Morphological and anatomical studies on some taxa of family Apocynaceae

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ABSTRACT

Apocynaceae is one of the important families that is present all over the world. The aim of this study is to provide some anatomical features of 7 species that represent 7 genera belonging to 4 subfamilies (Apocynoideae, Asclepiadoideae, Periplocoideae and Rauvolfioideae) related to Apocynaceae. The species samples were collected from different areas in Egypt. The study was focus on the morphological and anatomical characters of stems and leaves. The results were recorded in the form of comparison between the examined plants. Most of these plants are perennial herbs as in *Cynanchum acutum* L. but some are shrubs as in *Carissa spinarum* L. and trees as in *Alstoniascholar is* R.Br. The stem is woody in some of the investigated plants as in *Alstoniascholaris* R.Br. and succulent in some plants as in *Pachypodium lamerei.* The leaves are simple, spirally, opposite and opposite decussate. Leaves shape are ovate, elliptic, oblong-lanceolate or cordate with entire margin. The vascular bundles in all of the examined plants are bicollateral. From the analysis of all the available data by using the Multi Variate Statistical Package (MVSP) Program it could be stated that Apocynaceaeand Asclepiadaceae are very similar to each other which could be ranked in one large family Apocynaceae. In conclusion, we emphasize the previous recommendations to merge both Apocynaceae and Asclepiadaceae families in one large family, that is Apocynaceae.

Keywords: Morphology; Anatomy; Asclepiadoideae; Periplocoideae; Rauvolfioideae; Apocynaceae.

INTRODUCTION

Apocynaceae is one of the important families that is present all over the world. It includes five important sub families; Apocynoideae, Asclepiadoideae, Periplocoideae, Rauvolfioideae and Secamonoideae (Endress and Bruyns 2000). It is considered one of the medium sized families of the flowering plants as it includes 215 genera including 1900 species that spread all over the world. Also, Asclepiadaceae is an important family. It includes 315 genera including 2900 species that spread all over the world (Boulos, 2000). Some authors consider them as two distinct families: Apocynaceae and Asclepiadaceae (Dahlgren, 1980; Cronquist, 1981; Takhtajan, 1987; Rosatti, 1989). Others still consider them as one large family Apocynaceae (Judd *et al.,* 1994; Struwe *et al.,* 1994; Sennblad and Bremer, 1996; Endress and Bruyns 2000). Apocynaceous plants are herbs, shrubs or trees and perennial or very rarely annual (Muschler, 1912; Bailey, 1949; Boulos, 2000; Koyuncu, 2012; Venkateshwar *et al.,* 2013). The stem was erect, climbing or twining and trete or 4 angled (Bolos, 2000; Rodda and Simonsson, 2011; Sidney, 2012). The leaves are simple, alternate, opposite or whorled. Leaves shapes are ovate, obovate, oblong, linear, lanceolate or elliptic and their margin are entire or undulate with acute apex. The leaf is petiolate or sessile (Hutchinson 1973; Jafri 1966; Migahid and Hammouda 1974; El-Gazzar and Hamza 1980; Boulos, 2000; Kidyoo, 2014; Bibi *et al.*, 2015). The cortex is consisting of hypodermal collenchyma of thick-walled followed by slightly thick-walled parenchyma (8-16 rows) containing cluster crystals of calcium oxalate. (Al-Massarani, 2011). The palisade parenchyma is 3-layered at the adaxial side and 1-layered at the abaxial side of the lamina. The spongy parenchyma is 10-13 layered, with long armed cells. The vascular system is bicollateral. (Formiga *et al.*, 2011).

The aim of this study is to provide some anatomical features of some species of family Apocynaceae.

MATERIALS AND METHODS

Morphological studies

Sample of plants

This work was carried out in the Department of Agricultural Botany, Faculty of Agriculture, Al-Azhar University, Nasr city, Cairo, Egypt. Seven species belonging to 7 genera of Apocynaceae were collected from three different places: Al–Azhar University (Az), El- Orman Garden (Or) and flower exhibition (Fl).

Identification

Identification of the collected plants was achieved by comparing their morphological characters with the characters of the previously identificated plants as published by (Tächolm, 1974; Migahid and Hammouda, 1974; Boulos, 2005).

Anatomical studies

In laboratory, from young parts of the plant, samples of 1 cm long from the middle part of the technical length of the stem and 1 cm^2 from leaf was taken. Samples were dehydrated in a series of solutions of ascending concentrations of ethyl alcohol varying from 50% to 100% ethyl alcohol. The samples then embedded in paraffin wax [m.p. 58–61 °C] using xylol as a solvent. By using rotary microtome, sections were cut at the thickness of 15 µm and then mounted on slides with the aid of egg albumin as an adhesive. Wax dissolved in xylol and the slides were passed through descending series of ethyl alcohol solutions varying from 100% to 50% ethyl alcohol concentrations in descending order. The sections were stained with safranin and light green, and then the colored sections were kept as permanent preparations on the slides with Canada balsam as mounting medium (Nassar and Sahhar, 1998). All photographs were prepared by Nikon Camera on a Carl Zeiss Jena microscope photographs.

Multi Variate Statistical Package Programme (MVSP) was used to analyse the morphological and anatomical data (Sneath and Sokal 1973).

RESULTS AND DISCUSSION

Morphological observation habit

All the investigated plants of family Apocynaceae are perennial and evergreen except the plants of *Pachypodium lamerei* Drake. Which are deciduous. Some of the examined plants are herbs as in *Cynanchum acutum* L. (Fig. 1A), few plants are trees as in *Alstonia scholaris* R.Br. and shrubs in *Carissa spinarum* L. only. These results are in agreement with those obtained by (El-Gazzar and Hammouda, 2006; Bibi *et al.,* 2015) who recorded that Apocynaceae plants were herbs, shrubs or trees and perennial.

Stem

The stem is aerial and long in all the examined plants. It is woody in some of the investigated plants as in *Carissa spinarum* L., herbaceous in some of the plants as in *Cynanchum acutum* L. and succulent in *Pachypodium lamerei* Drake. only (Fig. 1C). It is erect in most of the examined plants as in *Alstonia scholaris* R.Br. and weak in some plants as in *Cynanchum acutum* L. (Fig. 1B) The texture of stem is smooth in all the plants, except *Pachypodium lamerei* Drake. are spiny (Fig. 1C). All the plants are monopodial branching, except *Pachypodium lamerei* Drake. which isapicale. The monopodial branching is uni-lateral in some plants as in *Alstonia scholaris* R.Br. and bi-lateral in some plants as in *Beaumontia grandiflora* wall. The stem is solid in most of the plants as in *Beaumontia grandiflora* Wall. And hollow in some plants as in *Stephanotis floribunda* Brongn. Similar results are reported by (Hutchinson, 1973; Boulos, 2000; Sidney, 2012; El-Kashef *et al*., 2015) who observed that the stem of Apoynaceae was erect or twining, trete or 4 angled and glabrous or hairy.

Leaves

The leaves are present in all the examined plants. Leaves are simple and cauline in all the plants (Fig. 1H). All the investigated plants are exstipulate except *Carissa spinarum* L. which is stipulate (Fig.1 D). Leaves are petiolate in all the plants (Fig. 1E). The leaf base is epulvinate in all the plants except in *Cryptostegia grandiflora* R Br. they are pulvinate. The leaves arrangement is spirally in some plants as in *Pachypodium lamerei* Drake. (Fig. 1C), opposite in some plants as in *C. spinarum* L. (Fig. 1I) and opposite decussate in some plants as in *Beaumontia grandiflora* Wall. (Fig. 1J). The leaf shape is cordate in *Cynanchum acutum* L. only (Fig. 1E), elliptic in *Alstonia scholaris* R.Br. only (Fig. 1G), oblong lanceolate in *Pachypodium lamerei* Drake. only (Fig. 1F) and ovate in some plants as in *Carissa spinarum* L. (Fig. 1D). The shape of leaf apex is acuminate in some of the plants as in *Beaumontia grandiflora* Wall. (Fig.1 H), obtuse in *Stephanotis floribunda* Brongn only, caudate in *Pachypodium lamerei* Drake. (Fig. 1F) only and mucoronta in *Cynanchum acutum* L. only (Fig. 1E). The shape of leaf base is acute in some of the plants as in *Pachypodium lamerei* Drake. (Fig. 1F), rounded in some of the plants as in *Carissa spinarum* L. (Fig. 1D) and cordate in *C. acutum* L. only (Fig. 1E). The venation of the leaf is pinnate reticulate in all the plants (Fig. 1G) except in *C. acutum* L., it is palmate reticulate (Fig. 1E). The color of leaf midrip is white in some of the plants as in *Alstonia scholaris* R.Br. (Fig. 1G) and green in some of the plants as in *Beaumontia grandiflora* Wall. (Fig. 1H). The lateral venation of the leaf is distinict in some of the studied plants as in *Beaumontia grandiflora* Wall. (Fig. 1J) and indistinict in some of the plants as in *Carissa spinarum* L. (Fig. 1I). The margin of the leaves is entire in all the examined plants. These results are in harmony with the findings of (Hutchinson, 1973; Migahid and Hammouda, 1974; El-Gazzar and Hamza, 1980; Gabr *et al.,* 2015) who mentioned that the leaves of Apocynaceaeas were opposite, alternate, opposite decussate or whorled. The leaf was sub sessile or petiolate. The leaf shapes were elliptic, ovate, linear or cordate. The blade apex was acute, apiculate, obtuse or acuminate. The blade texture was glabrous or tomentose.

Anatomical observation

Stem anatomy

The stem varies in the external shape. It is rounded in some of the examined plants as in *Stephanotis floribunda* Brongn. (Fig. 2A) and ovate in some of the plants as in *Cryptostegia grandiflora* R.Br. (Fig. 2B).

Epidermis

The epidermal cells are covered by cuticle layer. The cuticle layer is thin in some of the examined plants as in *Cynanchum acutum* L. (Fig. 2D) and thick in most of the plants as in *Carissa spinarum* L. (Fig. 2C). The multiepidermis is present in few plants as in *Cynanchum acutum* L. (Fig.2 D) but it is simple in most of the plants as in *Carissa spinarum* L. (Fig. 2C). The cork and lenticels are observed in most of the plants as in *Pachypodium lamerei* Drake. (Fig.2F) and *Alstonia scholaris* R.Br. (Fig. 2G) respectively. Similar results were reported by (Akyalcin *et al.*,2006; Poornima *et al.,* 2009; Al-Massarani, 2011; El-Kashef *et al.,* 2015) who found that the epidermis of Apocynaceae was semi-circular in cross section with one or two epidermal layers. The cork was formed of 2-3 layers of thin walled cells.

Cortex

The cortex consists of aerenchymatous tissuein some of the examined plants as in *Alstonia scholaris* R.Br. also storage parenchymatous tissue is observed in most of the plants as in *Pachypodium lamerei* Drake. (Fig. 2E). Collenchymatous cells are shown in most of the plants as in *Beaumontia grandiflora* Wall. (Fig. 2H), sclerenchymatous cells are observed in *Alstonia scholaris* R.Br. only and the water storage cells are noticed in *Pachypodium lamerei* Drake. only (Fig. 2I). Cortical vascular bundles are present in *Alstonia scholaris* R.Br. only (Fig. 3J). Rosette crystals are noticed in most of the studied plants as in *Beaumontia grandiflora* Wall. (Fig. 3K), prismatic crystals are shown in most of the plants as in *Carissa spinarum* L.; sandy crystals are also noticed in few of the plants as in *Alstonia scholaris* R.Br. Resin canals are observed in most of the plants as in *Cynanchum acutum* L. (Fig. 3L). Laticifers canals are shown in few of the plants as in *Pachypodium lamerei* Drake. (Fig. 3M). Secretory cells and canals are noticed in some of the plants as in *Carissa spinarum* L. (Fig. 2C) and secretory cavities are observed in few plants as in *Pachypodium lamerei* Drake. (Fig. 3N). These results are in harmony with the findings of (Akyalcin *et al.,* 2006; Poornima *et al.,* 2009; Al-Massarani, 2011; Duarte and Larrosa, 2011; Bibi *et al.,* 2015; El-Kashef *et al.,* 2015) who stated that the cortex of the stem of Apocynaceae plants was consisted of collenchyma of thick walled polyhedral elongated cells followed by slightly thick walled parenchyma (8-16 rows) and containing cluster crystals of calcium oxalate. The endodermis was formed of elongated cells. Latex tubes were present in the cortex region.

Pericycle

Parenchymatous and collenchymatous cells are noticed in most of the plants as in *Beaumontia grandiflora* Wall. (Fig. 2H). Rosette are crystals observed in some of the taxa as in *Beaumontia grandiflora* Wall. Similar results were reported by (Al-Massarani, 2011; Duarte and Larrosa, 2011; El-Kashef *et al.,* 2015) who reported that the pericycle of Apocynaceae plants was formed of Parenchymatous cells.

Vascular bundles

Vascular bundles of all the examined plants are bicollateral and present in complete ring in most of the plants as in *Cryptoste giagrandiflora* R.Br. or in group in *Pachypodium lamerei* Drake. only. The vessels are shown in chains in all of the plants (Fig. 3O) except *Pachypodium lamerei* Drake. which isclusters (Fig.3 P). Tyloses are observed in some plants as in *Cynanchum acutum* L. (Fig. 3Q). These results are in agreement with those obtained by (Akyalcin *et al.,* 2006; Al-Massarani, 2011; Duarte and Larrosa, 2011; El-Kashef *et al.,* 2015) who recorded that the vascular bundles of Apocynaceae plants were bicollateral bundles.

Xylem

Rosette crystals are noticed in some plants as in *Cynanchum acutum* L. Resin canals are present in few of the plants as in *Alstonia scholaris* R.Br. (Table 3). Anatomical observation of medulary rays revealed the presence of sclerenchyma tissues in most of the plants as in *Alstonia scholaris* R.Br. and collenchyma tissues in few of the plants as in *Beaumontia grandiflora* Wall. (Table3). Rosette crystals are recorded in *Cynanchum acutum* L. and *Stephanotis floribunda* Brongn. only (Table 3). Resin canals and secretory cells present in some plants as in *Alstonia scholaris* R.Br. Similar results were reported by (Poornima *et al.,* 2009; Al-Massarani, 2011; El-Kashef *et al.,* 2015) who found that the xylem of Apocynaceae plants was formed of thick walled elements consisting of vessels, fibres, tracheids and xylem parenchyma and separated by 2-9 rows of medullary rays. The medullary rays were uni or multi-seriate and formed of polygonal, thick walled cells

Phloem

Rosette crystals are observed in some of the examined plants as in *Cynanchum acutum* L. and sandy crystals are noticed in *Alstonia scholaris* R.Br. only (Table3). Resin canals are present in

most of the plants as in *Cynanchum acutum* L. Secretory cells are noticed in few plants as in *Alstonia scholaris* R.Br. These results were in agreement with (Al-Massarani, 2011; El-Kashef *et al.,* 2015) who recorded that the phloem of Apocynaceae plants was narrow and composed of sieve tubes, companion cells and phloem parenchyma. The phloem parenchyma cells were polygonal in shape. The medullary rays were uniseriate or biseriate and consisting of elongated parenchyma.

Pith

Pith is solid in most of the studied plants as in *Cryptostegia grandiflora* R.Br. and hollow in few plants as in *Stephanotis floribunda* Brongn. Aerenchymais observed in most of the plants as in *Cryptostegia grandiflora* R.Br. Also, storage parenchyma noticed in *Pachypodium lamerei* Drake. only (Table3). Sclerenchymatous cells are recorded in *Alstonia scholaris* R.Br. only (Table 3). Rosette crystals are noticed in some of the plants as in *Stephanotis floribunda* Brongn. (Table 3), prismatic crystals are shown in some plants as in *A. scholaris* R.Br. (Table 3). Secretory cells and canals are noticed in few plants as in *Alstonia scholaris* R.Br. and secretory cavities are present in *P. lamerei* Drake. only (Table 3). These results were in harmony with the findings of (Poornima *et al.,* 2009; Al-Massarani, 2011; Duarte and Larrosa 2011) who mentioned that the pith of stem of Apocynaceae was formed of large rounded, water storing cells, thin walled parenchymal cells containing numerous starch granules and prisms of calcium oxalate.

Leaf anatomy

Epidermis

The upper epidermal cells are covered by cuticle layer. The cuticle layer is thin in most of the examined plants as in *Cryptostegia grandiflora* R.Br. (Fig. 4S), and thick in some plants as in *Alstonia scholaris* R.Br. (Fig. 4R). Resin canals are observed in few plants as in *Alstonia scholaris* R.Br. The lower epidermal cells are covered by cuticle layer. The cuticle layer is thin and smooth in all of the examined plants. Similar results were reported by (Poornima *et al.,* 2009; Albert *et al.,* 2011; Duarte and Larrosa, 2011) who cited that the epidermis was single layered in Apocynaceae plants.

Mesophyllic tissue

The mesophylic tissue consists of spongy and palisade in all the examined plants. The palisade tissue is one row in most of the studied plants as in *Cryptostegia grandiflora* R.Br. and more than one row in some of the plants as in *Carissa spinarum* L. The palisade tissue is continuous in most of the plants as in *Carissa spinarum* L. but it is separated in some of the plants as in *Cryptostegia grandiflora* R.Br. The palisade tissue is monolateral in all plants. Mucilage cells are noticed in few plants as in *Carissa spinarum* L. (Fig. 4T). Rosette crystals are observed in most taxa as in *Carissa spinarum* L. Resin canals are present in *Alstonia scholaris* R.Br. only. Laticifers and secretory cells are present in some of the plants as in *Carissa spinarum* L. (Fig. 4T), secretory canals are noticed in *Stephanotis floribunda* Brongn. only.

Spongy tissue is noticed in all the examined plants. Aerenchymatous cells and armed parenchymatous cells are noticed in most of the plants as in *Carissa spinarum* L. (Fig. 4T and 4U). Rosette crystals and resin canals are recorded in some of the plants as in *Beaumontia grandiflora* Wall. (Fig. 4V). Secretory cells are showed in few of the plants as in *Carissa spinarum* L. These results were in harmony with the findings of (Poornima *et al*., 2009; Duarte and Larrosa, 2011; Formiga *et al*., 2011; Bibi *et al*., 2015) who observed that the mesophyllic tissue was consisted of palisade and spongyin Apocynaceae plants.

Midrib region

Midrib regionis convex in the lower surface of the leaf in most of the studied plants as in *Beaumontia grandiflora* Wall. (Fig. 4W) but straight in *Cryptostegia grandiflora* R.Br. only (Fig. 4X). Midrib regionis convex in the upper surface of the leaf in *Cynanchum acutum* L. (Fig. 4Y), straight in few of the examined plants as in *Cryptostegia grandiflora* R.Br. (Fig. 4X) and concave in *Carissa spinarum* L. only (Fig. 4Z). Aerenchymatous cells are noticed in some plants as in *Carissa spinarum* L., palisade is present in some of the plants as in *C. spinarum* L. and collenchymatous cells are observed in most of the plants as in *Cynanchum acutum* L. (Table 3). Rosette crystals are noticed in most of the taxa as in *Beaumontia grandiflora* Wall. Resin canals are present in most of the plants as in *Pachypodium lamerei* Drake. Secretory cells are noticed in some plants as in *Carissa spinarum* L.

Vascular bundles

Vascular bundles are bicollateral in all examined plants. The shape of vascular bundles is crescent in *Beaumontia grandiflora* Wall. (Fig. 4W), straight in *Cryptostegia grandiflora* R.Br. (Fig. 4X) and semi ring in *Alstonia scholaris* R.Br. only (Fig. 4a).

Phloem

Rosette crystals and resin canals are noticed in some of the examined plants as in *Cynanchum acutum* L. and *Alstonia scholaris* R.Br. respectively. Similar results were reported by (Inamdae *et al.,* 1975; Albert *et al.,* 2011; Duarte and Larrosa, 2011;

Formiga *et al.,* 2011) who cited that the vascular bundles were bicollateral in Apocynaceae plants.

It is obvious from the dendrogram that the studied species were divided in to four clusters based on the similarity between them. The first cluster contains two species *Beaumontia grandiflora* Wall. and *Pachypodium lamerei* Drake. at similarity (23.062). The second cluster included two species *Cynanchum acutum* L. and *Stephanotis floribunda Brongn*. at similarity (26.425). Both clusters were united together at similarity (36.995) the third cluster included two species *Alstonia scholaris* R.Br. and *Carissa spinarum* L. at similarity (36.995). The last cluster included one species *Cryptostegia grandiflora* R.Br. This cluster is similar to the previous three clusters at similarity (42.280). All clusters are similar to each other at similarity (53.811), because all the studied species were belonging to one family Apocynaceae.

Conclusion

In conclusion, we emphasize the previous recommendations to merge both Apocynaceae and Asclepiadaceae families in one large family, that is Apocynaceae.

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Table 1. Scientific names and collected sites of species of family Apocynaceae.

No.	Family: Apocynaceae	Collected sites
Sub family: Apocynoideae		
1	*Beaumontia grandiflora* Wall.	Or
2	*Pachypodium lamerei* Drake.	Fl
Sub family: Asclepiadoideae		
3	*Cynanchum acutum* L.	Az
4	*Stephanotis floribunda* Brongn.	Fl
Sub family: Rauvolfioideae		
5	*Alstonia scholaris* R.Br.	Or
6	*Carissa spinarum* L.	Or
Sub family: Periplocoideae		
7	*Cryptostegia grandiflora* R.Br.	Or

Table 2. List of 86 characters and character states recorded for 7 species representing 7 genera belonging to family Apocynaceae.

A Qualitative characters			
Morphological characters		Character states	
Habit			
1	Habit	Evergreen (+)	Deciduous (–)
Stem			
2	Growth habit	Erect (+)	Weak (–)
3	Texture	Smooth (+)	Spiny (–)
4	Stem anatomy	Solid (+)	Hollow (–)
5	Branching	Monopodial (+)	Apical (–)
6	Branching status	Uni-lateral (+)	Bi-lateral (–)
Leaf			
7	Stipules	Stipulate (+)	Exstipulate (–)
8	Base	Pulvinate (+)	Epulvinate (–)
9	Venation	pinnate (+)	palmate (–).
10	Midrip color	White (+)	green (–).
11	Lateral venation	Distinict (+)	indistinict (–).
Anatomical characters			
Stem anatomy			
Epidermis			
12	Cuticle layer	thick (+)	thin (–).
13	Epidermal layer	Simple (+)	multiple (–).
14	Cork	present (+)	absent (–).
15	Lenticels	present (+)	absent (–).
Cortex			
16	Aerenchyma tissue	Present (+)	absent (–).
17	Storage parenchyma tissue	present (+)	absent (–).
18	Collenchyma tissue	Present (+)	absent (–).
19	Sclerenchyma tissue	present (+)	absent (–).
20	Water storage cells	present (+)	absent (–).
21	Cortical vascular bundles	present (+)	absent (–).
22	Rosette crystals	present (+)	absent (–).
23	Prismatic crystals	present (+)	absent (–).
24	Sandy crystals	present (+)	absent (–).
25	Resin canals	present (+)	absent (–).
26	Laticifer tissue	present (+)	absent (–).
27	Secretory cells	present (+)	absent (–).
28	Secretory canals	present (+)	absent (–).
29	Secretory cavities	present (+)	absent (–).
Pericycle			
30	Collenchyma tissue	present (+)	absent (–).
31	Rosette crystals	present (+)	absent (–).
Vascular bundle			
32	Vascular bundles	complete ring (+)	groups (–).

Table 2. continues

Anatomical characters		Character states	
33	Vessels	chains (+)	clusters (–).
34	Tylosis	present (+)	absent (–).
Xylem			
35	Rosette crystals	present (+)	absent (–).
36	Resin canals	present (+)	absent (–).
Medullary rays:			
37	Collenchymal tissue	present (+)	absent (–).
38	Sclerenchymal tissue	present (+)	absent (–).
39	Rosette crystals	present (+)	absent (–).
40	Resin canals	present (+)	absent (–).
41	Secretory cells	present (+)	absent (–).
Phloem			
42	Rosette crystals	Present (+)	Absent (–).
43	Sandy crystals	Present (+)	Absent (–).
44	Resin canals	Present (+)	Absent (–).
45	Secretory cells	Present (+)	Absent (–).
Pith:			
46	Pith	Solid (+)	Hollow (–).
47	Aerenchymal tissue	Present (+)	Absent (–).
48	Storage parenchymal tissue	Present (+)	Absent (–).
49	Sclerenchymal tissue	Present (+)	Absent (–).
50	Rosette crystals	Present (+)	Absent (–).
51	Prismatic crystals	Present (+)	Absent (–).
52	Secretory cells	Present (+)	Absent (–).
53	Secretory canals	Present (+)	Absent (–).
54	Secretory cavities	Present (+)	Absent (–).
Leaf anatomy			
Upper epidermis :			
55	Cuticle layer	Thick (+)	Thin (–).
56	Resin canals	Present (+)	Absent (–).
Mesophylic tissue			
Palisade tissue			
57	Palisade tissue	One row (+)	More than (–).
58	„ „	Continuous (+)	Separated (–).
59	Mucilage cells	Present (+)	Absent (–).
60	Rosette crystals	Present (+)	Absent (–).
61	Resin canals	Present (+)	Absent (–).
62	Laticifer tissue	Present (+)	Absent (–).
63	Secretory cells	Present (+)	Absent (–).
64	Secretory canals	Present (+)	Absent (–).
Spongy tissue :			
65	Aerenchymal tissue	Present (+)	Absent (–).
66	Armed Parenchymal tissue	Present (+)	Absent (–).
Anatomical characters		Character States	
67	Rosette crystals	Present (+)	Absent (–).
68	Resin canals	Present (+)	Absent (–).
69	Secretory cells	Present (+)	Absent (–).
Midrib region			
70	Midripconcave lower surface (+)	Straight Lower Surface (–).	
71	Aerenchymal tissue	Present (+)	Absent (–).
72	Palisade tissue	Continuous (+)	Separated (–).
73	Rosette crystals	Present (+)	Absent (–).
74	Resin canals	Present (+)	Absent (–).
75	Secretory cells	Present (+)	Absent (–).
Phloem			
76	Rosette crystals	Present (+)	Absent (–).
77	Resin canals	Present (+)	Absent (–).

Table 2. continues

B- Multistate characters Morphological characters					
78	Habit 3 categories:	Herbs 1	shrubs 2	trees 3.	
79	Stem3 categories:	herbaceous 1	woody 2	succulent 3.	
80	Leaf shapes 4 categories:	cordate 1	elliptic 2	oblong lanceolate 3	ovate 4.
81	Leaf arrangement : 3 categories:	spirally 1	opposite 2	opposite decussate 3	
82	Leaf apex shape 4 categories:	acuminate 1	obtuse 2	caudate3	Mucoronta4
83	Leaf base shapes3 categories	acute 1	rounded 2	cordate 3.	
Anatomical characters					
Stem anatomy					
84	outline shapes3 categories :	rounded 1		tetragonal 2	ovate 3.
Leaf anatomy					
85	Midrib region shapes3 categories :	convex 1		concave 2	straight 3.
Vascular bundle					
86	Vascular bundle shapes3 categories	crescent 1	semi ring 2	straight3.	

Table 3. Data matrix of observed characters for the examined plants. List of 86 characters recorded comparatively for 7 species representing 7 genera belonging to Apocynaceae.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	+	+	+	+	+	-	-	-	+	-	+	-	+	-	-	+	-	+	-	-	-	+	+	-	-	-	+	-	-	+
2	-	+	-	+	-	+	-	-	+	-	-	-	+	+	-	+	+	-	-	+	-	-	-	-	+	+	-	-	+	-
3	+	-	+	-	+	-	-	-	-	-	+	-	-	-	-	-	-	+	-	-	-	+	-	-	+	-	-	-	-	+
4	+	-	+	-	+	+	-	-	+	+	-	-	-	+	+	-	-	+	-	-	-	+	+	-	+	-	+	+	+	+
5	+	+	+	+	+	+	-	-	+	+	+	+	+	+	+	+	-	-	+	-	+	-	+	+	+	+	+	-	-	-
6	+	+	+	+	+	+	+	-	+	-	-	+	+	-	-	+	-	-	-	-	-	+	+	+	-	-	+	+	-	+
7	+	-	+	+	+	-	-	+	+	+	+	+	+	+	-	-	-	+	-	-	-	-	-	-	+	-	-	-	-	+

	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58
1	+	+	+	-	+	-	+	-	-	-	-	+	-	+	+	+	+	-	-	-	-	-	-	-	+	-	+	+
2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	-	-	-	-	-	+	-	-	+	+
3	+	+	+	+	+	-	-	+	+	+	-	+	-	+	-	-	+	-	-	+	-	-	-	-	-	-	-	-
4	+	+	+	-	+	-	-	+	+	+	+	+	-	+	-	-	+	-	-	+	+	-	+	-	-	-	+	+
5	-	+	+	+	-	+	+	+	-	-	+	-	+	+	+	+	+	-	+	-	+	+	-	-	+	+	+	+
6	-	+	+	+	-	-	-	+	-	-	-	-	-	+	-	+	-	-	-	-	-	-	-	-	+	-	-	+
7	+	+	+	-	-	+	-	+	-	+	-	-	-	+	-	+	+	-	-	+	+	-	+	-	-	-	+	-

	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86
1	-	+	-	-	-	-	-	-	+	+	-	+	-	+	+	+	-	-	+	3	2	4	3	1	2	1	3	1
2	-	+	-	+	-	-	+	-	-	-	-	+	+	-	+	+	-	-	-	1	3	3	1	3	1	2	1	1
3	-	+	-	+	-	-	+	+	+	-	-	+	+	+	+	-	+	+	-	1	1	1	2	4	3	3	1	1
4	-	+	-	-	-	+	+	+	+	-	-	+	-	-	+	+	+	-	-	1	1	4	2	2	2	1	1	1
5	+	-	+	-	-	-	-	+	-	+	+	+	-	-	-	+	+	-	+	3	2	2	1	1	1	1	1	2
6	+	+	-	+	+	-	+	+	+	-	+	+	+	+	+	+	+	-	-	2	2	4	2	1	2	3	2	1
7	-	-	-	+	-	-	-	+	-	-	-	-	-	-	-	+	-	-	+	1	1	4	2	1	2	3	3	3

Table 4. Symbols used in this study.

Aerenchyma……..	AE	phloem…….…….……	PH
Armed parenchyma…….……..	AR	Pith…….……	PI
Collenchymatous cells……..	CN	Resin canals…….…….……	RE
Cork…….……..	CK	Rosette crystalss…….……..	RC
Cortex…….……	CO	Sclerenchyma tissue…….…….……	SC
Cuticular layer…….…….……	CL	Secretory canals …….…….……	SN
Cortical vascular bundles …….……....	CV	Secretorycavitie…….…….……	SV
Midrib region …….……	MR	Secretory cells…….…….……	SE
Epidermis……..	EP	Spongy tissue…….…….……	SS
Laticifer tissue…….…….……	LA	Storage parenchymal tissue…….…….……	SP
Lenticels…….…….……	LS	Tyloses…….…….……	TY
Lower epidermis…….…….……	LE	Upper epidermis…….…….…...	UE
Mucilage cells…….…….……	MU	Vascular bundle…….…….……	VB
Multiepidermis…….…….……	ME	Water storage cells …….…….……	WS
palisade tissue…….…….……	PS	Xylem…….……..	XY

Table 5. Similarity matrix of 7 species of Apocynaceae.

Distance matrix	1	2	3	4	5	6	7
1	0.000						
2	23.062	0.000					
3	32.190	36.995	0.000				
4	33.632	35.554	26.425	0.000			
5	35.073	41.799	53.811	43.721	0.000		
6	30.749	32.671	34.112	38.436	36.995	0.000	
7	23.542	31.229	30.749	30.269	42.280	40.839	0.000

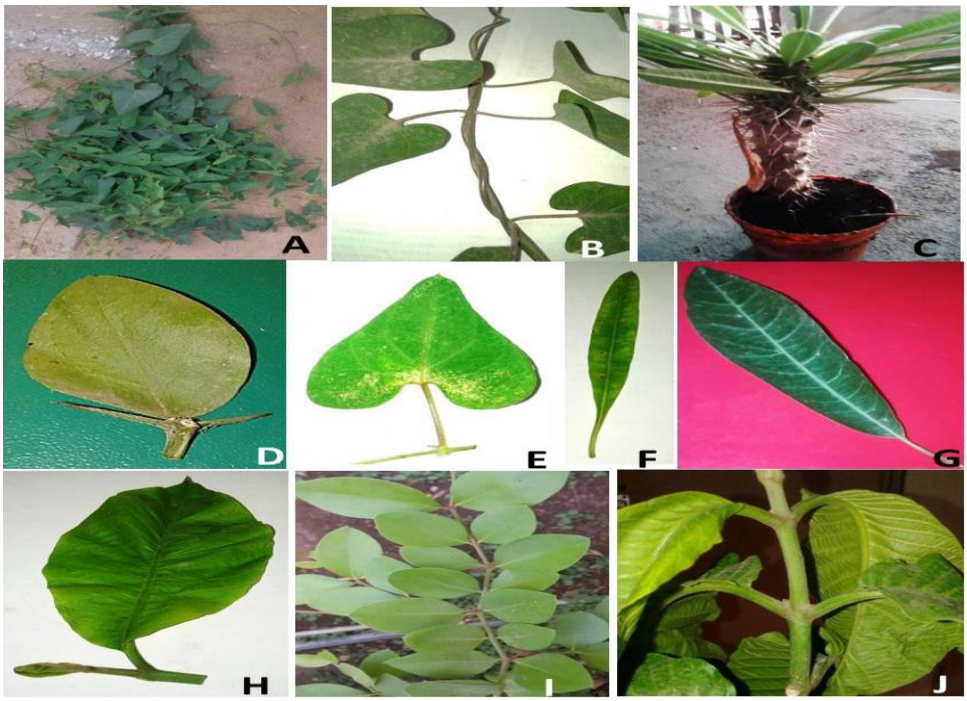

Fig. 1. Types of stem and leaf.

A. Herbaceous plants *Cynanchum acutum* L.; **B.** Weak stem *C. acutum* L.; **C.** Succulentin *Pachypodium lamerei* Drak. **D**. Stipulate leaf in *Carissa spinarum* L.; **E.** Cordate leaf in *Cynanchum acutum* L.; **F.** Oblong lanceolate leaf in *P. lamerei* Drak.; **G.** Elliptic leaf in *Alstonia scholaris* R.Br.; **H.** Acuminate in *Beaumontia grandiflora* Wall; **I.** Opposite leaf in *C. spinarum* L.; **J**. Opposite decussate leaf in *B. grandiflora* Wall.

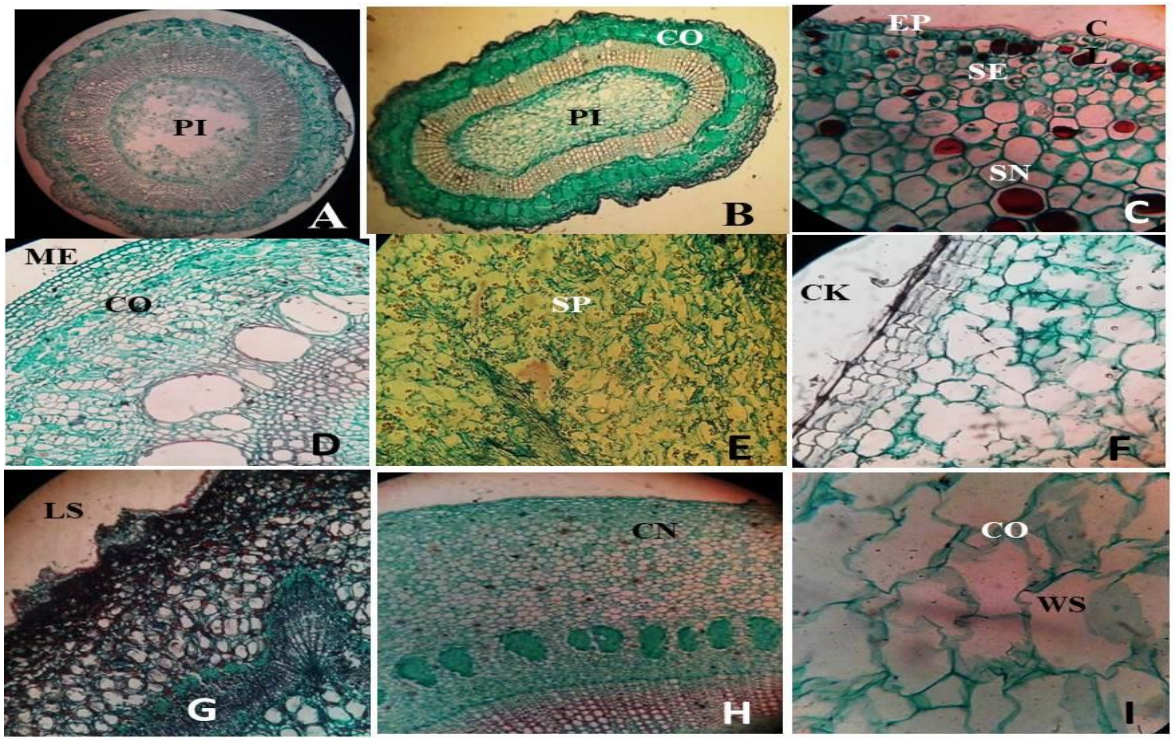

Fig. 2. Cross sections in stem of different studied species.

A. *Stephanotis floribunda* Brongn. (X_{47}); **B.** *Cryptostegia grandi flora* R.Br. (X_{47}); **C.** *Carissa spinarum* L. (X_{70}); **D.** *Cynanchum acutum* L. (X_{70}); **E.** *Pachypodium lamerei Drake.* (X_{70}); **F.** *P. lamerei* Drak. (X_{140}); **G.** *Alstonia scholaris* R.Br. (X_{70}); **H.** *Beaumontia grandiflora* Wall. (X_{70}); **I**. *P. lamerei* Drak. (X_{140}).

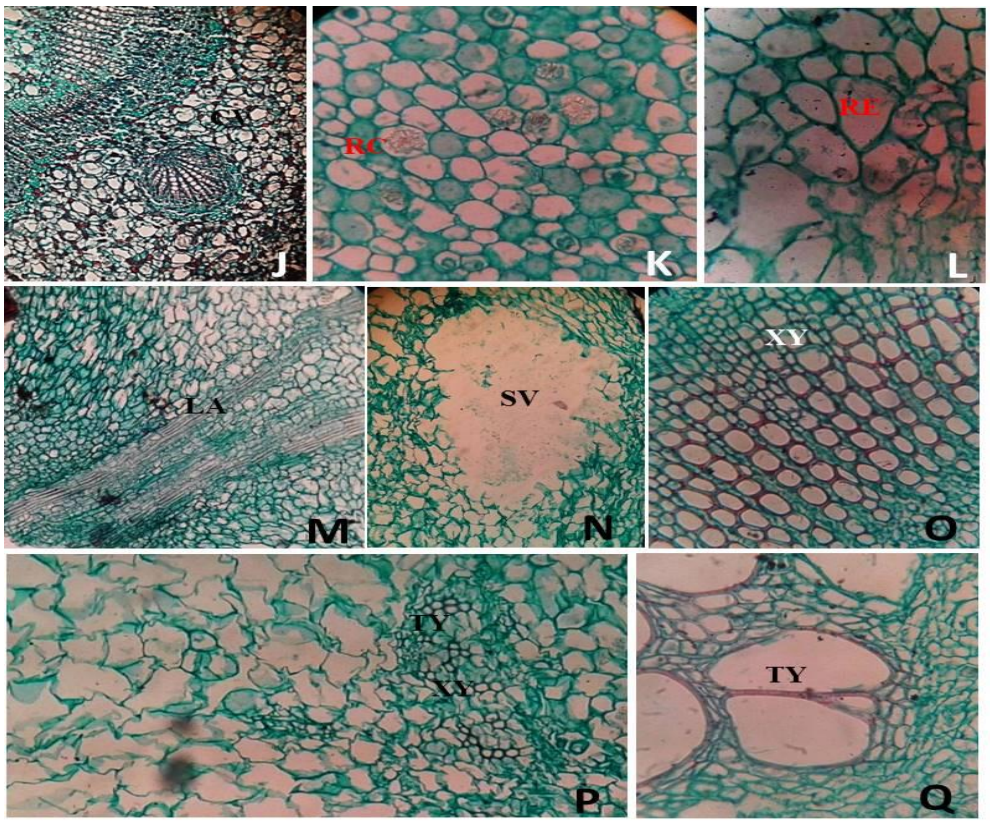

Fig. 3. Cross sections in stems of different studied species.
J . *A. scholaris* R.Br. (X70); **K.** *B. grandiflora* Wall. (X70); **L.** *C. acutum* L. (X140); **M.** *P. lamerei* Drak. (X70); **N.** *P. lamerei* Drak. (X70); **O.** *B. grandiflora* Wall. (X140); **P**. *P. lamerei* Drak. (X140); **Q.** *C. acutum* L. (X140).

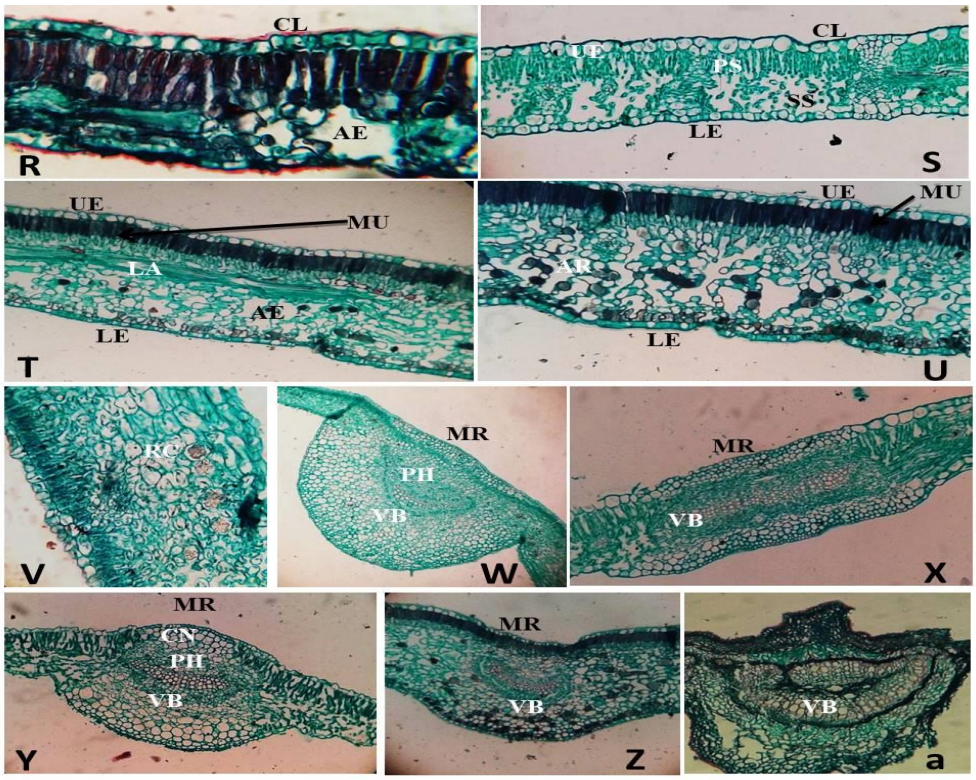

Fig. 4. Vertical sections in leaf of different studied species.
R. *A. scholaris* R.Br. (X70); **S.** *C. grandiflora* R. Br. (X70); **T.** *C. spinarum* L. (X70); **U.** *C. spinarum* L. (X70); **V**. *B. grandiflora* Wall. (X140); **W.** *B. grandiflora* Wall. (X70); **X**. *C. grandiflora* R. Br. (X70); **Y.** *C. acutum* L. (X70); **Z** *C. spinarum* L. (X70); **a**. *A. scholaris* R.Br. (X70).

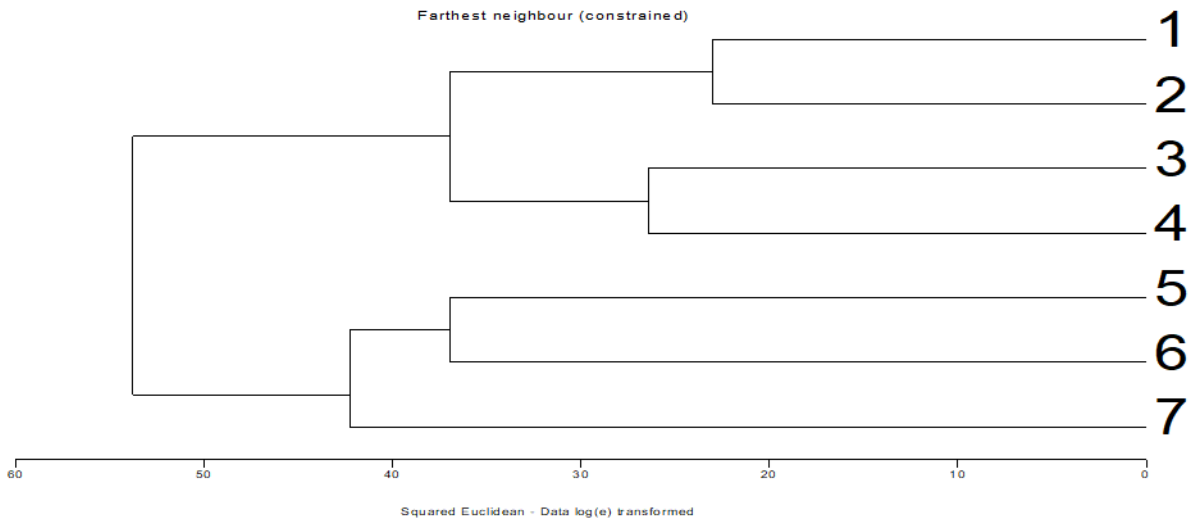

Fig. 5. Dendrogram represented the similarity and dissimilarity between 7 species belonging to Apocynaceae.

دراسات مورفولوجيا وتشريحية على بعض نباتات الفصيلة الدفلية

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الملخص العربي

اجريت هذه الدراسة على 7 اجناس تتبع الفصيلة الابوسينية تم تجميع عينات الاجناس من مناطق مختلفة في مصر. اجريت الدراسة على الصفات المورفولوجية للسيقان والاوراق. كما درست الصفات التشريحية لكل من السيقان والاوراق. وقد سجلت النتائج بطريقة مقارنة بين النباتات محل الدراسة. واظهرت النتائج ان بعض النباتات محل الدراسة كانت اعشاب معمرة كما فى Cynanchum *acutum* L. او شجيرات كما في الكاريسا او اشجار كما في الستونيا وجدت السيقان الخشبية في معظم النباتات المدروسة في حين وجدت السيقان العصيرية كما في *Pachypodium lamerei Drake*. الاوراق بسيطة فى كل النباتات محل الدراسة وكانت مرتبة حلزون او متقابلة اومتقابلة متصالبة والحافة كاملة والاوراق غير مؤذنة ماعدا الكاريسا. واوضحت الدراسة التشريحية ان الحزمة الوعائية فى كل النباتات المدروسة حزمة وعائية مفتوحة ذات جانبين. من تحليل النتائج المتحصل عليها من الدراسة باستخدام برنامج(MVSP). نستخلص انه يمكن ضم كلا من الفصيلة العشارية والابوسينية في فصيلة واحدة وهي الفصيلة الابوسينية.