Taxonomic Implications of Seed Morphology and Seed Protein Electrophoresis of Some Egyptian Taxa of the Mimosoideae-Leguminosae.

N.M. George, H.A. Hussein, A. Ghareeb and M.M. El-Demerdash
Botany Department, Faculty of Science, Zagazig University, Egypt

THE SEED macro-morphological features including seed shape, colour, size, areole shape as well as the testa sculpturing patterns examined by scanning electron microscopy (SEM) and SDS-PAGE profiles of seed proteins of 14 species and one subspecies; representing eight genera of Mimosoideae were investigated. A key to the taxa studied was provided based on the recorded macro-morphological features and the testa sculpturing patterns as viewed under SEM. The phenogram generated from the numerical analysis of the scored characters from SDS-PAGE profiles of seed proteins was beneficial to discuss some of the fore-mentioned opinions concerning the taxonomic status of members of Mimosoideae.

Keywords: Mimosoideae; SEM; Seed Morphology; Testa Sculpture; SDS-PAGE.

Mimosoideae is one of the three widely recognized subfamilies of Leguminosae (Elias, 1981). The Mimosoideae (treated as family Mimosaceae by Hutchinson, 1964) comprises 82 genera and 3335 species distributed throughout tropical and warm temperate regions of the world (Stevens, 2001). Mimosoideae is represented in the Egyptian flora by 5 genera, 10 species, 4 subspecies and two varieties (Boulos, 1999).

Bentham (1875), in his revision, established six tribes namely; Acacieae, Adenanthereae, Eumimoseae, Ingeae, Parkieae and Piptadenieae containing 46 genera of the Mimosoideae. Later on, Bentham’s classification of Mimosoideae into tribes had been subjected to some modifications by Burkart (1939), Hutchinson (1964) and Lewis & Elias (1981). Furthermore, Elias (1981) distinguished between the following five tribes: Acacieae, Ingeae, Mimoseae, Mimozygantheae and Parkieae as constituents of the Mimosoideae depending upon the following characters: calyx either imbricate or valvate in bud; sepals either joined or free; stamens more than 10 or either 10 or fewer free or joined.

The use of SEM in studying the morphology of seeds has revealed new finer details on their surface which, in turn, yielded valuable taxonomic information adopted in solving many taxonomic problems (Chaung & Heckard, 1983; Hussein et al., 2002 a, b; Abou-El-Enain et al., 2007 and Gunes, 2012).
Morphology of seeds of many mimosoid taxa has been treated variously in
many studies among them: Manning & Van Staden (1987), Al-Gohary &
Mohamed (2007) and Karakish et al. (2013). Electrophoresis has become an
additional tool applied in resolving taxonomic and phylogenetic problems
(George et al., 2013 and Burghardt & Espert, 2007). Most applications of
electrophoretic techniques in plant classifications use gel medium supports.
This has resulted from the reliability of data produced by gel electrophoresis,
which have been accepted widely, particularly in studies of plant population genetics
(Omonhinmin & Ogunbodede, 2013 and Atoyebi et al., 2014). The use of seed
protein electrophoretic profiles in addressing taxonomic relationships among
some Leguminosae taxa has been highlighted by many researchers namely: Badr
(1995); Ghareeb et al. (1999) and Arslan & Ertugrul (2010). Thus, the present
study aims to characterize the seed morphological features including the testa
sculpturing patterns as viewed under SEM and to evaluate the genetic
diversity and taxonomic relationships among 12 species and 3 subspecies of
Egyptian Mimosoideae using SDS-PAGE analysis of seed storage proteins. The
main objective of this study is to collect additional criteria which can be of more
taxonomic interest in delimitation and differentiation among the taxa studied.

Material and Methods

Material
Specimens containing mature dry pods of 14 species and one subspecies of
Mimosoideae were collected from June, 2001 to August 2004. Some of them
were gained only as mature dry pods (Table 1). The collected specimens include
both wild and horticultural ones. The identification of both of them was achieved
by the morphological comparison against authentic herbarium specimens kept at
the herbarium of Orman Botanical Garden, Giza, Egypt. The scientific names,
synonyms and the author citations were rechecked and updated according the

Methods
A. Seed Morphological Features
The seed dimensions; length (L) and breadth (B) of each specimen, were
measured as average of 10 seeds by using the vernier caliper. The general macro-
morphological features of the seeds; including the shape, colour and the areole
shape were directly recorded from the specimens examined. For SEM-observations
of the testa surface patterns, at least two seeds for each specimen were mounted on
stubs, coated with a thin layer of gold and examined at different positions using
JEOL-JSM-5400 scanning electron microscope at Electron Microscope Unit,
Assiut University since 2003-2004. The characters were recorded and SEM-
micrographs, exhibiting the testa sculpturing were taken towards the mid-seed
involving the pleurogram and part of the areole with a range of magnification
between (500x-1500x). The terminology listed by Stearn (1983) and also that of
Lersten (1981), with some modifications by the authors, were adopted for
description of the seed surface sculpturing patterns. In addition, Polhill et al. (1981) defined that the hard seeds of Mimosoideae generally have an area on each face (the areole) bounded by a crack in the testa (the pleurogram). Gunn (1981) added that the fracture lines, on the seed surface, are cracks formed during seed maturation and appear to be in the thick cuticle layer.

**TABLE 1. The collection data with their sources of collection.**

<table>
<thead>
<tr>
<th>No.</th>
<th>Taxa</th>
<th>Source of collection in Egypt</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td><em>Acacia saligna</em> (Labill.) Wendl. (=<em>Acacia cyanophylla</em> Lindl.)</td>
<td>Parks at Zagazig Univ., Zagazig.</td>
</tr>
<tr>
<td>2.</td>
<td><em>Acacia farnesiana</em> (L.) Willd. (*)</td>
<td>Canal banks, Beni Swif.</td>
</tr>
<tr>
<td>3.</td>
<td><em>Acacia nilotica</em> (L.) Delile (=<em>Acacia nilotica</em> (L.) Delile subsp. nilotica)</td>
<td>Canal banks, Zagazig.</td>
</tr>
<tr>
<td>4.</td>
<td><em>Acacia tortilis</em> (Forsk.) Hayne(*) (=<em>Acacia tortilis</em> (Forsk.) Hayne subsp. tortilis)</td>
<td>El Tur, South Sinai.</td>
</tr>
<tr>
<td>5.</td>
<td><em>Acacia tortilis</em> (Forsk.) Hayne subsp. <em>radiiana</em> (Savi) Brenan(*) (=<em>Acacia tortilis</em> (Forsk.) Hayne subsp. radiiana (Savi) Brenan)</td>
<td>El Tur, South Sinai.</td>
</tr>
<tr>
<td>7.</td>
<td><em>Albizia lebbeck</em> (L.) Benth.</td>
<td>Salah Salem road, Cairo.</td>
</tr>
<tr>
<td>12.</td>
<td><em>Leucaena leucocephala</em> (Lam.) de Wit (=<em>Leucaena glauca</em> (L.) Benth.)</td>
<td>The Zoo, Giza.</td>
</tr>
<tr>
<td>13.</td>
<td><em>Pithecellobium dulce</em> (Roxb.) Benth. (=<em>Inga dulcis</em> (Roxb.) Willd.)</td>
<td>The Zoo, Giza.</td>
</tr>
<tr>
<td>15.</td>
<td><em>Prosopis juliflora</em> (Sw.) DC.</td>
<td>The Zoo, Giza.</td>
</tr>
</tbody>
</table>

(*) Specimens collected from the herbarium of Cairo University.  
(**) Specimen collected from herbarium of Orman Botanical Garden.

**B. Seed protein electrophoresis**

Total protein from 0.2 gm of milled seeds, of each of the collected specimens, were extracted overnight using 0.2 M Tris-HCl buffer, PH 6.8 containing 2% SDS and 10% glycerol. Centrifugation was carried out at 9000 rpm for 6 min. Then 30 µl supernatant were loaded in 12.5% acrylamide slab gels containing 10% SDS. Run power was 15 mA for about 30 min. Then raised up to 25 mA for 6-7 hr. The molecular weights of separated protein bands were compared with standards protein ladder ranging from 27 to 116 KDa. Gel was then stained in Comassie blue for 16 hr at room temperature, destained and photographed. The bands produced by each sample were directly scored as 0 for absent and 1 for present bands.

*Egypt. J. Bot., Vol. 56, No. 1 (2016)*
The data were treated by numerical analysis using the program NTSYS-pc. (Rholf, 1988). The similarity between each two taxa; based on comparisons of their SDS-PAGE profiles, was calculated using Jaccard's coefficient of similarity.

Results and Discussion

A. Seed Morphological Features

Variation in macro-morphological features of the seed including seed shape, colour, size and the areole shape as well as the testa sculpturing patterns as seen by SEM were outlined in Table 2. In addition, the testa surface, in the taxa studied, as viewed under SEM exhibited the pleurogram as a break in the testa surrounding the areole. Cracks or fracture lines were, also, commonly observed at different parts of the seed especially near the hilum or towards the mid-seed (Fig. 1A-Q).

The seed was either compressed (11 taxa) or not compressed in Acacia farnesiana, Enterolobium contortisiliquum, E. cyclocarpum and Prosopis juliflora. The shape of seed was oval, broad oval, oval-oblong or oblong. The colour of seed varied from pale brown to glossy dark brown and only brown mottled with yellowish white streaks and spots in Acacia nilotica. The mean length of seeds ranged from 4.9 mm to 11.9 mm. The smallest seeds were recorded in Acacia saligna and Dichrostachys cinerea whereas seeds of Enterolobium cyclocarpum are the longest ones. The areole shape was linear oblong in Acacia saligna, oblong in Albizia julibrissin and A. lebbeck, oval-oblong in Acacia tortilis, Enterolobium contortisiliquum and E. cyclocarpum; broad oval in Acacia nilotica and Dichrostachys cinerea and oval in the remaining seven taxa (Table 2). The testa sculpturing patterns observed under SEM were clearly variable among the taxa investigated (Table 2 and Fig. 1A-Q).

The seed morphological characteristics such as shape, colour, size and areole shape; if present, in combination with the testa sculpturing peculiarities observed under SEM had been found very useful in delimitation and identification of genera and species within family Leguminosae (Hussein et al., 2002 a, b; Taia, 2004; Abou-El-Enain et al., 2007 and Al-Gohary & Mohamed, 2007). Hussein et al. (2012) stated that diversity in the characteristics of the micropyle, hilum, and lens of seeds of Mimosoideae, when observed under SEM, offer indispensable criteria for separation primarily at the species level and sometimes at the subspecies level as well as very rarely at the rank of genus. In this work, the seed shape seems to be a reliable criterion for separating some of the taxa at the species level. Albizia lebbeck with compressed oval-oblong seeds could be distinguished from A. julibrissin with compressed oblong seeds. Prosopis farcta with compressed oval seeds could be differentiated from Prosopis juliflora with oval seeds. Also, the seed shape may represent a useful character for separation of Acacia tortilis subsp. raddiana with compressed broad oval seeds from A. tortilis having compressed oval seeds. However, Enterolobium contortisiliquum and E. cyclocarpum retained a similar seed shape which is oval-oblong. The seed
colour appeared clearly distinctive to *Acacia nilotica*; where it is brown mottled with yellowish white streaks and spots. Gunn (1981) reported that the legume testa is usually monochrome brown to black, rarely red, cream or white or occasionally dichrome as mottling or two distinct coloured areas.

TABLE 2. The macro- and micro-morphological features of seeds of the studied Mimosaoidae taxa.

<table>
<thead>
<tr>
<th>Characters</th>
<th>Seed Comp</th>
<th>Shape</th>
<th>Colour</th>
<th>Size(**) mm</th>
<th>Areole</th>
<th>Surface Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Taxa</td>
<td></td>
<td></td>
<td>L</td>
<td>B</td>
<td>Grade</td>
</tr>
<tr>
<td>Acacia saligna</td>
<td>+</td>
<td>oval-oblong</td>
<td>glossy dark brown</td>
<td>4.9</td>
<td>2.4</td>
<td>(S)</td>
</tr>
<tr>
<td>Acacia farnesiana</td>
<td>-</td>
<td>oval</td>
<td>brown</td>
<td>7.2</td>
<td>5.1</td>
<td>(M)</td>
</tr>
<tr>
<td>Acacia nilotica</td>
<td>+</td>
<td>broad oval</td>
<td>brown(*)</td>
<td>7.8</td>
<td>5.7</td>
<td>(M)</td>
</tr>
<tr>
<td>Acacia tortilis</td>
<td>+</td>
<td>oval</td>
<td>brown</td>
<td>5.3</td>
<td>3.6</td>
<td>(M)</td>
</tr>
<tr>
<td>Acacia tortilis subsp. raddiana</td>
<td>+</td>
<td>broad oval</td>
<td>brown</td>
<td>6.4</td>
<td>4.7</td>
<td>(M)</td>
</tr>
<tr>
<td>Albizia julibrissin</td>
<td>+</td>
<td>oblong</td>
<td>brown</td>
<td>8.6</td>
<td>4.2</td>
<td>(M)</td>
</tr>
<tr>
<td>Albizia lebbeck</td>
<td>+</td>
<td>oval-oblong</td>
<td>pale brown</td>
<td>10.8</td>
<td>7.6</td>
<td>(L)</td>
</tr>
<tr>
<td>Dichrostachys cinerea</td>
<td>+</td>
<td>broad oval</td>
<td>glossy brown</td>
<td>4.9</td>
<td>3.7</td>
<td>(S)</td>
</tr>
</tbody>
</table>
TABLE 2 Cont. The macro- and micro-morphological features of seeds of the studied Mimosoideae taxa.

<table>
<thead>
<tr>
<th>Characters Taxa</th>
<th>Seed Comp</th>
<th>Shape</th>
<th>Colour</th>
<th>Size(**) mm</th>
<th>Areole</th>
<th>Surface Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>L</td>
<td>B</td>
<td>Grade</td>
</tr>
<tr>
<td>Enterolobium contortisiliquum</td>
<td>-</td>
<td>oval-oblong</td>
<td>dark brown</td>
<td>9.1</td>
<td>3.7</td>
<td>(M) oval-oblong</td>
</tr>
<tr>
<td>Enterolobium cyclocarpum</td>
<td>-</td>
<td>oval-oblong</td>
<td>dark brown</td>
<td>11.9</td>
<td>6.9</td>
<td>(L) oval-oblong</td>
</tr>
<tr>
<td>Faidherbia albida</td>
<td>+</td>
<td>oval</td>
<td>glossy brown</td>
<td>7.8</td>
<td>4.6</td>
<td>(M) oval</td>
</tr>
<tr>
<td>Leucaena leucocephala</td>
<td>+</td>
<td>oval</td>
<td>glossy brown</td>
<td>6.9</td>
<td>4.6</td>
<td>(M) oval</td>
</tr>
<tr>
<td>Pithecellobium dulce</td>
<td>+</td>
<td>broad oval</td>
<td>dark brown-black</td>
<td>10.8</td>
<td>8.8</td>
<td>(L) oval</td>
</tr>
<tr>
<td>Prosopis farcta</td>
<td>+</td>
<td>oval</td>
<td>brown</td>
<td>8.1</td>
<td>5.1</td>
<td>(M) oval</td>
</tr>
<tr>
<td>Prosopis juliflora</td>
<td>-</td>
<td>oval</td>
<td>glossy pale brown</td>
<td>5.2</td>
<td>3.8</td>
<td>(M) oval</td>
</tr>
</tbody>
</table>

*Seed compressed; - Seed not compressed; L=Length; B= Breadth; Brown (*) = Brown mottled with yellowish white streaks and spots; Comp* = Seed compression; (**) Concerning seed size the following grades were taken into consideration: Small-sized seeds (S) i.e. less than 5 mm long; Medium-sized seeds (M) i.e. 5-10 mm long; Large-sized seeds (L) i.e. More than 10 mm long.
Fig 1 (A-F). SEM-Photomicrographs showing variation in the testa sculpturing patterns. A&B. Acacia saligna, x = 500, 750, respectively; C. Acacia farnesiana, x = 1500; D. Acacia nilotica, x = 1500; E. Acacia tortilis subsp. raddiana, x = 1500; F. Acacia tortilis, x = 1500; Fl = Fracture lines; P = Pleurogram.
Fig. 1. "continued" (G-K): SEM-Photomicrographs showing variation in the testa sculpturing patterns. G. Albizia julibrissin, x = 1500; H. Albizia lebbeck, x = 1500; I. Dichrostachys cinerea, x = 1500; J. Enterolobium contortisiliquum, x = 750; K. Enterolobium cyclocarpum, x = 1500; Fl = Fracture lines; P = Pleurogram.

The testa surface, among the taxa studied, exhibited seven basic sculpturing patterns namely: regulate, reticulate-foveolate, foveolate, faint polygonal-discoid plates, tuberculate, papillose and ill-defined coupled with variable pits. Furthermore, intergraded forms within some of the basic patterns were also observed. Manning and Van Staden (1987) reported the common occurrence of cuticular sculpturing in seeds of Mimosoideae which is usually rugose but sometimes it also exhibits modifications. Furthermore, Lersten & Gunn (1982) stated that the papillose pattern of the testa in many members of Leguminosae results from the protrusion of the tips of the epidermal cells.
The variation in the testa sculpturing patterns has been found very useful in the differentiation of the taxa studied. The combination of the salient macro-morphological features with the testa surface sculpturing patterns have ascertained the differentiation and segregation of the taxa investigated as illustrated in the following key:

I. Seeds compressed
- A. Seeds oval-oblong or oblong
  - B1. Testa faint irregularly tuberculate ———————————————————Acacia saligna
  - B2. Testa irregularly foveolate with variable foveolae ———————————————————Albizia julibrissin
  - B3. Testa compact coarse rugulate frequently with exaggerated thick rugae coupled with sparsely scattered variable pits ———————————————————Albizia lebbeck
- AA. Seeds oval or broad oval
  - C1. Testa ill-defined coupled with some variable pits; seeds brown
  - D1. Areole oval ———————————————————Acacia tortilis subsp. radiana
  - D2. Areole oval-oblong ———————————————————Acacia tortilis
  - C2. Testa compact regulate; seeds brown mottled with yellowish white streaks and spots ———————————————————Acacia nilotica
  - C3. Testa inconspicuous rugulate to ill-defined coupled with variable pits; seeds glossy brown ———————————————————Dichrostachys cinerea
  - C4. Testa tuberculate
  - E1. Testa obsoletely tuberculate; seeds glossy brown ———Faidherbia albida
  - E2. Testa prominent irregularly tuberculate; seeds dark brown-black
  - F1. Seeds oval-oblong
  - G1. Testa irregularly regulate ———————————————————Acacia farnesiana
  - G2. Testa compact fine rugulate coupled with sparsely scattered variable pits ———Prosopis juliflora
  - F2. Seeds oval-oblong
  - H1. Testa irregularly reticulate-foveolate with thick anticlinal ridges ———————————————————Enterolobium contortisiliquum
  - H2. Testa irregularly papillose ———————————————————Enterolobium cyclocarpum

II. Seeds not compressed
- F1. Seeds oval
  - G1. Testa irregularly regulate ———————————————————Acacia farnesiana
  - G2. Testa compact fine rugulate coupled with sparsely scattered variable pits ———Prosopis juliflora
  - F2. Seeds oval-oblong
  - H1. Testa irregularly reticulate-foveolate with thick anticlinal ridges ———————————————————Enterolobium contortisiliquum
  - H2. Testa irregularly papillose ———————————————————Enterolobium cyclocarpum

B. Seed protein electrophoresis

The banding patterns of the investigated taxa are shown in Fig. 2A. A total of 88 bands were scored in the electrophoretic profiles of seed proteins of these taxa. The similarity matrix among the taxa was given in Table 3. The highest similarity (55.26%) was recorded between the two Enterolobium species namely: E. contortisiliquum and E. cyclocarpum, followed by (53.49%)
similarity observed between *Acacia tortilis* and *A. tortilis* subsp. *raddiana*. However, the lowest similarity (7.14 %) was recorded between *Acacia saligna* and *Albizia lebbeck* followed by (8.11 %) similarity recorded between *Acacia tortilis* and *Albizia lebbeck* and also between *Albizia lebbeck* and *Enterolobium cyclocarpum*. The phenogram (Fig. 2B) resulted from the hierarchical cluster analysis of the seed protein profiles of the examined taxa illustrated that these taxa are splitting into six clusters including two groups (Fig. 2 B & C).

Cluster 1, II, and VI representing one species each namely: *Albizia julibrissin*, *Pithecellobium dulce* and *Acacia saligna* respectively. Cluster III comprises *Acacia tortilis*, *A. tortilis* subsp. *raddiana* and *A. nilotica*. Cluster IV includes *Faidherbia albida (= Acacia albida), Enterolobium contortisiliquum*, and *E. cyclocarpum*. Cluster V involves two groups: group 1, including *Prosopis farcta* and *P. juliflora*, and group 2, including *Albizia lebbeck, Leucaena leucocephala, Dichrostachys cinerea* and *Acacia farnesiana*.

**TABLE 3. Similarity matrix of seed protein profiles among the studied Mimosoideae taxa.**

<table>
<thead>
<tr>
<th>Taxa*</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>29.27</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>33.33</td>
<td>28.95</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>37.21</td>
<td>23.08</td>
<td>37.50</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>42.86</td>
<td>34.09</td>
<td>51.16</td>
<td>53.49</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>25.49</td>
<td>23.26</td>
<td>20.00</td>
<td>18.00</td>
<td>20.69</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>7.14</td>
<td>9.68</td>
<td>13.89</td>
<td>8.11</td>
<td>8.51</td>
<td>18.42</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>17.07</td>
<td>19.35</td>
<td>15.79</td>
<td>13.16</td>
<td>17.39</td>
<td>20.00</td>
<td>16.00</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>23.08</td>
<td>20.45</td>
<td>30.43</td>
<td>22.92</td>
<td>29.63</td>
<td>30.61</td>
<td>12.50</td>
<td>17.07</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>22.92</td>
<td>29.22</td>
<td>25.00</td>
<td>28.57</td>
<td>27.45</td>
<td>22.92</td>
<td>8.11</td>
<td>16.22</td>
<td>55.26</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>26.00</td>
<td>18.18</td>
<td>28.26</td>
<td>20.83</td>
<td>32.69</td>
<td>26.00</td>
<td>10.00</td>
<td>27.03</td>
<td>36.96</td>
<td>31.82</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>24.53</td>
<td>17.02</td>
<td>26.53</td>
<td>22.00</td>
<td>24.14</td>
<td>22.22</td>
<td>27.03</td>
<td>19.05</td>
<td>24.53</td>
<td>27.08</td>
<td>36.84</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>19.57</td>
<td>25.72</td>
<td>21.43</td>
<td>19.05</td>
<td>24.49</td>
<td>14.58</td>
<td>9.09</td>
<td>30.00</td>
<td>37.50</td>
<td>42.86</td>
<td>28.57</td>
<td>26.67</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>24.49</td>
<td>21.95</td>
<td>29.55</td>
<td>30.23</td>
<td>24.04</td>
<td>27.08</td>
<td>20.00</td>
<td>15.38</td>
<td>22.00</td>
<td>27.27</td>
<td>30.43</td>
<td>36.96</td>
<td>23.81</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>21.28</td>
<td>24.32</td>
<td>35.90</td>
<td>20.93</td>
<td>31.25</td>
<td>16.33</td>
<td>15.15</td>
<td>17.14</td>
<td>14.00</td>
<td>23.81</td>
<td>24.44</td>
<td>25.53</td>
<td>23.08</td>
<td>31.71</td>
<td>100</td>
</tr>
</tbody>
</table>

Taxa* are numbered as in Table (1).

Albizia julibrissin presented a considerable difference in its testa sculpture from A. lebbeck. This difference may support its clustering alone in Cluster I away from A. lebbeck based on its seed protein electrophoretic profile. According to Vassal (1972) and Pedley (1978) Acacia saligna has been placed in subgenus Phyllodineae (Syn. Subgenus Heterophrullum) while the other studied species of genus Acacia were classified in subgenus Acacia. A. saligna is actually with leaf-like petioles called phyllodes (Tiedeman and Johnson, 1992) while the other investigated Acacia species are with bipinnate leaves (Karakish, 2013). Moreover, Seeds of Acacia saligna exhibited a glossy dark brown colour and faint irregularly tuberculate testa which are not observed in any of the studied Acacia species. Hence, the separation of A. saligna in a separate cluster alone based on its seed protein profile can be justified. According to Vassal (1972) both of Acacia tortilis and A. nilotica belong to the subgenus Acacia. Thus, the clustering of A. tortilis and A. tortilis subsp. raddiana with A. nilotica together, in Cluster III, may conform to this closeness. The degree of dissimilarity of Faidherbia albida (= Acacia albida) from the two studied Enterolobium species, Cluster IV, is insufficient for its further splitting but it is delimited as a different identity. Guinet (1969) referred that Acacia albida appeared sufficiently distinct in its pollen characters to warrant generic status. Vassal (1981) added that the unusual features of Acacia albida warrant the exclusion of the species from genus Acacia and its inclusion in the genus Faidherbia. Bentham (1875) was the first to restrict the tribe Acacieae to the genus Acacia but Vassal (1981) pointed out that it seems more appropriate to put the monotypic genus Faidherbia in the tribe Acacieae. However, Elias (1981) mentioned that Faidherbia albida (based on Acacia albida) is better transferred to tribe Ingeae and it may link the Ingeae with the Acacieae. Thus, the inclusion of Faidherbia albida with the two studied species of Enterolobium included in tribe Ingeae as listed by Nielsen (1981), in Cluster IV, may support the opinion of Elias (1981). In addition, the clustering of Enterolobium contortisiliquum and E. cyclocarpum at high degree of similarity may support the reliability of seed protein profiles for delimitation at the generic level. Similar observations were also recorded in members of Leguminosae by Hussein and George (2002) on some species representing genera of tribe Vicieae.

In Cluster V the three genera: Prosopis, Leucaena and Dichrostachys are included in the tribe Mimoseae (Lewis and Elias, 1981); but Acacia belongs to the tribe Acacieae (Vassal, 1981) and Albizia involved in tribe Ingeae (Nielsen, 1981). The inclusion of Albizia lebbeck with Leucana leucocephala, Dichrostachys cinerea and Acacia farnesiana in Cluster V; group 2 may refer to the phyletic position of tribe Acacieae which is always considered a link between Mimoseae and Ingeae (Karakish et al., 2013).
Conclusion

In this study, the variation in some macro-morphological seed features viz. seed shape, areole shape and colour of seed as well as peculiarities of the testa sculpturing patterns can be useful in delimitation and identification of the taxa studied. In addition, the phenogram produced from the numerical analysis of the obtained characters from SDS-PAGE profiles of seed protein supported some of the taxonomic considerations of some members from the Mimosoideae-Leguminosae.

References


TAXONOMIC IMPLICATIONS OF SEED MORPHOLOGY AND …


Omonhinmin, C. A. and Ogunbodede, O. O. (2013) Genetic diversity, taxonomy and
legumin implications of seed storage protein profiling in Fabaceae. Afr. J.


England.


507.

or less continuously updated since.” will do. http://www.mobot.org/MOBOT/
research/APweb/ Accessed 20/12/2014.

1287-1302.


Vassal, J. (1972) Apport des recherches ontogeniques et seminologiques a l'etude


Received 15/1/ 2015;
accepted 19/3/2015)

The taxonomic implications of seed morphology and the electrophoretic differentiation of seeds in some taxonomic units of the Egyptian Nymphaeaceae family - the Nymphaeaceae family.

Nieha Michelle George - Hossam Wabbaa Ataseh - Ahmad Ghrib - Moustafa Mohsen Eldemash

Department of Botany - Faculty of Science - Zagazig University - Egypt.

The study examines the morphology of seeds of 14 types and one taxonomic unit of one species of plants belonging to the Nymphaeaceae family, which are collected in Egypt using both the scanning electron microscope and electrophoresis of seed proteins to highlight the taxonomic importance of their morphological characteristics and protein patterns.

The study concluded that the establishment of an artificial taxonomic key identifies the taxonomic units under study based on the morphological characteristics of their seeds, as well as the patterns of the protein surface of those seeds, and showed that the results of the quantitative analysis of the characteristics and protein patterns of the seeds of the taxonomic units showed their importance as taxonomic criteria that facilitated the discussion of some of the taxonomic views concerning the taxonomic status of the units under study.