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ANATOMICAL AND PALYNOLOGICAL CHARACTERS OF CELTIS L. IN KURDISTAN-IRAQ

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ABSTRACT:
Anatomical and palynological characters of *Celtis* genus growing in Iraq were studied in an attempt to provide useful features to delimit taxa and to refine taxonomic relationships. Results revealed the presence of lithocysts inside the leaf structure of *C. tournefortii* with few of them forming very small protrusion out of the leaf, while in *C. australis* lithocysts form large protrusion out from the leaf. The large midrib adaxial hump of *C. tournefortii* constitute a wide area between the two sides of the leaf blade, while in *C. australis* the small midrib adaxial hump produce narrow area between the two sides of the leaf blade. Stomata are of anomocytic type in *C. australis* while, anomocytic and paracytic in *C. tourneforti*. Furthermore, simple hairs are dense on the adaxial side of the petiole of *C. tournefortii* var. *tournefortii*, while absent from the adaxial side of the petiole of *C. tournefortii* var. *glabrata*. Leaves of all taxa are distinctly bifacial, hypostomatic, and provided with one layer of palisade parenchyma. Pollen grains are 3-porate, rarely 4-porate. A sunken area in the aperture surrounding a pore is distinct. Pollen is mediae in size and subprolate in shape, the pollen grains of *C. australis* together with var. *glabrata* belong to Celtis-type grain, while, var. tournefoertii to the Ulmus-type grain. The high anatomical and palynological differences between varieties of *C. tournefoertii* support promotion of these two varieties to the specific level.

KEYWORDS: *Celtis australis* L., *Celtis tournefortii* Lam., *Celtis tournefortii* var. *tournefoertii*. *C. tournefortii* var. *glabrata* (Stev. ex Planch.) Bois., Lithocysts, Celtis-type grain, Ulmus-type grain.

1. INTRODUCTION

Since the mid-20th century, the discipline of plant anatomy becomes a separate, distinct field, and refers only to the internal plant structures (Raven et al., 2005), while plant anatomy is now investigated at the cellular level, and primary constitutes that the sectioning of tissues and microscopy. The use of anatomical characters in taxonomy has been confined to the last 135 years or so, since the high power microscopes have become commonly available. Moreover, there has been a remarkable revolution in the last 65 years, or so, in the investigation of vascular plant anatomy and its use in classification. The anatomical characters, as indicated by Stace (1980) are as valuable as morphological ones and must not be neglected. In taxonomy, every anatomical aspect of plant should be studied without insisting on some and ignoring others, therefore, the quantity of information accumulated are enormous. Most notable of these is the anatomy of the dicotyledons (Metcalfe and Chalk, 1950); Florin's (1933) work on the epidermis and cuticle of gymnosperms). Leaf anatomy and architecture of trees have been carried out as an interesting tool for identifying plants (Ponessa, et al. 1998; Leonardi, et al. 2002; Mantese and Montaldo, 2002; Suárez, et al. 2004; Wagner and Ponessa, 2004).

The leaf and stem anatomy of *Celtis australis* L. and *C. occidentalis* L. (Taha, et al. 2011) have been investigated to seek after diagnostic characters necessary for differentiating between these two *Celtis* species. Results show great similarity between the morphological characters of the two plants. It is apparent according to the researchers that the upper and lower leaf surfaces are covered with striated cuticle, but the lower surface shows strong cuticular ridges. Stomata are present only on the abaxial surface and are mostly of the paracytic type with few anisocytic and anomocytic stomata. Moreover, the palisade parenchyma cells are found to consist of one row of closely packed cells, interrupted by large cystoliths containing calcium carbonate. Cystoliths may be accompanied by unicellular hairs protruding from the epidermis, while the spongy tissue is found to form more or less rounded cells containing calcium oxalate cluster crystals.

The leaf crosses section and cuticular structure of *Celtis australis* was also investigated by Yaman (2005), his Results referred to the existence of stomata only on the abaxial surface (hypostomatic) and are of anomocytic type.

The same study of Yaman (2005) but on *Celtis* pollen grains indicated that pollen type in *Celtis australis* L. is stephanoporate, pollen shape is sphaeriodae, and ornamentation is verrucate. Based on palynological data the tribes Celteae and Ulmeae are more or less well distinguished (Erdtman, 1966). The pollen grains in Celteae are mostly 2- to3-porate, suboblate to oblate-spheroidal, with an arcoid streaked sexine. Pollen grains of Ulmeae are 4- to 6-porate, colpate, or rupate, oblate to suboblate, with an arcoid streaked sexine (Edward, 1971). Using light and scanning electron microscopy (SEM), Iranian *Celtis* species pollen morphology was compared with some African ones (Mehrdad et al., 2010). Results revealed that the Iranian *Celtis* pollen grains are triporate or tetraporate and the phenotypic shape is mostly prolate and subprolate, moreover, the maturity of the Iranian *Celtis* grains are larger in size, while lower in their sculptural density when compared with African *Celtis*. In Iraq, no taxonomic anatomical accounts for *Celtis* genus are available. Objective: The taxonomic relationships between species of the same genus as well as between taxa within species need more distinction and separation by diagnostic characters. The present

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study has been planned in an attempt to provide useful anatomical and palynological features to delimit taxa and to refine taxonomic relationships among them. The anatomical differences may provide key taxonomic traits to differentiate between the highly related taxa.

2. MATERIALS AND METHODS

Mature leaves were collected from naturally growing trees and shrubs of *Celtis australis*, *C. tournefortii* var. tournefoertii and *C. tournefortii* var. *glabrata* from different physiographic regions of northern Iraq. Five leaves from each 5 trees per each taxon were obtained. Specimens were deposited in the herbarium of the College of Agriculture, University of Duhok (DPUH).The vegetal material was fixed in FAA (formalin: glacial acetic acid: alcohol 5:5:90). For the anatomical study, free-hand sections were made on the central parts of leaf blades and petioles. The cross sections samples were stained with Safranin and fast green (Al-Muhtar, et al. 1982). Histological observations and micrographs were performed with Olympus CX2. Suitable images were photographed using Sony 18.2 mega pixel. Characters studied were those pointed out by many authors as taxonomically interesting (Ellis 1976, 1979; Devesa 1992).

2.1 Cuticular Structure

Mature leaves were selected for light microscope measurements. Samples were dehydrated using ethyl alcohol 90%, then stored in 70% ethanol. leaves of each taxon were sampled randomly from ethanol, washed in distilled water, dried, then immersed in glacial acetic acid and hydrogen peroxide (1:1 volumes), left in oven at 60 °C for 20-40 hours, depending on the taxon. Adaxial and abaxial peelings from the macerated leaves were stained with safranin–glycerin jelly, mounted on microscopic slides, covered by slides.
The following measurements were recorded, average of 25 observations for each:

1. Abaxial and adaxial epidermal cell dimensions.
2. Epidermal cell density = number of epidermal cells / mm^2.
3. Stomatal dimensions.
4. Stomatal density = number of stomata /mm^2.
5. Stomatal index % = {stomata density/(stomata density + epidermal cell density}*100.
6. Summary statistics (mean, range, and standard deviation) calculated for each character.

2.2 Pollen preparation

Flowering buds in the stage just before anthesis were collected from living plants of each taxon foundin wild populations. Flower samples were dried in the laboratory conditions, kept at 4Cº for later use. Preparation of pollen grain for observing by Light Microscope was achieved using stored fresh material. Pollen grains were mounted in methyl green-glycerin jelly; large chunks of pollen grains may be separated if necessary by stirring (1g methyl green dissolved in 100 ml alcohol 95%) (Radford, et al.1974). The following morphological characters were examined using the same Olympus microscope:
polar length (p), equatorial diameter (e), p/e ratio, number of apertures, mesocolpium (in the equatorial view), apocolpium, colpus length, exine thickness, shape of the aperture, mean, range and standard deviation for each character was based on 30 observation for each species, Size classes of Erdtman (1945) were assessed, while shape classes of Erdtman (1971) were followed. The pollen terminology was that indicated by Punt, et al. (1999) and Erdtman (1971).

3. RESULTS AND DISCUSSION

3.1 Leaf blade, Midrib, and Petiole Anatomy

3.1.1 Characteristics of the genus *Celtis*: Leaves of *Celtis* are mainly rough in structure, due to waxy protrusions and numerous lithocysts that protrude out from the leaf or remain at the surface, Figures (1). In general leaf thickness ranges between 94.23 to 218.64µm (Table 1). Cuticle is relatively thick covered by epicuticular wax or crust of varying sizes; sometimes thick especially on the blade abaxial side, others thin and vanish completely. The single layer epidermis and stomata has highly variable cell sizes of the leaf surface (Figure 1 and 2). The upper epidermis thickness ranges between 12.63 to 36.28µm and the lower records 7.51 to 23.47µm (Table 1). The cuticle and the epidermal cells of adaxial face are thicker than the abaxial face; huge size differences occur between the two epidermal layers.
Leaves of *Celtis* are distinctly bifacial with the mesophyll tissue differentiated into palisade and spongy cells. The palisade parenchyma consists of only one layer at the adaxial side forming 16.69 – 62.50 % of the total leaf thickness. Minor vascular bundles are interspersed in the mesophyll tissue; larger ones are strengthened by collenchymatous tissue at adaxial and abaxial sides. The spongy parenchyma tissue constitutes 20.68 – 63.41 % of the blade thickness. The spongy cells are highly variable in shape, never arranging in rows, some are isodiametric, others are elongated in different directions and marked by wide lacunae. Lacunae increases towards the abaxial epidermis (Figures 1).
Celtis australis.
Midrib is in the form of a hump convexes at the adaxial face, while strongly convexes and becomes semicircle at the abaxial faces (Figure 3). Collenchyma layer begins below the epidermis. The collateral vascular bundles are cupped by a well-developed sclerenchyma strip. Between collenchyma and the vascular bundle exists parenchyma tissue which greatly widens towards the abaxial face. Vascular bundle at the center of the midrib is u-shaped with sclerenchyma facing the abaxial side.
In petiole, epidermis also includes one layer of cells covered by cuticle. Petiole outline at the midpoint is elliptic or obovate in shape with a slight concave at the adaxial face. Cortex includes layers of sub epidermal collenchyma (54.82-118.70µm) followed by parenchyma layer tissue of variable width (94.97-211.95µm). From Figures (2 and 3) it is apparent that the anatomical characteristics of the petiole in *Celtis* taxa go along with their midrib characteristics. Like the midrib, the petiole vascular bundle is u-shaped cupped by sclerenchyma towards the abaxial face.

3.1.2 Differences between *C. tournefortii* var. *tournefortii* and *C. tournefortii* var. *glabrata*: Data displayed in Table (1) as a mean value indicate thicker leaf width, upper and lower cuticle, palisade height, spongy width for var. *tournefortii* than that of var. *glabrata*. On the other hand, nearly all petiole quantitative measurements of cortex, collenchyma, parenchyma, sclerenchyma, vascular bundle and pith are superior in var. *glabrata* than var. *tournefortii*. High overlapping occurs, thus providing insignificant characters for separating these two varieties. The only distinct difference which provides diagnostic character for distinguishing them is the presence of fine hairs covering the petiole, midrib, major veins, and leaf blade in var. *tournefortii*, while glabrous in var. *glabrata* (Figure 3).

3.1.3 Differences between *C. tournefortii* and *C. australis*:
Few leaf anatomical differences between *C. tournefortii* and *C. australis* could be observed (Table 1). Both possess epicuticular

wax or crust of varying sizes protruding from the epidermal cell wall in addition to numerous lithocysts (Figures1). In *C. tournefortii* lithocysts are only present inside the leaf structure, very few epidermal cells has lithocysts that form small protrusion out of the leaf, while in *C. australis* greater number and larger lithocysts protrude out from the leaf. In some of lithocysts, the calcium carbonate has grown (surface wall ingrowths) into a large cystolith that occupies part of the cell. In leaves of *C. tournefortii*the palisade layer and spongy parenchyma consist of less densely packed cells with more air spaces between them compared with leaves of *C. australis*. The midrib of *C. australis* convexes more at the abaxial side with less adaxial surface area between the two sides of the leaf blade compared to midribs of *C. tournefortii*. These features may constitute significant taxonomic application (Figure3). In figure (3-E) two separate vascular bundles of different size are commonly seen in the petiole cross section of *Celtis australis* near the leaf base.

Table 1. Quantitative Characters of Cells and Tissues in Cross Section of Leaf Blade of *Celtis* (µm).

Character		*Celtisaustralis*	*Celtistournefortii* var. *tournefortii*	*Celtistournefortii* var. *glabrata*
Leaf thickness	Av	144.12	175.74	126.81
	Ra	108.78-196.52	134.05-218.64	94.23 – 166.84
	σ	25.03	21.49	12.65
Upper cuticle thickness	Av	2.41	3.08	2.37
	Ra	1.69 – 3.65	2.07 - 4.33	1.87 – 2.69
	σ	0.452	0.490	0.242
Lower cuticle thickness	Av	1.49	1.61	1.44
	Ra	1.01-1.98	1.15 - 2.07	1.15 – 1.98
	σ	0.260	0.255	0.201
Upper epidermis thickness	Av	23.97	28.15	20.30
	Ra	13.78-35.66	18.65 –36.28	12.63 – 33.70
	σ	5.18	4.45	3.66
Lower epidermis thickness	Av	12.42	18.38	13.23
	Ra	8.57-16.80	11.79 –23.47	7.51 – 22.16
	σ	2.17	4.11	3.09
Palisade parenchyma height	Av	50.18	53.41	37.07
	Ra	37.29 – 68.27	32.77 - 71.12	27.47 - 41.32
	σ	10.71	11.23	4.89
Palisade parenchyma width	Av	7.48	6.02	6.11
	Ra	5.19 – 10.73	3.96 – 8.25	3.81 – 9.22
	σ	1.40	0.997	1.36
Spongy parenchyma width	Av	54.15	62.71	46.12
	Ra	36.12 – 69.03	49.09 –79.36	30.45 – 61.34
	σ	11.21	8.15	7.97
Epidermis thickness	Av	8.81	8.55	8.19
	Ra	5.17-12.90	4.07 - 11.53	5.37-12.62
	σ	2.61	1.98	1.93
	Av	321.92	223.04	259.14
Cortex thickness	Ra	267.18-376.95	175.15 - 260.31	233.11-287.41
	σ	30.19	27.69	15.11
Collenchyma thickness	Av	94.83	76.98	81.23
	Ra	76.35-118.70	62.93 - 87.99	54.82-114.86
	σ	12.90	6.51	15.67
Parenchyma thickness	Av	198.16	132.61	169.69
	Ra	183.91-211.95	94.97 – 164.11	151.46 – 184.19
	σ	9.92	24.26	9.11
Fiber layer thickness	Av	55.06	48.13	51.04
	Ra	44.72-67.07	40.06 – 56.33	42.69 – 57.63
	σ	7.35	4.36	5.14
Sclerenchyma thickness	Av	60.95	43.26	57.98
	Ra	49.18-77.14	35.31 – 57.69	46.88 – 69.74
	σ	8.05	6.65	7.24
Vascular tissue thickness	Av	164.25	96.14	130.54
	Ra	127.21-201.07	75.25 – 108.25	112.90-143.56
	σ	21.30	11.58	8.73
Pith thickness	Av	162.32	81.78	161.60
	Ra	131.06-194.57	61.32-97.61	138.64 – 178.15
	σ	21.39	11.36	12.03

Av: Mean, ***Ra***: Range, ***σ***: standard deviation.

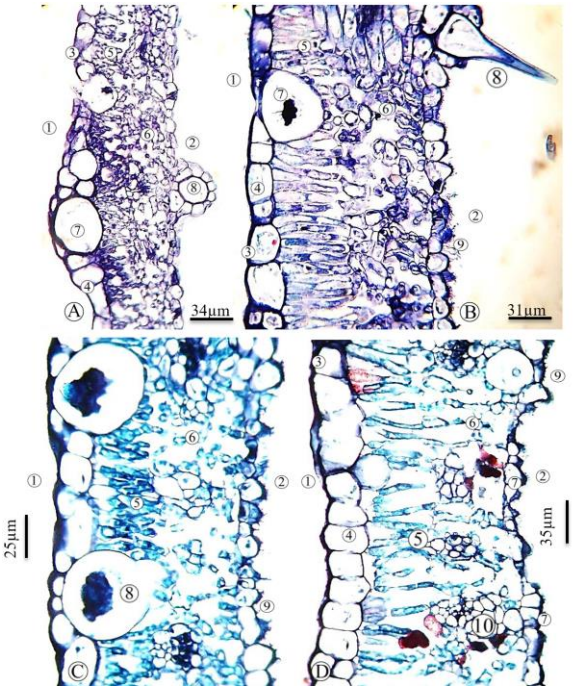

Figure 1. Leaf blade cross section. (A-B) *Celtis australis* C) *Celtis tournefortii* var. *glabrata*, (D) *Celtis tournefortii* var. *tournefortii*: 1. Adaxial face, 2. Abaxial face, 3. Cuticle layer, 4. Upper epidermal layer, 5. Palisade parenchyma, 6. Spongy parenchyma, 7. Lithocyst some with calcium carbonate crystal, 8. Lithocysts with large protrusion out from the leaf, 9. Waxy protrusion, 10. Veinlet vascular bundle.

3.1.4 Key to the taxa of *Celtis*:

1. Lithocysts only present inside the leaf structure with few of them forming very small protrusion out of the leaf; the large midrib adaxial hump form wide area between the two sides of the leaf blade ---------- 2

2. Simple hairs dense on the adaxial side of the petiole ---------- *C. tournefortii* var. *tournefortii*
2. Simple hairs absent or sparse on the adaxial side of the petiole ---------- *C. tournefortii* var. *glabrata*

1. Lithocysts present inside the leaf structure with many of them forming large protrusion out from the leaf; the small midrib adaxial hump form narrow area between the two sides of the leaf blade ---------- *C. australis*

3.2 Cuticular Structure

3.2.1 Genus characteristics: The epidermal cells on both the adaxial and abaxial sides are polygonal in shape, sometimes irregular. Straight too slightly curve anticlinal walls are the dominant type of walls in this genus. Plasmodesmata are usually presented penetrating the wall of adjacent cells. Striation is also common especially on the adaxial faces. As a mean size value, adaxial epidermal cell are significantly larger than abaxial epidermal cells (Table 2). Therefore, cells of the adaxial side are always less in density compared with those of the abaxial side.
Stomata are mostly anomocytic, elliptic in shape, and hypostomatic. Both prismatic and druses crystals are presented in all cuticular preparations. Lithocysts normally form a part of the epidermis structure, some protrude out from the leaf epidermis and are seen in cuticular preparations (Figure 4, 5, 6).

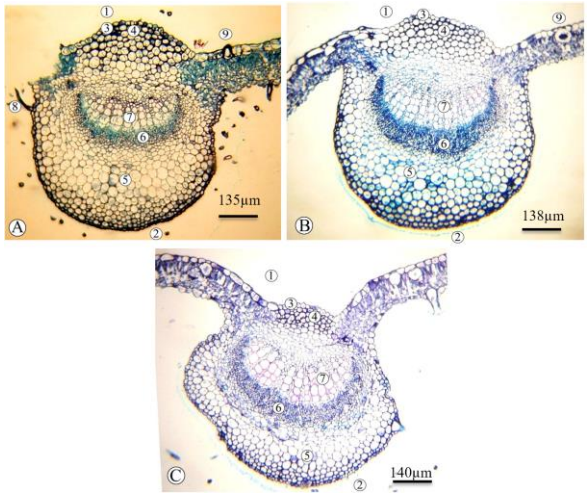

Figure 2. *Celtis tournefortii* var. *tournefortii*: (A-B) Main vein cross section, (C) Midrib cross section, (D) *Celtis tournefortii* var. *glabrata*, (E) *Celtis australis*: 1. Adaxial face, 2. Abaxial face, 3. Upper epidermal layer, 4. Collenchyma, 5. Parenchyma, 6. Sclerenchyma, 7. Vascular bundle, 8. Unicellular hair, 9. Lthocysts.

Species characteristics: Cells are highly variable; the trend is to produce epidermal cells of polygonal shapes. Pentagonal shapes are common in *C. australis*, while more multigonals are to be observed in *C. tournefortii*. No remarkable shape differences occur between the adaxial and abaxial surfaces. Anticlinal walls are straighter and less curved in *C. tournefortii* than walls of *C. australis* Figures (4, 4, 6). In all taxa, striation is observable, but more evident over the adaxial epidermis, thus obscuring the appearance of these cells. All *Celtis* taxa epidermis contain numerous lithocysts which predominantly protrude out from the epidermis and appear as a simple trichome in *C. australis*, while mostly remain within the epidermis and appear as trichome foot. Epidermal cell sizes and density, and stomatal sizes (Table 2) do not form significant characters for distinguishing between *C. australis* and *C. tournefortii*, as well as between the two varieties (var. *tournefortii* and var. *glabrata*), overlapping is too high. Stomata are anomocytic in *C. australis*, while anomocytic and occasionally paracytic in *C. tournefortii*, the paracytic stomatal type is especially found in epidermal preparations of *C. tournefortii* var. *glabrata* (Figure 6). This is in agreement with what Yaman (2005) referred to regarding stomata of *C. australis*. Mean stomatal density and index of *C. tournefortii* var. *tournefortii* (Table 2) show slight superiority over those of C. *australis* and *C. tournefortii* var. *glabrata*.

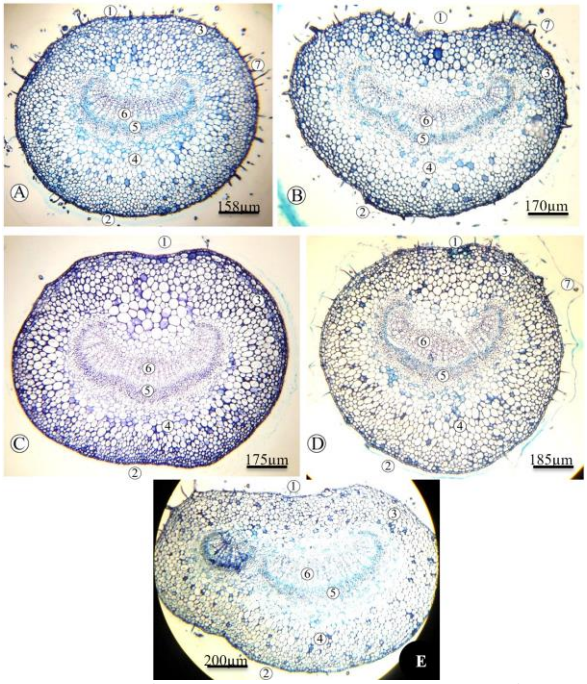

Figure 3. Leaf petiole cross section. (A-B) *Celtis tournefortii* var. *tournefortii*, (C) *Celtis tournefortii* var. *glabrata*, (D) *Celtis australis*, (E) *Celtis australis* petiole cross section near the leaf base: 1. Adaxial face, 2. Abaxial face, 3. Collenchyma, 4. Parenchyma, 5. Sclerenchyma, 6. Vascular bundle, 7. Unicellular hair.

Table 2. Dimension of the Epidermal Cells (µm), Stomatal density (stomata per mm²), and stomatal index for *Celtis* taxa.

Character				*Celtis australis*	*Celtis tournefortii var. tournefortii*	*Celtis tournefortii var. glabrata*
Adaxial	Epidermis cell	Length	Av	44.82	44.65	48.24
			Ra	20.33 - 69.16	23.65– 65.88	28.94 – 74.86
			σ	11.04	12.51	12.77
		Width	Av	20.73	18.34	26.54
			Ra	16.27 - 26.43	12.30 – 23.58	20.80 – 33.98
			σ	2.65	2.96	3.34
		Density	Av	1228.08	1243.64	1223.72

			Ra	1149 - 1315	1148 – 1364	1072 – 1335
			σ	50.91	48.72	70.79
Abaxial	Epidermis cell	Length	Av	28.66	27.09	28.28
			Ra	14.52 – 46.31	15.13 – 45.70	18.21 – 41.97
			σ	7.32	7.77	6.35
		Width	Av	13.74	16.41	17.29
			Ra	9.32 – 19.74	10.45 – 21.43	12.99 – 23.50
			σ	2.62	2.56	2.98
		Density	Av	2219.8	2194.24	2218.76
			Ra	2016 – 2456	2009 – 2471	2021 – 2378
			σ	113.13	105.89	91.27
	Stomata	Length	Av	24.18	25.53	22.99
			Ra	19.90 – 34.22	20.60 – 31.32	20.55 – 26.78
			σ	3.17	3.05	1.75
		Width	Av	17.14	16.76	16.63
			Ra	13.19 – 22.29	10.31 – 21.96	12.27 – 21.56
			σ	2.36	3.03	2.99
		Density	Av	197.52	203.52	198.48
			Ra	142 – 257	138 – 273	139 – 279
			σ	37.89	36.76	38.27
		Index	Av	8.17	8.47	8.19
			Ra	5.82 – 11.07	5.90 – 11.42	5.59 – 10.92
			σ	1.53	1.42	1.43

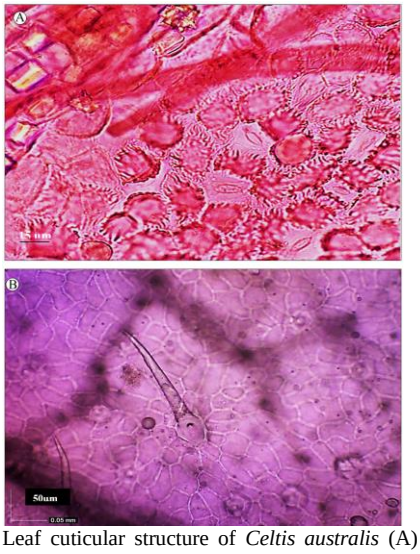

Figure 4. Leaf cuticular structure of *Celtis australis* (A) Abaxial epidermis, (B) Adaxial epidermis.

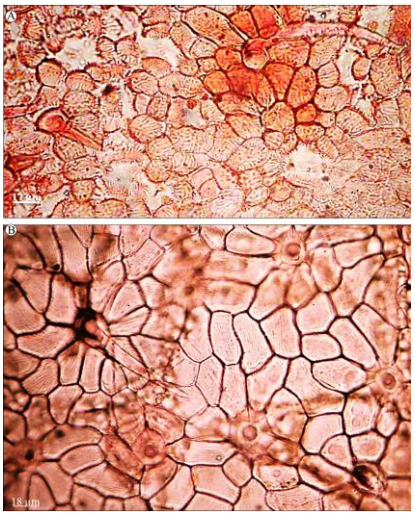

Figure 5. Leaf cuticular structure of *Celtis tournefortii* var. *tournefortii* (A) Abaxial epidermis, (B) Adaxial epidermis.

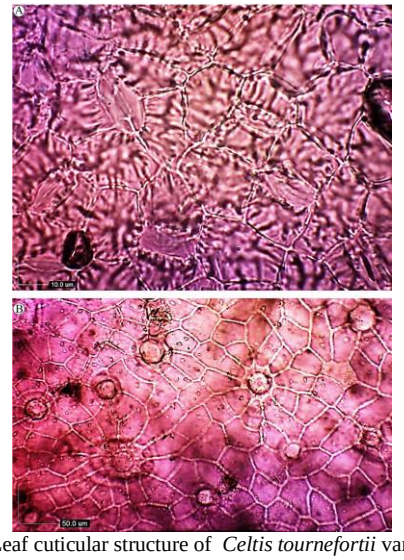

Figure 6. Leaf cuticular structure of *Celtis tournefortii* var. *glabrata*: (A) Abaxial epidermis, (B) Adaxial epidermis.

3.3 Pollen Grain Characteristics

3.3.1 ***Celtis australis*:** Pollen grains are in monads and of 3-porate, rarely 4-porate. A sunken area in the aperture surrounding a pore is also distinct; availability of the same feature was supported by (Mehrdad et al., 2010) using electron microscope. Exine sculpturing is granular, but granules are denser compared to *C. tournefortii* var. *tournefortii*. Sexine is usually as thick as nexine. The size classes of Erdtman (1945) refer to mediae size of pollen grains; with few of them are minutae. Shape classes of Erdtman (1971) demonstrate subprolate pollen shape, few of them are prolate spheroidal characters or symbols should be explained in a list of nomenclature.

3.3.2 ***Celtis tournefortii:***Pollen grains are monads and 3-4-porate. A sunken area in the aperture surrounding a pore is differentiated from the remainder of the exine (Figures 7). Like pollen of *C. australis*, the exine sculpturing of *C. Tournefortii*is granular. Sexine is also as thick as nexine. The smallest pollens of this group are those of var. *tournefortii* with the mean length of 26.98µmfor the polar axis and mean of 20.12µmfor the equatorial diameter. Relatively largest pollens are observed in

var. *glabrata*, with the length of 28.06µm for the polar axis and 20.08 µmfor the equatorial diameter. Since the two varieties of *Celtis tournefortii* are treated as distinct separate species in flora of Iran, data of our varieties are comparable with those of *C. tournefortii* Lam. (polar axis 25µm while .equatorial diameter17µm) and *C. glabrata* Steven ex Planch. (Polar axis 26 µm, equatorial diameter 16µm) (Mehrdad, et al. 2010).

The size classes based on the length of the longest pollen axis refers to mediae class for pollen grains of both *Celtis tournefortii* varieties (var. *tournefortii*and var. *glabrata*). Little pollens are minutae in size. On the other hand, shape classes refers to prolate shape for the two varieties; few of them are prolate spheroidal in shape.

There are little differences in measurements of polar length, equatorial diameter, polar length/equatorial diameter, and exine thickness between pollens of var. *tournefortii* and var. *glabrata*. Apertures are simple and provided by a sunken area. Data presented in table (3) and the morphological characters shown in figures (7) indicate that the pollen grains of *Celtis australis* together with *C. tournefoertii* var. *glabrata* belong to *Celtis*-type grain, while, *C. tournefoertii* var.*tournefoertii* to the Ulmus-type grain. This is in line with Erdtman (1971) and Zavada (1983) who pointed out that the Ulmus-type pollen grains possess 4-6 porate pollens, oblate to spheroidal shape, varying in size from 23µm to 42µm and distinguished by wholly granular ectexine and regulate sculpturing with spinules, while Celtis-type possess 2-3 (-5) porate pollens and all have middle granular layer in the exine and spinules with rod-like substructure on surface, varying in size from 15 µm to 29 µm. Moreover, Mehrdad et al. (2010) have pointed out to the same classification of the *Celtis* pollen grains growing in Iran and placed *Celtis australis* together with *C. tournefoertii* var. *glabrata* (synonym: *C. glabrata*) in the *Celtis*-type grain, while, *C. tournefoertii* var. *tournefoertii* (synonym: *C. tournefortii*) in the Ulmus-type grain.

The high anatomical and palynological differences between the two varieties of *C. tournefoertii* support promotion of these varieties into specific levels as treated in flora of Iran (Mehrdad, et al. 2010).

Table 3. Mean Range and STD of Pollen Grain Morphological Characters (µm).

Character		*Celtis australis*	*C. tournefortii* var. *tournefortii*	*C. tournefortii* var. *glabrata*
Polar length = P	Av	27.58	26.98	28.06
	Ra	20.71 – 35.71	20.32-35.22	21.32-35.27
	σ	3.98	4.44	3.799
Equatorial axis = E	Av	22.83	20.12	20.08
	Ra	18.29-31.37	15.12-24.22	16.07-24.41
	σ	3.56	2.51	2.44
Mean ratio P/E	Av	1.21	1.34	1.40
	Ra	1.03-1.42	1.12-1.57	1.09-1.63
	σ	0.099	0.137	0.142
Mesocolpium	Av	17.20	17.05	17.59
	Ra	9.96-26.68	10.84-24.93	12.52-28.04
	σ	3.73	3.31	3.16
Exine thickness	Av	0.818	0.846	0.891
	Ra	0.707-0.961	0.602-0.961	0.728-0.977
	σ	0.069	0.087	0.077

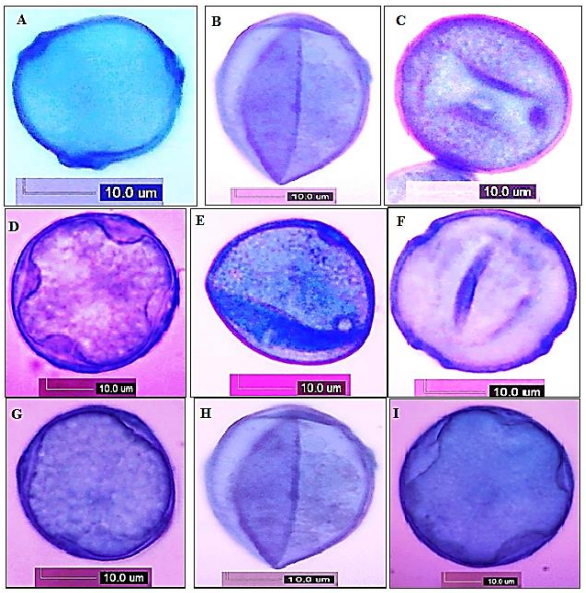

Figure 7. *Celtis australis*: A. Polar view of a semicircular tricolporate pollen grain, area of the exine surrounding a pore sharply differentiated from remainder of exine. B. Equatorial view of elliptic, prolate, tricolporate pollen grains. C. Equatorial view of elliptic, tricolporate pollen grain. *Celtis tournefortii* var. *tournefortii*, D. Polar view of a circular tetracolporate pollen grain, E. Equatorial view of an elliptic-obvate pollen grain. F. Tetracolporate circular pollen grain. *Celtis tournefortii* var. *glabrata:* G. Polar view of a circular tricolporate pollen grain, H. Equatorial view of elliptic tricolporate pollen grains, I tetracolporate pollen grains.

REFERENCES

Ellis, R. P. 1979: A Procedure for standardizing comparative leaf anatomy in the Poaceae , II. The epidermis as seen in surface view. - Bothalia 12(4): 641-671.

Erdtman, G. (1945). Pollen morphology and plant taxonomy. Morina, L., with an addition on Pollen- morphology terminology. Svensek. Botany Tidskr. Vol.39.

Erdtman, G. (1966). Pollen morphology and plant taxonomy-Angiosperms (An introduction to palynology). Revised Edition. Haner Pub. Co., New York and London.

Erdtman, G. (1971). Pollen morphology and plant taxonomy. Hsfner publishing company. New York. USA.

Florin R. (1933). Studien über die Cycadales des Mesozoikums. Erörterungen über die Spltöffnungdapparate der Bennettitales. K. Svenska Vet. Akad. handl. 12: 1-134.

Leonardi, D., O. Disapio, M. Gattuso and S. Gattuso. (2002). Caracteres morfoanatómicos de la corteza y hojas de Tabebuia impetiginosa y T. heptaphylla (Bignoniaceae). Bol. Soc. Argent. Bot. 37: 51-61.

Mantese, A. I. and N. H. Montaldo. (2002). Contribución a la anatomía foliar de Blepharocalyx salicifolius (Myrtaceae). Bol. Soc. Argent. Bot . 37: 167-170.

Mehrdad Zarafshar, Moslem Akbarinia, Ali Sattarian and Laurentius Josephus Gerardus van der Maesen. (2010). Pollen Morphology of Iranian *Celtis* (Celtidaceae -Ulmaceae). Botanica Serbica 34 (2): 145-149.

Metcalfe, C. R., & Chalk, L. (1950). Anatomy of the Dicotyledons. 2 vols. Clarendon Press, Oxford.

Ponessa, G. I.; A. M. Zenoff; M. F., Parrado; H., Moreno. (1998). Morfoanatomía y composición lipídica en hojas de Sapindus saponaria L. (Sapindaceae) y Tipuana tipu (Benth.) O. Kunth (Fabaceae).Lilloa 39: 137-141. Press, Oxford, pp. 23-25.

Punt, W., S. Blackman, S. Nilsoon and A. LeThomas (1999). Glossary of pollen and spore terminology. 2nd rev. (ed.P. Hoen) Utrech: LPP, Utrech. Univ. LPP Found. (http://WWW.bio.uu.nl/palaeo/glossary/glos-tin.htk.).

Radford, A. E. ; Dikison, W. C. ; Massey, J. R. and Beu, C. R. (1974). Vascular plant systematic, Harpar and Raw press, New York. USA.

Raven, P. H.; Evert, R. F. and Eichhorn, S. E. (2005) Biology of Plants (7th edition) W. H. Freeman, New York, page 9, ISBN 0-7167-1007-2

Stace, C. (1980). Plant taxonomy and Dicotyledonous, vol. I. Clarendon Suarez, G. M., A. M. C. Ruffino, M. E. Arias and P. L. Albornoz. (2004). Anatomía de hoja, fruto y semilla de Cupania vernalis (Sapindaceae), especie de importancia en frugivoría. Lilloa 41: 57-69.

Taha, Shahat M.A. El-Alfya, Hamida Mohamed A. El-Goharya, Nadia Mohamed Sokkara, Sahar Abd El-Tawabb, Dalia Adel Mohamed Al-Mahdya. (2011) Botanical and genetic characteristics of *Celtis australis* L. and *Celtis occidentalis* L. grow Bulletin of Faculty of Pharmacy, Cairo University, Egypt.Volume 49, Issue 1, PP. 37-57.

Wagner, M. L. & G. I. Ponessa. 2004. Morfología foliar y seminal de Fagara coco (Gill.) Engler (Rutaceae). Lilloa 41: 71-84.

Yaman, Ö (2005). The morphological, anatomical and palynological characteristic of hackberry (Celtis australis L. growing naturally in Turkey. M. Sc. thesis submitted to Zonguldak Karaelmas University, Graduate Scholl of Natural and Applied Sciences, Department of Forest Engineering.

Zavada M. (1983). Pollen Morphology of Ulmaceae. Grana 22: 23-30.

کورتیا لێکولینێ:

د بزاڤەکێدا بۆ ب دەستڤەهاتنا سەخلەتێن مفادار بۆ سنوردارکرنا پولان وکارکرن بۆ باشترکرنێ ل سەر پەیوەندییێن پولداری ل ژێر ڤەکولینا ساخلەتێن ئەنەتومییێن و دندکێن پیتاندنێ ژرەگەزێ (گە وك – Celtis) ئەوێن ل عیراقێ شین دبن. ئەنجام دیاربوون کو بەرچلکێن بەرکی ئەوێن د ناڤ پێکهاتەییێن بەلگی ژ جورێ C. tournefortii دا هەی، هندەك بەرزاییێن بچوك ل سەر بەلگی چێدکەن بەلێ د جورێ C. australis بەرزاییێن مەزن ل سەر بەلگی چێدکەن. رەهێن ناڤینێن ل سەرڤەی بەلگی د مەزن و دەرکەفتی وکڤانکینە و بیاڤەکێ بەرفرەە ژ هەردوو لاییێن بستیکا بەلگی ڤەدگریت, بەلێ د جورێ C. australis. C رەها ناڤین یا ل سەرڤەی بەلگی یا بچویك و دەرکەفتی وکڤانکیە و بیاڤەکێ بەرتەنگ ژبستیکا بەلگی ڤەدگریت. دەڤوکێن د C. australis ژ جورێ نە رێکخستینە، بەلێ د C. tournefortii ژ جورێ ل بەرلێڤا ییێن نە ریکخستیە. موبرەهێن ئەوێن ل سەر لایێ سەرڤە ژ بستیکا بەلگێ C. tournefortii var tournefortii د سادەنە و د بوشن بەلێ ئەو موبرەهێن ل سەر هەمان لا ژ بستیکا بەلگێ C. tournefortii var glabrata نینن. بەلگێن ئەڤی رەگەزی خودان دوور وییێن ئاشکەرانە ئەوێن پێچای ب قاتەکی ژخانەییێن ستوینکی و دەڤوکێن نقوبووی. دندکێن پیتاندنێ ژ جوری سێ کونکی و ب دەگمەنی چوار کونکی ، جهێ چال ژ ڤالاهیێ یا دورپێچە ب بیاڤەکێ ڤەکری و دندکێن پیتاندنێ د ناڤنجینە و پیچەك د درێژن. بەلێ دندکێن پیتاندنێ د C. australis. C دا ب رەخنێکڤەنە ل گەل ناڤ جور C. tournefortii var glabrata سەر ب جورێ Celtis grain ڤەنە ، بەلێ ناڤ جور C. tournefortii var tournefortii سەر ب جورێ Ulmus grain ڤەنە. جوداهییێن مەزن دسالوخەتێن ئەتونومیێ و سالوخەتێن پەیوەندیدار ب دندکێن پیتاندنێ د ناڤبەرا هەردوو ناڤ جور C. tournefortii var tournefortii و C. tournefortii var glabrata پشتەڤانیێ ب هێز د کەت بۆ ئەڤان هەردوو لێدەران بو ئاستێ جوری.

خلاصة البحث:

في محاولة لتوفير مميزات مفيدة لتحديد الاصناف واجراء التحسينات على العلاقات التصنيفية تمت دراسة الصفات التشريحية وحبوب اللقاح من جنس الميس Celtis النامي في العراق . واظهرت النتائج وجود بلورات الحويصلات الحجرية (العنقودية) (Lithocysts) في النوعC. tournefortii في تركيب الورقة والقليل منها تشكل نتؤات صغيرة خارج الورقة ، فضلا عن وجود عرق وسطي كبير محدب الشكل في السطح العلوي للورقة أحدب الشكل وذات مساحة عريضة يقع ما بين جانبي نصل الورقة ، بينما هذه الحويصلات الحجرية فيC. australis تشكل نتؤات كبيرة تخرج من الورقة والعرق الوسطي للسطح العلوي للورقة صغير و محدب الشكل وضيق المساحة ويقع ما بين جانبي نصل الورقة ، والثغور من النوع غير المنتظم في C. australis بينما في C. tournefortii يكون من النوع الجانبي غير المنتظم . الشعيرات تكون بسيطة وكثيفة على السطح العلوي من سويق الورقة في C. tournefortii var tournefortii بينما تكون معدومة على السطح العلوي من سويق الورقة في C. tournefortii var glabrata . أوراق هذا الجنس ذات وجهين واضحين تتكون من الخلايا الاسفنجية والخلايا العمادية ذات طبقة واحدة في هذا الجنس و تكون الثغور غائرة . حبوب اللقاح متوسطة الحجم وشبه متطاول في الشكل من نوع ذات ثلاث مسامات ونادرا ما يكون ذات أربعة مسامات والمنطقة الغائرة في التجويف تكون محاطة بفتحة مميزة , هذه الحبوب في النوع C. australis مع الضرب C. tournefortii var glabrata ينتميان الى حبوب اللقاح من نوع Celtis بينما ينتمي C. tournefortii var tournefortii الى حبوب اللقاح من نوع Ulmus. الاختلافات العالية في الصفات التشريحية وايضا حبوب اللقاح بين الضربين C. tournefortii var tournefortii و C. tournefortii var glabrata, تؤيد رفعهما الى مستوى النوع .