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BOTANICAL STUDIES ON SOME GENERA OF MIMOSACEAE AND CAESALPINIACEAE
II – SEED FEATURES

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ABSTRACT

The morphological, physico–mechanical and anatomical seed characters, in addition to seed surface sculptures appearance by Scanning Electron Microscope (SEM) of 4 species belong to 3 genera within Mimosaceae and Caesalpiniaceae were studied. The first family represented by *Leucaena leucocephala* Lam. De Wit., while the second represented by *Delonix regia* Bogor ex Hook and two species of genus *Bauhinia*; *B. variegata* L. and *B. alba* Buch-Ham.

The aim of this study was to distinguish the taxonomic relationships between these species and to confirm the results already obtained from the first paper published on the morphological and ultrastructural features of leaves of the same species.

From the morphological result, it could be stated that both species of genus *Bauhinia* are more close to each other than to the other studied species. They shared many similar morphological characters; *i.e.* testa surface topography, hilum width, seed shape and seed colour. The physico-mechanical and anatomical characters were not taxonomically sharp enough to differentiate between the studied species, because there are some overlapping in the measurements already calculated. From the SEM on seed testa surface result, it is worthy to mention that there are three patterns for the seed testa, each characterized one of the studied genera, *i.e.* ocellate characterizes testa of *B.variegata* and *B. alba*, granulate for *Dolenix regia* and aculeate for *L. Leucocephala*.

All the above mentioned seed characters; morphological, physico-mechanical, anatomical and SEM on seed surface were coded and applied in numerical analysis by using a Single Linkage Clustering technique, which represents the similarity or dissimilarity between the studied species in a form of dendrogram. reflecting the taxonomic relationships between these species.

INTRODUCTION

There is little doubt of the close relationship to each other of the three subfamilies of Leguminosae. The group as a whole has probably been derived from rosaceous ancestor with perhaps the closest relationship with the Rosaceae being shown by the Caesalpiniaceae (Heywood, 1993).

The taxonomic position and structure of family Leguminosae were, for a long time, a state of argument among taxonomists. Many considered the family Leguminosae split into 3 sub-families; namely Caesalpinioideae, Mimosoideae and Papilionoideae (Bentham and Hooker, 1862 and Englar and Prantl, 1931; c.a. Shukla and Misra, 2001) all under order Rosales. Some ranked these subfamilies under order Leguminales as three distinct families (Hutchinson, 1969; c.a. Pandey, 2001). Recently, Cronquist (1981) and Takhtajan (1997) treated Fabales as an order includes 3 families; Fabaceae, Mimosaceae and Caesalpiniaceae.

The family Mimosaceae is the smallest family of order Fabales, it includes some 40 genera and about 500-2000 species (Rendle, 1959), while

Heywood (1993) mentioned 56 genera and 500-3000 species. Mainly tropical and sub-tropical trees and shrubs. Mimosaceae split into 8 tribes based on the leaves nature and the number and degree of the stamens fusion (Willis, 1973) or separated to 5 groups on the basis of pollen grain types (Heywood, 1993).

The family Caesalpiniaceae is mainly tropical and sub-tropical trees and shrubs [approximately 180 genera and 2500-3000 species (Heywood, 1993)]. The family could be divided into 7 to 9 tribes or groups of genera based on number of characters including leaves nature, flower irregularity, sepals fusion degree and anthers dehiscence mode.

Generally, legume seeds are the second great group of seeds to the human consumption. Seeds are very rich in protein, carbohydrates, oils, liquid fats (used in manufacturing soap, glycerin, paint resins), solid fats (used as candles), starch (used with paper and textile), gums (for making drugs, pulp and paper, ice cream and lotion). Seeds are also had medicinal values for their contents of alkaloids, aromatic oils and flavored components. Soft drinks are also made from the extraction of some legume seeds.

The family Mimosaceae has species of major economic importance; black and golden wattle which used in tanning, some used as useful timbers, gum and animal stock feed.

Caesalpiniaceae also contains a number of useful species whose applied as food, in manufacturing and in medicinal uses. Senna dry leaves and oil extracted from seeds are source of the purgative, and used for skin diseases and malaria, while roots are given to stomach patients. Buds of *Bauhinia* spp. are used against dysentery. While some species *i.e. Delonix regia* (*Poinciana regia*) are grown as ornamentals in the tropics and in greenhouses in temperate zones.

The aim of this study was to distinguish the relationships between the studied species and to confirm the results obtained from the first part of this study, Youssef (2006), about morphological and ultrastructural features of leaves.

MATERIALS AND METHODS

The current investigation was performed in season 2005. Seeds of 4 species belong to 3 genera of Mimosaceae and Caesalpiniaceae were studied (Table1).

Table (1): Botanical and English names and Synonyms of the studied species

Genera	Botanical names	English names	Synonyms
Bauhinia	*B. variegata* L.	Mountain ebony or Butterfly tree	*B. variegata* L.
	B. alba Buch-Ham.	White orchid tree	*B. variegata* var. *candida* Roxbg.
			Poinciana regia Boj.
Delonix	*D. regia* Bojor ex Hook	Peacock flower	*L. glauca* (L.) Benth.
Leucaena	*L. Leucocephala* Lam. De Wit.	Leadtree	

A year before, through 2004, dry mature seeds of these species were obtained through the curtsey of the stuff of the Orman Botanic Garden, Giza, Egypt, in addition to seeds personally collected from the trees already existing at Faculty of Agriculture, Cairo University. On the dry seeds, the following characters were recorded:

Studies of morphological seed characteristics have been evolved during the last few decades, due to the progressive use of the Scanning Electron Microscope (SEM). SEM on seed surface was applied by mounting the completely mature dry seeds with SPI supplies on copper stubs and coated with a thin layer of gold palladium in Edwards Sputter Coater, S150 B. Scanning was carried out by JEOL– JSMT100 Model Scanning Electron Microscope at National Researches Center, Giza. The magnification power (X) was between 50 to 4000 for SEM photograph varied according to the seed sizes.

Physico-mechanical characters of the dry seeds were also recorded by choose randomly 20 seeds representing each species to identify the following: seed density, specific gravity, floating index and shrinking value in addition to weight of 100 seeds.

To study the anatomical features of seed testa of each species, the maceration method of 10% chromic and nitric acids was used (El-Deigey, 1984). With this method, seeds were soaked in water, then testa was removed. Seed coats were cut into pieces and placed into test tube. A blend of equal volume chromic and nitric acids (10% concentration each) was added and left for 2 hours. The solution, then, washed and small amount was smeared to examine sclereids of seed coats. The sclereid characters recorded were; length, width and secondary wall thickness. The anatomical and morphological information of seed characteristics provide valuable diagnostic features, which can be usefully employed as criteria in the identification of any concerned species (Lawrence, 1967).

Germination test was carried out on 100 seeds of each studied species, in Randomized Complete Block Design with 4 replicates, each replicate with 25 seeds. To break the seed coat dormancy before germination, the hot water treatment is more practical. Seeds should be dropped into about six-times their volume of 80-100ºC pre-heated water. Seeds should be left to cool and soak in the water for 12 to 24 hours, after that they are ready for sowing. The container used for this treatment should not be made of aluminum as it may be toxic to seeds. Also softened water should not be used since the amount and ratio of salts may be also toxic to seeds. After hot water treatment, the seeds should be sown promptly and not stored again (Baskin and Baskin, 1998). Seeds were sown in the fume seedling trays with holes fill with plain sand, each with one seed, irrigated regularly every 3 days and the trays were kept at room temperature until the appearance of the first true leaves (app. 20 days). The following germination appearance characters were recorded:

1- Germination percentage (G %) = $\frac{\text{No. of germinated seeds}}{\text{No. of sown seeds}} \times 100$

2-Germination velocity (G.V.) = $\overline{X}$ days (from sowing to plumule emergence)

3-Germination capacity (G.C.) = $\frac{G\%}{G.V.}$

4-Germination period (G.P.) = $\overline{X}$ days (from plumule emergence to full seedling)

$$\text{5-Daily germination speed (D.G.S.)} = \frac{\text{No. of germinated seeds}}{\text{G.P.}}$$

Numerical analysis, known as phenetic analysis, is based on overall affinity (resemblance), and will be concentrated in this study on the species level. The resemblance between the specimens [Operational Taxonomic Units (OTU)] representing these species can be calculated in two steps; the first is to calculate the similarity (or distance) values between all possible pairs of specimens under study for all studied characters, then forming the similarity matrix (distance table). When the similarity matrix has been calculated for all pairs, the matrix is analyzed using Single Linkage Clustering technique. The similarity coefficient between all pairs of specimens involved in the study was calculated through the following formula. Number of characters used in this study was 17.

$$S (a, b) = \frac{\text{No. of characters in which states are shared by a x b}}{\text{No. of characters in which a x b have been compared}}$$

S: Similarity a,b: pair of specimens

This coefficient has the following properties:

- $0 < S (a, b) < 1$: always between 0 and 1
- $S (a, b) = 1$: if it is 1, means that objects a and b are identical.
- $S (a, b) > S (c, d)$: means that a and b are more similar than c and d
- S (a, \`a) = 1: means that the similarity of an object to itself is always 1.
- $S (a, b) = S (b, a)$: means that the similarity of a to b is the same as between b to a.

RESULTS AND DISCUSSION

I- Seed characteristics:

1- Seed morphology:

The seed morphological characters and seed surface sculpture patterns under Scanning Electron Microscope (SEM), in addition to the seed physico-mechanical characters are represented in Table (2) and illustrated in Plate(1) and Photograph (1).

A- Seed volume (cm^3):

According to the Xylometer method (Omran,2002), the seed volumes of the studied species showed that *D. regia* and *B. variegata* exhibited the biggest seed volumes; 0.38 and 0.37 cm^3, respectively. While seeds of *B. alba* were intermediate in volume, since it showed 0.19 cm^3. The smallest seed volume was with *L. leucocephala*; 0.05 cm^3.

B- Seed dimensions:

This character was recorded by measuring the seed length (from the center of hilum to the opposite side of the seed) and width (from both sides of seed at center parallel to hilum). It could be recognized the following sizes (as an average of 20 seeds of each species):

-The smallest seed dimensions (length X width) were observed in *L. leucocephala* (7.4 x 4.8 mm).

-The intermediate seed dimensions were with *B. alba* (11.8 x 11.4 mm) and *D. regia* (19.2 x 6.0 mm).

-The biggest dimensions were with *B. variegata* seed; 14.6 x 15.2 mm.

C- Seed shape:

Four seed shapes could be distinguished (Fig.1) among the studied species as follows:

-Very widely ovate as in *B. variegata*.
-Widely depressed ovate as in *B. alba*.
-Ovate as in *L. leucocephala*.
-Narrowly elliptic as in *D. regia*.

Table (2): Morphological and physico-mechanical characters of seeds of the studied species

Characters / Species	*B. variegata*	*B. alba*	*D. regia*	*L. leucocephala*
1- Seed morphology:				
A. Seed volume(cm^3)	0.37	0.19	0.38	0.05
B. Seed dimensions (mm)	14.6x15.2	11.8x11.4	19.2x6.0	7.4x4.8
C. Seed shape	Very widely ovate	Widely depressed ovate	Narrowly elliptic	Ovate
D. Seed colour	Light red brown	Dark red brown	Ivory blotched with brown	Dark chocolate brown
2- Seed morphology using SEM:				
A. Seed surface sculpture patterns	Ocellate	Ocellate	Granulate	Aculeate
B. Hilum dimensions (µ)	3000x333.33	1500x333.33	500x312.5	50x50
C. Hilum shape	linearis or fsciarius	lanceolatus or anguste ellipticus	ellipticus or ovalis	orbicularis
D. Micropyle position	At hilum groove end, inside hilum groove edge		Beside, with distance, the hilum	Adjacent, with no distance, to the hilum
3. Physico-mechanical features of seeds:				
A- Size weight (gm)	839.19	976.32	1353.16	1154
B- Specific gravity	0.84	0.98	1.35	1.15
C- Floating index	7.14	6.52	2.08	7.68
D- Shrinking value	2.69	1.89	1.42	1.58
E- 100 seeds weight (gm)	31.05	18.55	51.42	5.77

D- Seed colour:

Generally, seed colour as a qualitative character is varied not only between species, but also among different specimens of the same species.

The seed colour of the under investigation species (Fig.1) is quite homogenous within the same species, where specimens of *B. variegata* showed a light red brown seed testa, while the dark red brown was with the seed of *B. alba*. The background colour of seed testa of *D. regia* was ivory blotched by brown colour on both surfaces and around the seed. The dark chocolate brown colour of seed was noticed in the specimens of *L. leucocephala*.

2- Seed morphology using SEM:

SEM is proving to be an especially suitable tool for studying the seed surface and helps to detect minute differences in seed coat patterns, which might enable to define species characters. The morphological descriptions of the seed surface (testa) features by SEM successfully provided taxonomic evidences for the identification and classification of species as well as in establishing phylogenetic relationships between them (Corner, 1976 and Prasad *et al.*, 1978).

Fig. (1): Photographs of seed shape, size and colour for 4 species of Mimosaceae and Caesalpiniaceae

A- Seed surface sculpture patterns:

The seed surface sculpture of the studied species was found in three patterns; the ocellate shape noticed with *B. alba* and *B. variegate*, the granulate of *D. regia* and aculeate was the shape of seed surface of *L. leucocephala* (Plate1).

B- Hilum dimensions:

A linear relationship was noticed between the hilum length and width, otherwords, if the length increase, the width will increase too and vise versa. The maximum values for average length and width of hilum (Table2 and Plate1) were with *B. variegata* (3000 x 333.3µ), followed by *B. alba* (1500 x 333.3µ). The spherical shape of seeds of *L. leucocephala* arises from the equality between its hilum length and width in measurements (50 x 50µ). The dimension of *D. regia* seed was intermediate between the previous species, where it was 500 x 312.5µ.

C- Hilum shape:

According to the above mentioned measurements of hilum, it could be stated that, because the length of hilum of *B. variegata* is tenfold its width, the hilum shape was linearis or fsciarius (band – shaped). The hilum length of *B. alba* exceeded its width by five times, so the shape of hilum was lanceolatus (narrowly elliptic) or anguste ellipticus; where the ratio between hilum length and width was about 5 : 1. In *D. regia* the ratio between hilum length to width was approximately 2 : 1, so the proposed hilum shape was ellipticus or ovalis. The hilum shape of *L. leucocephala* was orbicularis, which is perfectly circular, as the length of hilum is equal to its width.

D. Micropyle position (Location):

Micropyle is the gap left by the two integuments at the top of the ovule. The location of micropyle varied among the studied species, while it was inside the hilum groove edge in both species of genus *Bauhinia*, it was beside or adjacent to hilum in *D. regia* and *L. leucocephala* (Table2 and Plate1).

Referring to the previous findings, Yeh and Kakuma (1990) suggested that seed characters (colour, coat patterns, shape, size, hilum measurements) lead to better criteria for species identification and support the taxonomic positions of a taxon. Basak and Maiti (2000) pointed out that the seed characters (size, colour and surface ornamentation) are used for delimitation of the studied species. In contrary, Tantawy and Rabie (2000) and Hussein (2000) pointed out that seed colour is considered of very limited value for its possible fluctuation within the same taxon at different durations.

Thompson (1981) stated that seed size as a character is subjected to ecological and physiological variations, so Mourad (1988) reported that this character is unreliable for either identification or differentiation between taxa. Contrary, Chang *et al.* (2000) considered that the most useful characters for identifying seeds were seed length, width and shape.

Kaur *et al.* (1992) examined some species of *Bauhinia* under SEM. They reported that the seed shape varies from orbicular to ovoid- oblong and the spermoderm pattern differed in the different species (being; smooth, pitted and rugose) with stomata only recorded in seeds of *B. variegata*.

Lersten *et al.* (1992) revealed that the genus *Bauhinia* showed a lens–like structure, which lies next to the micropyle instead of the usual position on the other side of the hilum. They named each structure a pseudolens.

Hussein *et al.* (2002) using SEM, investigated the seed characteristics in 17 species of Caesalpiniaceae, they stated that the differences in the characters of the micropyle and hilum seem to be distinctive for seeds of some species. Moreover, the testa patterns presented an indispensable criterion for delimitation primarily at the species level.

It is clear from the above mentioned results that the seed morphology appears to be of significant value in determining the taxonomic relationships between taxa. Variations of seed characteristics provide a useful tool for taxonomic delimitation purposes. In this regard, seed coat pattern which is detected by SEM gave remarkable results and contribution in analyzing many taxonomic treatments, whereas seed size and colour are considered to be of less value for its possible fluctuation within the same taxon at different duration.

3- Physico-mechanical features of seeds:

Seeds varied according to the physico-mechanical characters (Table2) as follows:

A- Size weight (density):

Size weight or density of seeds defined as the seed weight which their size is liter, and also considered a certain size weight of seeds or weight of liter in gram. There are many factors affect the size weight, for example; chemical structure of seeds, since the size weight of albuminous seed is greater than that of oil seeds because the size weight of starch exceeded that of protein, oil or fat (El-Baggoury, 1984). Another factors, *i.e.* humidity and seed maturation degree.

In this study, the size weight of seeds (Table2) of *D. regia* is the greatest (1353.16 gm) among the studied species, followed by *L. leucocephala* (1154 gm). The lowest size weight of seed was with both *Bauhinia* species, especially *B. variegata* (839.19 gm).

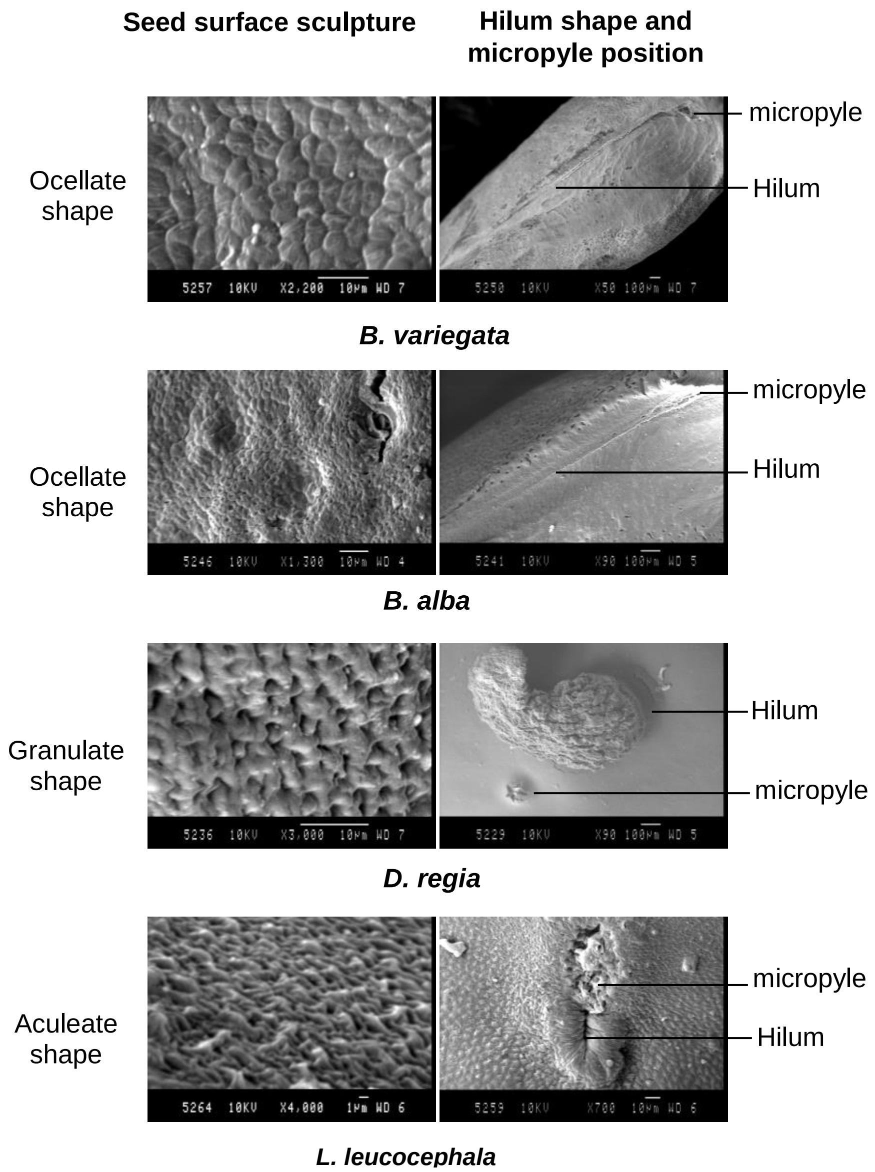

Plate (1): Seed surface sculpture patterns, hilum shape and micropyle position of the studied species as detected by SEM.

B- Specific gravity:

Seed specific gravity based on the physico-mechanical characters, humidity and the chemical and anatomical structure of seed. The specific gravity of albuminous seeds exceeded those contain protein and fat due to the difference in gravity of starch against protein and oil (El-Baggoury, 1984). Through this study, the same trend found with size weight of seed was observed also with seed specific gravity, since the greatest specific gravity was noticed in *D. regia* followed by *L. leucocephala*, then *B. alba*, while the lowest specific gravity was with *B. variegata* (Table2).

C- Floating index:

Floating index (Table2) is the relationship between the area of the biggest seed surface (cm^2) to its weight (gm). So, by increasing this area and decreasing its weight, the seed enable to transfer easily by wind.

The floating index of *L. leucocephala* seeds was the highest (7.68) among the studied species, followed by *B. variegata* (7.14), then *B. alba* (6.52). The lowest floating index was noticed with seeds of *D. regia*.

D- Shrinking value:

Seed shrinking occurs if its contents of humidity decrease suddenly, then seed shape becomes abnormal with irregular edge. The following formula is used to calculate the shrinking value:

$$\text{Shrinking value} = \frac{\text{Circumference of seed cross section}}{\text{Circumference of circle with equally area}}$$

If the result of this formula equal one, this indicates that the seed is full mature and vise versa. Under the present investigation the shrinking values of all studied seeds are great than one, it means that all these seeds are full mature. Both species of genus *Bauhinia* showed the greatest values; 2.69 and 1.89 for *B. variegata* and *B. alba*, respectively. With the other two species, the shrinking values exceeded one but less than the species of *Bauhinia* (Table2).

E- Specific weight (100 seed weight-gm):

This character considered as an indicator to seed size and its maturation. The 100 seeds weight of *D. regia* (51.42 gm) was the highest, followed by that of *B. varigata* (31.05 gm), then that of *B. alba* (18.55 gm). The lowest 100 seed weight (5.77 gm) was shown by *L. leucocephala* (Table2).

4- Anatomy of seed testa:

Testa (seed coat) is an outer protective layer of the seed, developed from the integuments of the ovule. Sclereids occur in many different places in the plant body (leaf mesophyll, vein endings, cortex, pith and stipules) as well as in seed coat (testa), or it is built entirely of sclereids (Vaughan, 1968 and Rao, 1974).

In this investigation, it could be recognized, among the studied species, only one pattern of sclereids; the macro-sclereids (rod-shaped) as seen in Figure(2), but differ in length, width and secondary wall thickness from species to another (Table3). The length of sclereids of *D. regia* was the greatest (92 µ) compared with those of the other species, despite its low secondary wall thickness (4 µ). The lowest length of sclereids (44.3 µ) occur in *B. alba*. It was also noticed that the presence of paratetracytic stomata occur only on the seed coats of both species of *Bauhinia; B. variegata* and *B. alba.* The above result was in accordance with that mentioned by Fahn, (1985), who classified the sclereids into 4 types; brachysclereids, osteosclereids, asterosclereids and macrosclereids. The macrosclereids cells often form a continuous layer in the seed testa of Leguminosae and this leads to exogenous dormancy for such seeds (Nikolaeva, 1977; c.a. Baskin and Baskin, 1998) which needs method to break dormancy before sowing.

Table (3): Sclereid measurements of seed testa of the four investigated species

Characters / Species	Sclereid length (μ)	Sclereid width (μ)	Secondary wall thickness (μ)
B. variegata	60	32	8
B. alba	44	32	4
D. rgia	92	3	4
L. leucocephala	76	16	6

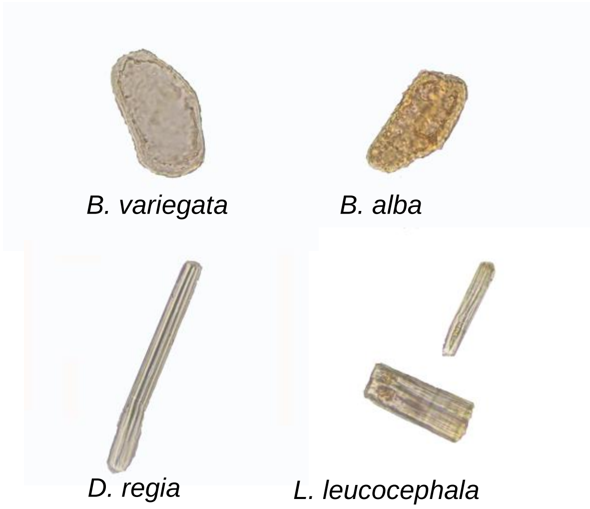

Fig. (2): Macerated tissue of seed testa of the 4 species of Mimosaceae and Caesalpiniaceae showing the macrosclereids. (200 X)

II- Germination characters:

Many seeds fail to germinate after processing and placement in favorable growing conditions, such seeds are said to be dormant. Generally, there are two types of seed dormancy, one of them is the seed coat dormancy. These seeds usually have a seed coat that is impermeable to oxygen and / or water (Baskin and Baskin, 1998). Macrosclereids or the hardened endocarp may be the reasons that seed coats become impermeable to water and caused a physical dormancy (Nikolaeva, 1977; c.a. Baskin and Baskin, 1998).

Methods of breaking seed coat dormancy include scarification, boiling water, dry heat, fire, acids treatment, light and cold or warm stratification (Baskin and Baskin, 1998). The results of the present experiment as seen in Table (4) could be summarized as follows:

The highest germination percentages (97% & 91%) were observed with the seeds of both species of genus *Bauhinia*. While the lowest percentages

(43% and 49%) were with seeds of *D. regia* and *L. leucocephala*, respectively. These results indicate that the seed testa of the latter two species included more mechanical tissues (sclereids) than those of genus *Bauhinia*. The average number of days from sowing seeds till the emergence of plumule (called germination velocity) was shorter in *L. leucocephala* (appr. 8 days) and *D. regia* (9 days) compared with those of *B. variegata* or *B. alba* (appr. 12 days). These results indicate that increasing the starch seed contents, increased the germination velocity too. This is supported by the results obtained earlier with size weight and specific gravity of seeds, thus *L. leucocephala* and *D. regia* seeds were germinated faster than those of *Bauhinia* species. Contrary, the average number of days for the germinated seeds to become real seedling (germination period) is shorter (6-7 days) with seeds of both species of *Bauhinia* than those of *D. regia* (9 days) or *L. leucocephala* (11 days). This could be due to some metabolic physiological activities within the seedling which reflected in turn on the germination period. The latter, when relative to the number of germinated seeds will affect the daily germination speed. Moreover, if this number was great and the germinated seed become seedling in a short time, the value of daily germination speed will be great, *i.e.* germination percentage of *B. variegata* was 97% and germination period was 6 days, then the D.G.S. is 16.17 compared to the other species.

Finally, increasing the germination percentage related to the decreasing in the germination velocity in some extent, the germination capacity will be great and vise versa. These results are in accordance with those obtained by El-Kady (2001) on *Livistonia* and *Sabal* palm and Radwan (1995) on *B. variegatga* and *D. regia*.

It is worthy to notice that the hypogeal type of germination could be observed in both species of genus *Bauhinia*, while the epigeal one was the characteristic of *D. regia* and *L. leucocephala* (Fig.3).

Table (4): Germination characteristics of the studied species

Species / Characters	*B. variegata*	*B. alba*	*D. regia*	*L. leucocephala*
1. Germination type	Hypogeal	Hypogeal	Epigeal	Epigeal
2. Germination percentage (%)	97	91	43	49
3. Germination velocity (days)	11.5	12	9	7.76
4. Germination period (days)	6	7	9	11
5. Daily germination speed	16.17	13	4.78	4.45
6. Germination capacity	8.43	7.58	4.78	6.31

III- Numerical analysis:

Numerical analysis is based on overall affinity (resemblance). Sneath and Sokal (1973) define numerical taxonomy as “the grouping by numerical methods of taxonomic units into taxa on the basis of their character states“. Many taxonomists regard phenetic and numerical taxonomy as being synonymous, but this is misleading as the latter by definition requires the application of numerical methods (Davis and Heywood, 1963).

The fundamental taxonomic units employed in numerical taxonomy of this study is referred to specimens as Operational Taxonomic Units (OTU) representing each studied species.

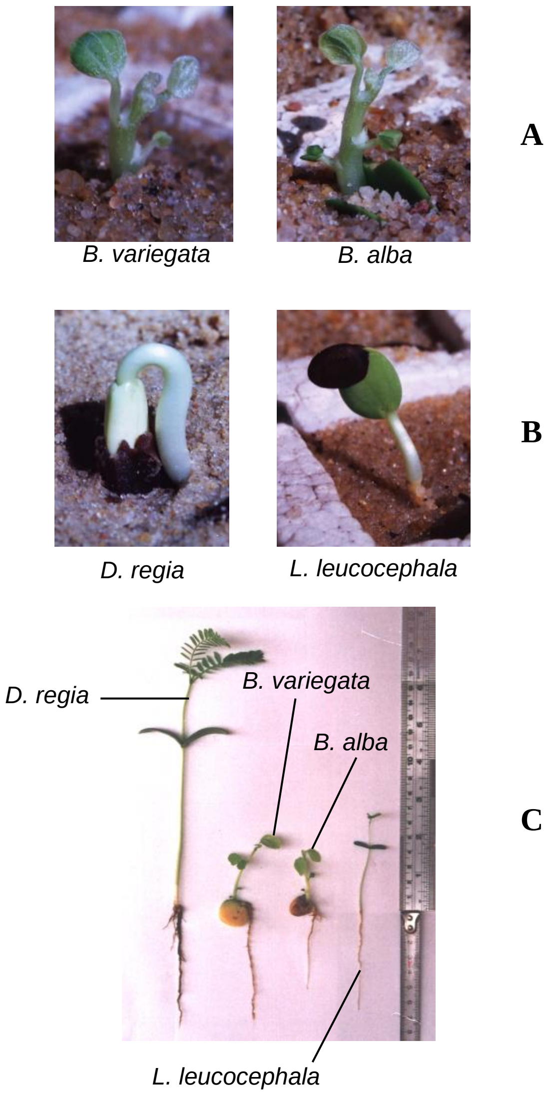

Fig. (5): Germination types and seedling shapes of the studied species.
A- Hypogeal germination.
B- Epigeal germination.
C- Seedling shapes.

All the morphological, physico-mechanical, anatomical and germination features of seed and seed testa surface were used to determine the similarity or dissimilarity between the studied species.

The dendrogram (Fig.4), produced by using these features of the specimens represent the studied species, has the highest average distance between clusters (Similarity level) at 0.80. At that level the studied specimens split into two clusters. The first which is distinguished at level 0.49, includes specimens representing the species; *Leucaena leucocephala*. Within this cluster some specimens are linked together at similarity level of 0.4, while the other specimens are formed hierarchically till level 0.49.

The second cluster divided into two major sub-clusters at level 0.72. The first sub-cluster which is determined at level 0.59 includes specimens representing the species *Delonix regia*. The second sub-cluster includes specimens, in different sub-cluster, are quite similar to each other. Some of these specimens exhibited sub-cluster of the species *B. alba* which is distinguished at level 0.60 and the other sub-cluster has specimens of *B. variegata* gathered at level 0.54.

The cluster which includes *Delonix regia* specimens was linked first to the clusters which have the specimens of *B. variegata* and *B. alba*. The main cluster which have all the above mentioned specimens was linked finally with the cluster with specimens of *L. leucocephala*.

Regardless the employed species, the present numerical analysis results were in accordance with those obtained by Khattab (2002) on some *Vicia* species, Youssef *et al.* (2003) and El-Sgai (2006) on some Poaceae species.

CONCLUSION

The results obtained from studying the morphological, physico-mechanical, testa anatomical and germination features of some species of families Mimosaceae and Caesalpiniaceae could be concluded as follows:

Invistigated species of genus *Bauhinia* (*B. variegata* and *B. alba*) are more close to each other than to the other studied species.

The other studied species under Caesalpiniaceae; *Delonix regia*, has some characters quite similar to both *Bauhinia* species, *i.e.* seed volume, hilum width, specific gravity, shrinking value, thickness of secondary wall, and germination velocity than to the species *L. leucocephala*.

The species *L. leucocephala* has different characters compared to other studied species, so the cluster which included its specimens was linked lately with the clusters included the specimens of the other species.

Seed testa surface sculptures appearance, seeds shape, floating index, thickness of secondary wall of sclereids, germination capacity are considered the most diagnostic taxonomic characters to differentiate between the studied species.

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دراسات نباتية على بعض أجناس الفصيلة الطلحية والبقمية
ثانيا- صفات البذرة:

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تم دراسة صفات البذرة المورفولوجية وخواصها الطبيعية الميكانيكية والتشريحية بالإضافة إلى أنماط سطح قصرة البذرة باستخدام المجهر الإلكتروني الماسح وذلك في اربعة أنواع تنتمي إلى ثلاثة أجناس تتبع الفصيلتين الطلحية و البقمية. وكان النوع *Leucaena leucocephala* ممثلا للفصيلة الأولى، بينما النوع *Delonix regia* والنوعان من جنس *Bauhinia* (*B. variegata* و *B. alba*) يمثلوا الفصيلة الثانية.

ويهدف هذا البحث إلى تحديد العلاقات التقسيمية بين تلك الأنواع وكذلك تأكيد النتائج المتحصل عليها في البحث الأول السابق نشره عن الصفات المورفولوجية وفوق المجهرية لأوراق نفس الأنواع.

وقد أظهرت النتائج المورفولوجية أن كلا النوعين من جنس *Bauhinia* كانا أكثر قرابة وتشابها لبعضهما عن الأنواع المدروسة الأخرى، حيث تشابها في العديد من الصفات مثل زخارف سطح البذرة وعرض السرة وشكل البذرة ولونها. وأظهرت النتائج التشريحية والطبيعية الميكانيكية أن هذه الصفات ليست فاصلة للتفرقة بين الأنواع المدروسة وذلك لوجود بعض التداخلات في القياسات التي تم أخذها.

و قد أوضح الفحص المورفولوجي لأسطح البذور باستخدام المجهر الإلكتروني الماسح وجود ثلاثة أنماط لسطح قصرة البذرة، يختص كل نمط منها بأحد الأجناس المدروسة، وهذه الأنماط هي: ذو العيون لقصرة بذرة النوعين *B. variegata* و *B. alba* ، والمحبب لقصرة النوع *D. regia* ، والشائك لقصرة النوع *L. leucocephala* .

وقد استخدمت جميع الصفات السابقة للبذرة في التحليل العنقودي العددي لتوضيح التشابه من عدمه بين الأنواع تحت الدراسة في صورة مخطط شجري، والذي يعكس بدوره العلاقات التقسيمية بين الأنواع.

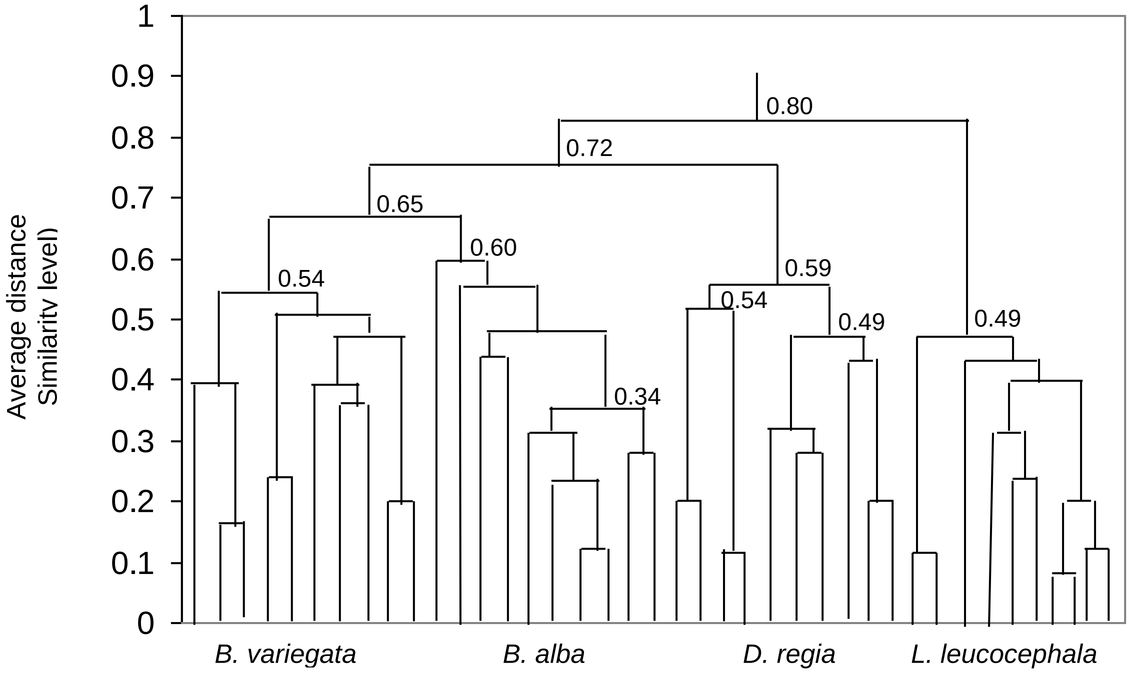

Fig. (3): Dendrogram of 40 specimens representing some species of Mimosaceae and Caesalpiniaceae based on morphological, physico-mechanical, testa anatomical and germination features.