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Full Length Research Paper

Palyonological studies of the semi-desert plant species from Pakistan

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The detailed palynological description of 40 angiospermic plant species, belonging to 22 families and 38 genera were made. Out of the 22 families, 3 families were monocotyledonous and 19 dicotyledonous. The Brassicaceae and Papilionaceae were the largest families regarding number of species having four species each. In all the species except Poaceae, the pollen types were tricolporate. In case of *Calendula arvensis* L., *Salvia aegyptica*, *Melia azedarrach* tetracolporate pollens were observed, in *Carum copticum* (L.) Bth, the pollens were bicolpate; in *Cynoglosum lanceolatum* Forssk., it was fenestrate while in *Bougainvillea glabra* Choisy., it was periporate. Thus, the present study was fruitful as it avoids the difficulties faced by taxonomists and plant scientists in correlating and differentiating plant species.

Key words: Palynology, semi-desert plant species, Pakistan.

INTRODUCTION

To the naked eye, pollen grains of the flowering plants appear simply as yellow powdery substance. However, under light microscope and scanning electron microscope, each pollen grain generally exhibits a varying sculpturing pattern on its outer wall (exine) surface. This variability of sculpturing pattern helps in identification of plant species, thus exhibiting the beautiful art work of nature. Like other disciplines, pollen grains have an important part in modern issue of plant taxonomy (Bashir and Khan, 2003). Palynology also helps in solving taxonomic problems concerned with hybrid plants. Pollen grains have various sculpturing on its outer resistant coat (exine) like spines, spores, grooves, reticulates, e.t.c. and such variations provide a means of identifying a pollen grain of particular taxa. Palynological characters are useful in solving complicated problems of inter-relationship between various taxa and assessment of their status in the classification, particularly with reference to the families, sub-families, tribes, genera, species and sub-species. With the help of characters like pollen size, shape, surface structures and internal detail, identification of pollen source to the appropriate botanical taxonomic level can be made.

Analysis of honey from the market does not contain a balanced amount of pollen which a natural honey must have in order to be an effective medicine (Zahur et al., 1978). The potential uses of pollen are steadily growing (Noor et al., 2004). Weber (1998) reported a systematic approach to categorize pollen types that enable the reader to recognize pollen characteristics of the most common botanical source and determine the relevant contributors top the aeroallergen burden. Erdman (1952) divided *Papaveraceae* into three subfamilies that is, *Fumaroidseae*, *Papaveroideae* and *Hypecoideae.* According to him, all these subfamilies are quite heterogeneous palynologically, especially *Fumaroideae*. Palynology also supports its exclusion from *Papaveraceae.* Gambel (1933) divided the family *Convolvulaceae* into two groups on the basis of spinulose and non-spinolose pollen, with further division on the basis of apertural types.

The present study dealt with the pollen morphology of sub-tropical region of Pakistan, which is located at 32.00 - 32.30° North latitude and 70.05 - 70.40° East longitude, with an altitude of 320.04 m from sea level (Anonymous, 1998). The aim of the study is to use palynological characters as aid for the differentiation and identification of closely related and problematic taxa.

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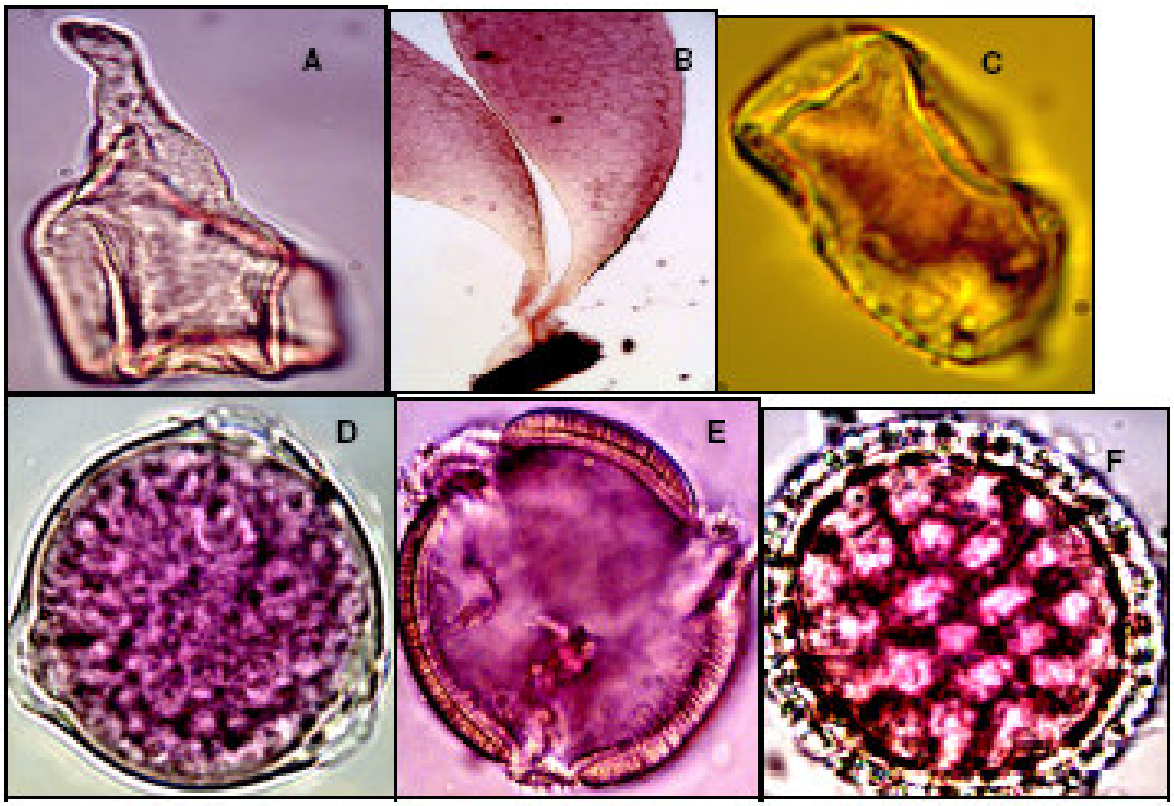

Plate 1. Micro photographs of pollen. A: Polar view of *Cyperus defformis* (100X) B: Pollinia of *Calotropis procera* (40X), C: Equatorial view of *Lathyrus aphaca* (100X), D: Polar view of *Vicia faba* (100X), E: Polar view of *Convolvulus arvensis* (100X), F: Polar view of *Tribulus terristris* (100X).

MATERIALS AND METHODS

Fresh polleniferous materials were used for pollen studies (Ronald 2000). Anthers were dissected from flower under binocular light and treated with acetic acid. Pollens were stained with glycerine jelly (Ahmad et al., 2008; Erdtman, 1952) and studied under light microscope (Model: MX5200H, MEIJI, Japan). Microphotographs were taken by using CCD digital camera (Model: DK 5000) fitted on Leica light Microscope (model: DM 1000). These micrographs were useful for identification and differentiation of pollen on the basis of microscopic features (Plates 1 and 2).

RESULTS AND DISCUSION

In this study the detailed palynological description of 40 angiospermic plant species, belonging to 22 families and 38 genera were made. The overall view of the palynological study with the largest polar diameter (40.87 µm) was observed in *Tribulus terristris* L. and the smallest (11.9 µm) in *Carum copticum* (L.) Bth. In all the species except the members of family Poaceae, the pollen types were tricolpate but in *Calendula arvensis* L. (Plate 2), *Salvia aegyptica* and *Melia azedarach*, tetracolpate pollen were also observed. In *Chenopodium album* L., *Chenopodium murale* L. and *T. terristris* L., the pollens were pentaporate; in *Cynoglosum lanceolatum* Forssk., it was fenestrate; in *Bougainvillea glabra* Choisy., it was periporate and in *C. copticum* (L.) Bth., the pollens were bicolporate.

In the family of Poaceae, the pollens were of same types, sculpturing and polar view that is monoporate, psilate and circular, respectively, which are the characteristic of Poaceae. The average polar diameter was 23.15 µm; the largest, 23.75 µm was in *Polypogan monspeliensis* (L.) Desf., (Plate 2, F) and the smallest, 22.1 µm was in *Cynodon dactylon* (L.) Pers. The average equatorial diameter was 19.06 µm; largest, 22.3 µm in *Ochthochloa compressa* (Forssk.) Hilu and smallest, 16.8 µm in *C. dactylon* (L.) Pers. The shape in equatorial view was irregular in *O. compressa* (Forssk.) Hilu, *Poa annua* L. and spheroidal to prolate in *C. dactylon* (L.) Pers. It was variable that is, from spheroidal-prolate to perprolate-cup shaped in *P. monspeliensis* (L.) Desf., (Plate 2, E). The P\E ratio and exine thickness was 1.311 and 0.5 µm in *C. dactylon* (L.) Pers.; 1.033 and 1.3 µm in *O. compressa* (Forssk.) Hilu; 1.388 and 1.25 µm in *P. annua* L. and 1.187 and 1 µm in *P. monspeliensis*(L.) Desf., respectively. The average percentage fertility of the family species was 88.88, the highest was 90.90 in *P.*

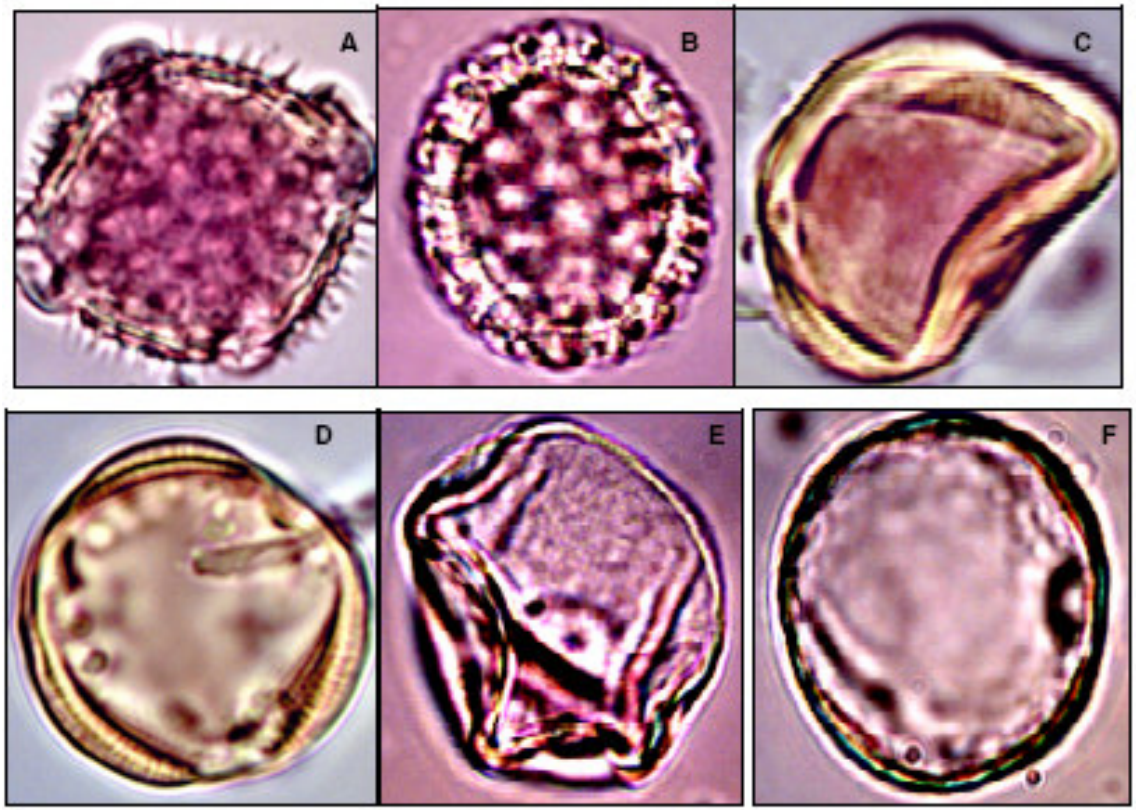

Plate 2. Micro photographs of pollen. A: Polar view of *Calendula arvensis* (100X), B: Polar view of *Bougainvillea glabra* (40X), C and D: Equatorial and Polar view of *Vaccaryia pyramedica* (100X), E and F: Equatorial and Polar view of *Polypogan monspeliensis* (100X).

monspeliensis (L.) Desf. and lowest was 85.106 in *P. annua* L. According to Zahur et al. (1978), in Poaceae of monocot the pollen grains are usually monoporate, annulate, spherical, psilate with wall layers about 1 µm thick.

The Palynology of family Papilionaceae was: The average polar diameter was 24.9 µm; largest, 30.7 µm in *Vicia faba* L., (Plate 1, D) and smallest, 9.8 µm in *Lathyrus aphaca* L. The average equatorial diameter was 20.5 µm; largest, 26.09 µm in *Trifolium alexandrianum* L. and smallest, 17.6 µm in *Melilotus indica* (L.) All. The P\E ratio and exine thickness were 1.299 and 1.2 µm in *L. aphaca* L.; 0.952 and 1.25 µm in *M. indica* (L.) All; 1.478 and 1.2 µm in *T. alexandrianum* L. and 1.178 and 1.25 µm in *V. faba*, respectively. The shape in polar and equatorial view of *L. aphaca* L., was problate and oblate-spheroidal to spheroidal- sub prolate in *M. indica*(L.) All; semi-angular and spheroidal- subprolate to prolate in *T. alexandrianum* L.; circular and nearly spheroidal to rectangular and cup shaped in *V. faba* L.; it was circular (Plate 1, D), cup shaped and perprolate, respectively. The colpi length and width was 2.4 and 2.4 µm in *L. aphaca* L.; 2.85 and 3.55 µm in *M. indica*(L.) All; 2.4 and 4.06 µm in *T. alexandrianum* L. and 3.5 and 3.5 µm in *V. faba* L., respectively. The pollen type tricolpate was common in all. The pollen morphology of 157 species, representing 37 genera, of the subfamily Papilionoideae from Pakistan have been examined by Perveen and Qaiser (1997), using light and scanning electron microscopy. According to them, Papilionoideae is a eurypalynous subfamily. The pollen grains are generally free, radially symmetrical, isopolar, mostly tricolporate, rarely colpate or porate. The shape is commonly prolate to sub-prolate, or prolate-spherodial, less commonly to oblate-spheroidal or sub-oblate and often perprolate. The ora is commonly la-longate or circular, rarely lolongate. Colpal membrane is psilate to sub-psilate or granulated often scabrate. The sexine is thicker than or as thick as the nexine. A reticulate tectum type is the most common. However, other tectum types that is, rugulate, foveolate, striate and areolate tectum, are also found in a considerable number of taxa. The delimitation of genera on the basis of pollen characteristics is difficult. However, shape, apertural types and eine ornamentation were found to be more significant pollen characters.

The pollen detail of family Brassicaceae was: On the basis of shape in polar view they are of two types that is

Table 1. Qualitative analysis of pollen morphology.

S/No	Taxa	Shape in polar view	Shape in equatorial view	Type	Sculpturing
1	*Carum copticum* (L.) Bth,.	Near to tubular	Rectangular	Mostly bicolpate, rarely Tricolpate	Psilate
2	*Calendula arvensis* L.	Square to Rectangular	-	Tri-tetracolpate	Echinate
3	*Cynoglosum lanceolatum* Forssk.	Nearly polyhedral	Spheroidal to prolate	Fenestrate	Psilate
4	*Brassica campestris* L.	Circular to semi-angular to inter semi-angular	Irregular	Tricolpate	Psilate
5	*Lepidium apitalum* Willd.	Circular	Prolate to perprolate	Tricolpate	Psilate
6	*Raphanus sativus* L.	Circular	Spheroidal	Tricolpate	Psilate
7	*Sisymbrium irio* L.	Circular	Prolate to perprolate to apple shaped	Tricolpate	Psilate
8	*Cleome brachycarpa* Vahl ex Dc.	Semi-angular	Mostly spheroidal to perprolate to apple shaped also	Tricolpate	Psilate
9	*Spergularia arvensis* L.	Semi-angular	Prolate to spheroidal to nearly rectangular	Tricolpate	Psilate
10	*Vaccaryia pyramedica* Medik.	Circular	Prolate	Tricolpate	Psilate
11	*Chenopodium album* L.	Circular	Irregular but mostly near to crescent shaped	Pentaporate	Psilate
12	*Chenopodium murale* L.	Circular	Prolate to apple-shaped to oblate-spheroidal	Pentaporate	Psilate
13	*Convolvulus arvensis* L.	Circular	Spheroidal to subprolate to prolate	Tricolpate	Psilate
14	*Cyperus defformis* L.Amoen.	-	Irregular	-	Psilate
15	*Euphorbia helioscopia* L.	Circular	Subprolate to prolate to perprolate	Tricolpate	Psilate
16	*Salvia aegyptica* L.	Circular	Spheroidal to some apple shaped also	Tri to tetracolpate	Psilate
17	*Allium cepa* L.	Irregular	Irregular	Tricolpate	Psilate
18	*Asphodelus tenuifolius* Carvan.	-	Spheroidal to problate to prolate to perprolate	-	Psilate

(1) Circular in *Lepidium apitalum* Willd., *Raphanus sativus* L. and *Sisymbrium irio* L. and (2) Circular to semi-circular and inter semi-circular in *Brassica campestris* L., while each has separate shape in equatorial view that is irregular in *B. campestris* L.; prolate to perprolate in *L. apitalum* Willd.; spheroidal in *R. sativus* L. and prolate to perprolate, apple shaped in *S. irio* L. According to Rehana (2005), pollen type of *S. irio* L., was 3- colpate. P\E ratio: 22 - 33: 19 - 25 µm; size: small to medium. Aperture: colpate and syncopalte; colpi variation in length

Table 1. Contd.

S/No	Taxa	Shape in polar view	Shape in equatorial view	Type	Sculpturing
19	*Melia azedarrach* L.	Circular (tri) Rectangular (tetra)	Irregular	Tri to tetracolpate	Psilate
20	*Bougainvillea glabra* Choisy.	Circular	Prolate to perprolate	Periporate	Gammete
21	*Argyrolobium rosium*	Circular	Oblate-Spheroidal to Spheroidal to Sub prolate	Tricolpate	Psilate
22	*Lathyrus aphaca* L.	Problate	Irregular	Tricolpate	Psilate
23	*Melilotus indica* (L.) All	Semi-angular	Spheroidal to subprolate to prolate	Tricolpate	Psilate
24	*Trifolium alexandrianum* L.	Circular	Nearly spheroidal to rectangular and cup shaped	Tricolpate	Psilate
25	*Vicia faba* L.	Circular	Cup shaped to perprolate	Tricolpate	Psilate
26	*Plantago major* L.	Circular	Variable that is, having no specific shape	Tricolpate	Psilate
27	*Plantago ovata* Forssk.	Circular	Variable that is, having no specific shape	Tricolpate	Psilate
28	*Cynodon dactylon* (L.) Pers,.	Circular	Spheroidal to prolate	Monoporate	Psilate
29	*Ochthochloa compressa* (Forssk.) Hilu	Circular	Irregular	Monoporate	Psilate
30	*Poa annua* L.	Circular	Irregular	Monoporate	Psilate
31	*Polypogan monspeliensis* (L.) Desf.	Circular	Variable that is, spheroidal to prolate to perprolate to cup shaped	Monoporate	Psilate
32	*Polygonum plebijum* R. Br., Prodr	Circular	Near to prolate	Tricolpate	Psilate
33	*Rumex vesicarius* L.	Circular	Spheroidal	Tricolpate	Psilate
34	*Salix acmophylla* Boiss., Diagn.	Circular	Prolate to perprolate	Tricolpate	Psilate
35	*Datura stramonium* L.	Circular	Nearly rectangular to prolate to perprolate	Tricolpate	Psilate

was very long to very short, broad in the middle and acute in the end. Exine: Sexine was much thicker then nexine, more or less as thick as nexine. Outline: it was isopolar, Inter-subangular, slightly circular. Measurement: its polar axis was 22- 36 µm; equatorial diameter, 20 - 31 µm; exine, 1.1 - 4 µm; calpi range from 16.5 x 1.1 - 27.5 x 3.3 µm long; mesocolpiun, 16.5 - 22.0 µm in diameter; apocolpia, 3.3 - 5.5 µm in diameter. The average polar diameter was 17.7 µm; highest, 19.6 µm in *L. apitalum* Willd. and lowest, 15 µm in *B. campestris* L. According to the findings of Perveen and Qaiser (2004), the pollen grain of *Brassica rapa* var, *campestris* L., has P\E ratio of

Table 1. Contd.

S/No	Taxa	Shape in polar view	Shape in equatorial view	Type	Sculpturing
36	*Lycopersicon esculentum* Miller, Gard. Dict.	Semi-angular	Subulate to subprolate	Tricolpate	Psilate
37	*Solanum surratense* Brum.	Semi-angular to inter semi-angular	Prolate to perprolate to apple shaped	Tricolpate	Psilate
38	*Fagonia indica* Brum.	Circular	Spheroidal to prolate to apple shaped	Tricolpate	Psilate
39	*Peganum harmalla* L.	Circular to semi-circular	Much irregular	Tricolpate	Psilate
40	*Tribulus terristris* L.	Circular	-	Pentaporate	Echinate

Table 2. Quantitative analysis of pollen morphology.

S/No	Taxa	Polar diameter (µm)	Equatorial diameter (µm)	P\E Ratio	Exine thickness (µm)	Colpi length (µm)	Colpi width (µm)
1	*Carum copticum* (L.) Bth,.	11.94 (10 - 12.5)	10.87 (10 - 12.5)	1.09	1.25	3 (2.5 - 5)	2.7 (2.5 - 5)
2	*Calendula arvensis* L.	29.7 (27.5 - 32.5)	31 (30 - 32)	0.98	2.5 (1.2 - 5)	5.3 (2.5 - 7.5)	3.9 (2.5 - 5)
3	*Cynoglosum lanceolatum* Forssk.	23.25 (20 - 25)	21 (18.75 - 25)	1.10	1.25	2.5	2.5
4	*Brassica campestris* L.	15 (11.2 - 16.25)	14.37 (10 - 17.5)	1.043	1.25	2.5	2.5
5	*Lepidium apitalum* Willd.	19.62 (17.5 - 22.5)	15 (12.5 - 17.5)	1.308	1.2	3 (2.5 - 5)	2.5
6	*Raphanus sativus* L.	17.87 (15 - 20)	20.37 (17.5 - 22.5)	0.88	0.6 (1.3 - 2.5)	3 (2 - 5)	2.75 (2 - 5)
7	*Sisymbrium irio* L.	18.6 (15 - 20)	16.25 (15 - 17.5)	1.14	1.25	2.5	2.5
8	*Cleome brachycarpa* Vahl ex Dc.	23.125 (22.5 - 23.7)	23.12 (17.5 - 25)	1	2.03 (1.25 - 2.25)	3.12 (2.5 - 5)	2.5
9	*Spergularia arvensis* L.	21.52 (17.5 - 25)	20.31 (15 - 25)	1.06	1.25	2.5	3.4 (2.5 - 5)
10	*Vaccaryia pyramedica* Medik.	23.33 (20 - 27.5)	20.2 (17.5 - 25)	1.15	1.2	2.5	2.5
11	*Chenopodium album* L.	14.12 (12.5 - 17.5)	10.87 (10 - 12.5)	1.3	1.2	-	-

1.17; polar length in µm was 24.0(27.0) 30.0; equatorial diameter in µm was 18.0 (23.0) and 26.0 and exine thickness in µm was 4.4. The average equatorial diameter was 16.62 µm; largest (20.37 µm), was that of *R. sativus* L and smallest (14.3 µm), was that of *B. campestris*. The P\E ratio and exine thickness was 1.043 and 1.25 µm in *B. campestris* L.; 1.308 and 1.2 µm in *L. apitalum* Willd.; 0.877 and 0.6 µm in *R. sativus* L. and 1.144 and 1.25 µm in *S. irio* L., respectively. The colpi length and width was 2.5 µm in *B. campestris* L.; 3 and 2.5 µm in *L. apitalum* Willd.; 3 and 2.75 µm in *R. sativus* and 3.12 and 2.5 µm in *S. irio* L., respectively. The ave-

Table 2. Contd.

S/No	Taxa	Polar diameter (µm)	Equatorial diameter (µm)	P\E Ratio	Exine thickness (µm)	Colpi length (µm)	Colpi Width (µm)
12	*Chenopodium murale* L.	14.12 (12.5 - 17.5)	17 (15 - 21.25)	0.83	0.5 (0.2 - 1.2)	-	-
13	*Convolvulus arvensis* L.	52.5 (45 - 50)	46 (30 - 50)	1.14	3.375	3.5 (2.5 - 5)	6.2 (2.5 - 10)
14	*Cyperus defformis* L. Amoen.	-	24.25 (22.5 - 30)	-	1.25	-	-
15	*Euphorbia helioscopia* L.	25.6 (17.5 - 30)	26.25 (20 - 30)	0.97	2.43 (2 - 2.5)	9.58 (3.75 - 10)	5.2 (3.7 - 7.5)
16	*Salvia aegyptica* L.	23.92 (20 - 27.5)	24.37 (20 - 25)	0.98	1.6 (1.2 - 2.5)	3.34 (2.5 - 5)	2.78 (2.5 - 5)
17	*Allium cepa* L.	18.25 (17.5 - 20)	21	0.87	1.25	2.5	2.5
18	*Asphodelus tenuifolius* Carvan.	-	39.5 (30 - 50)	-	1.41 (1 - 2.25)	-	-
19	*Melia azedarrach* L.	34.5 (32.5 - 40)	28.2 (20 - 36)	1.22	1.8 (1.2 - 2.5)	3.12 (2.5 - 5)	3.12 (2.5 - 5)
20	*Bougainvillea glabra* Choisy.	25 .5 (22.5 - 28.7)	14.4 (10 - 17.5)	1.77	2.5 (p) 1.2 (E)	-	-
21	*Argyrolobium rosium* (Camb.) Jaub.	16.67 (15 - 17.5)	16.12 (13.75 - 17.5)	1.03	1.25	2.7 (2.5 - 3.7)	2.8 (2.5 - 3.7)
22	*Lathyrus aphaca L.*	23 (17.5 - 25)	17.7 (15 - 22.5)	1.29	1.2	2.4	2.4
23	*Melilotus indica (L.) All*	19.87 (17.5 - 21.25)	20.87 (20 - 22.5)	0.95	1.25	2.85 (2.5 - 5)	3.55 (2.5 - 5)
24	*Trifolium alexandrianum L.*	26.12 (20 - 28)	17.67 (15 - 20)	1.47	1.2	2.4	4.06 (2.4 - 5)
25	*Vicia faba L.*	30.75 (28.75 - 35)	26.09 (22.5 - 30)	1.17	1.25	3.5 (2.5 - 5)	3.5 (2.4 - 5)
26	*Plantago major L.*	24.25 (20 - 27.5)	18.25 (17.5 - 22.5)	1.32	1.25	2.5	2.5
27	*Plantago ovata Forssk.*	24.2 (20 - 27)	18.2 (17.5 - 22)	1.32	1.2	2.5	2.5
28	*Cynodon dactylon (L.) Pers,.*	22.12 (20 - 25)	16.87 (16.25 - 17.5)	1.31	0.5	-	-
29	*Ochthochloa compressa (Forssk.) Hilu*	23.125 (18.75 - 27.5)	22.37 (15 - 31.25)	1.03	1.3	-	-
30	*Poa annua L.*	23.6 (21.2 - 25)	17 (15 - 21.25)	1.38	1.25	-	-
31	*Polypogan monspeliensis (L.) Desf.*	23.75 (22.5 - 25)	20 (15 - 25)	1.18	.91 (0.5 - 1.5)	2	2
32	*Polygonum plebijum R.Br., Prodr*	12	12 (10 - 12.5)	1	1.5 (1.2 - 2.5)	-	-

rage percentage fertility of the species of Brassicaceae was 91.05; highest was 98.03 in *S. irio* L and lowest, 85.71 in *L. apitalum* Willd. Javied and Naqshi (1975) utilized pollen data in the classification of family Brassicaceae. Chiguriaeva (1973) examined the pollen morphology of the family Brassicaceae in relation to taxo-

Table 2. Contd.

S/No	Taxa	Polar diameter (µm)	Equatorial diameter (µm)	P\E Ratio	Exine thickness (µm)	Colpi length (µm)	Colpi Width (µm)
33	*Rumex vesicarius* L.	23.125 (20 - 25)	21 (18.75 - 25)	1.10	1.25	2.54	2.54
34	*Salix acmophylla* Boiss., Diagn.	17. 37 (15 - 20)	12.87 (10 - 15)	1.34	1.2	2.4	2.4
35	*Datura stramonium* L.	51 (47.5 - 60)	29.75 (25 - 40)	1.71	2.5	5	5
36	*Lycopersicon esculentum* Miller, Gard. Dict.	19.12 (17.5 - 20)	14.5 (12.5 - 17.5)	1.31	1.25	2.5	3.125 (2.5 - 5)
37	*Solanum surratense* Brum.	18. 34 (17.5 - 22.5)	17.62 (15 - 20)	1.04	1.1 (0.2 - 1.2)	4 (2.5 - 5)	2.5
38	*Fagonia indica* Brum.	26. 2 (25 - 27.5)	24.12 (22.5 - 32.5)	1.08	1.25	2.5	2.5
39	*Peganum harmalla* L.	17. 5 (15 - 20)	12. 42 (10 - 15)	1.40	1.25	2.5	2.5
40	*Tribulus terristris* L.	40.87 (37.5 - 45)	-	-	3.6 (21.5 - 5)	-	-

nomy. Pollen morphology of 77 species belonging to 36 genera of the family Brassicaceae from Pakistan has been examined by Perveen and Qaiser (2004). According to them the pollen grains are usually radially symmetrical, isopolar, sub-prolate to prolate or prolate-spheroidal and rarely oblate-spheroidal to tricolpate and rarely 4 - 8 colpate.

The family Zygophyllaceae has such detail: The *Peganum harmalla* L., has circular to semi-circular shape and 17.5 µm diameter in polar view while in equatorial view its shape was much irregular; its diameter was 12.4 µm and exine thickness was 12.42 µm (10 - 15 µm). According to the findings of Perveen et al. (2006), the *P. harmalla* L., has rugulate-reticulate tectum. The *T. terristris* L., was only found in polar view with diameter much larger that was 40.87 µm (37.5 - 45 µm) with exine thickness of 2.15 µm; it has periporate pollen type and echinate sculpturing (Plate 1, F). According to the findings of Perveen et al. (2006), the *T. terristris* L., has a prolate Oblate-spheroidal shape, 32.3 (35.9 ± 0.71) 34.5 lengths in µm, 1.52 µm Pore diameter and 6.82 (7.14 ± 0.06) 7.18 exine thickness in µm. The *Fagonia indica* Burm. had both the polar and equatorial views with diameter of 26.2 and 24.12 µm, respectively. Its P\E ratio was 1.086 and exine thickness was 1.25 µm; shape in equatorial view was spheroidal-prolate to apple shaped; colpi length and width was 2.5 µm. The shape in polar view was circular and psilate sculpturing in *F. indica* Burm. According to Perveen et al. (2006), the *F. indica* had a prolate shape; 21.0 (24.2 ± 0.50) 26.6 polar axis in µm; 15.4 (17.85 ± 0.66) 22.4 equatorial diameter in µm and 1.26 (1.38 ± 0.02) 1.4 exine thickness in µm. The average percentage fertility of Zygophyllaceae was 90.67; the highest (99) in *P. harmalla* L. and lowest, (80.48) in *F. indica* Burm. Yunus and Nair (1988) examined pollen morphology of 3 genera of the family Zygophyllaceae from India. Pollen morphology of 14 species representing 5 genera of the family Zygophyllaceae from Pakistan was examined by Perveen and Qaiser (2006). According to them, Zygophyllaceae is a very heterogeneous family. Pollen grains are usually radially symmetrical, or apolar 3-polycolporate-pentoporate, prolate-spheroidal to sub-prolate or prolate and rarely oblate-spheroidal. Pollen grains are pantaporate in *T. terristris* L. and Tectum regulate-reticulate in *P. harmalla* L.; pollen grains are prolate in *F. indica* Burm.

The family Chenopodiaceae and Plantaginaceae both have one genus with 2 species. The detail of the 2 species *C. album* L. and *C. murale* L., were: Both have the same polar shapes and diameters that is circular and 14.12 µm respectively and same pollen types- periporate and psilate sculpturing. *C. album* L., has irregular but mostly near to crescent shaped pollens in equatorial view while *C. murale* L., has prolate-apple-shaped to oblate-spheroidal shapes. According to the findings of Pinar and Inceoglu (1998), the *C. murale* L. pollen grains had radial symmetrical, isopolar, pentoporate, spheroidal. The equatorial diameter, P\E ratio and exine thickness in both *C. album* and *C. murale* were 10.87 and 17 µm; 1.298 and 0.830; 1.2 and 0.5 µm, respectively. Pollen grains of 12 species of the genus Chenopodium L. (Chenopodiaceae), of which morphological separation is problemati-

tical, have been examined in detail by Pinar and Inceoglu (1998). According to them, pollen grains of Chenopodium L. species examined were radially symmetrical, isopolar, pantaporate and spheroidal. Their exine structure was similar. In the genus, five pollen types have been defined, mainly on the basis of pollen size. *C. murale* L. and *C. album* L. both have just the same characters except in diameter.

The two species *Plantago major* L. and *Plantago ovata* Forssk.had the following characteristics: Both were same in polar and equatorial diameter that is 24.2 and 18.2 µm respectively. Exine thickness was 1.25 µm; polar shapes, circular; equatorial shapes were variable that is having no specific shapes; pollen type, tricolpate, psilate sculpturing; colpi length and width, 2.5 µm and were common in both. Their P\E ratio was 1.328 and 1.329, respectively. According to the findings of Perveen and Qaiser (2004), the *P. major* L., pollen grains were spheroidal, having 25.5 (26.7) - 27.5 diameter in µm. Number of pores was 82.25 (2.14) - 2.75 pore diameter in µm and 1.25 (1.91) - 2.5 exine thickness in µm and the *P. ovata* Forssk. had 19.8 (22.6) - 23.1 diameter in µm. Number of pores pantoporate was 0.7 (0.85) - 1.65 pore diameter in µm and 0.66 exine thickness in µm. Pollen morphology of 14 *Plantago* species of the family Plantaginaceae from Pakistan has been examined by Perveen and Qaiser (2004). According to them Plantaginaceae is a stenopalynous family. Pollen grains are generally free, radially symmetrical, apolar, prolate. The shape of the pollen grains was spheroidal; sexine is thicker or thinner than nexine; tectum is aerolate or scabrate. The pollen morphology of the family Plantaginaceae is significantly helpful at specific level. Pollens of all the 14 species, belonging to a single genus that is *Plantago* are remarkably uniform in their pollen characters. However, species of *Plantago* showed little variation in their tectun type. Tectum was aerolate in *P. major* L. and was scabrate in *P. ovata* Forssk. (Perveen and Qaiser, 2004).

Thus the present findings proved that the Palynology is one of the basic characters in delimiting closely related and problematic taxa.

REFRENCES

Perveen A Aftab R (2006). A palynological study of some cultivated trees from Karachi. Pak. J. Bot., 38(1): 15-28.

Ahmad M, Khan MA, Hussan A, Zafar M, Sultana S (2008). Chemotaxonomic standardization of herbal drugs: Milkthistle and Globe thistle. Asian Journal of Chemistry Vol. 20 (6): 1443-1453.

Ahmad M, Zafar M, Khan MA, Sultana S (2008). Transesterificaiton of cotton oil to biodiesel. Asian J. Chem. India.

Anonymous (1998). District censes report of Tank, Population censes department Islamabad.

Bashir S, Khan (2003). Pollen morphology as an aid to identification of medicinal plants, Hamdard Medicus, XIVI: 7-10.

Chiguriaeva AA (1973). Pollen morphology of Cruciferae in pollen and spore morphology of recent plant (in Russian). *Pora-3rd* Int. Palynology Conf. Acad. Sci. USSR. 93-98: 3 pl.

Erdtman G (1952). Pollen Morphology and plant taxonomy. Angiosperms. Almqvist and Wiksell, Stockholm.

Erdtman G (1952). Pollen Morphology and plant taxonomy. Angiosperms. Chronica botanica co., Waltham, Massachuselts.

Gambel JS (1933). Flora of the presidency of Madras V. pp. 769-962.

Javeid GM, Naqshi AR (1976). Pollen grains as an aid to taxonomy of Brassicaceae. Int. Symp. Physiology of sexual reproduction in flowering plants. Department of Botany, Punjab Agricultural University Abstract A-6.

Noor MJ, Ahmad M, Asgher R, Kamal A, Pervaiz S (2004). Palynological studies of cultivated species at University of Arid Agriculture, Rawalpindi, Pakistan. A. J. P. S. 3(4): 467- 479.

Perveen A, Mohammad Qaiser (1997). Pollen Flora of Pakistan - VIII Leguminosae (Subfamily: Papilionoideae). Tr. J. Bot. 22 (1998) 73-91 © TÜBITAK.

Perveen A, Qaiser M (2006). Pollen flora of Pakistan -XLIX. Plantaginaceae, Pak. J. Bot. 36(1): 19-24.

Perveen A, Qaiser M (2006). Pollen flora of Pakistan -XXXVIII. Zygophyllaceae, Pak. J. Bot. 38(2): 225-232.

Perveen A, Qaiser M, Rehana khan (2004). Pollen Flora of Pakistran-XLII. Brassicaceae. Pak. J. Bot. 36(4): 683-700.

Pinar NM, Inceoglu O (1998) Pollen Morphology of Turkish *Chenopodiun* L. *(Chenopodiaceae)*, Tr. J. Bot. 23(1999) 179-186 TUB|TAK.

Yunus D, Nair PKK (1988). Pollen morphology of Indian Geraniales. V. XV-XVI.1-22. Today and omorrow's Printer. Publishers. New Dehli.

Weber RW (1998). Pollen identification. Ann-allery-Asthma-Immunol. 80(2): 141-147.

Zahur MS, Bhutta AA, Ashraf M (1978). (A) Palynological studies of the plants growing in Punjab. (B) Seasonal variation in the frequency of airborne pollen and spores which causes allergies and asthma special reference to Central Punjab. Final Research Report. Pak. Sci. Foundation.