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W}oo v s Œ] Ÿ}v• u}vP •}u µoŸÀ š Citrus ^‰] • v]š• Z o š ' v Œ]v PÇ‰š

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•šŒ š

dZ‰Œ •]wÀš •ŸP Ÿ}v• •šµ šZ ‰}oo v‰Z}o}PÇ šŒ •šŒµ šµŒ }(‰}ooP Œ]v Œ š Œ] Ÿ]v Citrus species and three related genera µoŸÀ]šv PÇ‰š dZ ‰}ooP Œ]v• Œ‰Z}š}PŒ ‰Z]vP šZ >]PZš D] Œ}• }‰D v ^ vv]vP šŒ]vŒ}• }‰ D À oÀµ o]š Ÿ À ‹µ vŸš ‰À }o}‰Z}o}P] o Z Œ š Œ• š} + Œ vŸušvP šZ •šµ]š Æ^ Ÿ•Ÿ vooÇ }(‰ oÇv}o}P] o šš Z pollen size, shape, colpi length, apertures number and type, ora size, amb shape, u •}}o‰]]µu š ŒU Z Æ]vŒ v u vš Ÿ}v šZu}•š]•ŸvPµ]•Z Z Œ š Œ•µ• Œ}(š Ÿ]š Æv Á Œ (š Æ}v}u] oµ X KvšZ }všŒ šZ }Œ µ•]‰}ooZvŒ š µŒ Ÿ}šÁ v W}oo v P šZ l ‹µ š}u Œ •UŒ Z ‰v Æ]š Z]lvÁ•Œ v}š (}µvš }(š Æ}v}u] o vš Z]+ Œ vŸ Ÿ}v}(šZ o}• Œ Ço š taxa of]šŒµ•U &}Œšµv >Ç u ‹µ Z}PŒ Ÿ}U]Œµ• in the present study.

< ÇÁ}Œ]šŒµ•V &}Œšµv >Ç u u ŒšPŒ Ÿ}V ‰}oo v u}Œ‰Z}o}PÇV W}v]Œµ•V Rutaceae

Œ À] Ÿ}v• >D W]PZš D] Œ}• }‰ D W >]PZš D] Œ}• }‰ X]v Œ v ^ W ^ Ÿ•Ÿ vooÇ ^Ç•š u

Z]À October 22, 2019; ‰š November 04, 2019; Wµ o] November 13, 2019

]š Ÿ}v d]t < U Œ Z]D U © Œ D ~î ì í õ• W}oo v Œ] Ÿ}v• P}u µoŸÀ š Citrus ^‰] •]šZ o š Genera in Egypt. Eur Exp Biol Vol.9 No. 4:14.

/vš Œ} µ Ÿ}v

µoŸÀ š Citrus are derived from various Citrus species found]všZ Á]o ^ u Œ}v oÇ Ÿ}v (šZ }Œ]P]v]oš Ç‰ while others are hybrids between two or more ancestors. Many Citrus šÇ‰ Á •Œ vŸ. v v u Çv]À]šµ Æ}v}u] • Œ •µo]vP ŒvPµu]Œ vŸ.•‰]ô•ÁÇ íõòõ count [1].

Citrus plants belong to family Rutaceae, they are characterized ÇZ À]vP+ Œ o}(}Œu•šŒ v •ZŒ Citrus species u Ç(Œ ‹µ v}šoÇ Œ}u Ÿ}u‰}µÁ]šZ o ‰ o]v on the stems, leaves and fruits. The leaves are usually opposite, }u‰}µv Á]šZ }µš ‰µ }u Ÿ}v u Á]šZ Z}Œv î X According to Engler [3] Rutaceae is divided into seven subfamilies, Z .v šZ ••µ (u]o‰ Œ]u ŒPÇ }]µuŒ š especially the fruit type Citrus species and its related genera are o}• ŒÇ o šv o o o}v P•µ šŒ]šŒ Citreae, of the orange subfamily µŒ v Ÿ}] The Citrus fruit is of berry or hesperidium type. Species within the genus Citrus are highly

economic and medicinal plants distributed all over the world €ð^XÀ Œ Œ}v}u] •À o ••].À Œ]}µ• }(Citrus species into groups and given them valid names [5-9]. Nicolosi €íìu vŸ}v šZ šZ ŒŒšÁ}µŒ Œ}µ •‰ }v•Ç•š u• }(••]. Ÿ}(Citrus They are those of Swingle [11] and ^Á]vPo Z €ð}•(šZh^ U d v l€íî}(: ‰ &Œ}u šZ•š v ‰}]šZ P Œ}Á}ŒŸZ}Œ Ÿ µošµŒ]šZ ‰Œo vš •] vŸ ^Á]U P oÇ •š ‰‰ š Œ •šZu}•šµ• o X

}Œ]vP Á]vP oÇ••šZ]šŒ]•µ šŒ] µ]À] u]vš}šZŒ PŒ}µ‰• ‰Œ]u]Ÿ À –]•š v Œ o ŸÀ • the closer 'near Citrus' including Citrus Œ o P v Œo]l }u‰}µvš • v and the 'true Citrus', which included W}v]Œµ•, &}Œšµv Œo u},]šŒµ•, and Clymenia, all but the Œ• vš ÁÀ] Á š}(o]šŒ Citrus He subdivided Citrus into šÁ}µ P v Œ .Œ •µ P v Eucitrus (later called simply subgenus Citrus) includes citrons, ‰}u o• mandarins, oranges, grapefruits, and lemons, while the hardy but slow-growing trees Á]šŒ o ŸÀ‰ oÇ Œ]‰o]v•µ P vW •‰.

species and related genera according to
because
the genus
species is unclear, as many of the named species are hybrids
clonally propagated through seeds (by apomixes) and there
Citrus
species, there is confusion around correct botanical names
Citrus
Citrus
sixth-largest producer and the second-largest exporter in the
pollen morphology in solving taxonomic problems has been used
nine
Egypt using pollen morphological characters.

Materials and Methods

nine
Citrus
Citrus
Citrus
Swing., and
This orchard located 120 Km away from Alexandria on Alexandria-
faculty of Agriculture, Alexandria University, as well as vouchers
of the studied taxa are allocated there.

The trees were grown in sandy soil and received the same cultural
were selected from each
of the branches to obtain the mature pollen grains used in this

Pollen grain samples of all studied taxa were acetolyzed according to Erdtman's technique [19]. The acetolyzed samples were used
eye-piece micrometer. Measurements given are the means of forty acetolyzed well-developed pollen grains from each taxon.

Results and Discussion

The mean values of the pollen characters, of all the taxa under
Electron Microscope present in the Faculty of Science, Alexandria
Erdtman [19].

Pollen morphology

The results obtained from the twelve studied taxa are summarized in
pollen grains of all taxa were monads, radially symmetric, isopolar
spheroidal to sub-prolate except in
it was oblate spheroidal. The mean polar axis length varied
Mean Equatorial Diameter (P/E) was 1 in both
and

The types of apertures were either colpate or colporate and number of apertures were found to be within the same taxa and within the same anther as well. Five groups of aperture types
tri-tetra-colporate aperture types,
reshni
sinensis
. The second group included also three taxa characterized by tetra-penta-colporate aperture types in
and
. The third group has only
which
colporate ones
. The taxa in the fourth group characterized by tri-tetra-colpate and tri-tetra-colporate aperture types in
and
with
pollen grains that have tetra-penta-colpate and tetra-penta-colporate types of apertures
.

The ecto-aperture colpi, in all the studied taxa were long, wide, with
They were characterized by uneven margins and covered with granular membranes. The mean colpi length varied within the
and

d o ó X Pollen morphological characters of the studied Citrus species and it's related taxa.

Sr. E}X	Z Œ š Œ • W}u u}v d Æ Y	v u	P. L. ~…u•	X ~…u•	X W l	W}o X Z X Sh.	‰ X	C. L. ~…u•X	D •}X ~…u•	Ora L. ~…u•	Ora W. ~…u•	u Sh.	Æ X ~…u•	d Z X Æ
1	X µŒ vŸ(}o] ~ ZŒ]•š•Ál X P X	Mexican lime	31.3	î ó X ñ	1.14	3	2	î ó	õ X ó	î X ì ô	ó X ó í	2	2.4	4
2	X µŒ v >X µu	Sour orange	ï ì X ó	î ô X ï	1.09	2	5	25.4	9.36	3.2	ô X ï	2	î X ó	3
3	X P Œ ~>X} K• l	Pummelo	34.5	33.4	1.03	2	4	29.1	11.22	3.06	ó X õ	1	2.4	1
4	X o Ÿ(}o] ~ }]v	d Z]oŸ u	31.6	26.4	1.2	3	5	26.4	9.36	î X õ ó	ó X ò õ	2	2.4	4
5	X o] u Risso	Sweet lime	ï ï X ó	ï í X ô	í X ì ó	2	1	î ô X ð	í î X ó î	3.2	ó X ï	1	2.4	4
6	X ‰ Œ Macf.•	Marsh grapefruit	33.1	30.6	1.09	2	5	î ó X õ	10.54	3.3	6.9	2	2.4	1
ó	C. reshni Hort. ex d v l	o }‰ šŒ mandarin	ï õ X ô	î ó X ñ	1.09	2	1	24.5	õ X ó ô	4.2	ô X í	1	2.4	2
ô	X Œ Ÿ µo š Blanco	o u v Ÿ v tangerine	30.5	î ô X í	1.09	2	2	î ð X ô	10.3	2.9	ò X ô	2	2.4	2
9	C. sinensis ~>X• K• l	Succari orange	32.2	29.6	1.1	2	4	î ó X ò	10.4	3.6	ó X î	1	2.4	1
10	&}Œšµv oo u Œ P] (lour.) Swing.	Oval Œ]š Kumquat	26	26.2	1	1	3	21	õ X ô î	3.5	ò X ì ô	3	2.4	3
11	>]u ‹µ~šÇ Œ] • µŒ](}o] ~ ZŒ]•šu >X• Swing.X &X i ‰ (Thunb.) Swing.]	>]u ‹µ š } v (hybrid)	26.6	26.1	1.02	2	1	21	õ X ô î	3	6.4	1	2.4	3
12	W}v]Œµ• šŒ](}o] ~>X• Z (X	Trifoliate orange	32.3	31.2	1.04	2	2	26.4	í ì X ó î	3.2	6.4	2	2.4	3
> ^$_{0.05}$			0.93	ì X ô õ	0.03			0.94		ì X ó í	0.44	ì X ô		0.04

W>X WW}o>ŒPšZ. uVX X‹µ š}Œ]] uo š]Œ…uVWVl ZWŸ}šÁ W}oo ŒPšZl ‹µ š}Œ]o š Œ}XZ•WWo ô Zv ‰ (1. Oblate spheroidal, 2. Prolate spheroidal, 3. Sub-prolate); Ap.: Aperture number and type (1. Tricolporate and tetracolporate, 2. Tetracolporate and pentacolporate, 3. Tricolporate, tetracoporate and pentacolporate, 4. Tricolpate, Tetracolpate and Tricolporate); d šŒ }o‰]XE šŒUŒ }o‰ všš U}o‰ šŒ }o‰ W}ŒšŸ U }o‰ XE >X ŠW]vP šZ..uD •}X D •}}o‰]] u š]Œ…uK Œ>XK Œ> vPšZ..uK ŒX K Œ] šZ].v uV ^ZXW ^Z ‰ í X Z}µv šŒ] vPµo ‹µ Œ î X ^‹µ Œ v Œ}µv ï X Œ}µv šŒ] vPµo Œ v Œ}µv XÆ X ÆWd Z] l v•. u X KŒ X Æ l K Œ v u všŸ X v d š šr‰ Œ(}Œ šš U r‰ Œ(}ŒŒ Œ Ÿ ï µo š•]v õ X Ÿ µ o š •

>]u ‹µš] u Æ]uµ (î õ X ì. ô µ] v X P Œ Moreover, the Æ]vŒ v u vš }(š Z ‰}oo P Œ]v š Z •šµ]š Æ •V u vu •} }o‰]]µ u šÀŒ ŒÀ[Œ} u] v]uµ (õ X ï. ò µ observed by the scanning electron microscope appeared in four in X µŒ and X µu X o Ÿ(}í ó. î. µ] v X o] u The endo-]+ Œ šÇ‰ • d Z X Œ š Ç ‰ Á • š š ‰ Œ (}Œ šZ }}šZ apertures pori were lalongate in all the studied taxa, where the tectum, which is provided by more or less rounded pores in C. }ŒÁ] šZ vP(Œ}ò X ì. ô u r ò. X ó µ] v & X u Œ P >]Œ] šµ š P Œ v (&]•P µ ó), C. sinensis (&]P µ ó) and X ‰ Œ (&]•P µ Œ and W X šŒ •}(}o]Á šo Œ }ò X õ. ó X. ï. µ] v X Œ Ÿ, Ç µ o î •XdZ• }všÇ‰ Á •š š ‰ Œ(}š šu š Œ}Œ Ÿ µ o ‰ Œ , C. sinensis and X o] u © u }Œš Z ó X. ï. µ] v š Z Á]šZ Ÿ u µ Œ] š Ÿ µ Á µ] µ] Z Œ š Œ Ç ì }Œ • rest of the taxa. The amb shapes are mostly rounded triangular straight and smooth muri and rounded to oval small-sized lumina }Œ ‹µ Œv •}u Ÿ u •}š ZZ ‰ Œ(}µv dZ ‰}o ou v in C. reshni (&]P µ) and X Œ Ÿ (&]P µ). The third type was rounded triangular and square in X o] u ~ &] P µ Œ î Á v(}À }o Á š]šZ Ÿ u µ Œ] š Ÿ µ Á µ] µ] • Z Œ š Œ] î , C. reshni ~&]P µ Œ ï U >]u ‹µ ~&]P µ Œ ð , by more or less straight and smooth muri and nearly rounded X P Œ ~ &]P µ Œ ô and C. sinensis ~&]P µ Œ õ . large-sized lumina in & X u Œ P (&]P µŒ • >]u ‹µ ~&]P µ Œ While it was square and rounded in X µŒ v (&]P µŒ ñ ð) and W X šŒ (&]P µ Œ) and X µŒ v (&]P µŒ í ì ñ ,• X Œ Ÿ (&]P µŒ ò and W X šŒ (&]P µŒ vó í ì•X d Z (}µŒšZ ÇÁ •Œ Ÿ µ Á š Z v P µ• Ÿ u µ Œ š v ó, •X µŒ v Ÿ (&]P µ Œ , X ì o Ÿ (&]P µ Œ í í Œ v Ÿ µ Á µ] µ] Z Œ š Œ Ç] š Œ] v P Z š }µP ZŒ v í í ,• X ‰ Œ (&]P µŒ í î X /w í]Ÿ •}š Z u Á • š Z o µ u]Á Œ]+ Œ v•š]ì v •Z ‰ v X o] u (&]P µ Œ rounded triangular, square and rounded & X u Œ P (&]P µŒ î), U X µŒ v (&]P µŒ ñ v X o Ÿ (&]P µ Œ). í v í •

Æ]vdW Æ]v• }v•] Œ š Z]ÇšÁ • î X ð. uš Z]] v all the studied taxa, except in X µŒ v]šÁ µ î X ó. u X Z

W}oo v PŒ]v• o ••]. Ÿ}v

}Œ]všPZo ÇµP]š Æ v o ••].] v š š Z Œ]+ Œ v š

&] P µ Œ ϭ SEM (r• v > D ~ and) photomicrographs of & } Œ š µ v o o µ pollen grains; W Equatorial view (colpate, aperture number); W Æ] v Œ v u v š Ÿ } v V Polar view (aperture number).

&] P µ Œ ϰ SEM (r) photomicrographs of X o] µ u pollen grains; W Equatorial and polar views (colporate, aperture number); W Polar view (aperture number); W Exine } Œ v u v š Ÿ } v X

&] P µ Œ ϯ SEM (r• v > D~) photomicrographs of C. reshni pollen grains; W Equatorial view (colporate); W Polar view (aperture number); W Æ] v } Œ v u v š Ÿ } v V Polar view (aperture number).

P Œ } µ ‰ } Œ] v š Z ‰ } o o v Œ š Œ • W Œ • • Œ } µ ‰] v o µ . À š Æ X V P Œ v X] o] µ u ‰ Œ C. sinensis

&] P µ Œ ϱ SEM (r• v > D~ • ‰ Z } š } u] Œ } P Œ ‰ Z • } (Œ] ‰ Z µ š hybrid pollen grains; W Equatorial view (colpate, colporate); W Polar view (aperture number); W Exine } Œ v u v š Ÿ } v V Polar view (aperture number).

&] P µ Œ ϲ SEM (r• v > D~) photomicrographs of X µ Œ v Ÿ (} o] pollen grains; a W Equatorial view (colpate and colporate); W Polar view (aperture number); W Æ] v } Œ v u v š Ÿ } v V W Polar view (aperture number) .

&] P µ Œ ϳ SEM (r• v > D~) photomicrographs of X Œ Ÿ µ o š pollen grains; W Equatorial view (colporate); W Polar view (aperture number); W Æ] v } Œ v u v š Ÿ } v V Polar view (aperture number).

&] P µ Œ 6 SEM (r • v > D~) photomicrographs of W } v] Œ µ • š Œ] (} o] µ š pollen grains; W Equatorial view (colporate); W Polar view (aperture number); W Æ] v Œ v u v š Ÿ } v V W Polar view (aperture number).

&] P µ Œ 7 SEM (r) photomicrographs of X µ Œ v Ÿ pollen grains; W Equatorial view (colpate and colporate); W Polar view (aperture number); W Æ] v Œ v u v š Ÿ } v (colpate); W Æ] v Œ v u v š ~Ÿ } o ‰ } Œ š • X

&] P µ Œ 8 SEM (r • v > D~) photomicrographs of X P Œ v] • pollen grains; W Equatorial view (colpate); W Equatorial view (colporate); W Polar view (aperture number); W Æ] v Œ v u v š Ÿ } v V W Polar view (aperture number).

&] P µ Œ 9 SEM (r) photomicrographs of X µ Œ v Ÿ pollen grains; W Equatorial view (colpate and colporate); W Polar view (aperture number); W Æ] v Œ v u v š Ÿ } v (colpate); W Æ] v Œ v u v š ~Ÿ } o ‰ } Œ š • X

&] P µ Œ 10 SEM (r) photomicrographs of *C. sinensis* pollen grains; W Equatorial and polar views (colpate, aperture number); W Equatorial and polar views (colporate, aperture number); W Æ] v Œ v u v š Ÿ } v X

&] P µ Œ 11 SEM (r • v > D~) photomicrographs of X o Ÿ (} o] pollen grains; W Equatorial view (colpate); W Equatorial view (colporate); W Polar view (aperture number); W Æ] v Œ v u v š Ÿ } v V W Polar view (aperture number).

and W X š Œ Ÿ (} o] µ • š Œ Æ Œ Z Œ š Œ] Ì] P P • š pollen size; where the polar axis length was more than 32.20 µm, with prolate spheroidal pollen shape, colpi length more than 26.44 µm and mesocolpium diameter exceed 10.30 µm.

d Z • } v P Œ } µ ‰ • o µ . À š Æ • Á o o X µ Œ v Ÿ (} o] µ Œ v Ÿ µ X µ o Ÿ (} o] , *C. reshni* and X Œ Ÿ . These taxa

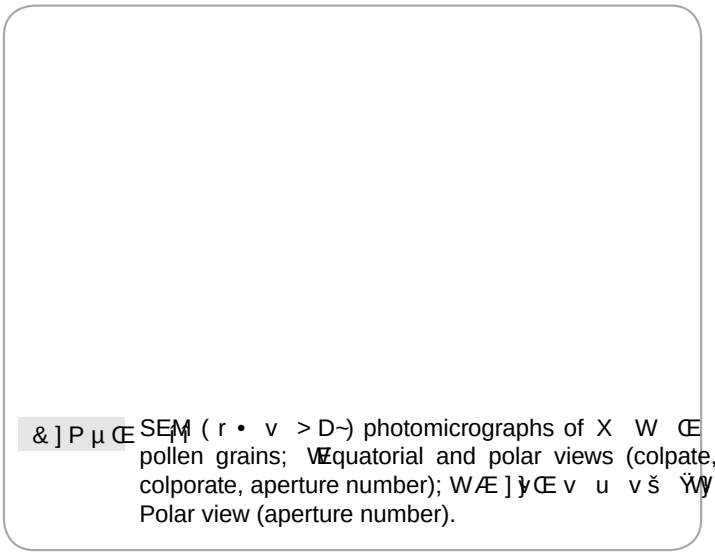

Figure 1: SEM (r • v > D~) photomicrographs of X W Œ pollen grains; W Equatorial and polar views (colpate, colporate, aperture number); W Æ] Polar view (aperture number).

Z Àu] µ u ‰ } o ÆE p • v P šEZ W P (Œ } îu õ X õš } ïí X ñÁ õ] š Z prolate spheroidal and sub-prolate shapes, colpi length ranged (Œ } îu õ X õR ô u š } î ò X õR õ u v u • } } o ‰] µ u u š Œ E v P from 9.36 µm to 10.30 µm. While the third group included two taxa only; & X u Œ P v Œ E] š ‹ µ š š X Z ‰] Z • À š Z ‰ } o Œ axis length ranged from 26 µm to 26.6 µm, oblate spheroidal or spheroidal in shape, with shorter colpi ranged from 20.96 µm to î ì X ì R u v u • } } o ‰] µ u š } Œ } µ š X õR î u X

^ š Ÿ • Ÿ o v o Ç •] •

/ v š Z ‰ Œ •• š v µ š ‰ o U o Ç v } o] } v P À] • ÿ P]Ÿ v } v] • š š Z š À Œ] Ÿ] ¥ ‰ • } o u } v Œ ‰ Z } o } Z P] Œ o š Á Œ Œ • (š Æ } v } u] •] P v] . v] š + o Œ E (v Œ š } u Z } š Z] Œ E •] Æ µ v Ÿ š Ÿ À pollen characters out of eight; this includes polar length, equatorial diameter, colpi length, ora length, ora diameter, u • } } o ‰] u š t Œ Z] X o š Z Œ E Ÿ š Á š Z W } o o Œ E v P š Z v ‹ µ š } Œ] o š + Œ E W l v š Z Æ] v š Z] l v Á • Œ E] v •] P v] .] v + š o Œ Ç (v Œ š } u Z } š Z + Œ E o). í

] • µ • •] } v

W } o o } v Œ E ‰ Z } Z o } • P Ç v µ • •] v } o } v P u P]] v • } o À] v P š Æ } v } u ‰] Œ E } o š u •] + Œ E o v š À (• W] o] P • U v Œ E v • ‰] € í õ U î ï U î ' ó U µ ì Citrus and its related two genera: & } Œ E š µ a n d o W } v] a Œ E µ o considered one of the important economic and medicinal fruits in the world, they are rich plants] v À] š u] w À] o Ÿ] o o d X ‰ Œ E } Á] š Z š] Z v • š Æ] • š Z (Œ E ‹ µ Z v Ç š Œ E]] ì Ÿ š } Á v • š v Z] ‰] Á • Z U] u Z š Z] Œ E taxonomy very confusing.

d Z o • •] . Ÿ v] v • ‰] • o] u] š Ÿ (š š v Z P v µ Z • • o } v P been a controversial issue by a number of authors as Swingle [11], who included only 16 species of Citrus Á Z] o d v l € õ • • Œ] í ò ì î • ‰] µ Ÿ ^ } Œ E í ñ • v Œ @ v Z } € ï ï • . v } v o š Ç Z Œ š Œ E µ ‰] Á • š Z š] Z P v µ Citrus, which are Pummelo (X P Œ E v] • > X] š K Œ E } X l u]) and X Mandarin (X Œ E Ÿ µ o š). They indicated that all other Citrus • ‰] Œ E • • µ o (Ÿ Œ E v] Z u Ç Œ E]] ì Ÿ š Á v š v Z • •] • ‰] > • X š ^ Œ E } U Œ € ï ì • v } š Z š Œ E µ ‰] C. • halimii Stone.

Pollen morphology of Rutaceae has been examined by several Á } Œ E l Œ E Z • V Ç) µ v š Z] š Œ E Æ } v } u] P v] .] v + Œ E v š taxonomic levels, depending on the plant groups [19,25,33,34]. However, there are no reports on pollen morphology of Citrus species in Egypt. Inyama et al. [25] found that palynological Z Œ E š Á Œ E E µ • (µ] v o] u] Ÿ • v] Æ E š µ] Citrus species v š Z µ } µ o Æ ‰ o]] v š } v i µ v Ÿ Á } v š] Z š Z Œ E] v] v • ‰]] • v Ÿ . Ÿ } w Z Œ E š Œ E] Â Z Ÿ] š v Z U Ç Œ E] v •] P v] .] v š š Z Œ E o • •] . } (Ÿ š } Z v] v À • Ÿ P š š Æ / v X š Z ‰ Œ E • • š v µ š ‰ o U o Ç v } o } v P À] • ÿ P Ÿ] ¥ v] • š š Z š À Œ] Ÿ] ¥ ‰ • } o u } v Œ E ‰ Z } o } Z P] Œ E o š Á Œ E E • (š Æ } v } u] •] P v] . v X

] / v ‰ Œ E Ÿ š µ Z o š Á E U o À š µ] š Æ Á Œ E •] P v] . v] š + o Œ E v š (Œ E } u Z } š Z] Œ E •] Æ µ v Ÿ š Ÿ ‰ À } o o Z v Œ E š ‰ Œ E } o W Œ E length, equatorial diameter, colpi length, ora length, ora diameter, mesocolpi diameter. These results were in agreement with those reported by Breis et al. [35] and Mohammad et al. [36]. The pollen shape varies from oblate-spheriodal, prolate-spheriodal to sub-‰ Œ E } p v š o š o Z • š µ] š Æ d Z X] • v] v P P Œ E Á] š š Z Z (š] µ v Ç z š o € X i ó • v D } Z u u š o € X i ò d X À Œ E] Ÿ { ‰ • } o o v •] ì Á Œ E • µ P P • š Ç < } ì l] v ,] Œ E €] ô • v D } Z u u š al. [36] where they reported that pollen grain of X P Œ E and] • W } v] Œ E µ • š a E E l a r g e r pollen than X o Ÿ , ( ) X o] p] u a n d & X u Œ E , W h i l e E t h o s e of X µ Œ E , C Ÿ s i n e n s i s a n d C. reshni Á Œ E] v š Œ E u]] v • š] ì d X Z • • µ P P • Ÿ Á } v Œ E] v P Œ E u v š with the results of the present study where the studied taxa o • •] .] v š š Z Œ E] + Œ E P v Œ E } µ ‰ •] Œ E] š v } ¥ Z] ¥ Œ E } o o v •] ì d X Z . Œ E P š Œ E }] µ v ‰ o µ X P Œ E , v X] o] u , Œ ‰ C.] • sinensis v W X š Œ E w h (c h) have the largest pollen grains. The second group included X µ Œ E v Ÿ X (} o] µ Œ E , v Ÿ X µ o Ÿ , (} o] C. reshni and X Œ E Ÿ have medium size pollen grains. While the third one included two taxa & X u Œ E P v Œ E] š u ‹ µ Á š Z the smallest pollen grains. On the contrary, these groups did not coordinate with Al-Anbariet al. [34], which recognized four groups in the Iraqi pollen grains based on pollen size and exine } Œ E v u v š } Ÿ v] v Ç X

Meanwhile, the most variable characters found in the present] v À • Ÿ P Á Ÿ] Œ E Á] š Z š] Z v µ u Œ E š Ç ‰ (‰ Œ E š µ Æ E] v • U } Œ E v u v š Ÿ] Œ E Á •] U š Z • Á o • u • } } o ‰]] µ u u š Œ E • X š o € X i ó • v D } Z u u š o € X i ò µ • • } š Z] Œ E Á] š Z v u • } } o ‰] u š Œ E À o µ z] Œ E š v š E Z •] v Ÿ . Ÿ } v of Citrus • ‰] š • Z V • Œ E • µ P š Œ E Á] š š Z Z Œ E • µ } (š š Z] Á • } Œ E l X

' Œ E v š o € X i ó (• µ v } v •] Œ E À o Œ E] Ÿ v ‰ o v } o } o Œ E ‰ Z } o } P } (• µ (u] o µ Ç Œ E v Ÿ }] Á Z] U Z] À] š Z • š µ] š Æ] v š } À ‰ } o š Ç v ‰ o d Z X] + Œ E v] v • o µ ‰ Œ E š v µ Œ E Œ E š U } r } o ‰ • µ Z • ‰ v •] ì U Æ E] ¥ Œ E v u v š Ÿ v Á o • š Œ E µ š µ Œ E t Z v •] P v Ÿ ‰ v] P o š Ç v ‰ (} € E Z • µ (u] o µ Ç Œ E v Ÿ }] U the principal characters used were the aperture number and Æ] v } Œ E v u v š Ÿ d Z v X Z Œ E š Á Œ E E •] v } v } u] š v š with the obtained results and as a conclusion, the aperture š Ç ‰ v } Œ E •] ì Á Œ E š Z u } • š] • Ÿ v P µ] • Z Œ E š v š E Z •] Œ E µ u • Œ E } (‰] Z Ÿ • š v µ] š Æ X } Œ E] š v } ¥ Z š Ç ‰ v v µ u Œ E ‰ Œ E š µ À Œ E š Ç ‰ Á • Œ E } • Œ E À] v š Z • š µ] taxa. Type (1) Tri-tetra-colporate was found in X o] u , Œ © reshni v >] u ‹ µ š Œ X ‰ î d š Œ E r ‰ v š r } o (‰ u } v Œ E š in X µ Œ E v Ÿ X (} o E Ÿ a n d o W š X š Œ E] (v) o e] (3) š Penta-

colporate was found in& X u Œ.PType (4) included both "tri- in X µ Œ v ŸX{}o]Ÿa(}do]X o]uXdŒZ •.v]vP•Œ tetracolpate and tri-tetra-colporate" were found inX P Œand]•Á]šsZZ}•(}µv Çz š o•ïó•v D}Z uu š o•ïò•X C. sinensisFinally, type (5) included both "tetra-penta-colpate t Z]o]• P Œ•Á]šsZZ Œ •µ}o(š<•}Ì l]v ,]Œ€Ìï ô•ÁUZ} and tetra-penta-colporate" were found inX µ Œ ,vŸXµuu Ÿ(}•oš] šš Z šsZ Æ]‰ © Œ•v••µ r Œ Ÿ]µvšZš‰]}(• and X ‰ Œ•dZ]•µ µ oš•Ÿ Ç %}(‰}oo‰v Œ šÁµ Œ•E(}•µv Citrus, W}v]adEdµ•}Œ šµv oo in the studied species from the same anther which may be due š}ZŒ}u}•}uvo}Œu o]•Ÿu •v}v Ç^š š o•Xð ì•X }v o µ•]}v

/všZ]••šµ šÇZU Æ]vš Z] lvÁ•• v]v•]P v]. Zvš•E š /Œ•šUZ‰Œ •]wÀš •Ÿ P šŸZ‰U}o•]ìv‰}o•Zv‰ }o‰] ÁZ]šš Z Æ]ì•Œv u vš Ÿ•Z‰ì•Á P Œ ÀšŒ] Ÿ]ìvšZ length, the apertures number and type, ora size, amb shape, • µo‰šµ Œ‰wP Z Àš Æ}v}À]o µvšZ o ••]. Ÿ}µv •} }o‰]]µu š Œ•UÆ]ì•Œv u vš Á•Ÿ}Œš Zu}•š }(šZ•šµ]š Æ X}Œ]šv}P Z Æ]ì•Œv u vš Ÿ}}µvŒ•E]•Ÿ vP µ]•Z Œ š]vŒ•E•] Œ µu• Œ}](‰Z•Ÿ}šµ]]+ Œ švÇš‰Á•Œ} • Œ ÀdÇ‰ íd š ‰ Œ(}]Œ•. š taxa. All the studied pollen grain characters except ora shape P Œ ì• X• ‰ Œ•and Ç•šsinensisType (2) Tectate perforate to v Æ]všZ] lv •}µo }v•] Œ}(š Æ}v}À]oµ u] Œ•E} Ÿ µ]oC.šreshni X Œ Ÿ. WhileType (3) Foveolate]všZ]+ Œ v Ÿ ví}vPšZ o}• Œ•Ç o š Æ}(Citrus, Á]šoZ Ÿ u µ Œ•E šŸ µ]ovµXu µ Œ ,v&ŸXµ u Œ•E•]Œ•E]<šµ š&}Œ šµv•]uo‹µZšÇ Œv] W}v]nŒ•Ehe present study. and WX šŒX](Ç‰}ðZ• Ÿ µoÁ}šš Zv P µ•Ÿ u µŒ•E Ÿš µ o µ u U

Z (Œ v •

1 ^ š } v U> } Á Œ Œ Ç ' } Œ Z t U : } v P < ~ í õ ó ÷ Œ Citrus halimii A new species from Malaya and Peninsular Thailand". Biotropica 5: 102-110.

2 Sharma OP (1993) Plant Taxonomy. Tata McGraw-Hill Publishing } u ‰ v Œ Ç Á o Z] r E z } Á Œ ‰ U ‰ ð W r î ð ó X

3 v P o U Œ W Œ l v ~ š í o õ ï í ÷] v š º Œ o] W Z G w Ì v (u ^ o] } w U] Ÿ } v x P o u > v] ‰ í Ì] P W ó r ï ñ õ X

4 ^ Á] v P t o d U Z W ~ í õ ò d ÷ Z } š v Ç (Citrus and its wild Œ o Ÿ À v W Z Citrus] v µ • š Œ V Ç À X Œ } • [š Ç] (} Œ W Œ • • U Œ l o í W Ç õ U r ð ï ì X

5 Z } Æ µ t Œ – P í Z ï ï & • o } / Œ] î nd d Z l Œ } u ‰ v Ç d U µ © v W Œ µ o Œ e Ç v U } u ‰ v > Ç ¡ U } ÿ W W õ X

6 Œ v] X ô ó Z X µ š d Z W (} Œ G • š Œ E (v] Œ š r Á v • š v š Œ o / v] X } v • š ^ š } u ‰ v > Ç ¡ X] š] Ÿ } v U v } ‰ ‰ ì W ñ ò X

ó Marcovitch VV (1926) Indeeling van het geslacht Citrus X > v } µ Á U pp: 2-41.

ô Hodgson RW (1965) Taxonomy and nomenclature of Citrus fruits. In: À v] • v P Œ] µ o š] µ Œ v o š Z] Œ ‰ o] D Ÿ } v X P Œ] ‰ ‰ í W r ï ï ï X

9 d v l d ~ í õ ó & µ v u v š] • o µ • •] } Citrus o • •] . Ÿ š v µ X] š Œ ð W ò X

10 E] } o } •] î ì ì ó • Œ] P v] v š Æ } v } u Ç Œ X Citrus P v Ÿ • Œ U] v P v] } š Z v } o } P Ç v X s Œ v Ÿ t] v o o d U P (h } v Œ] š ‹] v P } u U pp: 19-44.

11 Swingle WT (1943) The botany of Citrus v] š Á] o Œ o Ÿ À š Z } Œ v P µ (u] o v Ç Œ X Z] š Œ] µ • µ • š h Œ Z Ç À Œ } • [š Ç] (} Œ v] W Œ • • Œ U l o ‰ Ç ‰ U W W ô r ð ó ð X

12 d v l d ~ í õ ï ò d • Z š Æ } v } u v Ç v } u v o š] µ (Œ Z µ š r µ Œ v Ÿ }] o µ X ì î W ì í r í í ì X

13 Moore GA (2001) Oranges and lemons: clues to the taxonomy of Citrus (Œ } u } o µ u Œ l Œ E Œ X v] v • v Ÿ í ó W ï ò r ñ ð ì X

14 Z • D t U D } Œ š] D v ‹ t o o µ v +] õ õ W ÷ Z Ç o } P Œ v ó Ÿ Ÿ } v • Z] ‰ v • š Œ v Ÿ } w (o Œ v] v W o v D š U Œ] v v v À] Œ } v u v š } (Z µ š W ð] • Ÿ v o Ç } (š Z • µ (u] o µ] • } v P À] v (Œ } Z u v d W ‹ µ v À Œ] Ÿ µ] v X } š ô ò ì W õ r í r í í õ õ X

15 ^ } Œ Z t ~ í õ ó K v š Z Z] • š } Œ Ç Œ] P } (Citrus X µ o o } Ÿ (š Z d } Œ Œ] š Ç v] o o µ X ‹ : W o ^ v š] ì ì W ò õ r ï ó ñ X

16 } µ o } ~ í õ õ ó o }] Œ P Ç ‰ o š X Œ ‰ µ o] • Z]] v Œ P } R U Ç ‰ W ð W ì í ñ ó r í ó í X

í ó , u Ì D U d š ~ î ì í ó • P Ç ‰ Ÿ Œ v v P Æ ‰ } š Œ Z š ÷ •] š À Z • v š • } µ Œ Œ v À Ç o µ Ÿ h] v] x š ^ š š • ‰ Œ š u } (v š P Œ] µ o š µ Œ Z z U D ‹ } v P • U Z v y P , ~ í õ ô ^ š µ] } v š Z ‰ } o o u } v Œ ‰ Z } } o (} P Ç Foreign Agricultural Service. Gain Report, Global Agricultural Citrus X ^] v Ÿ P Œ] µ o š v µ] Œ W ð ì r ò ò X

í ô À] W , µ Ç Á } } s , ~ í õ ó W • Œ] v] (‰ v o P ÷ } • ‰ š Œ Æ E u } v } u Ç X Z } Œ X ÷ Œ] W P µ Œ o] • Z ÷] µ ‰ P v , Q U W Ÿ v P š E } v Á ð } Œ l X

19 Erdtman G (1952) Pollen morphology and plant taxonomy of v P] } • ‰ Œ E u • À] v š t] l • o ^ ð ‹] l Z } o u ì X Œ E W o ^ v š] ‰ ñ W õ X

20 Tschudy RH, Scot AR (1969) Aspects of Palynology. Wiley Inter- •] v EU Á z } Œ ‰ U ‰ ð W r î î ð X

21 t o l Œ t ~ í õ ó í ÷ v š Œ] µ Ÿ] š ÷ Z ‰ } o o u } v Œ ‰ Z } o v } P Ç phylogeny of the Annonaceae l Grana 11: 45-54.

22 Taia WK, Sheha MA (2001) Palynological study within some Atriplex • ‰] }) ÷] v Z • Œ µ Z o í Ÿ ð W í r õ ó X

23 Taia WK (2004) Palynological study within tribe Trifolieae ~ > P µ u] v } W ‹ •] ÷ } ^ þ W ì ï r í ï í ñ X

24 À ^] Ù v l U v U Œ U W] v E Œ î ì í ï W } o u } v Œ ‰ Z } } o (} P Ç the genus Onobrychis & (•] v d µ Œ l d Ç Œ š ï ó W ò r ò ô í X

25 / v Ç u E U K • µ } Z s h E D J P Á & µ E U µ Œ µ D ~ î ì í ñ ^ • Ç • š u Ÿ •] P v] . } v (‰ } o u } v Œ ‰ Z } } o (; P u Ç (Rutaceae) from Owerri. Med Aromat Plants 4: 191.

26 D Œ Ç U ' } ‰ ' o s ~ î ì í ô W } o o D } v Œ ‰ Z } } o (• P o Ç š š Æ } (Z Œ Ÿ (Œ } t u • š Œ Z š • / U] x v o (W o ^ v š ô W õ ð ò r 2450.

íó Faegri K (1956) Recent trends in Palynology. Botanical Review 22: 639-664.

íô ^ v } ' Œ E U } Z Œ t ' v ~ í õ ^ ÷ š Ÿ • Ÿ u š Z } ó š Z X d Z Iowa State Uni press Ames Iowa USA, p: 593.

29 ^] v P • Z U > ^] v P ~ Z ì ì ô • Z ^ ^ ^ Ç • š ( ) Œ E v } Á • S U Œ •] ð } X í ï U ^ ^ / v • Ÿ š µ š U Œ E Ç U d ^ X

30 t } Z } µ • Z W ~ í õ ï ñ W } o o P Œ Æ š v Z •] • Œ E Œ µ š] µ Œ E Ÿ U Ÿ } v U v •] P v] . v] v •] v v u]] v D X ' Œ Á r ,] } o d } u ‰ v / Ç U E X Á z } Œ E v > } v u X : W o ^ v š] ‰ u ‰ ô W õ r í õ ó ô X

31 Œ Œ E Œ Z } • D ~ í õ ó ò v • µ u Œ Æ š Æ ß } v } • u š] µ } Ç 8 v] š Ç Œ o Ÿ } v] Z] µ ‰ o Ÿ À C s t r u s v] š • o } • Œ o Ÿ ^ À Ç • š u Ÿ } š v Ç u X : W o ^ v š] W ì ñ r í ì ò X

32 ^ } Œ E Z t ~ í õ ô] } Z u] • š Œ E Ç v } u v Ç À } o µ Ÿ } (u } Œ v µ o Ÿ À C s t r u s X W Œ E } } (v] P š Œ v Ÿ] v] o š Ç š Œ] µ o š µ í W ó r í ô õ X

33 W Œ E À U v] • D Œ E ~ î ì ì ñ W } o o G } v Œ E (W l] • š y v • š Z X µ š X W l } š ì ó ð W õ ñ r ñ ì í X

34 o v Œ E] < U Œ µ • Œ E U W Æ E Œ v ‰ } v P Œ E] W ð W Æ Z Œ E µ Œ E v l P µ o ‰] • P (2015) Pollen grain morphology of Citrus (Rutaceae) in Iraq. ‰ v • š Œ v Ÿ } } w (o Œ v] v W o v D š U Œ] v v v À] Œ } v u v š ^] v ~ • W D ^ r î ‰ ‰ ô ð W ï X

35 Œ E ß • U v Z v W ' U] o Œ Œ E Š • Ÿ o D } ~ í õ õ d • Z ‰ } o o v morphology of Citrus limon cv. “Verna” from the Murcia region, S.E. Anales de Biologia 19: 63-69.

36 D } Z u u W U Z] Œ E D • U d] } : U P µ i ^ U K Z u] v z ~ í õ õ • Z Œ š Œ E Á ì] š Æ Z } v v v] v o P š Œ E] v Œ } • } (‰ Z ‰ } o) (v] š Œ E ‰ µ o ^ v š Œ E Z P Œ E ñ W õ r ï ñ X

íõ Œ z U D ‹ } v P • U Z v y P , ~ í õ ô ^ š µ] } v š Z ‰ } o u } v Œ ‰ Z } } o (} P Ç Citrus X ^] v Ÿ P Œ] µ o š v µ] Œ W ð ì r ò ò X

íô < } ì I] U] Œ E D] ~ í õ ô W • o u o v š Œ • š Œ E (Citrus fruit taxonomic Z } Œ X ÷ Œ] W P µ Œ o] • Z] µ ‰ P v , Q U W Ÿ v P š E } v Á ð } Œ l X D] v] • š (Œ E P Q Œ E] µ o & š µ Œ E Œ • ¡ U Œ E Ç • Z Œ] ‰ • U ‰ ì W ó X

39 ' Œ E v ð š U o l u } Œ E U D } Œ E š } v • î ì ì ì W } o o u } v Œ ‰ Z } } o (š P Z Ç • µ (u] o u Œ E v Ÿ] Rutaceae • X Œ E v ï õ W ð W r î ò X

40 ^ š , D U Œ E u • š Œ E } U P u • ^ , ~ í õ õ ï Ç š } À } o µ Ÿ ‰ v © Œ E Ç v • in Rutaceae X W o ^ v Ç š • À } í ô ó í W ì ô X