prismatic, associated with fibers, sclereids & parenchyma	Oil globules Present	Reticulate vessel occurring singly; spiral vessels abundant; xylem fiber	Clusters of brachysclereids
<i>Globimetula oreophila</i>	2 layers	Absent	Protruded	Absent	Absent	Absent	Reticulate xylem vessel, short fibers	Few brachysclereids
<i>Helixanthera mannii</i>	2 layers	Absent	Highly Protruded	Absent	Prismatic, associated with fibers	Absent	Xylem fibers many, spiral and reticulate vessels few	Few astroclereids
<i>Helixanthera spathulata</i>	1 layers,	Present	Protruded	Absent	Prismatic with sclereids	Absent	Scleriform & reticulate vessels	Few brachysclereids

Table 2: Anatomical features of transverse sections of the leaves of Loranthaceae species in Nigeria

Taxa	Palisade layer	Presence of hypodermis	Midrib	Trichome	Crystal	Oil globules	Type of pits	Sclereids
<i>Phragmanthera capitata</i>	2 layers, cell wall of 2 nd layer wavy	Absent	Protruded	Abundant stellate trichomes	Prismatic crystals associated with xylem fibers & mesophyll, abundant; druses	Abundant oil globules	Spiral xylem vessels abundant; long xylem fibers	Abundant brachysclereids (peculiar shaped)
<i>Phragmanthera nigritana</i>	1 layer	Present	Protruded	Abundant dendritic, two-arm & unbranched trichomes	Few prismatic crystals attached to sclereids; druses	Oil globules abundant on palisade cells	Reticulate & scleriform xylem vessels; long xylem fibers	Abundant brachysclereid associated with xylem vessels at the midrib
<i>Phragmanthera talbotirum</i>	3 layers	Absent	Protruded	Absent	Scanty prismatic crystal with sclereids	Abundant oil globules on mesophyll & cell wall	Reticulate vessel; Long fibers,	Abundant brachysclereid & astroscleids associated with xylem vessels at midrib
<i>Tapinanthus bangwensis</i>	2 layers	Absent	Protruded	Absent	Prismatic crystals associated with sclereids at the midrib	Present more on one surface especially midrib abaxial	Reticulate & scleriform vessel; short xylem fibers	Few brachysclereids associated with fibers at the midrib
<i>Tapinanthus cordifolius</i>	2 layers	Absent		Absent	Crystal absent; druses present	Abundant oil globules	Scleriform & reticulate xylem vessels; short fibers	Absent

Table 2: Anatomical features of transverse sections of the leaves of Loranthaceae species in Nigeria

Taxa	Palisade layer	Presence of hypodermis	Midrib	Trichome	Crystal	Oil globules	Type of pits	Sclereids
<i>Tapinanthus globiferus</i>	3 layers	Absent	Protruded	Absent	Prismatic crystal attached to sclereids at the mesophyll	Very few in some specimens but abundant in some that it obscure view	Reticulate xylem vessels; short fibers	Few brachysclereids surrounding the vascular bundle

RESULTS

Leaf Anatomy

Table 2 shows characters of the species of Loranthaceae obtained from transverse sections of leaves. Palisade tissues were one – three layers in the family. There were two layers in *Agelanthus bruneus*, *Englerina gabonensis*, *Globimetula oreophila*, *Helixanthera mannii* and *Phragmanthera capitata* (Table 2; Plate 1a-b, 2a-b, 2e-f, 3a-b, 3d-g), one layer in *Helixanthera spathulata* and *Phragmanthera nigritana* (Table 2, Plate 3c, 4a-d) and three layers in *Agelanthus dodoneifolius*, *Globimetula braunii*, *Phragmanthera talbotiorum* and *Tapinanthus cordifolius* (Table 2; Plate 1e-f, 2c-d, 4e-f, 5c-d). *Agelanthus heteromorphus* has palisade cells on both layers (Table 2; Plate 1e-f). The palisade cells of *Agelanthus dodoneifolius* were not elongated like the typical palisade cells; they were more or less isodiametric in nature (Plate 1c-d). *Englerina gabonensis* and *Phragmanthera capitata*'s second layer of palisade cells was wavy in nature (Plate 2d, 3d). Single layer of epidermal cells was observed in all the specimens and they were elongated or box-like in shape (Plate 1-5). Hypodermal cells were present in only 3 species, *Agelanthus heteromorphus* on the abaxial surface, *Helixanthera spathulata* and *Phragmanthera nigritana* on the adaxial surface (Plate 1e-f, 3c, 4a-d). The midrib was much protruded in some species and not so in others it protruded adaxially and abaxially in *Agelanthus bruneus*, *Agelanthus dodoneifolius* and *Tapinanthus bangwensis*. Different types of trichomes were observed in three species; *Agelanthus heteromorphus*, *Phragmanthera capitata* and *Phragmanthera nigritana* (Table 2; Plate 1e, 3g, 4c). Prismatic crystals were present in most of the species and they were either associated with sclereids only or with sclereids and xylem fibers (Table 2; Plates 1a-d, 2c-d, 3-5). Acicular crystals were found in *Agelanthus bruneus* (Table 2; Plate 1b). Oil globules were abundant in some species, scanty in one species and totally absent in others (Table 2; Plate 1d, 2b, 2d, 3e-f, 4b, 4f, 5b, 5c-d, 5e-g). Reticulate and scleriform pit type in xylem vessels were observed in most of the species. Xylem fibers were short

in some species compared to other species that had long fibers (Table 2, Plates 1-5). Isodiametric or brachysclereids and irregular or astrosclereids were found in the family (Table 2; Plates 1a-d, 2c-f, 3-5a-b, 5e-g) and druses were observed in *Phragmanthera capitata*, *Phragmanthera nigritana* and *Tapinanthus cordifolius* (Table 2; Plate 3e-f, 4d, 5d).

DISCUSSION

The results obtained from the transverse sections of the leaves from the present study are very informative and are similar to earlier studies on parasitic plants^{33,34,17,35}. The different types of sclereid and cristarque cells i.e cells containing crystals as they were referred to by Kuijt & Lye³⁴ on Neotropical Loranthaceae leaves were also found in the leaves of the Loranthaceae in Nigeria. Sclerenchymatous cells were observed in the leaves of Amazonian mistletoes, *Cladocolea micrantha*¹⁷. Sclerenchymatous cells have been described for many angiosperms³⁶ and Kuijt & Lye³⁴ have also used the information obtained from their study on foliar sclerenchyma to make taxonomic decisions for the plants studied. Likewise, the information obtained from this study on the occurrence of irregular- branched sclereid (astrosclereid) and isodiametric sclereid (brachysclereids) either occurring together or separately in all the species except *Agelanthus heteromorphus*, *Englerina gabonensis* and *Tapinanthus cordifolius*, the cluster of isodiametric sclereids in *Globimetula braunii*, the peculiar shaped sclereids attached to the epidermal cells or on the palisade cells of *Phragmanthera capitata* and the association of sclereids with xylem fibers in *Phragmanthera nigritana*, *Phragmanthera talbotiorum* *Tapinanthus bangwensis* and *Tapinanthus globiferus* are all of taxonomic value and they can be used in conjunction with other characters to delimit the species of Loranthaceae in Nigeria. The simple and two-armed trichome types in *Agelanthus heteromorphus*, stellate trichomes in *Phragmanthera capitata* and the dendritic trichome type in *Phragmanthera nigritana* are diagnostic for these species and therefore can be used to separate them from the other species in the

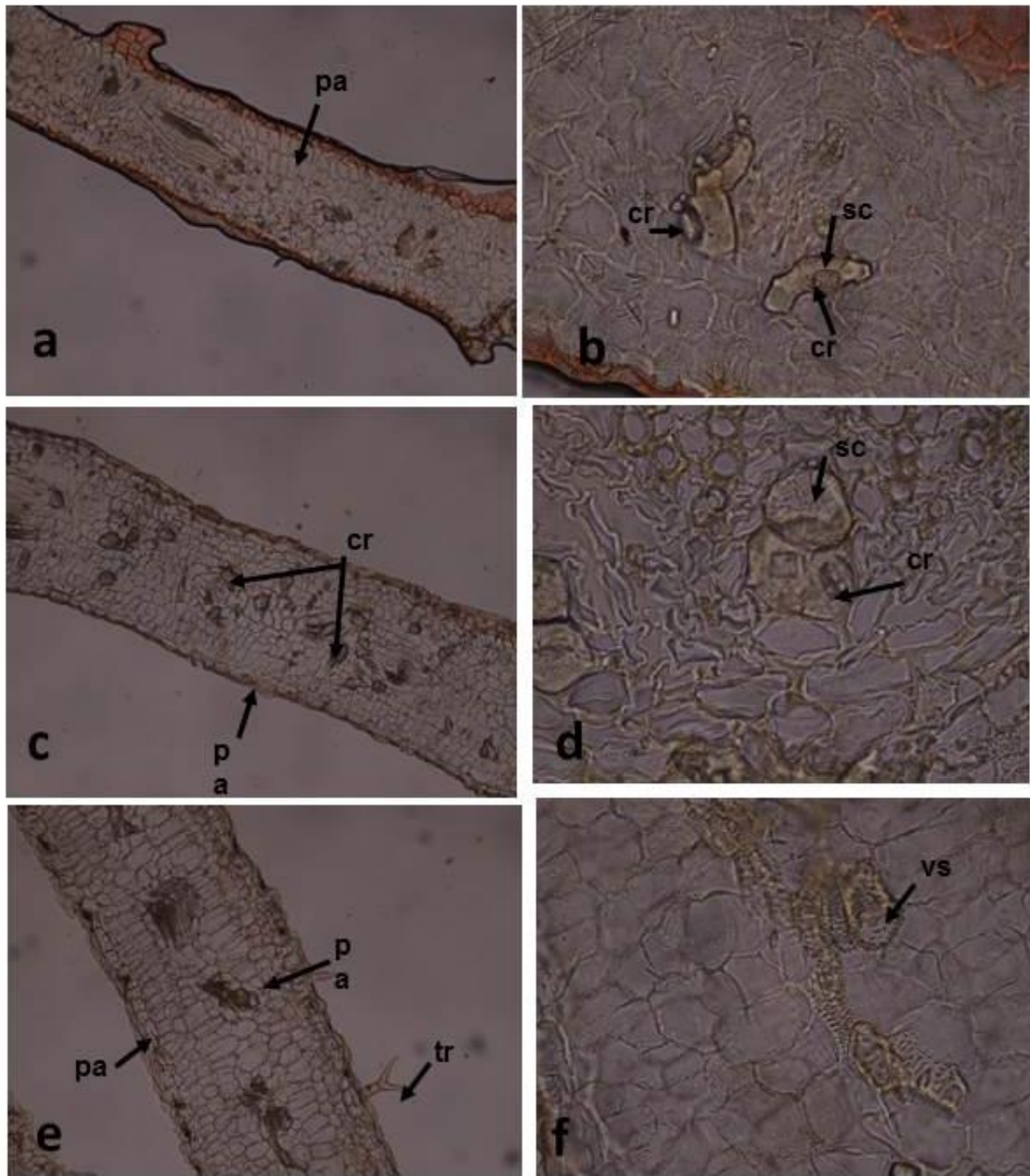


PLATE 1: Photomicrographs of transverse sections of leaves of Genus *Agelanthus* in Nigeria

Key: a & b= *Agelanthus brunneus*; c & d = *Agelanthus dodoneifolium*; e & f = *Agelanthus heteromorphus*; pa = palisade cells; cr = crystals (embedded in sclereids); tr = trichomes (simple & branched); vs = xylem vessels; sc = sclereids

family. This character was also used by Polhill and Wiens²³ as one of the diagnostic features to describe these species. Trichomes are found to be significant at intra-specific level taxonomically³⁷. The taxonomic value of trichomes in angiosperms have been well documented in literature^{38,31}, also it has been reported that leaf surfaces i.e whether glabrous, tomentose or hairy is under strong genetic control and therefore, environmental factors may

have little or no effect at all on the appearance of a leaf. Okpon³⁹ and Stace⁴⁰ stated that types of hairs are usually constant in many species that possess them. *Phragmanthera talbotiorum* shows the presence of trichome bases but no trichome was observed on the transverse sections of the leaf. This lack of trichomes also confirmed the glabrescent nature of the leaf. Prismatic crystals associated with only sclereids in *Agelanthus*

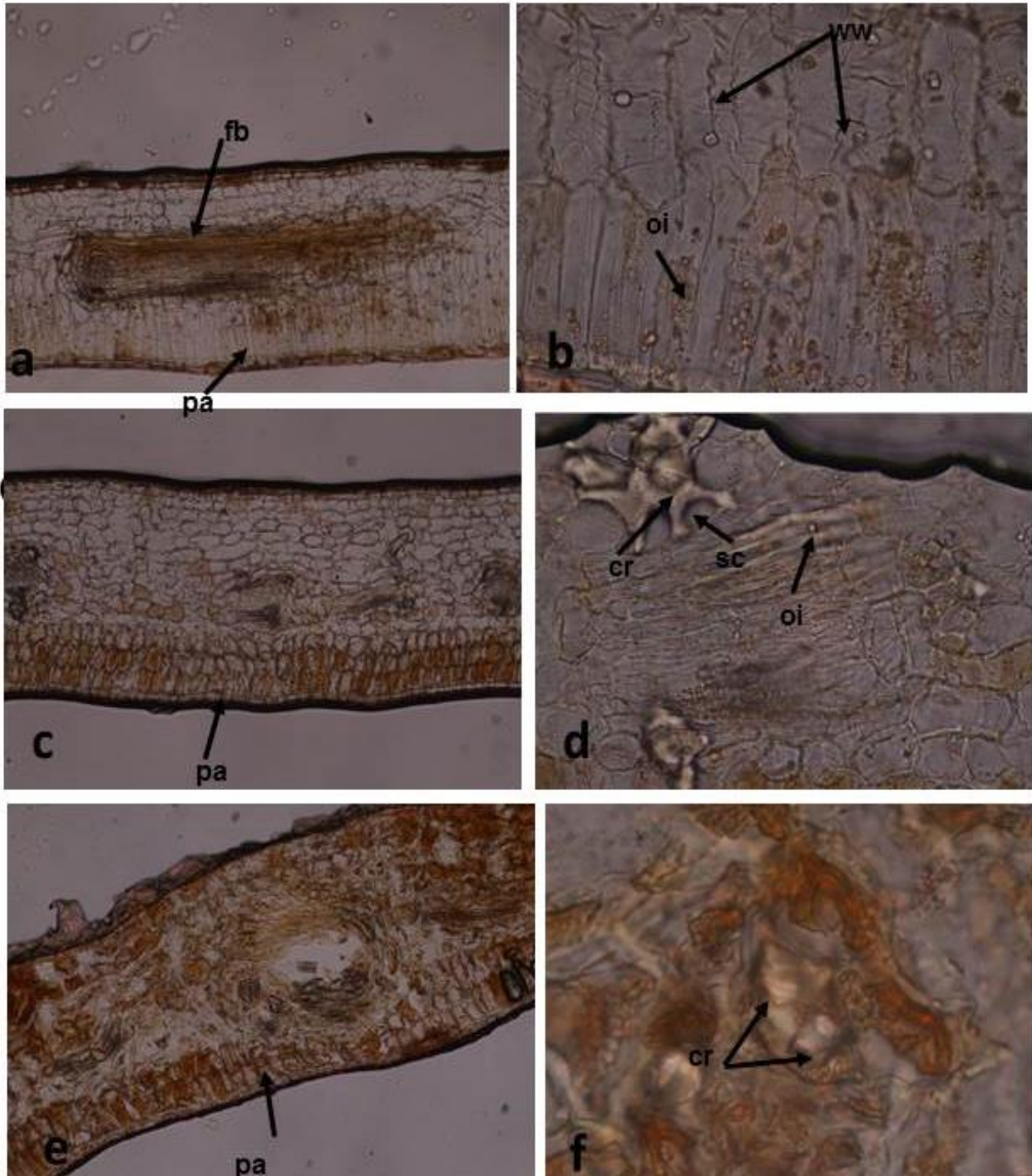


PLATE 2: Photomicrographs of transverse sections of leaves of *Englerina gabonensis* and genus *Globimetula* in Nigeria
 Key: a & b= *Englerina gabonensis*; c & d = *Globimetula braunii*; e & f = *Globimetula oreophila*; pa = palisade cells; cr = crystals; oi = oil (abundant) globules; sc = sclereids; ww = wavy wall palisade cells; fb = fibers

bruneus, *Agelanthus dodoneifolius*, *Helixanthera spathulata*, *Phragmanthera nigritana*, *Phragmanthera talbotiorum* and *Tapinanthus bangwensis* or associated with sclereids, fibers and mesophyll cells in *Globimetula braunii* and *Tapinanthus globiferus* or with only fibers in *Helixanthera mannii* and *Phragmanthera capitata* are all taxonomically useful. The acicular crystals in the mesophyll cells of *Agelanthus bruneus* in addition to prismatic crystals found in them are also taxonomically important because it is the only taxon in which this

character occurs in the family. Sclereids containing prismatic crystals have also been observed in other species of Loranthaceae³⁴ where they were referred to as cristarque cells. Varela *et al.*¹⁶ observed the presence of oxalate crystals in the center of the mesophyll and fibers surrounding the vascular bundles in *Phoradendron liga* (Gill. Ex H. et A.) Eichl. Khan *et al.*³⁵ observed the occurrence of crystals in some species of parasitic plants studied.

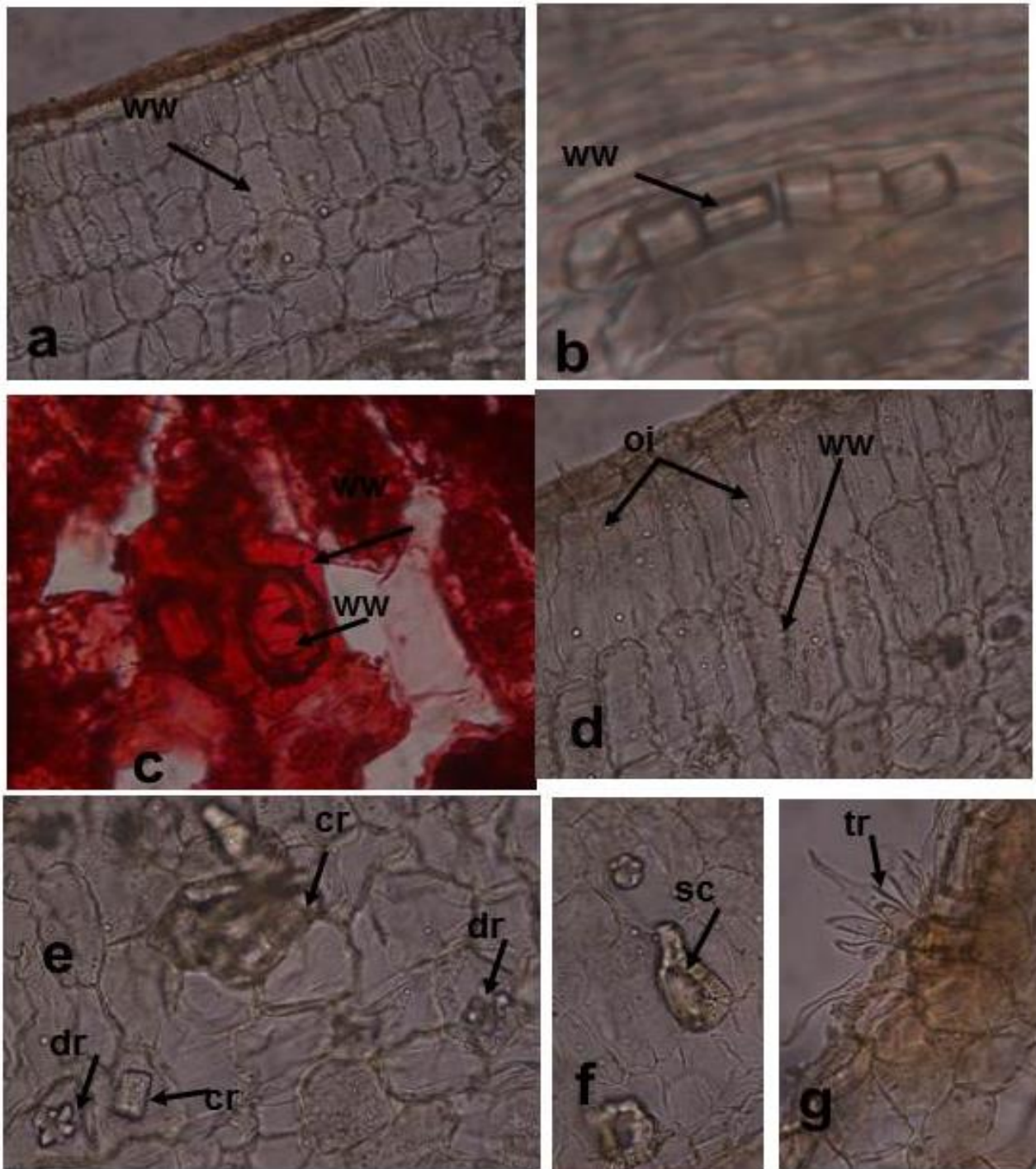


PLATE 3: Photomicrographs of transverse sections of leaves of the Genus *Helixanthera* and *Phragmanthera capitata* in Nigeria

Key: a & b= *Helixanthera mannii*; c = *Helixanthera spathulata*; d – g = *Phragmanthera capitata*; ww = wavy wall palisade cells; cr = crystals; oi = oil globules; sc = sclereids; dr = druses; tr = trichome (stellate)

CONCLUSION

The anatomical features observed from the transverse section of leaves of Loranthaceae could be utilized for taxonomic purposes especially as diagnostic features for the species. And when used in conjunctions with other characters (macromorphology, epidermal morphology etc.) would be helpful in the identification of the species. The diagnostic characters could also be used for plant material in fragments which might subsequently reduce

adulteration due to intentional and unintentional substitution since the family is of high medicinal values in Nigeria and beyond.

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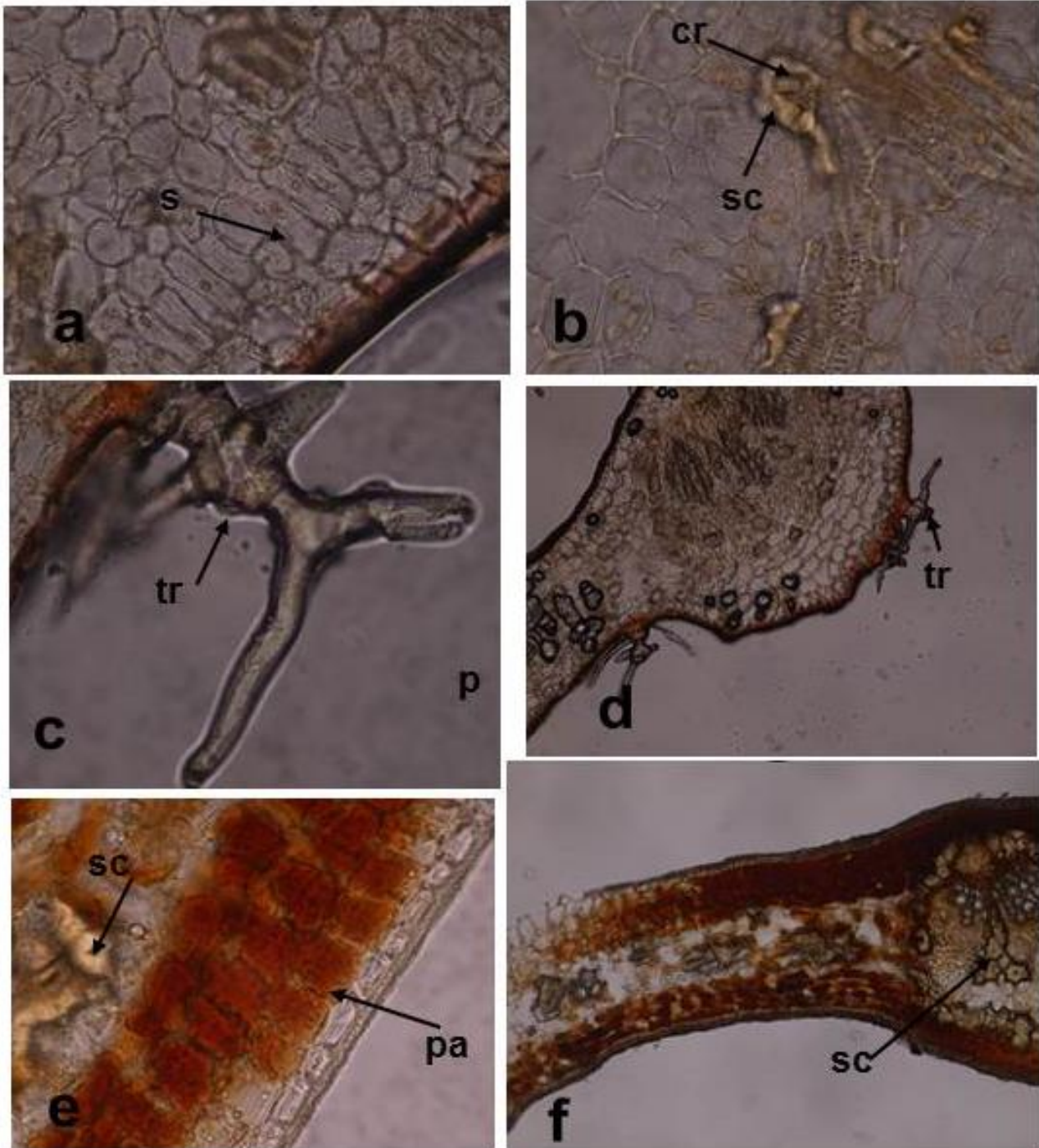


PLATE 4: Photomicrographs of transverse sections of leaves of the Genus *Phragmanthera* in Nigeria

Key: a – d = *Phragmanthera nigritana*; e & f = *Phragmanthera talbotiorum*; pa = palisade cells; cr = crystals; sc = sclereids; tr = trichome (dendritic)

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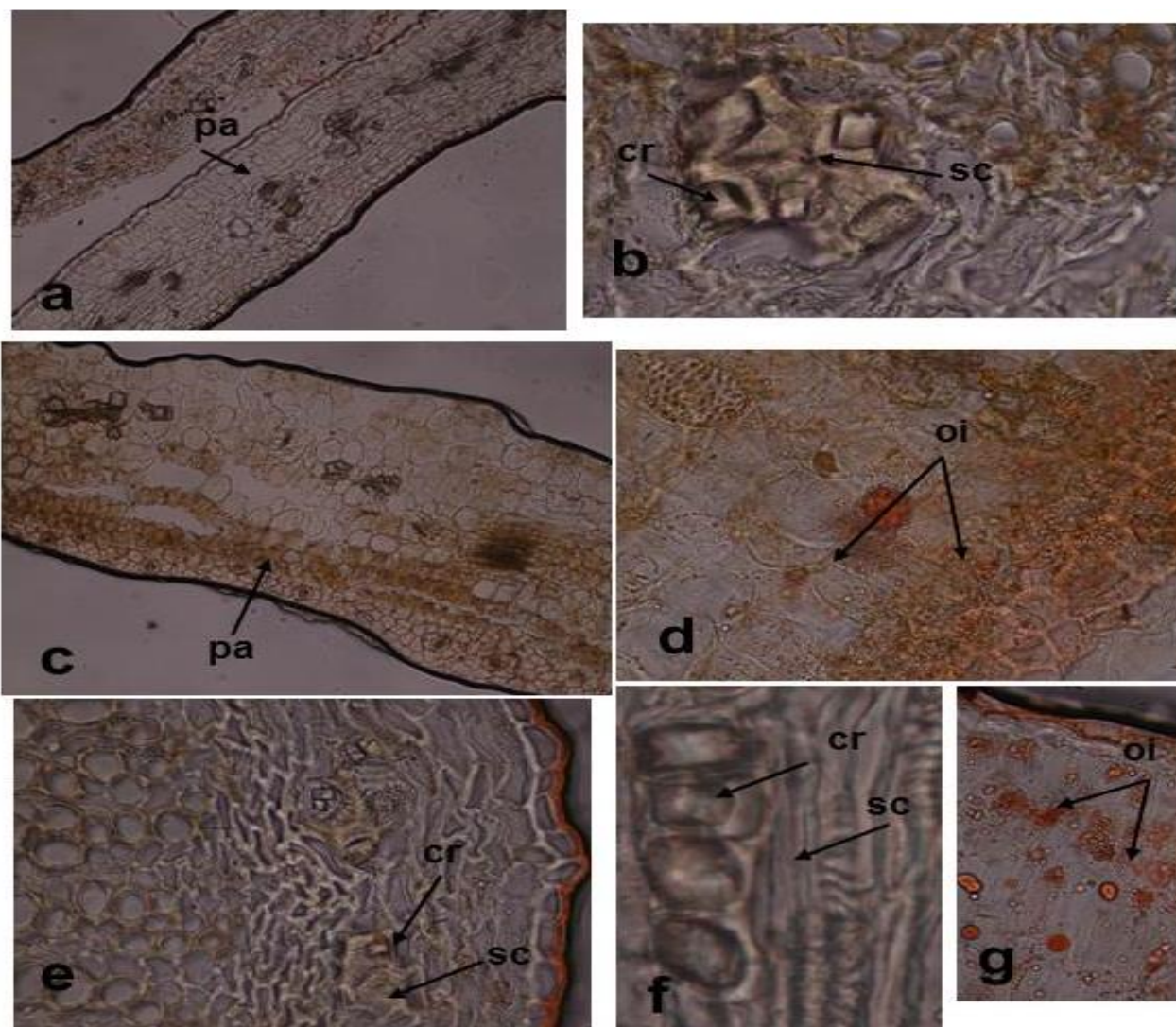


PLATE 5: Photomicrographs of transverse sections of leaves of the Genus *Tapinanthus* in Nigeria

Key: a & b = *Tapinanthus bangwensis*; c & d = *Tapinanthus cordifolius*; e – g = *Tapinanthus globiferus*; pa = palisade cells; cr = crystals; sc = sclereids; oi = oil glands

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