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BOTANICAL STUDIES ON SOME GENERA OF MIMOSACEAE AND CAESALPINIACEAE
I- MORPHOLOGICAL AND ULTRASTRUCTURAL FEATURES OF LEAVES:

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ABSTRACT

Taxonomic relationships between 4 species belong to 3 genera of two fabaceous families; namely, Mimosaceae and Caesalpiniaceae were identified. These species were; *Leucaena leucocephala, Bauhinia variegata, Bauhinia alba* and *Delonix regia*.

The objective of this study was to through the light on the taxonomic relationships between these species by using leaf morphological characters and the lamina surface characteristics (stomata and trichomes) under the Scanning Electron Microscope (SEM). Single Linkage Clustering technique was applied to analyze these characters to represent the relationships between the studied species.

Morphological description results indicated that both species of genus *Bauhinia* and the species of genus *Delonix* are more close to each other in most of the studied characters. The SEM on lamina surface is supporting the obtained morphological results. A key includes morphological and SEM features studied was proposed.

INTRODUCTION

Bentham and Hooker, 1862 and Englar and Prantl, 1931(c.a. Shukla and Misra, 2001) and many other taxonomists considered Caesalpinioideae, Mimosoideae and Papilionoideae as 3 sub-families of the family Leguminosae under order Rosales. While, these sub-families are treated as distinct families by many botanists (Heywood, 1993 and Pandey, 2004) except those who cling to tradition. The authors are accepting the last point of view as separate families based on vast diversity of fruits and certain other characters. Hutchinson, 1969 (c.a. Pandey, 2001) has treated the 3 sub-families under order Leguminales.

Recently, the order Fabales includes 3 families; namely, Fabaceae, Mimosaceae and Caesalpiniaceae (Pandey, 2004). The family Mimosaceae (Acacia family), the smallest family of order Fabales; mainly tropical and sub-tropical trees and shrubs. It includes approximately 40 genera and 500-2000 species (Rendle, 1959). Leaves are often bipinnate and flowers regular with petals valvate in floral bud, with 10 or more stamens. Mimosaceae can be separated into 8 tribes on the basis primarily of the leaves nature and the number and degree of the stamens fusion (Willis, 1973). In addition, some classified it into 5 groups based on pollen type (Heywood, 1993).

The family Caesalpiniaceae (Cassia family) mainly tropical and subtropical trees and shrubs. The family comprised of 133 genera and 2500-3000 species (Rendle, 1959). Leaves are usually pinnate, but some times bipinnate. Flowers are usually more or less irregular with lateral petals (wings) covering the standard inside the floral bud, and with 10 or fewer

stamens, free or monadelphous (Pandey, 2004). Caesalpiniaceae can be divided into from 7 to 9 tribes or groups of genera on the basis of number of characters (Willis, 1973).

Plants of Mimosaceae are considered commercially important wood source for construction purposes, in making furniture or burnt as a fuel. Wattle bark is used in tanning. Some plants are used as source of useful timbers or as animal stock feed. Fruits (pods) are used as detergent for washing hair, silk and woolen fabrics. Gum obtained from the bark is of good quality, which is used in confectionery, textile, mucilage and polishpaste. Baskets are made from green twigs. Twigs are used as tooth green brushes. Perfume of good quality is obtained from the flowers of some plants. The writing and printing papers are made from the wood pulp of *Acacia* sp. The bark is used in the preparation of spirits from sugar and palm juice, acting as a classifying and flavouring agent. The dried leaves are used as substitute of soap.

Floral formula: ⊕ ♀ K5 C5 A∝ $\underline{G1}$.

Plants of family Caesalpiniaceae are either ornamental [Common ornamental plants are found belong to this family, i.e. *Bauhinia variegata* and *Delonix* sp. (*Poinciana*)] or of medicinal importance, few used as food or involved in some manufacture purposes. Leaves are used to cure ring-worm, skin diseases, malaria and with fruits as laxative and purgative. Bark is used in diabetes, chronic fevers and gonorrhea. Roots are relieving the spasms of stomach. Oil extracted from seeds is applied externally in leprosy and skin diseases (Pandey, 2001 and Shukla and Misra, 2001). Floral buds of *Bauhinia variegata* are used as vegetables.

Floral formula: ⊕ or % ♀ K5, or (5), C5, A10, $\underline{\overline{G1}}$.

The objective of this study is, taxonomically, to through the light on the relationships between some selected species of both families; Mimosaceae and Caesalpiniaceae using morphological and SEM features of leaf as evidences reflecting these relationships.

MATERIALS AND METHODS

Four species of Mimosaceae and Caesapliniaceae representing 3 genera were studied (Table1). The study was concentrated on plants representing these species in the juvenile stage. The reason of that is because there are some doubts about the identification of these species at this certain stage. Seeds of these species were personally collected, a year before sawing, from existing trees at Faculty of Agriculture, Cairo University, and Orman Botanical Garden, Ministry of Agriculture, Giza, Egypt. Seeds were sown at March 2006, after pretreated with boiled water to break seed dormancy. The experiment carry out was Randomized Complete Block Design with 4 replicates, each replicate with 12 plants. Leaves of 3 plants from each replicate were gathered for morphological and SEM studies. Samples for SEM technique were embedded in a critical point dryer at which completely immersed in absolute alcohol, and then it will substitute alcohol instead of water in the presence of CO_2 gas for coating and increasing

pressure. The temperature will rise until approximately 31°C, then the alcohol will evaporate and the samples become completely dry and their cells don't deform. The insulator samples must be coated by a thin layer of gold to get a highly focused image with the temperature not rise, so avoid damaging the samples. Scanning Electron Microscope (SEM) on the lamina surface of the sample operates at 10^{-5} torr vacum, accelerating voltage 60 kv and 40µA filament current. Scanning was carried out by JxA 840 A electron probe microanalizer JEOL model at National Researches Center, Giza. The SEM micrographs were used to facilitate the description of leaf surface morphology. The magnification power was expressed by (X) for each SEM photograph. It should be mentioned that the magnification power was in between X = 50 to X = 5000.

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

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

From the numerical analysis point of view, the number of characters used in this study was 17 (Tables 2 and 3), and the technique used was Single Linkage Clustering (Sneath and Sokal, 1973).

RESULTS AND DISCUSSION

This investigation was carried out to evaluate the relationships between 4 species representing 3 genera of Mimosoaceae and Caesalpiniaceae (Table 1). Leaf morphological characters and those of lamina surface scan, in addition to the numerical analysis were shown in the forms of accumulative tables, plates, microphotographic pictures and dendrogram aiming to facilitate the similarity or dissimilarity between the studied species.

The description of leaf morphology and lamina surface features of the studied species are presented in Tables (2 and 3) and illustrated in Figures (1,2 and 3) and Plates (1 and 2) as follows:

***Bauhinia variegata*:**

Leaf simple, upper leaf surface smooth, lower rough, margin smooth, elliptic shape, leaf apex deeply emarginate, leaf base cordatus, stipule reddish, leaf axis green, moderately hairy. Stomatal type paratetracytic, stomatal pore 2.7µ in length, stomatal apparatus 8.3 x 4.7 µ in dimension, average number of stomata on the upper surface 23.3 and 55.6 on the lower one.

***Bauhinia alba*:**

Leaf simple, upper leaf surface smooth, lower rough, margin smooth, elliptic shape, leaf apex deeply emarginate, leaf base cordatus, stipule green, leaf axis green, sparsely hairy. Stomatal type paratetracytic , stomatal pore 5.7µ in length , stomatal apparatus 10.7x7.1 µ in dimension, average number of stomata on the upper surface 5.6 and 11.1 on the lower one.

Table (2): Morphological description of leaves of the studied species.

Species / Characters	*B. variegata*	*B. alba*	*D. regia*	*L. leucocephala*
1. Leaf type	Simple (Prophyle exist)	Simple (Prophyle exist)	Bipinnate (Pinnate in first 3 leaves)	Bipinnate (Pinnate in first leaf)
2. Upper lamina surface texture	Smooth	Smooth	Smooth	Smooth
3. Lower lamina surface texture	Rough	Rough	Weakly rough	Smooth
4. Lamina margin texture	Smooth	Smooth	Rough	Rough
5.Lamina shape	Elliptic	Elliptic	Oblong	Falcatus
6.Lamina apex shape	Deeply emarginate	Deeply emarginated	Cuspidate	Retuse
7. Lamina base shape	Cordatus	Cordatus	Inaequilaterus	Oblique
8. Stipule colour	Reddish	Green	Green	Green
9. Leaf axis colour	Green	Green	Green	Red on adaxial surface
10- Hair density	Moderately	Sparsely	Few	None

Table (3): Scanning Electron Microscope description on lamina surface of the studied species.

Species / Characters	*B. variegata*	*B. alba*	*D. regia*	*L. leucocephala*
1. Stomatal type	Paratetracytic	Paratetracytic	Paracytic	Anomocytic
2. Stomatal pore length (μ)	2.7	5.7	4	8
3. Stomatal apparatus length (μ)	8.3	10.7	10	15
4. Stomatal apparatus width (μ)	4.7	7.1	6	10
5. Stomatal apparatus dimention (μ)	39.01	76	60	150
6. No. of stomata/cm^2 on lamina upper surface	23.26	5.56	6.67	5.93
7. No. of stomata/cm^2 on lamina lower surface	55.56	11.11	13.33	11.00

***Delonix regia*:**

Leaf bipinnate (pinnate in the first 3 leaves), upper lamina surface smooth, lower weakly rough, margin rough, oblong shape, lamina apex cuspidate, lamina base inaequilaterus, stipule green, leaf axis green, few hairs. Stomatal type paracytic, stomatol pore 4μ in length, stomatal apparatus 10 x 6 μ in dimension, average number of stomata on the upper surface 6.7 and 13.3 on the lower one.

***Leucaena leucocephala*:**

Leaf bipinnate (pinnate in the first leaf), upper lamina surface smooth, lower smooth, margin rough, falcatus shape, lamina apex retuse, lamina base

oblique, stipule green, leaf axis red on adaxial surface, glabrous. Stomatal type anomocytic, stomatal pore 8 µ in length, stomatal apparatus 15 x 10 µ in dimension, average number of stomata on the upper surface 5.9 and 11.0 on the lower one.

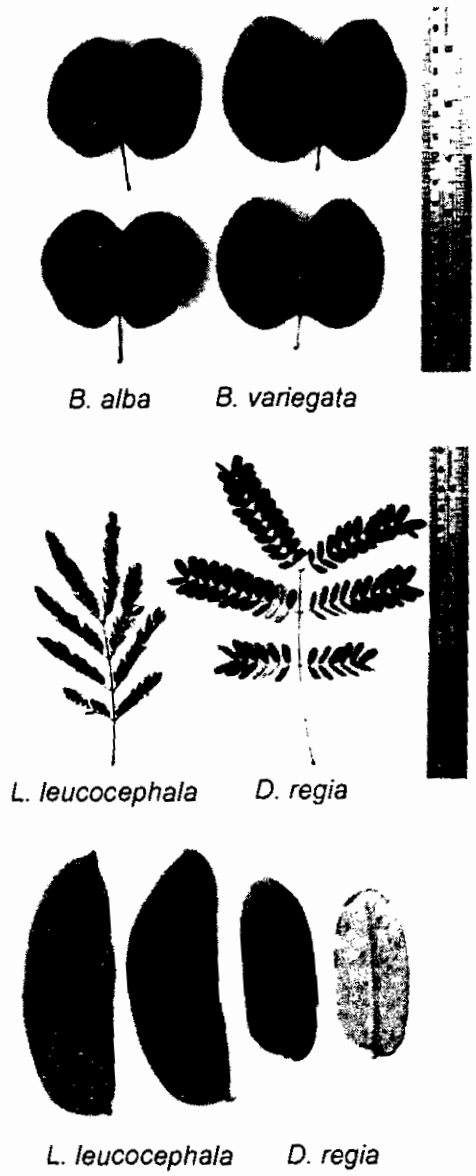
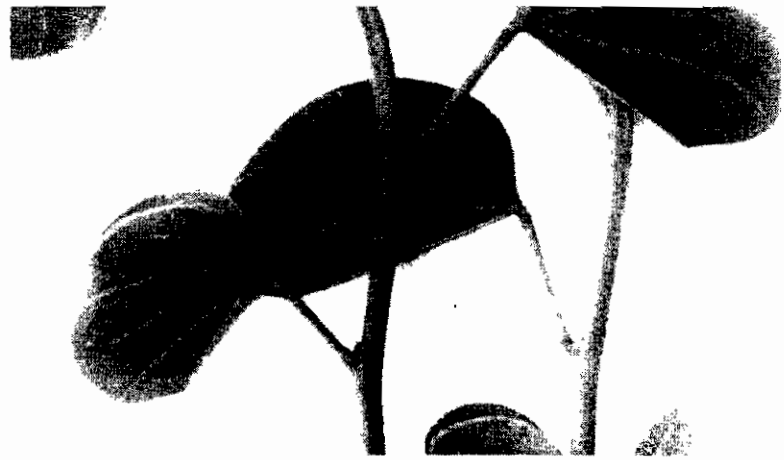


Fig. (1): Leaf types and shapes of lamina apex and base of the studied species.



B. variegata *B. alba*

L. leucocephala *D. regia*

Fig. (2): Colour of leaf axis and stipules of the studied species.

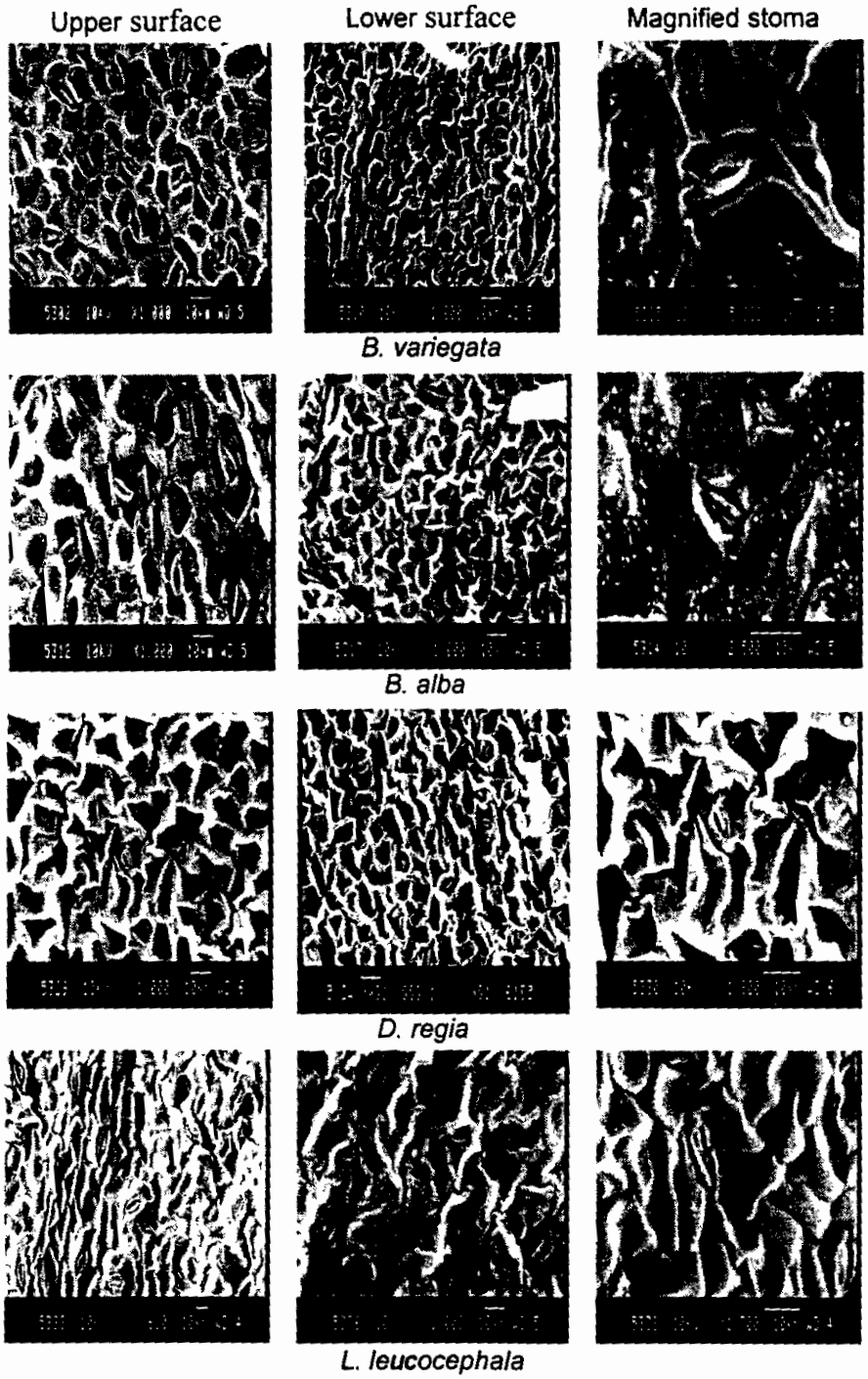
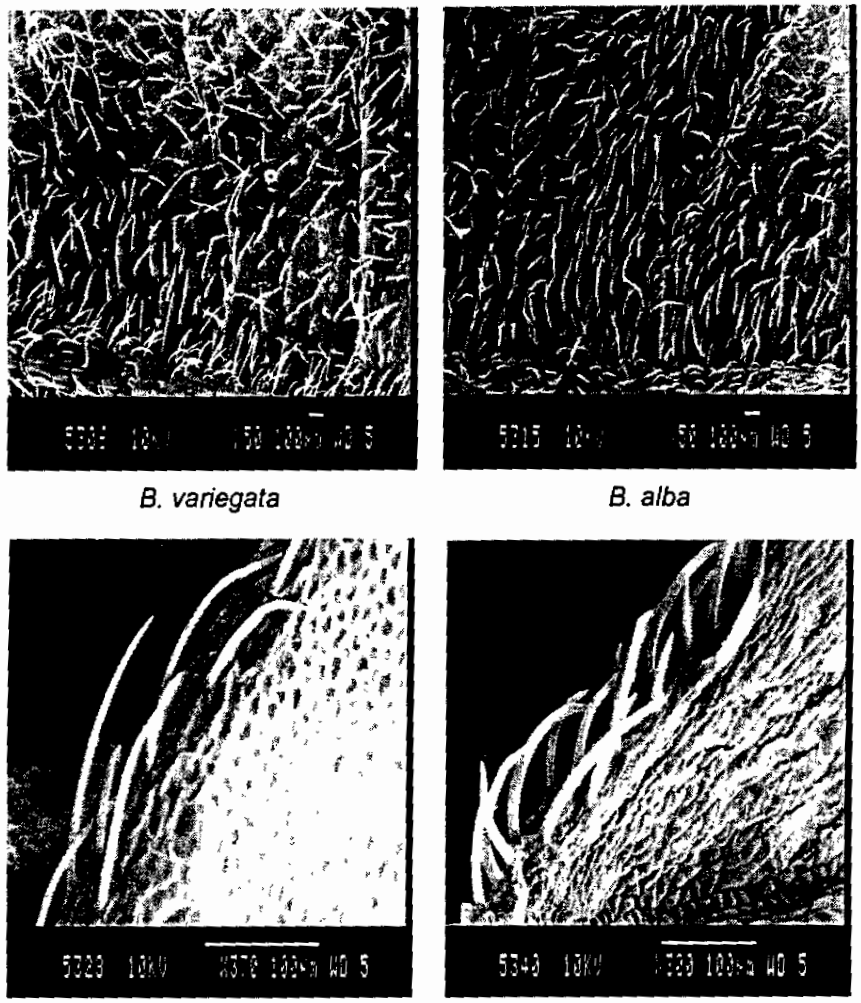


Plate (1): Lamina stomatal shape and density as shown by SEM.



B. variegata *B. alba*

D. regia *L. leucocephala*

Plate (2): Lower lamina surface texture as shown by SEM.

Results obtained from some leaf morphological description and scanning of lamina surface of each species provide good taxonomic evidences for differentiating between these species. Leaf type, and shapes of lamina, apex and base, in addition to stomatal type and stomatal apparatus dimension are considered sharp taxonomic characters, since these characters split the studied species into 3 groups. One includes both species of genus *Bauhinia*, the second includes *Delonix regia* and the third with *Leucaena leucocephala*.

Numerical analysis:

Data obtained from the leaf morphological characters and SEM on lamina surface were applies in clustering analysis using Single Linkage Cluster Analysis technique. The final result of this technique is a dendrogram (Fig. 3) representing the level of similarity in which the studied species have been shared.

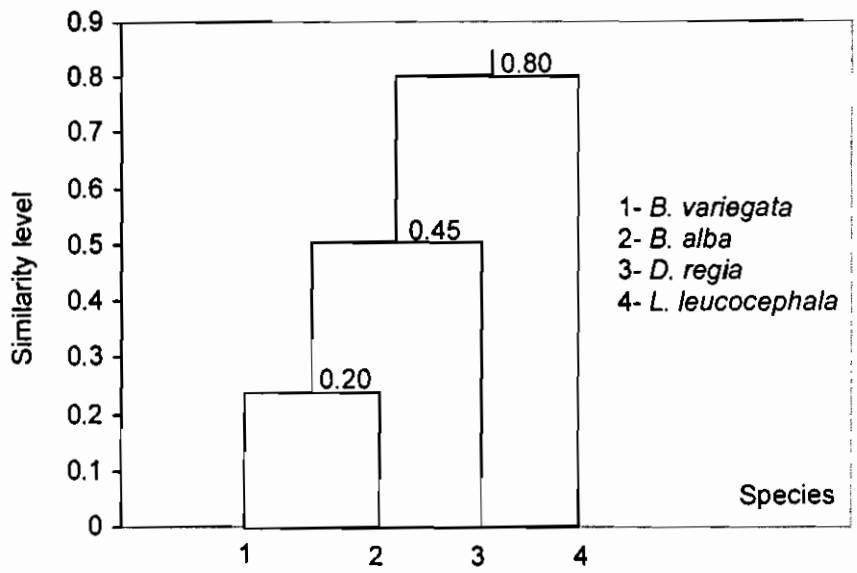


Fig. (3): Dendrogram representing the similarity between 4 species belong to Mimosoaceae and Caesalpiniaceae

The dendrogram created had the highest average taxonomic similarity value of 0.80. At this level; the studied species divided into two major groups. The first which was distinguished at level 0.45, included species of genus *Bauhinia* (*B. variegata* and *B. alba*) at level 0.20 and *Delonix regia* at level 0.45. The second group, which was distinguished at level 0.80 included the species *leucaena leucocephala*.

From the dendrogram, it could be stated that all the specimens representing either *B. variagata* or *B. alba* were joined together early in one cluster at low similarity level (0.20). Contrary, all the specimens representing *L. leucocephala* formed a cluster separated from the other clusters and joined them at the highest similarity level (0.80). It could be noticed also that the specimens of *Delonix regia* have characters quite similar to specimens of *B. variegata* and *B. alba* rather than to specimens of *L. leucocephala*.

The present numerical analysis results were in harmony with those reported by Khattab (2002) on *Vicia* species, Youssef *et al.*, (2003) and El-Sgai (2006) on some species of Poaceae.

The proposed key was already established based on the leaf morphological characters and on the SEM of lamina surface to identify the studies species:

A- Leaf simple, lamina shape elliptic, stomatal dimension vary.
  B- Stipule colour reddish, leaf moderately hairy, stomatal apparatus dimension ± 40 µ .... *B. variegata*
  BB-Stipule colour green, leaf sparsely hairy, stomatal apparatus dimension ± 70µ ..... *B. alba*
AA- Leaf bipinnate, lamina shape vary, stomatal shape vary.
  C- Lamina apex cuspidate, lamina base inaequilaterus, stomatal shape paracytic ..... *D. regia*
  CC-Lamina apex retuse, lamina base oblique, stomatal shape anomcytic ..... *L. leucocephala*

CONCLUSION

The results obtained from leaf morphological characters and SEM on lamina surface, in addition to the numerical analysis results could be concluded as follows:

- Both species of genus *Bauhinia* (*B. variegata* and *B. alba*) were more close to each other in most studied characters.
- Species of genus *Delonix* (*D. regia*) has quite number of characters varied from other studied species, but similar to species of genus *Bauhinia* more than to that of *Leucaena*.
- Species of genus *Leucaena* (*L. leucocephala*) has mostly different characters than those of the other species, either of genus *Bauhinia* or *Delonix*.

The above mentioned results were in agreement with those obtained by Leelavathi and Ramayya, 1983, Kotresha and Seetharam, 1995, Hughes, 1998, and Arpita *et al.*, 2002.

REFERENCES

Arpita, B.; C.H. Rahaman; R.K. Kar and M. Sudhendu. (2002). Micromorphology of foliar epidermis of some tropical tree legumes. Phytomorphology. 52(2/3): 223-230.

El-Sgai, M.U. (2006). Comparative morphological and ultrastructural studies on grains of some Poaceae species. J. Agric. Sci. Mansoura Univ. 31(1): 175-191.

Heywood, V. (1993). Flowering plants of the world. BT Batsford Ltd. London, UK. Pp 336.

Hughes, C. (1998). Monograph of *Leucaena* (Leguminosae-Mimosoideae). Systematic Botany Monographs. 55: 244. (c.a. CAB Abstr. 19991603312).

Khattab, A.M. (2002). Features of seeds and their ultrastructure surface variation in some taxa of genus *Vicia* (Fabaceae). J. Agric. Sci. Mansoura Univ. 27(5): 3005-3020.

Kotresha, K. and Y.N. Seetharam. (1995). Epidermal studies in some species of *Bauhinia* L. (Caesalpinioideae). Phytomorphology. 45(1/2): 127-137.

Leelavathi, P. and N. Ramayya. (1983). Structure, distribution and classification of plant trichomes in relation to taxonomy II. Caesalpinioideae. Indian J. of Forestry. 6(1): 43-56.

Pandey, B.P. (2001). Taxonomy of angiosperms. S. Chanad and Company LTD., New Delhi, India. Pp 551.

---------- (2004). A text book of botany; angiosperms. S. Chanad and Company LTD., New Delhi, India. Pp 990.

Rendle, A.B. (1959). The classification of flowering plants. Cambridge Univ. Press, UK. Pp 428.

Shukla, P. and S.P. Misra. (2001). An introduction to taxonomy of angiosperms. Vikas Publishing House Pvt Ltd., New Delhi, India. Pp 546.

Sneath H.A. and R.R. Sokal. (1973). Numerical taxonomy, the principles and practice of numerical taxonomy. Freeman and Co., San Francisco, USA. Pp 359.

Willis, J.C. (1973). A dictionary of flowering plants and ferns. Cambridge Univ. Press, UK. Pp 1323.

Youssef, Fadia A.; A.M. Khattab; S.H. Rabie and Hanan S. Abd-El Maksoud. (2003). Using grains as an evidence for taxonomy of some species of Poaceae. J. Agric. Sci. Mansoura Univ. 28(6): 4493-4516.

دراسات نباتية على بعض أجناس الفصيلة الطلحية والبقمية:
أولا- الصفات المورفولوجية وفوق المجهرية للأوراق:

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تم تحديد العلاقات التقسيمية بين ٤ أنواع تنتمي إلى ٣ أجناس لفصيلتين بقوليتين هما الطلحية و البقمية وكانت تلك الأنواع هي *Leucaena leucocephala* و *Bauhinia variegate* و *Bauhinia alba* و *Delonix regia* .

وتهدف هذه الدراسة إلى إلقاء الضوء على العلاقات التقسيمية بين هذه الأنواع باستخدام الصفات المورفولوجية للورقة وصفات المسح السطحي لنصل الورقة والتي اشتملت على الثغور والزوائد وذلك باستخدام الميكروسكوب الإلكتروني الماسح، وقد تم استخدام التحليل العنقودي العددي في تحليل هذه الصفات لتوضيح العلاقات بين الأنواع تحت الدراسة.

ولقد أوضحت نتائج الوصف المورفولوجي أن هناك تقاربا في أغلب الصفات للأنواع المدروسة بين جنسي *Bauhinia* و *Delonix* ، ولقد دعمت نتائج الميكروسكوب الإلكتروني الماسح على سطح الورقة تلك النتائج المورفولوجية المتحصل عليها. هذا وقد اقترح مفتاح نباتي يشتمل على الصفات المورفولوجية للأوراق وكذلك صفات المسح الإلكتروني لسطوح أنصال تلك الأوراق للتمييز بين الأنواع المدروسة.