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Comparative Leaf Morphology and Anatomy of some Nigerian Rattans (Arecaceae – Calamoideae Beilschm.)

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Abstract

Collections of 14 species of rattan palms were made from forest habitats along the coastal areas and major forest zones in Nigeria. The aim was to study the leaf morphological and anatomical characters of the palms with a view to facilitating their identification. Morphological characters as well as anatomical features were examined. Analysis of variance (ANOVA) indicated significant differences ($p \leq 0.05$) among morphological characters such as trichome length, internode length, cirrus length and leaf width. Trichomes were present in all the species except in *Ancistrophyllum novum* Burr. and *Laccosperma robustum* (Burr.) [J. Dransf.] Presence of uniseriate epidermis, ergastic substances, sunken stomata and peripheral arrangement of vascular supply was noted and the significance of this is discussed in relation to the family Arecaceae. The high demand of rattan products has been a serious concern with respect to the sustainability of rattan species worldwide. Conservation methods to ensure continued use of rattan palms might be to sensitize farmers, foresters and users on the overall biology of rattan palms and their cultivation techniques.

Key words: Anatomy, Rattan palms, Taxonomy, Nigeria.

Introduction

The rattans of Africa are represented by the three endemic genera *Laccosperma* (G. Mann & H. Wendl.) Drude, *Eremospatha* (G. Mann & H. Wendl.) H. Wendl. and *Oncocalamus* (G. Mann & H. Wendl.) as well as by a single representation of the Asian genus *Calamus* Linn. In Nigeria, they are represented by 14 species and are of vast economic importance. The range of rattans extends from the sea level to more than 300m elevation, from equatorial rainforests to monsoon savannas and the foothills of Himalayas [1]. Thus, the large number of rattan species is matched by great ecological adaptation and diversity. Most, admittedly crude, ecological preferences for rattan species have generally been identified during taxonomic inventory work, yet these broad ecological summaries are invaluable as a basis for establishing cultivation procedures.

Generally, rattan species are found in a wide variety of forest and soil types. Some species are common components of the forest under-storey; others rely on good light penetration for their growth; hence, some species are found in gap vegetation and may respond well to canopy manipulation. Other species grow in swamps and seasonally inundated forest, whereas others are common on dry ridge tops. Taxa such as *Calamus deeratus* (G. Mann & H. Wendl.), *C. pilosellus* Becc., *Laccosperma secundiflorum* (G. Mann & H. Wendl.) Kuntze, *L. leave* (G. Mann & H. Wendl.) Kuntze and *Eremospatha wendladiana* Dammer ex Becc. were found in a wide array of forest types, ranging from dry to wet habitat and occupying all the strata of the habitat whereas others exhibited restricted distribution. The petiole in most rattan palms is somewhat variable in length [2]. Usually, it is much

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longer in juvenile than in mature leaves and it may be absent altogether. The petiole, where present, and the rachis are often heavily armed with spines and has been speculated that the spine is not necessarily adapted for the climbing process but appear to function as a means of trapping light from the forest canopy probably for the primary purpose of nutrients accumulation [3].

In terms of utilization, [4] stated that the largest demand for canes is for making furniture, for which they provide both frames and decorative trimmings and facings. [5] noted that the unsplit canes are utilized as broom handles, sewer rods, walking sticks, ski sticks and snow brooms, while split canes are used for chair seats and in basketry works.[4] listed the uses of canes to include mats, handicrafts and souvenirs. Rattans have also been used for items such as belts, wristlets, lashing of articles such as axe-head or other instrument heads to their handle [3]. In spite of their diverse indigenous uses, little is known about their leaf micro-morphology. The objective of this work was to elucidate the leaf anatomical characters of the rattan palms with a view to facilitating their identification, even from leaf fragments.

Materials and Methods

The leaf specimens used were obtained from living collections made from forest habitats along the coastal areas and major forest zones in Nigeria between the years 2006 and 2008 during the periodic field trips (Fig. 1; Table 1).

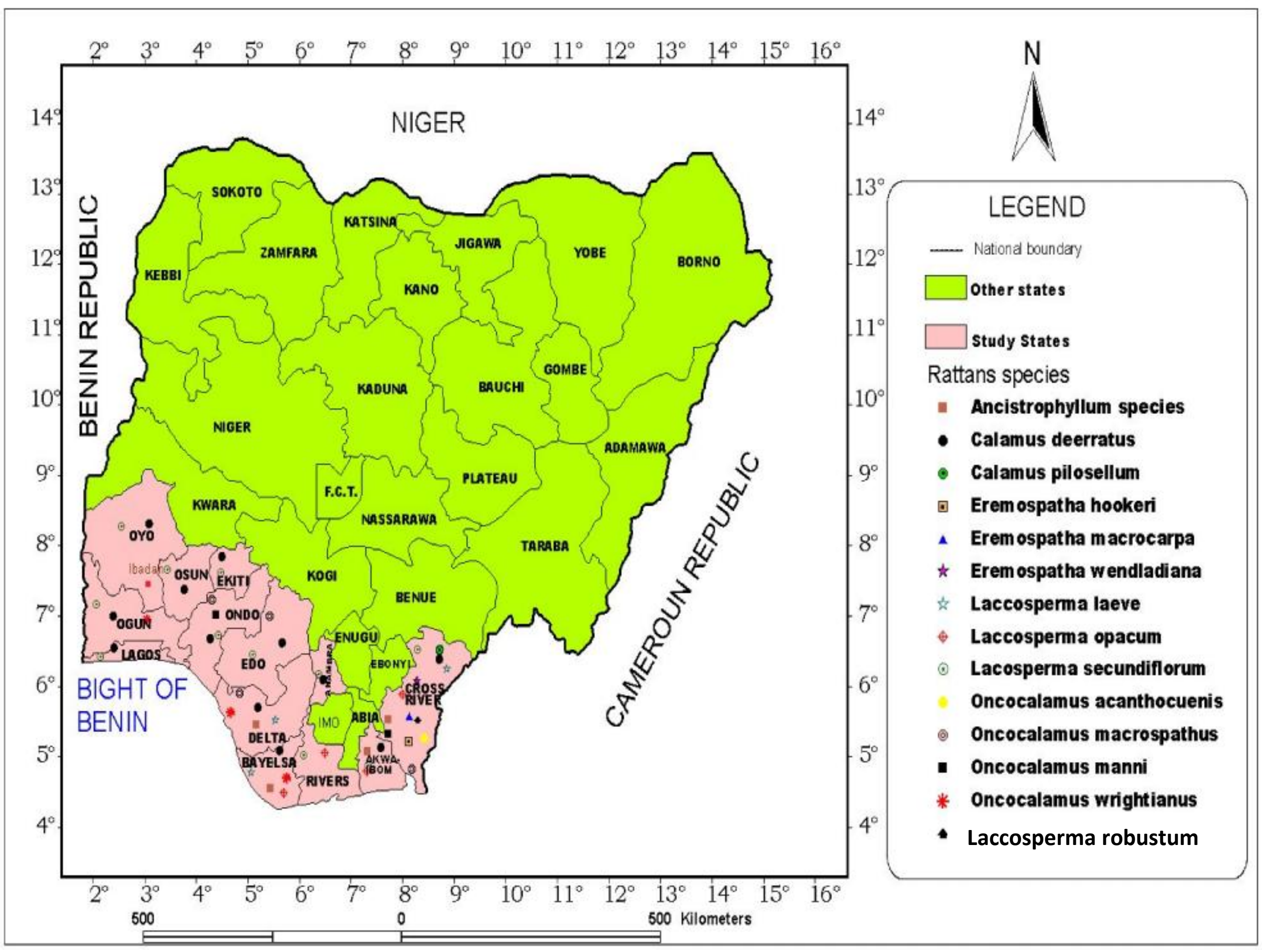

Fig. 1: Geographical distribution of rattan species in Nigeria and the collection sites.

Table 1: List of Representative Specimens Studied

S/N	Taxa	Locality	Herbarium No.
1.	*Ancistrophyllum novum* Burr.	Ughelli; Edjeba; Warri; Akampa; C.R.S.	FHI 32931
2.	*Calamus deeratus* G. Mann & H. Wendl.	Iwopi; J4 F.R., Ogun State; Badagry, Epe Lagos State; Ife-Odan, Oyo	FHI 34638
3.	*Calamus pilosellus* Becc.	Ikot-Okpora, Akwa Ibom; Sapoba, Edo State; Onitsha, Anambra State	FHI 3862
4.	*Eremospatha hookeri* H. Wendl.	Oban F.R.; Obubra F.R.; Edondon F.R.	FHI 5752
5.	*Eremospatha macrocarpa* G. Mann & H. Wendl.	Edondon, C.R.S.; Obubra, Awi, C.R.S.	FHI 3851
6.	*Eremospatha wendladiana* Dammer ex Becc.	Oban F.R.; Obula, C.R.S.; Apiapum, C.R.S.	UIH 3443
7.	*Laccosperma leave* (G. Mann & H. Wendl.) Kuntze	Akampa, Edondon; Oban River, Obubra	UIH 1006
8.	*Laccosperma opacum* G. Mann & H. Wendl.	Ediene, Akwa Ibom; Edondon, C.R.S.; Elele, Rumuji, Bayelsa State	FHI 11120
9.	*Laccosperma robustum* (Burr.) J. Dransf.	Edondon F.R.; Abia, Oyigbo, Obuaku, River State	FHI 10028
10.	*Laccosperma secundiflorum* (G. Mann & H. Wendl.) Kuntze	Edun F.R., Ilaro; Oban F.R., Ediene, Akwa Ibom, Apiagun F.R., Obubra, J4 F.R., Aifesoba, Edo State; Badagry, Lagos State; Ekiti	FHI 50908
11.	*Oncocalamus acanthocuenis* Drude	River Obubra; Lekki, Lagos State; Ediene, Akwa Ibom	FHI 5752
12.	*Oncocalamus macrospathus* Burr.	Oban F.R.; Ogbese F.R.; Ughuri, Edo State	FHI 92561
13.	*Oncocalamus manni* H. Wendl.	Obubra, Ovonum; Awi, C.R.S.	UIH 1002
14.	*Oncocalamus wrightianus* Hutch.	Edun F.R., Ilaro; Edjeba, Warri, Ughelli, delta State; Ahoada, Bayelsa	FHI 17419

F.R. = Forest Reserve; C.R.S. = Cross River State.

The leaves were pressed and identified at the Forestry Research Institute of Nigeria herbarium (FHI) and University of Ibadan herbarium (UIH); voucher specimens were deposited in the herbaria. Fresh specimens were used for the anatomical investigation. From five specimens of each of the 14 taxa studied, $1cm^2$ portions were cut at the apical, median and basal regions of the preserved mature leaflets. Samples were revived by boiling in water and fixed in formaldehyde acetic acid (FAA 50%) for 24 hours [6] followed by dehydration in series of ethanol (30-95%). Infiltration was done with paraplast (soft wax) and tissue mat (hard wax) using tertiary butyl alcohol (TBA) as base for 24-48 hours at 50°C [6]. Infiltrated specimens were transferred into the embedding liquid (melted wax poured into improvised moulds) to cast hard blocks. Trimming of the relatively hard polymerised blocks was done with the aid of disposable knives. The transverse sections, about 13µm, were made with Leica 820 II rotary microtome available in the pathology laboratory at the International Institute of Tropical Agriculture (IITA) Ibadan, Nigeria. Using, one-way disposable knife, each section was transferred into drops of warm distilled water on a clean slide on which adhesive had been previously rubbed. The warm distilled water served in a place of water bath for stretching the sections. After drying on a slide warmer (Fisher slide warmer SE 2417), slides were de-waxed in xylene and subsequently hydrated through ethanol series (5-30%). Staining was done with safranin for 15-20 mins. and subsequently rinsed in distilled water and differentiated ethanol series (30-95%); counterstained in fast green for 5secs, transferred into xylene for 5mins., cleared in clove oil for 10mins. and mounted in DPX® mountant. Anatomical descriptions followed the conventions established by [6] as modified by [7]. Data were expressed as mean ± SD, and differences in means were assessed for significance at $P \leq 0.05$ by Duncan's Multiple Range Test (DMRT) [8].

Results

Morphology

Quantitative morphological parameters of the rattans are presented in Table 2. The leaflet width differs among the species of rattans studied; it ranged from 1.9cm in *Ancistrophyllum novum* Burr. and *Oncocalamus manni* H. Wendl. to 24.1cm in *Calamus pilosellus* Becc. The leaflet widths in *Laccosperma secundiflorum* and *Eremospatha hookeri* are not significantly different. The same trend was observed for *Ancistrophyllum novum* and *Oncocalamus manni*, and *Calamus deeratus* and *Eremospatha wendladiana*. Mean number of paired leaflets of the species differs; this ranged from 4.5 in *Laccosperma robustum* (Burr.) J. Dransf. to 48 in *Laccosperma opacum* (G. Mann & H. Wendl.) and *Calamus deeratus* (G. Mann & H. Wendl.) The values observed are similar in *Oncocalamus macrospatha* Burr. and *O. acanthocuenis* Drude both having 18 each. Also, the numbers of paired leaflets are similar in *Oncocalamus wrightianus* Hutch., *O. manni* H. Wendl. and *Calamus pilosellus* Becc. each having 35. The remaining species have variable number of paired leaflets which could be diagnostic.

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Table 2: Quantitative Morphological Parameters of the Rattans Studied

Taxa	Trichome Length (cm) Base	Mid	Apex	Internode length (cm)	Cirrus length (cm)	Leaflet width (cm)	No. of paired leaflet
Ancistrophyllum novum Burr.	n.p.	n.p.	n.p.	$18.80^{c}\pm1.08$	$0.20^{b}\pm0.01$	$1.90^{a}\pm0.01$	25.00±4.00
Calamus deeratus G. Mann & H. Wendl.	1.20±0.03	1.20±0.04	1.10±0.06	$29.20^{e}\pm0.44$	$2.90^{i}\pm0.03$	$2.80^{b}\pm0.02$	48.00±2.00
Calamus pilosellus Becc.	0.60±0.06	0.70±0.01	0.70±0.02	$12.90^{a}\pm0.20$	$0.40^{c}\pm0.02$	$24.10^{j}\pm0.09$	35.00±3.00
Eremospatha hookeri H. Wendl.	1.20±0.04	1.20±0.02	1.00±0.08	$13.00^{a}\pm0.02$	$2.40^{g}\pm0.03$	$5.30^{f}\pm0.09$	20.00±2.00
Eremospatha macrocarpa G. Mann & H. Wendl.	0.50±0.02	0.70±0.01	1.10±0.05	$13.30^{a}\pm0.35$	$1.80^{f}\pm0.07$	$3.30^{c}\pm0.01$	47.00±2.00
Eremospatha wendladiana Dammer ex Becc.	1.10±0.09	1.10±0.05	0.80±0.02	$15.10^{b}\pm0.35$	$3.60^{j}\pm0.01$	$2.90^{b}\pm0.01$	45.00±5.00
Laccosperma leave (G. Mann & H. Wendl.) Kuntze	0.70±0.04	0.90±0.02	0.80±0.04	$15.50^{b}\pm0.29$	$0.40^{c}\pm0.02$	$3.20^{c}\pm0.01$	13.00±4.00
Laccosperma opacum G. Mann & H. Wendl.	1.20±0.03	1.10±0.05	0.70±0.02	$18.00^{c}\pm0.87$	$4.10^{k}\pm0.02$	$7.10^{h}\pm0.09$	48.00±2.00
Laccosperma robustum (Burr.) J. Dransf.	n.p.	n.p.	n.p.	$32.30^{f}\pm0.40$	$3.60^{j}\pm0.03$	$13.90^{i}\pm0.02$	45.00±0.50
Laccosperma secundiflorum (G. Mann & H. Wendl.) Kuntze	0.50±0.04	0.40±0.01	0.70±0.01	$17.30^{c}\pm0.33$	$1.50^{d}\pm0.02$	$5.20^{f}\pm0.01$	17.00±2.00
Oncocalamus acanthocuenis Drude	0.96±0.07	1.00±0.09	1.10±0.10	$13.00^{a}\pm0.02$	$2.60^{h}\pm0.03$	$3.40^{d}\pm0.06$	18.00±2.00
Oncocalamus macrospathus Burr.	0.80±0.03	0.60±0.04	0.50±0.07	$13.60^{a}\pm0.03$	$1.60^{e}\pm0.04$	$4.70^{e}\pm0.09$	18.00±2.00
Oncocalamus manni H. Wendl.	1.00±0.09	1.70±0.05	0.70±0.01	$25.70^{d}\pm0.60$	$2.60^{h}\pm0.04$	$1.90^{a}\pm0.01$	35.00±5.00
Oncocalamus wrightianus Hutch.	0.10±0.10	0.10±0.01	0.10±0.01	$12.30^{a}\pm0.44$	$0.10^{a}\pm0.01$	$5.40^{g}\pm0.04$	35.00±3.00

Values are mean ± SD; n=3. Means followed by the same alphabet in the same column are not significantly different (Spearman, p>0.05); n.p. = not present.

Anatomy

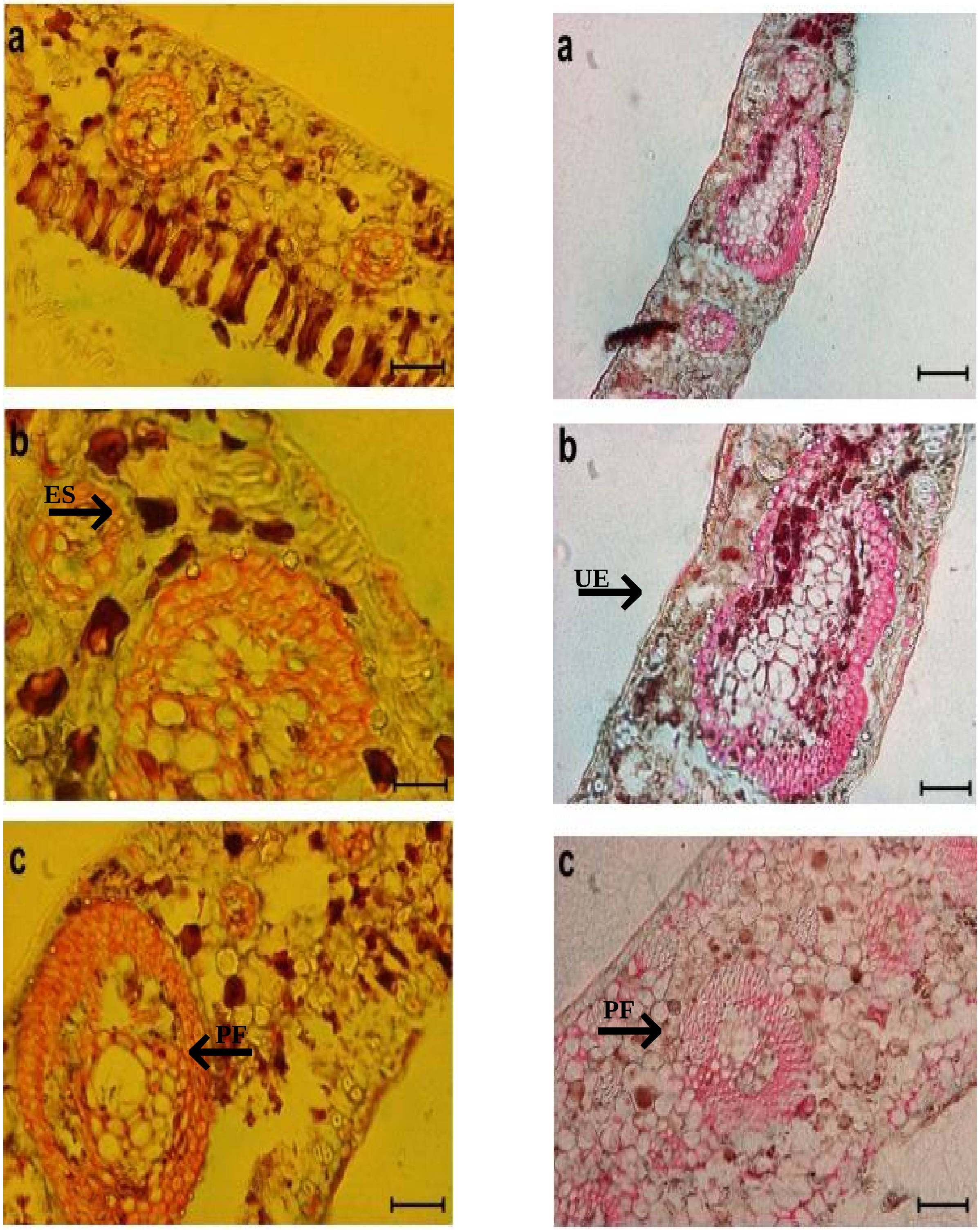
Photomicrographs of the species studied are presented in Plates 1-7. The epidermis is composed of rectangular cells with outer thickened wall and few sunken stomata. The epidermal cells are in longitudinal files and are usually square or rectangular. One or more cell layers immediately beneath the epidermis form a colourless hypodermis and often indistinct. The peripheral bundles are sometimes irregularly and incompletely fused to form an almost continuous peripheral sclerotic cylinder in *Laccosperma robustum* (Burr.) J. Dransf. The ground tissue of the leaf axis contains numerous scattered, longitudinal-running, large vascular bundles among which are interspersed occasionally with small vascular bundles. The ground parenchyma of the central part of the axis was uniform in all the observed genera. The vascular tissues are sheathed by two distinct layers; the outer sheath is parenchymayous, compact and always uniseriate. The cells are clearly distinguishable from the adjacent mesophyll cells which sometimes are rectangular or elongated as found in *Eremospatha macrocarpa* (G. Mann & H. Wendl.) and *E. hookeri* H. Wendl. The inner sheath is mostly sclerotic, often multiseriate and immediately surrounds the vascular tissue.

Discussion

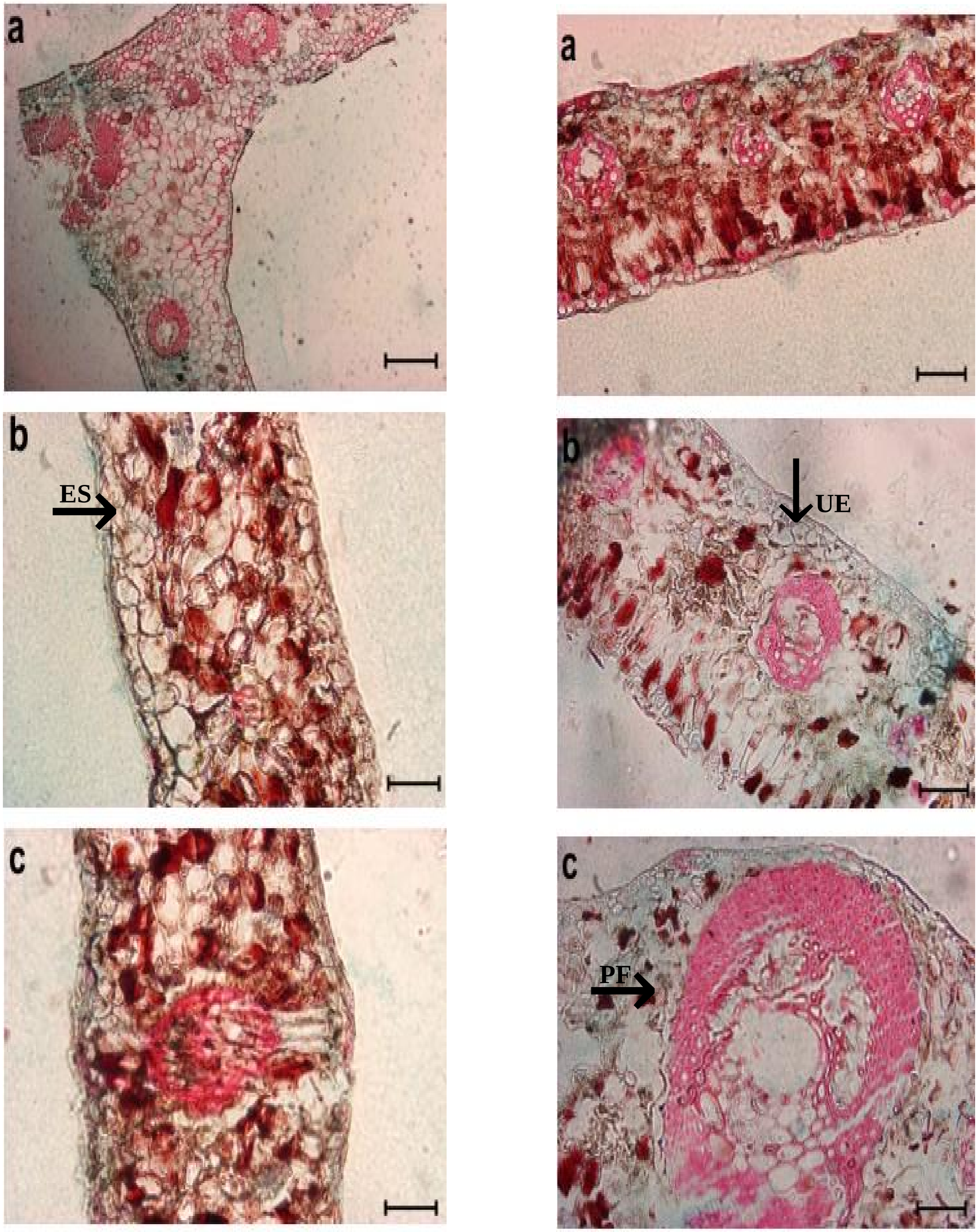
The morphological parameters observed in all the species revealed that differences exist in the internode length, cirrus length and leaflets width, and such differences could be used in the delimitation and identification of the taxa. The qualitative and quantitative characters are not genus-bound. The characters occur in similar proportions in different genera. The correct identification of rattans is essential in establishing priorities for conservation and use strategies.

The absence of trichomes in *Ancistrophyllum novum* and *Laccosperma robustum* which often is a reflection of physiological response to a combination of environmental factors could be useful for diagnostic purpose at the species level. This is in agreement with [9] who used trichomes to delimit five species of economic rattan in Ghana. The anatomical variation observed in this study shows that the most promising characteristic features in species separation are the trichome length, internode length and cirrus length. The features suggested by [10] for generic separations are of little diagnostic value at the species level as many characters overlap among the species. During ontogeny [11], the shape of the leaves changes with change in the internode shape to avoid self-shading within a crown; however, with the possible combination of several anatomical and morphological characters, an experienced plant anatomist could succeed in identifying the rattan species of Nigeria especially when the geographic source of the rattan is known.

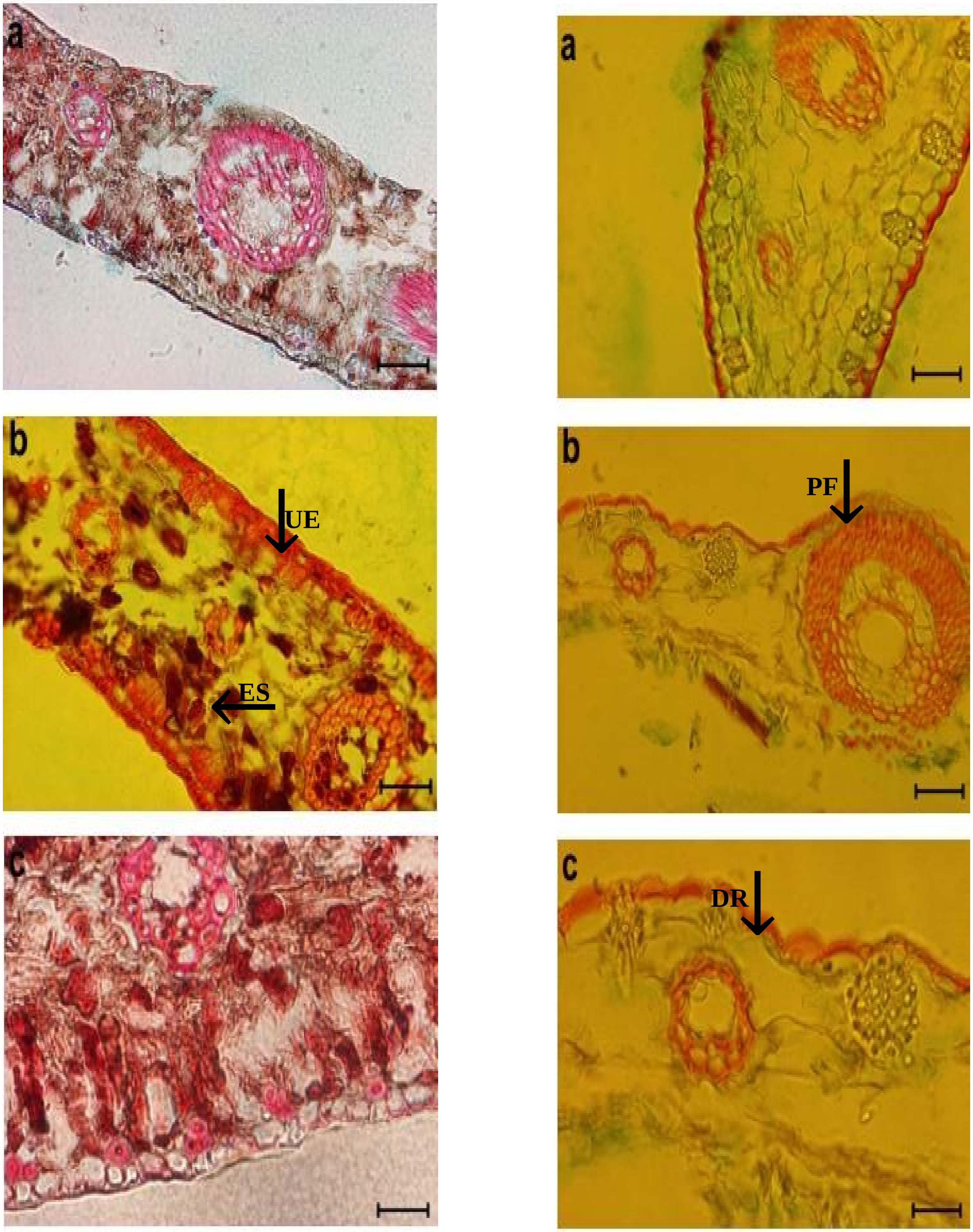
The unique mix of characteristics such as durability and flexibility make rattan very good raw materials for furniture and handicraft industries [12]. The high demand of rattan products has been a serious concern with respect to the sustainability of rattan species worldwide [13]; among these concerns are their use as food, for furniture and household handicrafts, habitat destruction, and little or no conservation efforts. Viable methods to remedy the situation might be to sensitize farmers, foresters and users on the overall biology of rattan palms and their cultivation techniques.



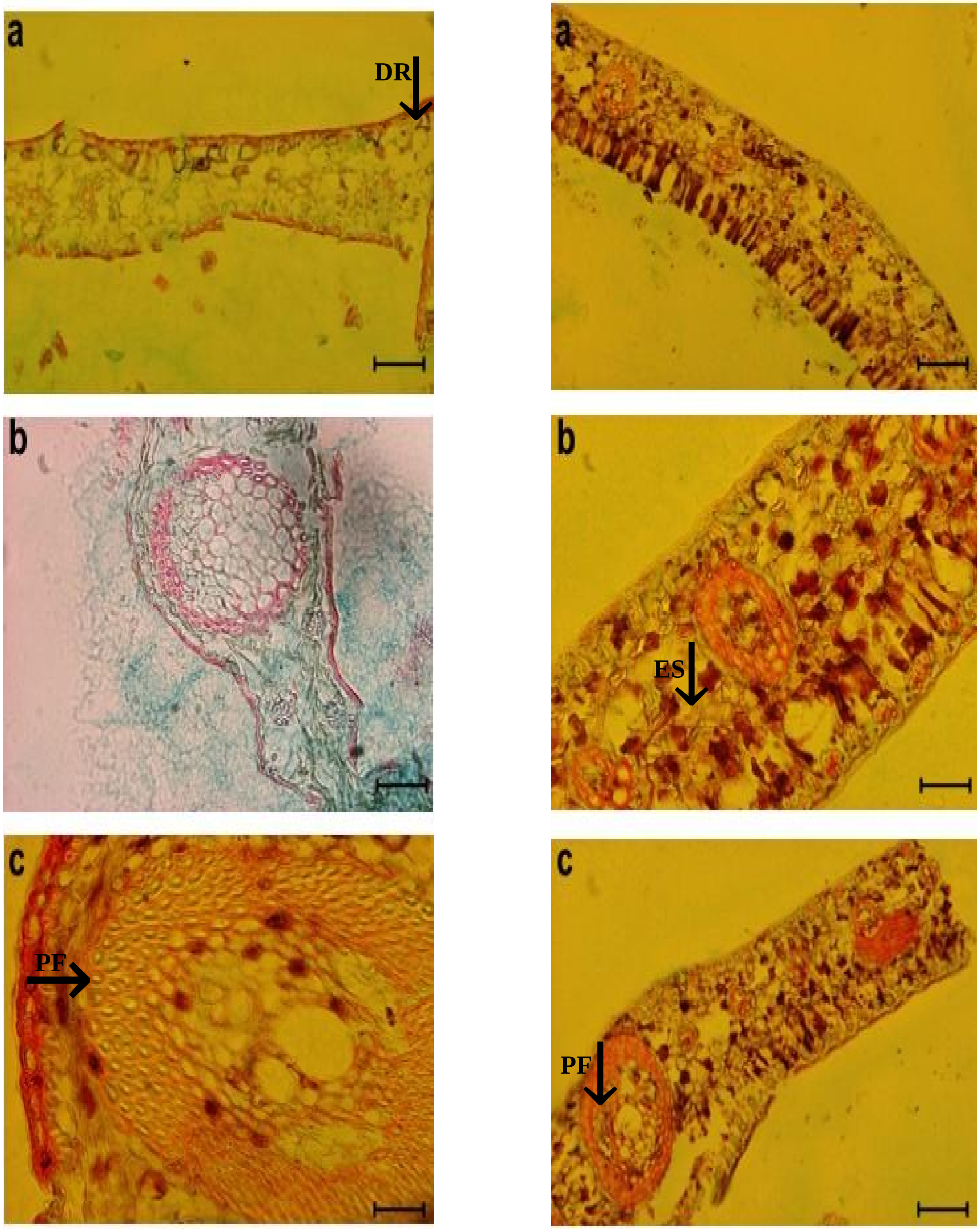
Plates 1a-c: Transverse sections of *Oncocalamus macrospathus* Burr. and *Laccosperma secundiflorum* (G. Mann & H. Wendl.) Kuntze leaf. a, apical region; b, mid-region; c, basal region. (Scale bars = 100µm.) UE = uniseriate epidermis; ES = ergastic substances; PF = Phloem field.



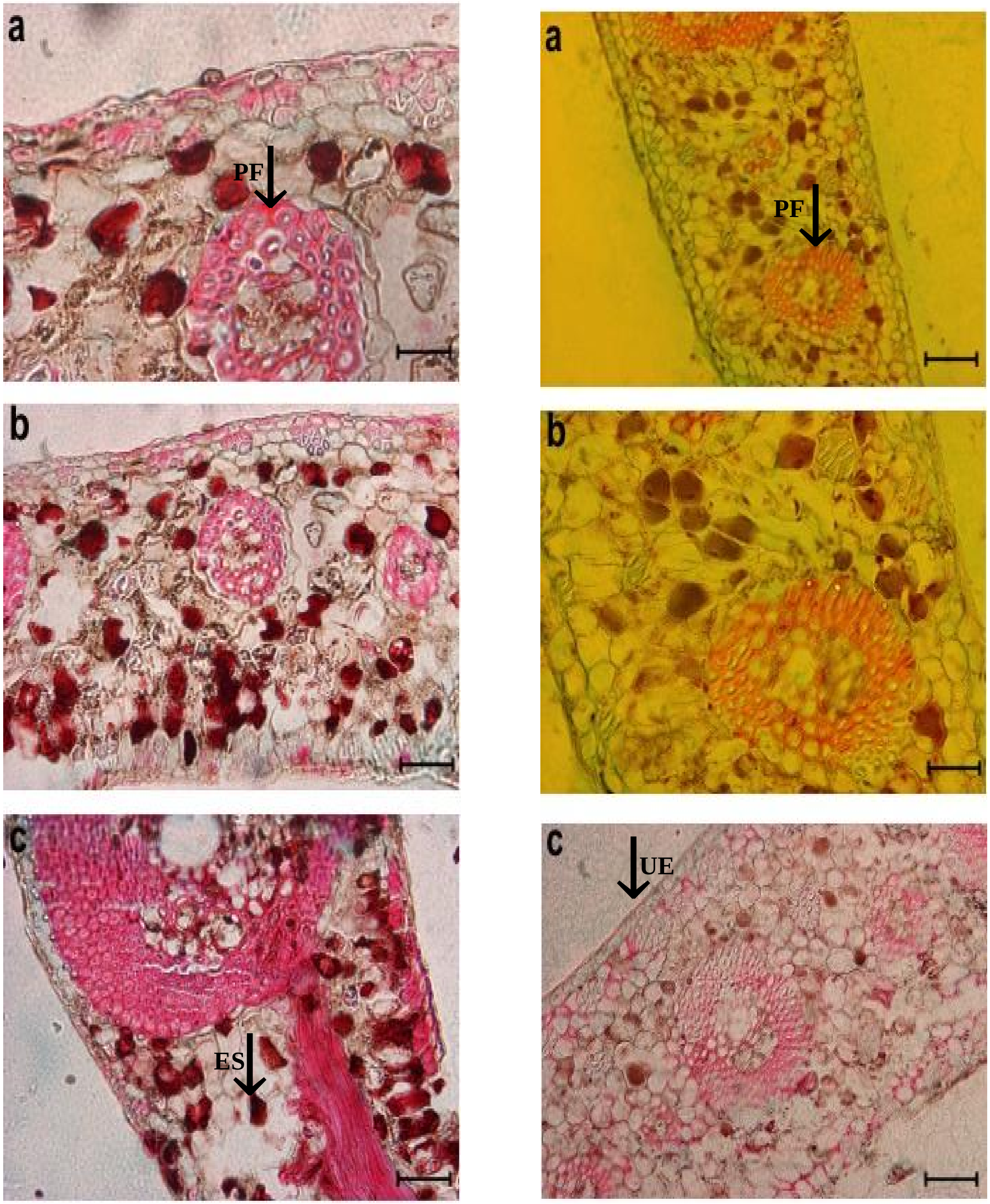
Plates 2a-c: Transverse sections of *Oncocalamus wrightianus* Hutch. and *Ancistrophyllum novum* Burr. leaf. a, apical region; b, mid-region; c, basal region. (Scale bars = 100µm.) UE = uniseriate epidermis; ES = ergastic substances; PF = Phloem field.



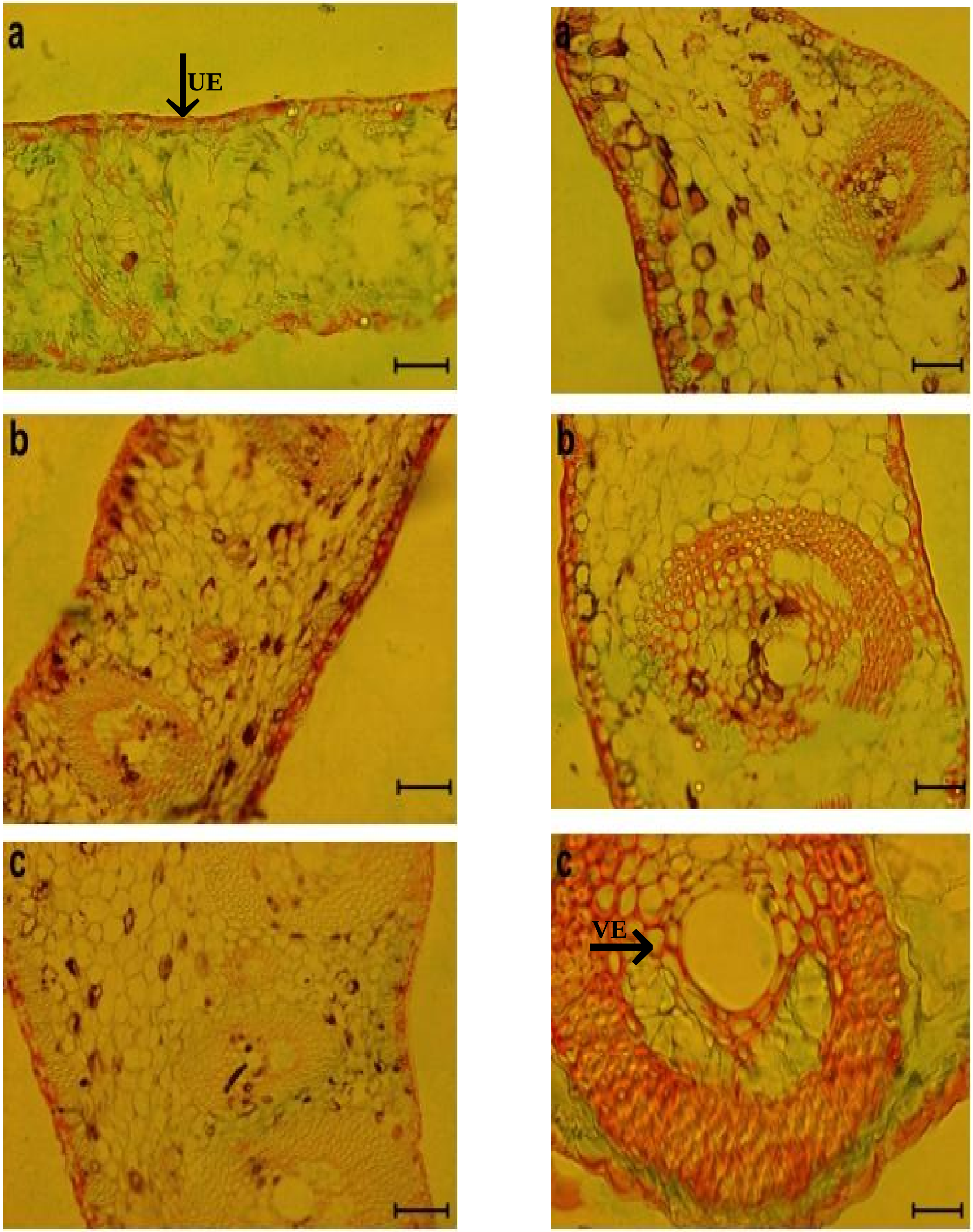
Plates 3a-c: Transverse sections of *Eremospatha macrocarpa* G. Mann. & H. Wendl. and *Laccospermum robustum* (Burr.) J. Dransf. leaf. a, apical region; b, mid-region; c, basal region. (Scale bars = 100µm.) UE = uniseriate epidermis; ES = ergastic substances; PF = Phloem filed; DR = Druses.



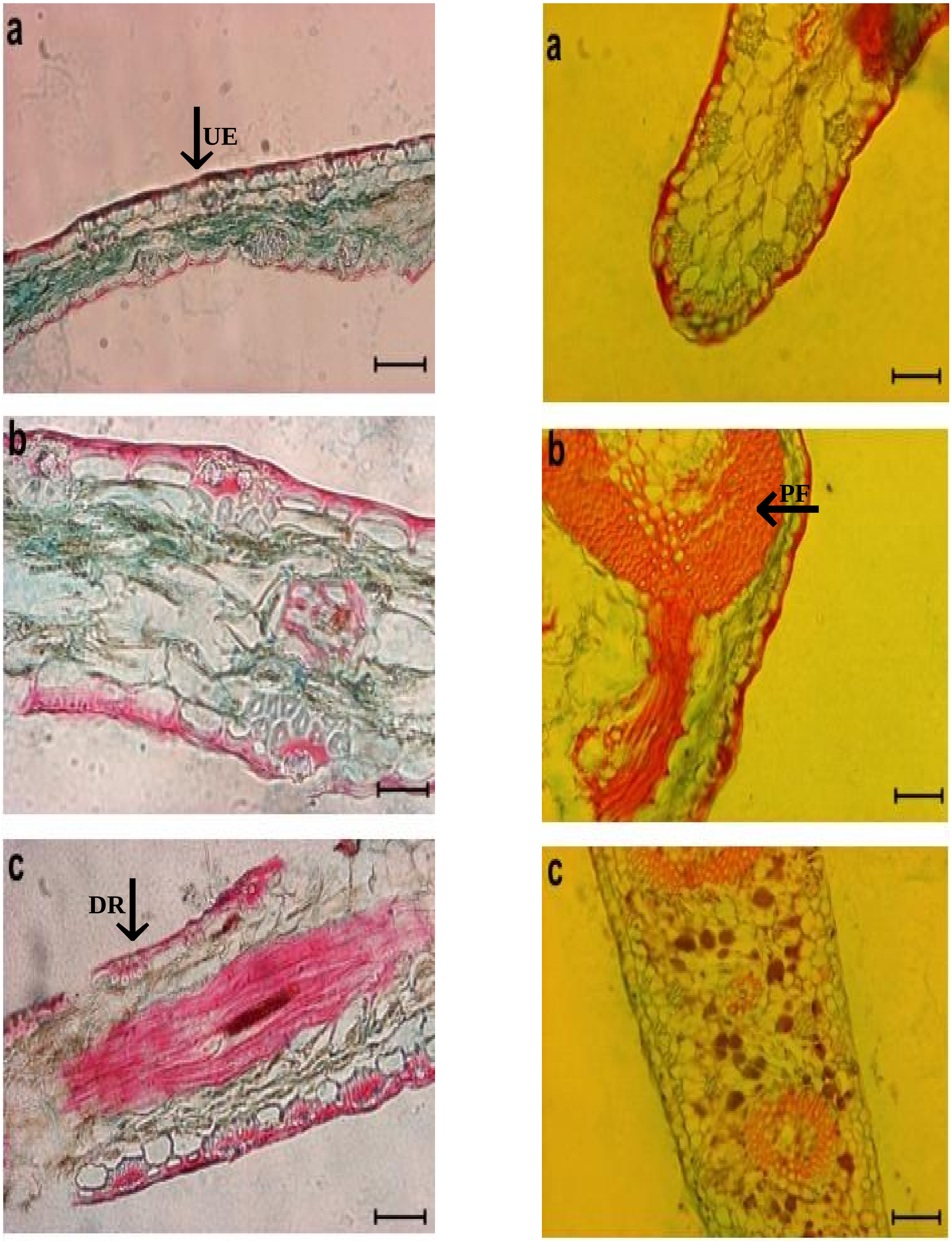
Plates 4a-c: Transverse sections of *Laccosperma opacum* G. Mann. & H. Wendl. and *Oncocalamus manni* H. Wendl. leaf. a, apical region; b, mid-region; c, basal region. (Scale bars = 100µm.) DR = druses; ES = ergastic substances; PF = Phloem field.



Plates 5a-c: Transverse sections of *Laccosperma leave* (G. Mann. & H. Wendl.) Kuntze and *Calamus pilosellus* Becc. leaf. a, apical region; b, mid-region; c, basal region. (Scale bars = 100µm.) UE = uniseriate epidermis; ES = ergastic substances; PF = Phloem field.



Plates 6a-c: Transverse sections of *Calamus deeratus* G. Mann. & H. Wendl. and *Eremospatha wendladiana* Dammer ex Becc. a, apical region; b, mid-region; c, basal region. (Scale bars = 100µm.) UE = uniseriate epidermis; VE = Vessel element.



Plates 7a-c: Transverse sections of *Eremospatha hookeri* H. Wendl. and *Oncocalamus acanthocuenis* Drude leaf. a, apical region; b, mid-region; c, basal region. (Scale bars = 100µm.) UE = uniseriate epidermis; PF = Phloem field; DR = Druses.

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