Plant Archives Vol. 17 No. 2, 2017 pp. 1711-1723 *ISSN 0972-5210*

MORPHOLOGICAL STUDY OF POLLEN GRAINS FOR SOME GENERA OF SUBFAMILY PAPILIONOIDEAE

Shaemaa Muhi AL-Amery and Nedaa Adnan Abu-Serag

Department of Biology, Faculty of Science, Babylon University, Iraq.

Abstract

Pollen grain morphology of 18 species belonging to nine genera of the subfamily Papilionoideae was studied with light and scaning electron microscope. Pollen grains were monad and zonocolporate in all genera except *Onobrychis*, which was zonocolpate, the pollen is small or medium in size, the exine showed agreat variety in the patterns of sculpture (ornamentation), reticulate, microreticulate, Regulate, Psilate, Perforate. Morphology of pollen grain in polar and equatorial outline were found to be valuable, light microscope (LM.) and Scaning electron microscope (SEM) micrographs to each pollen grains were done.

Key words : Pollen grain, Colporate, Papilionoideae, Subprolate.

Introduction

Fabaceae is one of the most important and largest family of the flowering plants (Mabberley, 1997), it is the third family below the rank of Orchidaceae and Asteraceae (Ghosh and Kreshri, 2007). Fabaceae is a well represented family with (650-750) genera and more than 18.000 species (Tekin and Yilmeaz, 2015; Mirzaei *et al*., 2015).

In Iraq, the family Fabaceae has economic importance after Gramineae, includes about 550 genera with 13,000 species (AL-Musawi, 1987; AL-Khatib, 2000).

The family are herbs, shrubs, woody vines or trees. Leaves are usually pinnately or palmately compound or unifoliate, alternate or opposite on the stem. Flower Zygomorphic, corolla has a standard, two wings and a keel formed by the fusion of the two lower petals. There are ten stamens and all are free or nine are fused into a tube and one is free (diadelphous) or all stamens are fused (Walters and Keil, 1988; Harlow *et al*., 1991).

The most important characters of Fabaceae pollen grains are symmetry, shape of pollen grain and characters of aperture (Perveen and Qaiser, 1998). All Fabaceae pollen grains are isopolar , oblong-semioblong or oblate –oblate sphaerical, rarly prolate- spheroidal, tricolporate, rarly prolate or colpate only. Erdtman (1969), Melhem (1971), Primer (1974), Perveen and Qaiser (1998) pointed at the taxonomic importance of the study of the Legume pollen grains. They are usually monad, but sometimes Dyads, tetrads and polyads may also exist (Silvester and Capelato, 1993; Watson and Dallwitz, 1992; Guinet, 1981).

In Iraq, taxonomic studies based on the palynology of the family were developed by (AL-Aubaidy, 2006) for the genus *Trigonilla* L.), (AL-Dobassi, 2008) for different genera in Al-jadriaha district (AL-Saadi, 2013) for the genus *Trifolium* L. and (AL-Shammary, 2015) for the genera *Scorpiurus* L. and *Melilotus* Mill.

Aim of this study is to use different characteristics of pollen grains in delimitation of different genera within different tribes of subfamily Papilionoideae and clairly the evolutionary relationships among them.

Materials and Methods

The materials used for ihe present study were collected from the wild . plant specimens were deposited at Babylon University Herbarium (BUH).

Collectors and localities are shown in the table.

Pollen slides were preparded using the technique of AL-Mayah (1983). The pollen grains were mounted in safranin-glycerine jelly. Light microscope observation were made using SN 281166 microscope to measure polar axis length, equatorial width, thickness of the exine, colpus

Table 1 : Numbers and locations of the samples in which the pollen was studied with the date of collection and the herbicides deposited therein.

The sample site	Date of collection	The herbicide deposited	Sample number	Species
-Assalman& from Shbecha -50 Km. from najaf toward Ruhba Ukhaidhir, 45Km.W.of Kerbala	1977 1993-3-7 1970-4-8	BUH BLN	004241 - 1607	*Astragalus kahiricus*
-Assalman & from Shbecha	1973-6-25	BLN	-	*A. rhodosemius*
Arbil		BLN	SN	*Colutea cilicica*
Arbil -Saran village, Karoukh region -20 KM. NW of Sulaimaniya	2016-4-21 1959-6-8 14-6-1957	BLN BAG BAG	SN 27275 2172	*Coronilla scorpioides*
Arbil	2016-4-5	BLN	SN	*Glycyrrhiza glabra* var. *glandulifera*
Arbil	1978-4-6	BLN	SN	*Hippocrepisunisiliquosa* var. *bisiliqua*
-3 K m N. of Saadiya -5Km from Salman to Samawah	1978-3-7 1978-2-15	BAG BAG	48671 48222	
Arbil - Sharma dary - Jabal al-Muwaila near Kawait, E of JabalHamrine, 70 Km	2016-4-7 1979-4-28 1957-3-28	BLN SUH BAG	SN 00675 17538	*Hymenocarpos circinnatus*
-20 Km. to Khanaqin - Badra, on Persian barder east of Zerbatiya **14 Km S. of Saadiya**	1973-3-7 1947-3-18 1978-3-6	BAG BAG BAG	39596 6633 48812	*Onobrychis acaulis*
Arbil - Shana dary - Mawet alt. 900m.	2016-4-6 1979-4-28 1979-5-9	BLN SUH SUH	SN 00673 00741	*O.caput-galli*
Arbil - On the top of mountain with Quuercus tree. Sinjarjabal. -W.HagiOmran (200-300)m. west of the spring	2016-4-5 1979-5-28 1959-6-14	BLN BAG BAG	SN 50287 27872	*O.carduchorum*
Arbil - Shana dary - Shewasoor near chemchemal	2016-4-5 1979-4-28 1980-5-14	BLN SUH SUH	SN 00677 1883	*O. crista-galli*
Arbil - Serseer alt. 1480 m. -Tirwanish 10 Km E KaniMasi	2016-4-5 1980-6-6 1976-7-7	BLN SUH BAG	SN 3960 45714	*O. galegifplia*
- Shewasoor near chamchemal - WadiHauran near H1	1980-5-14 1981-3-10	SUH BAG	1913 52990	*O. haussknechtii*
- Between Faida & AL Baqaq -170-190 Km. Wof Ramadi	1976-5-12 1959-4-21	BAG BAG	44925 27032	*O.ptolemaica* subsp. *ptolemaica*
- 10 Km E. of Zmbatia - JabalMakhul near Baiji -10 Km. west of Razaza lake	1976-3-31 1954-5-4 1995-3-27	BUH BAG BLN	44279 13197 -	*O.ptolemaica* subsp. *macroptera*
- Near Bazian - Qaradagh mountain Timara Singar, south face	1973-5-18 1973-5-18 1987-3-26	SUH BAG BUH	1376 40628	*O.schahuensis*
- Jabal Singar	1981-4-22	BAG	-53344	*Pisum sativum subsp. elatius*
Babilon University	2016-4-5	BLN	SN	*S.muricatusvar*

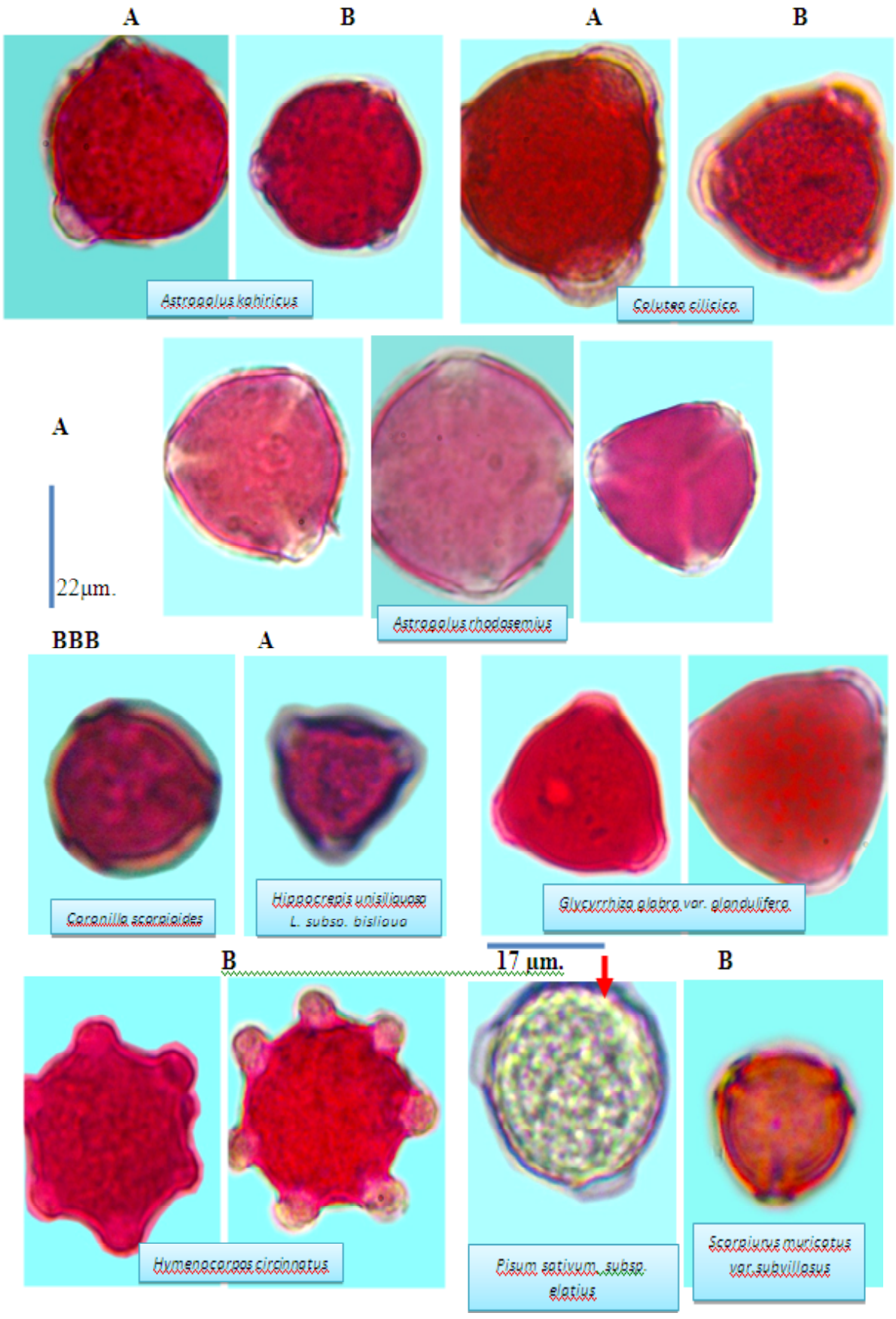

Fig. 1 : Variations in pollen characteristics (polar view) of some species studied. A 100X B 40x.

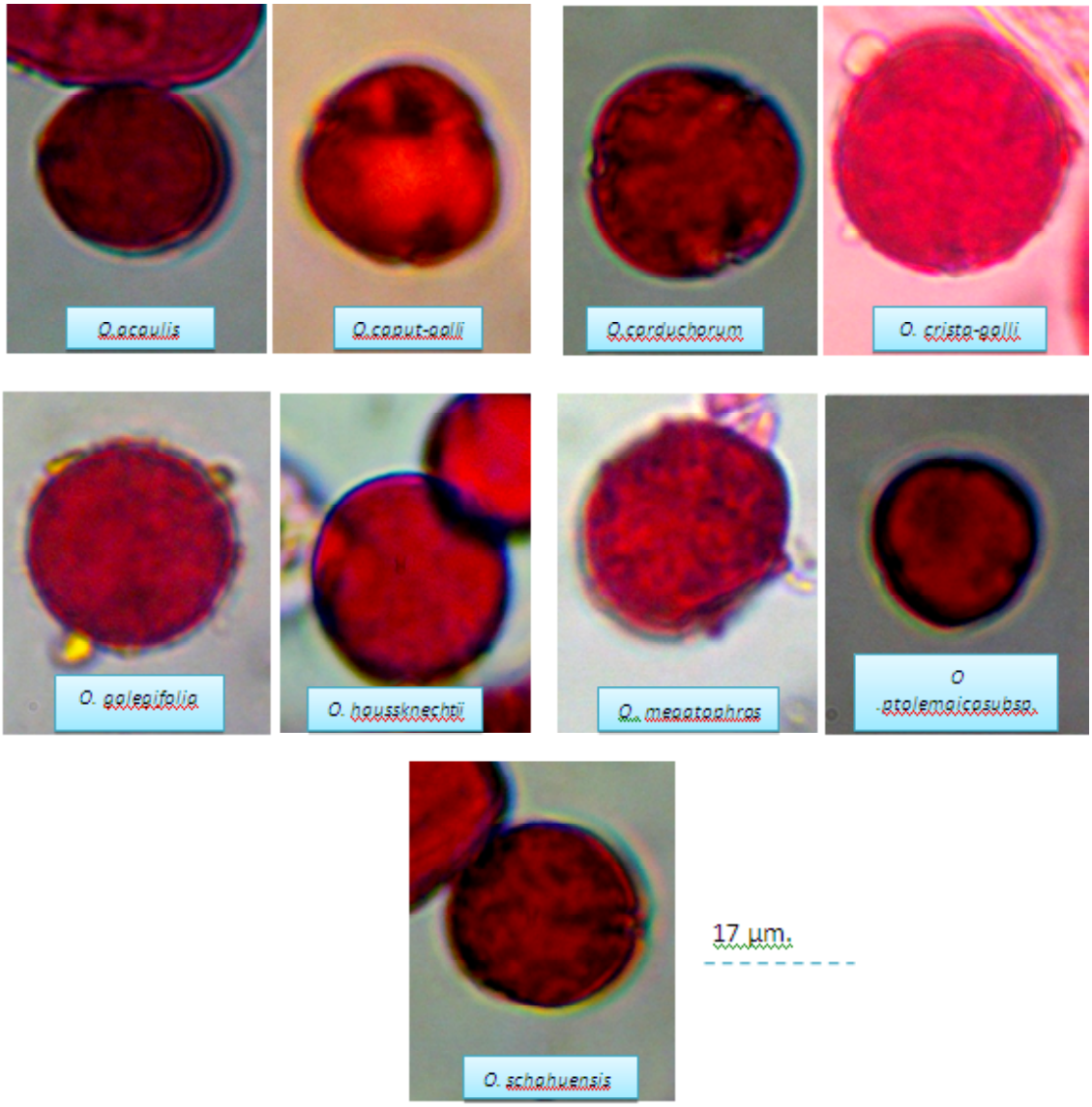

Fig. 2 : Variations in pollen characteristics (polar view) of some species of genus *Onobrychis* studied (40x) .

length (diameter). Measurements were based on 25 or more pollen grains for each species. For scaning electron microscope (SEM) dry pollen grains were mounted on stubs, morphological observation were made with a electron microscope.

The terminology used is mainly that of Punted *et al*. (2007).

Results

1. Genus : *Astragalus* (1: *A.kahiricus*). figs 1 and3, fig. SEM 5, table 2.

Pollen grains are 3-zonocolporate , subprolate (P/E: 1.18), medium in size, polar axis length32.5 (27.5-35) µm., Equatorial axis 27.5 (17.5-35)µm. The shape of pollen grain is triangular or trilobulate in polar outline and elliptic in equatorial outline, with ornamentation microreticulate (medium reticulate), the exine is (1) µm. thick, germinating pores 3, colporate.

(2: *A. rhodosemius*) (Figs. 1 and 3). Fig. SEM 5, table 2.

Pollen grains are 3-zonocolporate or 4- zonocolporate, subprolate (P/E: 1.33), medium in size, polar axis length30 (27.5-32.5) µm, E.axis 22.5 (15-25)µm. The The shape of pollen grain is Triangular in polar outline and elliptic in equatorial outline, with ornamentation reticulate, the exine is (1-1.3) µm. thick, germinating pores 3-4, colporate.

2. Genus : *Colutea* (*Col.cilicica*). , Figs. 1 and 3. Fig. SEM 5, table 2.

Pollen grains are zonocolporate , prolate (P/E: 1.37), medium in size, polar axis length27.5 (25-35) µm , Ew

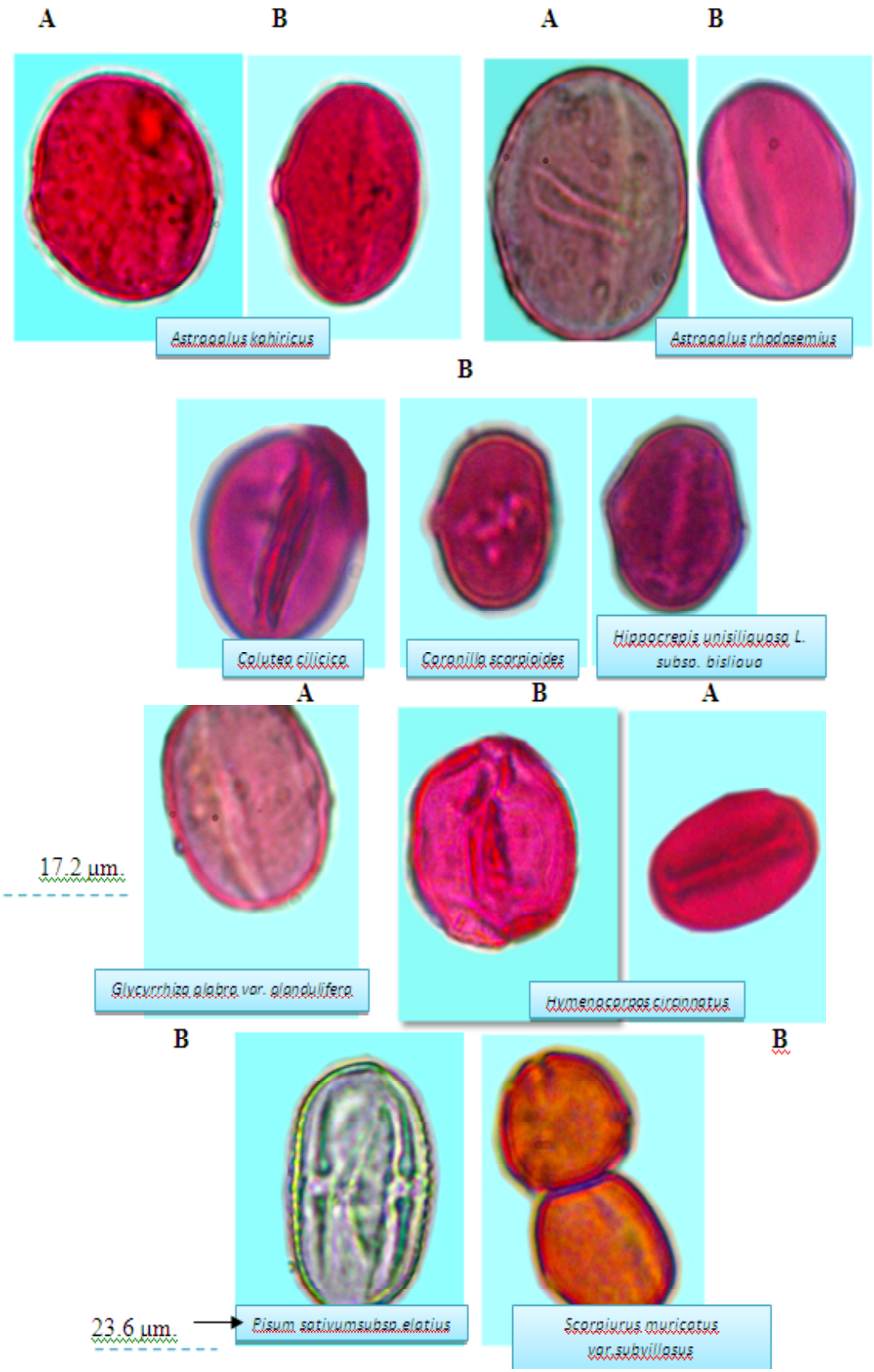

Fig. 3 : Variations in pollen characteristics (Equatorial view) of species studied. A: 100 x B : 40x

Fig. 4 : Variations in pollen characteristics (Equatorial view) of some species of genus *Onobrychis* studied. (40x)

20 (15-22.5)µm. The The shape of pollen grain is triangular or trilobed in polar outline and semiprolate-spheroidal in equatorial outline, with ornamentation reticulate-fossulate, the exine is 1 or less than 1 µm thick, germinating pores 3, colporate.

3. Genus: *Coronilla* (*Cor. scorpioides*). Figs. 1 and. Fig. SEM 6, table 2.

Pollen grains are 3-zonocolporate, subprolate (P/E: 1.16), small in size, polar axis length 17.5 (17.5-22.5) µm , Ew 15 (12.5-17.5)µm. The The shape of pollen grain is triangular-circular in polar outline and rectangular-elliptic in equatorial outline, with ornamentation striate-rugulate, the exine is 1 or less than 1 µm thick, germinating pores 3, colporate.

4. Genus : *Glycyrrhiza* (*G glabra* var. *glandulifera*). Figs. 1 and 3, fig. SEM 6, table 2.

Pollen grains are 3-zonocolporate, prolate (P/E: 1.4), in size, polar axis length 25 (27.5-37.5) µm, E. axis 25 (22.5-27.5)µm. The The shape of pollen grain is trilobulate, oblate-spheroidal in polar outline and wide elliptical in equatorial outline with ornamentation Rugulate-reticulate or regulate-fossulate, the exine is 1 or less than 1 µm thick, germinating pore 3, colporate.

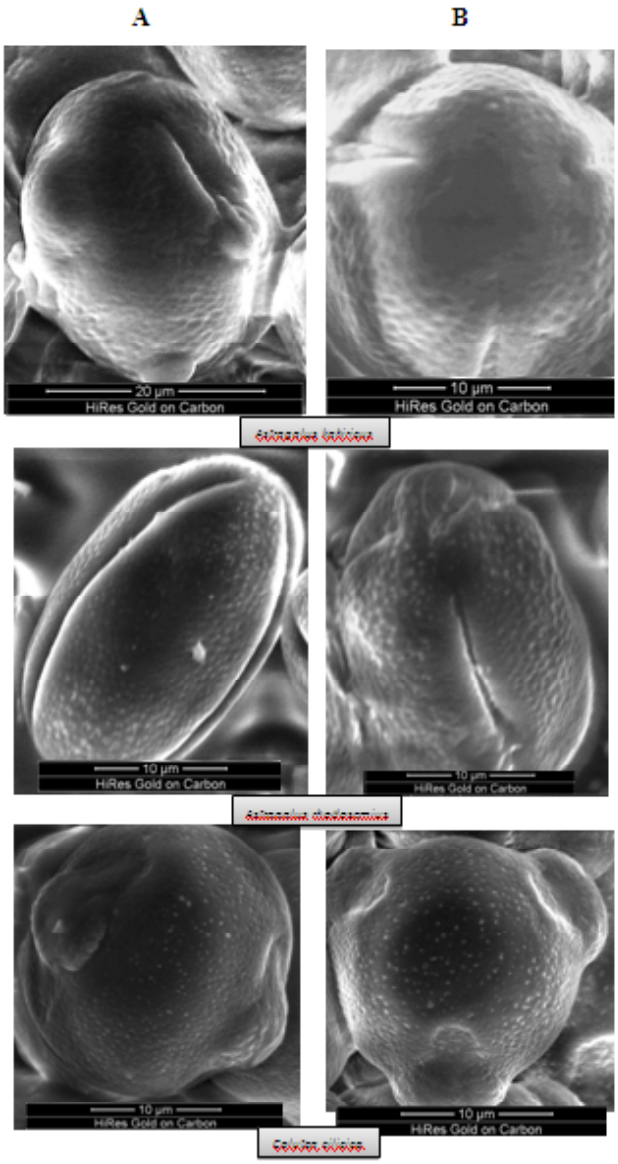

Fig. 5 : Variations in the shape and ornementation of the surface of pollen grain of some studied species. A : Equatorial view. B : Polar view.

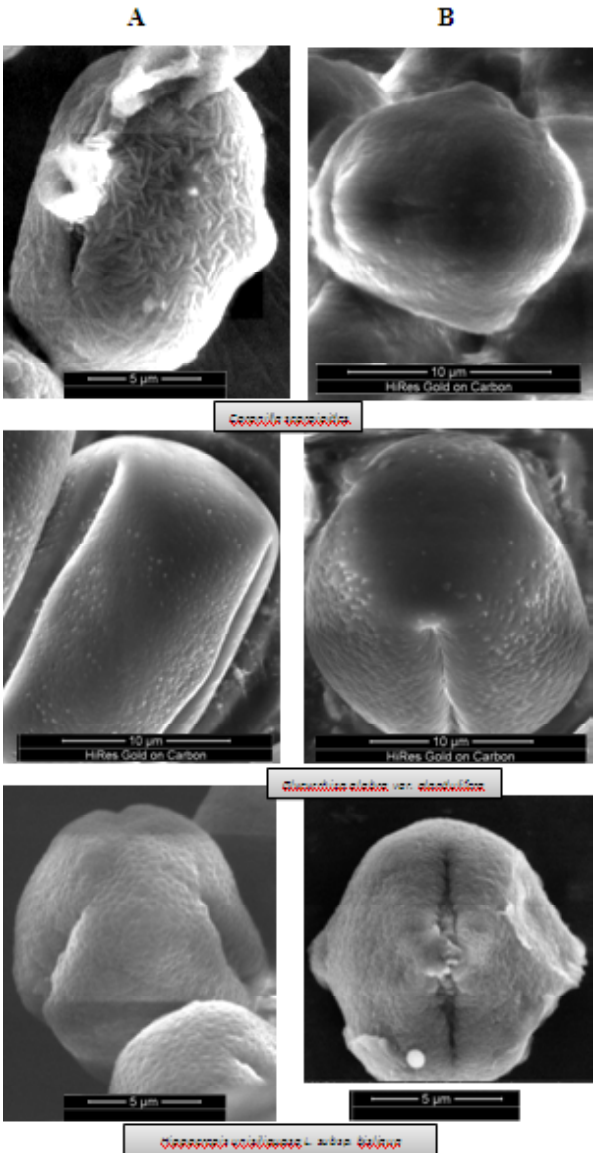

Fig. 6 : Variations in the shape and ornementation of the surface of pollen grain wall of some studied species. A : Equatorial view. B : Polar view.

5. Genus : *Hippocrepis* (*H.unisiliquosa* subsp.), figs. 1 and 3. Fig. SEM 6, table 2.

Pollen grains are 3-zonocolporate, subprolate, (P/E: 1.33), small in size, polar axis length 20 (17.5-25) µm, E. axis 15 (15-17.5)µm. The The shape of pollen grain is triangular – circular in polar putline and elliptical or rectangular – elliptical in equatorial outline, with ornamentation perforate, the exine is 1 or less than 1, germinating pores 3, colporate.

6. Genus : *Hymenocarpos* (*Hy. circinnatus*). Figs. 1 and 3. Fig. SEM 7, table 2.

Pollen grains are zonocolporate, subprolate (P/E: 1.22) , medium in size, polar axis length 27.5 (17.5-32.5) µm., E axis 22.5 (17.5-27.5)µm. The shape of pollen grain is hexagonal angular aperture in polar outline and rectangular-elliptical in equatorial outline, with ornamentation Psilate, finely perforate. The exine is 1 or less than 1 µm thick, germinating pore 6-7, colporate.

7. Genus : *Onobrychis* (1: *O. acaulis*). Figs. 2 and 4. Fig. SEM 7, table 2.

Pollen grains are zonocolporate, prolate (P/E: 1.71), medium-small in size, polar axis length 30 (25-32.5) µm, Ew 17.5 (15-20)µm. The The shape of pollen grain is oblate-spheroidal in polar outline and rectangular-obtuse in equatorial outline with ornamentation Simple reticulate, the exine is less than 1 µm thick, germinating pore 3, colpate.

2. *O.caput-galli.* Figs. 2 and 4. Fig. SEM 7, table 2.

Table 2 : Variations in pollen characteristics of the species studied are measured by micrometer.

قطر فتحة الأنبلت	Wall thick	Ornamentation	Pollen grain size	Aperture type	Shapes of pollen grains		Pollen apperture no.	Ratio P/E	Equatorial axis length (E)	Polar axis length (P)	Species	S
					Equatorial outline	Polar outline						
5-7	1	Microreticulate (medium	Medium	Colporate	Elliptic	Triangular,	3	1.18	(35-17.5) 27.5	(35-27.5) 32.5	*Astragalus kahiricus*	1
6-7	1-1.3	Reticulate	Medium	Colporate	Elliptic	Triangular	3-4	1.33	(25-15) 22.5	(32.5-27.5) 30	*Astragalus rhodosemius*	2
12-17	1-less 1	Regulate-fossulate	Medium	Colporate	Semiprolate-spheroidal	Triangular or trilobed	3	1.37	(22.5-15) 20	(35-27) 27.5	*Colutea cilicica*	3
3-4	1-less 1	Striate-regulate	Small	Colporate	Rectangular-Elliptical	Triangular or circular	3	1.16	(17.5-12.5) 15	(22.5-17.5) 17.5	*Coronilla scorpioides*	4
7-9	1-less 1	Regulate-reticulate or regulate-fossulate	Medium	Colporate	Wide elliptical	Trilobulate obla-tespheroidal	3	1.4	(27.5-22.5) 25	(37.5-27.5) 35	*Glycyrrhiza* glabra*	5
	1-less 1	منثقب Perforate	Small	Colporate	Elliptical or rectangular-elliptical	Triangular-circular	3	1.33	(17.5-15)15	(25-17.5)20	*Hippocrepis unisiliquosa*	6
6-7	1-less 1	Psilate, finely perforate	Medium	Colporate	Rectangular-elliptical	Hexagonal angular perturate	6-7	1.22	(27.5-17.5) 22.5	(32.5-17.5) 27.5	*Hymenocarpos circinnatus*	7
-	Less 1	Reticulate	Small-medium	Colpate	rectangular-obtuse	Circular	3	1.71	(20-15)17.5	(32.5-25)30	*Onobrychisacaulis*	8
-	1-less 1	Reticulate	Medium	Colpate	Elliptical elongated	Triangular-obtuse	3	2.28	(22.5-12.5) 17.5	(42.5-27.7)40	*O. caput-galli*	9
-	1	Suprareticulate	Small-medium	Colpate	Elliptical	Circular	3	1.62	(20-15) 20	(37.5-25)32.5	*O.cardechorum*	10
-	1	ReticulateSupra	medium	Colpate	Elliptical elongated	Circular	3	1.87	(30-20) 27.5	(45-25)37.5	*O.crista-galli*	11
-	Less 1	Microreticulate perforate	Small-medium	Colpate	rectangular-obtuse	Circular	3	1.67	(22.5-17.5) 20	(42.5-22.5) 37.5	*O. galegifolia*	12
-	Less 1	Suprareticulate	Small-medium	Colpate	rectangular-obtuse	Circular	3	1.67	(17.5-12.5) 15	(30-22.5)25	*O. haussknechtii*	13

Table 2 continiued...

Table 2 continued...

-	Less 1	Reticulate	Small-medium	Colpate	rectangular-obtuse	Circular	3	1.5	(20-15) 20	(32.5-25)30	*O.megatophros*	14
-	-	-	-	-	-	-	-	-	-	-	*O.ptolemaical*	15
-	- 1-less 1	Reticulate	Small-medium	Colpate	Ellipyical elongated to rectangular-obtuse	Triangular	3	1.67	(22.5-15) 15	(32.5-20)25	*O. ptolemaica 2*	16
?		Supraerticulate	Small-medium	Colpate	rectangular-obtuse	Spheroidal	3	1.83	(17.5-15) 15	(32.5-25)27.5	*O.schahuensis*	17
	Less 1	Reticulate	medium	Colporate	Elliptica	Circular	3			(50-42.5)47.5	*Pisumsativum*	18
2-3	1 Less than 1	Microreticulate finely reticulate	small	Colporate	Elliptical or rectangular-elliptical	Circular		1.33	(17.5-12.5) 15	(20-15)20	*Scorpiurusmuricatus*	19

Values outside the brackets represents the average either inside the minimum and maximum, 1= *O.ptolemaica subsp.macroptera* . 2= = *O.ptolemaica subsp.ptolemaica.*

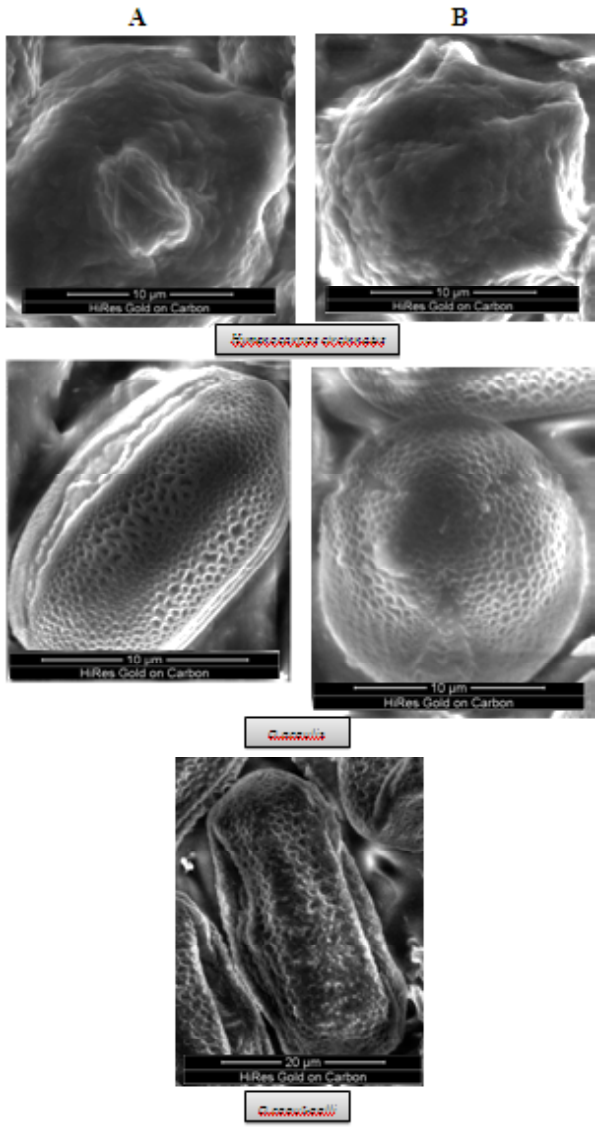

Fig. 7 : Variations in the shape and ornementation of the surface of pollen grain wall of some studied species. A : Equatorial view. B : Polar view.

Pollen grains are zonocolpate, perprolate (P/E: 2.28), medium in size, polar axis length 40 (27.5-42.5) µm, E. axis 17.5 (12.5-22.5)µm. The The shape of pollen grain is triangular-obtuse in polar outline and elliptic in equatorial outline, with ornamentation Supra reticulate, the exine is 1 0r less than 1 µm. thick, germinating pores 3, colpate.

3. *O.carduchorum.* Figs. 2 and 4, fig. SEM 8, table 2.

Pollen grains are zonocolpate, subprolate (P/E: 1.62), medium in size, polar axis length 32.5 (25-37.5) µm , E.axis 20 (15-20)µm. The shape of pollen grain is Spheroidal in polar outline and elliptical in equatorial outline, with ornamentation supra reticulate, the exine is 1 µm. thick, germinating pores 3, colpate .

4. *O.crista-galli.* Figs. 2 and 4. Fig. SEM 8, table 2.

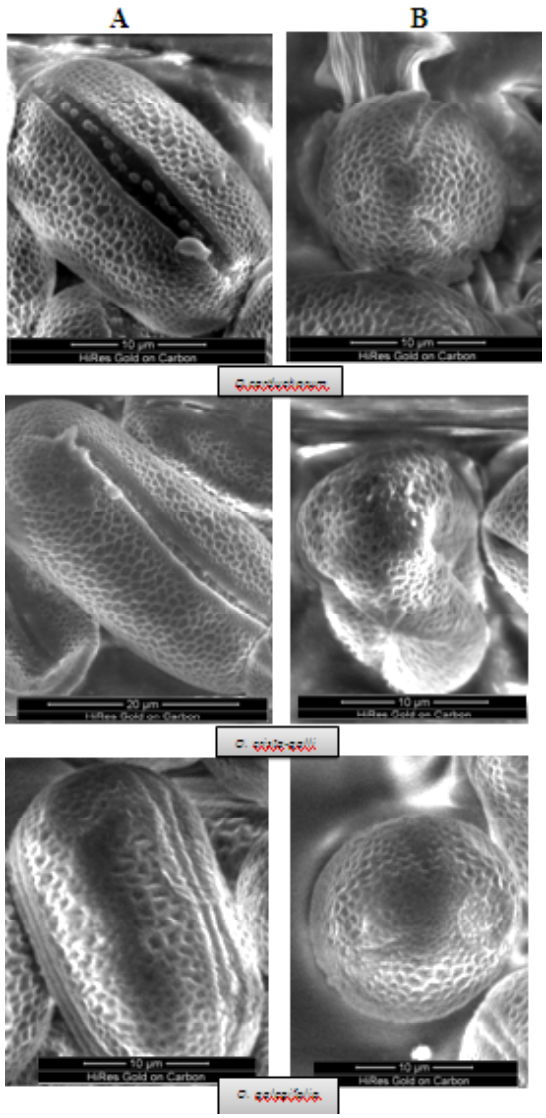

Fig. 8 : Variations in the shape and ornementation of the surface of pollen grain wall of some studied species. A : Equatorial view. B : Polar view.

Pollen grains are zonocolpate, prolate (P/E: 1.87), medium in size, polar axis length 37 (25-42) µm, E axis 27.5 (20-30)µm. The The shape of pollen grain is circular in polar outline and elliptical elongated in equatorial outline, with ornamentation Supra reticulate, the exine is 1 µm. thick, germinating pores 3, colpate.

5. *O.galegifolia.* Figs. 2 and 4. Fig. SEM 8, table 2.

Pollen grains are zonocolporate, subprolate (P/E: 1.67), medium in size, polar axis length 37.5 (22.5-42.5) µm, Ew :20 (17.5-22.5)µm. The The shape of pollen grain is Spheroidal in polar outline and rectangular-obtuse in equatorial outline, with ornamentation microreticulate-perforate, the exine is 1 µm. thick, germinating pores 3, colpate.

6. *O.haussknechtii.* Figs.2 and4, fig. SEM 9, table 2.

Fig. 9 : Variations in the shape and ornementation of the surface of pollen grain wall of some species of *Onobrychis* studied. A : Equatorial view. B : Polar view.

Pollen grains are zonocolpate, subprolate (P/E: 1.67), small-medium in size, polar length 25 (22.5-30) µm, Ew 15 (12.5-17.5)µm. The The shape of pollen grain is Spheroidal in polar outline and rectangular-obtuse in equatorial outline, with ornamentation Supra reticulate, the exine is less than 1µm. thick, germinating pores 3, colpate.

7. *O.megatophros.* Figs. 2 and 4. Fig. SEM 9, table 2.

Pollen grains are zonocolporate, prolate (P/E: 1.5), small-medium in size, polar axis length 30 (25-32.5) µm, Ew 20 (15-20)µm. The shape of pollen grain is Spheroidal

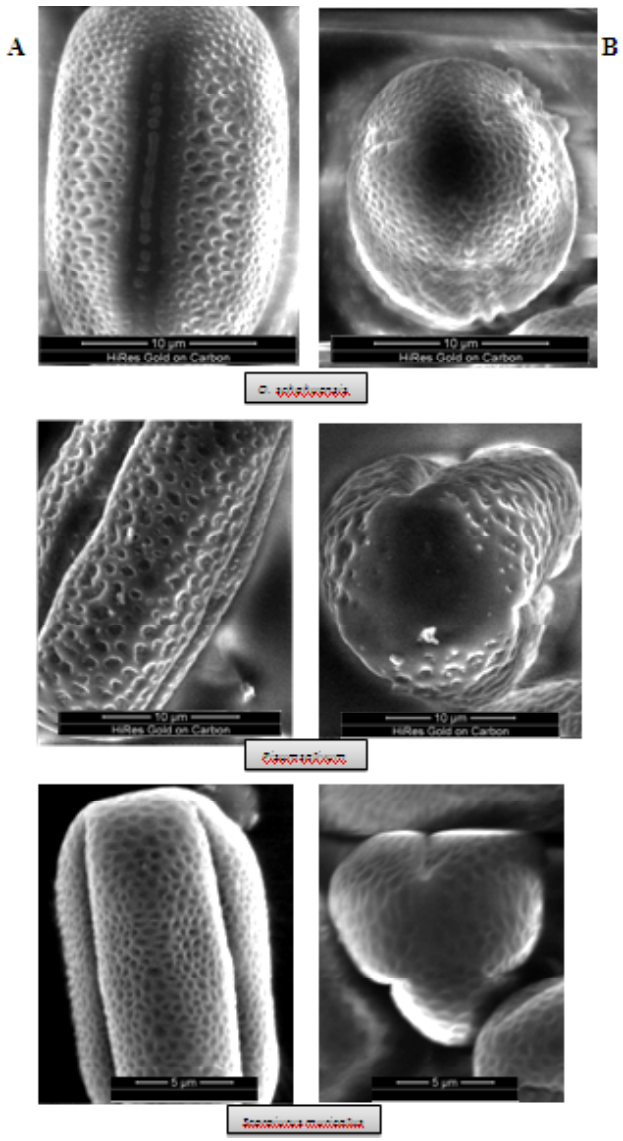

Fig. 10 : Variations in the shape and ornementation of the surface of pollen grain wall of some studied species. A : Equatorial view. B : Polar view.

in polar outline and rectangular-obtuse in equatorial outline , with ornamentation Simple reticulate, the exine is less than 1 µm. thick, germinating pores 3, colpate.

8. *O.ptolemaica*. Figs. 2 and 4, fig. SEM 9, table 2.

Pollen grains are zonocolporate, prolate (P/E: 1.67), small-medium in size, polar axis length 25 (20-32.5) µm, E.axis 15 (15-22.5)µm. The shape of pollen grain is Spheroidal in polar outline and elliptical elongated to rectangular-obtuse in equatorial outline, with ornamentation Simple reticulate, the exine is 1 or less than 1 µm. thick, germinating pores 3, colpate.

9. *O.schahuensis*. Figs. 2 and 4, Fig. SEM 10, table 2.

Pollen grains are zonocolpate, prolate (P/E: 1.83), small-medium in size, polar length 27.5(25.5-32.5) µm, E.axis 15 (15-17.5)µm. The The shape of pollen grain is Spheroidal in polar outline and rectangular-obtuse elliptic in equatorial outline, with ornamentation suprareticulate, the exine is less than 1µm. thick, germinating pores 3, colpate.

8. Genus : *Pisum*. (*P. sativum* subsp. *elatius*). Figs. 1 and 3. Fig. SEM 10, table 2.

Pollen grains are 3-zonocolporate, oblate (P/E: 1.8), medium in size, polar axis length 40 (42.5-50) µm, Ex. 22.5 (20-30)µm. The The shape of pollen grain is Spheroidal in polar outline and in equatorial outline, with ornamentation reticulate, the exine is 1 µm. thick, germinating pores 3, colporate.

9. Genus: *Scorpiurus* (*S. muricatus* var. *subvillosus*). Figs. 1 and 3. Fig. SEM 10, table 2.

Pollen grains are 3-zonocolporate, subprolate (P/E: 1.33), small in size, polar axis length 20 (15-20) µm, E axis 15 (12.5-17.5)µm. The The shape of pollen grain is Spheroidal in polar outline and elliptic in equatorial outline, with ornamentation Microreticulate finely reticulate, the exine is 1 or less than 1 µm. thick, germinating pores 3 colporate.

Discussion

In this investigation, pollen grains of eighteen species belonging to nine genera of the subfamily : Papilionoideae have been studied. The result show that the pollen grains are 3-zonocolpate in the genus *Onobrychis* and 3-zonocolporate in other genera, sometimes 4-onocolporate in *As.rhodosemius*, 6-7 zonocolporate also occure in *Hy.circinnatus*, evolutionary tricolporate pollen grains may be considered as in advanced status (Bhattacharya *et al*., 2015), pollen morphological study of Bhattacharya *et al*. (2015) supported this observation.

Tricolpate is the main and basic type found in eudicot, while other aperture types are regarded as derived among eudicot, such as 5-colpate, 6-colpate, porate, colporate (Walker and Doyle, 1975).

Size of pollen grains are valuable at generic level , the smallest pollen grains are those of *Hi. unisiliquosa* and *S.muricatus* and the largest one are those of *P.sativum* L. Varation in pollen size is caused by either anomalies in meiosis or hybridization (Matsuda, 1928; Aytug *et al*., 1971). Chanda and Ghosh (1976) considered the size of pollen grains have teritiary importance, after the characters of germinating pores and ornamentation of exine.

In current study, all examined species showed a great varation in the shape of pollen grain at polar and equatorial outline.

Nair (1964) pointed out that characters of pollen morphology such as the ahape is a useful tool in solving problems at various taxonomic levels.

Patterns of the sculpture of exine have a great taxonomic importance at generic and species level, in the terms of morphological evolution of pollen grain , exine sculturing evolution have secondary importance (Chanda and Ghase, 1976), also Ferguson (1985) mention to the Papilionoideae especially in the exine stratification and sculpturing.

The number of germinating pore was signification at generic level and help in differentiation of *Hy.circinnatus* and *A. rhodosemius,* which have more than 3-pores. Chanda and Ghosh (1976) considered the characters of germinating pore to be as a primary importance , because they are more conservative.

Conclusion

Characters of palynological study of some genera of Papilionoideae valuable at generic and species level especially shape of pollen and the exine sculpture.

References

AL-Aubaidy, A. K. (2006). Acomparative systematic study of the genus *Trigonella* L. Spp. In Iraq. thesis, Education College , Univ.Diyala.

AL-Dobaissi, E. A-R. M. (2008). Morphological study of pollen grains in wild dicotyledons s pecies grown in Baghdad university compus /Jadiriya. Thesis, Science Collage, Univ. Baghdad.

AL-Katib, Y. M. (1988). *Taxonomy of floweing plants*. Baghdad Univ., Iraq. P. 398-401.

AL-Mayah, A. A. (1983). Taxonomy of *Terminalia* (Combretaceae). *Ph.D. Thesis*, Univ. of Leicester, U.K.

AL-Musawi, M.H. (1987). *Plant taxonomy*. Univ. Baghdad. p. 379.

AL-Saadi, M. H. M. (2013). A systematic study of the genus *Trifolium* L. (Leguminosae) in Iraq. *Ph.D. Thesis*, Science College, Univ of Kufa.

AL-Shammary, W. I. J. (2015). A comparative morphological and anatomical study of *Melilotus* Mill. and *Scorpiurus* L.genera (Leguminosae) in Iraq. *Thesis*, Education College, Univ. Qadisiya.

Aytug, B., S. Ayrut, N. Merev and G. Edis (1971). Atlas des pollens des environs d'Istanbul. Kutulmus Matbaasi. Istanbul.

Bhattacharya (Sasmal), P., S. Biswas and J. K. Pal (2015). Palyno-taxonomic study of some plant taxa of Fabaceae from Arambagh region of Hooghly district, West Bengal, eastern India. *Bioscience Discovery*, **6(1)** : 27-34.

Chana, S. and K. Ghosh (1976). Pollen morphology and its evolutionary significance in Xanthorrhoeaceae. In: Devi, R. K., N. V. Rajesh and R. G. Kumari, R. G. (2013). Palynological studies on selected eight species of Acacia, wild in south India. *Rom. J. Biol-Plant Biol*., **58(1)** : 69-77.

Erdtman, G. (1969). *Handbook of Palynology* (Morphology – Taxonomy – Ecology). Hafner publishing Co. New York. pp. 486.

Freguson, I. K. (1985). *The role of pollen morphology in plant systematic*. An. Asoc. Palinol. Leng. Esp. 2:5-18.

Ghosh, S. and J. P. Keshri (2007). Levant2 s Q and A Series Botany (1st .ed). Sarat Book Distributer, Kilkata, pp. 237-238.

Guinet, P. H. (1981). Comparative account of pollen characters in the Leguminosae. In : Santos, F.A.R., D. M. Novaes, and L. P. Queiroz (2012). Pollen of *Bauhinia* L. & *Phanersa* Lour. (Leguminosae-Caesalpinioideae) from the Brazilian Caatinga. *American Journal of plant science*, **3** : 909-920.

Harlow, W. M., E. S. Harrar, J. W. Hardin and F. M. White (1991). Textbook of Dendrology: Covering the Important Forest Trees of the United States and Canada. Ed. 7. McGraw-Hill, Inc.Pp.1-501.

Mabberley, D. J. (1997) Mabberley′s Plant-Book.A Portable Dictionary of the Vascular Plants. 2nd edn. Cambridge University Press, Cape Town. In : Dizkirici, A. and Z. Kaya (2013). Comparative molecular phylogenetics of *Astragalus* L. sections from Turkey with New World *Astragalus* species using nrDNA ITS sequences. *Plant Sys. Evol*., DOI 10.1007/s00606- 013- 0868-9.

Matsuda, H. (1928). On the origin of big pollen grains with abnormal numbers of chromosomes. *Cellules*, **38** : 213-243.

Melhem, T. (1971). Pollen grains of plants of the Cerrado-Leguminosae-Lotoideae. *Tribe Phaseoleae. Hoehnea*, **1** : 119-151.

Mirzaei, L., I. Mehregan, N. Taher and M. Assadi (2015). Phylogeny analysis of *Colutea* L. (Fabaceae). From Iran based on ITS sequence data. *Biodiversitas*, **16(2)** : 168-172.

Nair, P. K. K. (1964). *Pollen morphology*. In : Devi, R. K., N. K. Rajesh and R. G. Kumari (2013). Palynological studies on selected eight species of *Acacia,* Willd in south India. *Rom.J.Biol.-Plant Biol*., **58(1)** : 69-77.

Perveen, A. and M. Qaiser (1998). Pollen flora of Pakistan – VIII Leguminosae (subfamily : Papilionoideae). *Tr. J. of Botany*, **22** : 73-91.

Punt, W., P. P. Hoen, S. Blackmore, S. Nilsson and A. Le Thomas (2007). Glossary of pollen and spore terminology. *Review of Palaeobotany and Palynology*, **143** : 1-81.

Silvestre-Capelato, M. S. F. (1993). Palinologia das Leguminosae da reserve biologica do Purque Estadual das Fontes do Ipiranga (Brasil). *Ph.D. thesis.*

Tekin, M. and G. Yilmaz (2015). Comparative root and stem anatomy of four rare *Onobrychis* Mill. (Fabaceae) Taxa Endemic in Turkey. *Notulae Scientia Biologicae*, **7(3)** : 308-312.

Walker, J. W. and J. A. Doyle (1975). The Bases of Angiosperm Phylogeny: Palynology. *Ann. Miss. Bot. Gard*., **62(3)** : 664-723.

Walter, D. R. and D. J. Keil (1988). *Vascular plant taxonomy*. ed. 3. Kendall/Hunt. Publishing Company.

Watson, L. and M. J. Dallwitz (2009). *The Families of Flowering Plants-Primulaceae*. http://delta-intkey.com/