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Amaricf_Basra office@yahoo.com
abdulalwan@yahoo.com
.marshbulletin@yahoo.com

Pollen Morphological Study of the Dicots Wetland Plants of Southern Marshes of Iraq

S.A. A. Al-Saadi and A.R.A. Al- Mayah

Department of Biology, College of Science, University of Basra. Iraq

Abstract

Palynological features of the pollen grains of Dicots wetland plants of the Southern Marshlands of Iraq were studied. Forty nine species belong to twenty five families were investigated .The results showed that there were significant difference and high diversity in shape, size, ornamentation and apertures of the pollen grains of most genera and species studied. Most families and genera have their own characteristic pollen types. On the basis of ornamentation and apertural types, nineteen distinct pollen types were recognized. Pantoporate pollen grains were showed in several families such as Chenopodiaceae and Amaranthaceae. Most species contain three colpi as in *Bacopa monniera*, while *Myriophyllum spicatum* contains 4-5 clopi, but many species contained colp and pore as in most of Dicots species as in Compositae. Ornamentations were varied from psilate in the *Utricularia australis* to echinate in some species of Compositae.

1- Introduction

Pollen morphology of sixteen species of aquatic angiosperms distributed in 14 families from Karachi has been studied by Perveen (1999). He showed that pollen grains were free, rarely united, mostly radically symmetrical, isopolar or apolar, occasionally heteropolar; simple aperture (porate or colpate), tectum was variable from reticulate to rugulate, striate, echinate, scabrate and areolate. Perveen (2000) provided pollen morphology of 353 species from Karachi, belonging to 67 families of angiosperms, distributed in 58 dicots and 9 monocots. The 15 species of genus *Lycopus* examined by Moon and Hong (2003)

showed that the pollen grains were hexacolpate, medium or small in size, the shape was oblate to prolate. Aftab and Perveen (2006) examined pollen morphology of 25 species belonging to 23 genera distributed in 13 families by light microscopy and scanning electron microscope. They showed that pollen grains occurred singly and rarely in polyads, 3-colporate in family Apocynaceae, however, the family Malvaceae had pantoporate pollen grains, tectum reticulate or regulate in addition to its scabrate and echinate. Alwadie (2008) studied pollen morphology of six aquatic angiosperms from Saudi Arabia, and showed several types; non-apertures pollen grains as in *Elodea canadensis, Potamogeton crispus, P. pectinatus* and *Ruppia maritima*, porate pollen as in *Lemna gibba*, and colpate pollen grains as in *Myriophyllum spicatum*. Few species of family Malvaceae have been studied by Bibi *et al.* (2010) they showed that *Malva parviflora* is pantoporate, monocolpate, spherical to subspherical in polar view while it is reniform in equatorial view.

There are no previous studies on pollen morphology of wetland and aquatic plants from Southern Iraq. The present study aims to study the pollen morphology of the species of wetland angiosperms in Southern Iraq and their major evolutionary trends.

2-Materials and methods

Pollen samples were collected from plants of different locations in southern wetland of Iraq. Six stations in the marshes, namely Um Al-Naaj and Um Al-warid in Hewaiza marsh, Abo-Sobat and Abo – Cholan in Chabaish marsh, and Burga and Nagara in east Hammar marsh, In addition to Shatt-Al-Arab, were chosen for sampling. The pollen samples were procured from closed mature anthers. The materials were suspended in glacial acetic acid, centrifuged and acetolysed (Erdtman, 1952). The acetolysis fluid was poured off and the sediments washed in distilled water (3 times) by shaking the tubes, centrifuged and decanted. Then pollen grains were mounted in Safranine stained glycerin jelly, and micro morphological observations were made with light microscope (Model: Leitz, Japan). Microphotographs were taken by using digital camera (Model: DC 2000) and measurements were made using an ocular micrometer in the light- microscope, the measurements were based on 20-25 readings from each specimen. Polar axis (P), equatorial diameter (E), colpi length, spine length and exine thickness were measured. The terminology used for the description is in accordance with Erdtman (1952), Faegri and Iversen (1964) and Moore and Webb (1978).

3-Results

Wetland angiosperms exhibited great diversity in their pollen characters, such as shape, size, apertures, polarity and tectum type, but the exine pattern and aperture types are the most significant pollen characters.

From the family Amaranthaceae, three species *Alternanthera sessilis, Amaranthus graecizans* and *Amaranthus viridis* were examined. Pollen grain was apolar and spheroidal. It was polypantoporate in the genus *Amaranthus* and12-forate in *Alternanthera sessilis*, all pollen grains were small in size, with spinulose tectum. Mean of largest pollen grains was recorded in *Amaranthus graecizans* 22.67 µm and the smallest was in *Alternanthera sessilis* 13.45 µm (plate1, table 1).

In Apocynaceae one species *Trachomitum venetum* was studied, pollen grains were aggregate in tetrad, diameter 28.54-35 µm, tetrahedral in shape, 4-6 pore in all pollen grains, subprolate in equatorial view, tectum reticulate(plate 1, table 1).

In Asclepiadaceae one species *Cynancum acutum* was examined, pollen shed in aggregates, in the form of pollinia, with reticulate tectum (plate 1, table1). Capparaceae showed that *Capparis spinosa* with pollen grains tricolporate, isopolar, sub-prolate, tectum generally spinulose, polar axis (18) 22.45(23.65) µm, and equatorial diameter (17) 19.30 (24.2) µm. P/E ratio: 1.16 (plate1, table 1). Within Caryophyllaceae, one species *Spergularia diandra* was studied, pollen grains 3-5 colpate, psilate, isopolar, subprolate(plate 1,table 1).

In Ceratophyllaceae, one species *Ceratophyllum demersum* was studied, pollen grains monoaperturate, diameter 25-47.5 µm, spheroidal, medium in size (plate 1, table 1).

From the family Chenopodiaceae, six species were studied. Pollen grains were apolar, pantoporate, and spheroidal. Number of pores was variable among species, it was 30 pores in *Salsola baryosma* , 30-40 pores in *Chenopodium murale* and *Suaeda aegyptiaca*, 40-50 in *Suaeda vermiculata* and 22-30 in *Salicornia herbacea*(plate 1,table 1). From the family Compositae, eight species were examined (plate 2, table 2). Those species were characterized by tricolporate type. Shape of pollen grain was prolate spheroidal in *Eclipta alba* and *Silybum marianum* ,oblate spheroidal in the rest species, the smallest pollen grain in *Eclipta alba* was 21.36 × 21.60 µm, the largest in *Silybum marianum was* 51.66 × 52.5 µm, tectum varies between the species, it was reticulate in *Senecio vernalis* , punctuate in *Centaurea solstitialis* and spinules in the rest species.

In Convolvulaceae, the species *Cressa cretica* was examined, pollen grains were

isopolar, tricolpate, shape of pollen in polar view was circular to semi-circular and in equatorial view was prolate spheroidal, with punctate tectum. Pollen morphology of two species of family Cruciferae (Brassicaceae) *Cardaria draba*(*Cardaria draba* var. *draba* and *Cardaria draba* var. *chalepensis*) and *Sinapis arvensis* were examined. Pollen type is 3-colpate, it was prolate spheroidal in *Cardaria draba*, subprolate in *Sinapis arvensis*, exine thicker than nexine. Pollen grain size varies from medium to small size in *Cardaria draba*, medium size in *Sinapis arvensis* (plate 2, table 1).

Myriophyllum spicatum (Haloragaceae) pollen grains were isopolar, oblate spheroidal, 4-5-zonocolpate, elliptic, size: polar axis, 25.5(26) 30 µm, and equatorial diameter (25) 27.5 (32.5) µm, the mean of exine 0.85 µm thick, sexine thicker than nexine. Tectum was punctate (plate 3, table 3).One species of family Labiatae (*Lycopus europaeus*) was examined. Pollen grains were isopolar, (hexacolpate) 6-colpate, oblate spheroidal, medium in size, tectum reticulate (plate 3, table 3).

Pollen morphology of the Leguminosae was examined for two species, *Alhagi graecorum* and *Trifolium resupinatum*, pollen grains were generally isopolar, 3-colporate, the shape of pollen grain was prolate in *A. graecorum* and suboblate in *T. resupinatum*, sexine thicker than nexine, tectum baculate. The largest mean of polar diameter was 20.85 µm in *A. graecorum* and smallest 19 um in *T. resupinatum*, the largest mean of equatorial diameter was 24.5 µm in *T. resupinatum* and smallest, 14.67 µm in *A. graecorum* (plate 3, table 3).

Utricularia australis (Lentibularaceae) pollen grains were medium sized they were 25(26.50)27.5 µm in polar view and 30(32.75)35 µm in equatorial view, polycolporoidate, isopolar, the shape of the grains was suboblate, ornamentation was psilate (plate3, table 3). Pollen of *Malva parviflora* from family Malvaceae was polypantoporate echinate, spherical in shape with pollen diameter 95(98.33)105 µm. Pores are small with pore diameter of about 1(1.50)1.75 µm, circular in shape and located usually at the base of spine. Exine thickness was about 8(12.5)13 µm, tectum echinate. Spine number 25 (40)54, vary in size, larger one with spine height of 1.5-3 µm (plate 4, table 3).

Menyanthaceae: tow species *Nymphoides indica* and *N. peltata* were studied. Pollen grains heteropolar, subprolate and suboblate in *Nymphoides indica* and *N. peltata* respectively, tricolpate, sexine thicker than nexine. Tectum spinulose in *N. indica* and reticulate in *N. peltata*(plate 4, table 3). Nymphaceae: *Nymphaea alba* pollen grains monosculate, bilateral, heteropolar, boat-shaped, size in polar view (32.5) 34.37 (37.5) µm and equatorial view

(25)26.87 (30) µm, tectum was wart (plate 4 table 3).

Pollen grains in *Ludwigia repens* (Onagraceae) were isopolar, tricolporate, oblate spheroidal and wart tectum.Mean of polar view was 96.66 µm and 108.33 µm in equatorial view, ratio of P/E was 0.89 (plate 4, table 3). Three species *Polygonum aviculare*, *Persicaria salicifolia* and *Rumex dentatus* from Polygonaceae family were examined, they had three types of pollen grains; they were tricolporate, pantopolyporate and tetracolporate respectively. Pollen morphology was more specialized in ornamentation; tectum was reticulate in *Persicaria salicifolia* and *Rumex dentatus* and punctate in *Polygonum aviculare* (plate 5, table 3). Pollen grain of *Samolus valerandi* from Primulaceae is 3- colporoidate, subprolate, small in size 15-17.5 µm, tectum reticulate (plate 5, table3). *Rannunculus sphaerospermus* from the family Ranunculaceae was characterized by tricolpate, isopolar grains; with punctuate tectum (plate 5, table 3). While Scruphularaceae pollen grains (*Bacopa monniera*) were isopolar, oblate spheroidal, tricolpate, medium in size, reticulate tectum, the mean of polar view 28.68 µm and 29.37 µm in equatorial view (plate 5, table 3). *Solanum nigrum* (Solanaceae) pollen grain was isopolar, oblate spheroidal, tricolporate and psilate (plate 6, table 3).

From the family Tamaricaceae five species were examined. These species were characterized by tricolpate,small size with reticulate tectum. Shape of pollen grain was suboblate in *T.arceuthoides*, oblate spheroidal *in T.aralensis* and *T.brachystachys*, while prolate spheroidal in *T. aphylla* and *T.ramosissima*. The smallest pollen grain in equatorial view was in *T. ramosissima* 14.78 x15 µm, and the largest was in *T.brachystachys* 18.14x 18.33 µm (plate 6, table 4).

In Verbenaceae, *Phyla nodiflora* pollen grains were tricolporate, isopolar, suboblate, size in polar view was (20) 24.37 (27.5) µm and in equatorial view was (27.5)29 (32.5) µm, tectum was reticulate (plate 6, table 3).

Table (1) Some pollen morphological characters of dicotyledons species.

family	Species	Ornamen-tation	Type	Polar length of pollen in µm (P)	Equatorial diameter in µm (E)	P/E	P/E x100	Shape	Size	Colp diameter (µm)		Distance between colp	Pore diameter (µm)		Exine thickness (µm)
										length	width		Length	width	
Amaranthaceae	*Alternanthera sissilis*	spinuliferous	12 porate	(10- 18) 13.45	-	-	-	hexagonal	S	-	-	-	(1-4) 3.45	(1-4) 3.42	(1-1.90) 1.76
	Amaranthus graecizans	spinuliferous	pantoporate	(17-25) 22.67	-	-	-	Spheroidal	S	-	-	-	(1-2.30) 1.90	(1-2) 1.68	(1-2.20) 2
	Amaranthus viridis	spinuliferous	pantoporate	(15.5-21) 18.45	-	-	-	spheroidal	S	-	-	-	(1-2.67) 2.10	(1-2.90) 2.50	(2.5-3.78) 3.32
Apocynaceae	*Trachomitum venetum*	reticulate	tetrads	(28.54- 38) 36.45	(33.20 - 44) 36.83	1.13	113	Subprolate	M	-	-	-	(3 - 6.7) 5.56	(1-3.5) 2.13	(1-3.78) 2.54
Asclepiadaceae	*Cynancum acutum*	reticulate	-	(250-350) 311.67	(27-39.54) 30.91	1.17	117	subprolate	M	-	-	-	(2-5.60) 3.67	(1.2-4) 2.78	(1- 1.25) 1.12
Capparaceae	*Capparis spinosa*	spinuliferous	3 - colporat	(18- 23.65) 22.45	(17-24.2) 19.30	1.16	116	subprolate	S	(10-17.3) 13	(2-6.20) 4.23	(1-3) 2.54	-	-	(1-2) 1.8 2
Caryophyllaceae	*Spergularia diandra*	Psilate	3 - 5 colpate	(25-35) 30	(20-27.5) 24	1.25	125	subprolate	S-M	(19-30) 28.70	(5-18.5) 16.23	-	-	-	(0.62-2.5) 1.45
Ceratophyllaceae	*Ceratophyllum demersum*	Psilate	1- aperturate	(25-47.5) 40	-	-	-	spheroidal	M	-	-	-	(2-6.30) 4.75	(2-5.50) 4.66	(0.62-1) 0.93
	Chenopodium murale	spinuliferous	pantoporate	(12-[illegible]) 1[illegible]	-	-	-	spheroidal	S	-	-	-	(1-2) 1.34	(1-1.50) 1.23	(1-1.80) 1.32
	Halocnemum strobilaceum	spinuliferous	pantoporate	(25-[illegible]) 31.32	-	-	-	spheroidal	M	-	-	-	(1-2.25) 2	(1-1.76) 1.55	(0.86-2) 1.23
	Salicornia herbace	spinuliferous	pantoporate	(30- 25) 27.08	-	-	-	spheroidal	M	-	-	-	(1.25-2) 1.81	(1.25-2.5) 2.0	(2.5 - 5) 3.90
	Salsola baryosma	spinuliferous	pantoporate	(12-19.60) 15.65	-	-	-	spheroidal	S	-	-	-	(1-2) 1.45	(1-2) 1.34	(1-2.10) 1.70
	Suaeda aegyptiaca	scabrate	pantoporate	(16-24.65) 20.53	-	-	-	spheroidal	S	-	-	-	(1.25-2) 1.80	(1 -2) 1.45	(1-2.5) 1.77
	Suada vermiculata	scabrate	pantoporate	(18-25.5) 20.76	-	-	-	spheroidal	S	-	-	-	(1-2) 1.28	(1-2) 1	(1-1.90) 1.30
Convolvulaceae	*Cressa cretica*	punctate	3-colpate	(32.4-35) 34.16	(33 -38.5) 37.5	0.91	91	proplate spheroidal	M	(23.5-27) 25.40	(2-3) 2.50	(2-4.5) 3.10	-	-	(1.25-2.5) 1.92
	Cardaria draba var. chalepensis	reticulate	3-colpate	(22.5-28) 27.8 0	(25.5 -30) 27.1 5	1.02	102	prolate spheroidal	M	(22-26.76) 25.22	(2.75-5) 3.60	-	-	-	(1-1.5) 1.25
	Cardaria draba var. draba	reticulate	3-colpate	(22.5-27.5) 24.28	(22.5-25) 23.92	1.01	101	prolate spheroidal	S-M	(12.5-15) 14.37	(12.5-15) 13.75	-	-	-	(1.25-2.5) 2.08
	Sinapis arvensis	reticulate	3-colpate	(15-22.5) 21.0 8	(15.5-25) 18.28	1.15	115	subprolate	S	(14.5-16) 15.30	(1-2.75) 2.50	-	-	-	(1.25-1.87) 1.10

S=small , M = medium

Table (2) Some pollen morphological characters of Compositae species.

Species	Ornamen-tation	Type	Polar length in um(P)	Equatorial dameter in µm (E)	P/E	P/E x100	Shape	Size	Colp diameter (µm) length	Colp diameter (µm) width	Distance between colpi	Pore diameter (µm)	Exine thickness (µm)	Spines length (µm)
Aster tripolium	spinuliferous	3-colporate	(-32.5) 27.5	(25-32.5) 28.75	0.95	95	Oblate spheroidal	M	(19-23.23) 20.32	(2.5-3.13) 2.90	(10-7.5) 8.21	(4.5-8.70) 7.34	(2.5-5) 3.10	(2.5-5) 3.82
Aster squamatus	spinuliferous	3-colporate	(26.34-30) 29.40	(27.88-35) 30.70	0.95	95	Oblate spheroidal	M	(25.3-30) 27.44	(2-3.76) 3.11	(9.30-6) 7.86	(3.24-6) 5.93	(2.5-5) 4.50	(3.23-5.5) 4.11
Centaurea solstitialis	punctate	3-colporate	(25-37.5) 32.50	(30-37.5) 35.35	0.91	91	Oblate spheroidal	M	(25-30) 28.33	(2.5-5) 3.33	(7.65-4) 5.62	(5-7.5) 5.83	(1.25-2.5) 2.08	(0.62-0.85) 0.73
Eclipta alba	spinuliferous	3-colporate	(15-27.5) 21.60	(12.5-26) 21.36	1.01	101	Prolate spheroidal	S	(10-22.4) 19.50	(1.5-4.10) 3.10	(11.50-6) 9.30	(6-12.70) 9.52	(1.75-2.5) 2.25	(2.5-5) 3.75
Senecio desfontinei	spinuliferous	3-colporate	(25-27.5) 26.25	(25-27.5) 26.66	0.98	98	Oblate spheroidal	M	(20-22.5) 21.25	(2.5-3.5) 3	(13-10) 12.5	(7.5-9.12) 8.01	(2.7-3.75) 3.33	(2.5-3.87) 3.12
Senecio vernalis	reticulate	3-colporate	(27.5-30) 28.75	(22.5-35) 29.37	0.97	97	Oblate spheroidal	M	(20-28.40) 24.50	(6.50-2) 3.90	(8-15.6) 12.45	(11-20) 13.33	(2.5-5) 3.90	(1-2) 1.34
Silybum marianum	spinuliferous	3-colporate	(40-57.5) 52.5	(42.5-62.5) 51.66	1.01	101	Prolate spheroidal	L	(27.5-37) 32.5	(6.60-3) 5.12	(12-15) 14.40	(5-10) 6.60	(2.5-7.5) 5.62	(5-6) 5.34
Sonchus maritimus	spinuliferous	3-colporate	(30-37.5) 33.12	(32.5-40) 36.87	0.89	89.	Oblate spheroidal	M	(24-26.60) 25.26	(5.90-2.5) 4.32	(5-10.3) 7.34	(3.7-9.6) 7.90	(2-3.5) 3.10	(2.12-4.4) 3.10

S=small , M = medium

Table (3) Some pollen morphological characters of dicotyledons species.

family	Species	Ornamentation	Type	Polar length (µm) (P)	Equatorial length(µm) (E)	P/E	P/E x100	Shape	Size	Colp diameter (µm)		Distance between colpi	Pore diameter (µm)		Exine thickness (µm)
										length	width		Length	width	
Haloragaceae	*Myriophyllum spicatum*	Punctuate	4-5- aperturate	(25.5-30) 26	(25-32.5) 27.5	0.94	94	Oblate spheroidal	L	(22.5-25) 24.16	(10-15) 12.5	(3- 9) 8.30	(2.5-5) 3.21	(2.5-5) 3.57	(0.62-1.25) 0.85
Labiatae	*Lycopus europaeus*	Reticulate	6-colpate	(22.5-27.5) 25.86	(25-30.20) 27.50	0.94	94	Oblate spheroidal	M	(20-25.20) 22.50	(7.5-10) 8.75	(1-3) 2.36	-	-	(0.5-1) 0.85
Leguminosae	*Alhagi graecorum*	Baculate	3-colporate	(16-21.65) 20.85	(13- 16) 14.67	1.42	142	Prolate	S	(12.50-16) 15.44	(1-2.56) 1.76	(1-3) 2.21	(2-6.76) 5.36	(0.75-2) 1.45	(0.5-1.25) 0.90
	Trifolium resupinatum	Baculate	3-colporate	(17.5-20) 19	(22.5-25) 24.5	0.77	77	suboblate	S	(10-16.78) 14.56	(2-4.60) 3.67	(1-3) 1.67	(5-7.5) 6	(5-7.5) 6	(17.5-20) 18.75
Lentibulariaceae	*Utricularia australis*	Psilate	polycolporoidate	(25-27.5) 26.50	(30-35) 32.75	0.80	80	suboblate	M	(22-34) 27.65	(15-25) 20.20	(2-6) 4.30	-	-	(2.5-5) 3.75
Malvaceae	*Malva parviflora*	Spinulife-rous	polypantoporate	(105-95) 98.33	-	-	-	-	L-V.L	-	-	-	(1-1.75) 1.50	(1-1.75) 1.25	(8-13) 12.5
Nymphaceae	*Nymphaea alba*	Wart	monosulcate	(32.5-37.5) 34.37	(25-30) 26.87	1.27	127	subprolate	M	(10-12.5) 11.25	(5- 20) 13.33		-	-	(2.5-5) 3.5
Menyanthaceae	*Nymphoides indica*	Spinulife-rous	3- colpate	(24.3-33.5) 27.61	(18.5-24.5) 22.43	1.23	123	subprolate	S-M	(16-25.70) 21.54	(3.75-8.90) 6.96	(2.5-8.87) 5.34	-	-	(1.76-4.89) 3.78
	Nymphoides peltata	Reticulate	3- colpate	(45.5-50) 48.50	(50-62.5) 56.25	0.86	86	suboblate	M-L	(30-50) 46.87	(2-10) 6.87	-	-	-	-
Onagraceae	*Ludwigia repens*	Wart	tricolporate	(75-105) 96.66	(105-112.5) 108.33	0.89	89	Oblate spheroidal	L	(12.5-25) 21	(10-22.5) 17.5	(1.50-8) 6.50	-		(2.5-5) 3.43
Polygonaceae	*Persicaria salicifolia*	Reticulate	Pantopolyporate	(34-58) 42.85	-		100	spheroidal	M-L	-	-	-	(3-6.5) 5.54	-	(2-3) 2.76
	Polygonum aviculare	Punctuate	3- colporate	(19.5-25) 23.67	(18.5-23.65) 20.21	1.17	117	subprolate	S-M	(15.2-20.76) 17.23	(1-3.5) 2.42	(2.74-5.90) 4.78	(1-2.5) 1.85	-	(0.6-1.2) 0.98
	Rumex dentatus	Reticulate	Tetracolporate	(21-24.5) 23.12	(22.2-25.69) 24.32	0.95	95	Oblate spheroidal	S-M	(9.21-14.78) 12.65	(1-1.5) 1.12	(5.21-8.45) 6.89	(1.5-4.87) 3.23	(1.5-4.4) 3.32	(1-2) 1.75
Primulaceae	*Samolus valerandi*	Reticulate	3-colpate	(15-17.5) 15.83	(15-17.5) 16.25	0.97	97	subprolate	S	(9-14.5) 12.50	(2-4.5) 3.10	(3-7) 2.56	-	-	(0.62-0.62) 0.62
Rannunculaceae	*Ranunculus spherospermus*	Punctuate	3 -colpate	(22.5-27.5) 25	(20-30) 25.25	0.99	99	Oblate spheroidal	S - M	(12.5-17.5) 16.25	(3.75-5) 4.68	(2-3.75) 3.12	-	-	(1.25-5) 2.75
Scrophulariaceae	*Bacopa monniera*	Reticulate	3-colpate	(27.5-37.5) 28.68	(25-35) 29.37	0.97	97	Oblate spheroidal	M	(12.5-15) 14.16	(10-12.5) 11.66	(2- 4) 2.65	-	-	(1.25-2.5) 1.87
Solanaceae	*Solanum nigrum*	Psilate	3- colporate	(20-38.10) 27.13	(22-35) 28.18	0.96	96	Oblate spheroidal	M-S	(11-13.5) 12.26	(10-13) 11.61	(2-4) 3.16	-	-	(0.5-1.5) 1.25
Verbenaceae	*Phyla nodiflora*	Reticulate	3- colporate	(20- 27.5) 24.37	(27.5-32.5) 29	0.84	84	suboblate	M	(20-25) 22.5	(7.5-17.5) 13.33	(2-8.50) 6.50	(2-3) 2.75	(2.5-3) 2.5	(1.25-1.87) 1.56

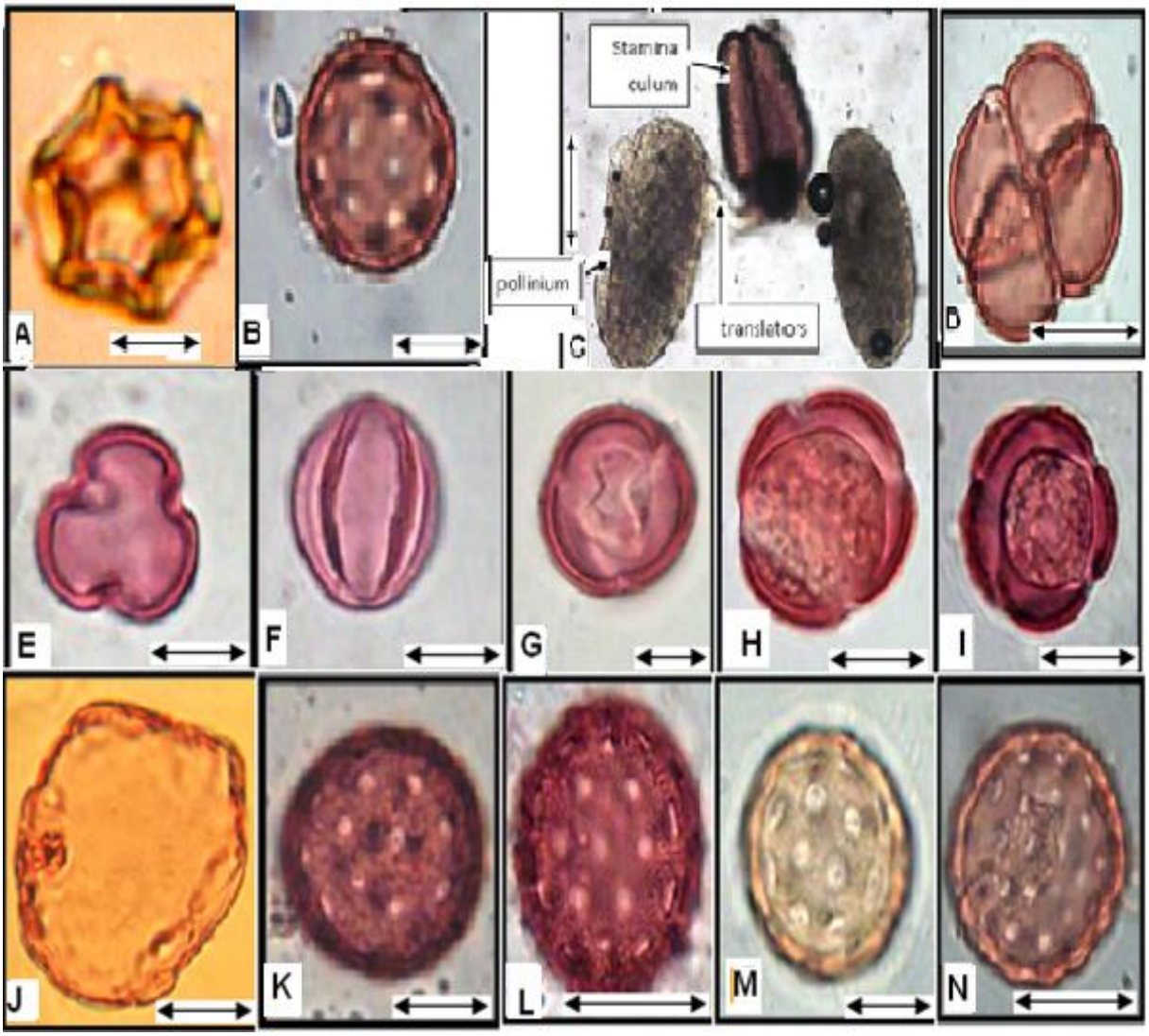
S=small , M = medium

Table (4) Some pollen morphological characters of *Tamarix* species.

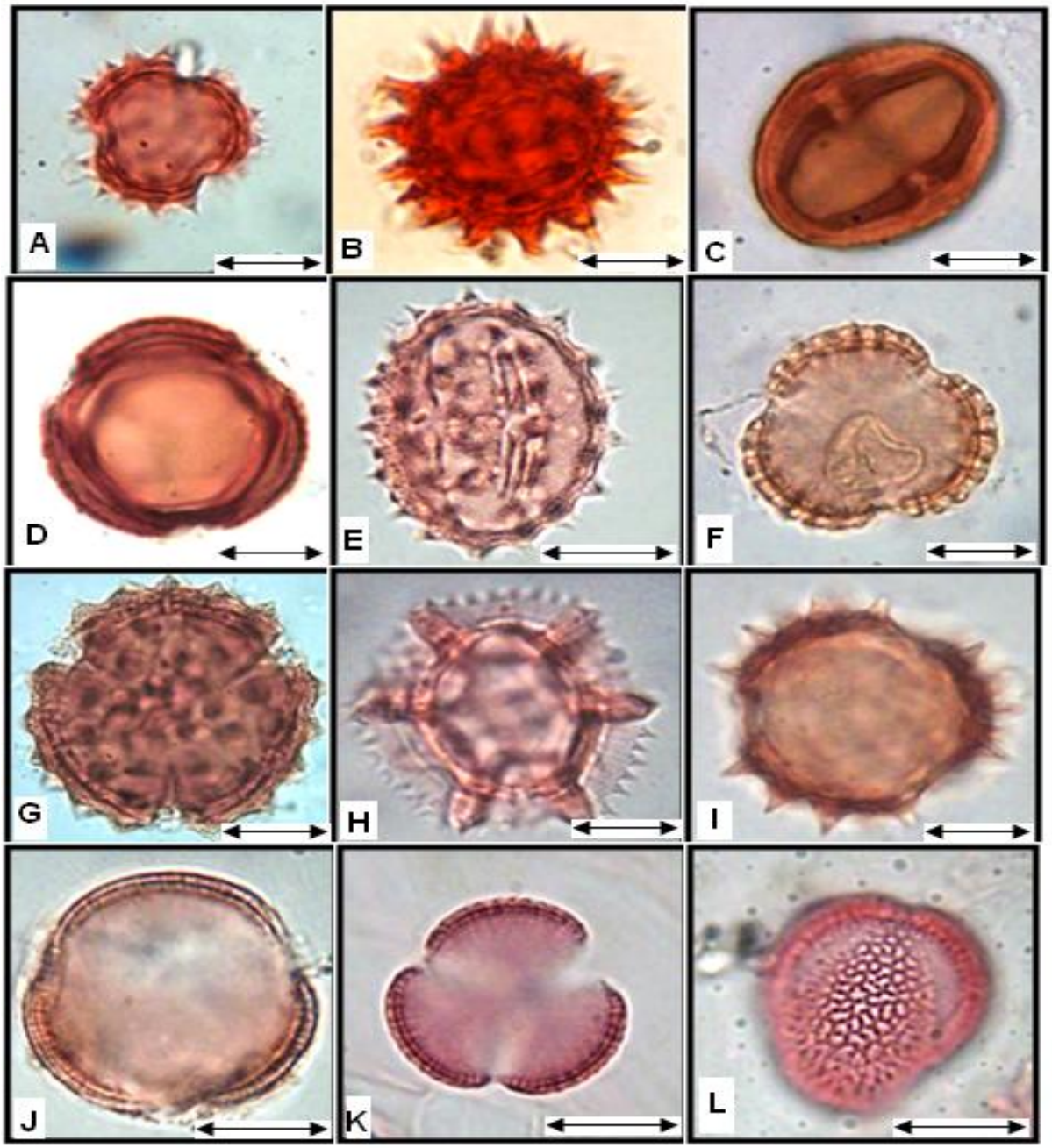
Species	Ornamen -tation	Type	Polar length of pollen in µm (P)	Equatorial dameter in µm (E)	P/E	P/E x100	Shape	Size	Colp diameter (µm)		Distance between colp	Pore diameter (µm)	Exine thickness (µm)
									length	width			
T. aphylla	reticulate	3-colpate	(12.5-17.5) 16.25	(12.5-17.5) 14.45	1.12	112	Prolate spheroidal	small	(10-12.5) 11.25	(5-7.5) 6.25	(2- 4.78) 3.45	(7.5-10) 9.12	(0.62-1.25) 0.93
T.aralensis	reticulate	3-colpate	(15-18.75) 17.5	(15-20) 18.12	0.96	96.57	Oblate spheroidal	small	(12.5-15) 13.75	(2.5-7.5) 5.13	(2.5-6) 5	(2.5-6) 4.80	(1.25-1.25) 1.25
T.arceuthoides	reticulate	3-colpate	(12.5-15) 14.58	(15-17.5) 16.66	0.87	87.51	suboblate	small	(7.5-10) 9	(1.25-2.5) 1.87	(3.75 -5) 4.58	(2.5-5) 3.75	(0.62- 1.25) 0.89
T.brachystachys	reticulate	3-colpate	(15-20) 18.14	(15-19.5) 18.33	0.98	98.96	Oblate spheroidal	small	(10-15) 13.33	(0.5- 2.5) 2.08	(6.25- 7.5) 7.08	(5-10) 7.5	(0.62-1.25) 0.93
T.ramosissima	reticulate	3-colpate	(12.5-17.5) 15	(12.5-17.5) 14.78	1.01	101	Prolate spheroidal	small	(10-12.5) 11.25	(5-7.5) 6.65	(2.5- 5) 3.75	(2.5-12.5) 5.83	(0.62- 1.25) 0.93

Table (5) types of pollen grains

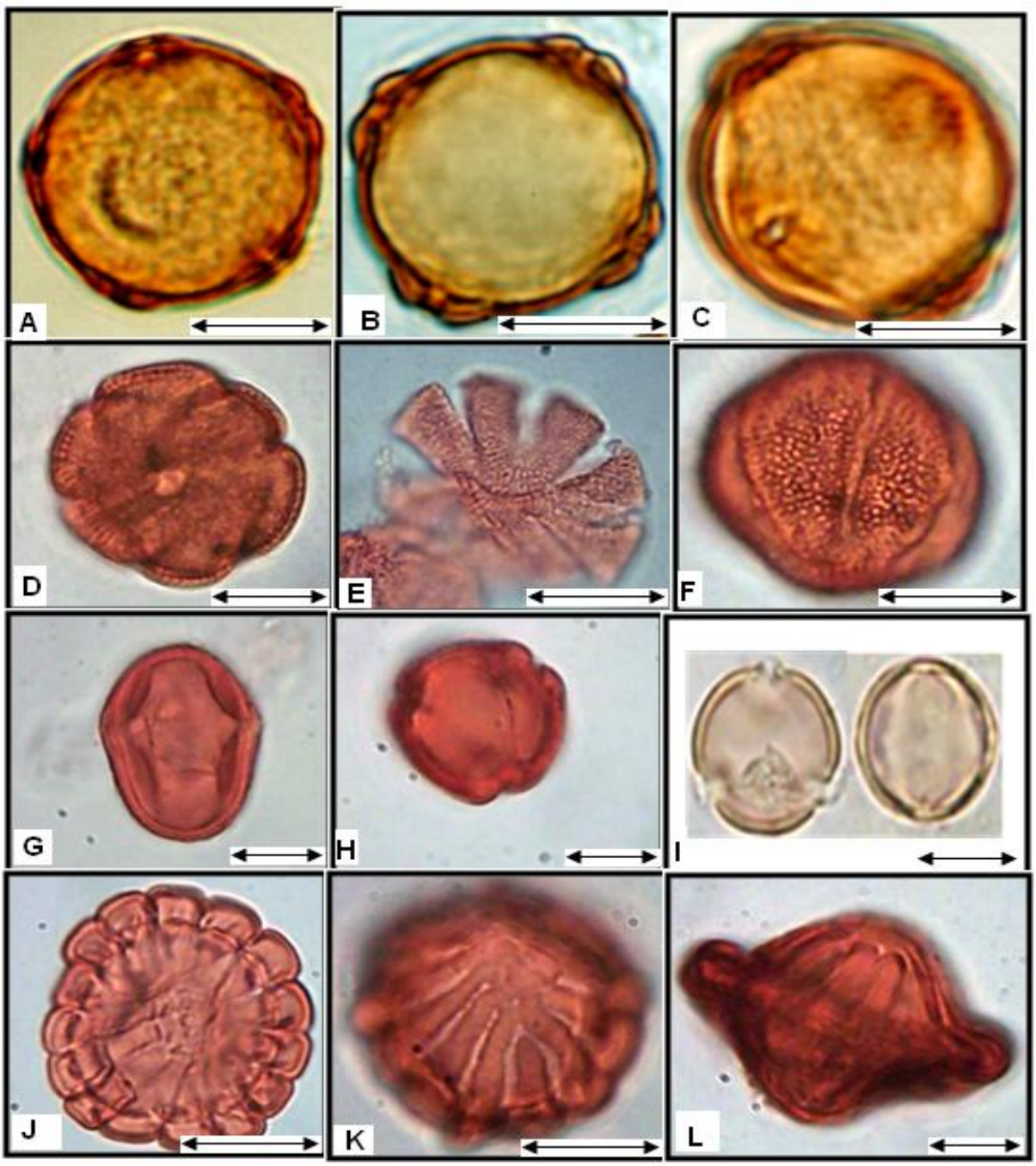
Type	Taxa
Monosulcate wart	*Nymphaea alba* (Nymphaceae)
monoaperturate (porate) psilate	*Ceratophyllum demersum*
tricolpate reticulate	species in family Tamarixaceae, *Cardaria draba* and *Sinapis arvensis* (Cruciferae), *Nymphoides peltata* (Menyanthaceae), *Bacopa monniera* and *Samalus valerandis*
tricolpate spinuliferous	*Nymphoidesindica*
tricolpate psilate	*Spergularia diandra* (Caryophyllaceae)
tricolpate punctate	*Trifolium resupinatum*. *Alhagi graecorum*, *Cressa cretica* and *Ranunculus sphaerospermus*
hexacolpate reticulate	*Lycopus europaeus*,
tricolporate spinuliferous	Compositae, and *Capparis spinosa*
tricolporate punctate	*Centurea* and *Polygonum aviculare*
Tricolporate reticulate	*Phylla nodiflorae* and *Sencio vernalis*
tricolporate warted	*Ludwgia repans*
tetracolporate reticulate	*Rumex dentatus*
tricolporate psilate	*Solanum nigrum*.
polypantoporate reticulate	*Persicaria salicifolia*.
pantoporate spinuleferous	Amaranthaceae and Chenopodiaceae.
pantoporate scabrate	*Suaeda*
polypantoporate spinuleferous	*Malva parviflora*,
polycolporoidate psilate	*Utricularia australis*
tetracolpate punctate	*Myriophyllum spicatum*.



Plate(1)Pollen grains A- *Alternanthera sissilis*(12 porate) B- *Amaramnthus graecizans* (pantoporate) C- *Cynanchum acutum* D- *Trachomitum venetum*
E-*Capparis spinos*a(3-colporate, polar view) F- *Capparis spinos* (Equatorial view) G-*Spergularia diandra*(3-colpate) H- *Spergularia diandra* (4-colpate) I-*Spergularia diandra* (5-colpate) J-*Ceratophyllum demersum* (monoaperturate) K- *Halocnemum strobilaceum* (pantoporate) L- *Suaeda vermiculata* M- *Salsola baryosma* N- *Salicornia herbacea* (scale bar = 10 µm)



Plate(2)Pollen grains A-B,D (3-colporate, polar view) A- *Aster tripolium* B- *Eclipta alba* C–*Centaurea solstitialis* (equatorial view) D- *Centaurea solstitialis* (3-colporate, polar view) E - *Senecio desfontainei* (equatorial view) F- *Senecio vernalis* (polar view) G- *Silybum marianum* (polar view) H- *Sonchus maritimus* I- *Pluchea tomentosa* (polar view) J- *Cressa cretica*(3-colpate, polar view) K- *Sinapis arvensis* (3- colpate , polar view) *L- Sinapis arvensis*(reticulate tectum) (scale bar = 10 µm)



Plate(3)Pollen grains A- *Myriophyllum spicatum(5-colpate)* B- *Myriophyllum spicatum*(4-colpate) C – *Myriophyllum spicatum* (equatorial view) D-E-*Lycopus europaeus* (6-colpate) F- *Lycopus europaeus* (reticulate tectum) G- *Trifolium resupinatum* (equatorial view) H- *Trifolium resupinatum* (polar view) I- *Alhagi graecorum*(polar and equatorial view) J-L- *Utricularia australis* (polycolporoidate) (scale bar = 10 µm).

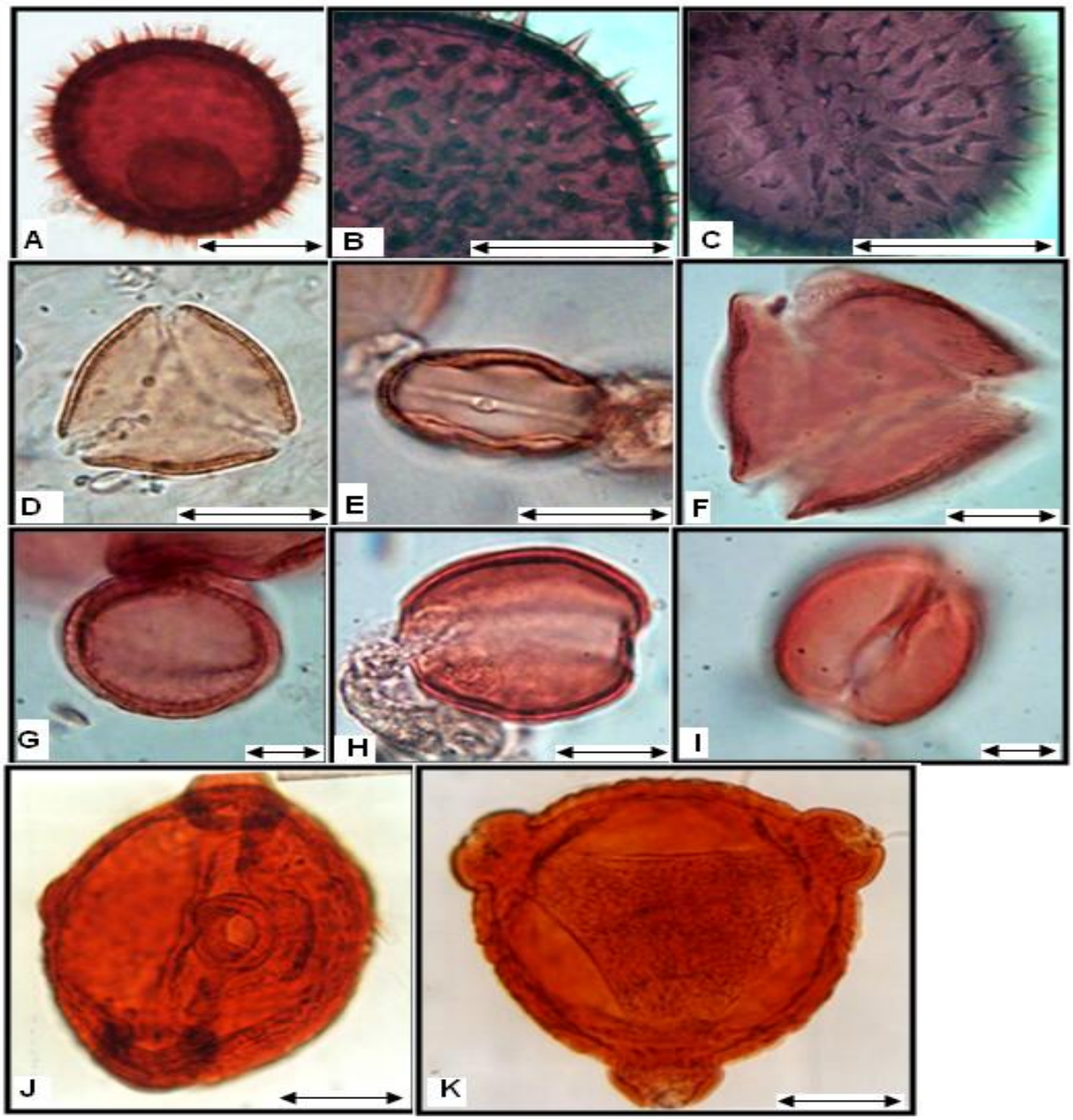


Plate (4) Pollen grains A-C- *Malva parviflora* (polypantoporate) D-E- *Nymphoides indica*, 3-colpate (D-polar view E- equatorial view) F- G-*Nymphoides peltata* (3-colpate, F-polar view, G- equatorial view) H-I-*Nymphaea alba* (monosulcate) J-*Ludwigia repens* (equatorial view) K- *Ludwigia repens*(tricolporate ,polar view) (scale bar = 10 µm).

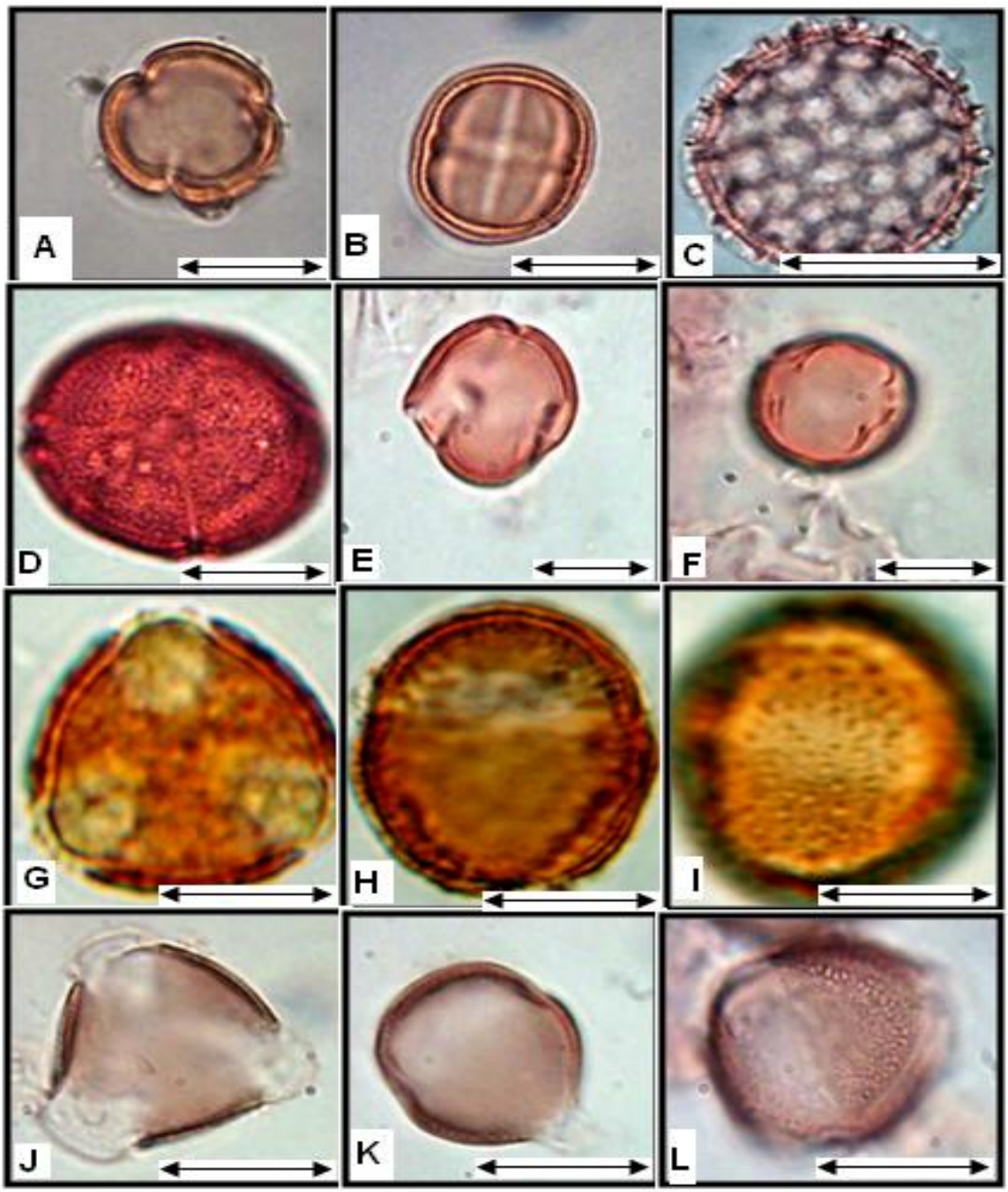


Plate (5) Pollen grains A-B- *polygonum aviculare*, 3-colporate (A-polar view B- equatorial view*)* C *–Persicaria salcifolia* (pantopolyporate) D- *Rumex dentatus* (tetracolporate :polar view) E-L- 3-colpate, E- *Samolus valerandi*(polar view) F- *Samolus valerandi* (equatorial view) G-I- *Ranunculus sphaerospermu* (G- polar view H- equatorial view I- ornamentation) J-L- *Bacopa manniera*(J- polar view K- equatorial view L- ornamentation) (scale bar = 10 µm).

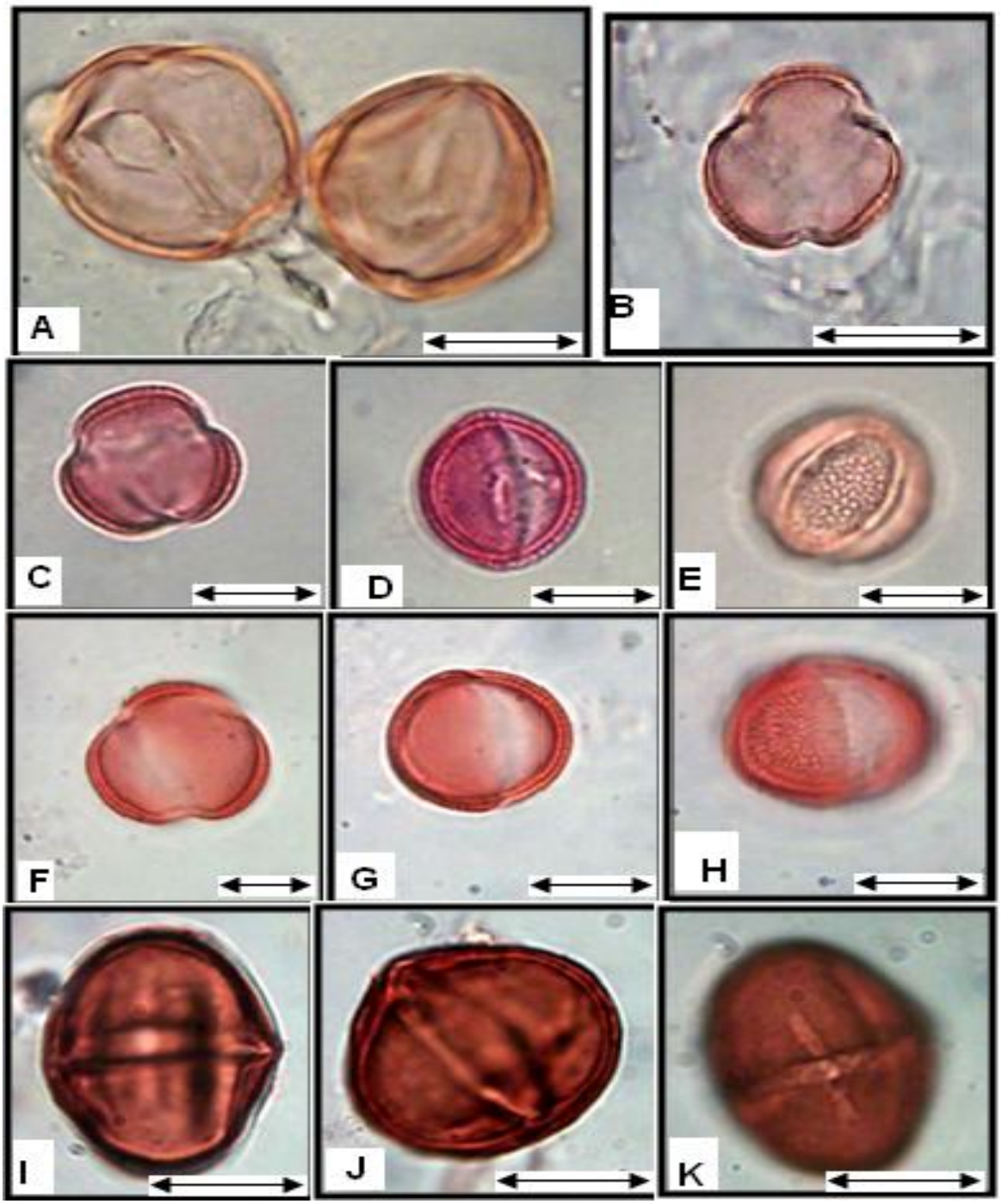


Plate (6) Pollen grains A-B- *Solanum nigrum* ,3-colporate (A- equatorial view B- polar view) C–E- *Tamarix aralensis* (C- 3-colpate, polar view D- equatorial view E- reticulate ornamentation) F-H- *Tamarix brachystachys* (F- polar view G- equatorial view) H- reticulate sculpture) I-K- *Phyla nodiflora* (3-colporate) (scale bar = 10 µm).

4-Discussion

Pollen grains are usually free, rarely united or tetrad, the shapes of pollen grains were sub-prolate in *Nymphaea* and *Nymphoides*, and oblate or oblate spheroidal in *Myriophyllum spicatum* and *Ranunculus spherospermus*.

Plants of wetlands showed clear differences in apertural types. On the basis of ornamentation and apertural types, nineteen distinct pollen types were recognized (table 5), type I : is monosulcate wart, this type includes *Nymphaea alba* (Nymphaceae).The pollen morphology of Nymphaeaceae was extremely distinct from the rest of the dicotyledonous families by the presence of monosulcate, heteropolar, bilateral symmetric grains, the shape subprolate (boat-shaped), and tectum warts (plate 4, table 3), these results agree with (Perveen,2000). Whereas (Erdtman, 1952) and Walker (1972) reported 2–3 sulcate grains in the *Nymphaea* genus. The presence of the most primitive types of pollen grain boat–shaped, monosulcate grains clearly indicates the primitive nature of order Nymphaeales (Magnoliidae) (Takhtajan, 1969; Sporne, 1972; Doyle *et al*. 1975). These primitive types of pollen were restricted to the subclass Magnoliidae and monocots. Pollen type 2: is characterized by its monoaperturate (porate) psilate pollen. Only a single species, *Ceratophyllum demersum* represents this type.

Pollen type 3: is readily delimited by having tricolpate reticulate; ten species were included in this pollen type, species in family Tamarixaceae, *Cardaria draba* and *Sinapis arvensis* (Cruciferae), *Nymphoides peltata* (Menyanthaceae), *Bacopa monniera* (Scrophulariaceae) and *Samalus valerandi* (Primulaceae). Pollen type 4: was readily delimited by having tricolpate spinuliferous, one species was included in this pollen type *Nymphoides indica*. While Pollen type 5: was easily recognized by having tricolpate psilate, including *Spergularia diandra* (Caryophyllaceae). Van Campo (1976) reported that an evolutionary trend from colpate to polycolpate was clearly seen in the genus *Spergularia* of Caryophyllaceae in which tri- pantocolpate pollen grains were found.

Pollen type 6: is characterized by its tricolpate punctate and includes *Trifolium resupinatum* and *Alhagi graecorum* (Leguminosae), *Cressa cretica* (Convolvulaceae) and *Ranunculus sphaerospermus* (Ranunculaceae). Many authors mentioned that Ranunculaceae have a more advanced type than monocolpate and nonaperturate pollen grains, as well as having three characteristics colpi, isopolar and three apertures. Perveen (2000) said that Ranunculidae are considered the first tricolpate–derived subclass, a basic type

from which other types have been derived (Walker, 1972, Walker and Doyle, 1975). In many taxa of Ranunculaceae pollen grain were same as of Centrospermous families like, Amaranthaceae, Caryophyllaceae and Chenopodiaceae (Nowicke & Skvarla 1979). However our study showed different pollen types.

Pollen type 7: is easily recognized by having hexacolpate reticulate, it includes one species *Lycopus europaeus*, this results agree with Moon and Hong (2003). Pollen type 8: is characterized by its tricolporate spinuliferous in some genera of Compositae, and genus *Capparis*. Two families Brassicaceae and Capparaceae placed in order Tamaricales, they have tricolpate pollen grains, therefore, the separation order Tiliales proposed by Hutchinson (1948) seems to be justified on palynological results. Takhtajan (1969) and Cronquist (1968) reported that Asteridae (including Asteraceae and Scrophulariaceae) was most advanced subclass; the data of pollen morphology also supports this idea. In Asteraceae pollen grains was tricolporate, with echinate tectum, in Scrophulariaceae usually tricolporate grains were also found.

Pollen type 9: is characterized by its tricolporate punctate in *Centaurea* and *Polygonum aviculare*. Pollen type 10: is recognized by having tricolporate reticulate, two species including in this type *Senecio vernalis* (Compositae) and *Phyla nodiflora* (Verbenaceae). Pollen type 11: is easily delimited by its tricolporate warted in *Ludwigia repens*, while pollen type 12: is characterized by its tetracolporate reticulate included one species *Rumex dentatus*. Pollen type 13: is characterized by its tricolporate psilate, one species including *Solanum nigrum*. Type 14: is characterized by its polypantoporate reticulate in *Persicaria salicifolia*. Polygonaceae were more specialized by having tricolporate and pantoporate pollen grains, in addition to simple (porate, colpate) grains, the tectum also varied from reticulate to punctate types. Our data agree with (Perveen, 2000), in spite of the Polygonaceae is a eurypalynous family, but palynological data do not agree with Takhtajan (1969) who suggested that the Polygonaceae is probably derived from the same stock as the Caryophyllales

Pollen type 15: is characterized by its pantoporate spinuleferous Amaranthaceae and Chenopodiaceae. Pollen type 16: is characterized by its pantoporate scabrate in *Suaeda*. In Chenopodiaceae and Amaranthaceae most taxa have pantoporate grains, number of pores 22–50, both often have spinulose tectum. Amaranthaceae and Chenopodiaceae have long been considered closely related families by having small inflorescence, reductive flower, 2–3 carpelled, unilocular ovary and also show

some distinct pollen morphological characters by having many apertures (pantoporate) (Preveen, 2000).

Pollen type 17: is characterized by its polypantoporate spinuleferous in *Malva parviflora*, the present study showed that the family Malvaceae is more advanced than the other families above, because of having echinate and polypantoporate pollen grains which agree with (Preveen, 2000).

Pollen type 18: is characterized by its polycolporoidate psilate in *Utricularia australis*. While Pollen type 19: is characterized by its tetracolpate punctate in *Myriophyllum spicatum*. From the pollen types mentioned above,it is clear that the pollen morphology can help in some cases, to solve systematic problems such as the cases in polygonaceae , where the pantoporate pollen type support separation of *Polygonum persicaria* from *Polygonum*(a colporate type) to a distinct genus *Persecaria*. The same cases showed in the genus *Spergularia* in Caryophyllaceae. In other cases pollen grain features may be of very little taxonomic importance such as the case in the pollen types of Tamaricaceae and Cruciferae which are often tricolpate reticulate.

The evolutionary trends in the pollen grains of the aquatic and wetland plants of Southern Iraq may be suggested as follow: Monosulcate may gives rise to two branches the 1st gives rise to monoporate then to polyporate and the 2nd gives rise to tricolpate then tricolporate and polycolporate.

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دراسة مظهرية لحبوب اللقاح في نباتات الاراضي الرطبة في الجزء الجنوبي من العراق

سحر عبد العباس مالك و عبد الرضا اكبر علوان المياح

قسم علوم الحياة / كلية العلوم / جامعة البصرة

الخلاصة

درست حبوب اللقاح لنباتات ذوات الفلقتين والمتواجدة في الاراضي الرطبة وشملت تسعة وأربعين نوعا" تعود الى خمسة وعشرين عائلة . تبين من النتائج ان هناك تغايرا" واضحا" في شكل وحجم وفتحات حبوب اللقاح بين الانواع المدروسة وعلى اساس نوع الفتحات والزخرفة أمكن تمييز تسعة عشر طرازا" من حبوب اللقاح، فقد تميز الطراز المتعدد الثقوب pantoporate في العائلتين الرمرامية chenopodiaceae وعائلة عرف الديك Amaranthaceae. كما تباينت اعداد الاخاديد في الانواع المدروسة ، فبدت أنها تحتوي على ثلاثة أخاديد في الجنس *Bacopa* في حين احتوت على 4–5 أخاديد في النوع *Myriophyllum spicatum* وقد احتوت بعض الانواع على ثقوب وأخاديد كما في انواع العائلة المركبة ، اما الزخارف فقد تباينت بين الزخرفة الملساء في حامول الماء *Utricularia australis* الى شوكية في بعض انواع العائلة المركبة .