Apocynaceae sensu lato is an interesting family with respect to pollen diversification. The pollen grains of 19 species (representing four out of five subfamilies and 18 genera) of Apocynaceae were collected and investigated using LM & SEM. The specific objective of the present study is to shed light on the different pollen morphological characters of the species under investigation and to discuss whether pollen morphology is considered an additional fundamental tool that helps in explanation of the evolutionary trend within the family. The obtained pollen data are considered diagnostic at the specific level viz. pollen association, class, polarity, sculpture, orientation and attachment of the translator. Carissa macrocarpa (Rauvolfioideae) gathered with the studied species of Apocynoideae based on the presence of porate pollen. In Cryptostegia grandiflora, the pseudo-pollinarium is considered a link between monads (as in Rauvolfioideae and Apocynoideae) and the true pollinia (as in Asclepiadoideae). Pollen criteria facilitate the construction of dendrogram, a tentative presentation of phylogenetic relationship and an artificial key to achieve further delimitation between the species under investigation and discussing the interrelationships in the view of dicta of advancement. The palynological criteria in the present study reinforced the treatment of Apocynaceae s.l. as two distinct taxonomic families (Apocynaceae and Asclepiadaceae).

**Keywords:** Apocynaceae, Asclepiadaceae, Eurypalynous, Pollen morphology, Pollinarium.

**Introduction**

Apocynaceae s.l. is a family of flowering plants that contains about 424 genus and 5100 species of evergreen trees, shrubs and herbs (Watson & Dallwitz, 1992; Li Ping-tao et al., 1995, Nazar, 2012; A.P.G., 2016). Tropical, subtropical rain forests or tropical arid environments are the suitable climatic conditions of these species; however, few species grow in temperate areas (Endress, 2000).


The phylogenetic studies supported the reunion of the Apocynaceae s.s. and Asclepiadaceae s.s. in one family; the Apocynaceae; with five subfamilies viz. Rauvolfioideae, Apocynoideae, Periplocoideae, Secamonoideae and Asclepiadoideae (Sennblad & Bremer, 1996; Endress & Bruyns, 2000; Potgieter & Albert, 2001; Endress et al., 2007; Livshultz, 2010; A.P.G., 2003, 2009, 2016; Simoes et al., 2010; Nazar, 2012). Rauvolfioideae and Apocynoideae, were previously allocated in Apocynaceae s.s., while Periplocoideae, Secamonoideae and Asclepiadoideae in Asclepiadaceae s.s. based on androecium morphological features and system of pollen transfer (Brown, 1811; Cronquist, 1981, 1988; Takhtajan, 1987).
In Apocynaceae there are great variation in pollen morphological features (Eurypalynous) viz. monad as in Rauvolfioideae and Apocynoideae, tetrad pollinarium (Pseudo- pollinarium) as in Periplocoideae or true pollinarium as in Secamonoideae and Asclepiadoideae (Van der Weide & Van der Ham, 2012; Chatterjee et al., 2014; El-Gazzar et al., 2018a, b). Monads, colporate as in Rauvolfioideae, porate as in Apocynoideae (Endress & Bruyns, 2000) or with psilate-perforate sculpture as in Apocynaceae s.s. (Middleton, 2007).

Pseudo-pollinarium is the arrangement of pollen cells in sticky masses of multiporate tetrads forming free pollinia without an outer wall or translator, while the true pollinia are the arrangement of pollen cells in compact sticky masses surrounded by an outer wall (Schill & Jakel, 1978; Kunze, 1993; Swarupanandan et al., 1996; Verhoeven & Venter, 2001; Wyatt & Lipow, 2007). Fishbein (2001) mentioned that Periplocoideae (pseudo-pollinarium) is more advanced than Rauvolfioideae and Apocynoideae (monad pollen), and Asclepiadoideae (true pollinia) is more advanced than Rauvolfioideae, Apocynoideae (monad) and Periplocoideae, (tetrads and pseudo-pollinarium). Pollinium characters viz. size, shape, colour, breadth and length of pollinium sac, breadth and length of corpusculum, pollinium orientation and attachment of translator (caudicle) are diagnostic features in Asclepiadaceae s.s. (Yaseen & Anjum, 2014).

Walker & Doyle (1975) and El-Atroush et al. (2015) have recognized the importance of pollen morphology in the identification and classification of flowering plants. Kuijt & Van der Ham (1997) and Erik & Raymond (2006) recognized some specific pollen characters within 42 Alstonia species and 19 species of Apocynaceae respectively. Several authors checked the classification for genera and species of angiosperm by analyzed their results using different numerical programs, e.g. Maowed et al. (2015). El-Gazzar et al. (2018a, b) used the numerical analysis to reveal the relationships between Apocynaceae and Asclepiadaceae according to morphological and pollen grain characters.

The specific objective of the present study is to throw light on the different pollen morphological characters of the species under investigation, to discuss whether pollen morphology is considered additional fundamental tool that can be of help in explanation of the evolutionary trend within the family.

**Materials and Methods**

In the present study 19 wild and ornamental species representing four out of five subfamilies of Apocynaceae s.l. were collected from different localities and botanical gardens from Egypt and Libya (Table.1, according to Endress et al., 2014; A.P.G., 2016). The wild species were identified by the aid of Täckholm (1974) and Boulos (2000), while the ornamental species by Bailey (1949). Synonyms were derived from the plant list (working list of all known plant species (http://www.theplantlist.org/), GRIN (Germplasm Resource Information Network, http://www.ars-grin.gov/cgi-bin/npgs/html/index.pl), and IPNI (The International Plant Names Index, http://www.ipni.org/ipni/plantnamesearchpage.do). For LM investigation (BEL: B103 T-PL light microscope), un-acetolyzed pollen grains were taken from the flowers of the species under investigation, fixed in 70% alcohol, the anthers were crushed or opened carefully by needle, mounted on glass slide with few drops of glycerin and stained with 4% safranine solution. The microphotographs were taken using digital camera (Canon power-shot A720, 8.0 mega pixels). About seven to ten pollen grains per species were subjected to the measurements. For Scanning Electron Microscope (SEM) investigation, pollen grains were dried, mounted onto stubs then coated with gold by sputter coaster (SPI-Module) and tested with (JEOL-JSM 5500 LV) scanning electron microscope at the Regional Center of Mycology and Biotechnology, Al-Zhar University, Cairo, Egypt. The used pollen sculpture patterns were according to Stearn (1992). The pollen terminology in the present study were according to Erdtman (1952) and Punt et al. (2007). For numerical analysis, the recorded palynological characters were coded as binary codes (0, 1) and a dendrogram was constructed using the NTSYS-PC version 2.02 software program (Rohlf, 2002).

*Egypt. J. Bot.* **60**, No.2 (2020)
TABLE 1. Collection data according to Endress et al. (2014) and A.P.G. (2016).

<table>
<thead>
<tr>
<th>Subfamily</th>
<th>Species</th>
<th>Source/locality</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><em>Catharanthus roseus</em> (L.) G.Don. -- Gen. Hist. 4(1): 95. 1837 (IK) = <em>Vinca rosea</em> L.</td>
<td>E</td>
</tr>
</tbody>
</table>

A, Agriculture Museum Garden; B, Al-Azhar University; C, Al-Zohriya Garden, Gizzira; Cairo; D, Botanical Garden, Botany Department, Faculty of Science, Ain Shams University, Alabbassia, Cairo; E, Botanical Garden, Botany Department, Al-Zawia University in Libya; F, Orman Botanical Garden, Giza; G, Saint Katherine, South Sinai; H, Western Mountain in Libya.
Results

In the present study the pollen data of 19 studied species are summarized in Table 2 and the specific structures in Plate I; text Fig. a-p. Pollen grains monad as in 12 studied species (belonging to Rauvolfioideae and Apocynoideae) or pollinarium as in seven studied species (belonging to Asclepiadoideae and Periplocoideae).

For monad pollen grain; shape class; oblate spheroidal & sub-oblate as in Carissa carandas, prolate as in Plumeria obtusa, prolate spheroidal as in as in four studied species or oblate spheroidal as in the rest six studied species. Pollen size; small in Alstonia scholaris, Nerium oleander & Tabernaemontana divaricata, small-medium as in Carissa carandas; medium as five studied species or large as in Carissa macrocarpa, Cerbera odollam & Cascabela thevetia. Pollen class, colpate as in Catharanthus roseus & Plumeria obtusa, colpate and colporate as in Carissa carandas, colporate as in five studied species or porate as in four studied species. Shape of pollen in polar view; circumaperture as in Nerium oleander & Wrightia coccinea or angulaperture as in the rest ten studied taxa. Shape of pollen in equatorial view; spheroidal & sub-spheroidal as in Carissa carandas, elliptic as in Catharanthus roseus, subspheroidal in Cascabela thevetia, Wrightia coccinea or spheroidal in the rest eight studied species. Polarity; apolar as in Adenium obesium, Carissa macrocarpa, Nerium oleander & Wrightia coccinea or isopolar as in the rest eight studied species. Aperture; simple as in six studied species, simple and composite as in Carissa carandas or composite as in five studied species. Sculptur; gleulate as in Alstonia scholaris, scabrate-foveate as in Cerbera odollam, foveolate as in four studied species or psilate as in the rest six studied species. Columellae, distinct in all studied species.

For pollinarium; Pollinum shape; spoon-like (pseudo-pollinarian) as in Cryptostegia grandiflora, obovate as in Calotropis procera, long ovate as in Solenostemma argel, ovate as in Huernia andreaeana & Cynanchum acutum or oblong-ovate as in Asclepias curassavica & Gomphocarpus sinalicus. Pollinium color; creamy as in Calotropis procera, brown as in Solenostemma argel, yellow as in Asclepias curassavica & Gomphocarpus sinalicus or brownish yellow as in Cynanchum acutum, Cryptostegia grandiflora & Huernia andreaeana. Pollinium orientation; erect as in Cynanchum acutum or pendulous as in Asclepias curassavica, Gomphocarpus sinalicus, Calotropis procera, Huernia andreaeana & Solenostemma argel. Pollinium – translator attachment; apical as in Huernia andreaeana, basal in Cynanchum acutum, Asclepias curassavica, Gomphocarpus sinalicus, Calotropis procera & Solenostemma argel or wanting as in Cryptostegia grandiflora. Pollinium surface sculpture; tuberculaste as in Cryptostegia grandiflora, reticulate as in Cynanchum acutum & Huernia andreaeana, colliculate as in Calotropis procera, reticulate-foveate as in Gomphocarpus sinalicus or psilate in Asclepias curassavica & Solenostemma argel. Wing; present as in Huernia andreaeana or not detected in the rest six studied species.

Discussion

In the present study the palynological data were coded as binary codes (0, 1) then subjected for computation using the NTSYS-PC version 2.02 software program (Rohlf, 2002). From the obtained dendrogram (Fig. 1), the species under investigation separated under two series; series I and II. Series I comprises 12 out of the studied species (belonging to Rauvolfioideae and Apocynoideae) at a taxonomic distance 0.81 based on the presence of monad pollen grains. Series II comprises the remaining seven studied species (belonging to Asclepiadoideae and Periplocoideae) at taxonomic distance 0.72 based on the presence of pollinarium. The separation of the studied species into series I & II is in accord with Brown (1989a, b). Dahlgren (1983), Cronquist (1981, 1988), Dahlgren (1983), Takhtajan (1987) and Rosatti (1989a, b).

Series I divided into two subseries; subseries A and B. Subseries A divided into two clusters; Cluster 1 and 2. The former cluster includes Carissa carandas due to the presence of two pollen class; colpate and colporate with simple and composite apertures. Cluster 2 includes five studied species due to sharing in colporate pollen grain with composite apertures. Subseries B divided into two clusters, 3 and 4. The former cluster includes Catharanthus roseus and Plumeria obtusa due to sharing in colporate pollen and isopolar. Cluster 4 includes four studied species due to sharing in porate pollen and apolar pollen grain.
<table>
<thead>
<tr>
<th>Sp.</th>
<th>C.</th>
<th>Dimension (μm)</th>
<th>Shape class</th>
<th>Pollen size 100 P+E</th>
<th>Pollen class</th>
<th>Shape in polar view</th>
<th>Shape in equatorial view</th>
<th>Polarity</th>
<th>Aperture</th>
<th>Sculpture</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Acokanthera oblongifolia</em></td>
<td>P= 31.5 E= 32</td>
<td></td>
<td>Oblate</td>
<td>Medium</td>
<td>Trizono colporate</td>
<td>Angulaperture</td>
<td>Spheroidal</td>
<td>Isopolar</td>
<td>Composite ectoapertures: colpus slit-like with rounded end</td>
<td>Foveolate</td>
</tr>
<tr>
<td><em>Adenium obesum</em></td>
<td>P= 31.7 E= 34.7</td>
<td>//</td>
<td>Pantoparat 4-6</td>
<td>//</td>
<td>//</td>
<td>Apolar</td>
<td>Simple, ectoapertures: circular leveled.</td>
<td>Psilate</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Alstonia scholaris</em></td>
<td>P= 22 E= 23</td>
<td>//</td>
<td>Small</td>
<td>Trizono colpate</td>
<td>//</td>
<td>Isopolar</td>
<td>Composite ectoapertures: colpus fusiform with rounded end</td>
<td>Glebulate</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Carissa carandas</em></td>
<td>P= 25 E= 26.5</td>
<td></td>
<td>Oblate</td>
<td>Medium</td>
<td>Trizono colporate</td>
<td>//</td>
<td>Sub spheroidal</td>
<td>Isopolar</td>
<td>Composite ectoapertures: colpus fusiform with tapered end</td>
<td>Foveolate</td>
</tr>
<tr>
<td><em>Carissa macrocarpa</em></td>
<td>P= 47.2 E= 45.4</td>
<td></td>
<td>Prolate</td>
<td>Large</td>
<td>Pantoparat 6-10</td>
<td>//</td>
<td>Spheroidal</td>
<td>Apolar</td>
<td>Simple ectoapertures: circular and leveled</td>
<td>Psilate</td>
</tr>
<tr>
<td><em>Cascabela thevetia</em></td>
<td>P= 64 E= 64.6</td>
<td>//</td>
<td>Oblate</td>
<td>Medium</td>
<td>Trizono colpate</td>
<td>//</td>
<td>Sub spheroidal</td>
<td>Isopolar</td>
<td>Composite ectoapertures: colpus slit-like with tapered end</td>
<td>Foveolate</td>
</tr>
<tr>
<td><em>Catharanthus roseus</em></td>
<td>P= 41 E= 43.3</td>
<td></td>
<td>Oblate</td>
<td>Medium</td>
<td>Trizono colpate</td>
<td>//</td>
<td>Elliptic</td>
<td>//</td>
<td>Simple ectoapertures: colpus slit-like with tapered end,</td>
<td></td>
</tr>
<tr>
<td><em>Cerbera odorollam</em></td>
<td>P= 73 E= 69</td>
<td>//</td>
<td>Prolate</td>
<td>Large</td>
<td>Trizono colpate</td>
<td>//</td>
<td>Spheroidal</td>
<td>//</td>
<td>Composite ectoapertures: colpus slit-like with tapered end</td>
<td>Scabra-foveate</td>
</tr>
<tr>
<td><em>Nerium oleander</em></td>
<td>P= 24 E= 24</td>
<td></td>
<td>Oblate</td>
<td>Small</td>
<td>Pantoparat 4-6</td>
<td>Circumaperture</td>
<td>//</td>
<td>Apolar</td>
<td>Simple ectoapertures: circular, sunken</td>
<td>Psilate</td>
</tr>
<tr>
<td><em>Plumeria obtusa</em></td>
<td>P= 37 E= 40</td>
<td></td>
<td>Prolate</td>
<td>Medium</td>
<td>Trizono colpate</td>
<td>Angulaperture</td>
<td>//</td>
<td>Isopolar</td>
<td>Simple ectoapertures: colpus slit-like with rounded end</td>
<td>//</td>
</tr>
<tr>
<td><em>Tabernaemontana divaricata</em></td>
<td>P= 25.6 E= 23</td>
<td></td>
<td>Prolate</td>
<td>Small</td>
<td>Trizono colpate</td>
<td>//</td>
<td>//</td>
<td>//</td>
<td>Composite ectoapertures: colpus short</td>
<td>//</td>
</tr>
<tr>
<td><em>Wrightia coccinea</em></td>
<td>P= 32.5 E= 30</td>
<td>//</td>
<td>Medium</td>
<td>Pantoparat 4-6</td>
<td>Circumaperture Sub spheroidal</td>
<td>Apolar</td>
<td>Simple ectoapertures: circular, sunken</td>
<td>//</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*/(/): As previous
<table>
<thead>
<tr>
<th>Sp.</th>
<th>C</th>
<th>Length of pollenium sac (μm)</th>
<th>Breadth of pollenium sac (μm)</th>
<th>Length of translator sac (μm)</th>
<th>Breadth of Corpusculum sac (μm)</th>
<th>Shape of pollenium sac</th>
<th>Colors of pollenium</th>
<th>Orientation of pollenium</th>
<th>Translator attachment to the pollenium</th>
<th>Surface sculpture</th>
<th>Wing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asclepias curassavica</td>
<td>933</td>
<td>346.6</td>
<td>493</td>
<td>133</td>
<td>440</td>
<td>Oblong-ovate</td>
<td>Yellow</td>
<td>Pendulous</td>
<td>Basal</td>
<td>Psilate</td>
<td>_</td>
</tr>
<tr>
<td>Calotropis procera</td>
<td>1035</td>
<td>517.6</td>
<td>411</td>
<td>58.8</td>
<td>470</td>
<td>Obovate</td>
<td>Creamy</td>
<td>//</td>
<td>//</td>
<td>Colliculate</td>
<td>//</td>
</tr>
<tr>
<td>Cryptostegia grandiflora</td>
<td>1666.6</td>
<td>1145.8</td>
<td>833.3</td>
<td>416.6</td>
<td>–</td>
<td>Spoon</td>
<td>Brownish yellow</td>
<td>–</td>
<td>–</td>
<td>Tuberculate</td>
<td>//</td>
</tr>
<tr>
<td>Cynanchum acutum</td>
<td>311</td>
<td>194.4</td>
<td>100</td>
<td>55.5</td>
<td>255.5</td>
<td>Ovate</td>
<td>Brownish yellow</td>
<td>Erect</td>
<td>Basal</td>
<td>Reticulate</td>
<td>//</td>
</tr>
<tr>
<td>Gomphocarpus sinaicus</td>
<td>847</td>
<td>235.2</td>
<td>294</td>
<td>70.5</td>
<td>258.8</td>
<td>Oblong-ovate</td>
<td>Yellow</td>
<td>Pendulous</td>
<td>//</td>
<td>Reticulate-foveate</td>
<td>//</td>
</tr>
<tr>
<td>Huernia andreaeana</td>
<td>323.5</td>
<td>258.8</td>
<td>100</td>
<td>41</td>
<td>176.4</td>
<td>Ovate</td>
<td>Brownish yellow</td>
<td>//</td>
<td>Apical</td>
<td>Reticulate</td>
<td>+</td>
</tr>
<tr>
<td>Solenostemma argel</td>
<td>909</td>
<td>200</td>
<td>300</td>
<td>90.9</td>
<td>345.4</td>
<td>Long-ovate</td>
<td>Brown</td>
<td>//</td>
<td>Basil</td>
<td>Psilate</td>
<td>_</td>
</tr>
</tbody>
</table>

Small (10-24μm); Medium (25-49μm); Large (50-99μm); Very short (50-199μm); Short (200-399μm); Long (400-599μm); Very long up 600μm; C: Character; Sp.: Species; +: Present; -: Absent.

Fig. 1. Dendrogram showing the relationship between the studied species based on pollen criteria [S: Series; Subs: Subseries; C: Cluster].
The separation of series I into two subseries, A & B based on aspect of pollen class indicated that, the pollen class in studied species belonging to Rauvolfioideae show colpate and colporate manner except in *Carissa macrocarpa* (porate pollen class) which gathered with the studied species of Apocynoideae (porate pollen class). This is in accord with Endress & Bruyns (2000), Enderson et al. (2002) and Middleton (2007). Fishbein (2001) stated that Rauvolfioideae is considered the most basal subfamily of Apocynoideae based on pollen class from colpate and colporate vs porate.

Series II divided into two subseries C and D. Subseries C (cluster 5) includes *Cryptostegia grandiflora* (Periplocoideae), due to the presence of pseudo-pollinarium. Subseries D divided into two clusters: 6 & 7 (species with true pollinia). The former cluster includes *Cynanchum acutum* and *Huernia andreaeana* based on small sized pollinia with ovate shape pollinial sac, erect pollinium with basally attached translator (*Cynanchum acutum*) or apical attachment winged pollinarium (*Huernia andreaeana*). Cluster 7 gathered *Asclepias curassavica*, *Calotropis procera*, *Gomphocarpus sinaicus* and *Solenostemma argel*, all are sharing the features of pollinarium with pendulous orientation and basal attachment of translator. Pollinial sac shapes varied from ovate in *Cynanchum acutum*, oblong ovate as in *Asclepias curassavica*, obovate as in *Calotropis procera* or spoon like as in *Cryptostegia grandiflora*. This is in accord with Mo et al. (2010), and Sinha & Mondal (2011), who stated that, the Asclepiadoideae showed great variation in shape of pollinial sac.

The separation of subseries D into cluster 6 & 7 (on the bases of pollinium orientation and translator attachment) is in agreement with Swarupanandan et al. (1996) and Sinha & Mondal (2011). The position of translators whether basal or apical and orientation of pollinia (erect, horizontal or pendulous) are considered diagnostic features for classification of Asclepiadaceae s.s. (Brown, 1811; Swarupanandan et al., 1996; Endress & Bruyns, 2000).

The separation of the studied species of series II into two subseries are in accordance with El-Gazzar et al. (1974), Schill & Jäckel (1978), Arekal & Ramakrishna (1978, 1979, 1980).

From the foregoing pollen criteria in the present study, *Cryptostegia grandiflora* is considered a transition state between the studied species of Rauvolfioideae, Apocynoideae and Asclepiadoideae and this is in accord with Verhoeven & Venter (2001) and Wyatt & Lipow, (2007). Comparison of the evolutionary trends of the most specific pollen parameters encourage the construction of an evolutionary proposed tentative presentation (Fig. 2) and an artificial key to render identification and separation between the studied species more easily and accurate.

Among taxonomists a great argument has always been arising with respect to the taxonomic character as regard its weight and consistency. For instance, in the present work, the pollen criteria lead to the following diagnostic and evolutionary trends, which can be summarized in the following points through the line of advancement (primitive vs. advanced) based on the dicta of evolution (Bessey, 1915).

1. Monads (Rauvolfioideae and Apocynoideae) vs. true pollinia (Asclepiadoideae) through pseudo-pollinarium as in *Cryptostegia grandiflora* (Periplocoideae) (Verhoeven & Venter, 2001; Wyatt & Lipow, 2007).

2. Colpate pollen vs. colporate vs. porate. *Carissa carandas* (colpate and colporate pollen) is considered as intermediate stage between colpate and porate (new observation and record). In *Carissa macrocarpa* (Rauvolfioideae), the porate pollen encourage the gathering of it with the studied species of Apocynoideae (Walker & Doyle, 1975; Moore et al., 1991).

3. Aperturate pollen is from simple vs. composite (Walker & Doyle, 1975; Moore et al., 1991).

4. Isopolar vs. apolar (Walker & Doyle, 1975).

5. Large vs. small sized pollen (Ezcurra, 1993; Ueckermann & Rooyen, 2000).

6. Sculpture of monad pollen is from psilate vs. scarbate-foveate, vs. foveolate vs. glebulate (week diagnostic character) (Walker, 1974; Walker & Doyle, 1975; Walker & Skvarla, 1975).
An artificial key of the studied species of Apocynaceae s.l. based on pollen characters.

1. Monad
2. Apolar, porate pollen
3. Oblate spheroidal pollen
4. Spheroidal pollen
5.骂e of two types (colpate & colporate)
6. Pollen one type (colpate or colporate)
7. Glebulate sculpture
8. Scabrate-foveolate sculpture
9. Psilate sculpture
10. Small pollen sized
11. Pollinarium winged
12. Pollinaria	
13. Pollinium sculpture tuberculate
14. Pollinium sculpture otherwise
15. Pollinium sac, brown
16. Psilate sculpture
17. Pollinium sac, yellow
18. Psilate sculpture
19. Reticulate-foveate sculpture

Carissa macrocarpa
Nerium oleander
Adenium obesum
Wrightia coccinea
Carissa carandas
Catharanthus roseus
Cerbera odollam
Plumeria obtusa
Alstonia scholaris
Tabernaemontana divaricata
Cassabela thevetia
Acokanthera oblongifolia
Huernia andreaeana
Cryptostegia grandiflora
Cynanchum acutum
Calotropis procera
Solenostemma argel
Asclepias curassavica
Gomphocarpus sinaicus

Fig. 2. Proposed schematic presentation illustrating the line of advancement within the studied species based on the pollen class based on the dicta of evolution of Bessey (1915).
Conclusion

In the present study the most specific pollen characters of the studied species reinforced the treatment of Apocynaceae s.l. as two distinct families (Apocynaceae and Asclepiadaceae).

References


مساهمة دلالات حبوب اللقاح في تقييم العلاقات بين بعض الأنواع من الفصيلة السوسية

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تعتبر الفصيلة الدفلية بمفهومها الواسع من الفصائل الجذابة للإهتمام استناداً لتتبع أشكال حبوب اللقاح. وقد شملت هذه الدراسة حبوب لقاح لتسع اشتملاً (تنتمي لأربعة تحت فصائل وثمانية عشر جنساً). تم تجميع وفحص صفات حبوب اللقاح باستخدام الميكروسكوب الضوئي والالكتروني الماسح. تهدف الدراسة إلى إلقاء الضوء على التباين في صفات حبوب اللقاح و مدى سهولة فصل بين الأنواع و تقييم الوضع التصنيفي للفصيلة الدفلية بمفهومها الواسع. وقد خلصت الدراسة إلى مجموعة من الصفات التشخيصية على سبيل المثال: أشكال، تراكيب وتجهيزات حبوب اللقاح، الزركشة، الزوب و الكؤوس في الطرق المختلفة والضرائب على السطح الخارجي وكذلك إنتاج ربط الناقل في البولينيات. وقد أظهرت صفات حبوب اللقاح في نوع Carissa macrocrpa التابعة لمجموعة (Rauvolfioideae) نوع حبوب اللقاح (Pollinia) (Apoecynoideae) في مجموعتين منفصلتين. كما أظهر شكل البولينيا في نوع Cryptostegia grandiflora (Apocynoideae & Rauvolfioideae) و منفصلتين منفصلتين (الفصيلة الدفلية والعشارية).