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ORIGINAL ARTICLE

PETAL EPIDERMAL MICROMORPHOLOGY AND ITS TAXONOMIC SIGNIFICANS IN SOME SPECIES OF BIGNONIACEAE FROM EGYPT

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ABSTRACT

Micromorphological characters of petals in 8 genera representing 12 taxa of Bignoniaceae from Egypt were carried out using scanning electron microscopy (SEM) to evaluate their taxonomic importance in petal epidermal micromorphology, including epidermal cell types (areolate, papillose conical, and areolate mixed with papillose conical), trichome types (non-glandular; funnel shape, flexible and stiff-bristly, and glandular; peltate, capitate, cupular, stipitate, and patelli-form), trichome ornamentation (striate, verucate, and smooth, and stomata on both the abaxial and adaxial surfaces. Stomata are present in all species except *Jacaranda acutifolia* Humb. & Bonpl., 1806 and *Markhamia zanzibarica* (Bojer ex DC.) K. Schum., 1895. We used the past 4.03 program to performs a statistical analysis on the data set matrices using the unweighted pair group method with arithmetic mean (UPGMA, and a phylogram was produced. Our result showed that the two studied genera of *Markhamia* Seem. ex Baill. ,1888 and *Tabebuia* Gomes ex DC., 1838 showed support for the monophyly, however, *Tecoma* (Juss., 1789) are not monophyletic genera.

Keywords: Bignoniaceae, Petal, SEM, Trichomes, UPGMA.

INTRODUCTION

The family Bignoniaceae comprises 80 genera and about 840 species, the majority of which are tropical. Only a few species are found in warm temperate climates (Fischer *et al.*, 2004). According to Lohmann and Ulloa (2019), it is a medium-sized collection of trees, shrubs, lianas, and climbers. Flowers that are terminal, axillary, racemic, or solitary are typically noticeable. Five-petaled calyx that is occasionally bilobed or unlobed and infrequently has a calyptra. A five-petalled, frequently 2-lipped, infrequently subrotating, imbricate, or infrequently valvate corolla. Androecium linked to the tube; stamens four, didynamous in two pairs; fifth (adaxial) stamen staminodial or absent; rarely, all five stamens fertile; more frequently, two fertile and three staminodial. Ovary superior, 2-carpellate, bilocular with a dividing septum, occasionally unilocular or 4-locular, placentation axile, style with 2-lobed stigma (Endress, 1996).

Petal epidermal micromorphology

According to Fischer *et al*. (2004), the petal surface microstructure of cells differs from other plant components in terms of its distinctive optical qualities. Petal micromorphological features in angiosperms have been demonstrated to be useful for taxonomic identification and as a source of phylogenetically informative attributes in a range of taxa, including Asteraceae (Compositae) (Baagøe, 1977, 1980; Hansen, 1991; Angulo and Dematteis, 2014). Boraginaceae (Akçin, 2009), Polygonaceae (Hong *et al*., 1998; Kong and Hong, 2018), Commelinaceae (Chwil, 2011), Orchidaceae (Barone Lumaga *et al*., 2012, and Menispermaceae (Wang *et al*., 2018).

Trichomes are present in the floral and vegetative portions of Bignoniaceae plants. Bureau and Schumann (1864) published the first documented report on the glandular trichomes of this family, followed by Schumann (1895), Sandwith (1938), and Siebert (1940, 1948), who demonstrated the taxonomic significance of the trichomes within the family and attempted to group them in 9-10 categories based on their position and structure after determining their taxonomic significance within the family. Trichomes are characterized as either glandular or non-glandular (Werker, 2000). Based on their shape, papillate (protruded), lenticular (elongated), or flat, different types of epidermal cells have been observed in petals (Kay *et al*., 1981; Ojeda *et al*., 2009). The quantity and size of protrusions on these cells, as well as the cuticular striations, differ from one another. Distinct species may contain distinct arrangements and configurations of these epidermal cell types. In 201 angiosperm species, the distribution of the various epidermal cell types in the petals has been investigated, about 78% of the species showed papillate types of cells, which were primarily found on the adaxial surface and sporadically occurring on the abaxial side (Kay *et al*., 1981).

The scanning electron microscopy (SEM) application has significantly enhanced our comprehension of the surface attributes of diverse vegetative and reproductive organs, while also providing significant taxonomic information (Barthlott, 1981; Stace, 1984; Ozcan, 2002). Gentry (1980) provided a thorough description of the taxonomic history, which was summarized by Sprangler and Olmstead (1999), and Fischer *et al*. (2004) recently classified the family. The African and Asian grouping, which consists of almost 29 genera and 115 species, are the components of the family that is still poorly understood (Lohmann and Ulloa, 2007).

The aims of this work were to document and exhibit a complete description of petal micromorphology of *Handroanthus* Mattos., 1970; J*acaranda* Juss., 1789, *Kigelia* Dc., 1838; *Markhamia* Seem. ex Baill.,1888; *Parmentiera* Dc.,1838; *Spathodea* Beauverd,1805; *Tabebuia* Gomes,1838; *Tecoma* Juss.,1789, from Egypt, using field emission scanning electron microscopy, as well as to assess the taxonomic or diagnostic significance of petal micromorphology.

MATERIALS AND METHODS

Collection of plant material: Eight horticultural taxa representing the genera; *Handroanthus* Mattos.,1970; *Jacaranda* Juss,1789; *Kigella* Dc.,1838; *Markhamia* Seem. ex Baill.,1888; *Parmentiera* Dc.,1838; *Spathodea* Beauverd,1805; *Tabebuia* Gomes ex DC.,1838; *Tecoma*

Juss.,1789 were the subject of this study (Tab. 1). Fresh plant samples were collected during April, May, and September from EL-Orman Botanical Garden in Egypt. The EL-Orman Botanical Garden, in Giza, Egypt, created the voucher herbarium specimens and compared them for identification with genuine ones. These reference specimens were archived in the herbarium of the Botany and Microbiology department at Zagazig University in Egypt. The International Plant Names Index's webpages (www.ipni.org./ipni/query_ipni.html) were used to double-check the scientific names and author citations. Additionally, the www.theplantlist.org website is utilized to check the acceptable scientific names in use.

Plant sampling: Fresh mature flowers were preserved in 70% ethyl alcohol for 24-48 hours after treatment in FAA solution (5:5:50:40 Formaldehyde, Glacial Acetic Acid, 95% ETOH, and distilled water) (Johansen, 1940). Both the stereo microscope and the OPTECH-light were used to analyze fresh and dry specimens. By using SEM, the ultrastructural characteristics of petals were seen and captured on camera. Using a scanning electron microscope (JEOL- JSM-6510 LV) at Mansoura University in Egypt, sections of dried petals (abaxial and adaxial half) were mounted on stubs without any prior preparation, coated with gold, and studied at various magnification powers.

Statistical analyses: In Tables (2, 3), features related to trichome type, epidermal type, and stomata presence are listed in comparison for the researched taxa. Through the inspection of specimens, characters and character states were identified and categorized as multistate characters. A multistate matrix was used to analyze the data matrix. A dendrogram was created to depict the relationships between the taxa after the data matrix underwent cluster analysis using UPGMA (unweighted pair group method with arithmetic mean) and the Jaccard similarity index. The past 4.03 program was used for all studies (Hammer *et al*., 2001).

Table (1): The studied taxa of Bignoniaceae with related tribe senso Schumann (1895).

No.	Taxa	Voucher numbers	Tribe senso Schumann (1895)
1	*Handroanthus impetiginosus* (Mart. e DC.) Mattos = (*Tabebuia palmeri* Rose.)	000933TC	Tecomeae
2	*Jacaranda acutifolia* Humb. & Bonpl. = (*J. ovalifolia* R. Br., *J. mimosifolia* D. Don)	000372JC	Tecomeae
3	*Kigelia africana* (Lam.) Benth. = (*K. tristis* A.Chev. , *Sotor aethiopiumm* Fenzl. , *K.pinnata* (Jacq.) DC., =*Tecoma Africana*(Lam) G. Don	000501KC	Crescentieae
4	*Markhamia lutea* (Benth.) K.Schum. =(*M. hildebrandtii* (Baker) Sprague, *Dolichandrone hildebrandtii* Baker)	000572MC	Tecomeae
5	*Markhamia zanzibarica (*Bojer ex DC.) K.Schum.= (*M. stenocarpa* (Baker) K.Schum.)	000580MC	Tecomeae

6	*Parmentiera aculeata* (Kunth) Seem.= (*Crescentia edulis* Desy., *Parmentiera edulis* DC.)	000630PC	Crescentieae
7	*Spathodea campanulata* (P. Beauv). =(*S. tulipifera* Schum., *S. danckelmaniana* Buttner, *Bignonia tulipifera* Schum.)	000873SC	Tecomeae
8	*Tabebuia aurea* (Benth. &Hook.)= (*Tabebuia argentea* Bureau &K.Schum.)	000923TC	Tecomeae
9	*Tabebuia rosea* (Bertol.) DC. =(*T. pentaphylla var. normalis* Kuntze, *T. punctatissima* Kraenzl.)	000938TC	Tecomeae
10	*Tecomaria capensis* (Thunb.) *Spach.*= (*T.krebsii* Klotzsch , *T. petersii* Klotzsch, , *Ducoudraea capensis* Bureau)	000933TC	Tecomeae
11	*Tecoma stans* (L.) Juss. ex Kunth= (*Bignonia stans* L., *Bignonia tecomoides* DC	000942TC	Tecomeae
12	*Tecoma stans var. angustata* (Rehder)	EGY-MAZHAR02040123	Tecomeae

RESULTS AND DISCUSSION

The micromorphological traits have been instrumental in the present classification of angiosperms and have provided valuable insights into the evolution and taxonomy of seed plants. The epidermal surface acts as a functional border layer between the living material and its environment, and interactions with the environment must pass through it. Many authors emphasized the value of petals, which had never been done previously, of leaf, fruit, seed, epidermis, and its ornamentation or surface sculpturing in identifying taxa and determining their relationships (Webb *et al*., 1990; Rejdali, 1991; Stace, 1984; Manning *et al*., 1991; Husain *et al*., 1990; Eldemerdash *et al*., 2021). The significance of the micro-sculpture in the petals of flowers in the family Orobanchaceae as well as the family Rosaceae was reported by Piwowarczyk and Kasińska (2017) and Song *et al.* (2020). Additionally, research has demonstrated that the infraspecific taxa can be separated using the micromorphology of the petals (Piwowarczyk and Kasińska, 2017). The use of SEM in stuyding petal micromorphology has viewed new finer details on their surface which, helped in taxa delimitation and identification in many taxonomic treatments as well as in solving many taxonomic and evolutionary problems (Metcalfe and Chalk, 1979; Ozcan, 2009). The examined species displayed a diversity of morphological traits, including trichomes (both glandular and non-glandular), trichome ornamentation (striate, verucate, and smooth), different types of epidermal cells, and stomata. It has been noted in angiosperm taxa that different types of epidermal sculpture can occasionally coexist within a single petal (Ojeda *et al*., 2009). All species in our study had areolate epidermal types on the abaxial surface, which is different from the adaxial side's areolate, papillose conical, and mixture of these types. The characteristics of trichomes on epidermal surfaces have been demonstrated in numerous studies to be significant criteria for classification (Adedeji *et al*., 2007; Hassan and Hamdy, 2023), and have long been used in delimiting species, genera, or families (Adedeji, 2007;

Hayat *et al*., 2009; Shaheen *et al*., 2009; Saheed and Illoh, 2010; Ajmal and Al Hemaid, 2011; Kemka and Nwachukwu, 2011; Al Sheef *et al*., 2013; Khosroshahi and Salmaki, 2019).

Table (2): Micro-morphological characters of the studied taxa.

No.	1	2	3	4.	5.	6.	7.
Taxa Characters	*Handroanthus impetiginosus*	*Jacaranda acutifolia*	*Kigelia africana*	*Markhamia lutea*	*Markhamia zanzibarica*	*Parmentiera edulis*	*Spathodea campanulata*
Abaxial							
Trichomes: Non-glandular	bicellular and multicellular (stiff-bristly)	Unicellular, bicellular and multicellular (Stiff-bristly) and funnel-shape	Unicellular and bicellular (stiff-bristly)	Absent	Absent	Absent	Absent
Trichomes: Glandular	Capitate	Absent	Peltate Capitate	Peltate	Peltate	Large sunken	Peltate Capitate
Trichome ornamentation	Verucate	Verucate	Striate	Verucate	Verucate	Verucate	Verucate
Epidermal type	Areolate	Areolate	Areolate	Areolate	Areolate	Areolate	Areolate
Adaxial							
Trichomes: Non-glandular	Unicellular and bicellular (flexible)	Unicellular, bicellular and multicellular (Stiff-bristly) and funnel-shape	Unicellular (flexible)	Bicellular and multicellular flexible	Absent	Unicellular (flexible	Absent
Trichomes: Glandular	Peltate Capitate	Capitate	Peltate Stipitate Patelli-form	Capitate	Peltate	Peltate	Peltate Capitate
Trichome ornamentation	striate	verucate	smooth	verucate	verucate	verucate	verucate
Epidermal type	Areolate	Areolate	Areolate mixed with papillose conical	Areolate mixed with papillose conical	papillose conical	Areolate	Areolate mixed with papillose conical

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8.	*Tabebuia argentea*	Absent	Peltate	Verucate	Areolate	Unicellu-lar (flexible	Absent	striate	Areolate
9.	*Tabebuia rosea*	Absent	Peltate	Verucate	Areolate	Unicellul ar (flexible	Absent	striate	Areolate mixed with papillose conical
10.	*Tecomaria capensis*	Unicellular (flexible)	Peltate Capitate Cupular	Smooth	Areolate	multicellula r (flexible)	Peltate Capitate	striate	papillose conical
11.	*Tecoma stans*	Multicellular (stiff-bristly)	Absent	Verucate	Areolate	Multicellular (stiff-bristly)	Capitate	striate	Areolate mixed with papillose conical
12.	*Tecoma - Stans var. angustata*	Multicellular (stiff-bristly)	Absent	Verucate	Areolate	Multicellula r (stiff-bristly)	Capitate	striate	Areolate

The different types of trichomes previously described by Luckwill (1943), and reported by Channarayappa *et al*. (1992) aimed specifically to limit the diversity of trichomes to glandular and non-glandular types. Although, this fundamental classification is unable to account for the vast differences between types of glandular and non-glandular trichomes (Watts and Kariyat, 2021). Trichomes, which serve various purposes and are found on the surface of petals belonging to the Bignoniaceae family, exhibit variability in their abundance within plants. Their structure and morphology can serve as taxonomic significance for intrageneric classification (Muravnik *et al*., 2021; Hassan and Hamdy, 2023). As a result, an attempt has been made in the current work to recognize the diversity and distribution pattern of different types of floral trichomes observed on petal surfaces within the species examined, principally to assess their importance and taxonomic value. The systematic importance of glandular trichomes on the floral sections of the Bignoniaceae family has been widely recognized (Schumann, 1895; Sandwith, 1938; Seibert, 1940). Members of the Bignoniaceae family often have peltate trichomes (Seibert, 1948). Tables (2-5) provide a summary of the micro-morphological traits of all analyzed taxa as well as their state and taxa versus character data matrix. At the abaxial surface, trichomes were non-glandular and glandular. Non-glandular; funnel-shape, unicellular, bicellular, and multicellular stiff-bristly in *Jacaranda acutifolia* (Pl. 1A)**,** unicellular and bicellular stiff-bristly in *Kigelia africana* (Pl. 1D)**,** bicellular and multicellular stiff (*Handroanthus impetiginosus*, Pl. 2B), multicellular stiff-bristly in *Tecoma stans* (Pl. 2K) and *Tecoma stans var. angustata*(Pl. 2L), unicellular flexible *Tecomaria capensis*(Pl. 2G) and absent in the other species. Glandular trichomes were cupular in *Tecomaria capensis* (Pl. 2H), large sunken *Parmentiera edulis* (Pl. 1M), capitate in *Kigelia*

africana (Pl. 2I), *Spathodea campanulata* (Pl. 1N), *Handroanthus impetiginosus* Pl. 2E and *Tecomaria capensis* (Pl. 3C), peltate (*Kigelia africana* Pl. 1C, *Markhamia lutea* (Pl. 1E), *Markhamia zanzibarica* (Pl. 1F), *Spathodea campanulata* (Pl. 2A), *Tabebuia argentea*(Pl. 2D), *Tabebuia rosea* (Pl. 2E), and *Tecomaria capensis* (Pl. 2F), *and* absent in the other species. Epidermal type was areolate in all species and stomata were absent in *Jacaranda acutifolia*, and *Markhamia zanzibarica* was present in the other species. The stomata were depressed in *T. rosea*, at level (*H. impetiginosus* and *T. capensis*) and superficial at the other species. The stomatal outline was elongated in *H. impetiginosus*, *T. rosea*, *T. stans* and *T. stans var. angustata* and suborbiculate in the other species.

Table (3): Stomatal characters of studied taxa.

	Abaxial					Adaxial				
C / T	Stomatal presence	Stomatal level	Stomatal outline	Stomatal aperture		Stomatal presence	Stomatal level	Stomatal outline	Stomatal aperture	
				Shape	width				shape	Width
1	present	At a level	Elongate	Elliptic	Wide	Absent	Absent	Absent	Absent	Absent
2	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
3	Present	Superfi-cial	Suborb-iculate	Elliptic	Wide	Present	At a level	Suborbic ulate	Elliptic	Wide
4	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
5	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
6	Present	Superfi -cial	Suborb - iculate	Elliptic	Wide	Absent	Absent	Absent	Absent	Absent
7	Present	Superfi-cial	Suborb-iculate	Elliptic	Wide	present	At a level	Suborbic ulate	Elliptic	Wide

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8	Present	Superfi-cial	Suborb-iculate	Elliptic	Narrow	Absent	Absent	Absent	Absent	Absent
9	Present	Depre-ssed	Elongate	Elliptic	Wide	Absent	Absent	Absent	Absent	Absent
10	Present	At a level	Suborb-iculate	Elliptic	Narrow	present	Superfic ial	Suborbic ulate	Round	Narrow
11	Present	Superfi-cial	Elongate	Elliptic	Narrow	Absent	Absent	Absent	Absent	Absent
12	Present	Superfi-cial	Elongate	Elliptic	Narrow	Absent	Absent	Absent	Absent	Absent

Table (4): Micro-morphological characters, their state and codes of taxa under investigation.

Character		Character state and its (code)
1.Trichomes	1.1. Non-glandular	Absent (0) Unicellular flexible (1) bicellular and multicellular flexible (2) bicellular and Multicellular stiff (3) Multicellular stiff (4) Unicellular and bicellular flexible (5) Unicellular and bicellular stiff (6) Unicellular, bicellular and multicellular stiff and Funnel shape (7)
	1.2. glandular	Absent (0) Peltate (1) Capitate (2) Peltate and Capitate (3) Peltate, Capitate and Cupular (4) Peltate, stipitate and Patelli- form (5) large sunken (6)
2.Trichome ornamentation		Smooth (0) Verucate (1) striate (2)
3.epidermal type		Areolate (0) Papillose conical (1) Areolate mixed with papillose (2)
4.Stomatal presence		Absent (0) Present (1)
5. Stomatal level		Absent (0) Superficial (1) Depressed (2) At a level (3)
6. Stomatal shape		Absent (0) Elongate (1) Suborbiculate (2)
7. Stomatal aperture shape		Absent (0) Elliptic (1) Round (2)
8. Stomatal aperture width		Absent (0) Wide (1) Narrow (2)

Table (5): Data matrix of 3 micro-morphological characters of all studied taxa.

C / T	Abaxial									Adaxial							
	1		2	3	4	5	6	7	8	1		2	3	4	5	6	7	8
	1.1	1.2								1.1	1.2							
1	3	2	1	0	1	3	1	1	1	5	3	2	0	0	0	0	0	0
2	7	0	1	0	0	0	0	0	0	7	2	1	0	0	0	0	0	0
3	6	3	2	0	1	1	2	1	1	1	5	0	2	1	3	2	1	1
4	0	1	1	0	0	0	0	0	0	2	1	1	2	0	0	0	0	0
5	0	1	1	0	0	0	0	0	0	0	1	1	2	0	0	0	0	0
6	0	6	1	0	1	1	2	1	1	1	1	1	0	0	0	0	0	0
7	0	3	1	0	1	1	2	1	1	0	3	1	2	1	3	2	1	1
8	0	1	1	0	1	1	2	1	2	1	0	2	0	0	0	0	0	0
9	0	1	1	0	1	2	1	1	1	1	0	2	2	0	0	0	0	0
10	1	4	0	0	1	3	2	1	2	4	3	2	1	1	1	2	2	2
11	4	0	1	0	1	1	1	1	2	4	3	2	2	0	0	0	0	0
12	4	0	1	0	1	1	1	1	2	4	3	2	2	0	0	0	0	0

At the adaxial surface, trichomes were Non-glandular and glandular. non-glandular trichomes were funnel-shape, unicellular, bicellular, and multicellular stiff-bristly in *Jacaranda acutifolia* (Pl. 1A)**,** multicellular stiff-bristly *Tecoma stans* Pl. 2K and *Tecoma stans var. angustata* (Pl. 2L)**,** unicellular flexible *Kigelia africana* (Pl. 1F), *Parmentiera edulis* (Pl. 1K), *Tabebuia argentea* (Pl. 2A) and *Tabebuia rosea* (Pl. 2E)**,** bicellular and multicellular flexible *Markhamia lutea* (Pl. 1H), multicellular flexible *Tecomaria capensis* (Pl. 2J), and unicellular and bicellular flexible *Handroanthus impetiginosus* (Pl. 2D) and absent in the other species. Glandular trichomes were absent in *Tabebuia argentea* and *Tabebuia rosea*, stipitate ,patelliform in *Kigelia Africana* (Pl. 1G, E, and F), peltate trichomes found in *Kigelia Africana* (Pl. 1F), *Markhamia lutea* Pl. 1H, *Markhamia zanzibarica* Pl. 1J, *Parmentiera edulis* Pl. 1L, *Spathodea campanulata* Pl. 1N, *Handroanthus impetiginosus* Pl. 2C, and *Tecomaria capensis* Pl. 2F) and capitate trichomes found in (*Jacaranda acutifolia* Pl. 1B, *Markhamia lutea* Pl. 1I, *Spathodea campanulata* Pl. 1N, *Handroanthus impetiginosus* Pl. 2D, *Tecomaria capensis* Pl. 2I, *Tecoma stans* Pl. 2K, *Tecoma stans var. angustata* Pl .2L). It has also been noted in angiosperm taxa that different types of epidermal sculpture can occasionally coexist within a single petal (Ojeda *et al*., 2009). Epidermal type was papillose conical in *Markhamia zanzibarica* and *Tecomaria capensis*, areolate (*Jacaranda acutifolia*, *Parmentiera edulis*, *Tabebuia argentea* and *Handroanthus impetiginosus* Pl. 2B), and areolate mixed with papillose conical in the other species. Stomata were present *in Kigelia africana*, *Spathodea campanulata*, and *Tecomaria capensis* while absent in the other species and superficial in *T. capensis* and at level at the rest. Stomata were suborbiculata in the four species.

From the obtained dendrogram (Diag. 1), the species under study were separated into two series; series I and II. Series I comprises nine of the studied species at a taxonomic distance of 0.53 and series II contains the remaining three species at a taxonomic distance of 0.51. Series

I includes two clusters; C1 and C2. C1 contains six species: *P. edulis*, *H. impetiginosus*, *T. rosea*, *T. aurea*, *T. stans*, and *T. stans var. angustata* due to sharing characters as the presence of stomata and areolate epidermal type at the abaxial surface. *Parmentiera* belongs to the tribe crescentieae, while in our study it is closer to Tecomeae tribe. *Handroanthus impetiginosus* was recently segregated into a separate genus, a treatment that matches the phylogenetic reclassification of many *Tabebuia* plants reported in our study as *T. aurea, T. rosea and T. palmeri.* C2 contains *K. africana, T. capensis*, and *S. campanulata*. Fischer *et al*. (2004), Goldblatt and Gentry (1979), and Gentry (1980) recommended that *Tecomaria capensis* should be included with *Tecoma*; however, our results showed that it is closer to *Kigelia* which belongs to tribe crescentieae according to Schumann (1895) and tribe coleeae according to Fischer (2004) but in our study it is closer to Tecomeae tribe. Series II comprise one cluster; C3 which contains 3 species belonging to tribe Tecomeae; *M. lutea*, *M. zanzibarica*, and *J. acutifolia* due to sharing characters viz. having areolate epidermal type and absence of stomata at the abaxial side.

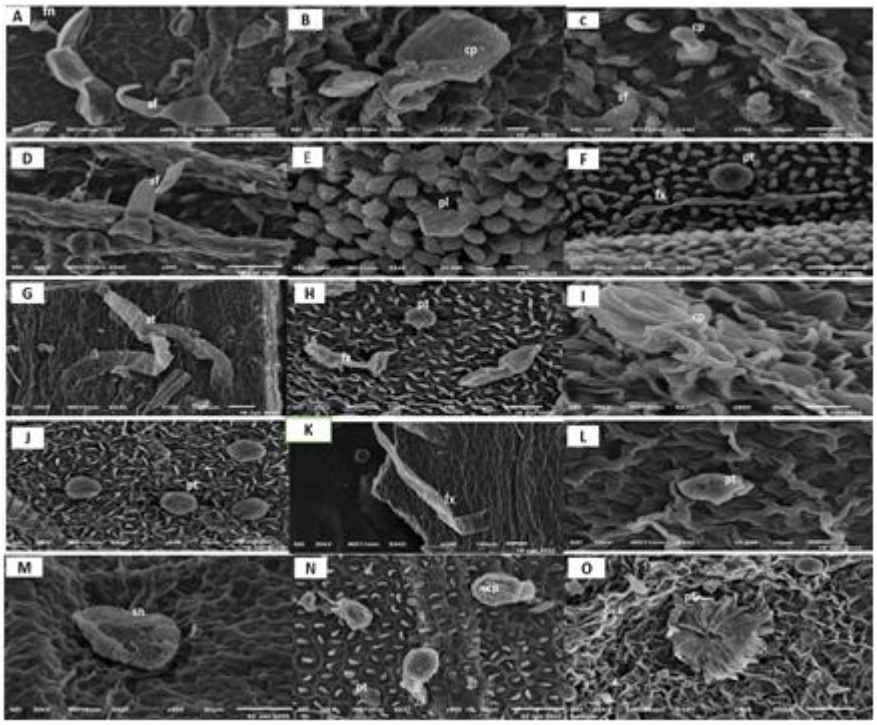

Plate (1): SEM showing morphological diversity of trichomes on abaxial and adaxial surfaces of petals in *Jacaranda acutifolia* (A, B), *Kigelia africana* (C-G), *Markhamia lutea* (H,I), *Markhamia zanzibarica* (J), *Parmentiera edulis* (K-M), *Spathodea campanulata* (N) and *Tabebuia aurea* (O). (fn=funnel shape, sf=stiff, cp=capitate, pt=peltate, pl=patelliform, fx=flexible trichome, sn=sunken and st=stipitate).

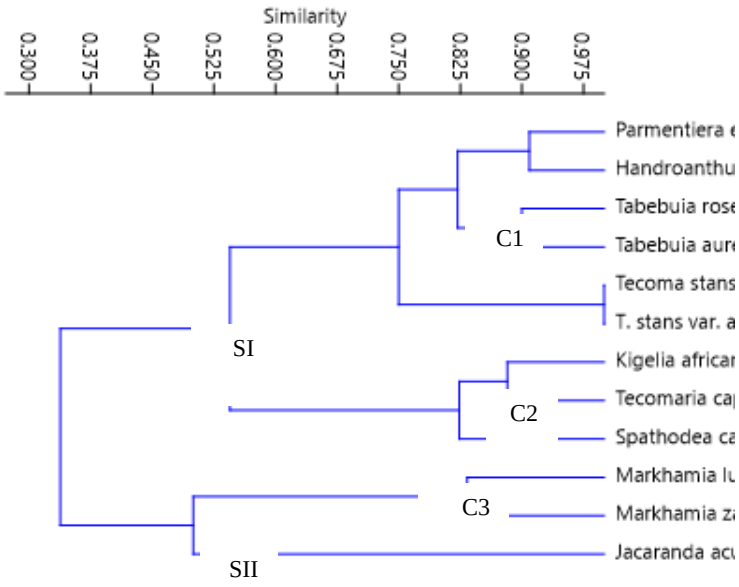

Diagram (1): UPGMA dendrogram illustrating the hierarchical phenetic relationships between 12 taxa of Bignoniaceae based on numerical analysis of petal micromorphological characters.

CONCLUSIONS

In this study, Petal micromorphological characters address the identification, classification and elucidation of species affinity and relationship between studied taxa. The SEM results revealed the presence of considerable taxonomic variations among the various species. The Petal surface micromorphology provided effective data on their characters as epidermal cell, Trichomes type, trichome ornamentation, stomatal presence, stomatal level, stomatal outline and stomatal aperture shape and width which provided useful character to distinguish Bignoniaceae members at tribe level. These results showed that the abaxial and adaxial surface of the petal ornamentation, could divide the species into two series, three clusters according to micromorphological character. The results suggested taxonomic significance of petal structure among species of Bignoniaceae family.

CONFLICT OF INTEREST STATEMENT

"The authors have no conflict of interest to declare".

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الصفات المورفولوجية الدقيقة لبشرة البتلة وعلاقتها التصنيفية في بعض انواع الفصيلة البنيونية في مصر

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الخلاصة

يتناول البحث دراسة الخصائص الميكروموفولوجية للبتلات. جُمعَت ثمان أجناس تمثل ثانية عشرنوع من نباتات الفصيلة البجنونية من مصر من حديقة الاورمان النباتية باستخدام الميكروسكوب الاكتروني الماسح. كان الهدف من الدراسة فحص سطح أنواع البتلات تحت الدراسة و تقييم أهميتها في ايضاح العلاقات التصنيفية قد شملت الدراسة ما يلي: انواع خلايا البشرة (الهالية، الحليمية المخروطية و الهالية المختلطة مع الحليمية المخروطية) ، أنواع الشعيرات (غير الغدية: قمعية الشكل، المرنة، المتيبسة والغدية :النخامية، الراسية،اكأسية الشكل، الرقطية وشكل الرضفة) ، زخرفة الشعيرات (مخططة، متعرجة وناعمة) وثغور علي كل من السطح العلوي والسفلي للبتلة و قد ظهرت الثغور في جميع الانواع ما عدا *Jacaranda acutifolia* Humb. & Bonpl.,1806 و *Markhamia zanzibarica* (Bojer ex DC.) K. Schum., 1895.

استخدم برنامج past لاجراء تحليل احصائي علي البيانات باستخدام طريقة UPGMA وتم انتاج مخطط لتوضيح العلاقة بين العينات. اوضحت النتائج ان النوعين محل الدراسة *Markhamia* Seem. ex Baill.,1888 و *Tabebuia* Gomes ex DC., 1838أحاديا العرق بينما *Tecoma* (Juss., 1789 ليست احادية العرق.